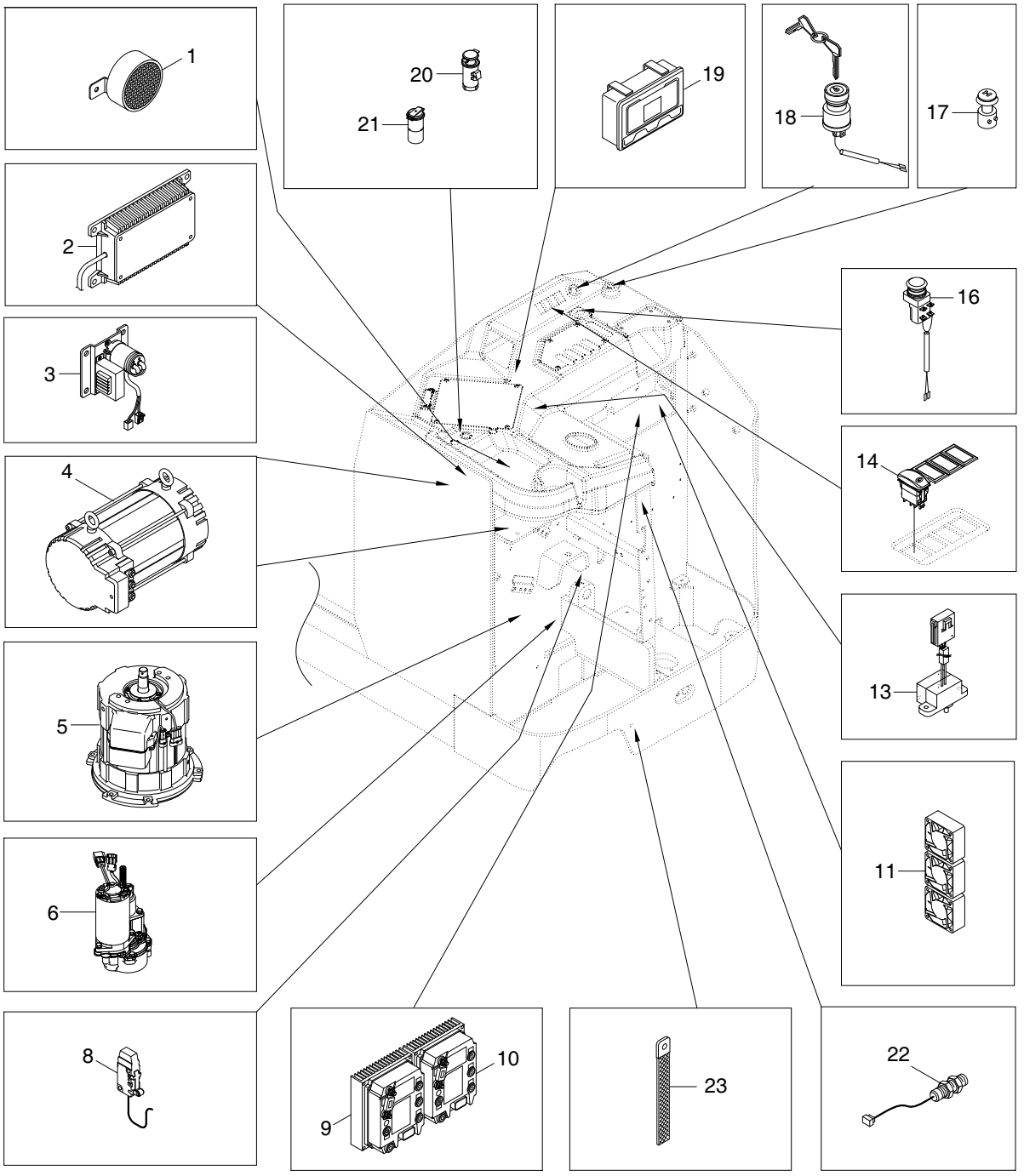
SECTION 7 ELECTRICAL SYSTEM

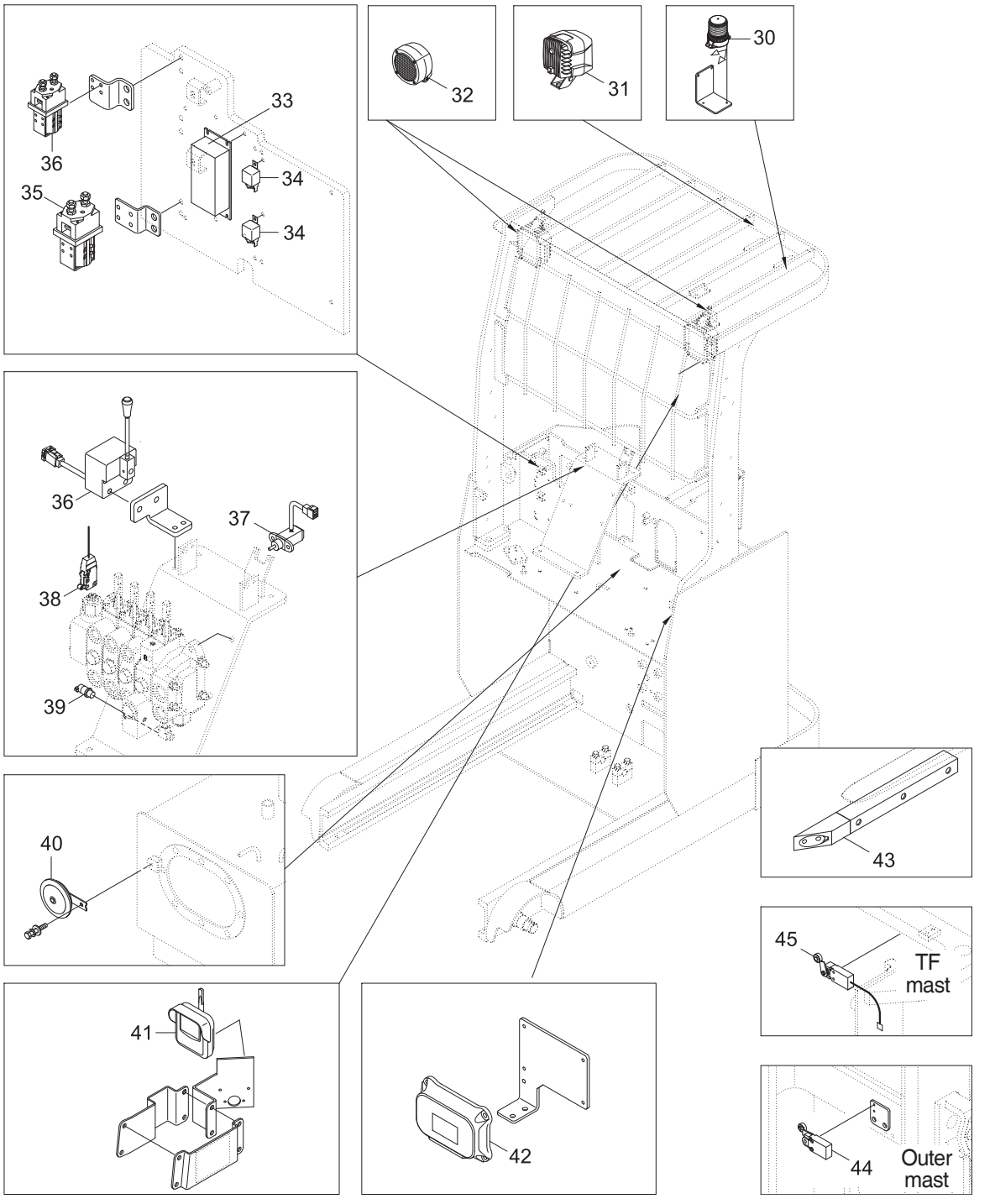
GROUP 1 MAIN COMPONENTS

1. MAIN COMPONENTS (1/2)



1	Back buzzer	9	Hydraulic controller	18	Key switch
2	EPS Controller	10	Driving controller	19	Cluster
3	EPS Filter	11	Fan	20	Socket
4	Pump motor	13	Angle sensor	21	USB Charger (Option)
5	Driving motor	14	Lamp switch	22	Sensor
6	EPS Actuator	16	Horn switch	23	Strap
8	Micro switch	17	Emergency switch		

2. MAIN COMPONENTS (2/2)



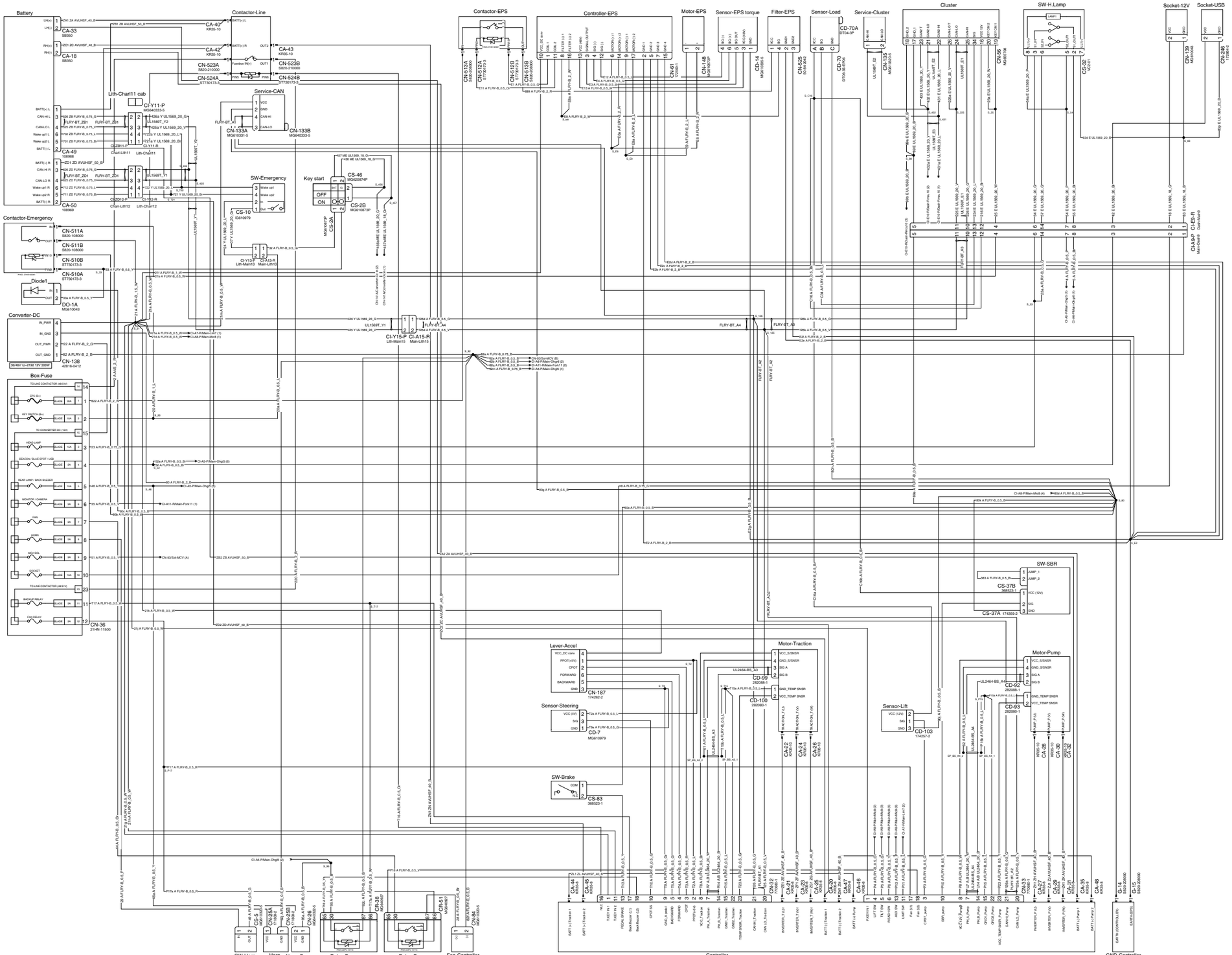
30 Warning light
31 Blue spot (Option)
32 Working lamp
33 DC-DC Converter
34 Relay
35 Contactor
36 Contactor
37 Sensor
38 Micro switch
39 Pressure sensor (Option)
40 Horn
41 Hi-mate Authentication Device (Option)
42 RMCU (Option)
43 Fork camera (Option)
44 TF-Mast Cutback switch (Option)
45 V-Mast cutback switch (Option)

GROUP 2 ELECTRIC CIRCUIT DIAGRAMS

1. CODES IN ELECTRIC CIRCUIT DIAGRAMS

Item	Name
A	Main harness
B	Main harness (UL)
E	Dashboard harness
GA	Overhead guard left harness (Bulb)
GB	Overhead guard left harness (LED)
GC	Overhead guard right harness (Bulb)
GD	Overhead guard right harness (LED)
ME	RMCU harness
QA	Limit switch harness
QB	Micro switch harness (3-spool)
QC	Micro switch harness (4-spool)
Y	Lithium harness
Z1	Contactor cable (UL)
ZA	Charging cable (Left_Pb)
ZB	Charging cable (Left_Li)
ZC	Charging cable (Right_Pb)
ZD	Charging cable (Right_Li)
ZE	Driving motor cable (U)
ZF	Driving motor cable (V)
ZG	Driving motor cable (W)
ZH	Pump motor cable (U)
ZJ	Pump motor cable (V)
ZK	Pump motor cable (W)
ZL	Cable (BF_+)
ZM	Cable (B-)
ZN	Line contactor cable
ZO	Charging cable (Left_Pb, UL)
ZP	Charging cable (Left_Li, UL)
ZQ	Charging cable (Right_Pb, UL)
ZR	Charging cable (Right_Li, UL)
ZS	Driving motor cable (U, UL)
ZT	Driving motor cable (V, UL)
ZU	Driving motor cable (W, UL)
ZV	Pump motor cable (U, UL)
ZW	Pump motor cable (V, UL)
ZX	Pump motor cable (W, UL)
ZY	Cable (BF_+, UL)
ZZ	Cable (B-, UL)

