SECTION 7 ELECTRICAL SYSTEM

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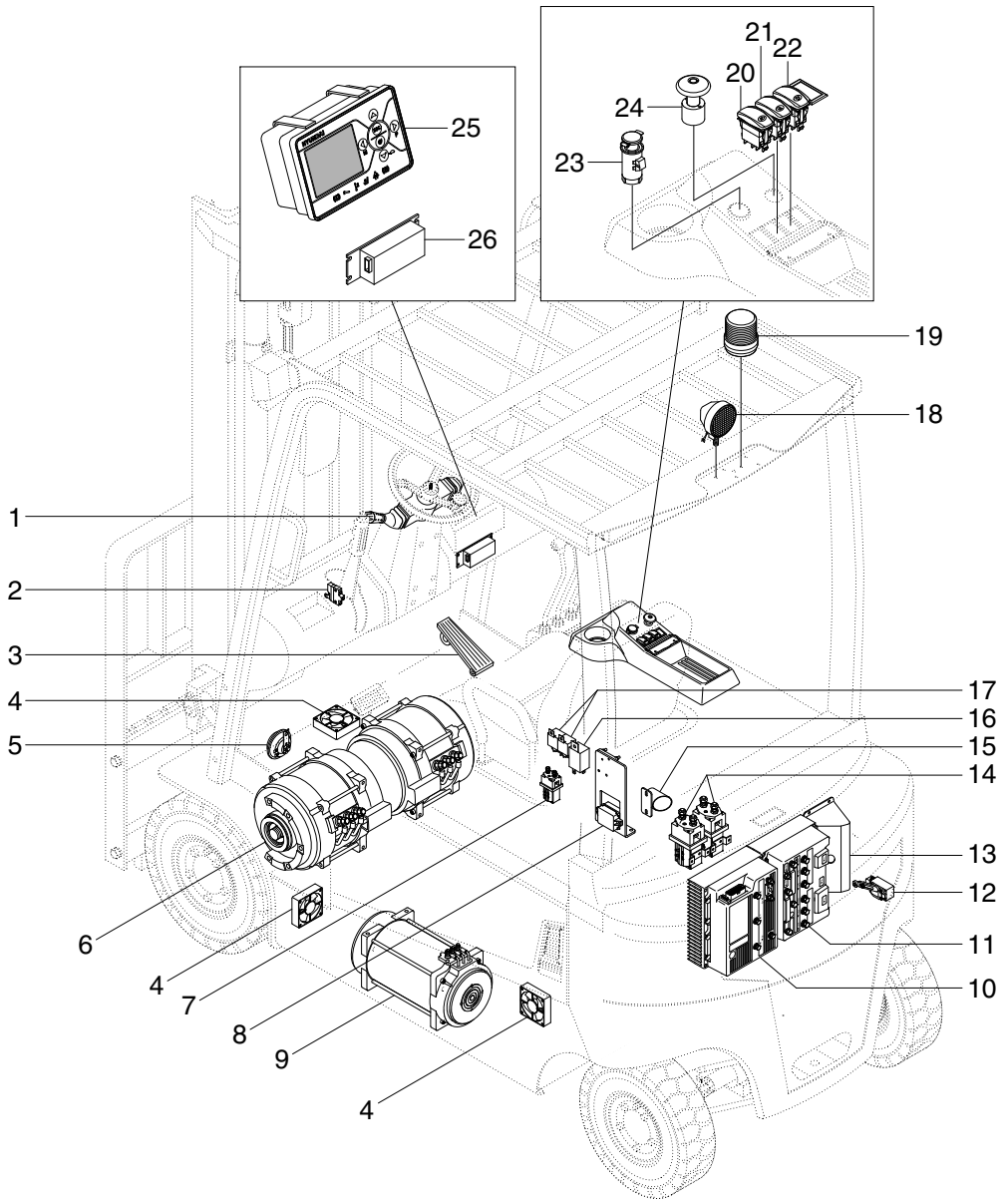
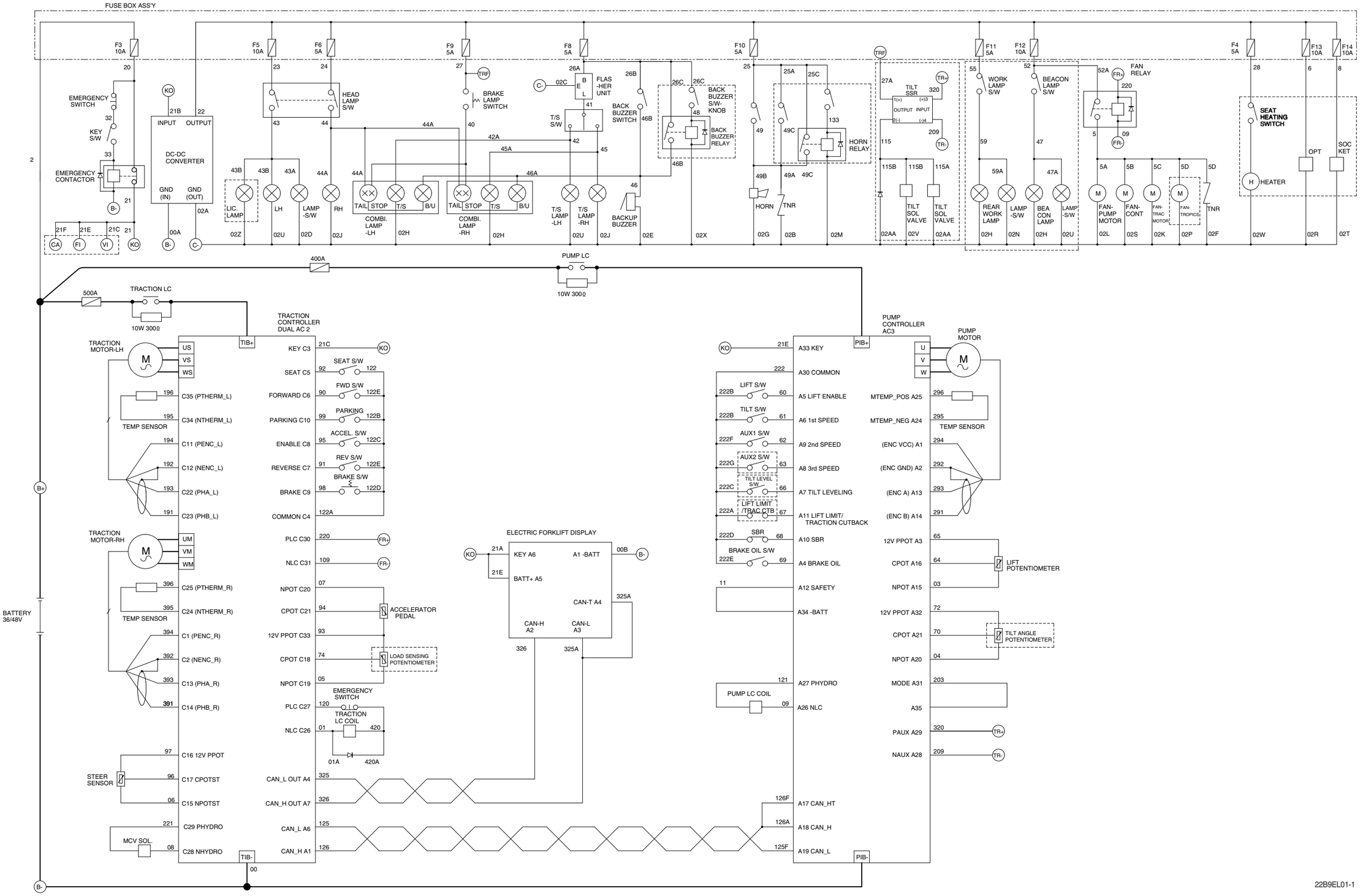
GROUP 1 COMPONENT LOCATION



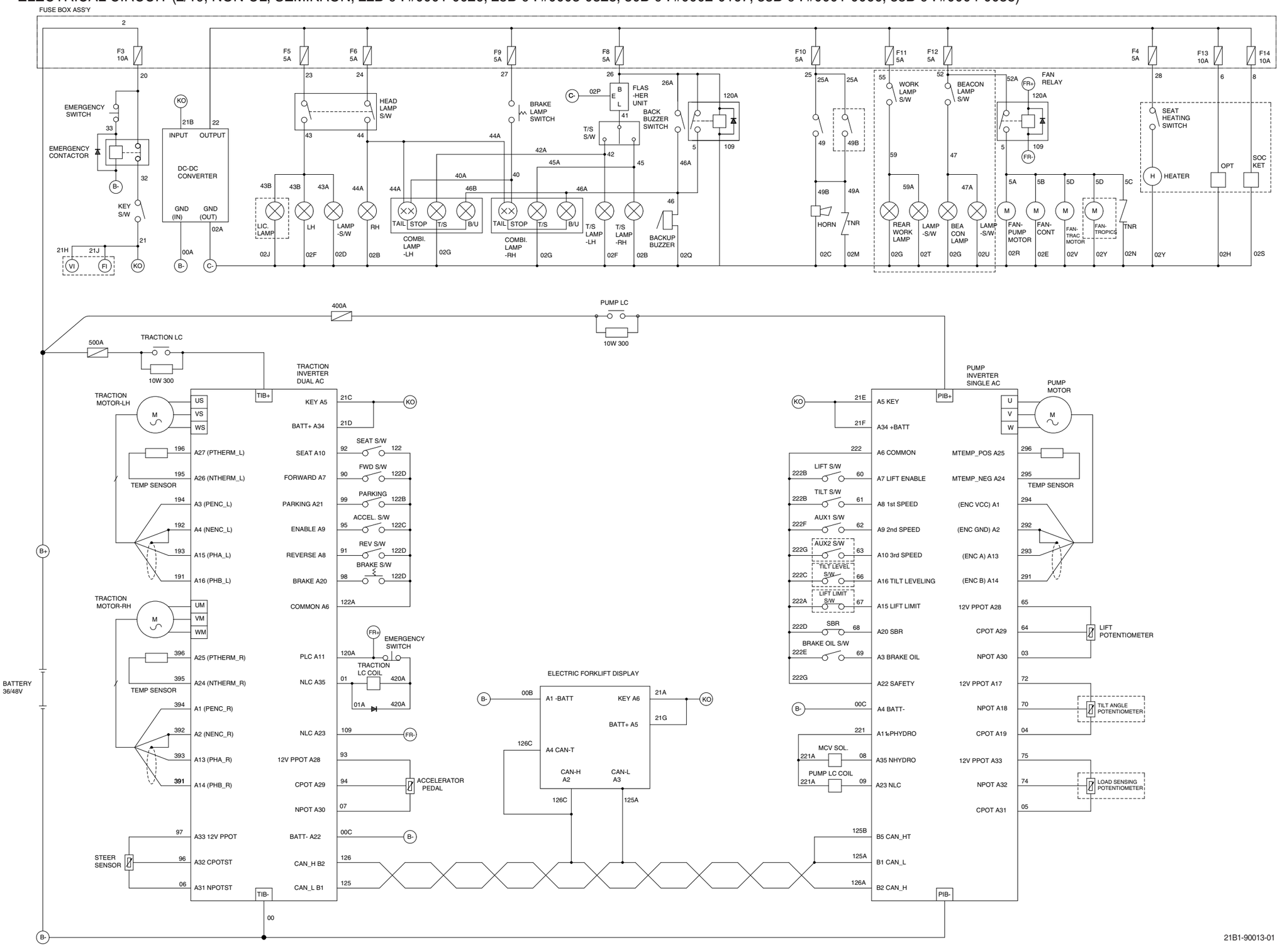
22B9EL02

1	Combination switch	10	Pump controller	19	Beacon lamp switch (opt)
2	Parking micro switch	11	Traction controller	20	Head lamp switch (opt)
3	Accelerator assy	12	SBR switch assy	21	Working lamp switch (opt)
4	Fan assy	13	Fan assy	22	Beacon switch (opt)
5	High horn	14	Contactor	23	Socket assy
6	Drive motor	15	Back up alarm	24	Emergency switch assy
7	E/M contactor	16	Flasher unit assy	25	Display
8	Fuse box assy	17	Relay	26	DC-DC converter
9	Pump motor	18	Working lamp (opt)		

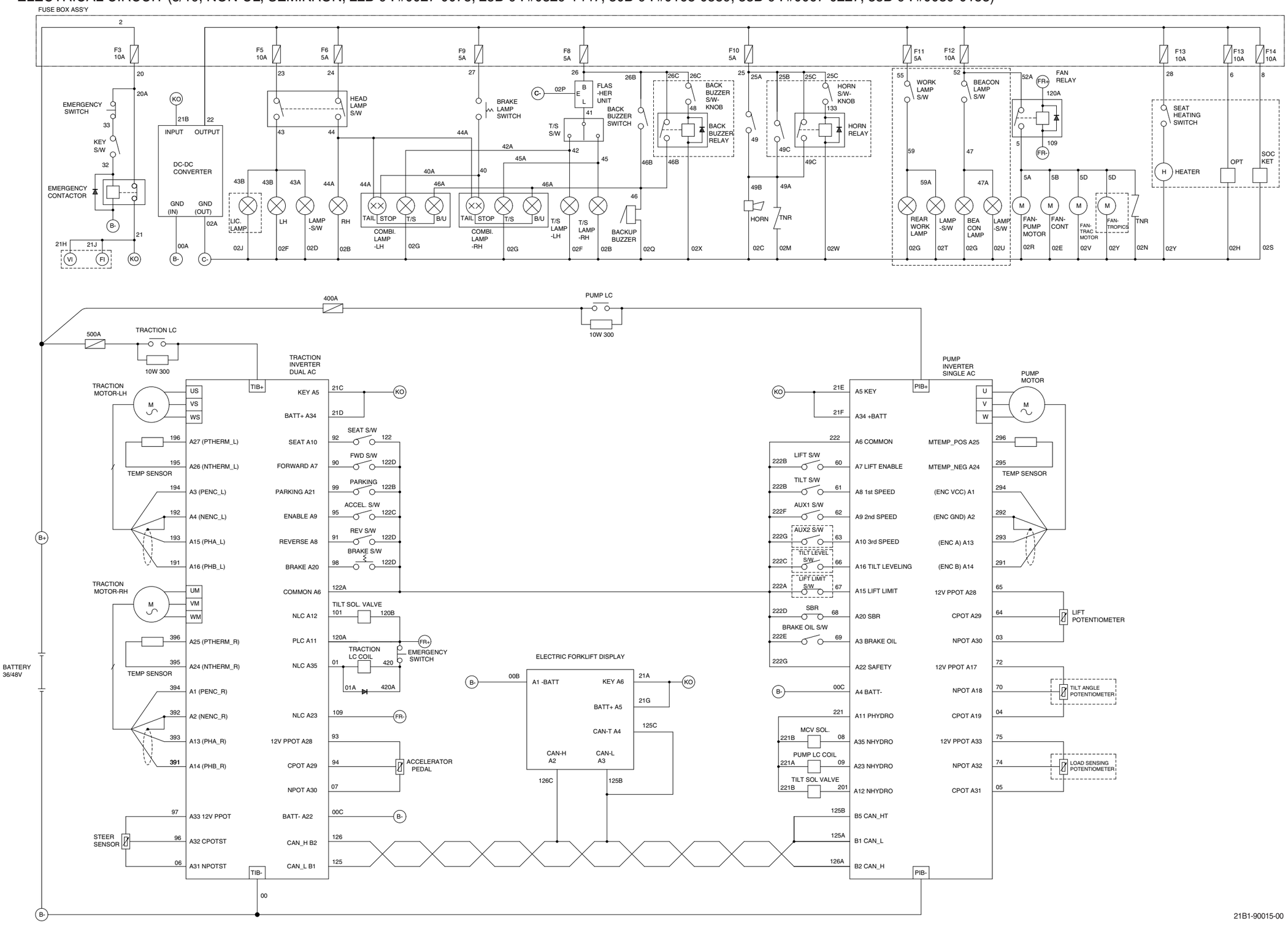
· ELECTRICAL CIRCUIT (1/19, NON-UL, SEMIKRON, 25B-9 : -#0002, 30B-9 : -#0001, 35B-9 : -#0003)



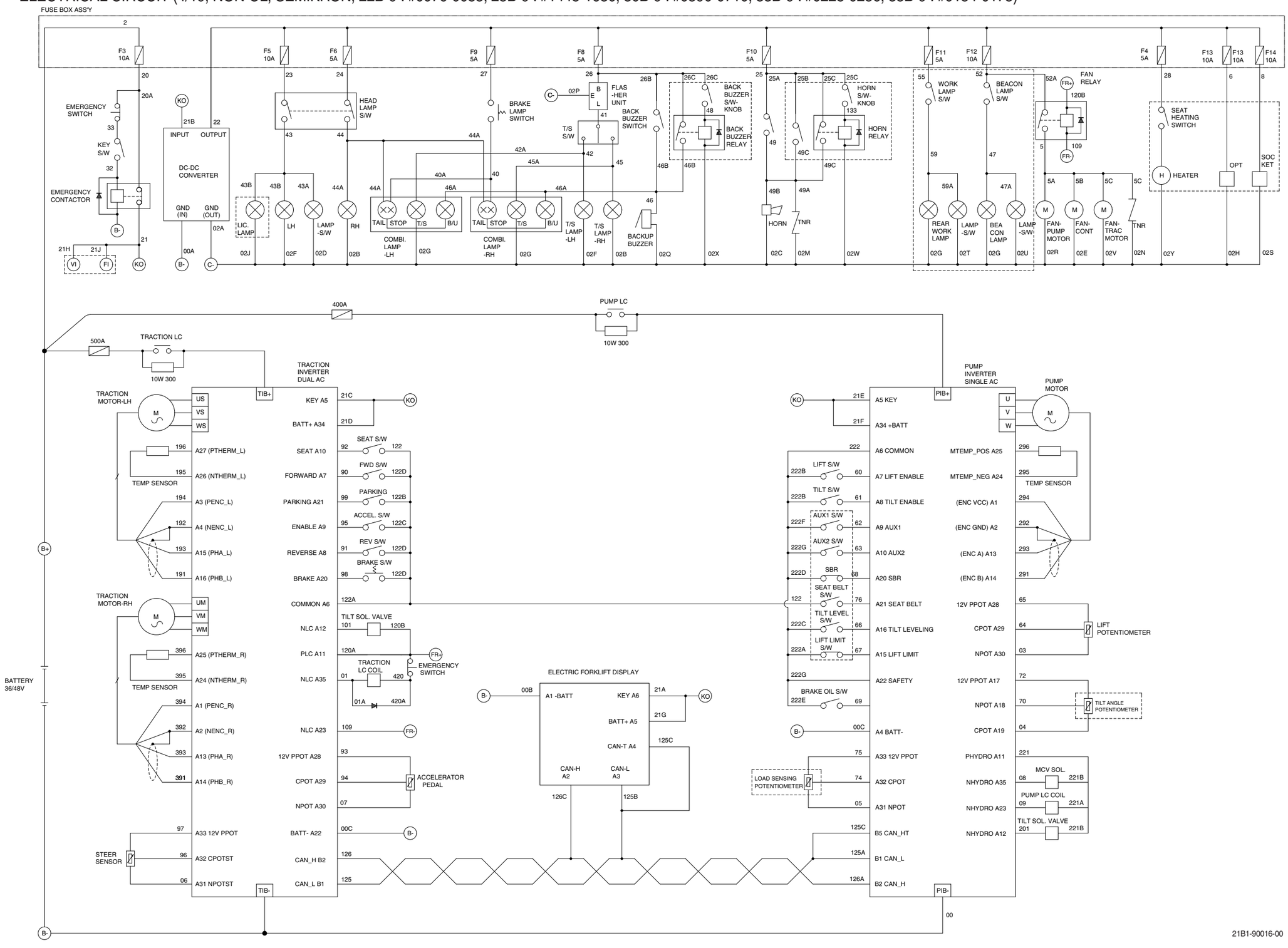
· ELECTRICAL CIRCUIT (2/19, NON-UL, SEMIKRON, 22B-9 : #0001-0026, 25B-9 : #0003-0328, 30B-9 : #0002-0167, 33B-9 : #0001-0066, 35B-9 : #0004-0038)



· ELECTRICAL CIRCUIT (3/19, NON-UL, SEMIKRON, 22B-9 : #0027-0075, 25B-9 : #0329-1447, 30B-9 : #0168-0589, 33B-9 : #0067-0227, 35B-9 : #0039-0153)

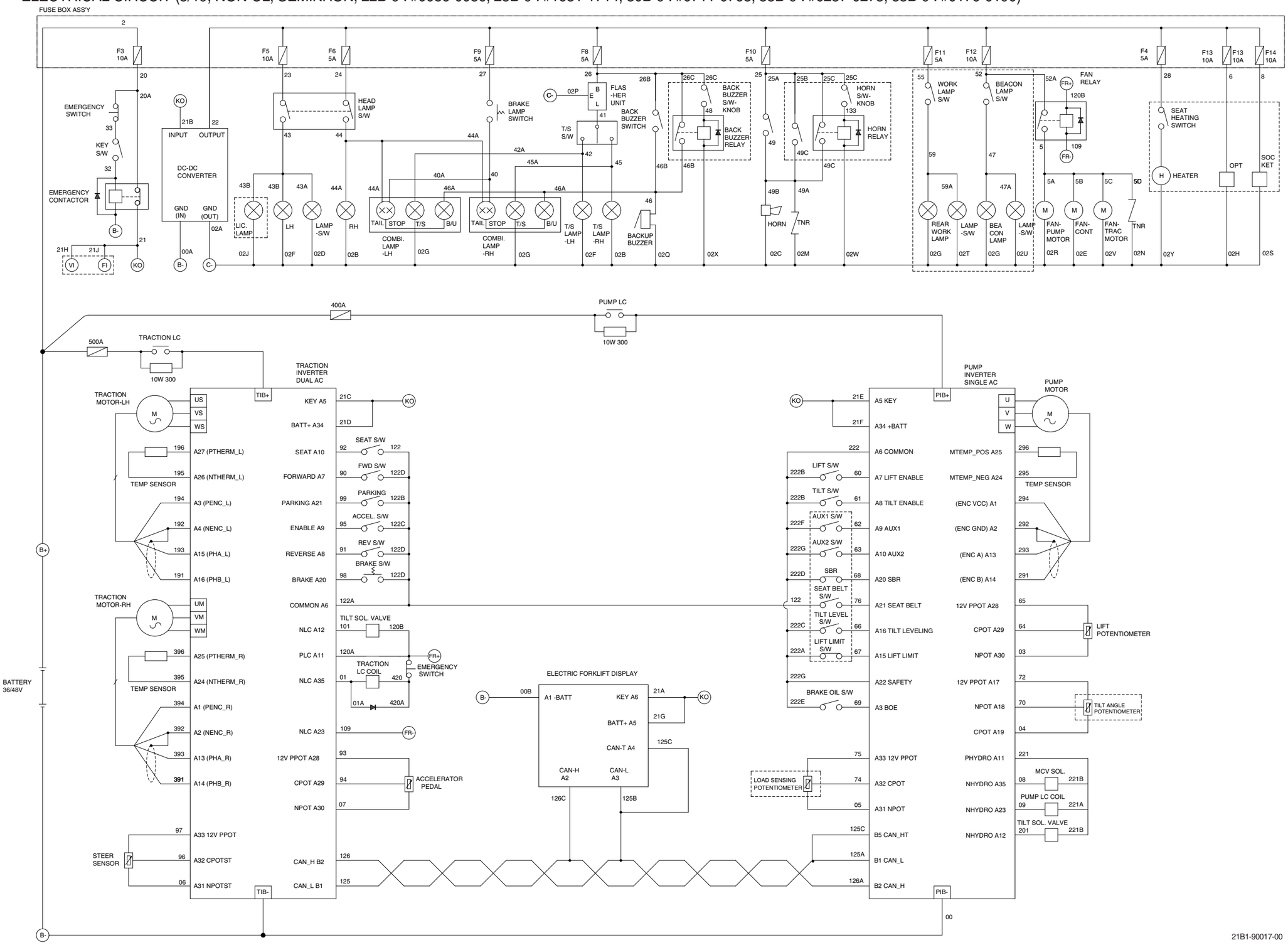


· ELECTRICAL CIRCUIT (4/19, NON-UL, SEMIKRON, 22B-9 : #0076-0085, 25B-9 : #1448-1630, 30B-9 : #0590-0710, 33B-9 : #0228-0256, 35B-9 : #0154-0175)

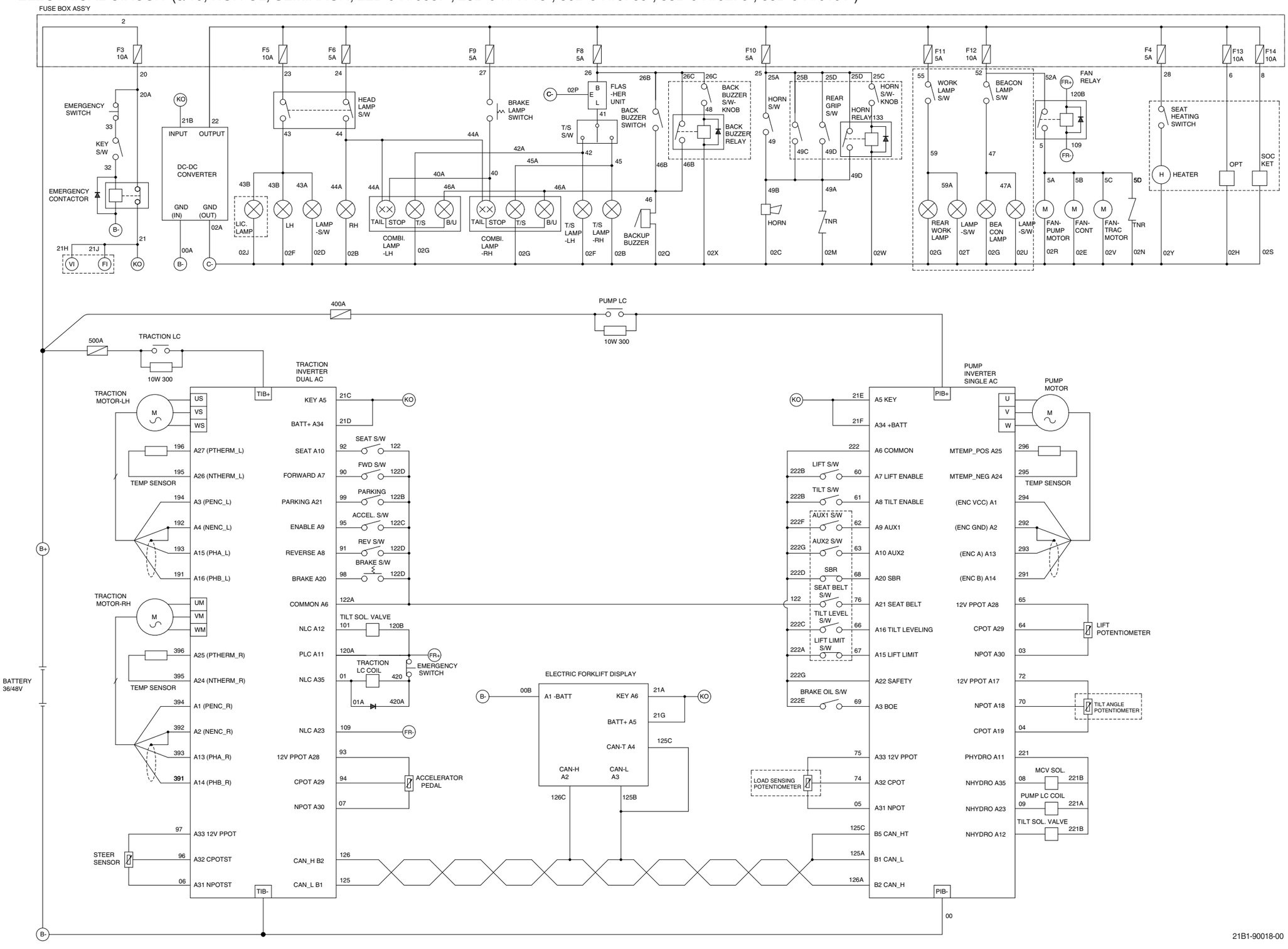


21B1-90016-00

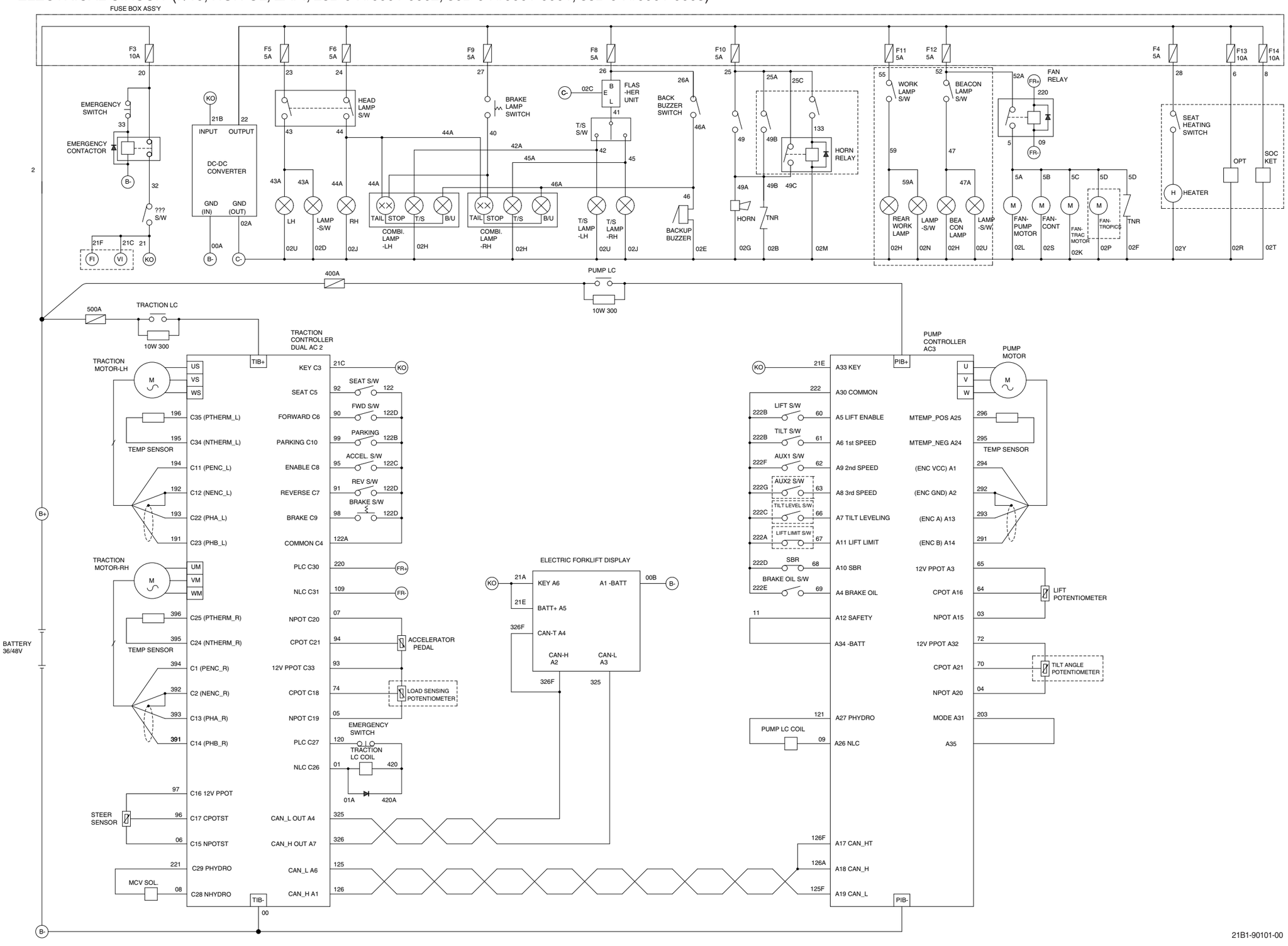
· ELECTRICAL CIRCUIT (5/19, NON-UL, SEMIKRON, 22B-9 : #0086-0086, 25B-9 : #1631-1714, 30B-9 : #0711-0768, 33B-9 : #0257-0275, 35B-9 : #0176-0190)



· ELECTRICAL CIRCUIT (6/19, NON-UL, SEMIKRON, 22B-9 : #0087-, 25B-9 : #1715-, 30B-9 : #0769-, 33B-9 : #0276-, 35B-9 : #0191-)

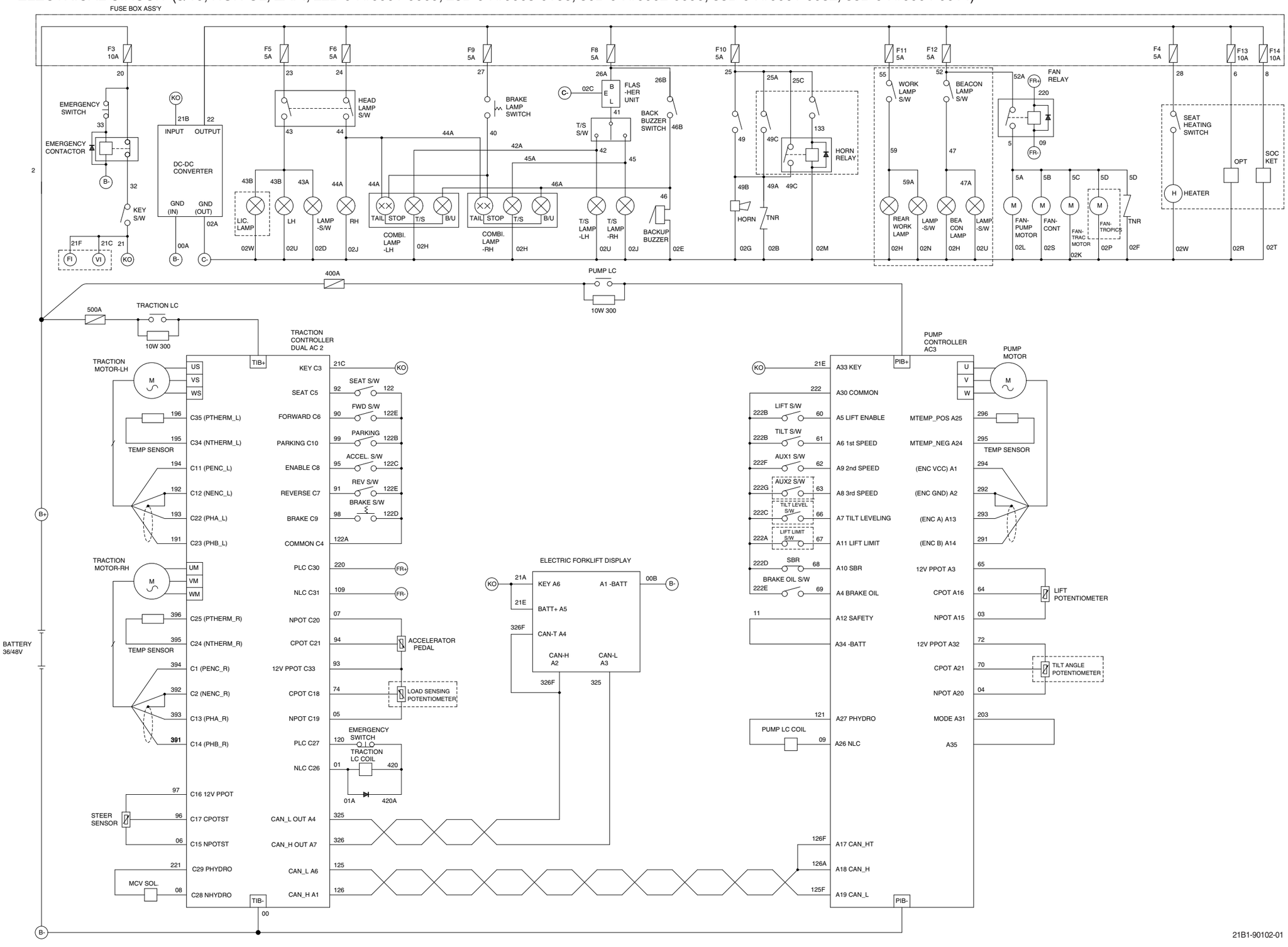


· ELECTRICAL CIRCUIT (7/19, NON-UL, ZAPI, 25B-9 : #0001-0002, 30B-9 : #0001-0001, 35B-9 : #0001-0003)

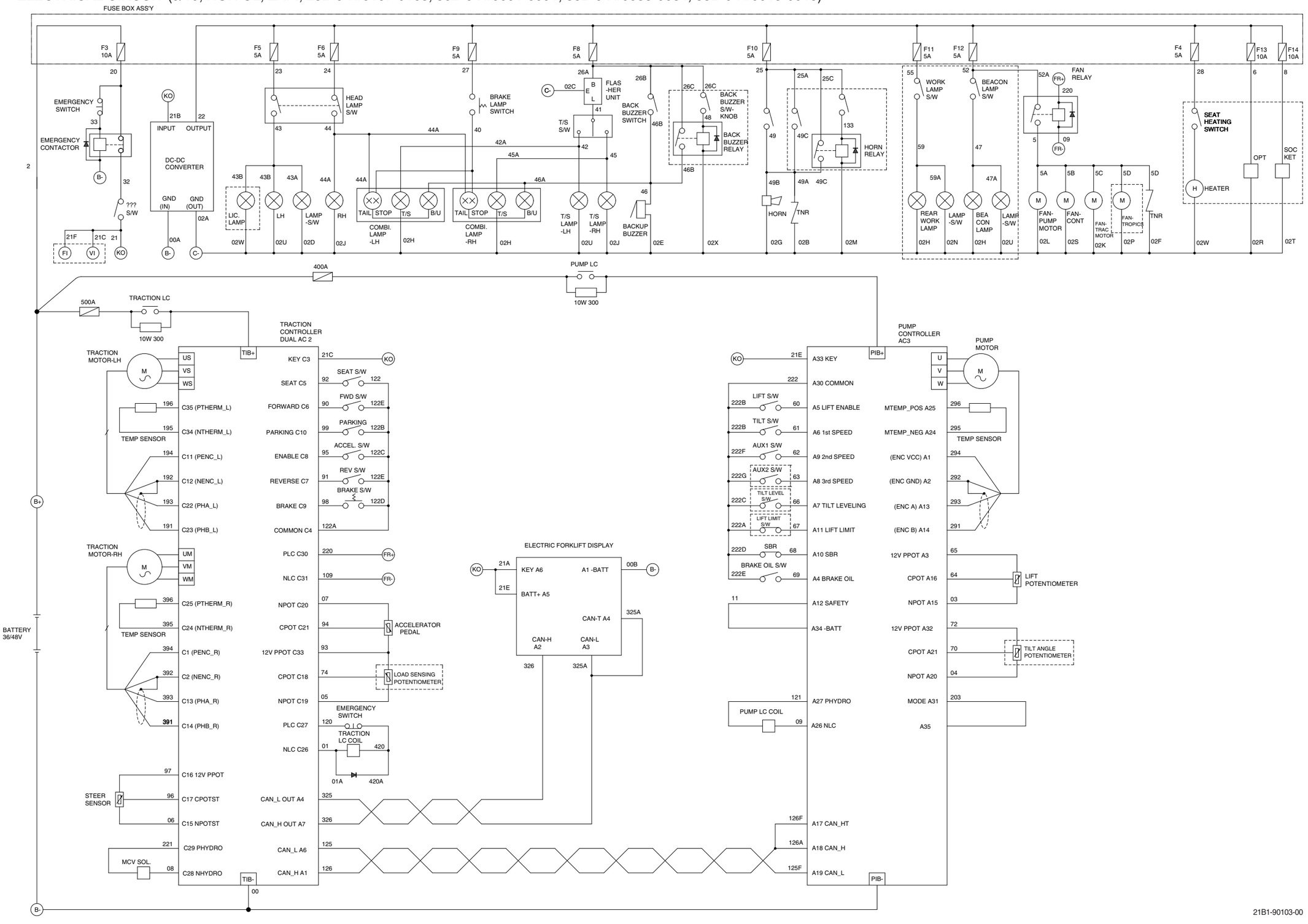


21B1-90101-00

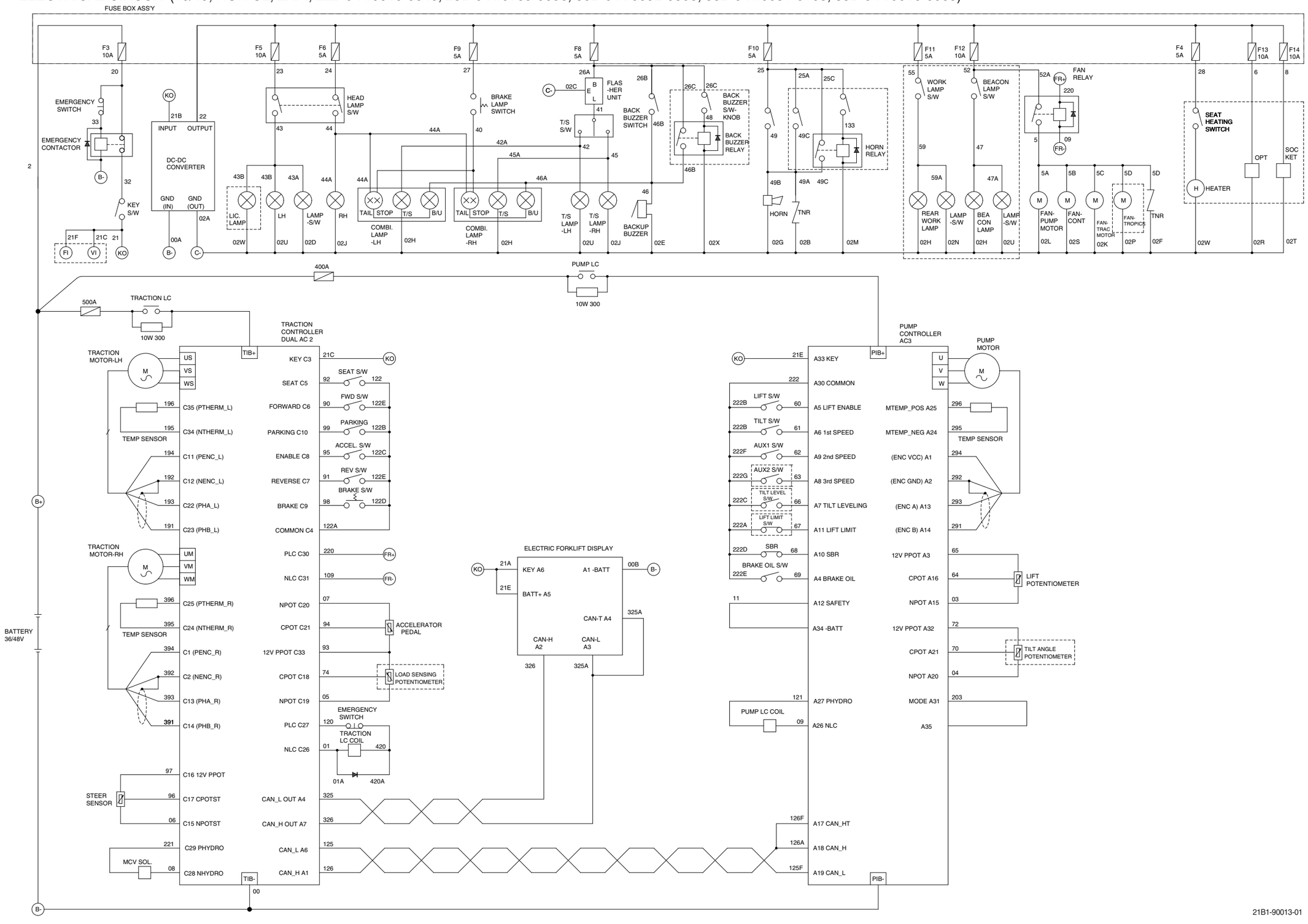
· ELECTRICAL CIRCUIT (8/19, NON-UL, ZAPI, 22B-9 : #0001-0009, 25B-9 : #0003-0166, 30B-9 : #0002-0090, 33B-9 : #0001-0032, 35B-9 : #0004-0014)



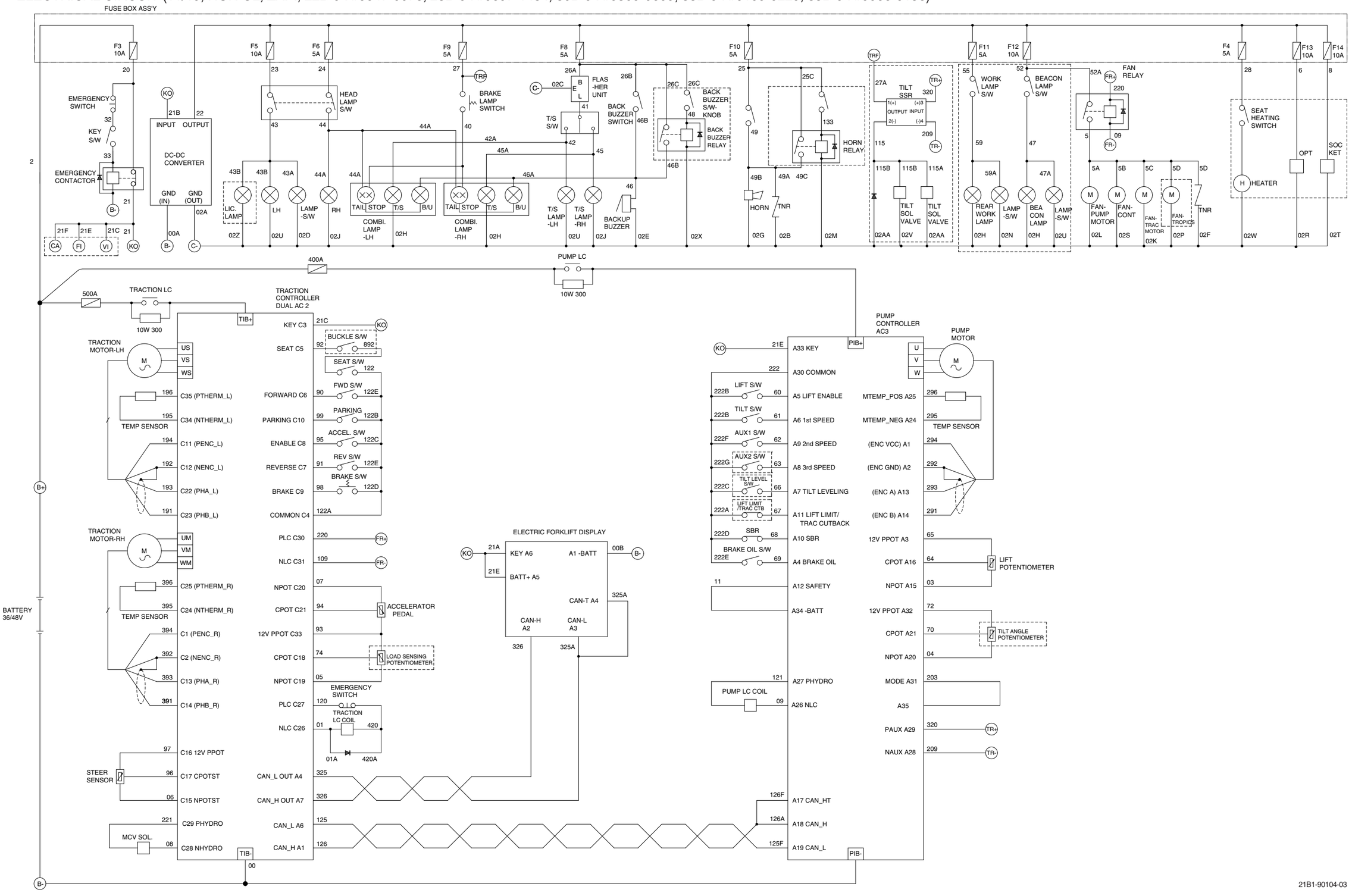
· ELECTRICAL CIRCUIT (9/19, NON-UL, ZAPI, 25B-9 : #0167-0168, 30B-9 : #0091-0091, 33B-9 : #0033-0034, 35B-9 : #0015-0015)



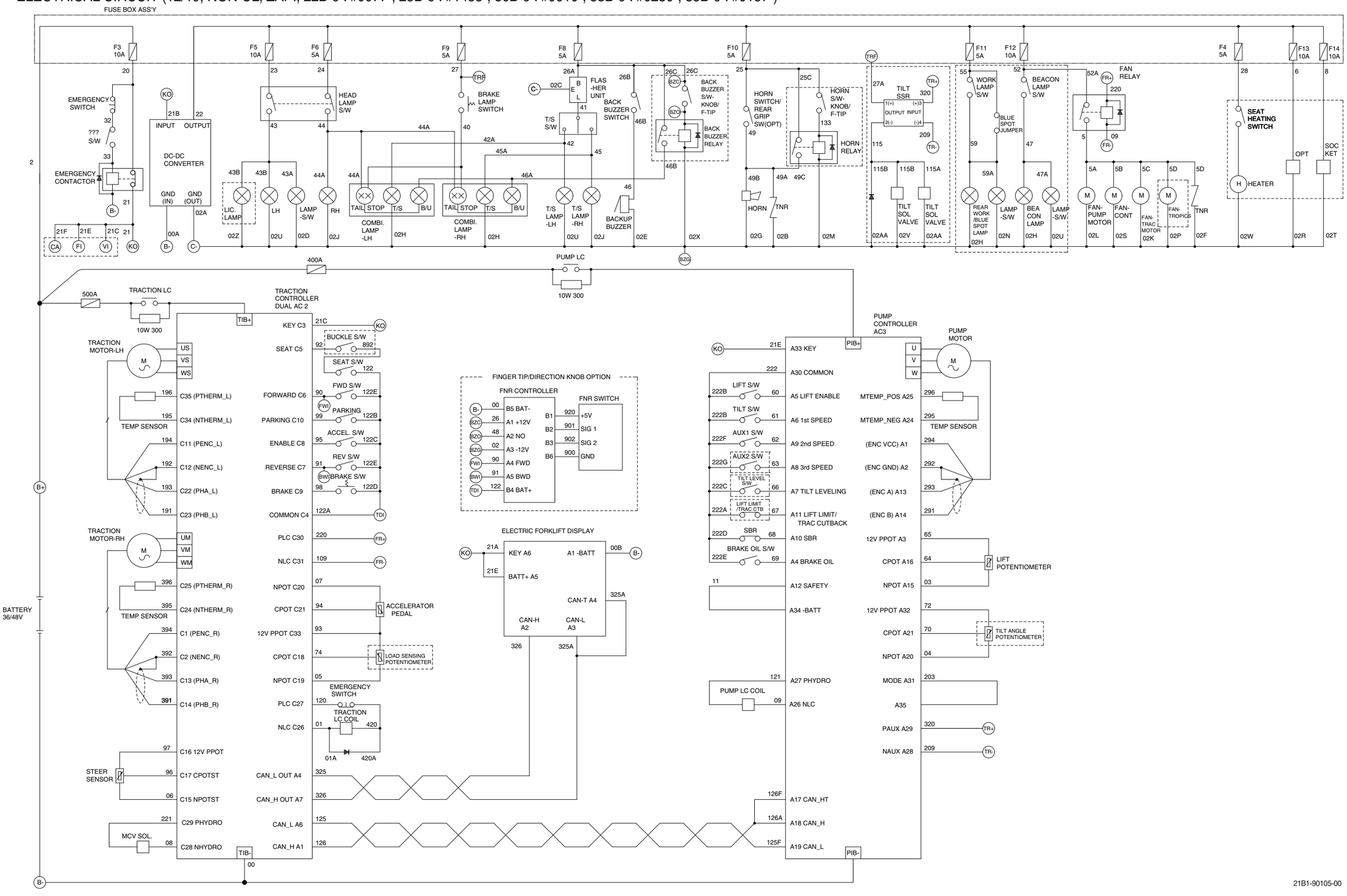
· ELECTRICAL CIRCUIT (10/19, NON-UL, ZAPI, 22B-9 : #0010-0046, 25B-9 : #0169-0696, 30B-9 : #0092-0308, 33B-9 : #0034-0108, 35B-9 : #0016-0065)



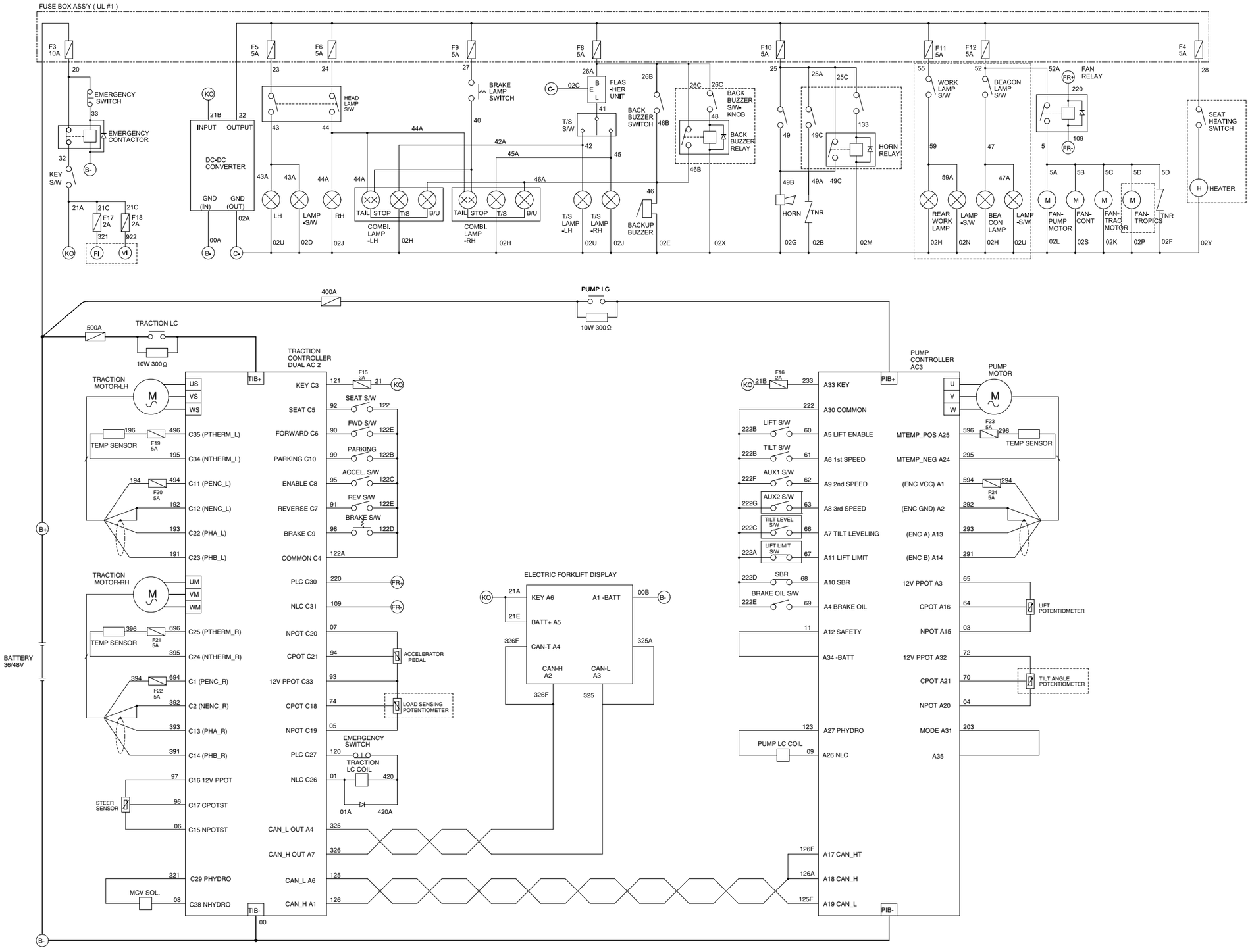
· ELECTRICAL CIRCUIT (11/19, NON-UL, ZAPI, 22B-9 : #0047-0076, 25B-9 : #0697-1454, 30B-9 : #0309-0609, 33B-9 : #0109-0229, 35B-9 : #0066-0156)



· ELECTRICAL CIRCUIT (12/19, NON-UL, ZAPI, 22B-9 : #0077-, 25B-9 : #1455-, 30B-9 : #0610-, 33B-9 : #0230-, 35B-9 : #0157-)

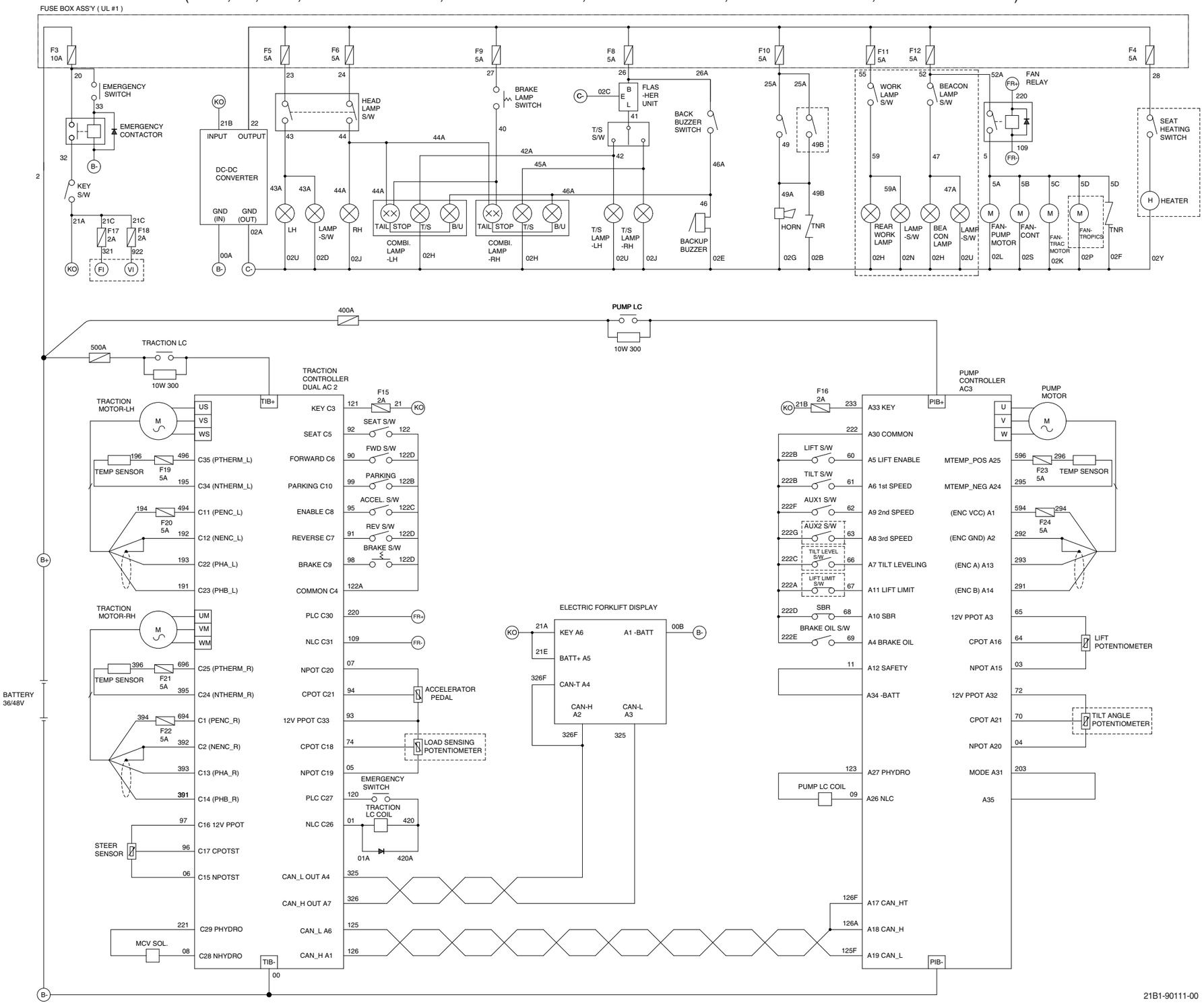


· ELECTRICAL CIRCUIT (13/19, UL, ZAPI, 35B-9 : 0001-0003)

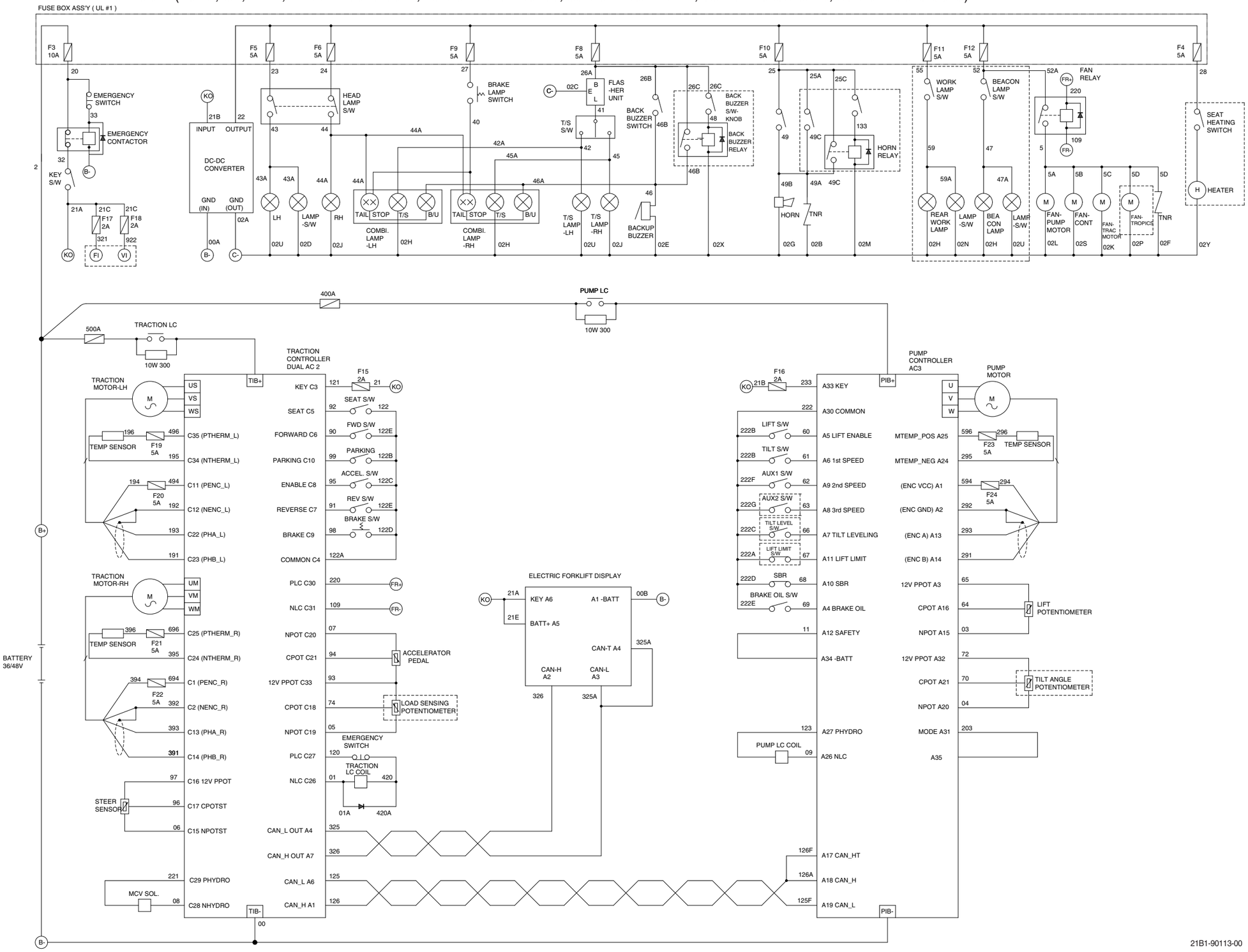


22B9EL01-2

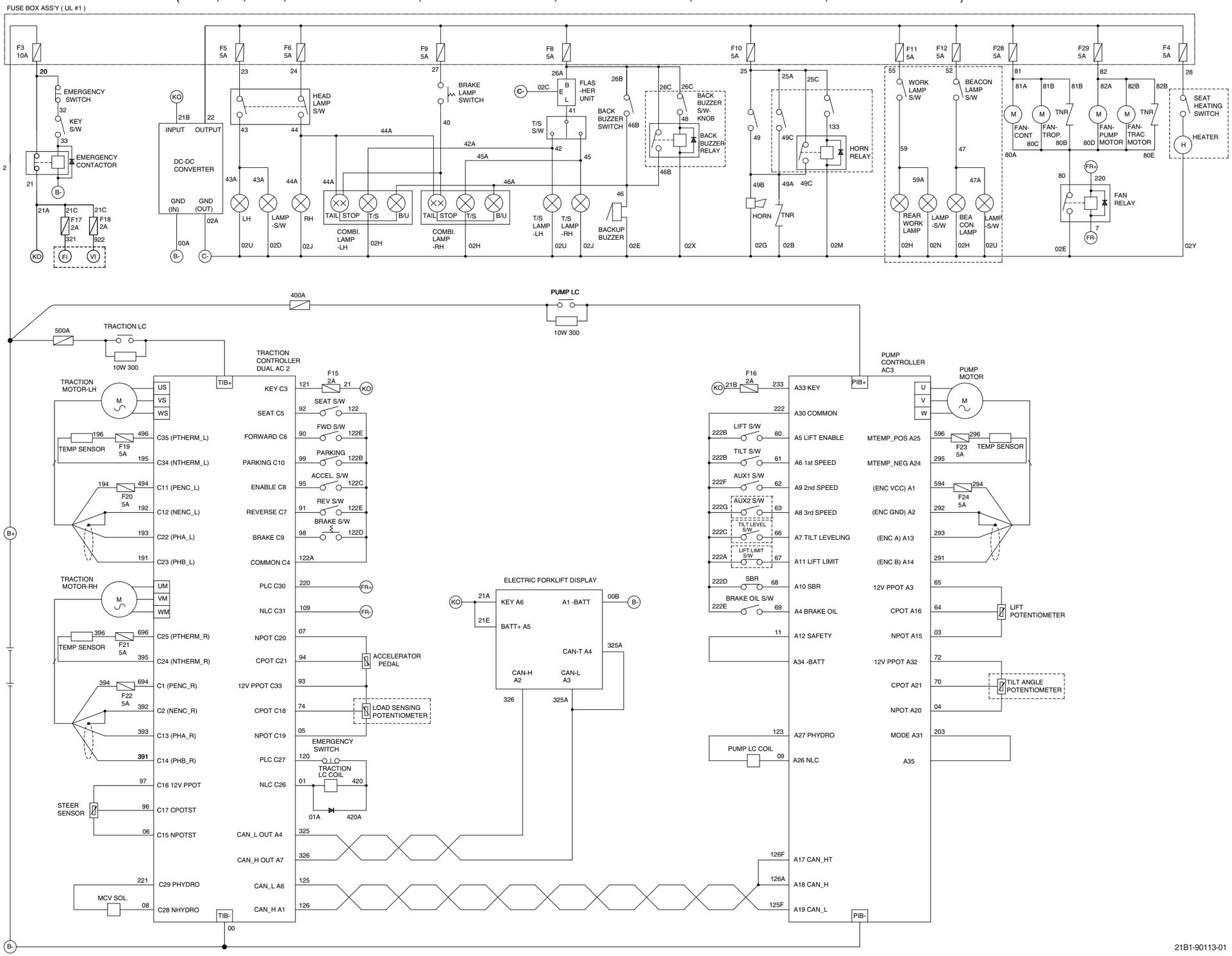
· ELECTRICAL CIRCUIT (14/19, UL, ZAPI, 22B-9 : #0001-0009, 25B-9 : #0001-0166, 30B-9 : #0001-0090, 33B-9 : #0001-0032-, 35B-9 : #0004-0014)