2. OVERALL CIRCUIT DIAGRAM (1/2)



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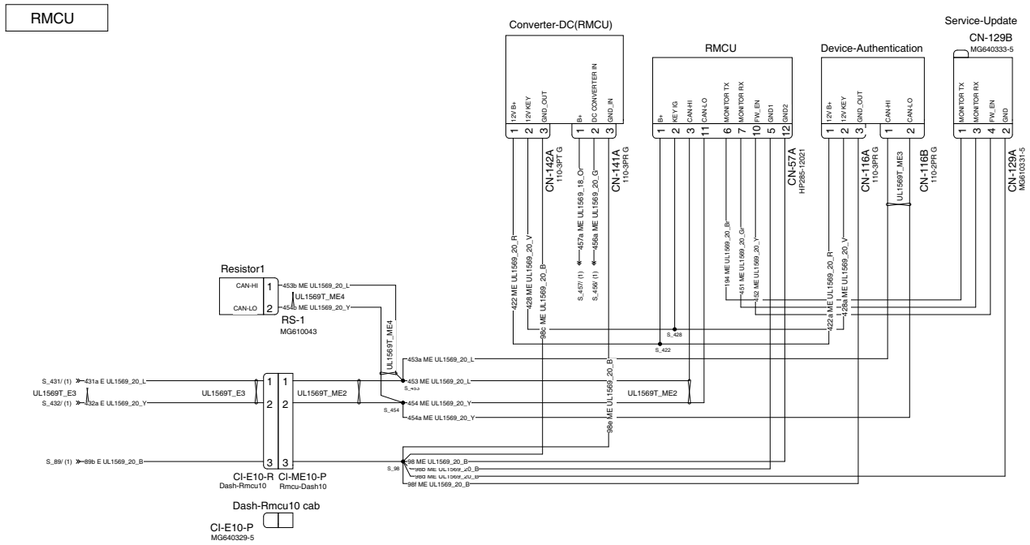
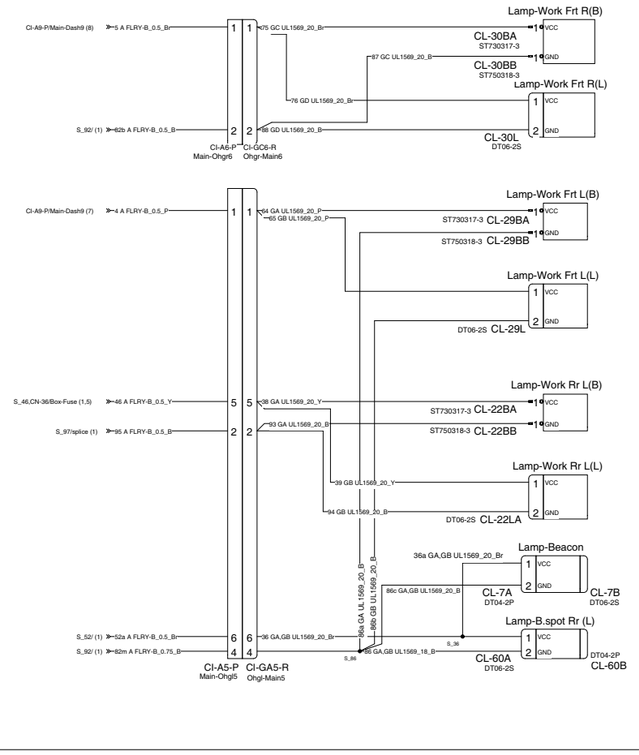
OVERALL CIRCUIT DIAGRAM (2/2)

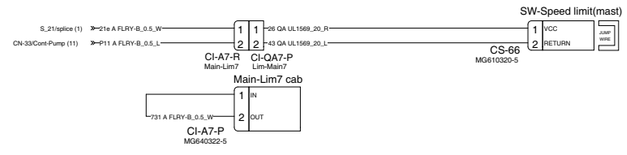
RMCU



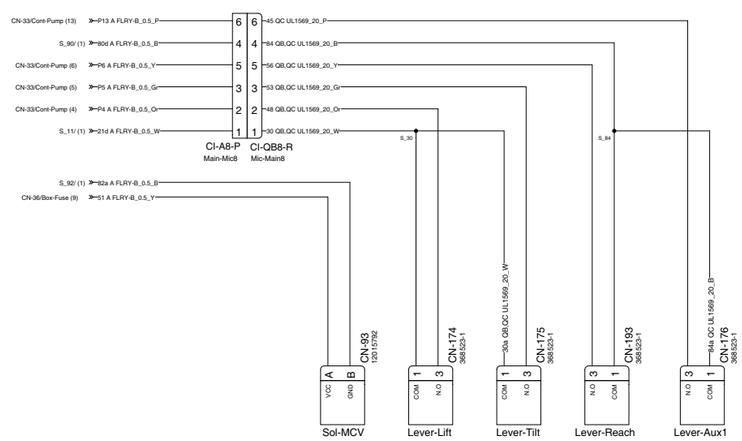
LAMP



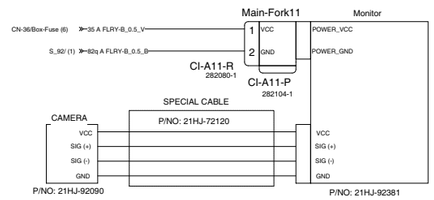
Speed Limit (MAST)



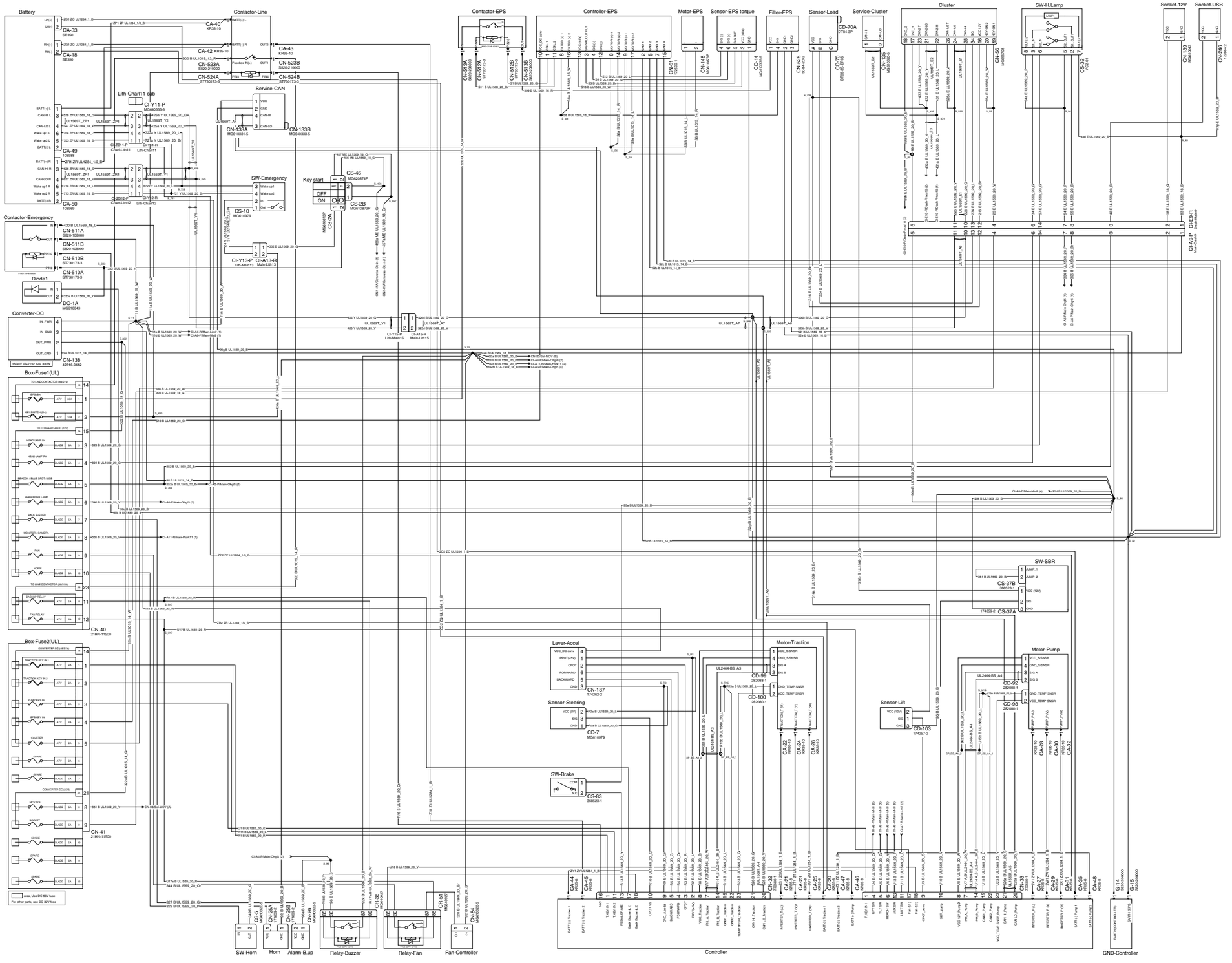
F/TIP-MCV



Camera, Monitor

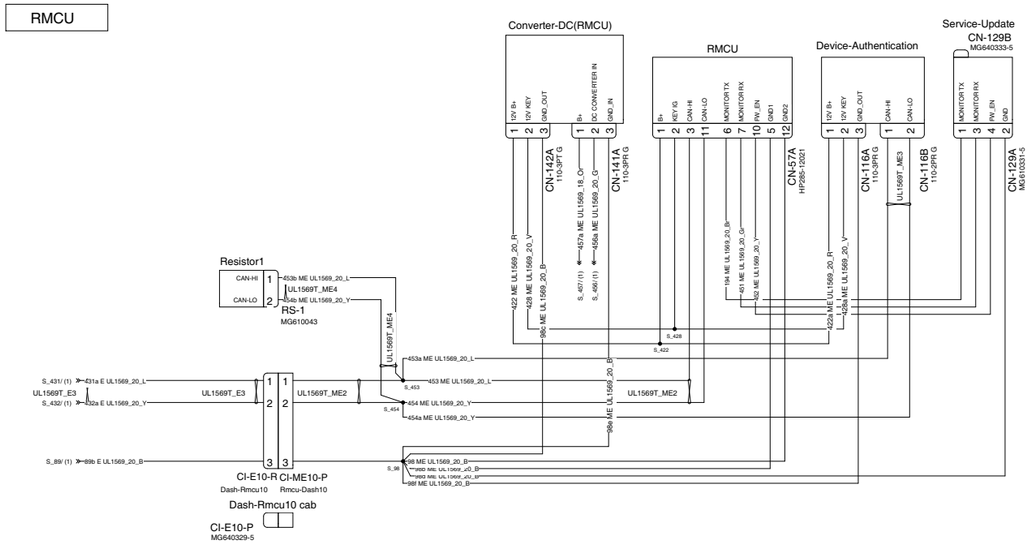


3. OVERALL CIRCUIT DIAGRAM (1/2, UL)

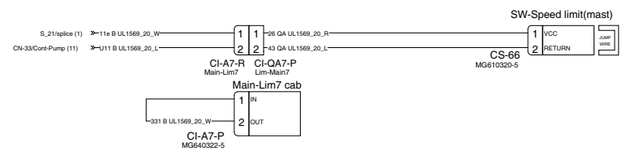


OVERALL CIRCUIT DIAGRAM (2/2, UL)

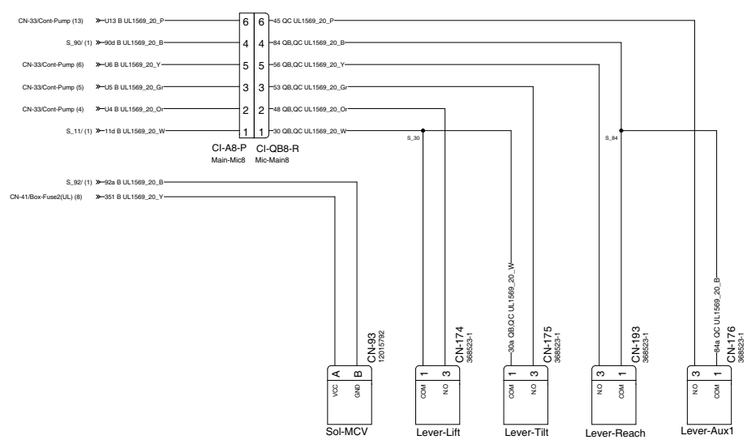
RMCU



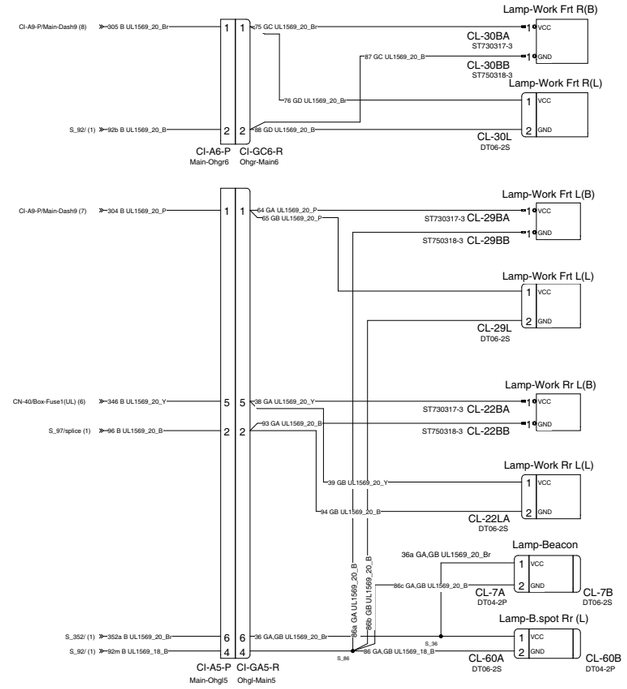
Speed Limit (MAST)