· ELECTRICAL CIRCUIT (15/19, UL, ZAPI, 22B-9 : #0010-0011, 25B-9 : #0167-00230, 30B-9 : #0091-0122, 33B-9 : #0033-0040, 35B-9 : #0015-0029)

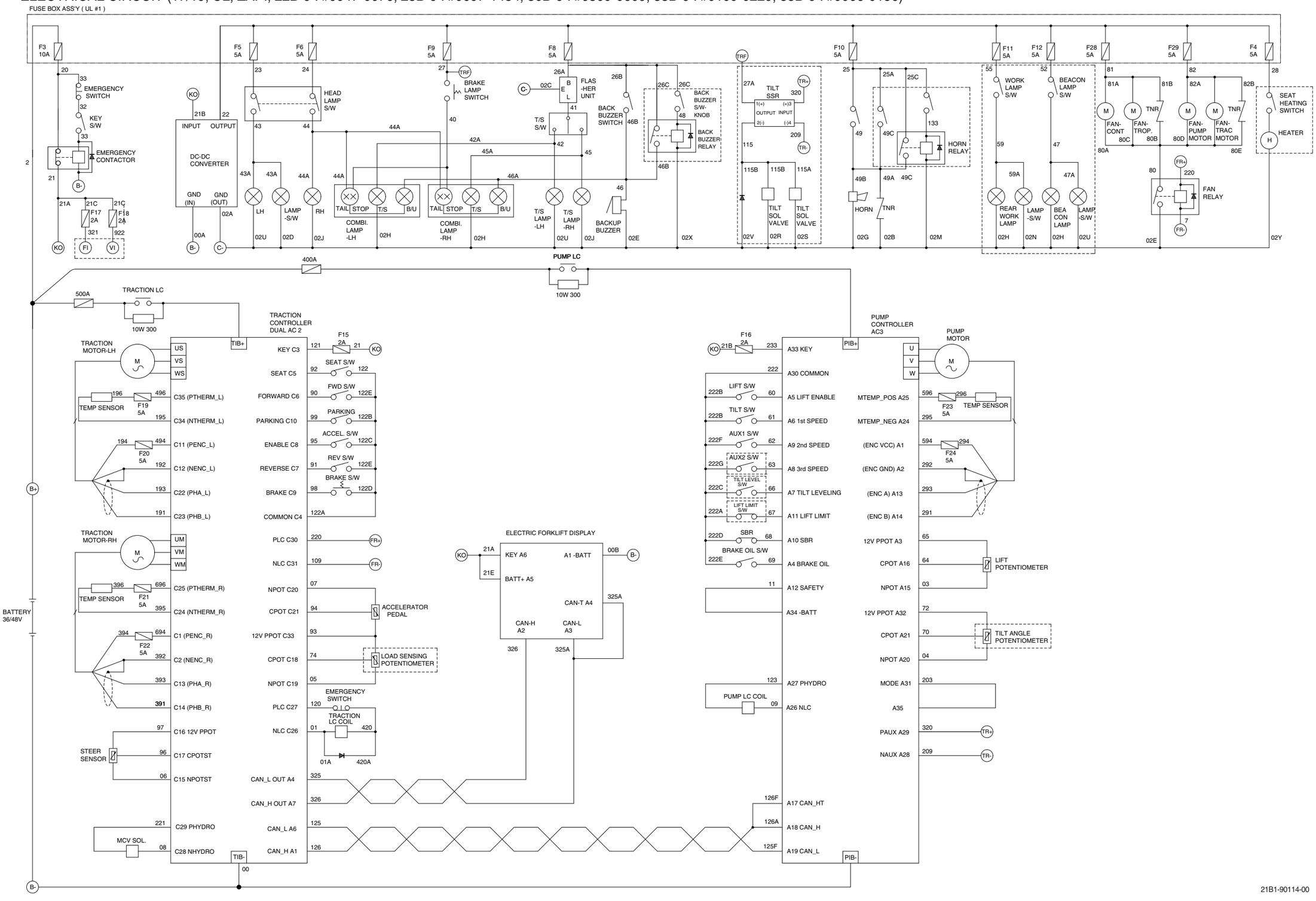


· ELECTRICAL CIRCUIT (16/19, UL, ZAPI, 22B-9 : #0012-0046, 25B-9 : #0231-0696, 30B-9 : #0123-0308, 33B-9 : #0041-0108, 35B-9 : #0030-0065)



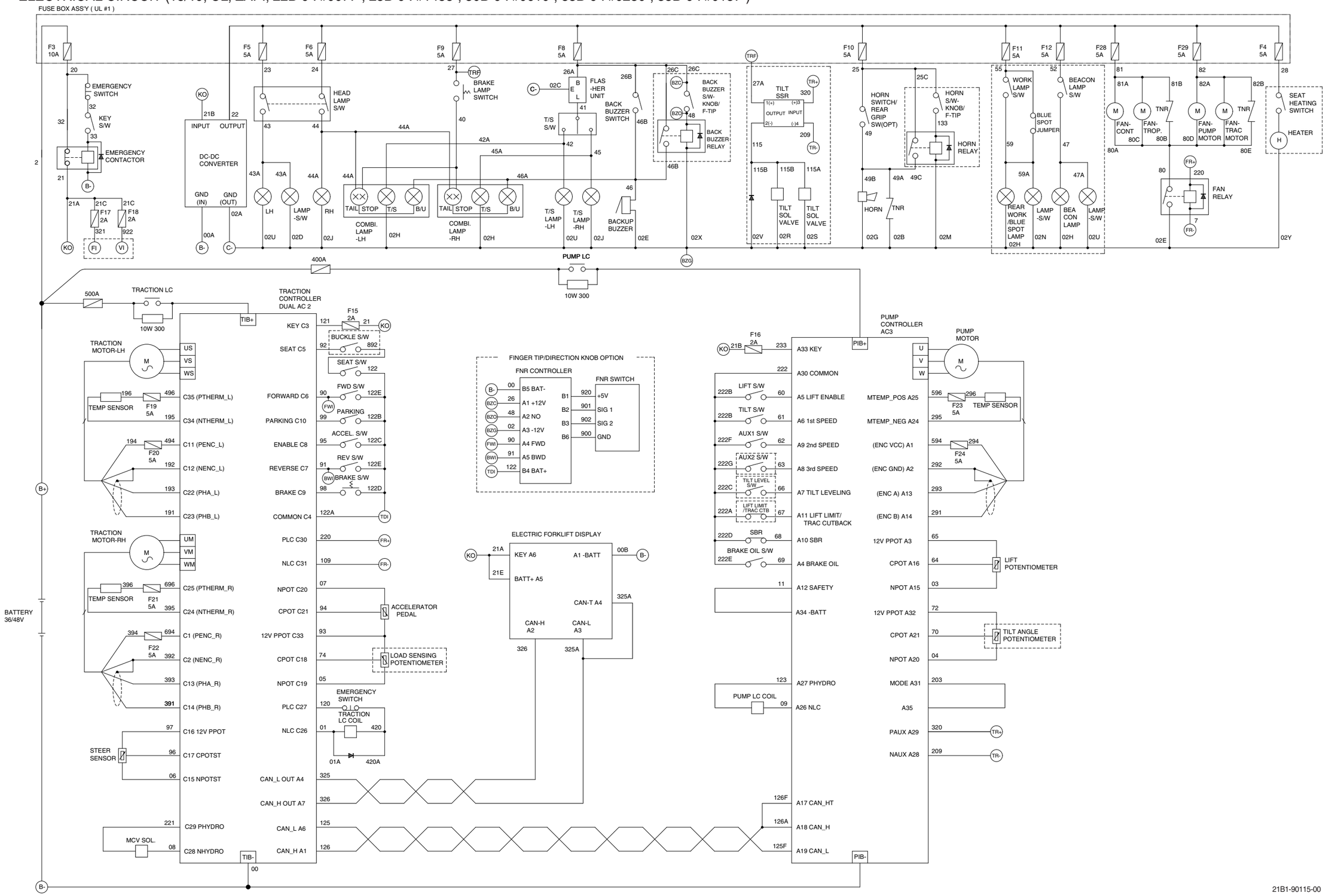
21B1-90113-01

· ELECTRICAL CIRCUIT (17/19, UL, ZAPI, 22B-9 : #0047-0076, 25B-9 : #0697-1454, 30B-9 : #0309-0609, 33B-9 : #0109-0229, 35B-9 : #0066-0156)



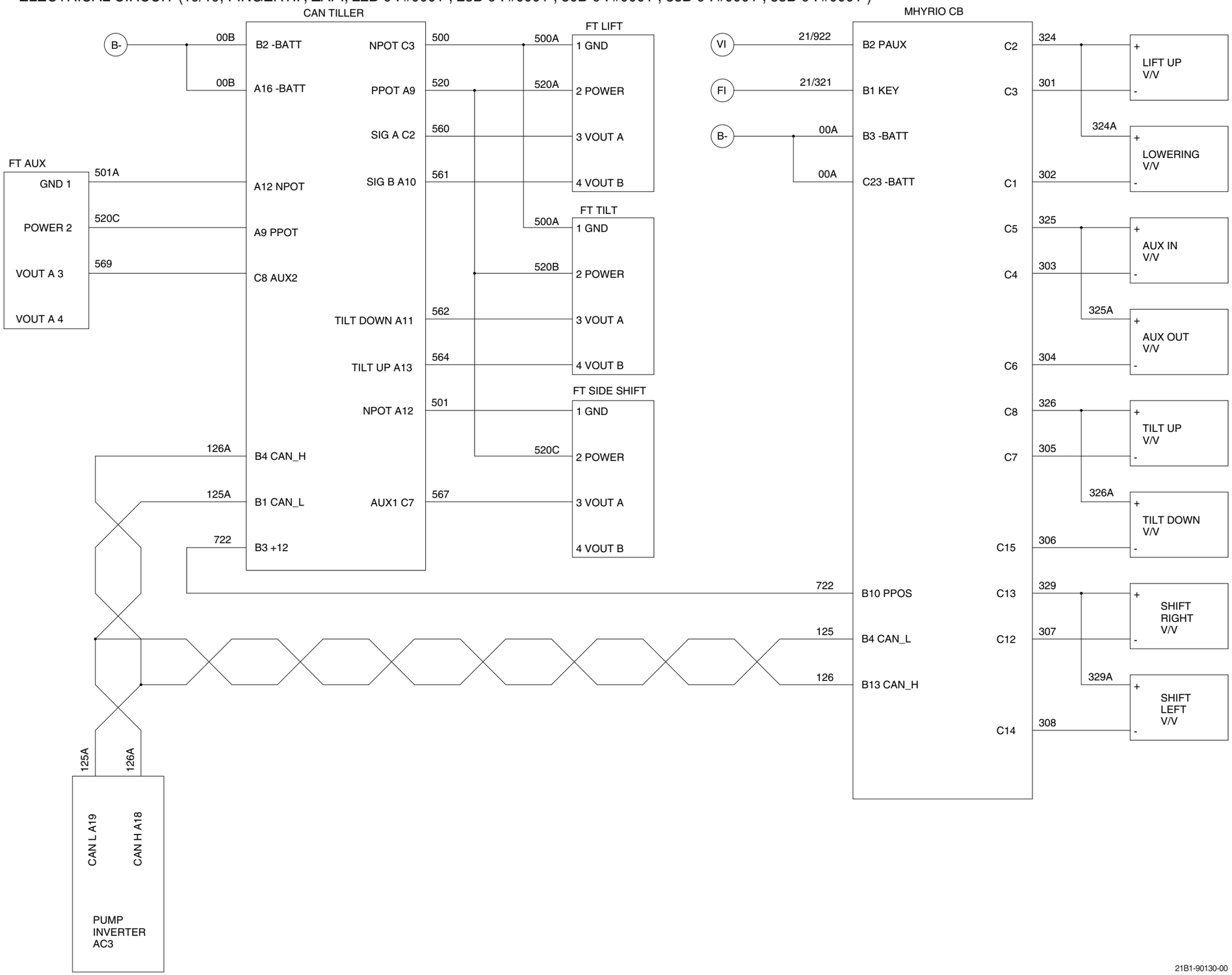
21B1-90114-00

· ELECTRICAL CIRCUIT (18/19, UL, ZAPI, 22B-9 : #0077-, 25B-9 : #1455-, 30B-9 : #0610-, 33B-9 : #0230-, 35B-9 : #0157-)



21B1-90115-00

· ELECTRICAL CIRCUIT (19/19, FINGERTIP, ZAPI, 22B-9 : #0001-, 25B-9 : #0001-, 30B-9 : #0001-, 33B-9 : #0001-, 35B-9 : #0001-)



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.

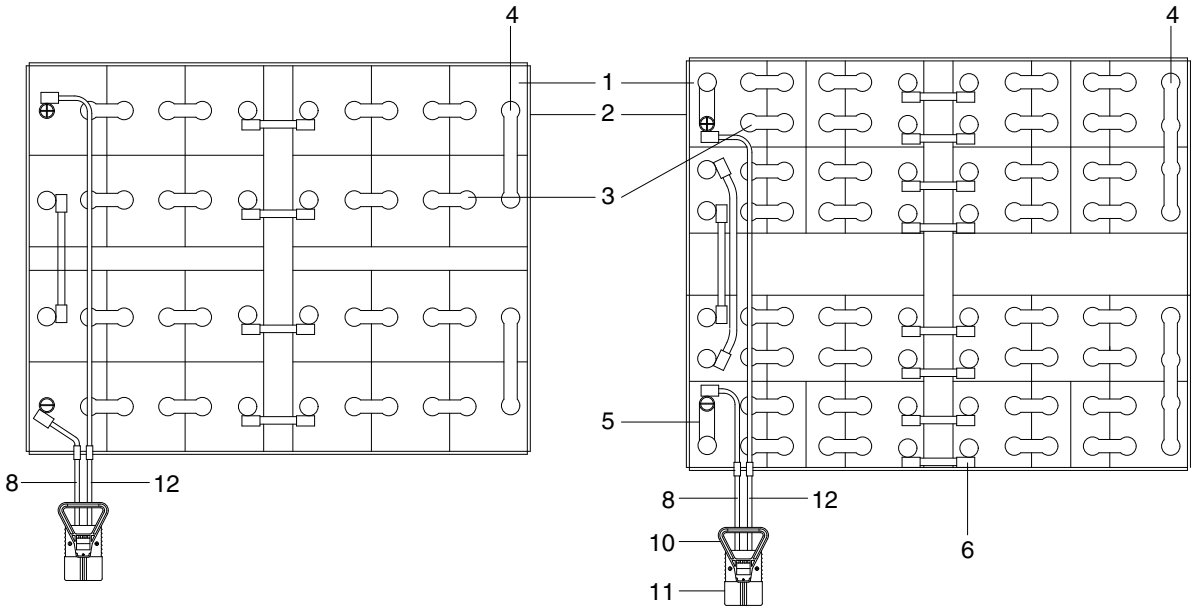
To drive the fork lift truck, a DRIVING CONTROL SYSTEM and some electric components such as direction change lever (forward/reverse section switch) and accelerator are required to select the driving direction and to control the speed of driving motor.

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



22/25B-9 30/32/35B-9

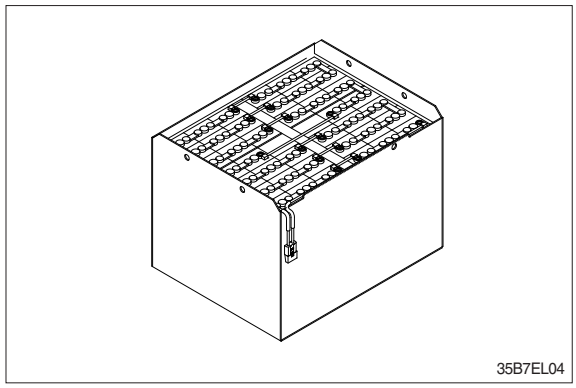
22B9EL03

1	Cells	6	Cable connector
2	Steel box	8	Negative leading cable
3	Cell connector	10	Handle (red)
4	Row connector	11	Plug
5	Terminal connector	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.



3) SPECIFICATION AND SERVICE DATA

Item	Unit	22B-9	25B-9	30/32/35B-9
Type	-	Lead Acid		
Rated voltage	V	48		
Capacity	AH/hr	660	715	740
Electrolyte	-	WET		
Dimension (W × D × H)	mm	1030 × 796 × 537		1030 × 990 × 537
Connector	-	SB 350 or SR 350 (SBE 320 BLUE)		
Weight	kg	970/1300	970/1300	1090/1495

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×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±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 ×1.0~1.5" at the start of charging, and at the final stage it is "5 hour rate current ×0.15~0.25". Normally the charge is terminated within 8~12 hours automatically.

b. Charging by constant current constant voltage automatic charger

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

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

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

c. Charging by constant current charger

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

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.

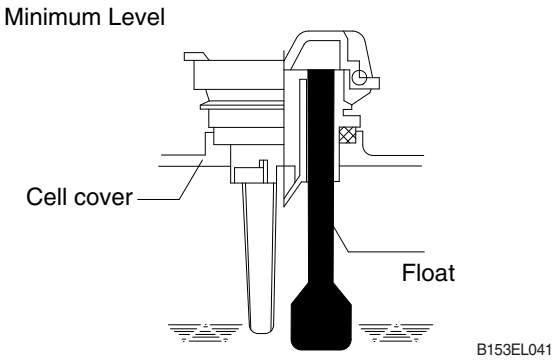
⑥ **Replenishment of distilled water**

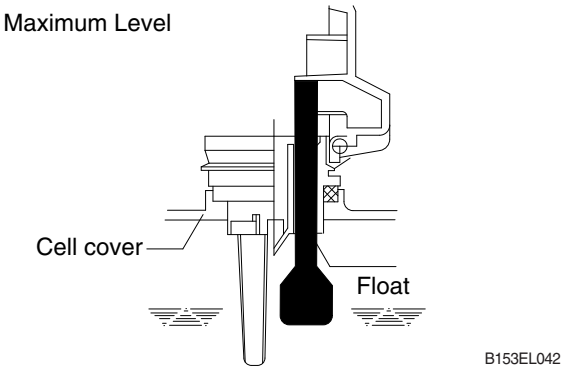
Only the water content of electrolyte is decreased due to electrolysis of distilled water during charge and natural evaporation. If a battery used with the electrolyte decreased excessively, plates will deteriorate resulting in markedly shortening of battery life. Be sure to check the electrolyte level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





⑦ **Cleaning**

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

⑧ **Notice on charging**

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

⑨ **Repair of failure cell**

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

⚠ 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.

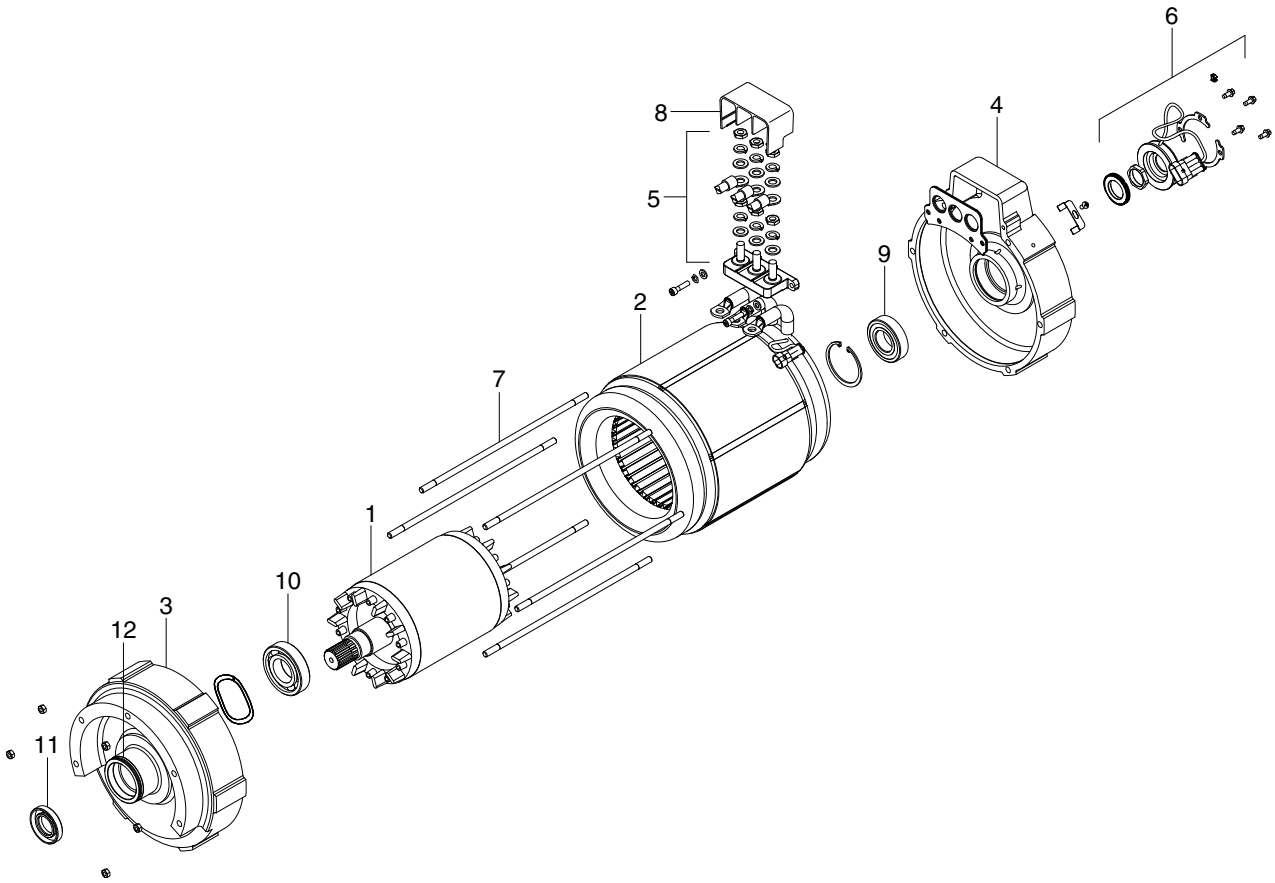
Contrarily if the temperature is high, especially if used at above 55°C, the battery life will be considerably shortened. Care must be taken so that the temperature during charge will be maintained at 55°C or lower. Even under unavoidable circumstances it should not exceed 55°C.

7) TROUBLESHOOTING

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

3. DRIVE MOTOR

1) STRUCTURE



22B9EL07

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

2) SPECIFICATION

Item	Unit	Specification
Type	-	AQDG4001
Rated voltage	Vac	30
Rated output	kW	7.0×2
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.

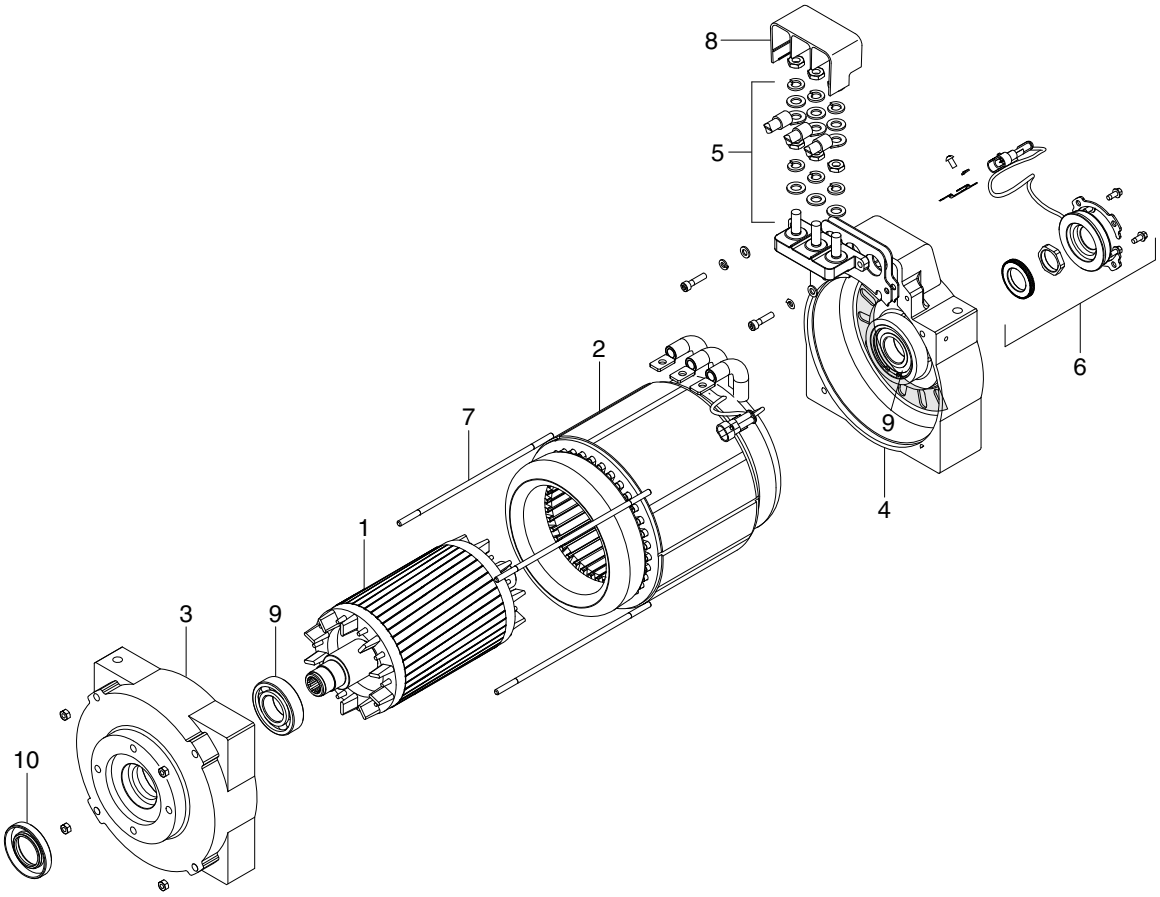
After approximately 10,000 operating hours the bearings have to be replaced.

(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



1	Rotor	5	Block-Terminal A	9	Bearing
2	Stator	6	Speed sensor kit	10	Oil seal
3	Endbell De	7	Stud bolt		
4	Endbell	8	Protector-Terminal		

2) SPECIFICATION

Item	Unit	Specification
Type	-	AMDL4001
Rated voltage	Vac	30
Rated output	kW	17
Insulation	-	Class F

3) INTERNAL INVOLUTE SPLINE DATA

Item	Unit	Specification
Flat root side fit	-	Class 7
No of teeth	EA	11
Spline pitch	mm	16/32
Pressure angle	Degree	30
Major diameter	mm	19.7104
Form diameter	mm	19.1516
Minor diameter	mm	16.0274
Pin diameter	mm	2.7432

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.

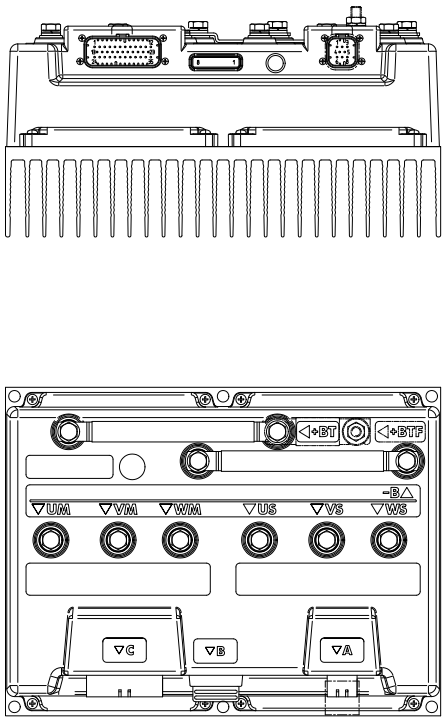
After approximately 10,000 operating hours the bearings have to be replaced.

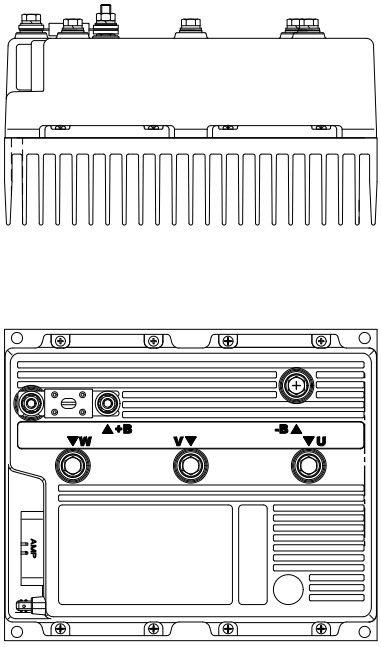
(2) Disassembly and assembly

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

5. CONTROLLER SYSTEM

1) STRUCTURE





Traction controller

Pump controller

22B7EL10

(1) Specifications

Model	Model	Application	Type	Power	Current limit
22/25/30/32/35B-9	DUAL AC2 Power	Traction	MOSFET	36-48V, 450+450A	450A/3min
	AC3	Pump	MOSFET	36-48V, 600A	600A/3min

2) OPERATIONAL FEATURES

(1) Features

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

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

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

(2) Diagnosis

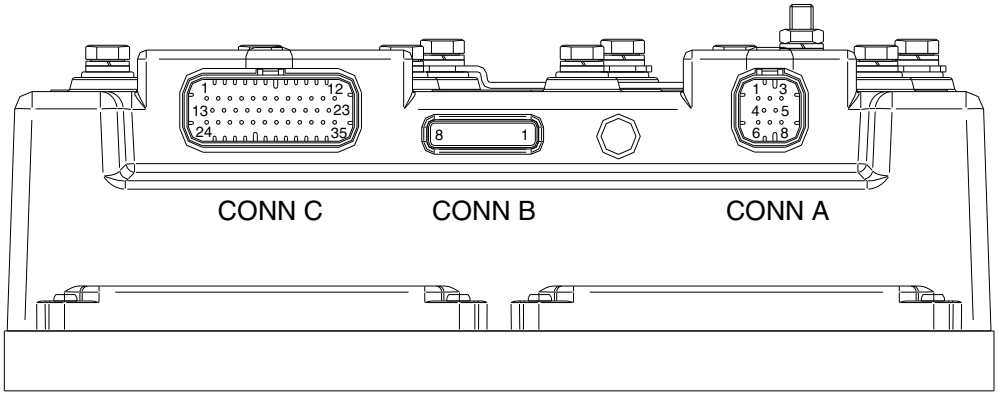
The microcontrollers continually monitor the inverter and carry out a diagnostic procedure on the main functions. The diagnosis is made in 4 points.

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

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

3) DESCRIPTION OF THE CONNECTORS

(1) Traction controller



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.

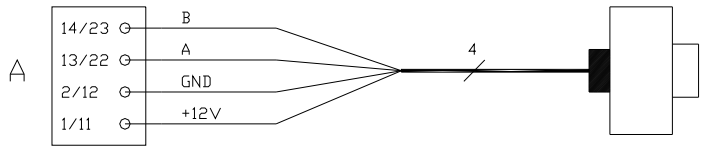
(1) Encoder installation

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.

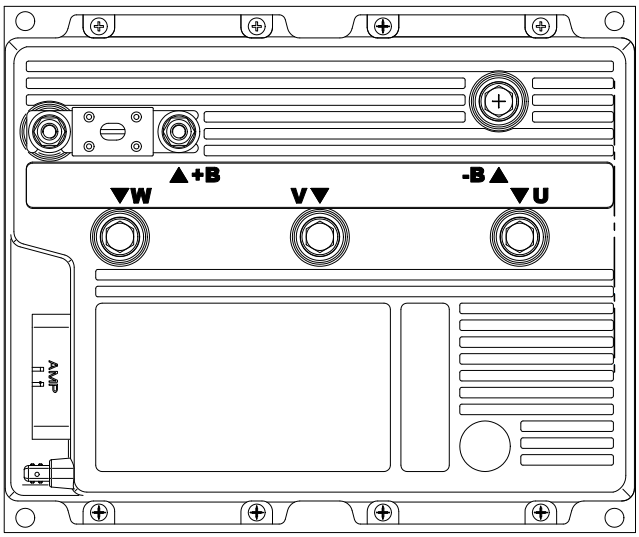
② Connection of encoder with open collector output; +12V power supply.



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



22B7EL14

No. of pin	Function	Description
A1	+12V (+5V)	Positive of encoder power supply.
A2	ENC GND	Negative of encoder power supply.
A3	PPOT	Lift potentiometer positive: 12V output; keep load > 1kΩ.
A4	BRAKE OIL	Brake oil.
A5	LIFT ENABLE	Input for potentiometer lifting enable input; it is active HIGH.
A6	TILT UP/DOWN	Input for tilt up and tilt down digital input; it is active HIGH.
A7	TILT LEVELLING	Tilt levelling input; it is active HIGH.
A8	AUX IN/OUT	Input for aux in and aux out digital input; it is active HIGH.
A9	SHIFT RGT/LFT	Input for shift right and shift left digital input; it is active HIGH.
A10	SBR	Input for side battery removal digital input; Active low.
A11	LIFT LIMIT SW	Speed reduction input. Active low.
A12	SAFETY	If not connected to -batt the MC coil power output will be disabled. It can also be used as a general purpose input.
A13	ENC A	Phase A of encoder.
A14	ENC B	Phase B of encoder.
A15	NPOT	Negative of lift potentiometer.
A16	CPOT	Lift potentiometer wiper.
A17	CAN T	CAN termination; connect to CAN H (A18) to insert can termination resistance.

No. of Pin	Function	Description
A18	CAN H	High level CAN-BUS voltage I/O.
A19	CAN L	Low level CAN-BUS voltage I/O.
A20	NPOT-AUX (TILT ANGLE)	Tilt angle potentiometer negative.
A21	CPOT-AUX (TILT ANGLE)	Tilt angle potentiometer wiper.
A22	ENC A*	Phase A inverted of encoder (encoder with differential output).
A23	ENC B*	Phase B inverted of encoder (encoder with differential output).
A24	-BATT	-Batt.
A25	MOT TH	Input for motor temperature sensor.
A26	NLC	Negative of the pump line contactor.
A27	PLC	Positive of the pump line contactor.
A28	NAUX	Spare output.
A29	PAUX	Positive for output A28. Spare.
A30	CM	Common of digital microswitches.
A31	MODE	This input allows the customer to select the software for traction or lifting application. To be connected with A35.
A32	PPOT-AUX	Tilt angle positive: 10V output; keep load> 1kΩ.
A33	KEY	Connected to the power supply through a key switch (CH) with a 10A fuse in series.
A34	-BATT	-Batt.
A35	-BATT	-Batt.
B1	PCLRXD	Positive serial reception.
B2	NCLRXD	Negative serial reception.
B3	PCLTXD	Positive serial transmission.
B4	NCLTXD	Negative serial transmission.
B5	GND	Negative console supply.
B6	+12V	Positive console supply.
B7	FLASH	-
B8	FLASH	-

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 static return to off is requested for starting the truck. The required sequence is :

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

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

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

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 #4 : 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.

⑫ **Pedal brake stop**

This parameter defines how truck drive if accel pedal & brake pedal is pressed simultaneously.

If set to on, truck is stopped when pedal brake is pressed.

If set to off, the traction current is reduced to half of the maximum current.

(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**

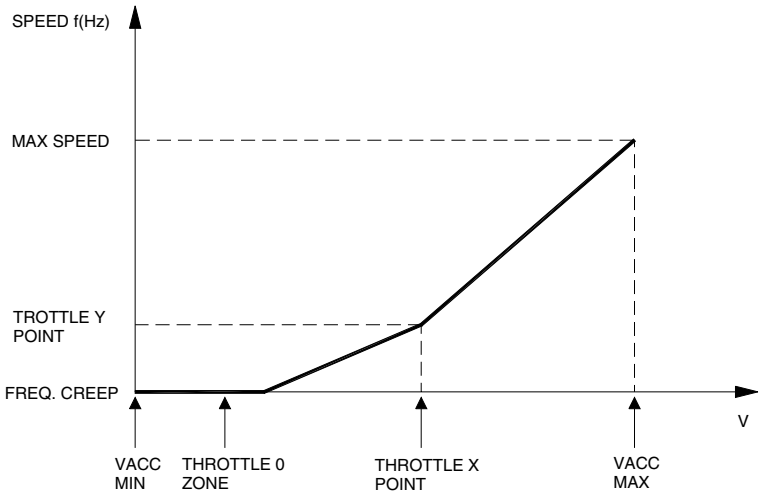
It establishes a deadband in the accelerator input curve (see also curve below).

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.



20B7EL17

VACC MIN and VACC MAX are values programmable by the "Program Vacc" 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 solenoid 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 :

Speed factor = 88 * rr * p / ø

where :

rr = total gearbox ratio

ø = traction wheel diameter (㎝)

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 configurate the reference load weight.

㉒ **Overload weight (option)**

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

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

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, 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 A25 input.
- ANALOG : An analog motor thermal sensor is connected A25 (the curve can be customized on a customer request).
- NONE : No motor thermal sensor switch is connected.

③ **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 disactivated.

⑤ **Aux function**

- ON : Fingertip Aux function is activated.
- OFF : Fingertip Aux function is disactivated.

⑥ **Digital lift**

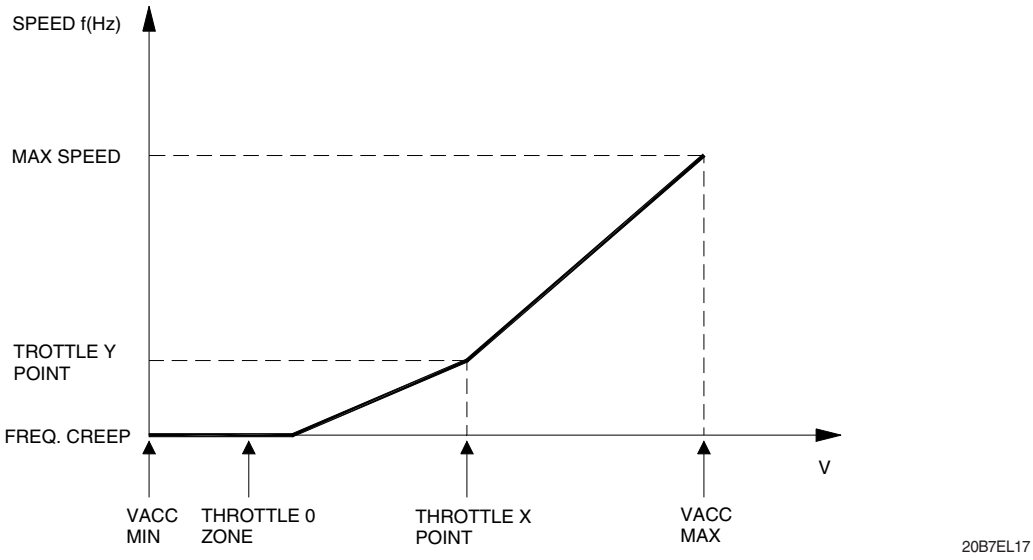
- OFF : The lift sensor includes a lift switch and an analogue lift sensor. Lift speed can be controlled proportionally with lever position.
- ON : The lift sensor includes a lift switch only. Lift speed cannot be controlled proportionally.

⑦ **Motor type**

- Standard pump : Configuration for standard pump motor of 22/25/30B-9.
- Option #1 : Configuration for standard pump motor of 32/35B-9 and all open type motor of 22/25/30/32/35B-9.

(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.



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 A27 output.
- ON: The PWM reduces the voltage to the set value.

⑧ **PWM on aux output**

- OFF: The inverter applies the battery voltage to the coil on A28 output.
- ON: The PWM reduces the voltage to the set value.

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

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

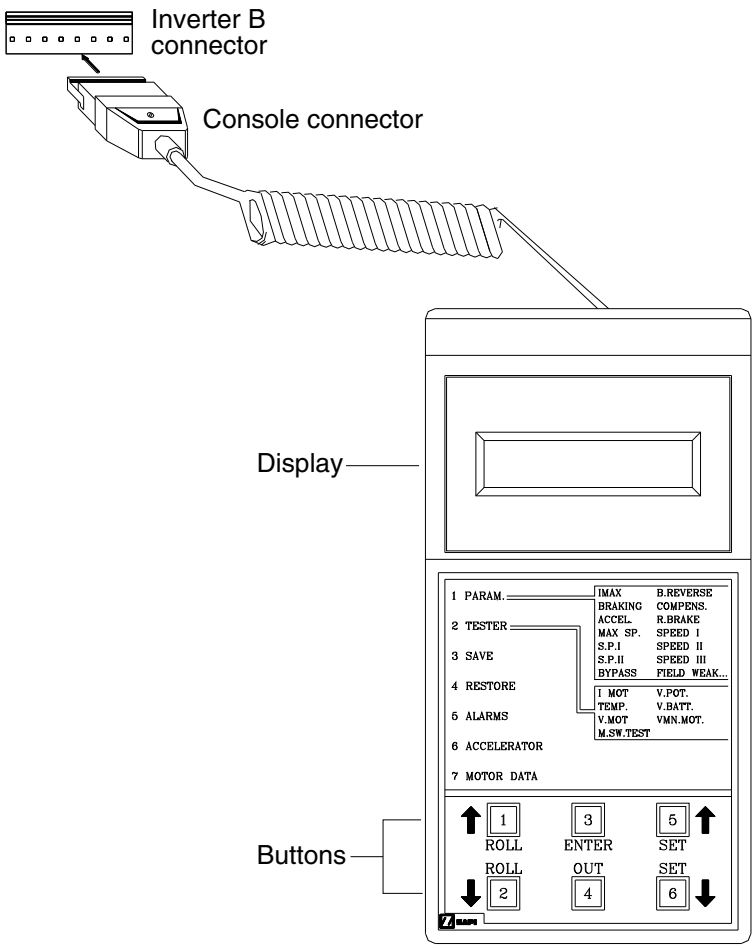
There are two ways to adjust parameter via a console or buttons on a display.

※ Adjustments via buttons on a display, please refer to the display section. (page 7-47)

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

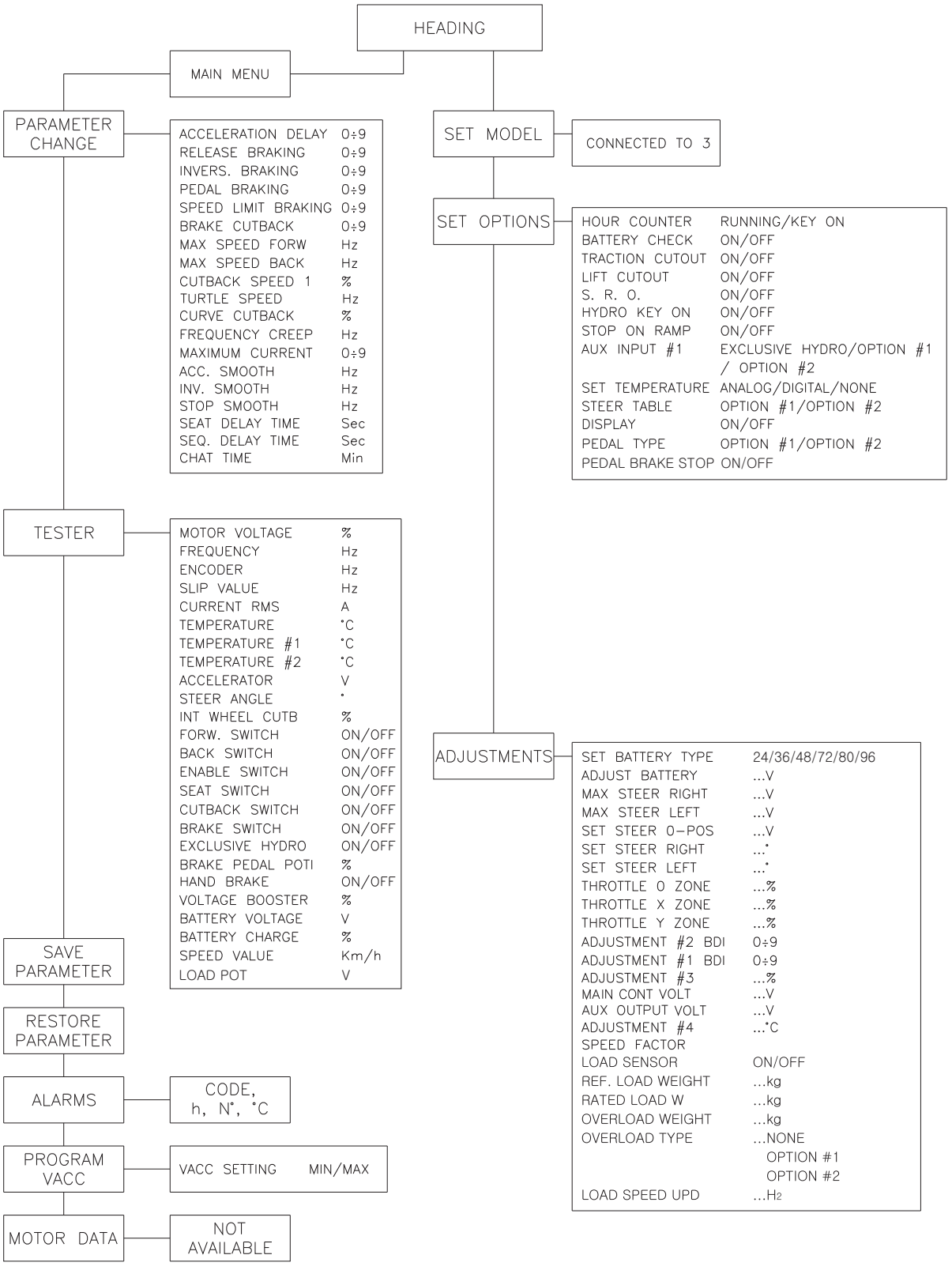


20B7EL15

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

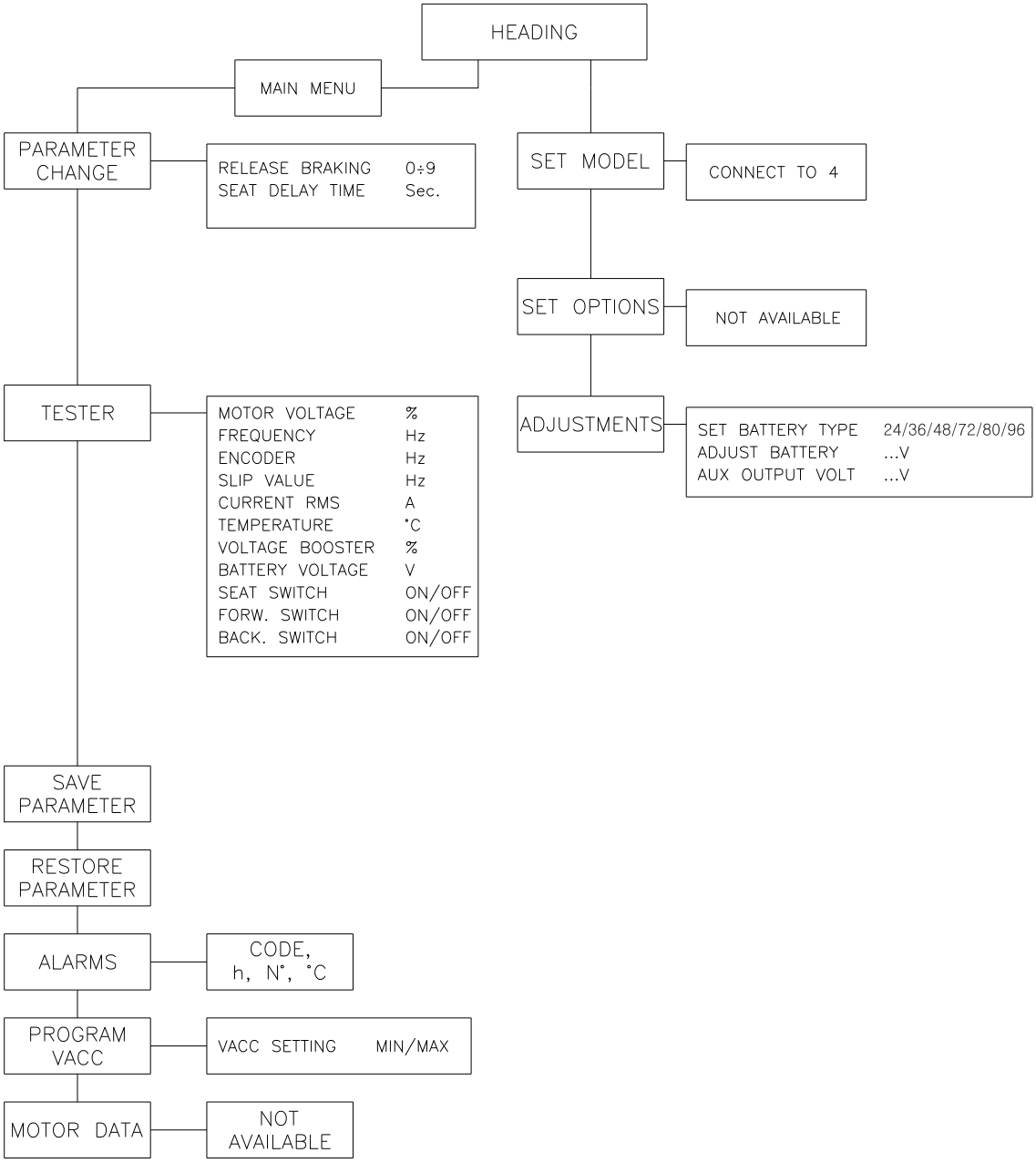
(2) Description of standard console menu

① Traction controller-Master



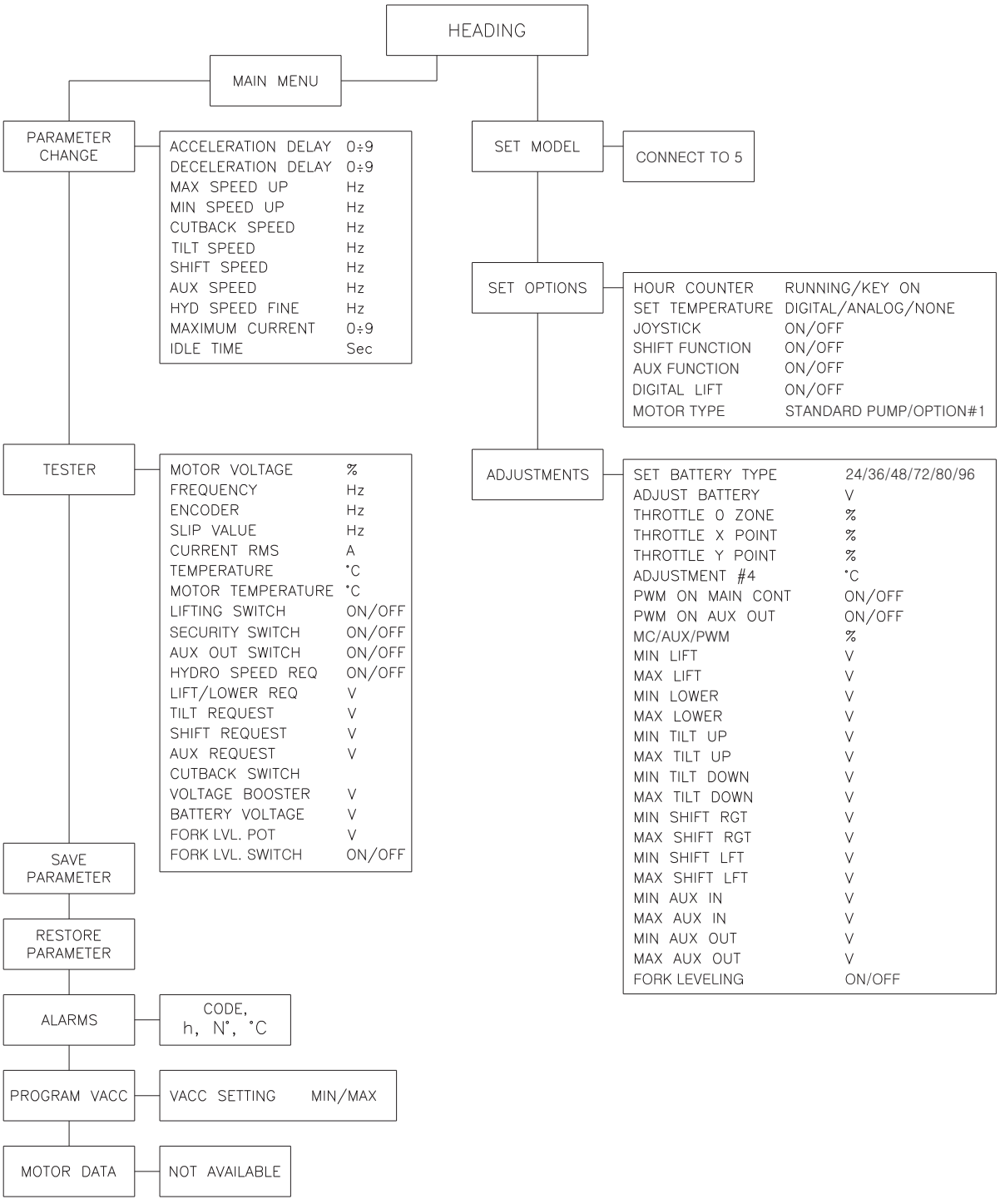
22B9EL18

② Traction controller-Slave



22B9EL19

③ Pump controller



22B9EL20

(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.

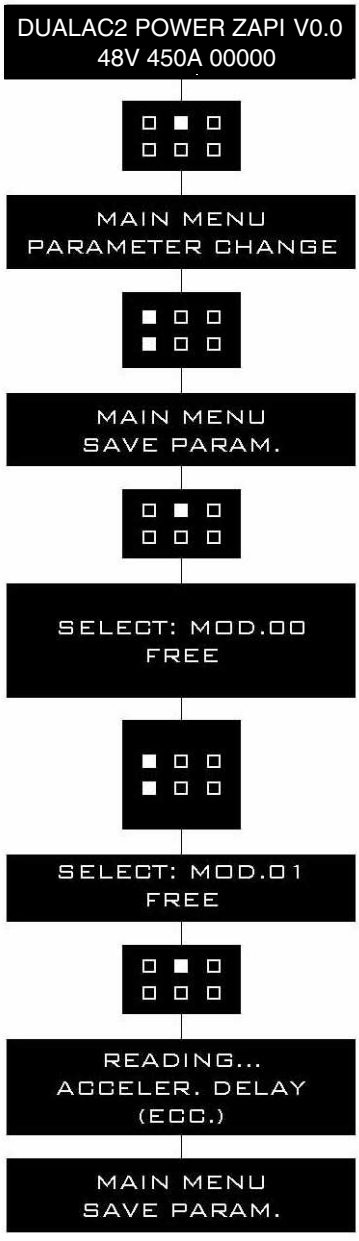
⑧ Keep pressing either ROLL UP or ROLL DOWN keys until the second Main indicates a FREE storage facility.

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.



22B7EL21

(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.

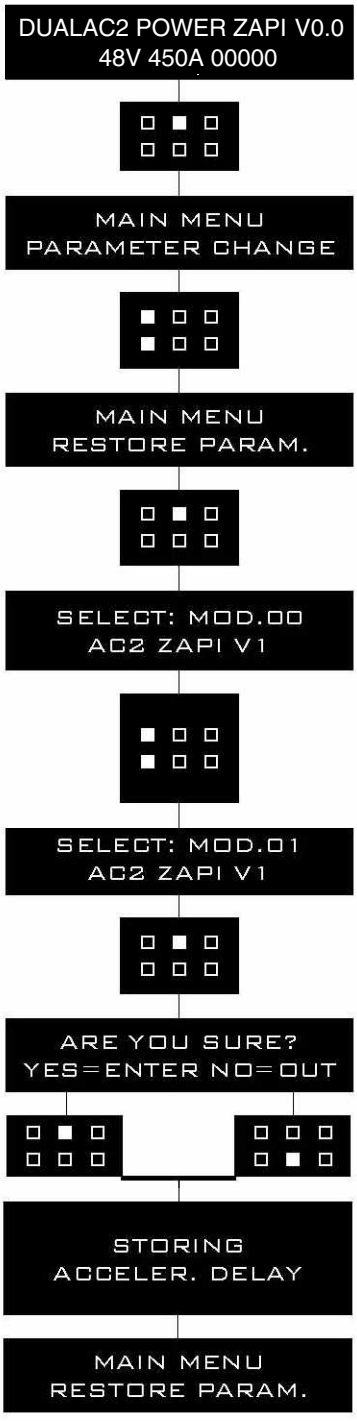
⑧ Keep pressing either ROLL UP or ROLL DOWN keys until the desired model appears on the display.

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.

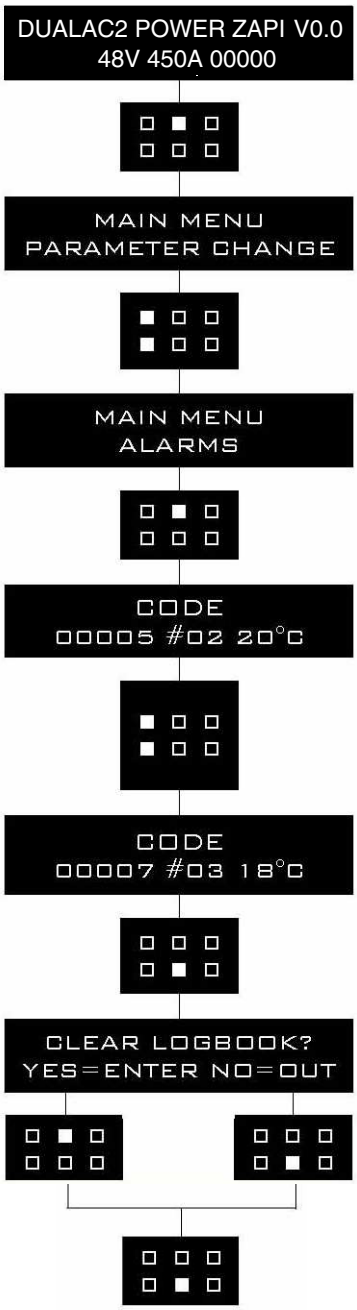
⑨ If an alarm has not occurred, the display will show: ALARM NULL.

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.

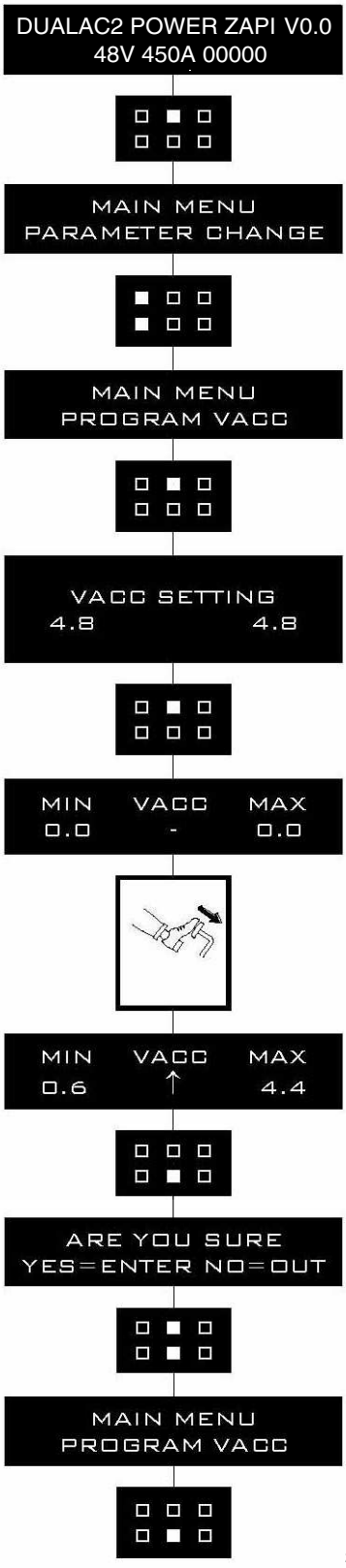
⑫ When finished, press OUT.

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

(7) DESCRIPTION OF CONSOLE USING

① Access to SET MODEL menu.

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

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

a. Opening Zapi menu.

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

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

d. Press ENTER to go into the SET MODEL.

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

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

g. New desired value appears.

h. Press OUT to exit the menu.

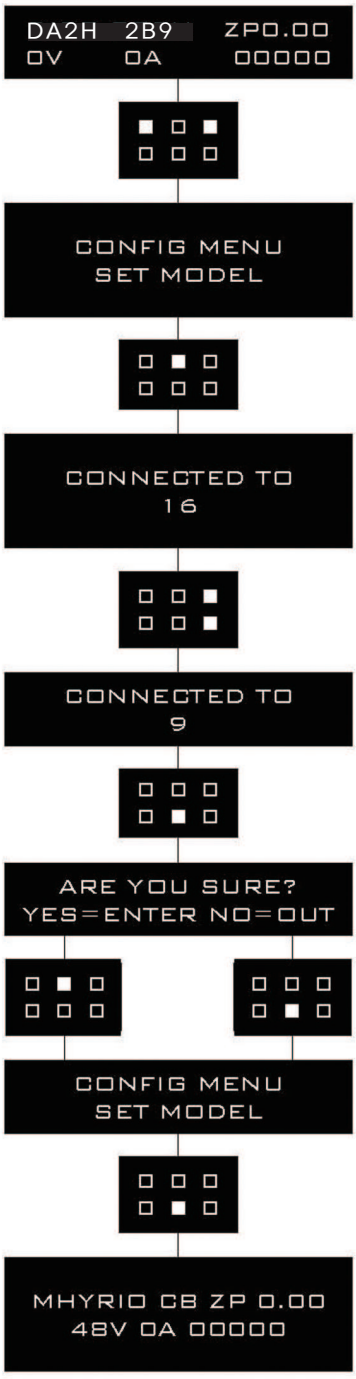
i. The display will ask "ARE YOU SURE?"

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

k. SET MODEL menu appears.

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

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



20B7EL28

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

a. Opening Zapi menu.

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

c. The display will show: SET MODEL.

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

e. SET OPTIONS menu appears.

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

g. The display will show the first option.

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

i. Desired option appears.

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

k. New value for selected option appears.

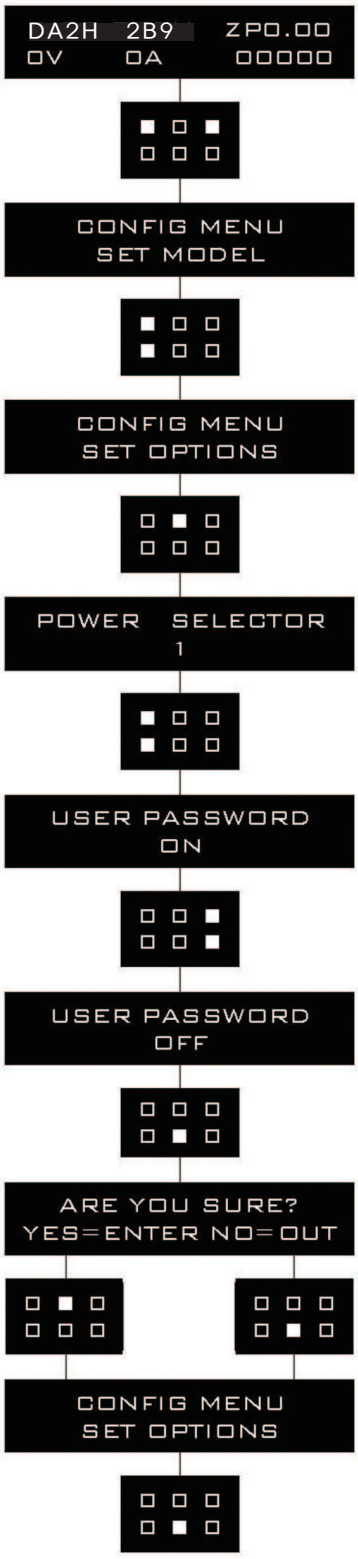
l. Press OUT to exit the menu.

m. Confirmation request appears.

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

o. SET OPTIONS menu appears.

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



20B7EL29

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

a. Opening Zapi menu.

b. Press ENTER to go into the MAIN MENU.

c. The display will show: PARAMETER CHANGE.

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

e. The display will show: TESTER.

f. Press ENTER to go into the TESTER function.

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

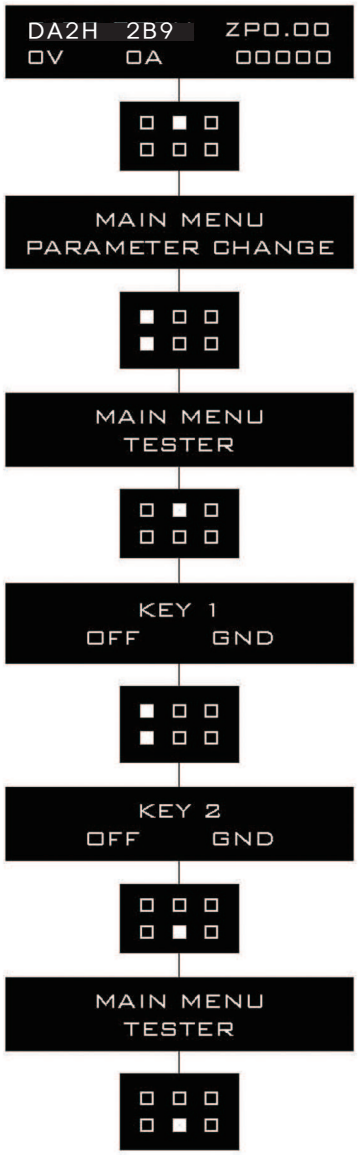
h. Press either ROLL UP or ROLL DOWN buttons.

i. Next variable for measurement appears.

j. When you have finished press OUT.

k. The Display will show: TESTER.

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



20B7EL30

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

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 MOSFETdevices.

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.

⑯ **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.