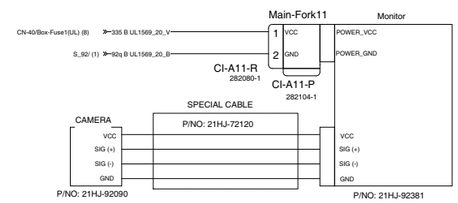
F/TIP-MCV



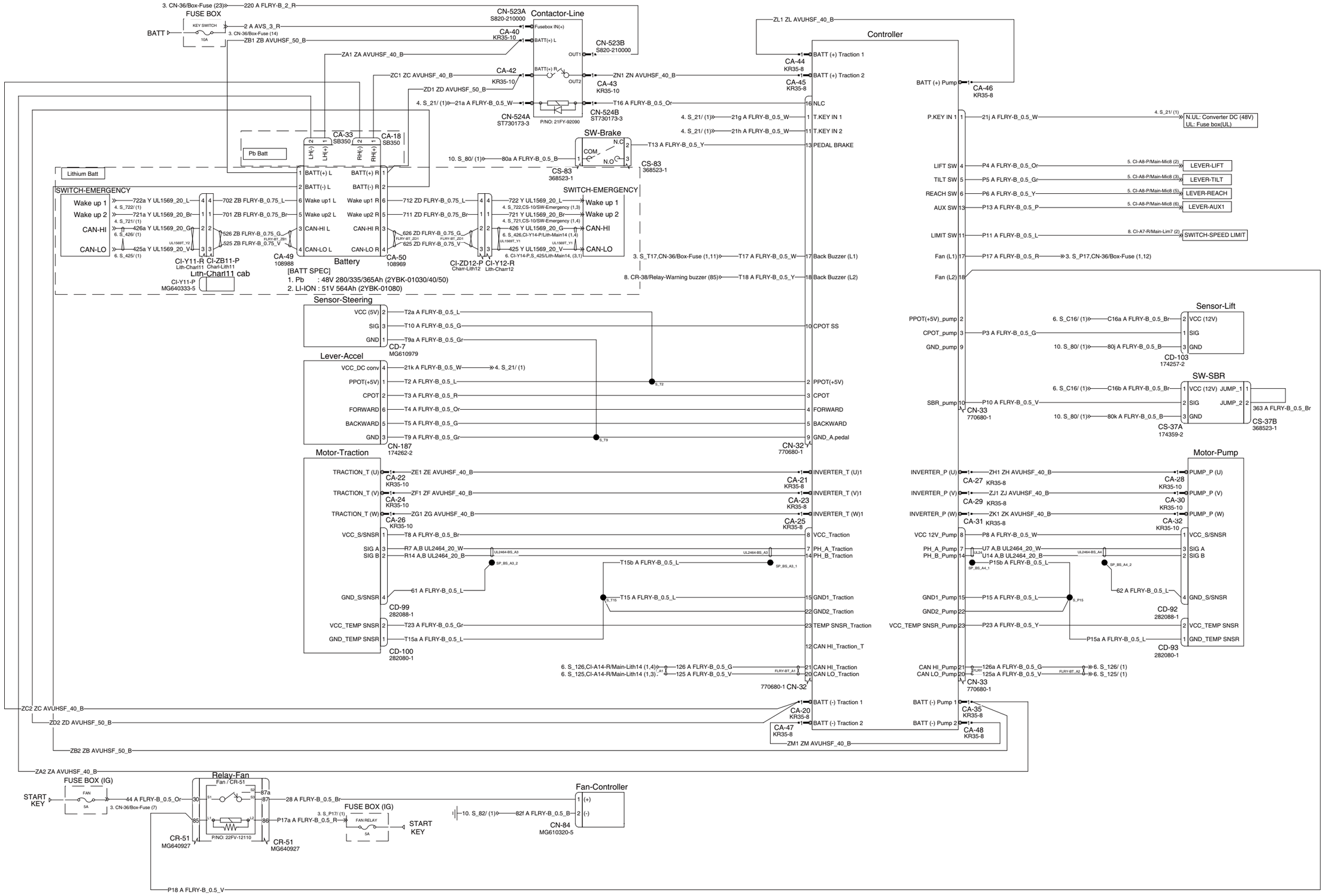
LAMP



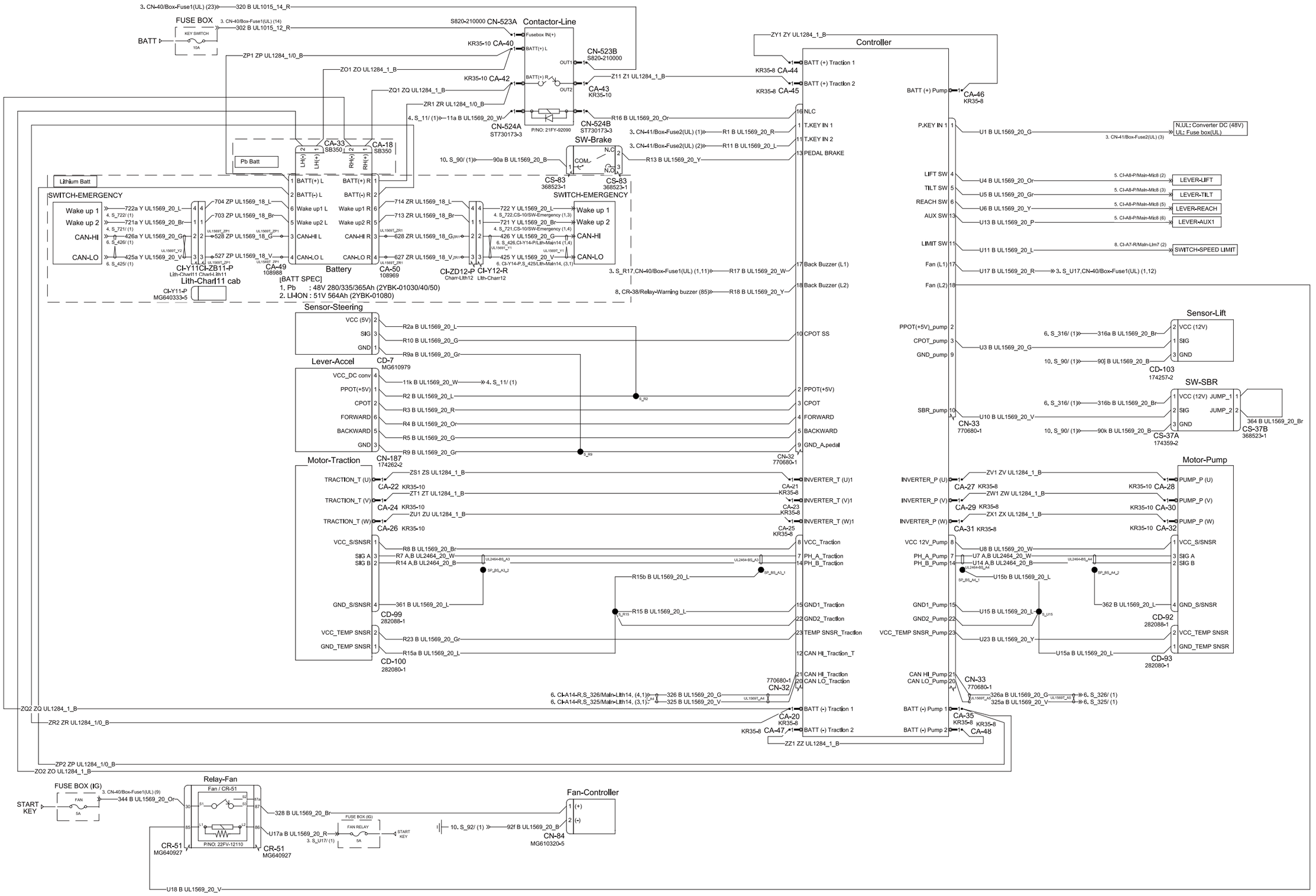
Camera, Monitor



4. CONTROLLER AND MOTOR



CONTROLLER AND MOTOR (UL)



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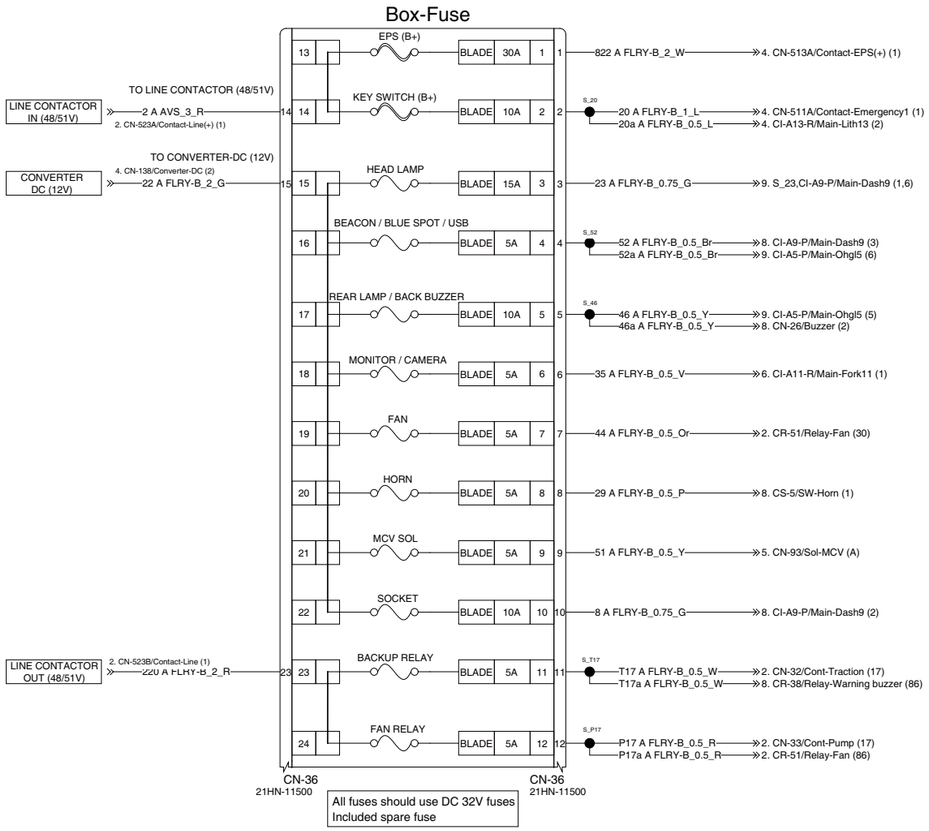
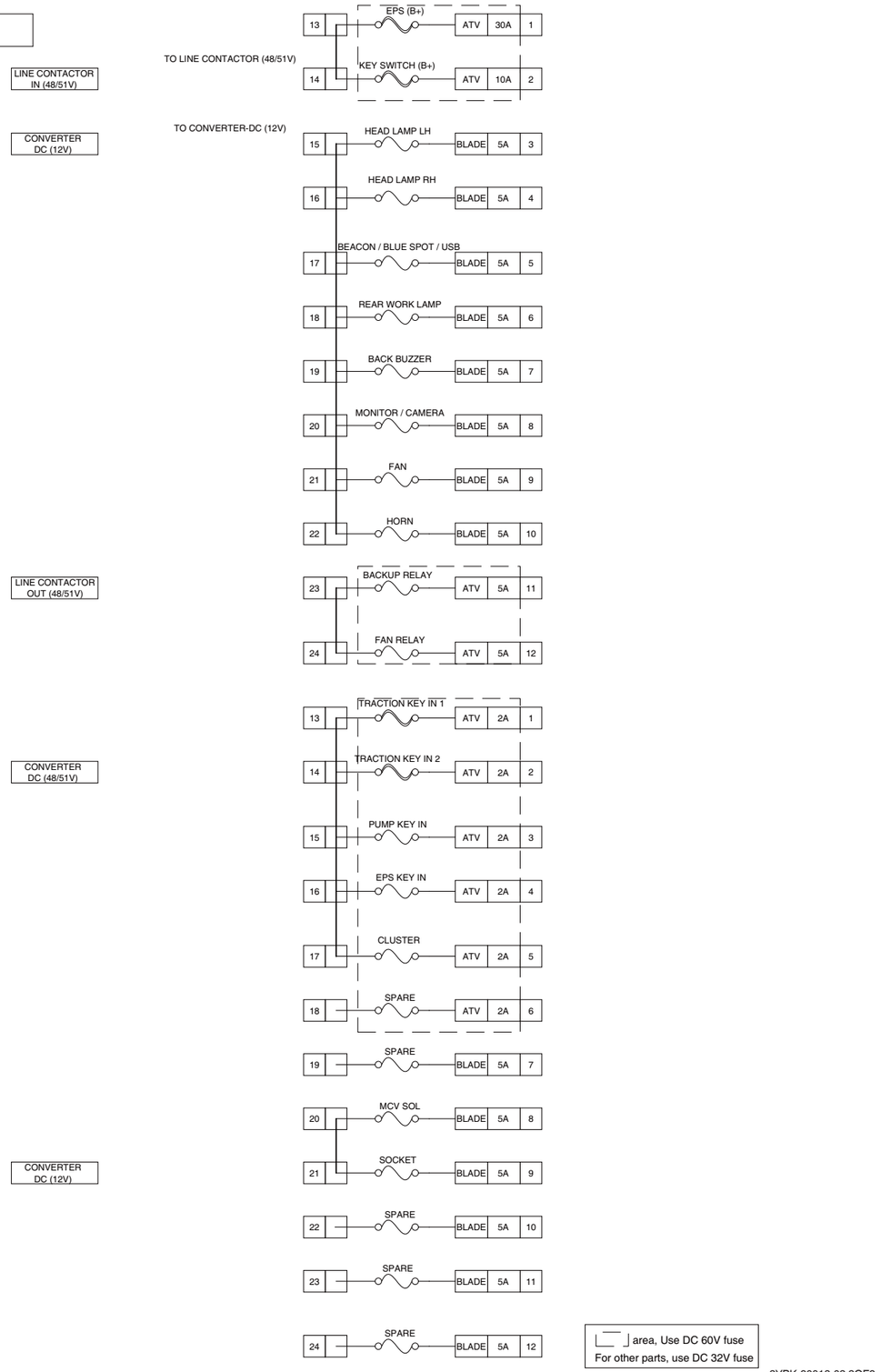
5. FUSE BOX

Non UL



UL



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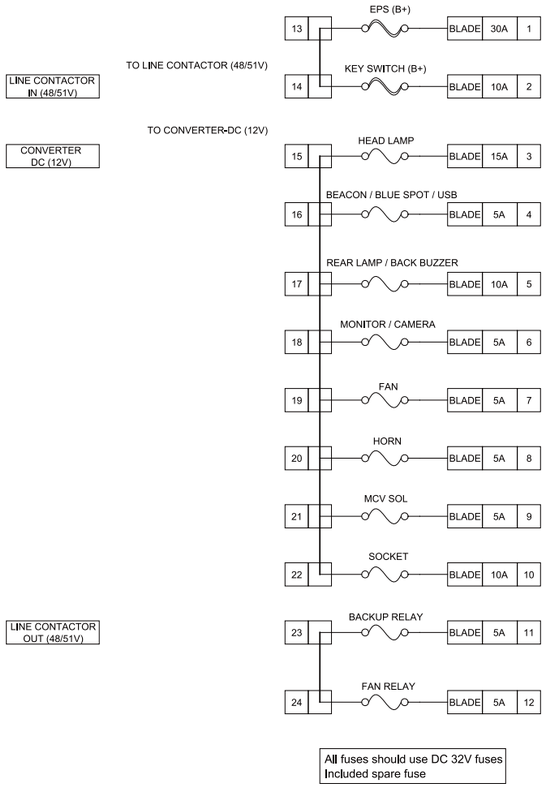
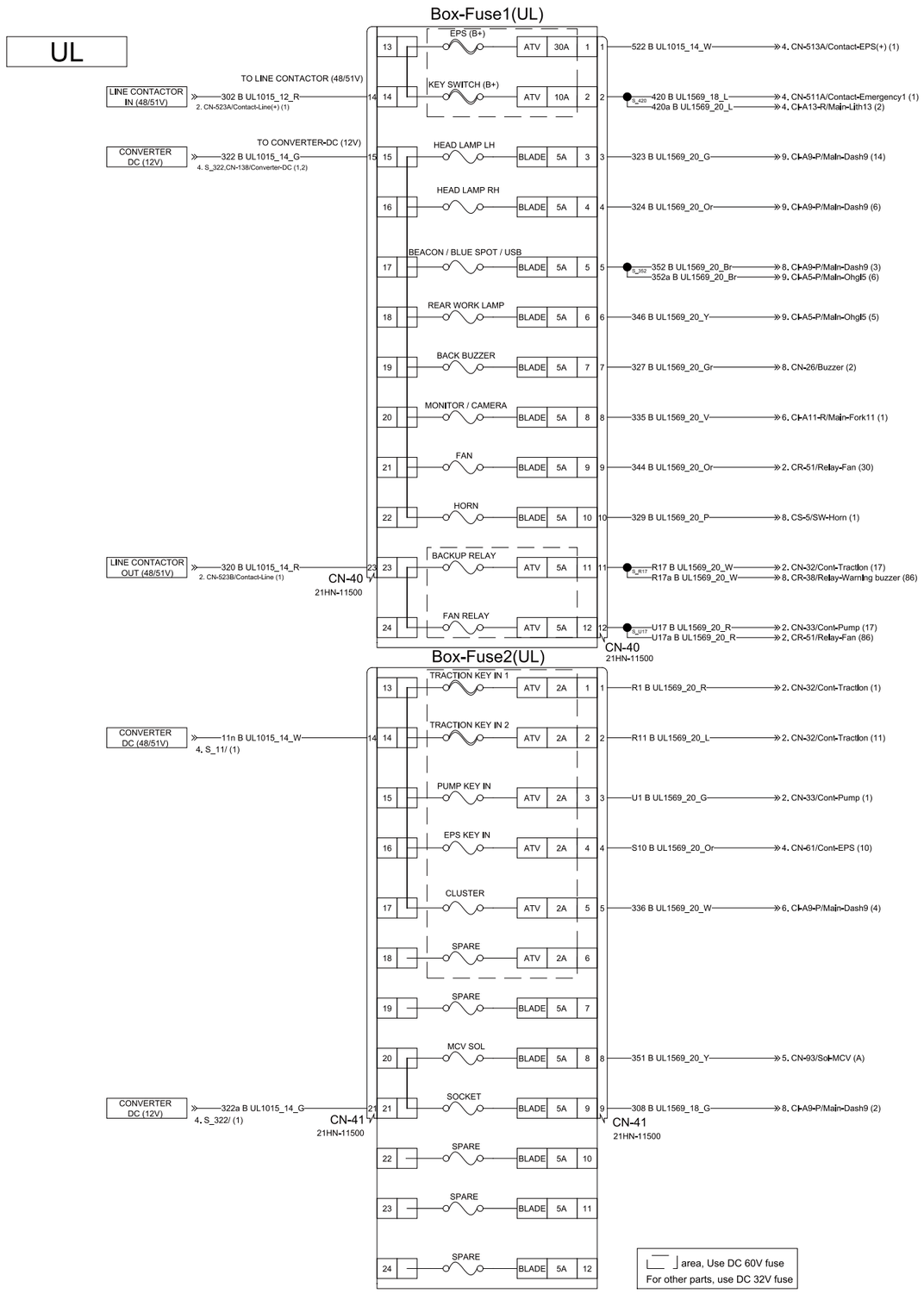
FUSE BOX (UL)

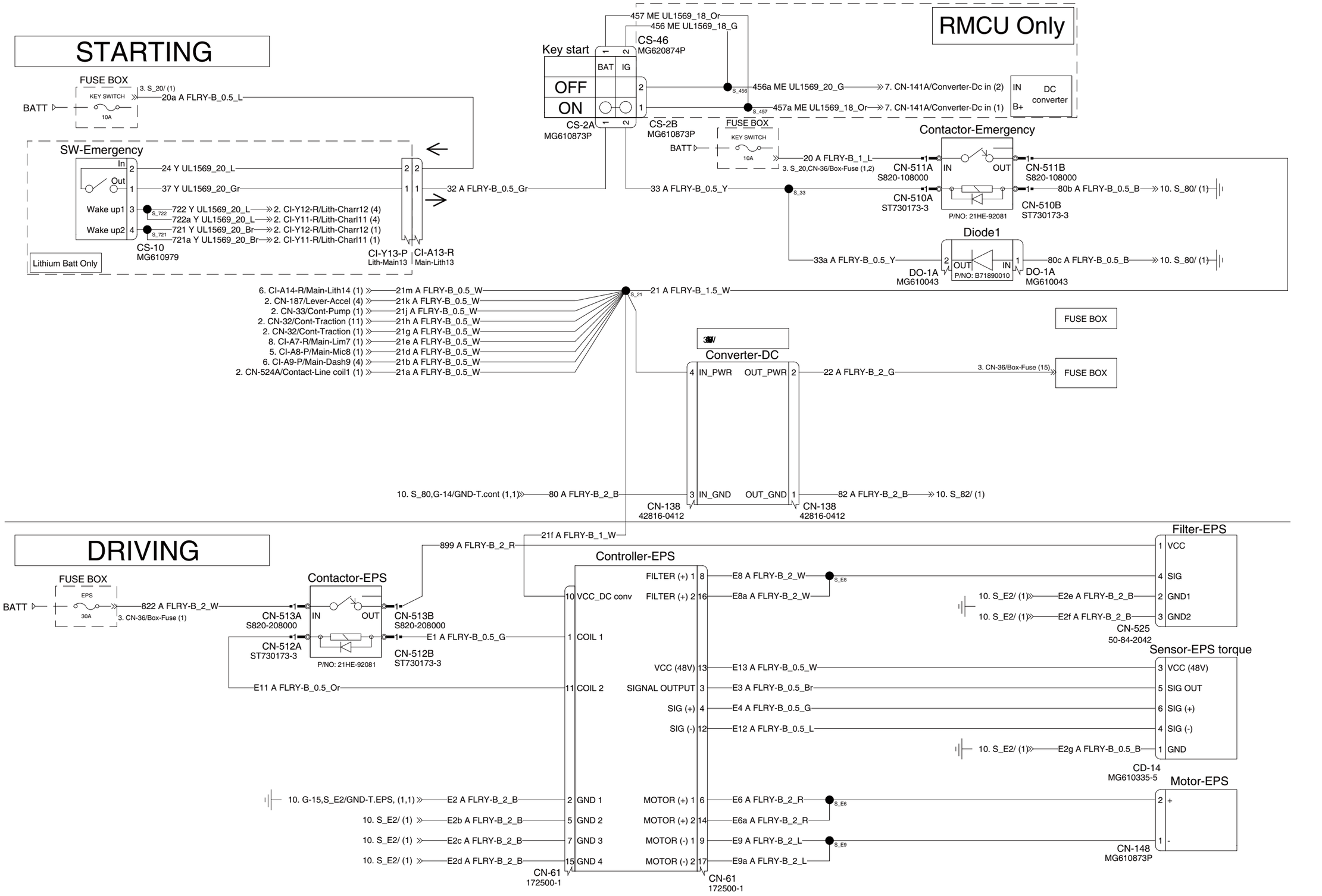
Non UL



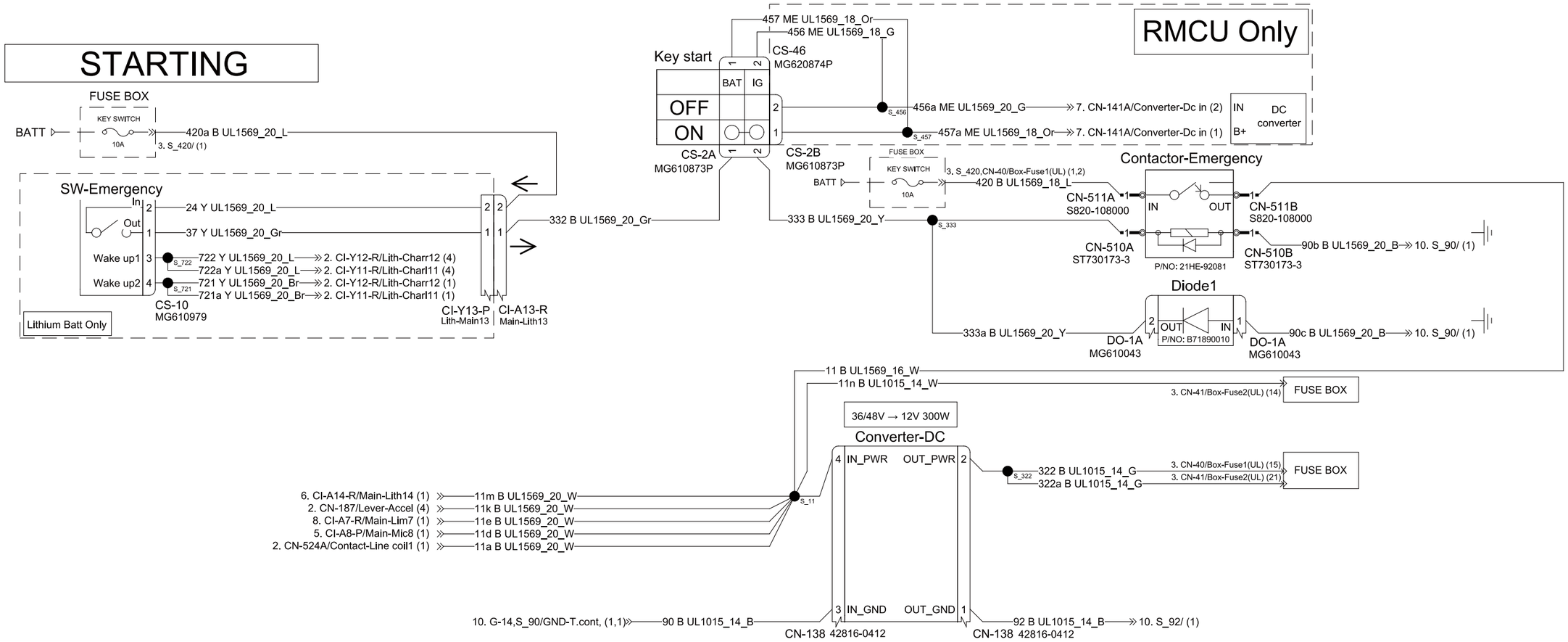
UL

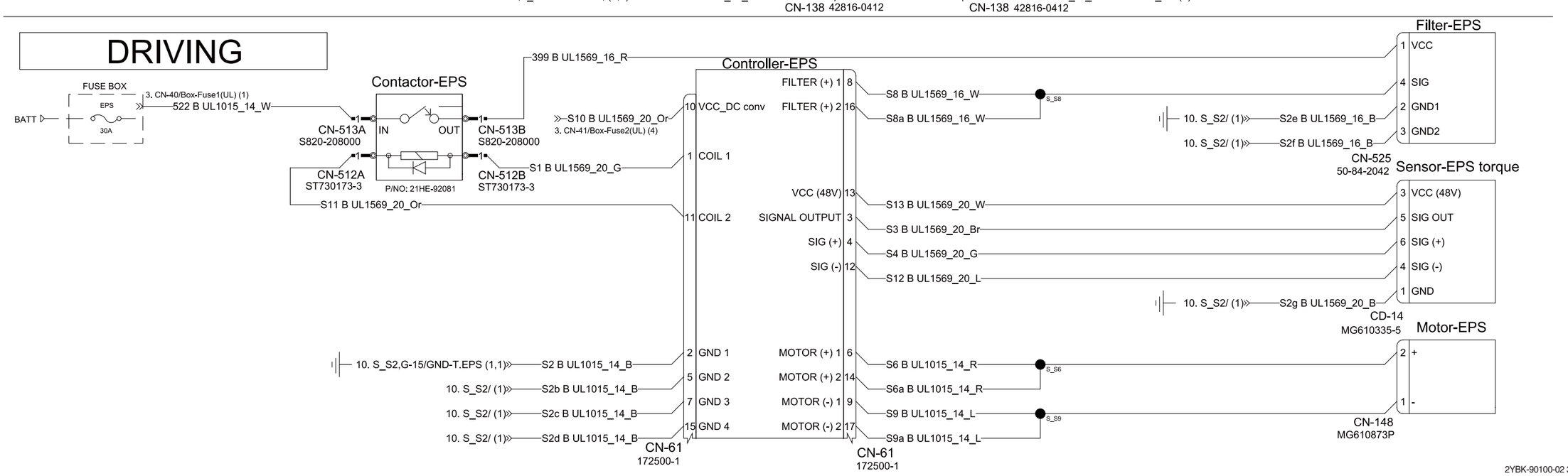


6. START AND DRIVING



START AND DRIVING (UL)