⑰ **Battery voltage:**

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

7) GENERAL SUGGESTION FOR SAFETY

For a proper installation take care of the following recommendations:

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

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

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

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

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

※ The method of discharging internal capacitor

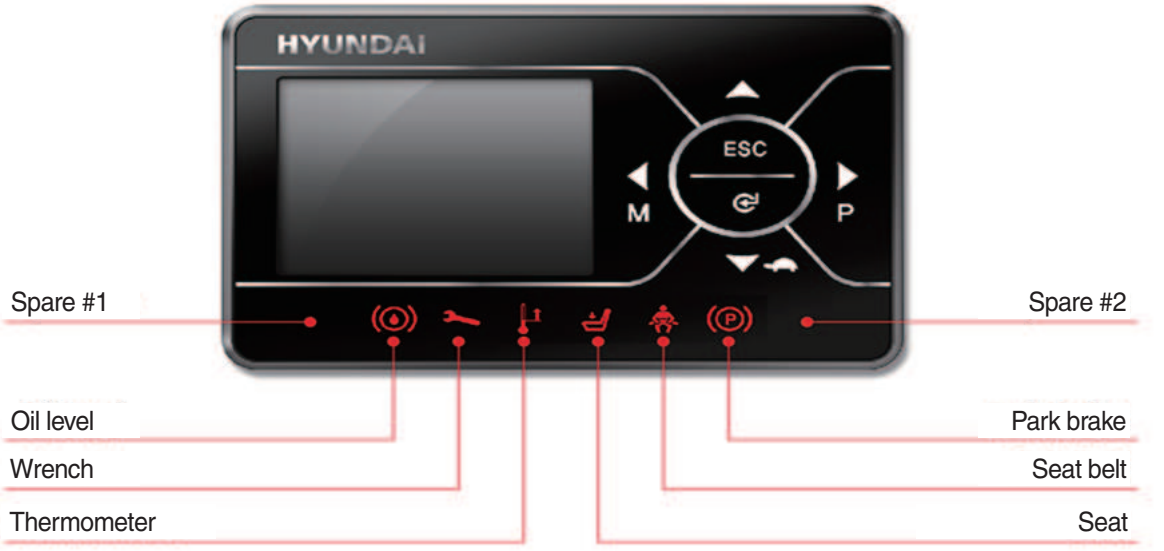
Bofore checking controllers, motors, cables and etc., discharge the internal capacitor in controllers by following below steps ;

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

6. INSTRUMENT PANEL : DISPLAY

1) STRUCTURE

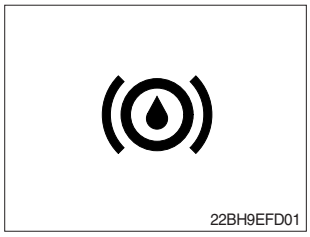
The DISPLAY has 6 red LEDs indicating the status information of the lift truck to the driver.



22BH9OM65

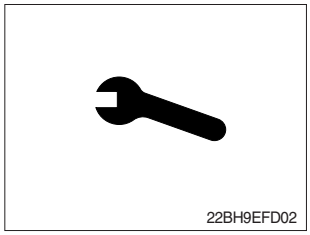
2) WARNING LAMP

(1) Brake oil level warning lamp



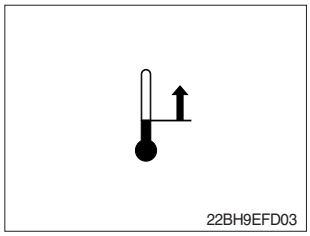
Blinks when the brake oil level in the reservoir is below the lower limit.

(2) Wrench warning lamp



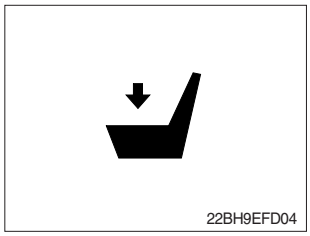
This LED lights when an electric device (controller, motor, cable, etc.) is in alarm condition.

(3) Thermometer warning lamp



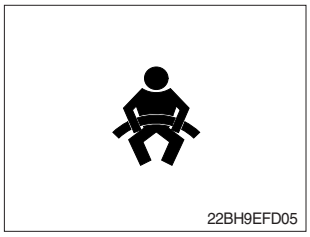
This LED lights when the controller or motor temperature is high.

(4) Seat warning lamp



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

(5) Seat belt warning lamp

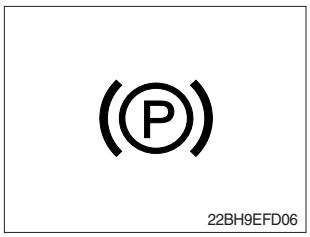


(1) This LED blinks in following 2 cases.

① When operator starts the truck, LED blinks for 5 seconds, which means initial diagnosis is on going, and buttons on display will work properely just after the diagnosis is completed.

② LED blinks when the seat belt is not correctly fastened.

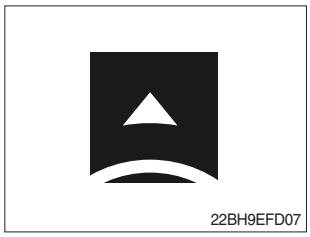
(6) Handbrake warning lamp



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

3) BUTTONS

(1) UP button

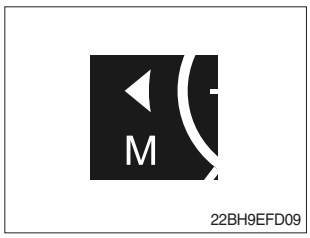


Press to select upward move

(2) DOWN button (DOWN/TURTLE button)

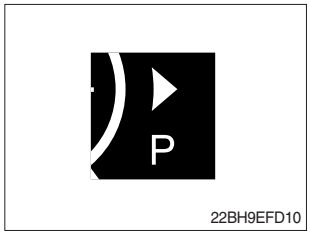
Press to select downward move
TURTLE MODE ON/OFF

(3) LEFT/MENU button



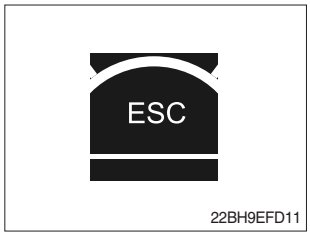
Press to select leftward move
Go into the menu

(4) RIGHT/PERFORMANCE button



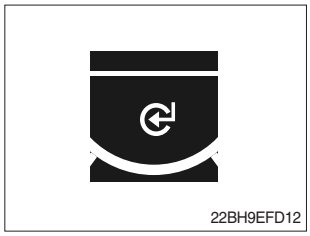
Press to select rightward move
POWER MODE H/N/E

(5) Cancel (ESC) button



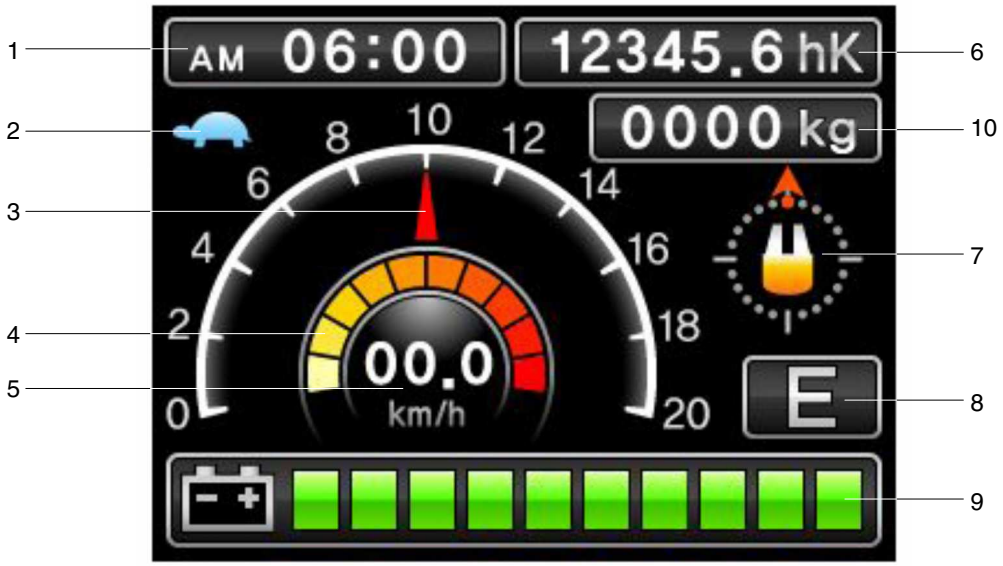
Press to select cancel
Keep pressing this button shows PASSWORD entry field.

(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 a adjust BDI with adjustment #1, #2 BDI menu.

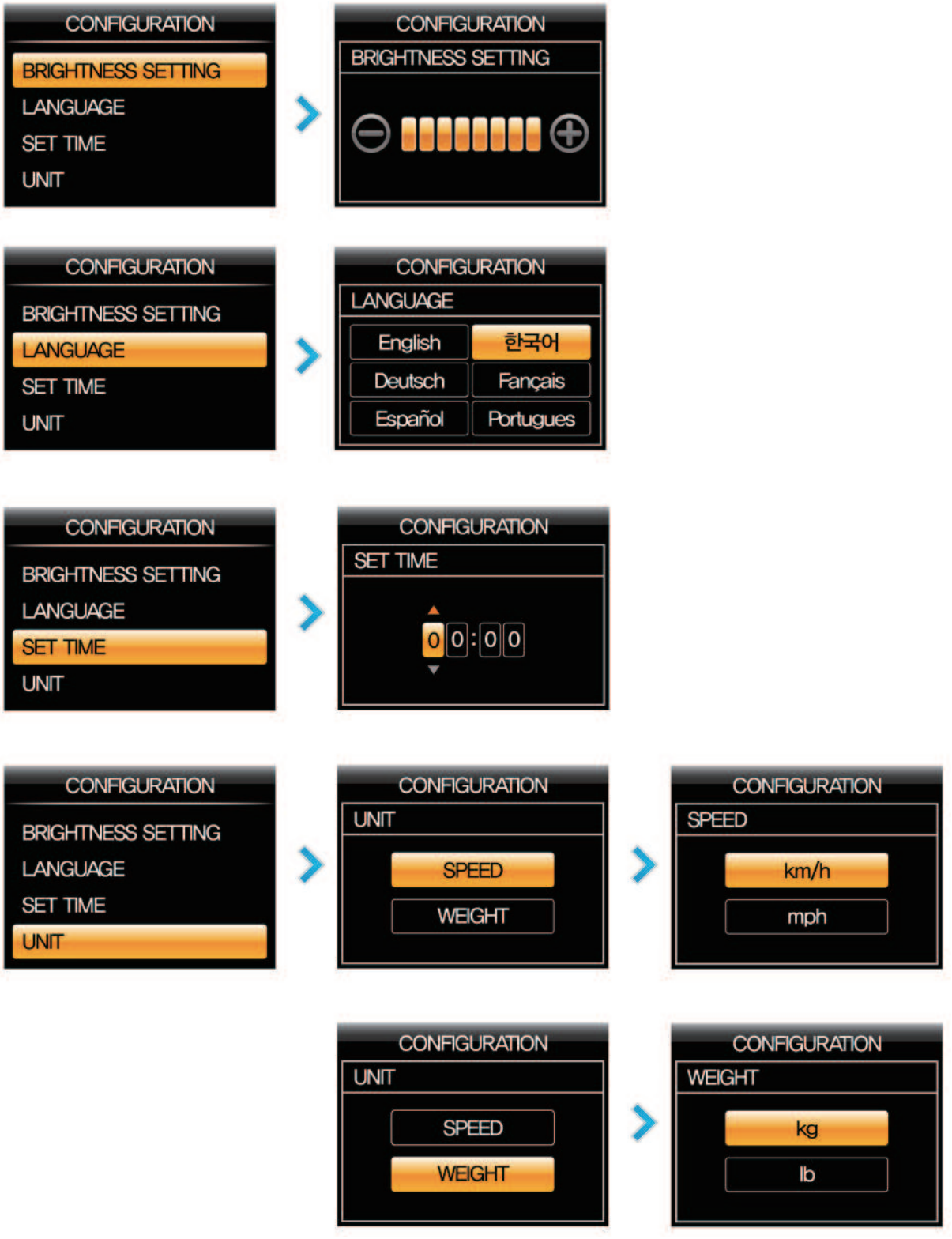
① Adjustment #1 BDI

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


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

22BH9EFD15

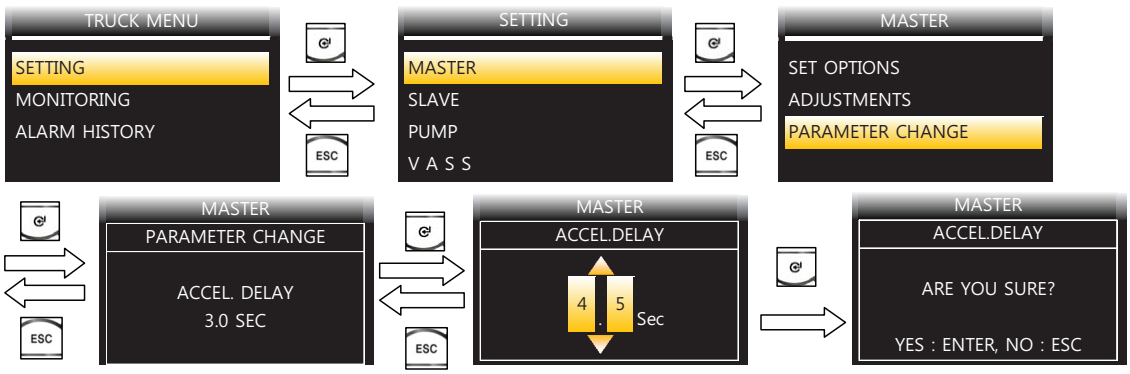
6) DESCRIPTION OF THE TRUCK MENU

(1) Access to truck menu

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

(2) How to change detail menus

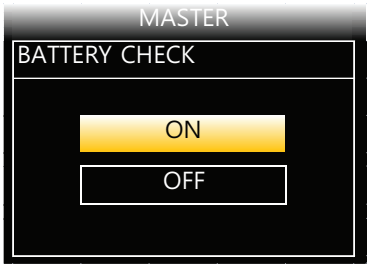
The detail items of menu can be changed as follows ;



22B9EL24

Selection can be made in 4 methods as follows ;

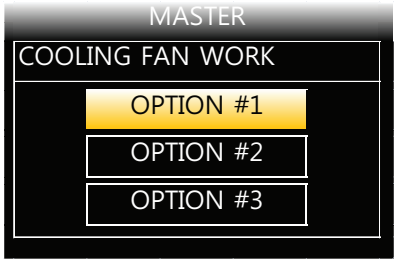
- ON/OFF Selection



22B9EL25

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

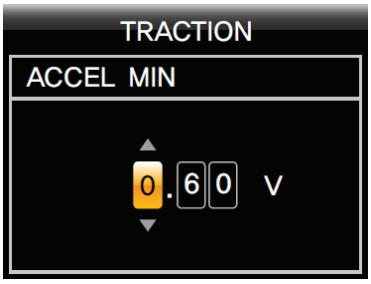
- Type Selection



22B9EL30

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

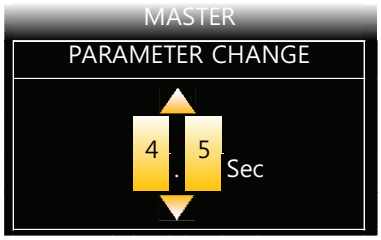
- Figure input



22B9EL31

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

- Level Selection



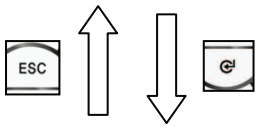
22B9EL30

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

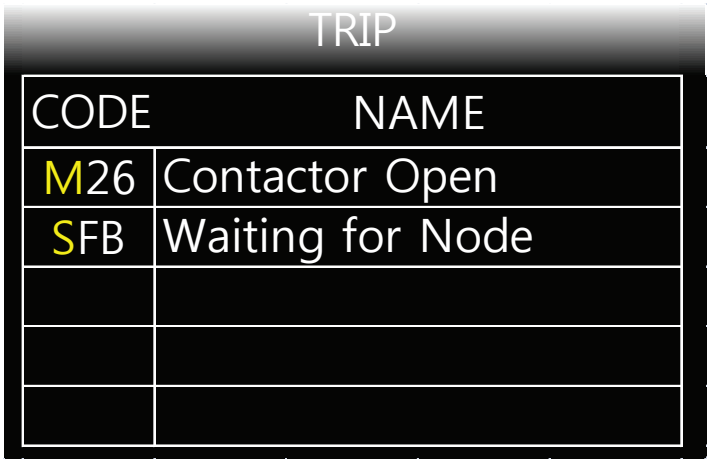
7) ALARM & ALARM HISTORY

(1) How to check alarms

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

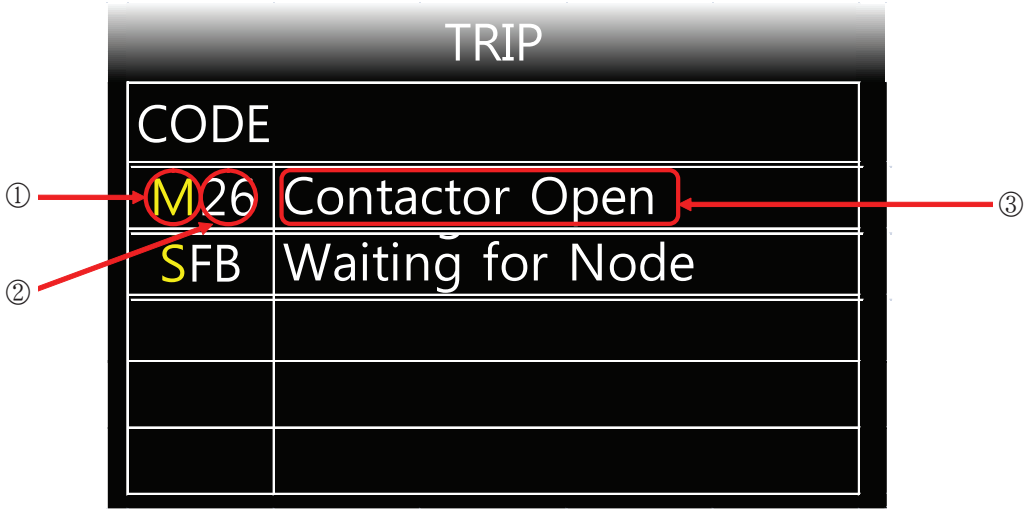


(Press more than 1 sec)



22B9EL35

(2) Detail description of ALARM SCREEN



22B9EL36

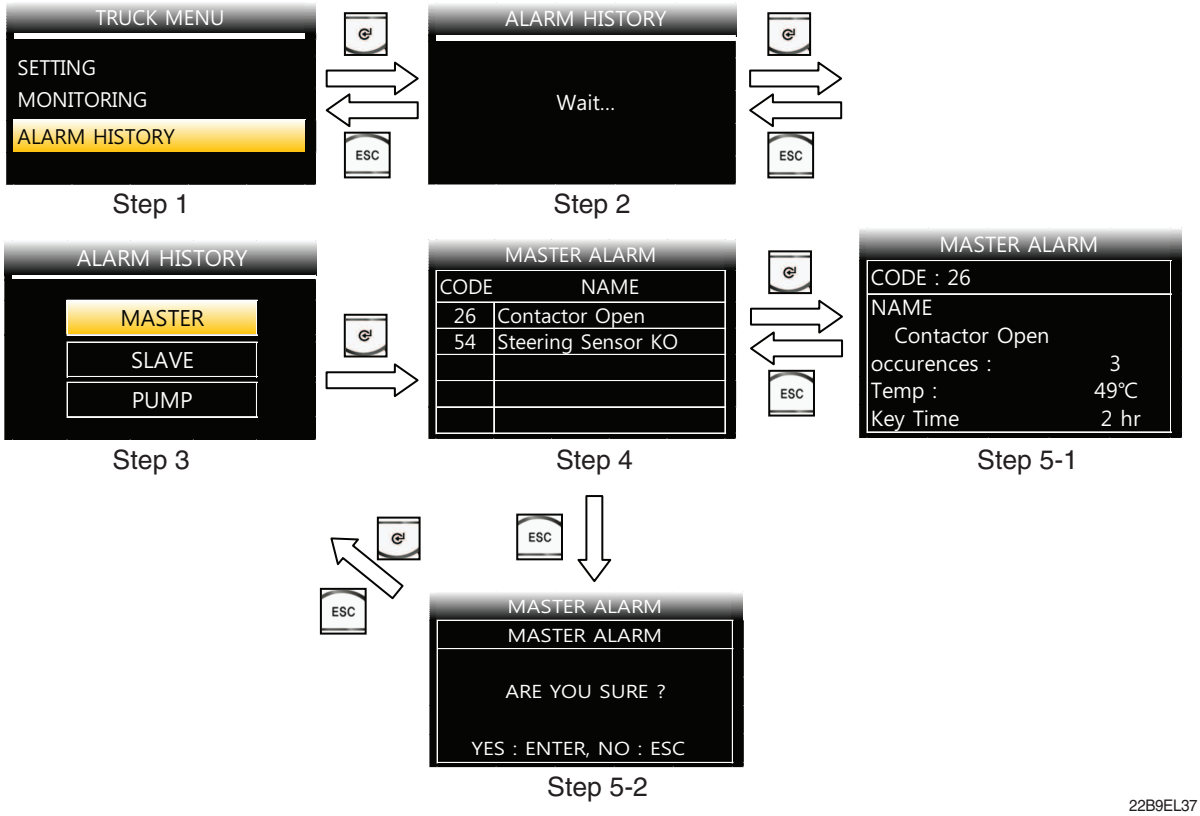
① First yellow capital letter shows in which controller the alarm happens as below;
M : Traction-Master
S : Traction-Slave
P : Pump
V : Mhyrio CB

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) Alatm history

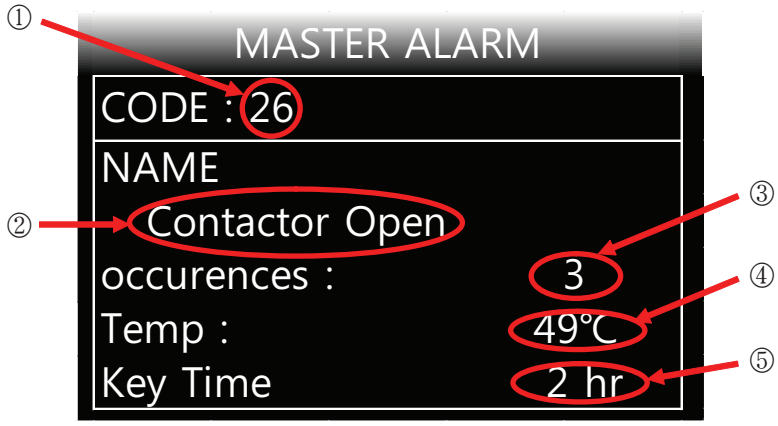
Alarm History can be looked up as follows ;



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 6-7)-(4) DETAIL ALARM INFORMATION (page 7-62)
⑥ Step 5-2 : When service man press [ESC] button at Step 4, service man can see a alarm clear menu. If service man press [↵] button, Recorded alarms of selected controller will be erased.
(to verify cleaned alarm records, service man should be back to Step 1 & 2 to refresh.)
If operator press [ESC] button, just escape to step 3 without clearing

(4) Detail alarm information



22B9EL38

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

8) VASS SETUP USING DISPLAY MENU

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

(All figures in belows are just example.)

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

(1) ACCEL VASS setting method

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

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

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

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

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

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

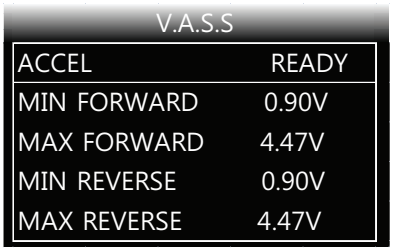
V.A.S.S	
ACCEL	READY
MIN FORWARD	0.90V
MAX FORWARD	4.47V
MIN REVERSE	0.76V
MAX REVERSE	1.76V

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

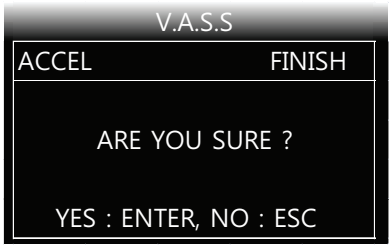
V.A.S.S	
ACCEL	READY
MIN FORWARD	0.90V
MAX FORWARD	4.47V
MIN REVERSE	0.90V
MAX REVERSE	0.90V

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

22B9EL39-1

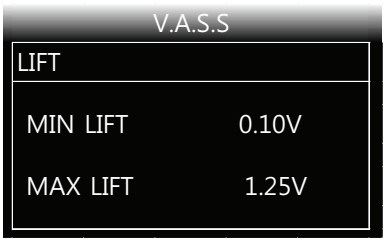


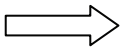
Now, you can see that voltage value of MAX REVERSE are changed.
Please make sure that all motors are not running & direction lever is in NEUTRAL position.



22B9EL39-2

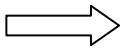
(2) LIFT VASS setting method

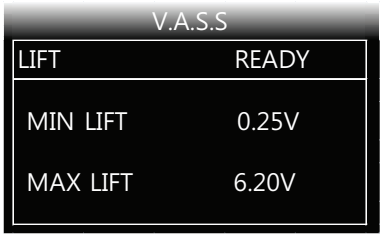




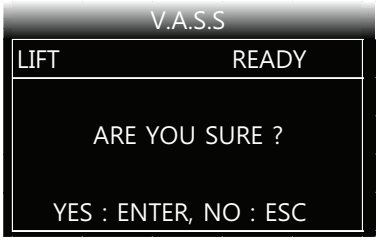
Please make sure that all motors are not running & direction lever is in NEUTRAL position.

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



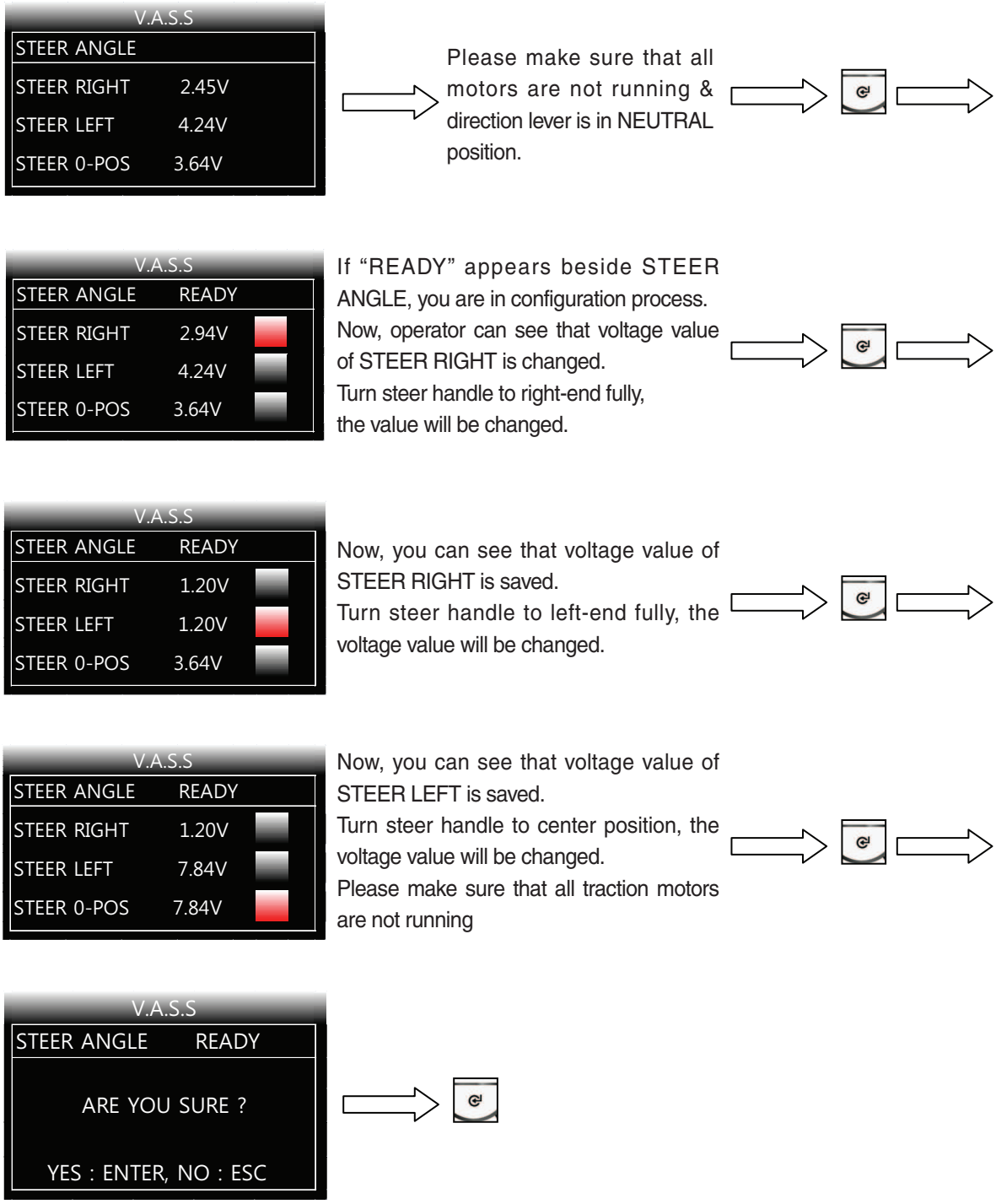


Now, you can see that voltage value of MAX LIFT are changed.
Please make sure that all motors are not running & direction lever is in NEUTRAL position.