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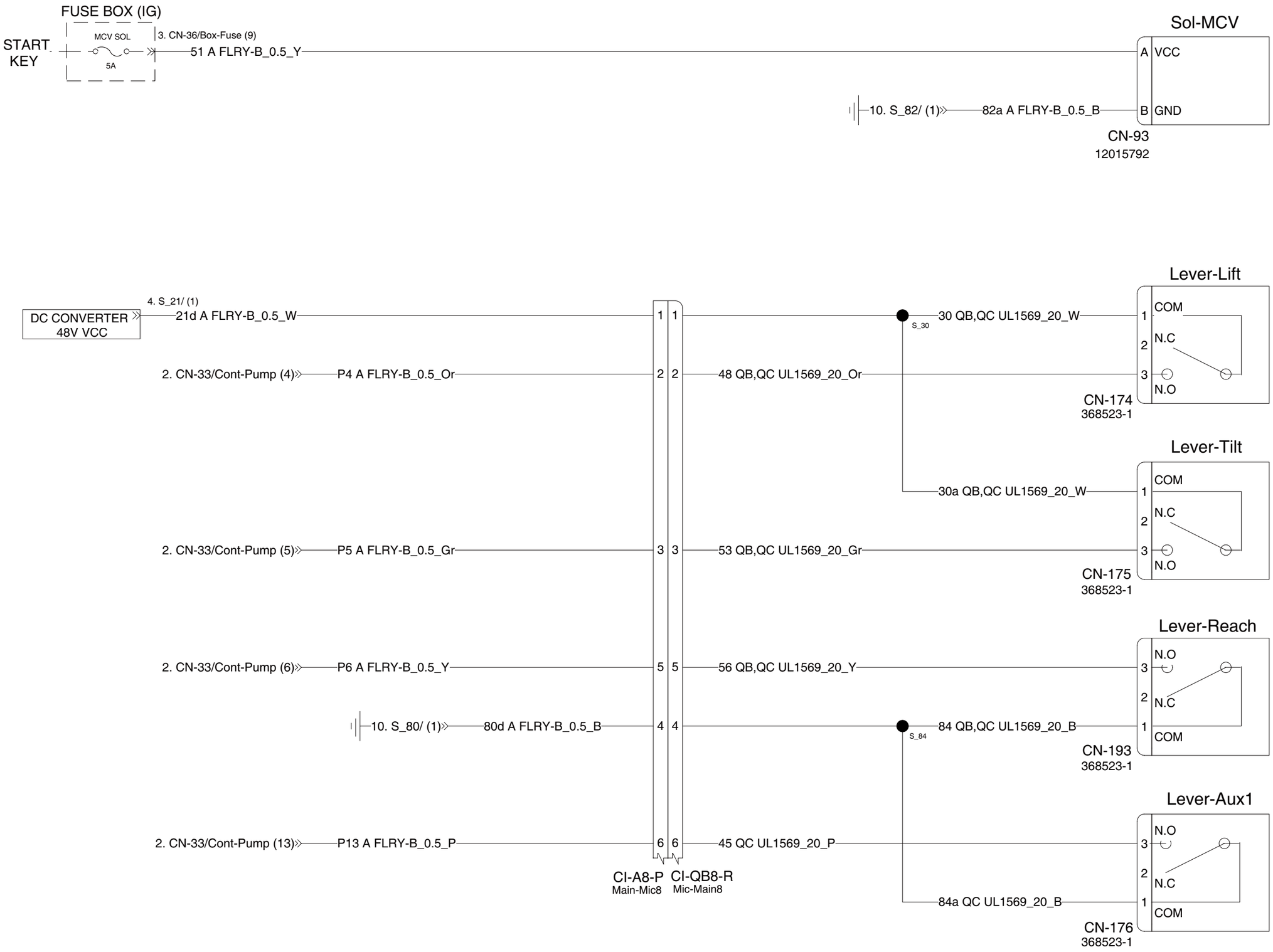
7. FINGERTIP



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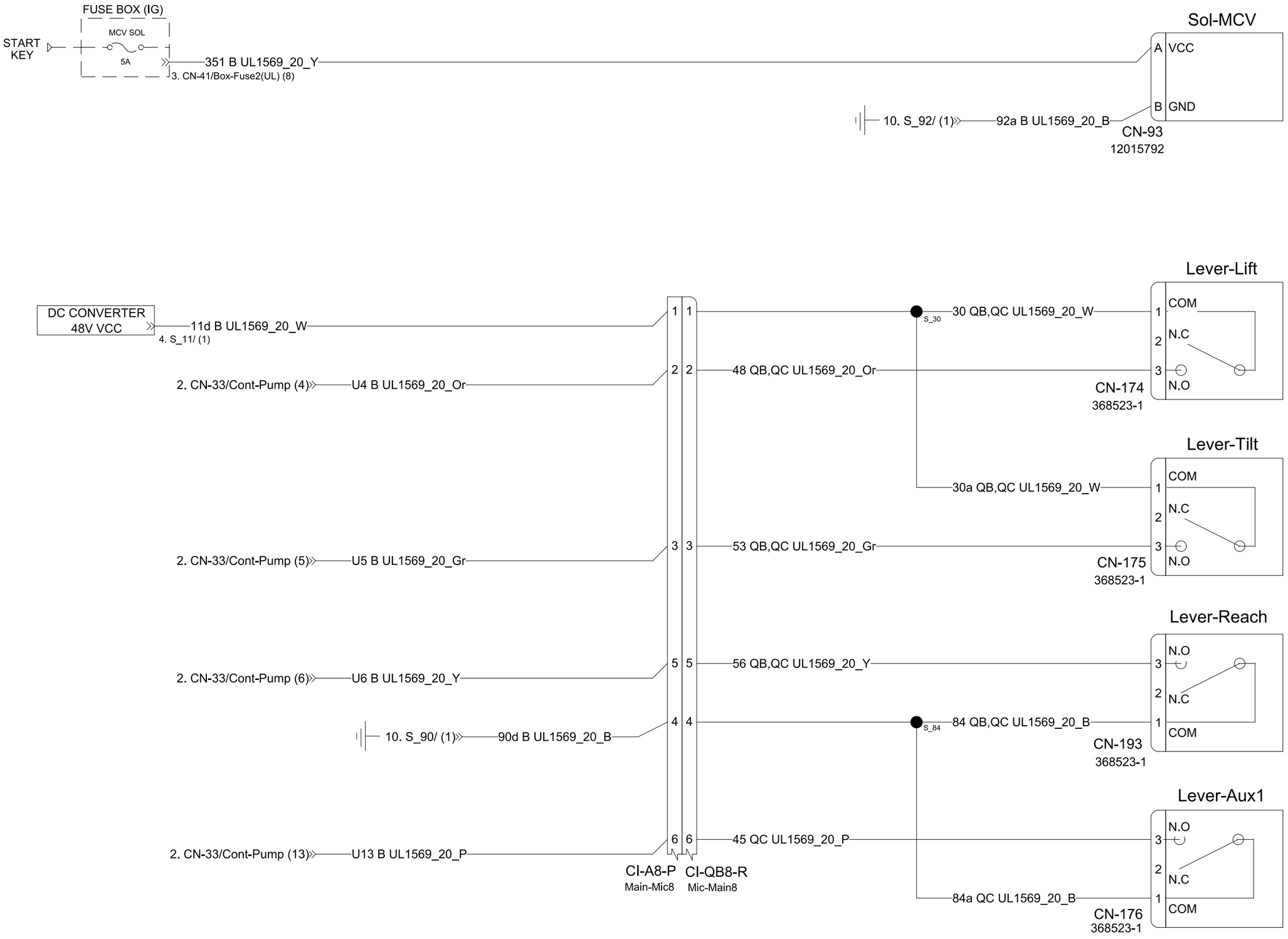
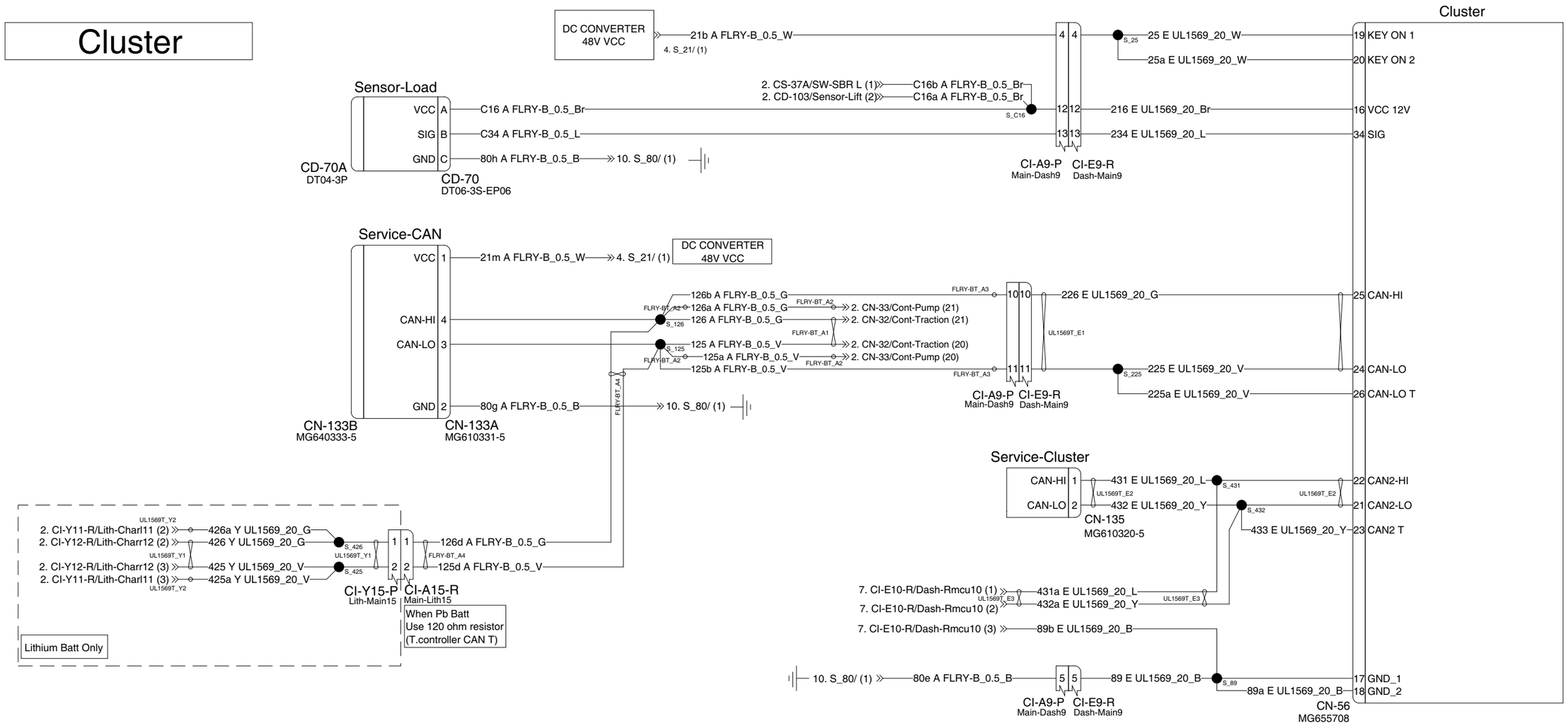
FINGERTIP (UL)