22B9EL40

(3) STEER ANGLE VASS setting method



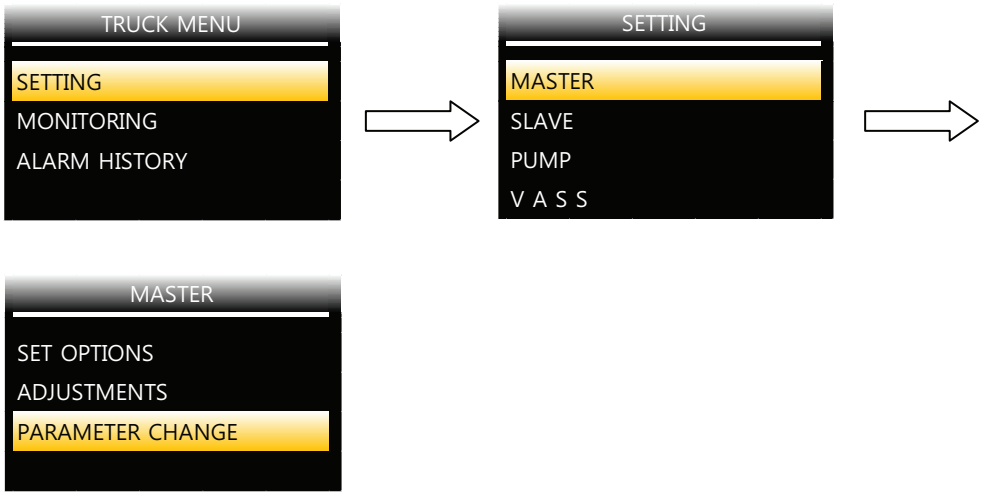
22B9EL41

9) STRUCTURE OF TRUCK MENU

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

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

(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)

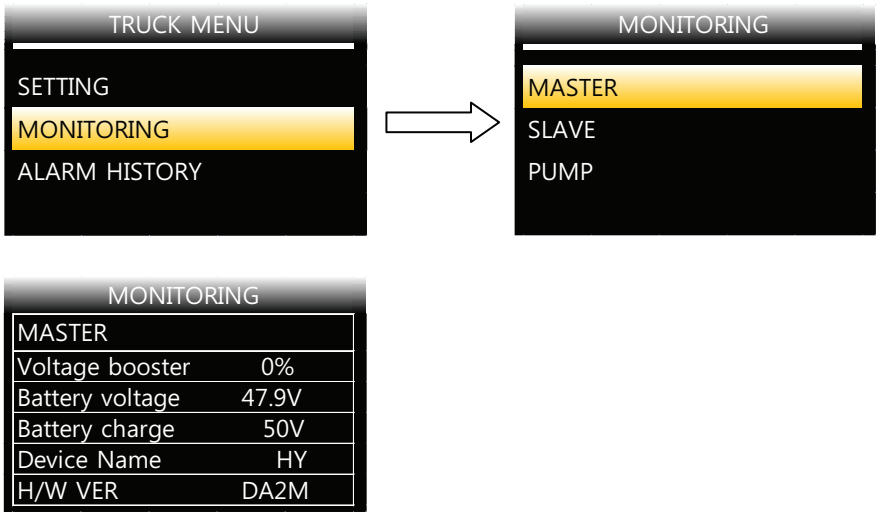
⑦ PUMP->SET OPTIONS
Refer to 5-4)- ■ “PUMP CONTROLLER”-(1) “SET OPTIONS” (page 7-31)

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	- If the alarm is present in Init status, remove the alarm condition - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a traction request
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	- To remove alarm condition + activation of traction request - Check the Controller
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	- To recycle the key switch - Sometimes if battery voltage is too low, it can be happens - Check the Controller
1E	VMN LOW	Alarm: wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor	- If the alarm is present in Init status, remove the alarm condition - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a traction request - Check the U,V,W cable and motor and if there is any shorted circuit with frame or any other parts of truck - Check the Controller
1F	VMN HIGH	Alarm: wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor	- If the alarm is present in Init status, remove the alarm condition - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a traction request - Check the U,V,W cable and motor and if there is any shorted circuit with frame or any other parts of truck - Check the Controller
25	CONTACTOR CLOSED	Alarm: line contactor power contact is stuck	- To remove alarm cause within a timeout; if the timeout is elapsed, it is necessary to re-cycle the key - Check the contactor & cables attached to the contactor
26	CONTACTOR OPEN	Alarm: line contactor power contact does not pull-in	- To remove alarm cause within a timeout; if the timeout is elapsed, it is necessary to re-cycle the key - Check the contactor & cables attached to the contactor
31	I = 0 EVER	Alarm: While truck is running, current value is 0 for more than 1 Sec	- Check the Main contactor - Check the controller

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	- If the alarm is present in Init status, remove the alarm condition - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a traction request
3C	CAPACITOR CHARGE	Alarm: power capacitor voltage does not increase when the key is turned ON; failure in the power section, or in the Logic PCB, or in the driver PCB, or in the motor	- To remove alarm condition - Check the contactor resistance (300Ω, 10W) - Check the controller
3D	HIGH TEMPERATURE	Warning: Master or Slave or both temperature higher than 75°C	- To remove Warning cause
41	MOTOR TEMPERA-TURE	Warning: Master or Slave or both motors temperature high	- To remove Warning cause - Check the motor temp-sensor
42	BATTERY LOW	Warning: battery charge level below 10%	- To remove Warning cause
4A	DRIVER SHORTED	Alarm: line contactor coil driver is shorted	- If the alarm is present in Init status, remove the alarm cause - If the alarm has occurred in stby or running mode, it is necessary to remove alarm cause and to activate traction request
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"	- If the alarm is present in Init status, remove the alarm cause - If the alarm has occurred in stby or running mode, it is necessary to remove alarm cause and to activate traction request
4E	VACC NOT OK	Warning: acc. signal (CPOT) voltage higher than VACC MIN +1V while the traction enable switch is open	- To remove Warning cause - Re-configurate VASS ACCEL
4F	INCORRECT START	Warning: wrong traction 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	- To recycle the key - Check the motor encoder
54	STEER SENSOR KO	Alarm: steering sensor signal out of range	- To remove alarm cause
56	PEDAL WIRE KO	Alarm: fault in accelerator negative (NPOT) input circuit	- To remove alarm cause and activate a traction request
EE	LOADSENS ERROR	Alarm: Load weight sensor detects that loaded weight exceeds the weight limitation, or load weight sensor is not working properly	- To remove alarm cause - Check the load weight sensor

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 µC detects a Slave µC 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 availabel, H/W VER, S/W VER will be blank.)
F6 (slave only)	MASTER KO	Alarm: Slave µC detects a Master µC 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 availabel, 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	- To remove alarm cause - Check if any other alarm happens (Some alarms such as CHAT TIME or PEDAL WIRE KO, alarms related to CONTACTOR, DISPLAY ENABLE, alarms related to CANBUS can make this alarm sometimes.) - Check the communication with all controllers (display TRUCK MENU->MONITORING-> choose controller->H/W VER, S/W VER. If CAN communication is not availabel, H/W VER, S/W VER will be blank.)
F8	DISPLAY ENABLE	Warning: the display enable signal has not been received to operate the truck	- To remove warning cause
F9	THERMIC SENSOR KO	Warning: Master or slave temp. sensor is out of range	- To remove Warning cause
FA	INPUT MISMATCH (SLAVE ONLY)	Alarm: Slave µC has detected a mismatch between inputs status and the input status transmitted via Canbus by Master µC	- To recycle the key
FA	HANDBRAKE (MASTER ONLY)	Warning: handbrake microswitch is open and a travel request is active	- To remove Warning cause
FB	WAITING FOR NODE	Warning: Master Controller signals that other controllers are in alarm status	- To remove Warning cause - Check if any other alarm happens (Some alarms such as CHAT TIME or PEDAL WIRE KO, alarms related to CONTACTOR, DISPLAY ENABLE, alarms related to CANBUS can make this alarm sometimes.) - Check the communication with all controllers (display TRUCK MENU-> MONITORING-> choose controller->H/W VER, S/W VER. If CAN communication is not availabel, H/W VER, S/W VER will be blank.) - Check other controllers
FC	CHAT MODE	Warning: the chat time has expired	- To activate traction or pump request
FD	AUX OUTPUT KO	Alarm: MCV SOL driver shorted or open	- If the alarm is present in Init status, remove the alarm cause - If the alarm has occurred in stby or running mode, it is necessary to remove alarm cause and to activate traction request
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	- If the alarm is present in Init status, remove the alarm condition - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a traction request
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	- To remove alarm condition + activation of traction request - Check the Controller
13	LOGIC FAILURE #1	Alarm: an overvoltage or undervolt. condition has been detected	- To recycle the key switch - Sometimes if battery voltage is too low, it can be happens - Check the Controller
1E	VMN LOW	Alarm: wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor	- If the alarm is present in Init status, remove the alarm condition - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a traction request - Check the U, V, W cable and motor and if there is any shorted circuit with frame or any other parts of truck - Check the Controller
1F	VMN HIGH	Alarm: wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor	- If the alarm is present in Init status, remove the alarm condition - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a traction request - Check the U, V, W cable and motor and if there is any shorted circuit with frame or any other parts of truck - Check the Controller
31	I = 0 EVER	Alarm: While truck is running, current value is 0 for more than 1 Sec	- Check the Main contactor - Check the controller
35	STBY I HIGH	Alarm: wrong voltage in the current sensor feedback circuit	- If the alarm is present in Init status, remove the alarm condition - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a traction request
3C	CAPACITOR CHARGE	Alarm: power capacitor voltage does not increase when the key is turned ON; failure in the power section, or in the Logic PCB, or in the driver PCB, or in the motor	- To remove alarm condition - Check the contactor resistance (300Ω, 10W)
3D	HIGH TEMPERATURE	Warning: Controller temperature higher than 75°C	- To remove Warning cause

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	- To remove Warning cause - Check the motor temp-sensor
42	BATTERY LOW	Warning: battery charge level below 10%	To remove Warning cause
4A	DRIVER SHORTED	Alarm: line contactor coil driver is shorted	- If the alarm is present in Init status, remove the alarm cause - If the alarm has occurred in stby or running mode, it is necessary to remove alarm cause and to activate traction request
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	- If the alarm is present in Init status, remove the alarm cause - If the alarm has occurred in stby or running mode, it is necessary to remove alarm cause and to activate traction request
4E	VACC NOT OK	Warning: acc/lift signal (CPOT) voltage higher than VACC MIN +1V while the traction/lift enable switch is open	- To remove Warning cause - Re-configurate VASS LIFT
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	- To recycle the key - Check the motor encoder
56	PEDAL WIRE KO	Alarm: fault in accelerator/Lift negative (NPOT) input circuit	To remove alarm cause and activate a traction/ pump request
DF	SBR SWITCH OPEN	SIDE BATTERY REMOVAL sensor is open	- To remove Warning cause - Check the sensor
E3	TILT SENS OUT RNG	Value of tilt sensor (AUTO TILT LEVELING) is out of range	- Check the Tilt Sensor of AUTO TILT LEVELING Option - Re-configurate Tilt Sensor of AUTO TILT LEVELING Option
E4	TILT SENS LOCKED	Value of tilt sensor (AUTO TILT LEVELING) is fixed even tilt request is activated	- Check the Tilt Sensor of AUTO TILT LEVELING Option - Re-configurate Tilt Sensor of AUTO TILT LEVELING Option
E5	AUX FUNCT KO	Fingertip aux function is not working properly	- Check the MCV valve - Re-configurate lever - Check the fingertip controller
E6	SHIFT FUNCT KO	Fingertip shift function is not working properly	- Check the MCV valve - Re-configurate lever - Check the fingertip controller

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	- Check the MCV valve - Re-configurate lever - Check the fingertip controller
E8	LIFT FUNCT KO	Fingertip lift function is not working properly	- Check the MCV valve - Re-configurate lever - Check the fingertip controller
E9	AUX OUT OF RNG	Voltage value of AUX sensor is out of range	- Re-configurate the AUX lever - Check the AUX lever
EA	SHIFT OUT OF RNG	Voltage value of SHIFT sensor is out of range	- Re-configurate the SHIFT lever - Check the SHIFT lever
EB	TILT OUT OF RNG	Voltage value of TILT sensor is out of range	- Re-configurate the TILT lever - Check the TILT lever
EC	LIFT OUT OF RNG	Voltage value of LIFT sensor is out of range	- Re-configurate the LIFT lever - Check the Lift lever
ED	ACQUIRE AUX	Controller is configurating “AUX” lever function	- Finish the configuration process
EE	ACQUIRE SHIFT	Controller is configurating “SHIFT” lever function	- Finish the configuration process
EF	ACQUIRE TILT	Controller is configurating “TILT” lever function	- Finish the configuration process
F0	ACQUIRE LIFT	Controller is configurating “LIFT” lever function	- Finish the configuration process
F2	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
F4	FORK WRONG DIR	Direction of “AUTO TILT LEVELING” movement is not correct	- Check if operator operates truck correctly - Check the Tilt Sensor of Fork leveling Option - Re-configurate Tilt Sensor of Fork leveling Option
F5	WRONG SET BATTERY	Alarm: the battery voltage does not correspond to SET BATTERY TYPE programming	- To remove alarm cause
F6	SAFETY KO	Alarm: the controller detects malfunction on safety circuit (PUMP CONTROLLER A12-A34)	- To recycle the key - Check if any other alarms happen on controllers - Check the safety circuit
F7	NO CAN MS	Alarm: Pump controller has lost Can communication with #X	- To remove alarm cause - Check if any other alarm happens (Some alarms such as CHAT TIME or PEDAL WIRE KO, alarms related to CONTACTOR, DISPLAY ENABLE, alarms related to CANBUS can make this alarm sometimes.) - Check the communication with all controllers (display TRUCK MENU->MONITORING-> choose controller->H/W VER, S/W VER. If CAN communication is not availabel, H/W VER, S/W VER will be blank.)"

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	- To remove Warning cause - Check if any other alarm happens (Some alarms such as CHAT TIME or PEDAL WIRE KO, alarms related to CONTACTOR, DISPLAY ENABLE, alarms related to CANBUS can make this alarm sometimes.) - Check the communication with all controllers (display TRUCK MENU->MONITORING-> choose controller->H/W VER, S/W VER. If CAN communication is not availabel, H/W VER, S/W VER will be blank.) - Check other controllers."
FD	AUX OUTPUT KO	Alarm: EB coil driver shorted or open	- If the alarm is present in Init status, remove the alarm cause - If the alarm has occurred in stby or running mode, it is necessary to remove alarm cause and to activate traction request"

8. BATTERY CHARGER

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

1) BASIC INFORMATION

(1) What is charger

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

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

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

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

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

④ It prevents from under charging and overcharging.

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

(2) Notice on caring chargers

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

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

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

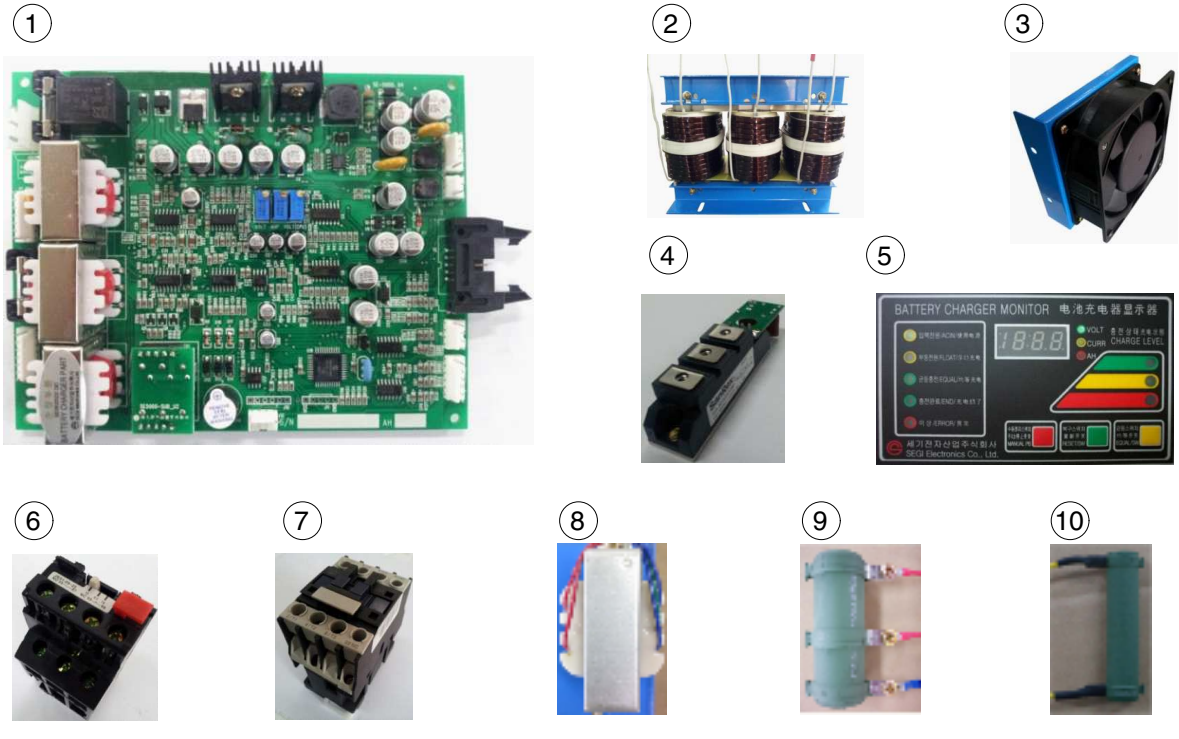
④ Check the electrolyte of the battery every week and provide distilled water immediately if it is required. (Electrolyte has to be provided between 10~12 ㎜ level on the positive plate inside storage battery)

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

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

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

(3) Names of each part (independent items)



22B9BAT30

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

2) CHARGER INSTALLATION METHOD

(1) Location for charger installation

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

(2) Check points before installing charger

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

(3) Table for capacity of charger input cable

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

3) HOW TO USE A CHARGER

(1) General charging method (Floating charging)

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

② Connect battery connecter and charger connecter.

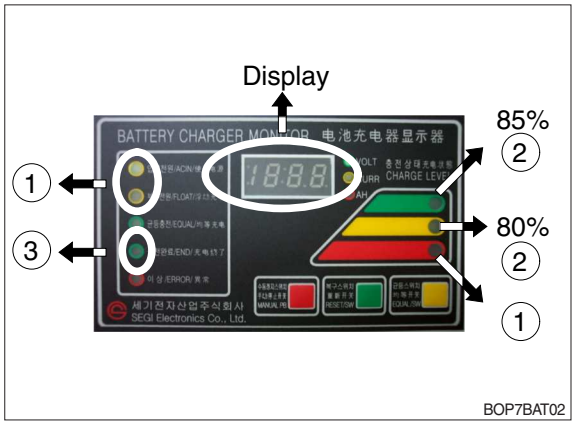
· **According to charging condition**

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

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

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

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



(2) Equalized charging

① **Equalized charging is**

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

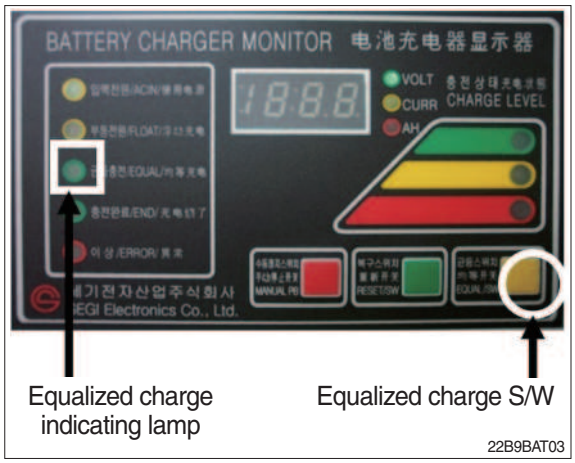
When equalized charging is required?

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

② **Tips for equalized charging**

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

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

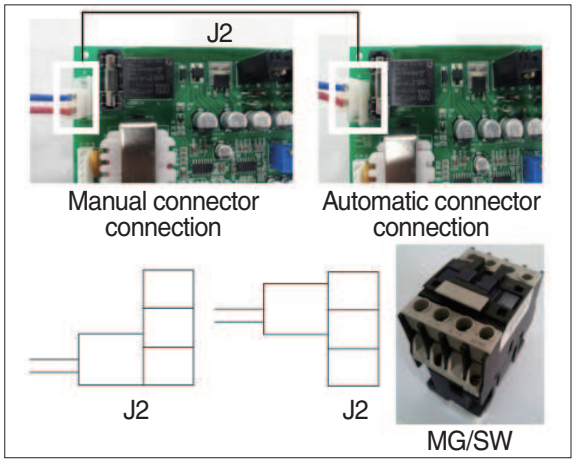


(3) Automatic/Manual switching method

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

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

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



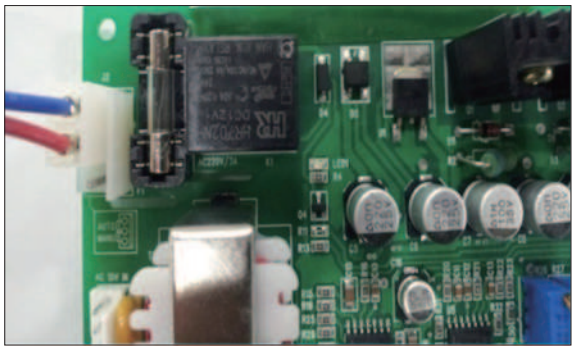
(4) Checking charging voltage soft start function (Refer to the monitor)

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

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

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

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



22B9BAT11

No	Code	Description of error
1	E.F	EPROM fail
2	O.V	Over voltage - Refer to page 7-86
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.

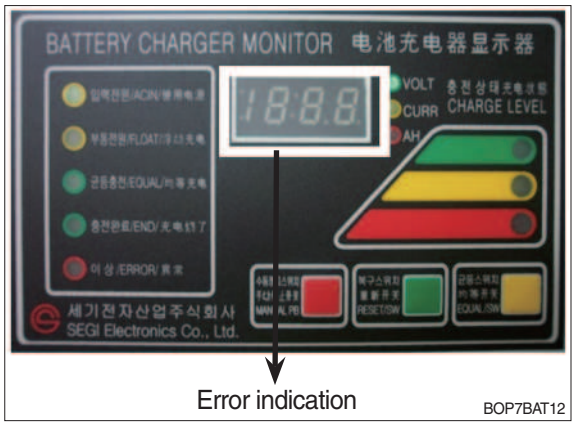
② A.O : Error on selection of input power source of 220V or 380V - Check it appropriately with full three phases.

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±1.0V.

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



5) ERROR DETECTION

(1) Error list

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

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

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

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

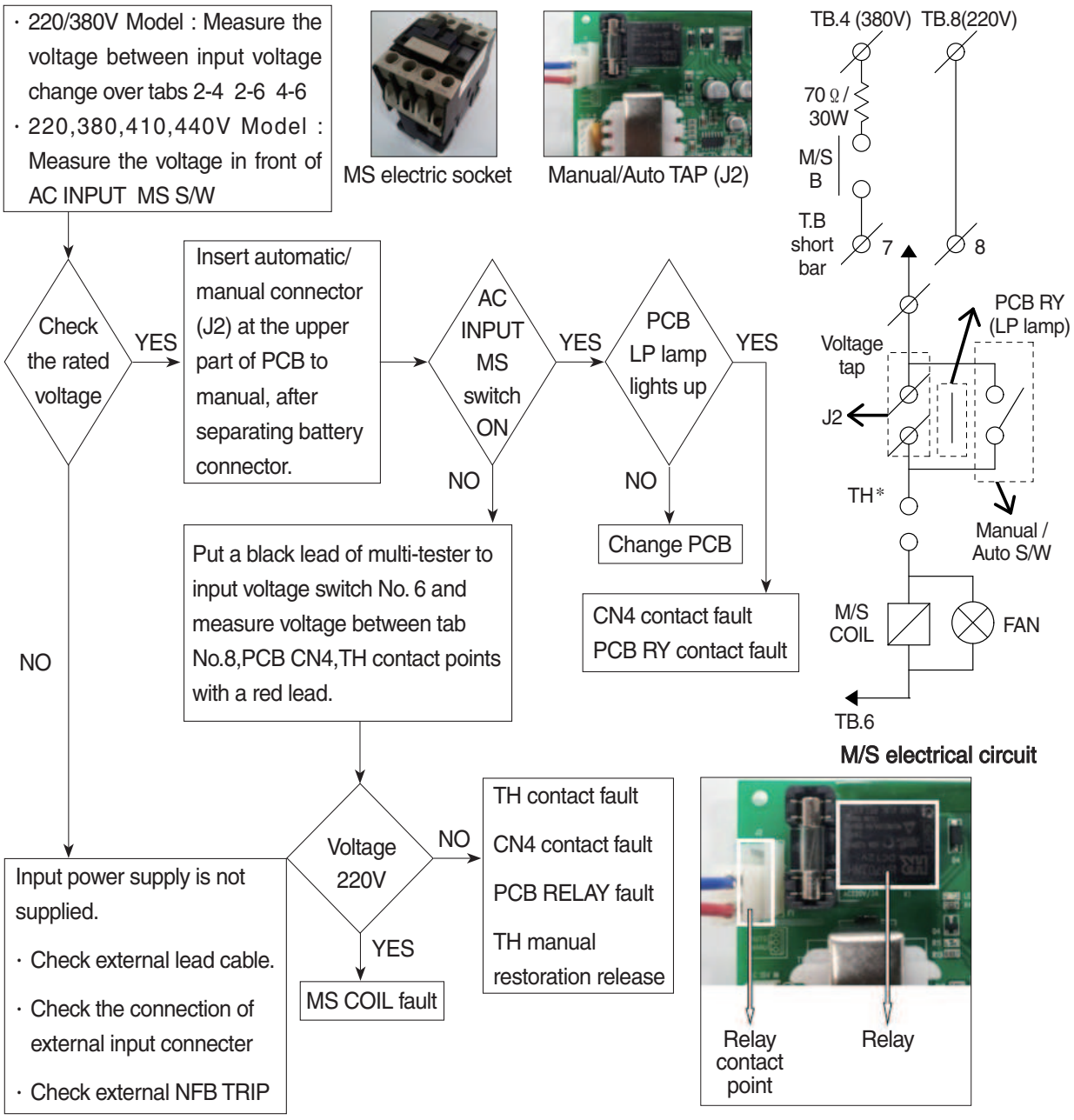
⑤ Charger TRIP is occurred after it started charging and charging completion lamp is on.

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

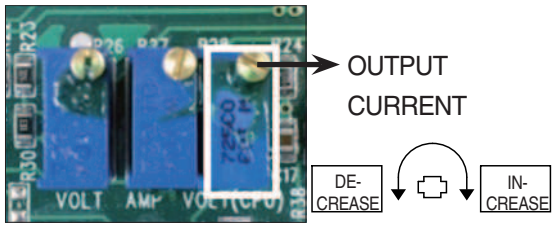
⑦ SCR module checking method

(2) Troubleshooting

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



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



Trans noise is severe at MS ON status

NO

Measure output current using DC current measure

Current value : 10~16A /100AH

NO

Exceed Standard current

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

YES

· TH Setting fault
· Re-adjust TH setting value

TH. TRIP

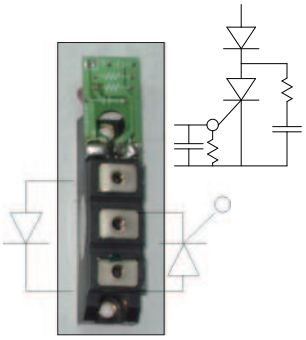
YES

Change TH

NO

Complete

* Refer to SCR Module checking method



Rated Current SETTING

YES

NO

Complete

Change PCB

YES

Separate the battery connector and tune the charger off

Check SCR Module

NO

Change SCR MODULE

YES

Check MAIN TRANS VOLT

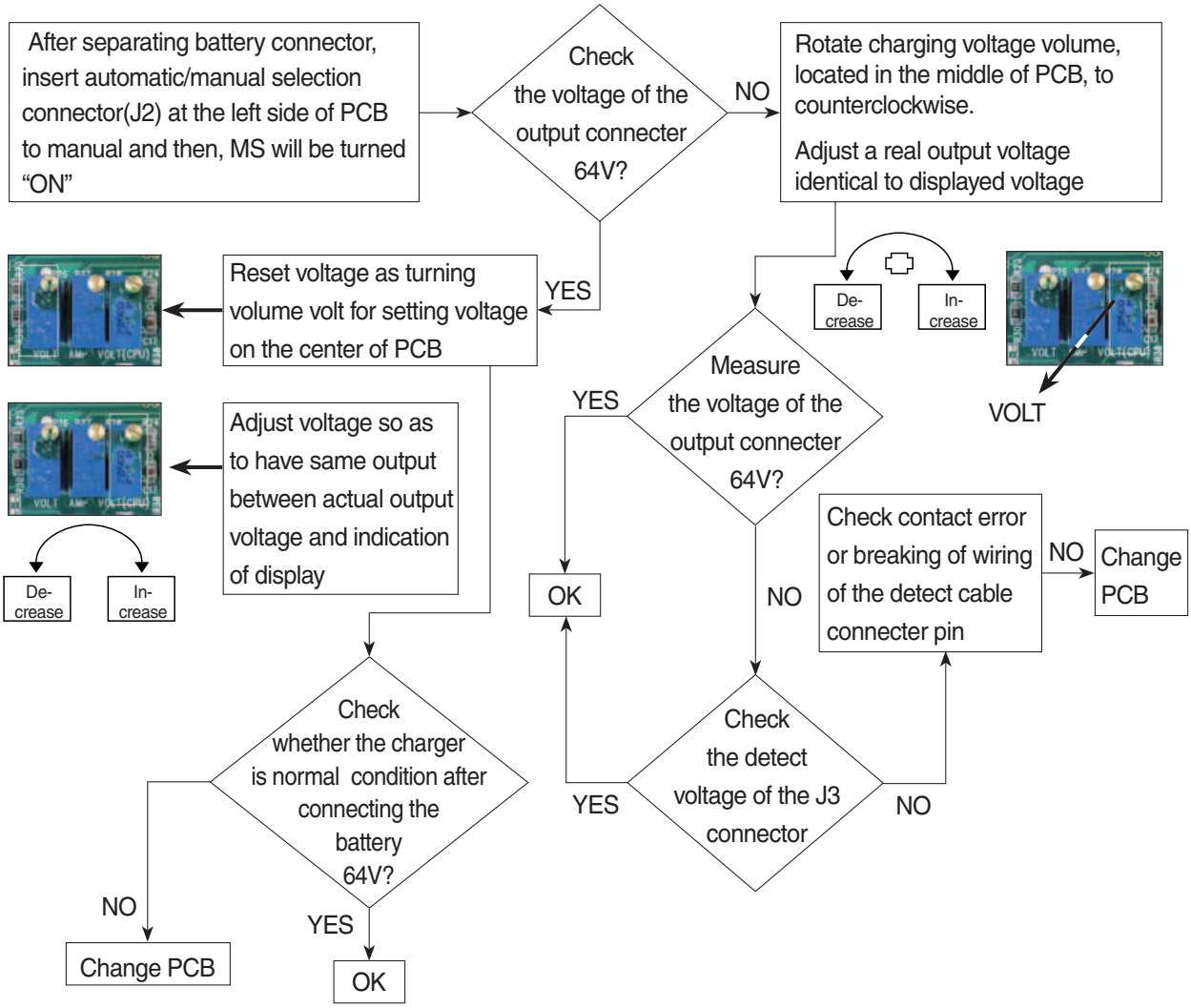
NO

Change PCB

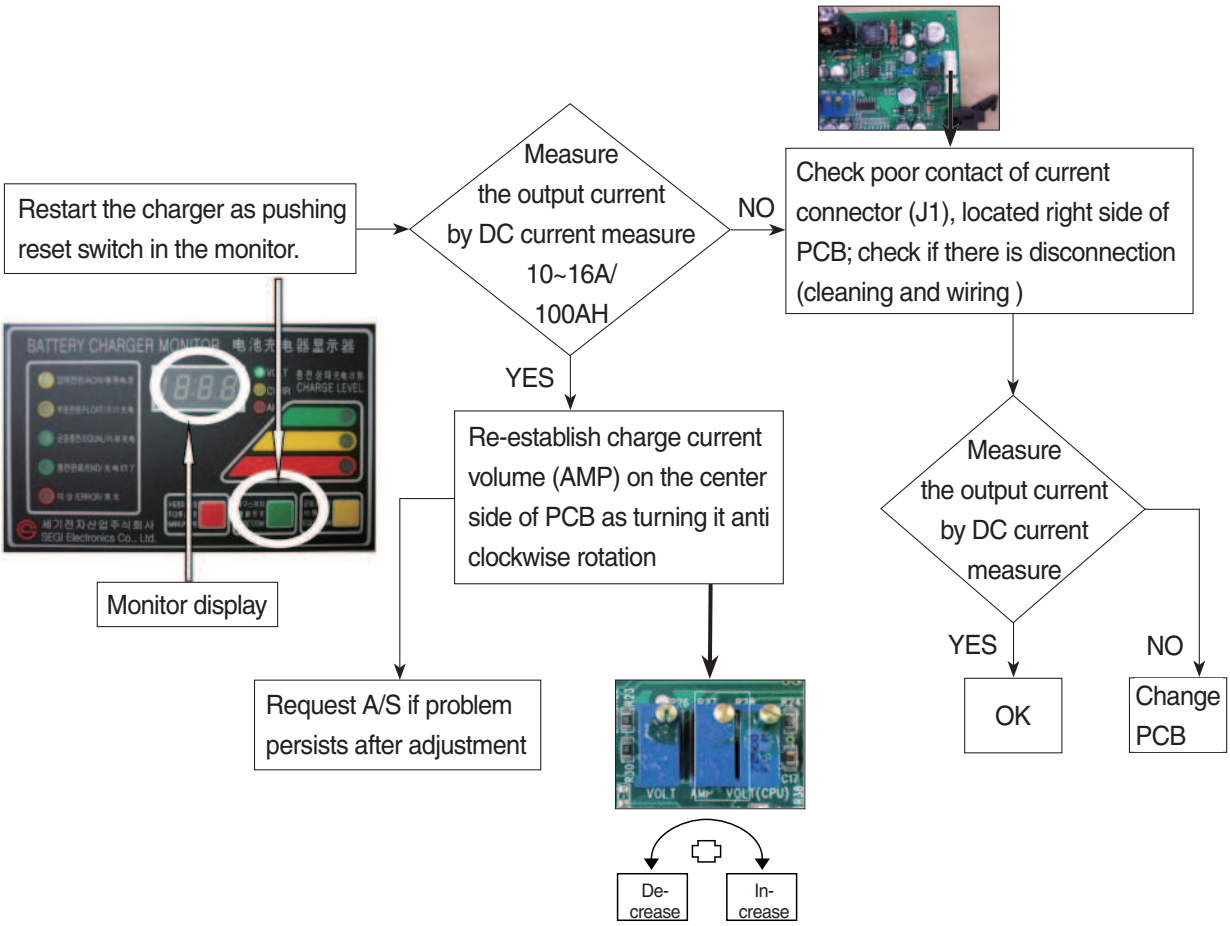
YES

Check the normal operating condition of the charger

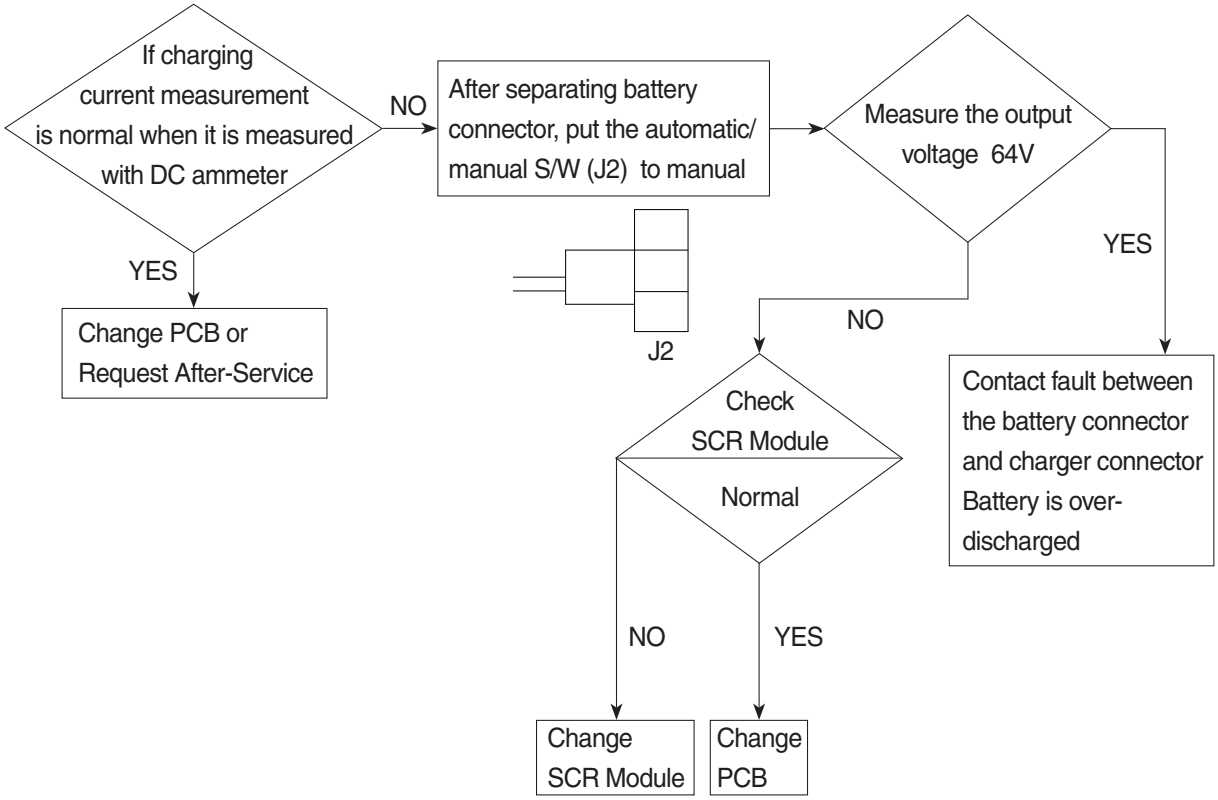
③ Charger TRIP is occurred after abnormality lamp is on.
In case error code is "O.V" → Over-voltage output / Set at 66V (In case of BATT 48V)
34V (In case of BATT 24V)
108V (In case of BATT 80V)



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

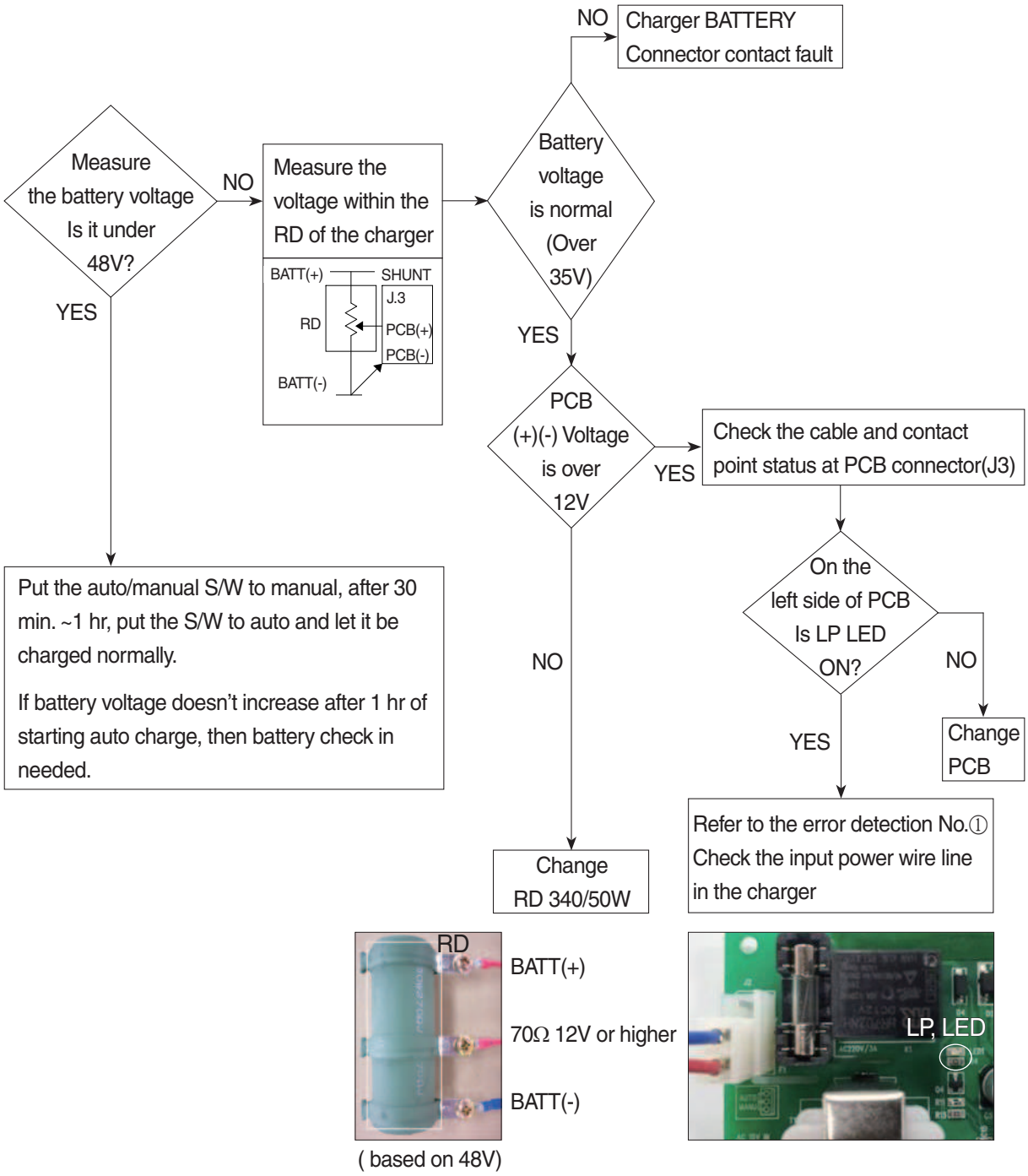


⑤ **Charger TRIP is occurred after it started charging and charging completion lamp is on.**
(In case input voltage is normal - Refer to the error detection No. 1)
Restore the charger as pushing reset switch.