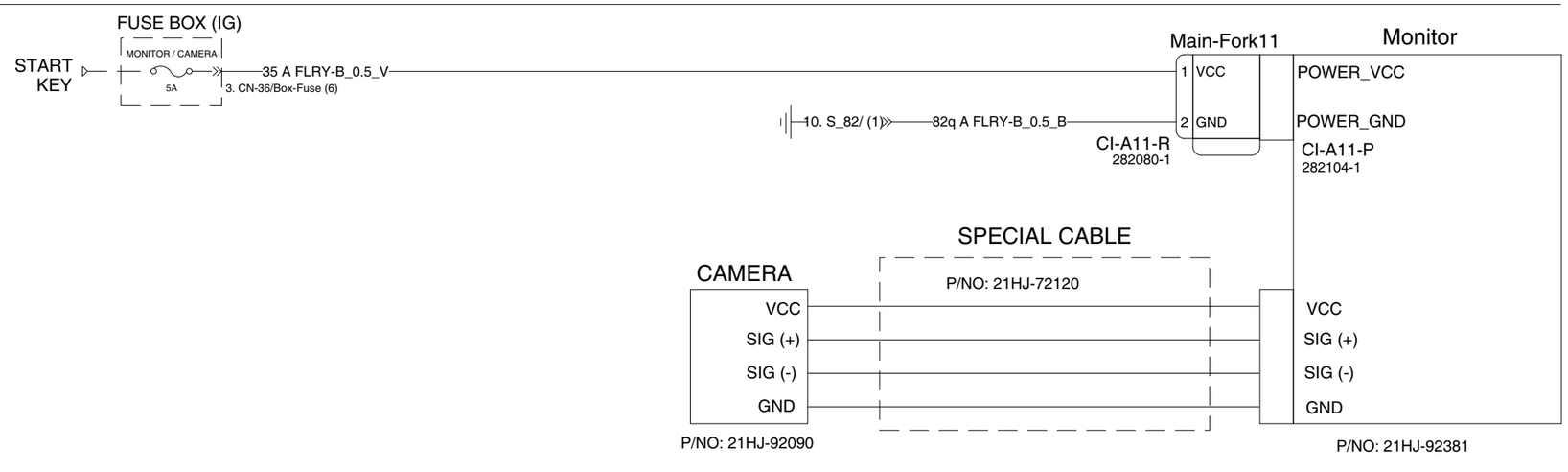


8. CLUSTER, CAMERA AND MONITOR

Cluster



Camera,Monitor



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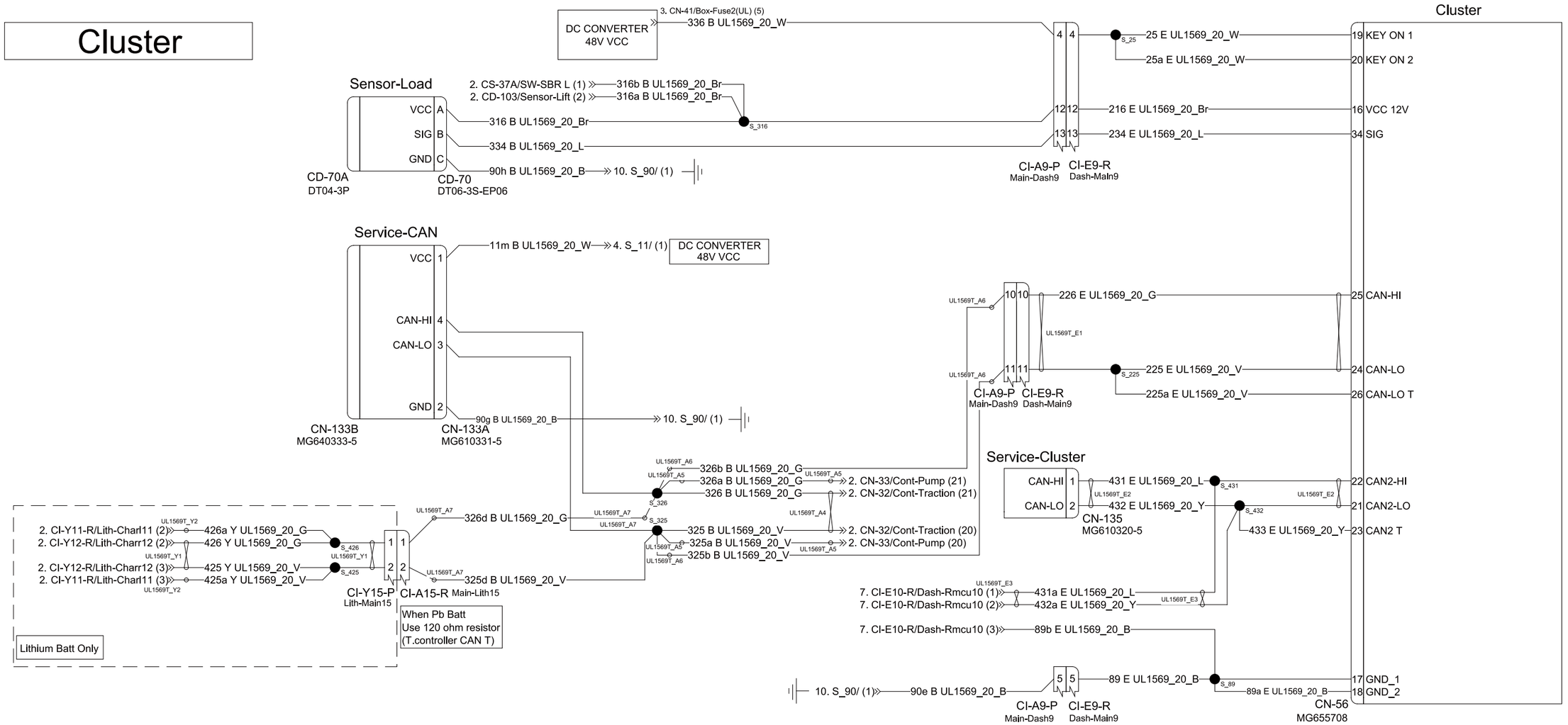
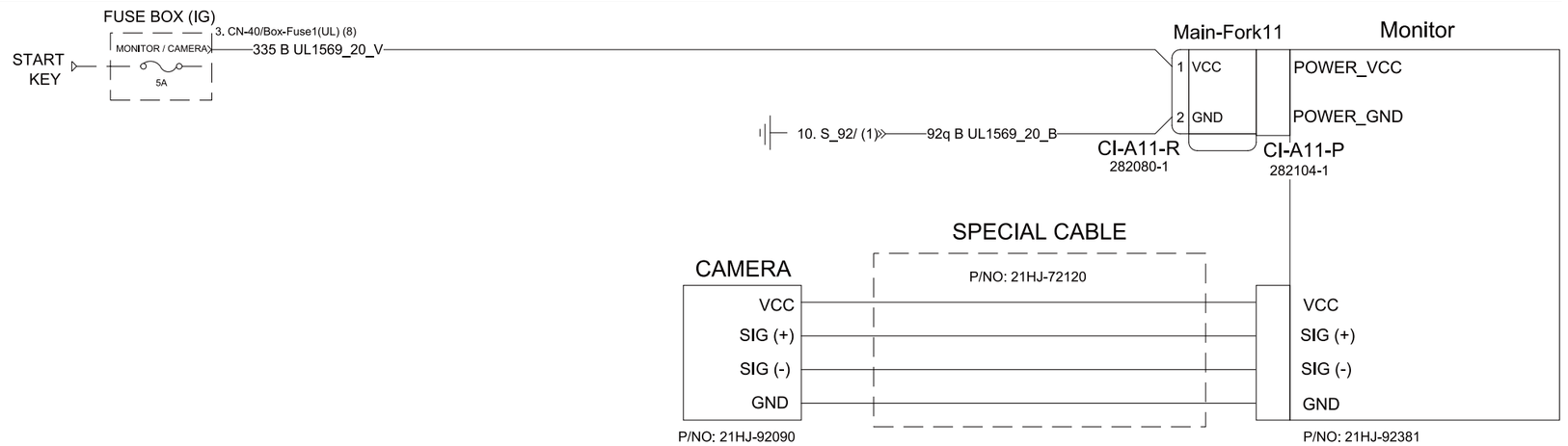
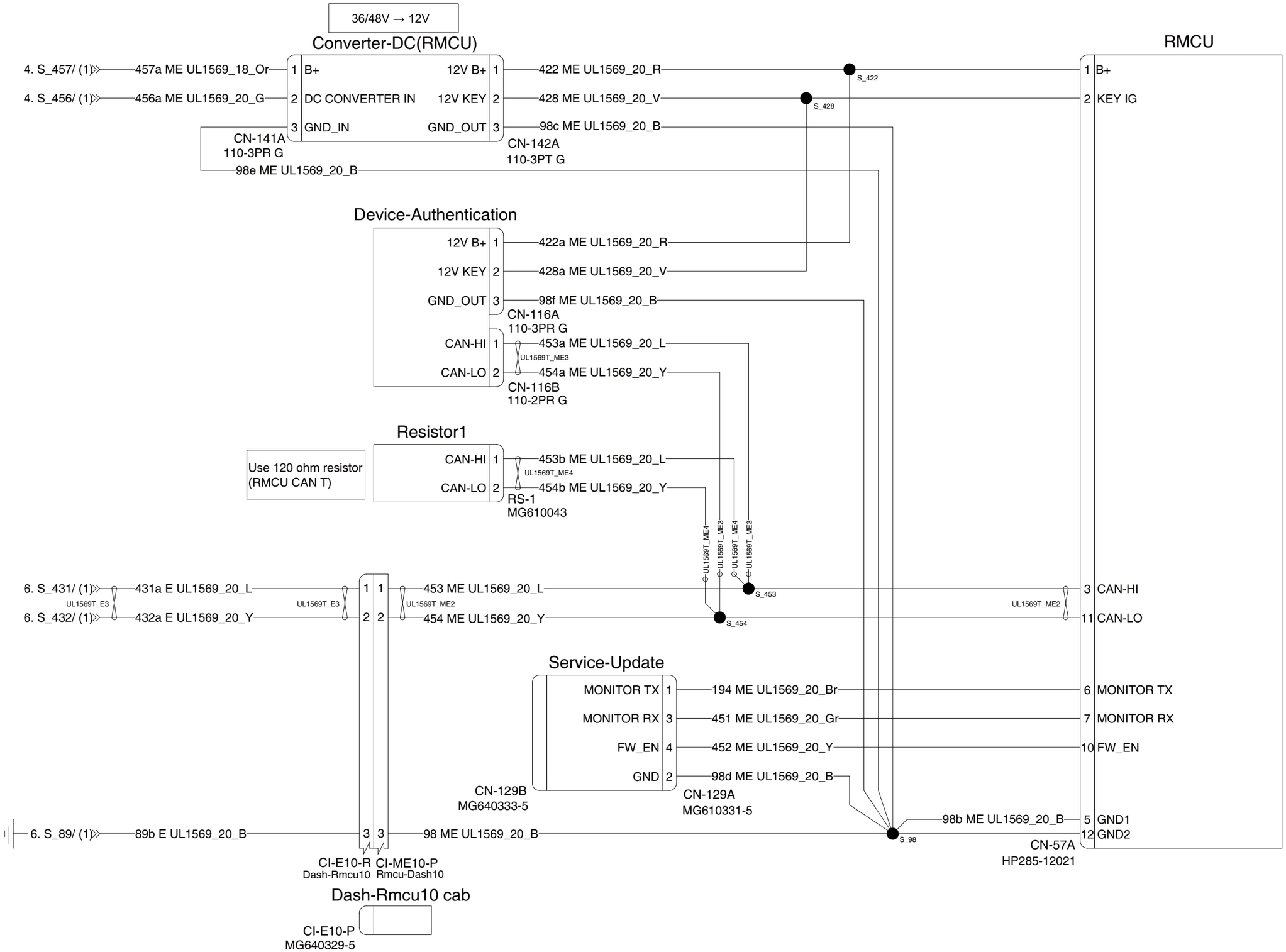
Cluster



Camera,Monitor



9. RMCU



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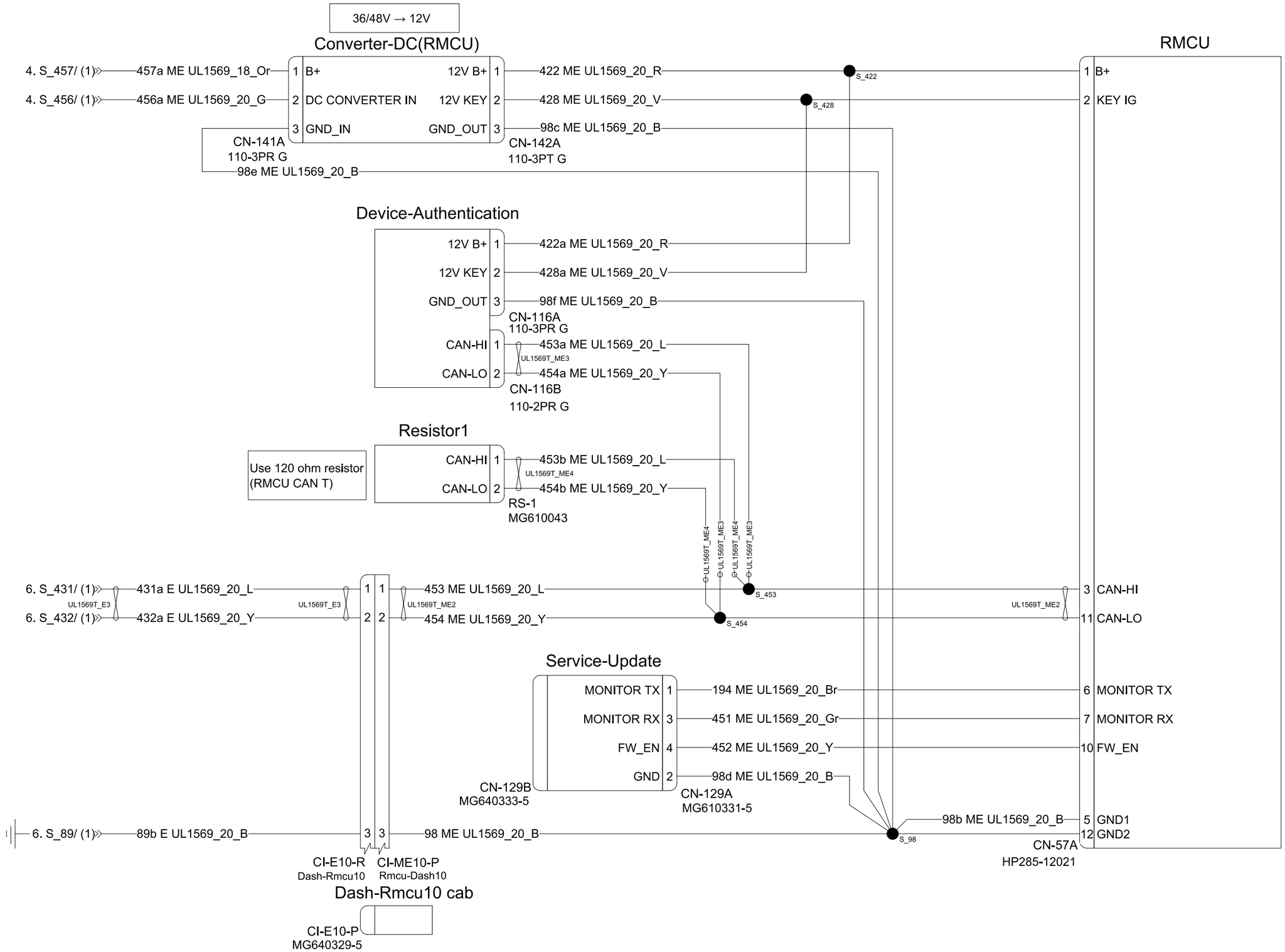
RMCU (UL)