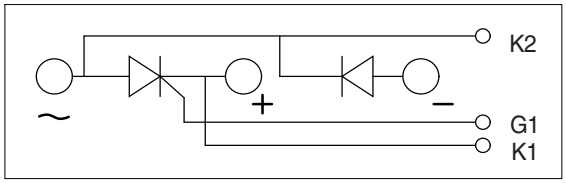
⑥ **Charger has no response even if the battery connector is connected.**

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

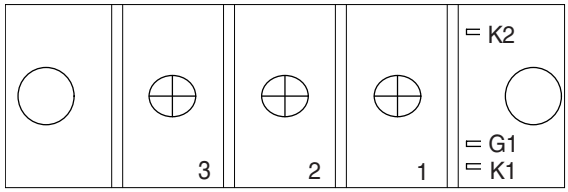


7) HOW TO CHECK THE SCR MODULE

Circuit

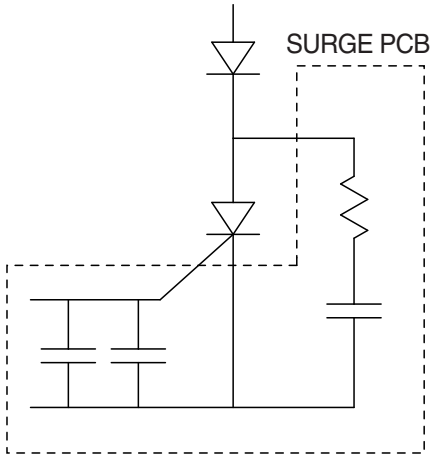


Real diagram

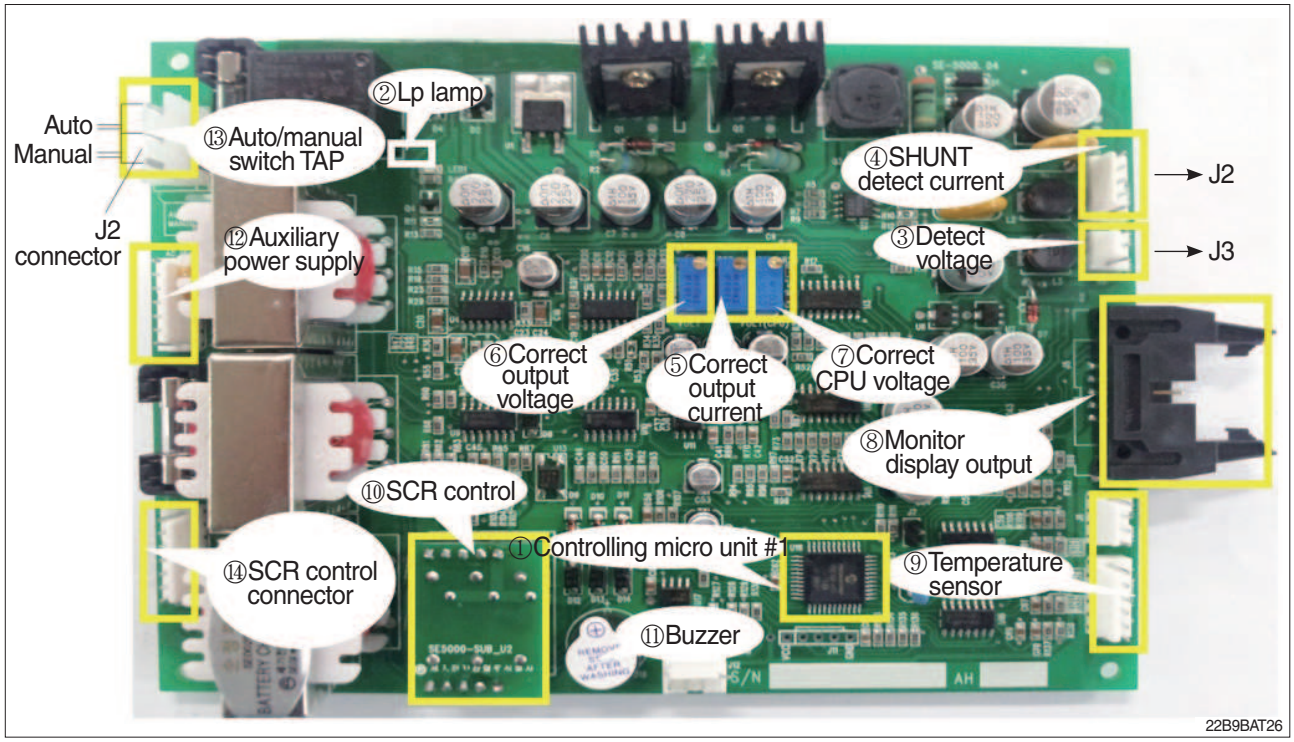


* Before checking SCR MODULE, be sure to disconnect bus bar and wire on the terminal.

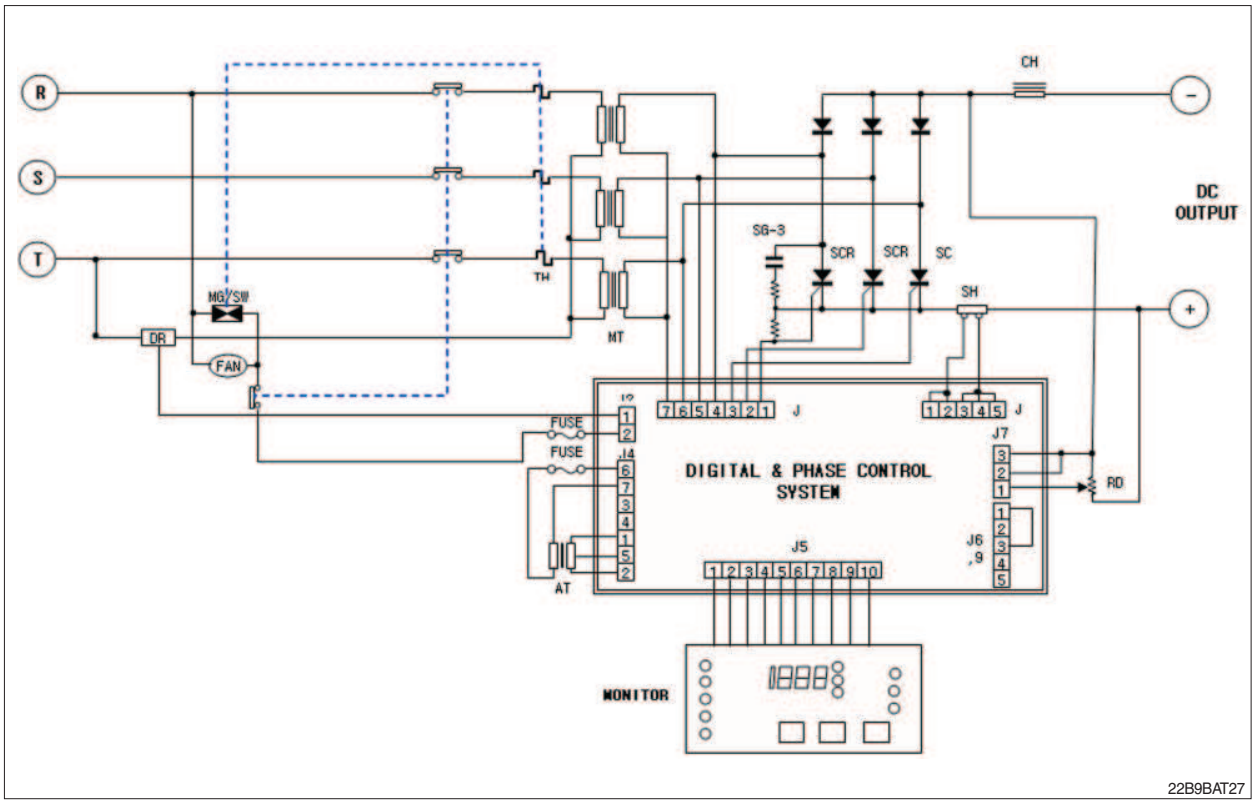
No.	Measuring point (Real diagram)	Measure value (Measurement of digital tester)
1	No.1 ~ No.3	Forward : Under 100 k ohm Reverse : Infinity (∞)
2	No.2 ~ No.3	Forward : Infinity (∞) Reverse : Infinity (∞)
3	G1 ~ K1	Forward : Under 100 ohm Reverse : Under 100 ohm But It depends on the module. If it is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



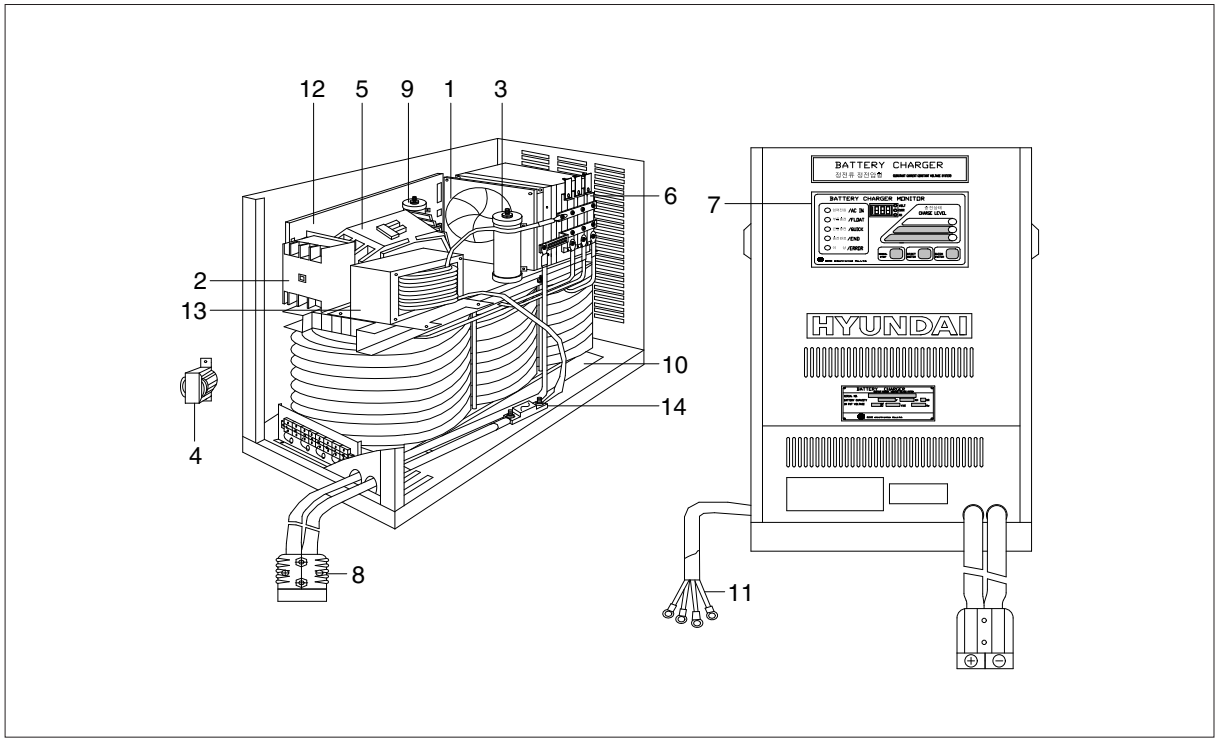
8) PCB MAJOR PARTS (NAME AND LOCATION)



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


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

CHARGER INTERIOR PARTS



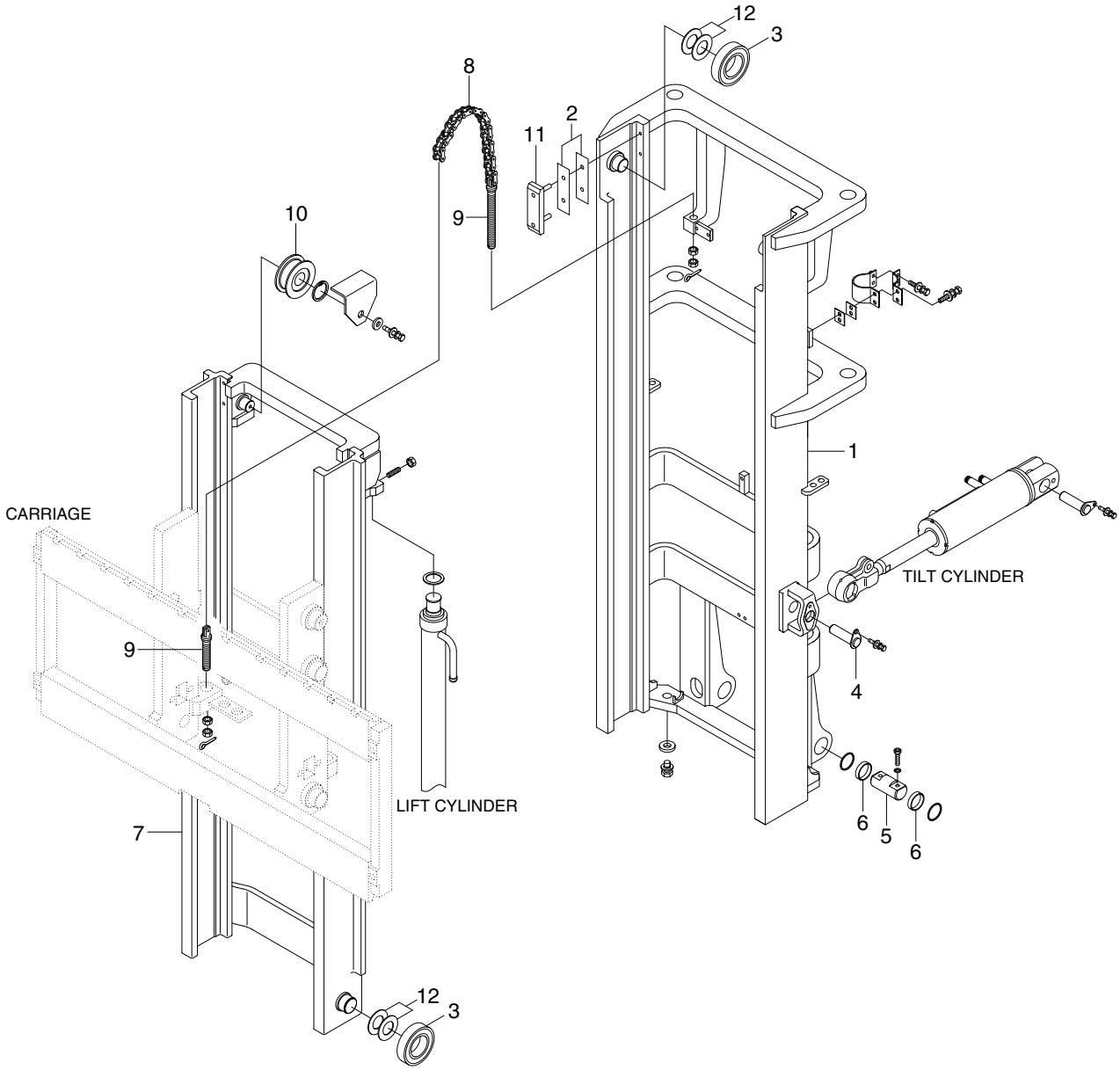
22B9BAT28

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

SECTION 8 MAST

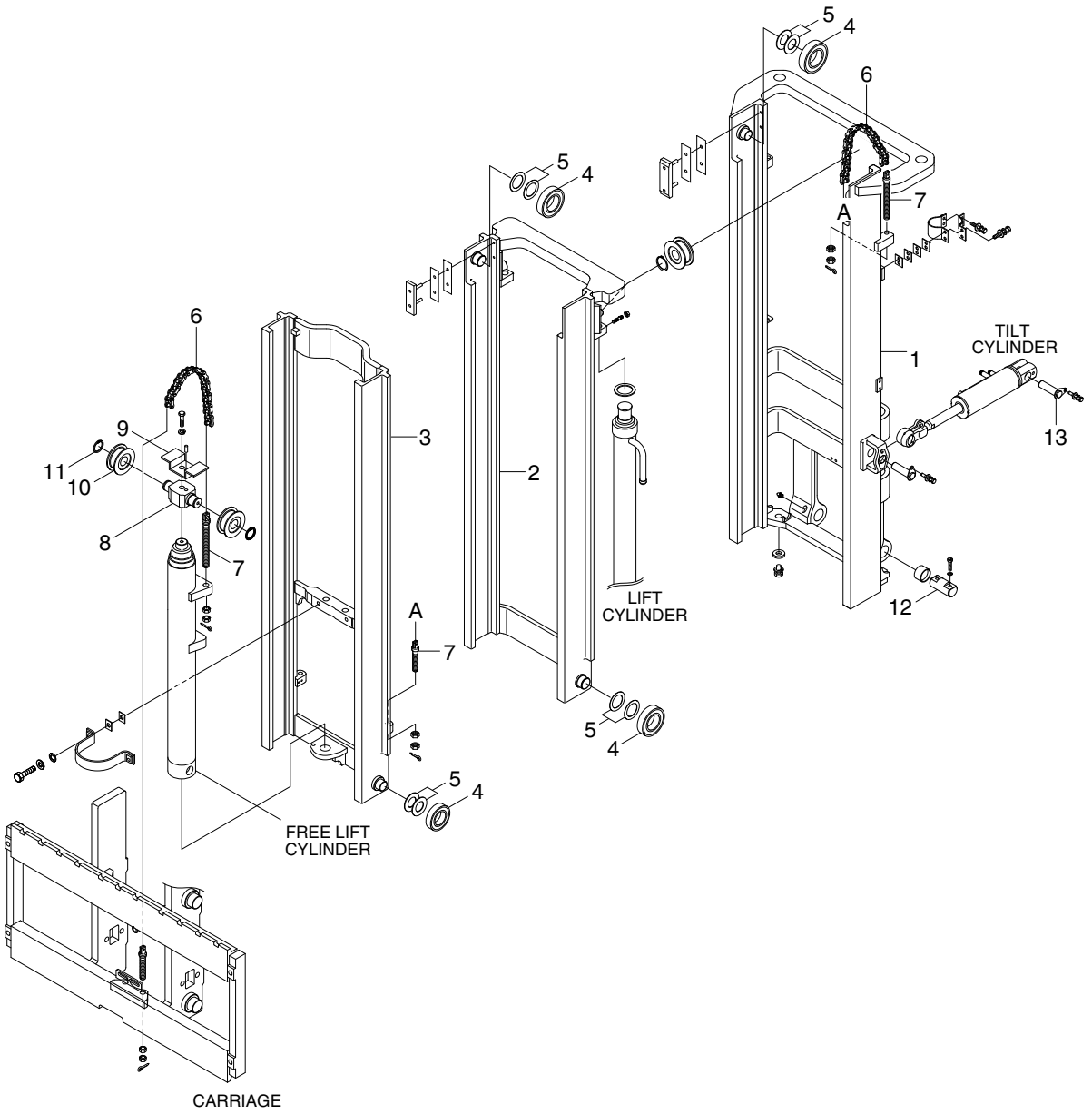
GROUP 1 STRUCTURE

1. 2 STAGE MAST (V MAST)



1	Outer mast	5	Mast mounting pin	9	Anchor bolt
2	Shim (0.5, 1.0t)	6	Bushing	10	Chain sheave
3	Roller	7	Inner mast	11	Back up liner
4	Tilt cylinder pin	8	Lift chain	12	Shim(0.5, 1.0t)

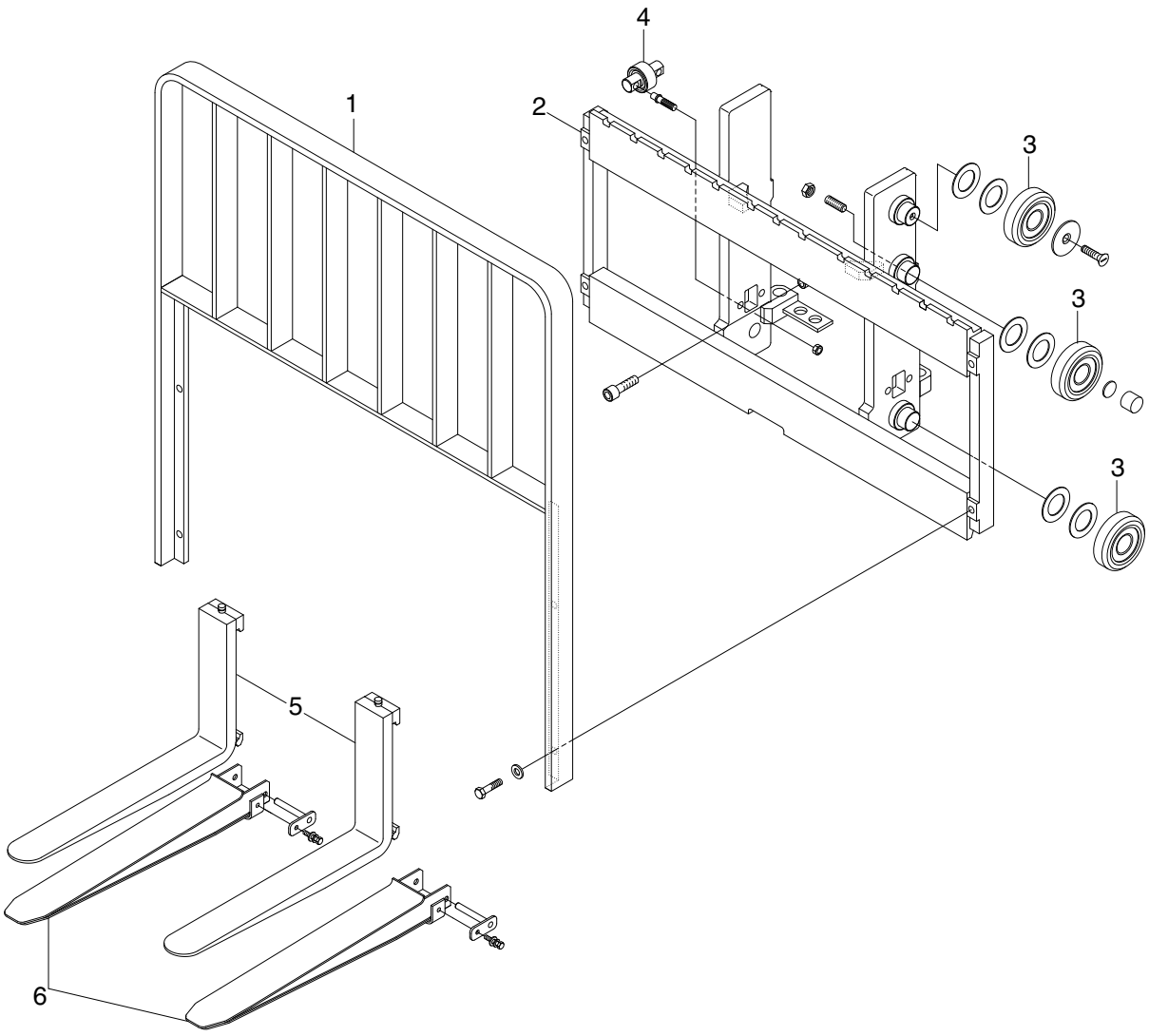
2. 3 STAGE MAST (TF MAST)



22B9MS02

1	Outer mast	6	Lift chain	10	Chain sheave
2	Middle mast	7	Anchor bolt	11	Retaining ring
3	Inner mast	8	Sheave bracket	12	Mast mounting pin
4	Roller	9	Chain guard	13	Tilt cylinder pin
5	Shim(0.5, 1.0t)				

3. CARRIAGE, BACKREST AND FORK



22BH9MS03

1	Backrest	3	Load roller	5	Fork assembly
2	Carriage	4	Side roller	6	Extension fork

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

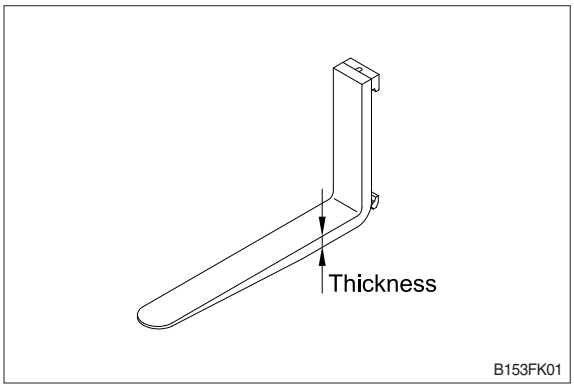
1. OPERATIONAL CHECKS

1) FORKS

(1) Measure thickness of root of forks and check that it is more than specified value.
EX : ℓ =1200 mm (47.2 in)

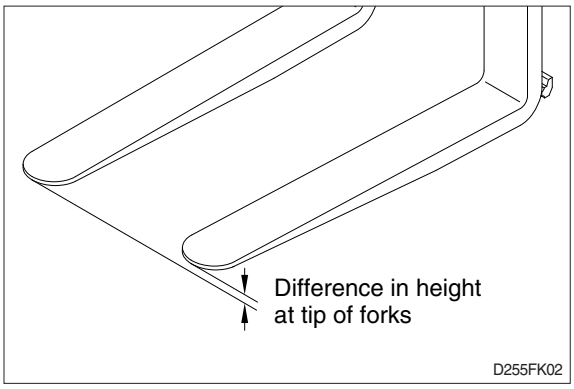
mm (in)

STD Fork assy	Applicable model	Standard	Limit
61HN-21030	22/25B-9	45 (1.8)	40 (1.6)
64HN-31020	30/32/35B-9	45 (1.8)	40 (1.6)



(2) Set forks in middle and measure difference in height at tip of forks.

Model	Fork length (mm)	Height difference(mm)
All	equal or below 1500	3
	above 1500	4



(3) Most force is concentrated at root of fork and at hook, so use crack detection method to check cracks.

2. MAST

1) Check for cracks at mast stay, tilt cylinder bracket, guide bar, fork carriage and roller shaft weld. Check visually or use crack detection method. Repair any abnormality.
2) Set mast vertical, raise forks about 10cm from ground and check front-to-rear clearance and left-to-right clearance between inner mast and fork carriage, and between outer mast and inner mast. Use these figures to judge if there is any play at roller or rail.
   - Front-to-rear clearance : Within 2.0 mm (0.08 in)
   - Left-to-right clearance : Within 2.5 mm (0.10 in)
3) Check that there is an oil groove in bushing at mast support.
4) Set mast vertical, raise forks about 10cm from ground, and push center of lift chain with finger to check for difference in tension.
   If there is any difference in tension, adjust chain stopper bolt.
5) Check visually for abnormalities at thread of chain anchor bolt, and at contact surface between chain wheel and chain.
   Rotate chain wheel by hand and check for any play of bearing.

2. TROUBLESHOOTING

1) MAST

Problem	Cause	Remedy
Forks fail to lower.	· Deformed mast or carriage.	· Disassemble, repair or replace.
Fork fails to elevate	· Faulty hydraulic equipment.	· See troubleshooting hydraulic pump and cylinders in section 6, hydraulic system.
	· Deformed mast assembly.	· Disassemble mast and replace damaged parts or replace complete mast assembly.
Slow lifting speed and insufficient handling capacity.	· Faulty hydraulic equipment.	· See troubleshooting hydraulic pump and cylinders in section 6, hydraulic system.
	· Deformed mast assembly.	· Disassemble mast and replace damaged parts or replace complete mast assembly.
Mast fails to lift smoothly.	· Deformed masts or carriage.	· Disassembly, repair or replace.
	· Faulty hydraulic equipment.	· See Troubleshooting Hydraulic Cylinders, pump and control valve in section 6, hydraulic system.
	· Damaged load and side rollers.	· Replace.
	· Unequal chain tension between LH & RH sides.	· Adjust chains.
	· LH & RH mast inclination angles are unequal. (Mast assembly is twisted when tilted)	· Adjust tilt cylinder rods.
Abnormal noise is produced when mast is lifted and lowered.	· Broken load roller bearings.	· Replace.
	· Broken side roller bearings.	· Replace.
	· Deformed masts.	· Disassemble, repair or replace.
	· Bent lift cylinder rod.	· Replace.
	· Deformed carriage.	· Replace.
	· Broken sheave bearing.	· Replace.
Abnormal noise is produced during tilting operation.	· Insufficient lubrication of anchor pin, or worn bushing and pin.	· Lubricate or replace.
	· Bent tilt cylinder rod.	· Replace.

2) FORKS

<table>
<tr><th>Problem</th><th>Cause</th><th>Remedy</th></tr>
<tr><td>Abrasion</td><td>Long-time operations causes the fork to wear and reduces the thickness of the fork.
Inspection for thickness is needed.
· Wear limit : Must be 90% of fork thickness</td><td>If the measured value is below the wear limit, replace fork.</td></tr>
<tr><td>Distortion</td><td>Forks are bent out of shape by a number of reasons such as overloading, glancing blows against walls and objects, and picking up load unevenly.
· Difference in fork tip height
<table>
<tr><th>Fork length (mm)</th><th>Height difference(mm)</th></tr>
<tr><td>equal or below 1500</td><td>3</td></tr>
<tr><td>above 1500</td><td>4</td></tr>
</table></td><td>If the measured value exceeds the allowance, replace fork.</td></tr>
<tr><td>Fatigue</td><td>Fatigue failure may result from the fatigue crack even though the stress to fork is below the static strength of the fork. Therefore, a daily inspection should be done.
· Crack on the fork heel.
· Crack on the fork weldments.</td><td>Repair fork by expert.
In case of excessive distortion, replace fork.</td></tr>
</table>

1. MAST LOAD ROLLER (V, VF MAST)

1) INNER/OUTER MAST ROLLER CLEARANCE ADJUSTMENT

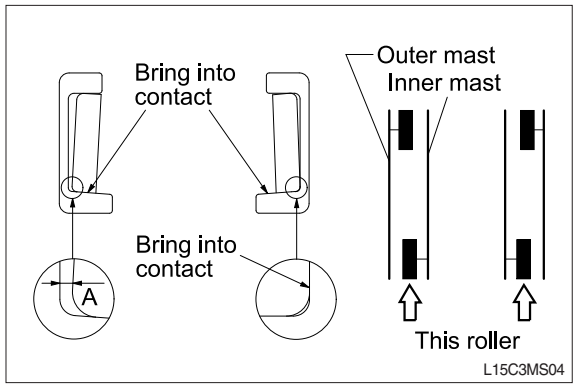
(1) Measure the clearance with the mast overlap at near 480mm.

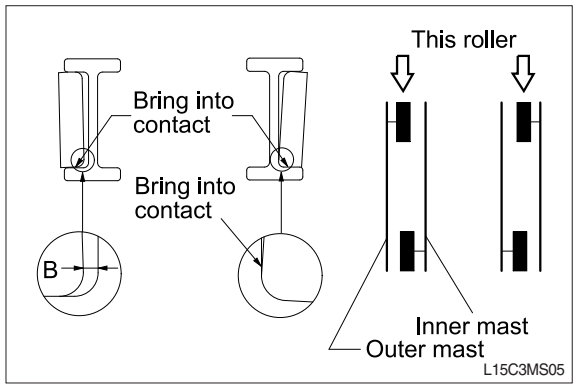
(2) Shift the inner mast to one side to bring the roller into contact with the outer mast, and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the inner/outer mast roller shim.

- Standard clearance A, B = 0~0.6 mm
- Shim thickness 0.5, 1.0 mm

(3) Distribute the shim thickness equally to the left and right roller. Refer to Mast load roller and back up liner, removal and Installation.

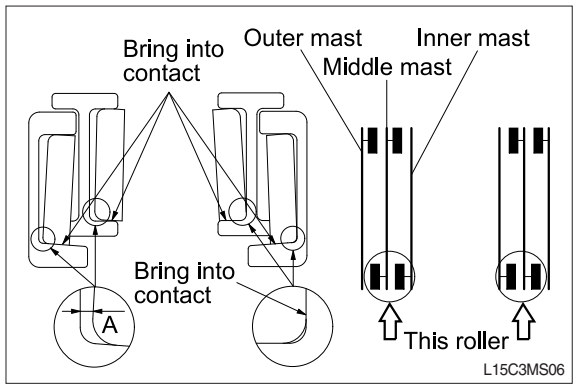
(4) After the adjustment, check that the inner mast moves smoothly in the outer mast.





2. MAST LOAD ROLLER (TF MAST)

1) INNER AND MIDDLE MAST ROLLER CLEARANCE ADJUSTMENT



(1) Measure the clearance with the mast overlap at near 480mm.

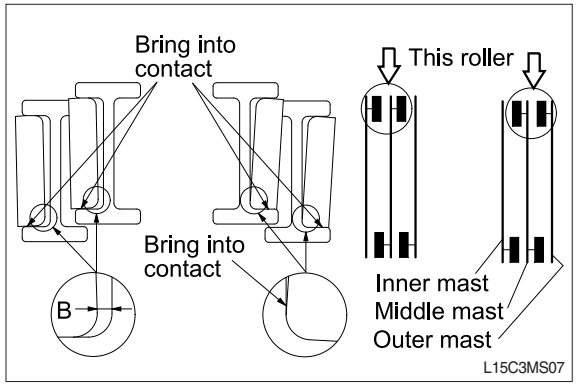
(2) Shift the inner mast to one side to bring the roller into contact with the outer mast and the middle mast, and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the inner and middle mast roller shim, respectively.

- Standard clearance A = 0~0.6mm
- Shim thickness 0.5, 1.0mm

(3) Distribute the shim thickness equally to the left and right roller. Refer to Mast load roller and back up liner, removal and Installation.

(4) After the adjustment, check that the inner mast moves smoothly in the middle mast, and the middle mast moves smoothly in the outer mast.

2) OUTER AND MIDDLE MAST UPPER ROLLER CLEARANCE ADJUSTMENT



(1) Measure the clearance with the mast overlap at near 480 mm.

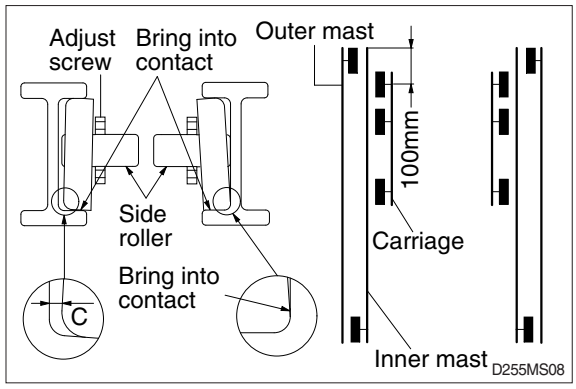
(2) Shift the inner mast to one side to bring the roller into contact with the outer mast and the middle mast, and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the outer and middle mast roller shim, respectively.

- Standard clearance B = 0~0.6 mm
- Shim thickness 0.5, 1.0 mm

(3) Distribute the shim thickness equally to the left and right roller. Refer to Mast load roller and back up liner, removal and installation.

(4) After the adjustment, check that the inner mast moves smoothly in the middle mast, and the middle mast moves smoothly in the outer mast.

3) CARRIAGE LOAD ROLLER



(1) Measure the clearance when the center of the carriage upper roller is 100㎜ from the top of the inner mast.

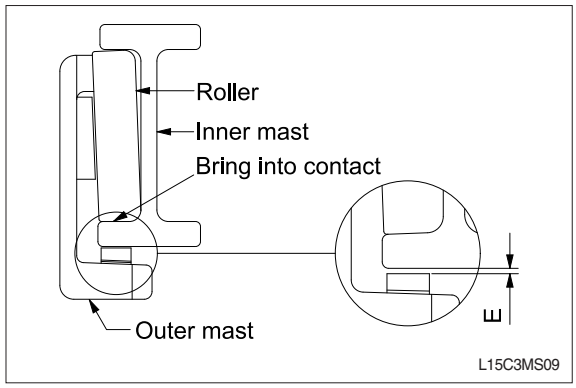
(2) Measure the clearance at upper, middle and lower rollers after loosen the adjust screws from the side rollers. Shift the carriage to one side to bring the roller into contact with the inner mast, and measure the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the carriage roller shim.

- Standard clearance C = 0~0.6 ㎜
- Shim thickness 0.5, 1.0 ㎜

(3) Distribute the shim thickness equally to the left and right roller. Refer to Carriage assembly.

(4) After the adjustment, the carriage should move smoothly along the overall mast length.

4) MAST BACK UP LINER



(1) Measure the clearance with the middle mast at the bottom position.

(2) With the middle mast in contact with the outer mast roller, adjust the clearance between the mast back up liner and middle mast to the following value by inserting the back up liner shim.

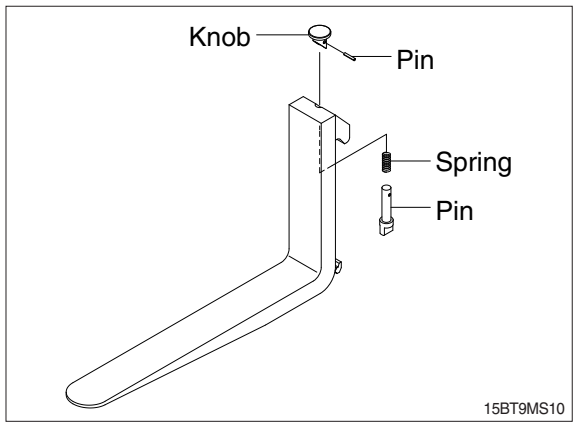
- Standard clearance E = 0.2 ~ 0.6 ㎜
- Shim thickness 0.5, 1.0 ㎜

(3) After the adjustment, the mast should move smoothly.

GROUP 4 REMOVAL AND INSTALLATION

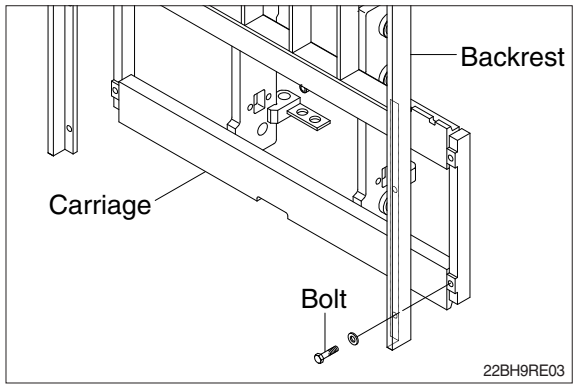
1. FORKS

1) Lower the fork carriage until the forks are approximately 25mm(1inch) from the floor.
2) Pull the knob up and slide forks, one by one, toward the center of the carriage where a notch has been cut in the bottom plate for easy fork removal.
3) Remove the fork one by one. On larger forks it may be necessary to use a block of wood.
4) Reverse the above procedure to install load forks.



2. BACKREST

1) Remove bolts securing backrest to fork carriage. Disassemble the backrest from the carriage.
2) Position backrest on carriage and lower in place. Install and tighten bolts.



3. CARRIAGE ASSEMBLY

1) CARRIAGE

(1) With the mast vertical, raise the carriage high enough to place blocks under the load forks. This is done to create slack in the load chains when the carriage is lowered. Lower the carriage all the way down to the floor. Make sure the carriage is level, this will prevent any binding when the mast is raised.
(2) While supporting lift chains, remove the split pin and slide out chain anchor pins from the chain anchors of stationary upright.
(3) Pull the chains out of the sheaves and drape them over the front of the carriage.
(4) Slowly raise elevating upright until mast clears top of fork carriage. Move carriage to work area and lower mast.

⚠ Make sure carriage remains on floor and does not bind while mast is being raised.

(5) Inspect all parts for wear or damage. Replace all worn or damaged pars.
(6) Reverse the above steps to reinstall.

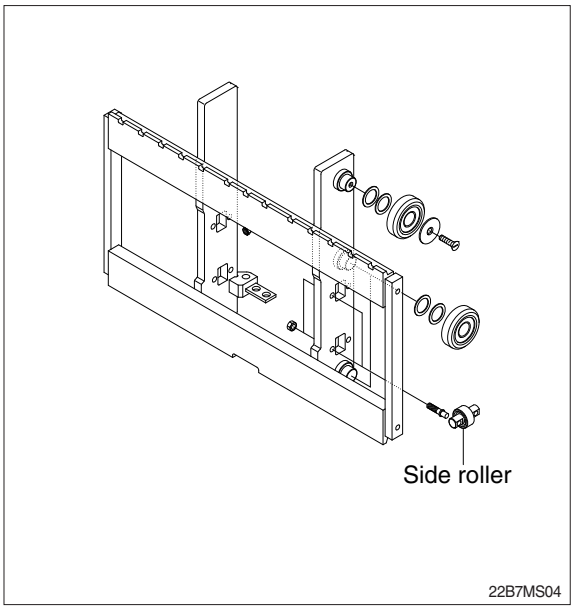
⚠ Replace the split pin of chain anchor with new one.

2) SIDE ROLLER

(1) Remove carriage as outlined in the carriage assembly and removal paragraph.
(2) Loosen and remove nuts, adjust screws and side rollers from carriage side pate.
(3) Thoroughly clean, inspect and replace all worn or damaged parts.
(4) Reverse the above procedure to assembly.

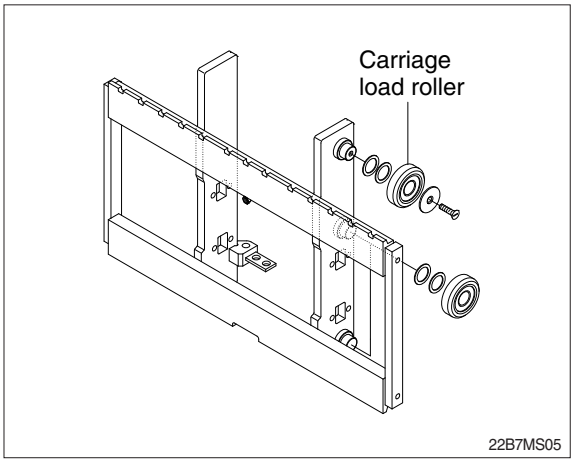
※ **Adjustment**

- Once carriage is properly installed, loosen nuts and adjust screws, (if not already done) allowing carriage to be centered in the inner mast.
- Adjust side roller by tightening screw until side roller just makes contact with mast. Back off approximately 1/10 turn on screw and tighten nut to lock screw in place.
- Run carriage up and down for the inner mast to be sure the carriage has free movement and does not stick. Also, make sure chains are properly adjusted. Refer to chain adjustment paragraph. Make adjustment when necessary and recheck operation of carriage.



3) CARRIAGE LOAD ROLLER

(1) Remove carriage as outlined in the carriage assembly removal paragraph.
(2) Loosen and remove flat head bolts and plain washers from top load roller bracket.
(3) Using a pryer, remove load rollers from load roller bracket.
(4) Reverse the above procedure to assemble. Refer to MAST ROLLER ADJUSTMENT paragraph.



4) MAST LOAD ROLLER AND BACK UP LINER

(1) 2 stage mast (V mast)

① Remove the carriage assembly and move them to one side.

② Loosen and remove hexagon bolts and washers securing lift cylinders to inner mast.

③ Loosen and remove hexagon bolts and nuts securing lift cylinders to inner mast.

④ Attach chains or sling to the inner mast section at top crossmember. Using an overhead hoist, slowly raise the inner mast high enough to clear lift cylinder.

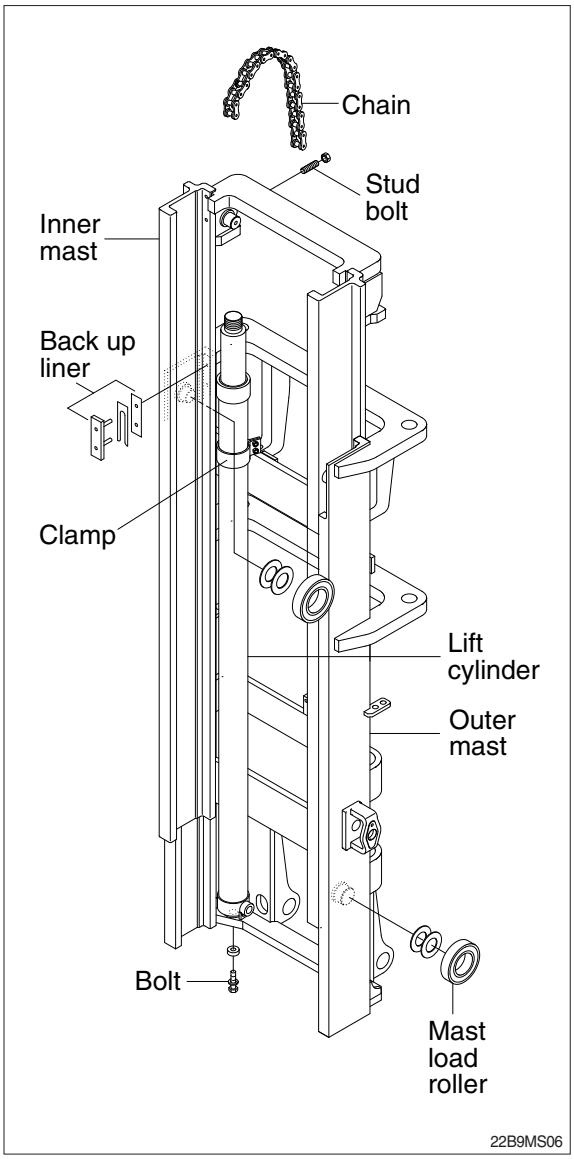
⑤ After lowering the lift cylinder rods, and disconnecting lift cylinder hose, tilt the lift cylinders LH and RH and them with ropes to the outer mast.

⑥ Using the overhead hoist, lower inner mast until top and bottom rollers and back up liners are exposed.

⑦ Using a pryer, remove load rollers from load roller bracket. Remove back up liners and shims.

⑧ Thoroughly clean, inspect and replace all worn or damaged parts.

⑨ Reverse the above procedure to assemble. Refer to MAST LOAD ROLLER ADJUSTMENT paragraph.



(2) 3 stage mast (TF mast)

① Remove the carriage assembly and move it to one side.

② Loosen and remove hexagon bolt securing bottom cylinder from outer mast.

③ Loosen and remove band and special washers securing lift cylinders to middle mast. Remove the spring pin.

④ Attach chains or sling to the inner and middle mast section at top crossmember. Using an overhead hoist, slowly raise the uprights high enough to clear lift cylinder.

⑤ After lowering the lift cylinder rods, and disconnecting lift cylinder hose, tilt the lift cylinders LH and RH and tie them with ropes to the outer mast.

⑥ Using the overhead hoist raise inner and middle masts. Place 4 inch block of wood under the free lift cylinder bracket of the inner mast then lower mast sections (this will create slack in the chains).

⑦ Remove retaining rings securing chain sheaves to sheave support brackets. While support chains, remove chain sheaves and let chains hang free. The upper outer and lower middle mast rollers and back up liners are now exposed.

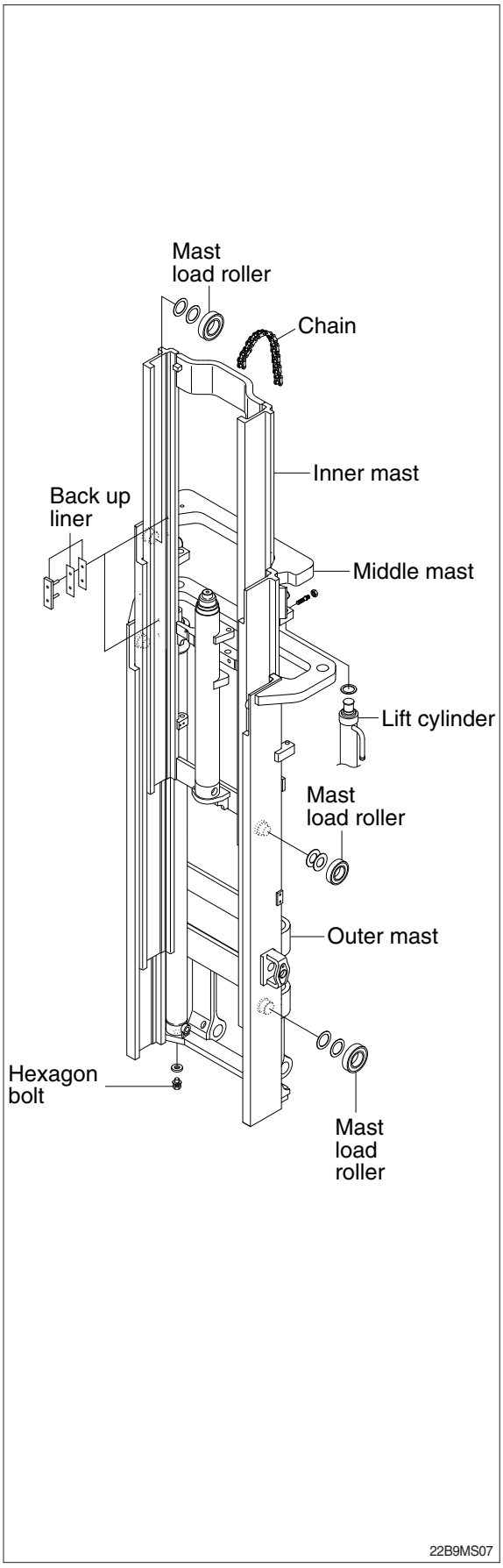
⑧ Using a player, remove load rollers from load bracket. Remove back up liners and shims.

⑨ Attach chains or sling to the middle mast section at top crossmember. Using an overhead hoist, slowly raise the middle mast until top and bottom rollers are exposed.

⑩ Using a pryer, remove load rollers from load roller bracket.

⑪ Thoroughly clean, inspect and replace all worn or damaged parts.

⑫ Reverse the above procedure to assemble. Refer to MAST LOAD ROLLER ADJUSTMENT paragraph.



5) ELEVATING MAST

(1) Inner mast (V mast)

① After completing all necessary steps for load rollers and back up liner removal use an overhead hoist and sling or chain around upper crossmember of the inner mast section.

② Lift inner mast upright straight up and out of outer mast section.

③ Replace and reverse above procedure to install. Make all necessary measurements and adjustments.

(2) Inner and middle mast (TF mast)

① After completing all necessary steps for load rollers and back up liner removal. Remove rear chains and sheave support if not already done.

② Disconnect free lift cylinder hose. Drain hose into a suitable pan or container and cap hose.

③ While supporting free lift cylinder assembly, remove bolts and washers securing cylinder to mast crossmember.

④ Place a sling around free lift cylinder and attach to an overhead hoist. Slowly raise and move cylinder to one side.

⑤ Attach chains or sling to the inner mast section at top crossmember. Using an overhead hoist slowly raise the upright straight up and out of middle mast section.

⑥ Attach chains or sling to the middle mast section at top crossmember. Using an overhead hoist slowly raise the upright straight up and out of outer mast section.

⑦ Replace upright and reverse above procedure to install. Make all necessary measurements and adjustments.

6) CHAIN

(1) Chain sheave (V mast)

① Place a sling around carriage and attach to an overhead hoist. Lift carriage high enough so that the tension on the chain over sheaves is relieved after the carriage is blocked. Position wooden blocks under the carriage and lower it.

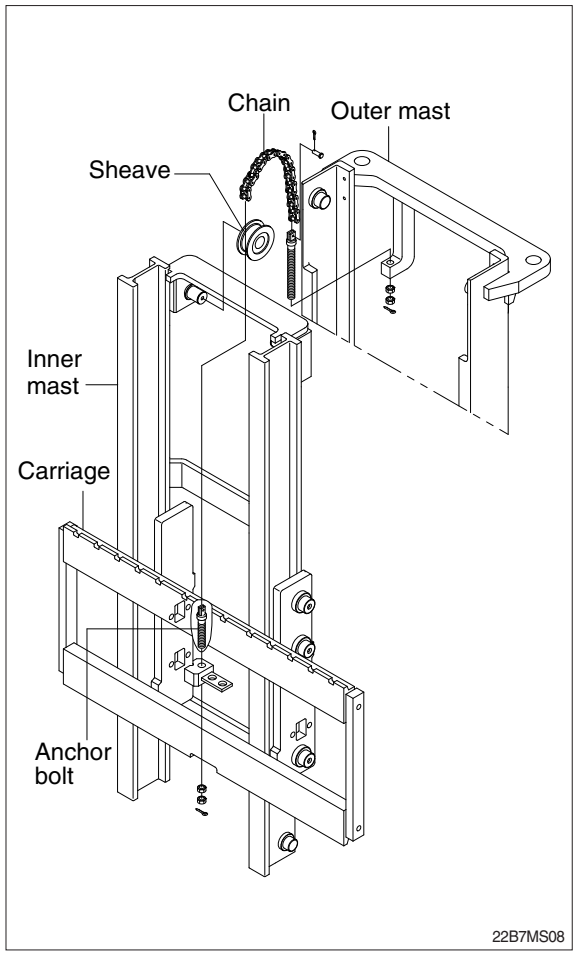
② Remove the split pin securing the chain anchor pins and discard.
While supporting the chains, remove the chain anchor pins and drape the chains over the carriage.

③ Remove retaining ring securing sheaves to sheave support. Remove sheaves with bearings.

④ Remove bearing retaining ring from sheave and press bearings from sheaves.

⑤ Thoroughly clean, inspect and replace all worn or damaged parts.

⑥ Reverse the above to assemble and install. Use new split pins in chain anchor pins.



(2) Rear chain sheave (TF mast)

① Raise and securely block carriage and inner mast section.

② Remove the split pin securing the chain anchor pins and discard. While supporting the chains, remove the chain anchor pins from outer mast section.

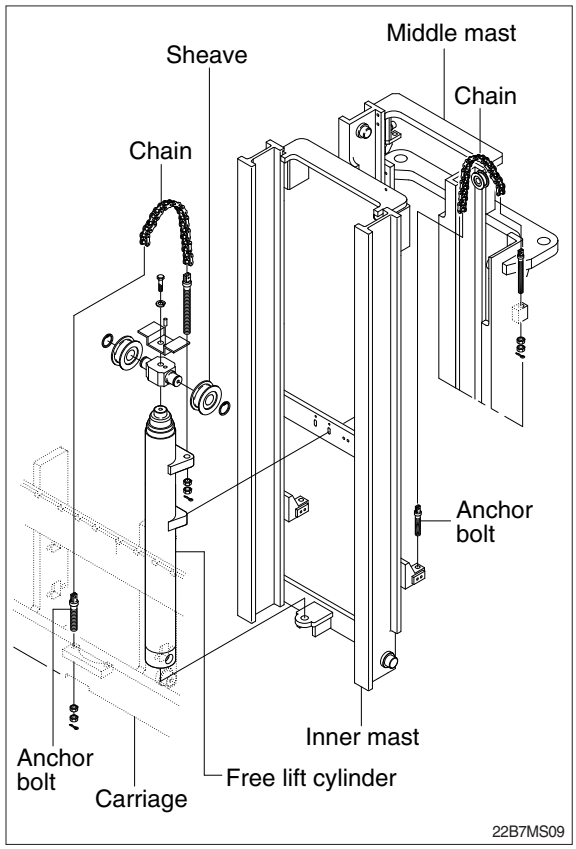
③ Remove chains.

④ Remove retaining ring securing chain sheaves to sheave support. Pry off sheaves with bearings.

⑤ Remove bearing retaining ring from sheave and press bearings from sheaves.

⑥ Thoroughly clean, inspect and replace all worn or damaged parts.

⑦ Reverse the above procedure to assemble and install. Use new split pins in chain anchor pins.



(3) Chain wheel bearing support (TF mast)

① Remove the carriage assembly and move to one side.
② After removing bolt to securing chain wheel bearing support assembly to free lift cylinder.
After a sling to the chain wheel bearing support assembly. Using an overhead hoist, lift support assembly straight up and off of free lift cylinder. Move assembly to work area.
③ Remove retaining ring securing chain wheel bearing to chain wheel bearing support.
④ Remove bearing retaining ring from chain wheel bearing and press bearings from chain wheel bearings.
⑤ Thoroughly clean, inspect and replace all worn or damaged parts.
⑥ Reverse the above procedure to install.

(4) Rear chain (TF mast)

① Remove the carriage assembly and move to one side. Refer to carriage removal and installation.
② Raise and securely block truck approximately 6 inches from the floor.
③ Using a sling or chain around inner mast section attached to an overhead hoist, slowly raise inner mast until there is enough slack in the chains to remove them. Block inner mast section.
④ Remove split pins and chain anchor pins securing chains to chain anchor (part of inner mast).
⑤ While supporting the chains, remove split and chain anchor pins securing chains to chain anchors attached to outer mast section.
⑥ Remove chains.
⑦ Reverse the above to assemble and install. Use new split pins in chain anchor pins. Refer to this section for Load chain lubrication and adjustment.

(5) Carriage chain

① Place a sling around carriage front plate and attach to an overhead hoist. Lift and secure carriage high enough so that split and chain anchor pins on carriage can be easily be removed. Remove chain anchor pins from carriage and drape chains out over carriage.
② Place a wooden block under the carriage and lower the carriage on the block.
③ While supporting the chains, remove split pins and chain anchor pins from chain anchors.
④ Remove chains and wash them with solvent. Refer to this section for Load chain inspection and maintenance.
⑤ Reverse the above procedure to assemble and install. Use new split pins in chain anchor pins. Refer to this section for Load chain lubrication and adjustment.

(6) Load chain inspection and maintenance

After every 200 hours of truck operation, lift chains should be inspected and lubricated inspect for the following chain conditions :

① **Wear**

As the chain flexes on and off the chain wheel bearings, the joints very gradually wear. The stretch a chain develops in service is due to material being worn off pin outer diameter and pitch hole inner diameter on the inside plate.

Chain wear can be measured using a wear scale or steel tape. When chains have elongated 2%, they should be discarded. When checking chain wear, be sure to measure a segment of chain that operates over a sheave. Do not repair chains by cutting our the worn section and splicing in a new piece. If part of the chain is worn, replace all the chains on the truck.

② **Rust and corrosion**

Chains used on lift trucks are highly stressed precision components. It is very important that the "as-manufactured" ultimate strength and fatigue strength be maintained throughout the chain service life. Corrosion will cause a major reduction in the load-carrying capacity of lift chain or roller chain because corrosion causes side plate cracking.

③ **Cracked plate**

The most common cause of plate cracking is fatigue failure. Fatigue is a phenomenon that affects most metals and many plastics. After many repeated heavy loads, the plates may crack and the chains will eventually break. Fatigue cracks are almost always found through the pitch holes perpendicular to the pitch line. Contrast this failure mode to the random failures caused by stress-corrosion cracking. If cracks are present, replace all the chain on the truck. Noise in the chain indicates that the plate is on the verge of cracking and will be failed before long.

④ **Tight joints**

All joints in lift chain should flex freely. Tight joints resist flexure, increase internal friction, thus increasing chain tension required to lift a given load. Increased tension accelerates wear and fatigue problems.

Tight joints in lift chains can be caused by :

- Bent pins or plates.
- Rusty joints.
- Peened plate edges.

Oil rusty chains and replace chains with bent or peened components.

⑤ **Protruding or turned pins**

Heavily loaded chains operating with lube generate tremendous friction between pins and plates. In extreme cases, the frictional torque in the joint can actually turn pins in the press-fit outside plates. If chain is allowed to operate in this condition, the pins slowly work out of the chain causing chain failure. Turned pins can be quickly spotted because the flats on the V heads are no longer in line. Chains with turned or protruding pins should be replaced immediately. Do not attempt to repair the chain by driving pins back into the chain.

⑥ **Chain side wear**

A wear pattern on pin heads and outside plates indicates misalignment. This condition damages chain and sheaves as well as increasing internal friction in the chain system.

⑦ **Chain anchors and chain wheel bearings**

An inspection of the chain system includes a close examination of chain anchors and chain wheel bearings. Check chain anchors for wear, breakage and misalignment.

Anchors with worn or broken fingers should be replaced. Anchors should be adjusted to eliminate twisting or other misalignment in the chain. When chain is misaligned, load is not distributed uniformly between the plates. Prolonged operation will result in premature fatigue failure. Chain wheel bearings with badly worn flanges and outside diameter should be replaced. Heavy flange wear indicates chain misalignment.

⑧ **Chain wear scale**

The chain can be checked for wear or stretching with the use of a chain wear scale. Stretching of a chain is due to the elongation of the pitch holes and wearing of the pin O.D. The greatest amount of stretching occurs at the areas of the chain that flex over the sheaves most frequently. Check the chain at this point with a scale. The wear scale has instructions printed on the sides for use in determining chain stretch and are as follows :

- Determine pitch length of chain using 6 inch scale on one side of wear scale.
- If pitch is 1/2 (12.7 ㎜), 3/4 (19.05㎜), 1 (25.4 ㎜), 1-1/2 (38.1 ㎜), 2 (50.8 ㎜), use side A of scale.
- If pitch is 5/8 (15.875 ㎜), 1-1/4 (31.75 ㎜) or 2 (50.8 ㎜), use side B.
- Align point A or B to center of a pin and note position of the opposite A or B point.
- If other point also lines up with a pin, the chain is worn and should be replaced.

If any of the above conditions exists (cracked plates, turned pins, stretching etc), the chains should be replaced in pairs as a complete assembly. Order chains by part number to insure the correct chain length, pitch and material specifications.

(7) Load chain lubrication and adjustment

① **Lubrication**

The most important consideration in field maintenance of lift chains is lubrication. Hard working, heavily loaded chains cannot be expected to give satisfactory wear life without scheduled periodic re-lubrication. Like all bearing surfaces, the precision manufactured, hardened steel, joint-wearing surfaces require a film of oil between mating parts to prevent rapid wear. Oil must penetrate the chain joint to prevent wear. Applying oil to external surfaces will prevent rust, but oil must flow into the live bearing surfaces for maximum wear life. Frequency of re-lube will vary with operating conditions and environment, the best estimate of lube period is 200 hours. Trucks parked outdoors or trucks in extremely severe service, may require more frequent re-lube to maintain an oil film on all chain surface.

- Wipe off the old oil with a clean cloth and blow out the remaining dirt with compressed air.

⚠ Wear eye protection.

- With a clean brush, apply EP-140 extreme pressure lubricant or heavy motor oil (40W).

② **Replacement**

Replace chains as a pair. It will be virtually impossible to maintain uniform loading between the strands if a new chain is put into service opposite an old chain. The joints in the old chain will be greater than that on the new chain, greatly complicating the problem of maintaining equal chain tension. The new chain will wear more slowly causing it to bear the major portion of the load resulting in premature wear and fatigue failure. Don't steam clean or decrease new chains.

The manufacturer's grease is effective in reducing wear and corrosion. If the original factory lube is dried out or wiped off, soak the new chain in heavy engine oil for at 1/2 hour prior to installing on truck. After the old chains have been stripped from the mast, very carefully inspect chain anchors and chain wheel bearing. Broken, cracked or worn anchor must be replaced using the new anchor pin and split pin. Do not paint newly replaced chain after it has been installed.

③ **Adjustment**

Chain adjustments are important for the following reasons :

- Equal loading of chain.
- Proper sequencing of mast.
- Prevent over-stretching of chains.
- Prevent chains from jumping off sheaves if they are too loose.

④ **Adjustment procedure**

- With mast in its fully collapsed and vertical position, lower the fork to the floor.
- Adjust the chain length by loosening or tightening nut on the chain anchor.

After making adjustment on the mast, be sure to tighten the nut.