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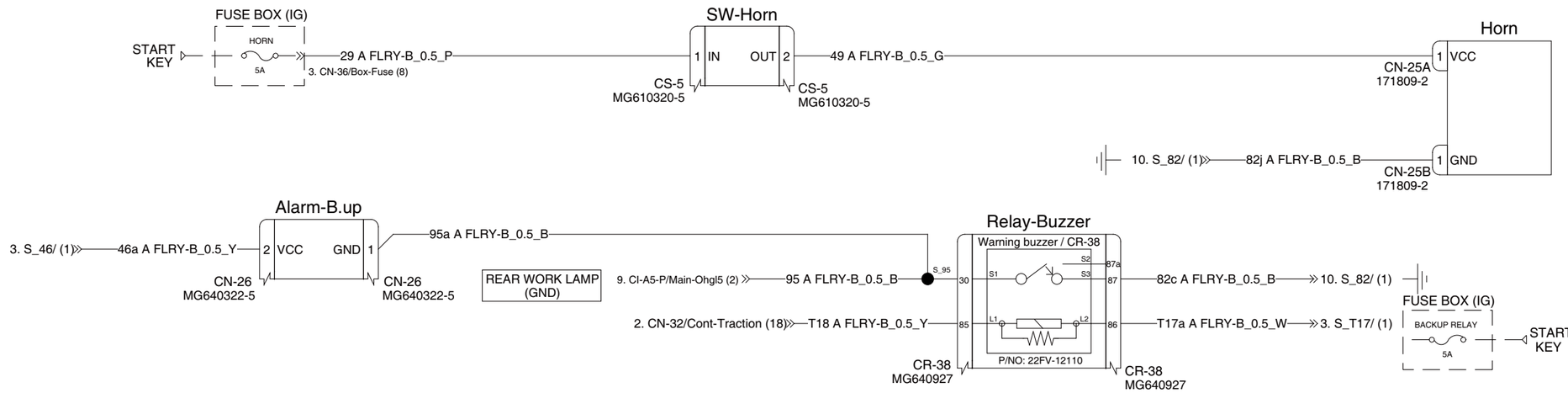
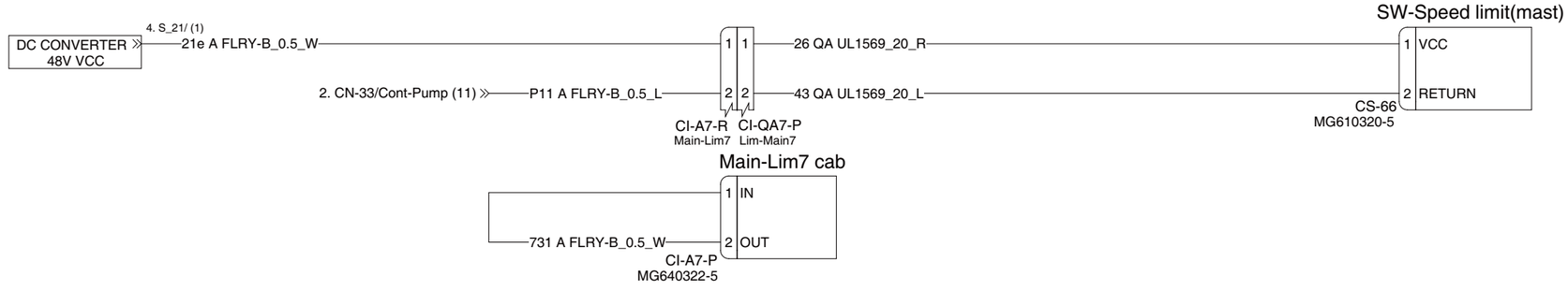
10. HORN, SOCKET, USB AND MAST

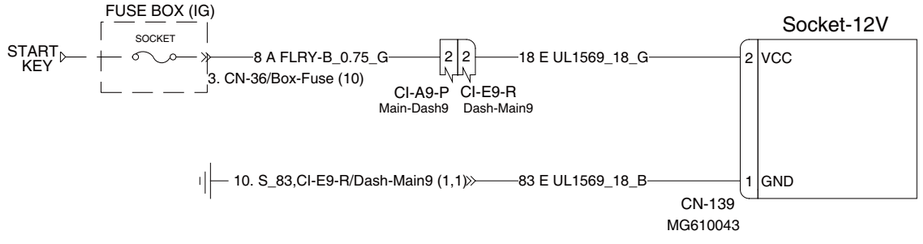
HORN



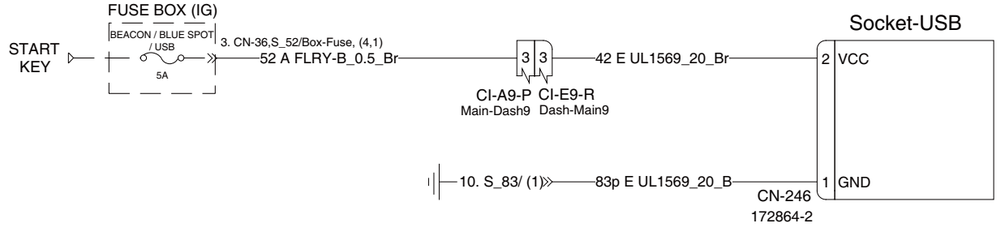
MAST



12V SOCKET

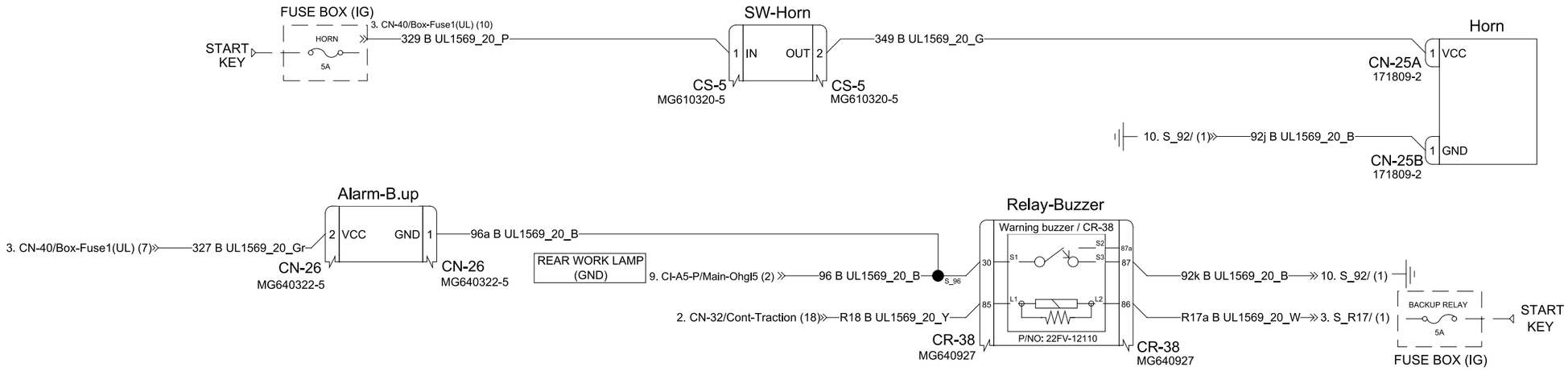


USB CHARGER

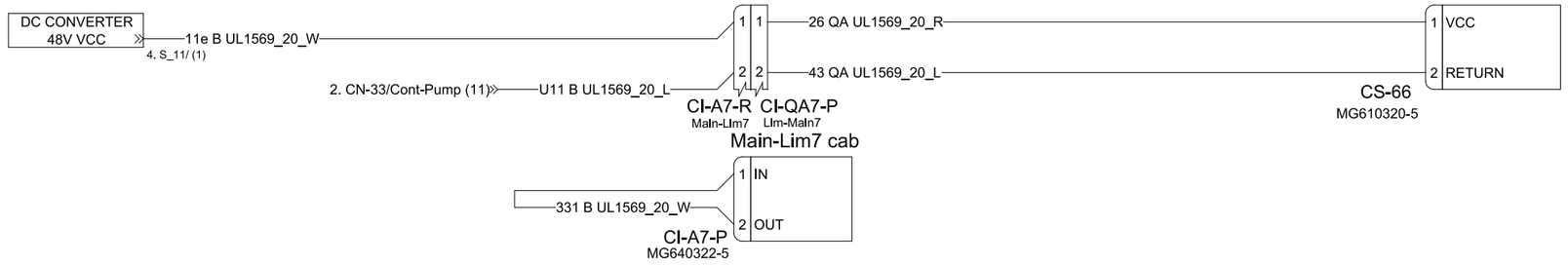


HORN, SOCKET, USB AND MAST (UL)

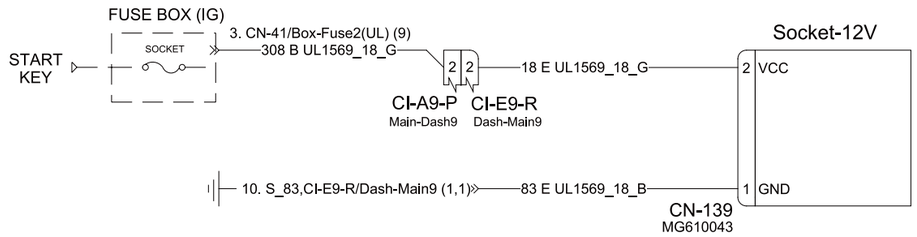
HORN



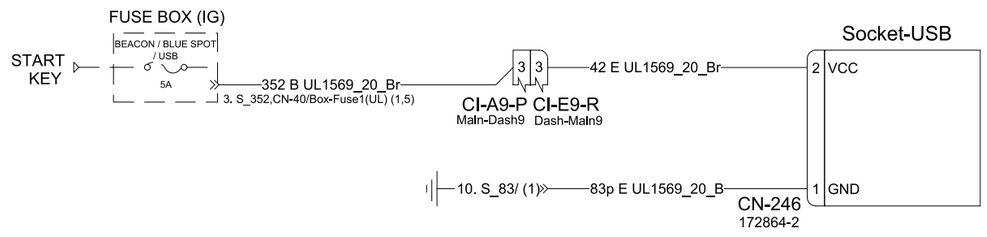
MAST



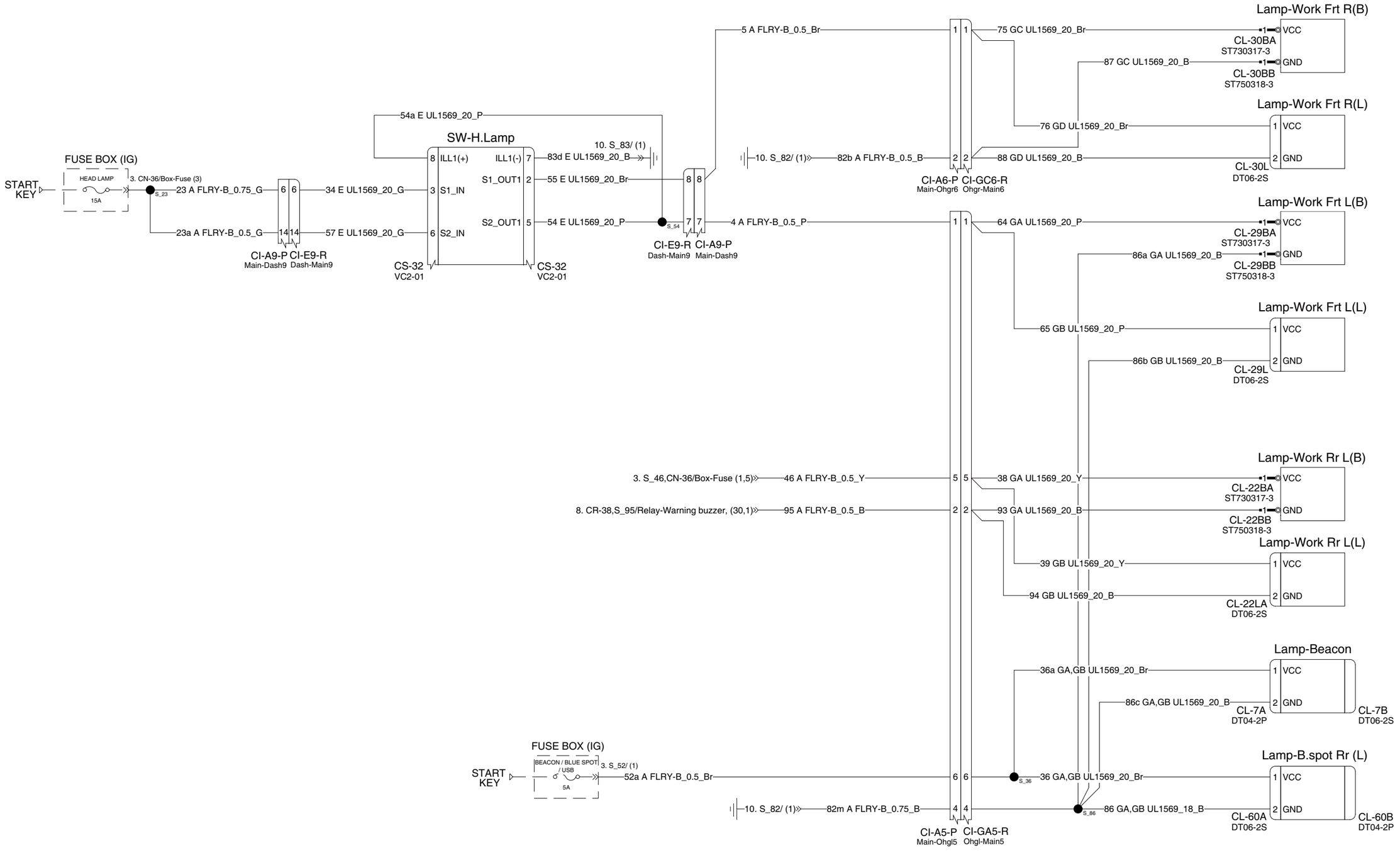
12V SOCKET



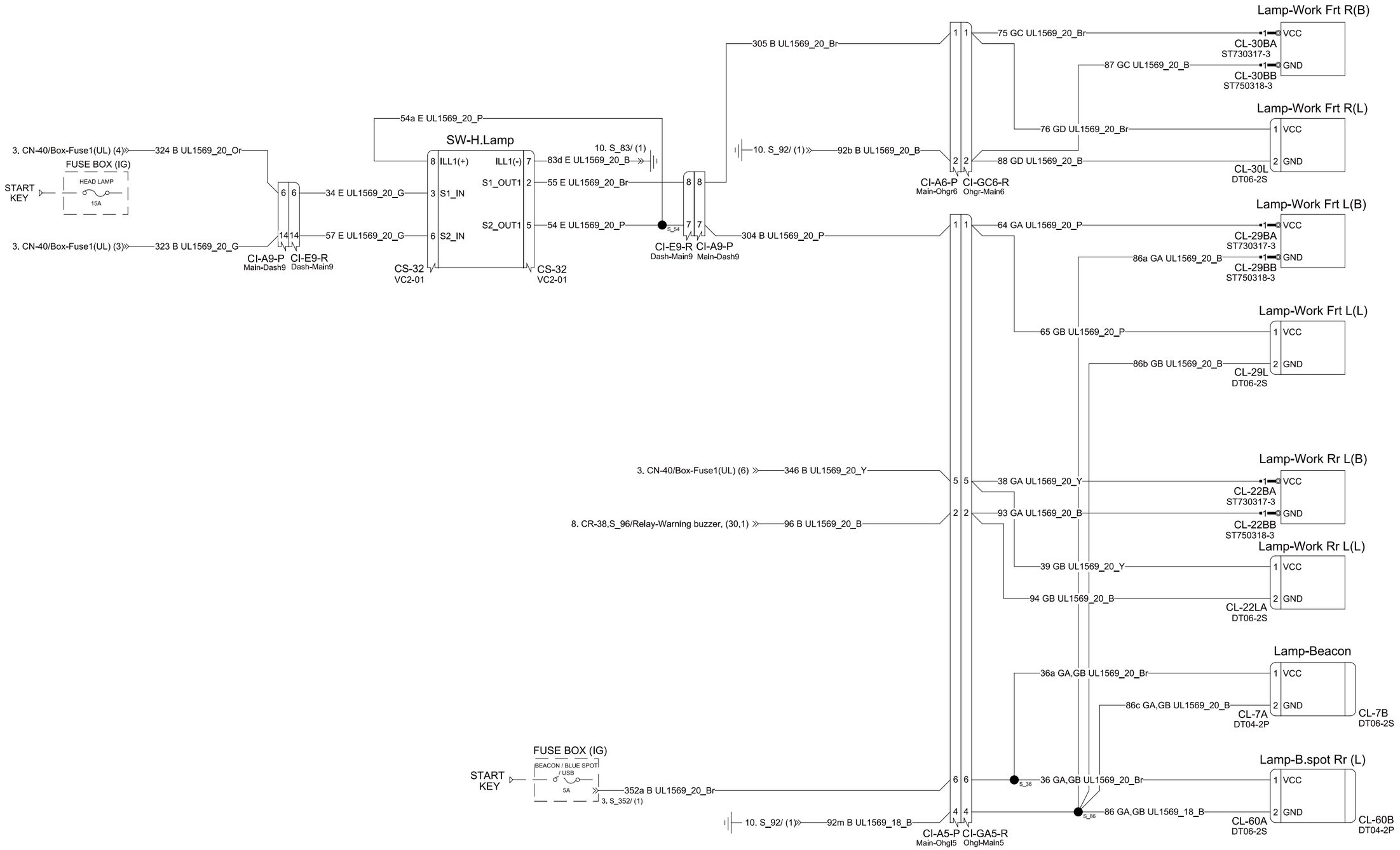
USB CHARGER



11. LAMP


Lamp-Work Frt R(B)
CL-30BA
ST730317-3
CL-30BB
ST750318-3
VCC
GND
Lamp-Work Frt R(L)
CL-30L
DT06-2S
Lamp-Work Frt L(B)
CL-29BA
ST730317-3
CL-29BB
ST750318-3
Lamp-Work Frt L(L)
CL-29L
DT06-2S
Lamp-Work Rr L(B)
CL-22BA
ST730317-3
CL-22BB
ST750318-3
Lamp-Work Rr L(L)
CL-22LA
DT06-2S
Lamp-Beacon
CL-7A
DT04-2P
CL-7B
DT06-2S
Lamp-B.spot Rr (L)
CL-60A
DT06-2S
CL-60B
DT04-2P
SW-H.Lamp
ILL1(+)
ILL1(-)
S1_OUT1
S1_IN
S2_OUT1
S2_IN
CS-32
VC2-01
FUSE BOX (IG)
HEAD LAMP
15A
START KEY
3. CN-36/Box-Fuse (3)
23 A FLRY-B_0.75_G
23a A FLRY-B_0.5_G
34 E UL1569_20_G
57 E UL1569_20_G
54a E UL1569_20_P
83d E UL1569_20_B
55 E UL1569_20_Br
54 E UL1569_20_P
10. S_83/ (1)
10. S_82/ (1)
82b A FLRY-B_0.5_B
5 A FLRY-B_0.5_Br
4 A FLRY-B_0.5_P
75 GC UL1569_20_Br
87 GC UL1569_20_B
76 GD UL1569_20_Br
88 GD UL1569_20_B
64 GA UL1569_20_P
86a GA UL1569_20_B
65 GB UL1569_20_P
86b GB UL1569_20_B
3. S_46,CN-36/Box-Fuse (1,5)
46 A FLRY-B_0.5_Y
8. CR-38,S_95/Relay-Warning buzzer, (30,1)
95 A FLRY-B_0.5_B
38 GA UL1569_20_Y
93 GA UL1569_20_B
39 GB UL1569_20_Y
94 GB UL1569_20_B
36a GA,GB UL1569_20_Br
86c GA,GB UL1569_20_B
3. S_52/ (1)
52a A FLRY-B_0.5_Br
36 GA,GB UL1569_20_Br
86 GA,GB UL1569_18_B
10. S_82/ (1)
82m A FLRY-B_0.75_B
BEACON / BLUE SPOT / USB
5A
CI-A9-P CI-E9-R
Main-Dash9 Dash-Main9
CI-E9-R CI-A9-P
Dash-Main9 Main-Dash9
CI-A6-P CI-GC6-R
Main-Ohgr6 Ohgr-Main6
CI-A5-P CI-GA5-R
Main-Ohgl5 Ohgl-Main5
S_23
S_54
S_36
S_86

LAMP (UL)



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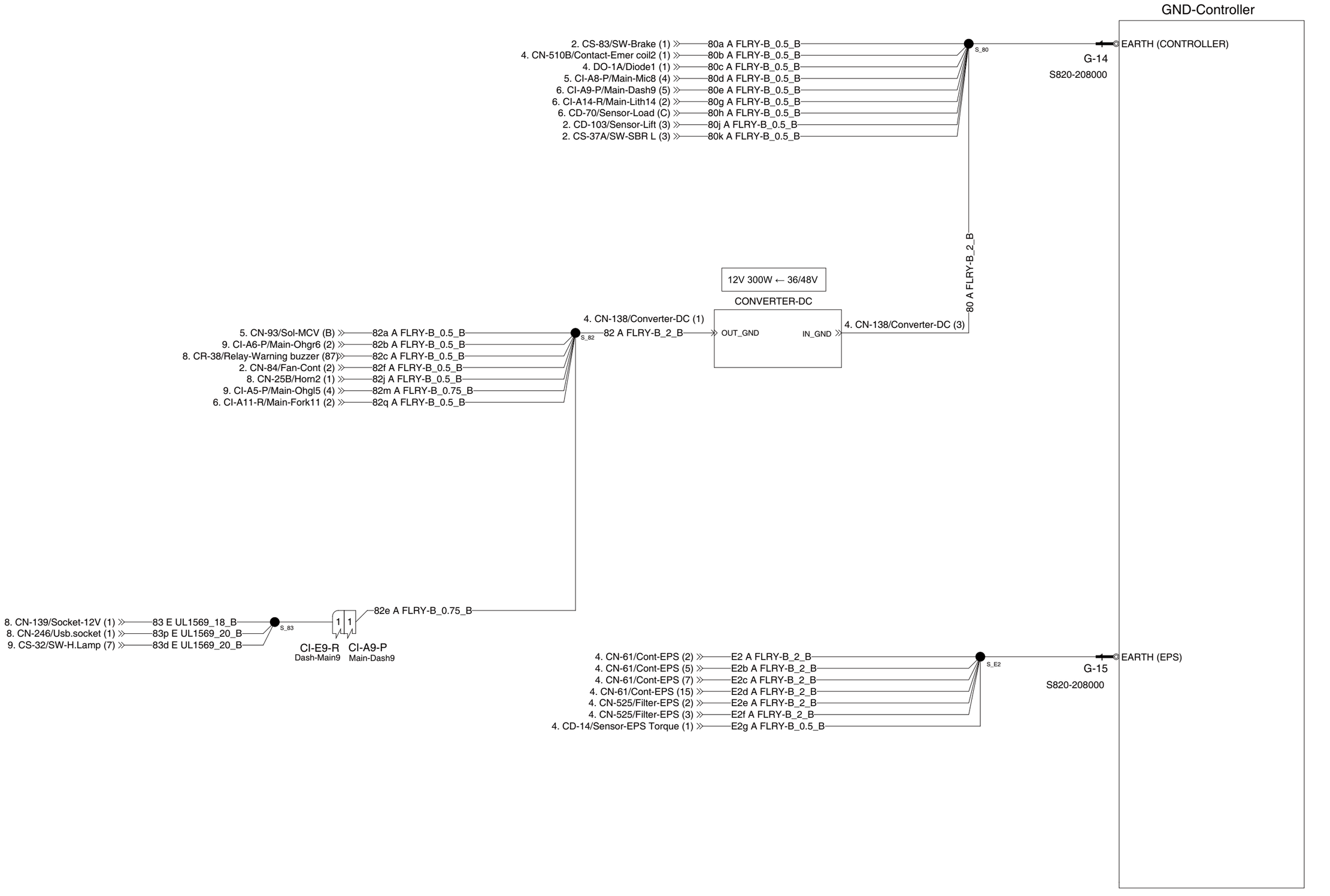
12. GROUNDING



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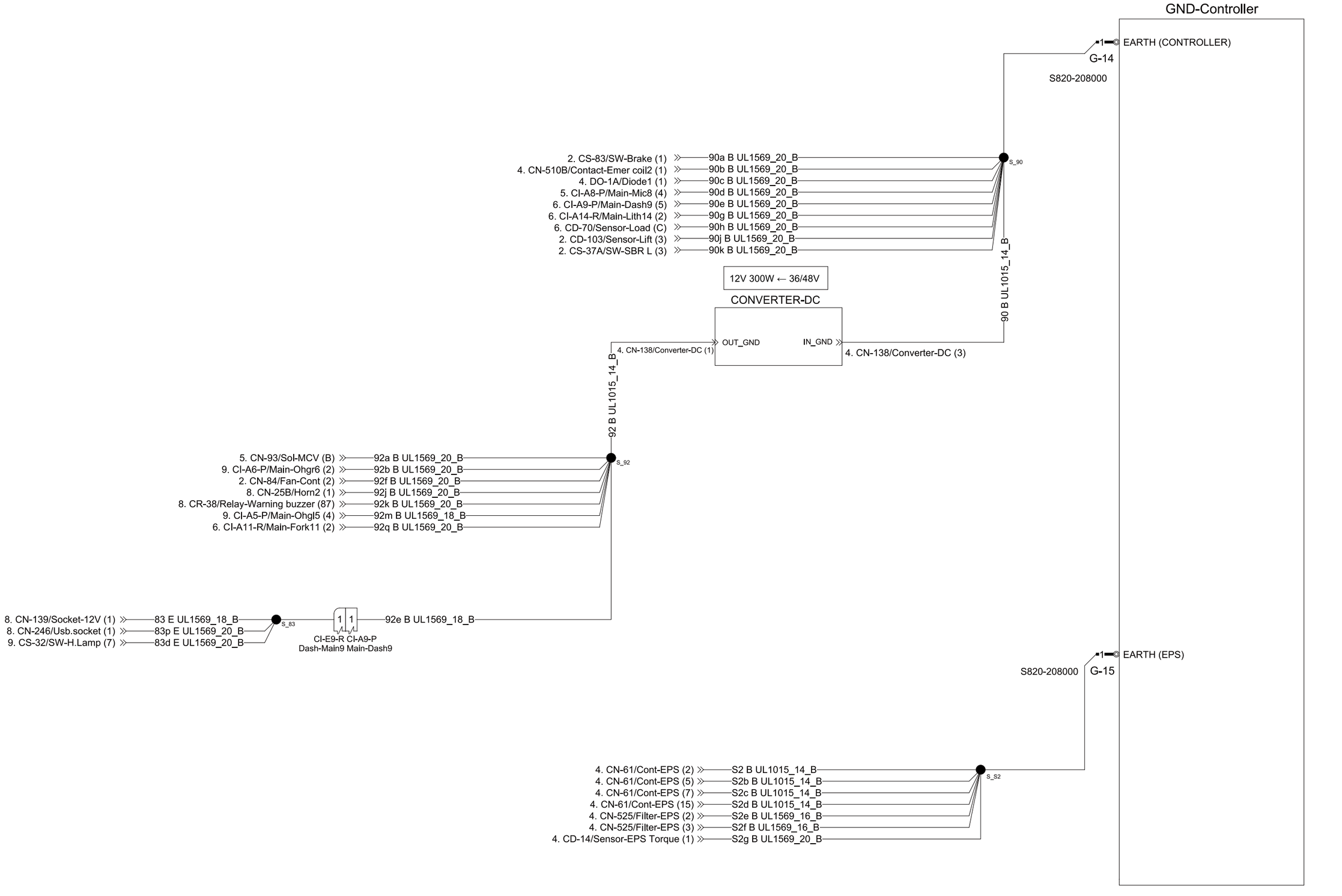
GROUNDING (UL)

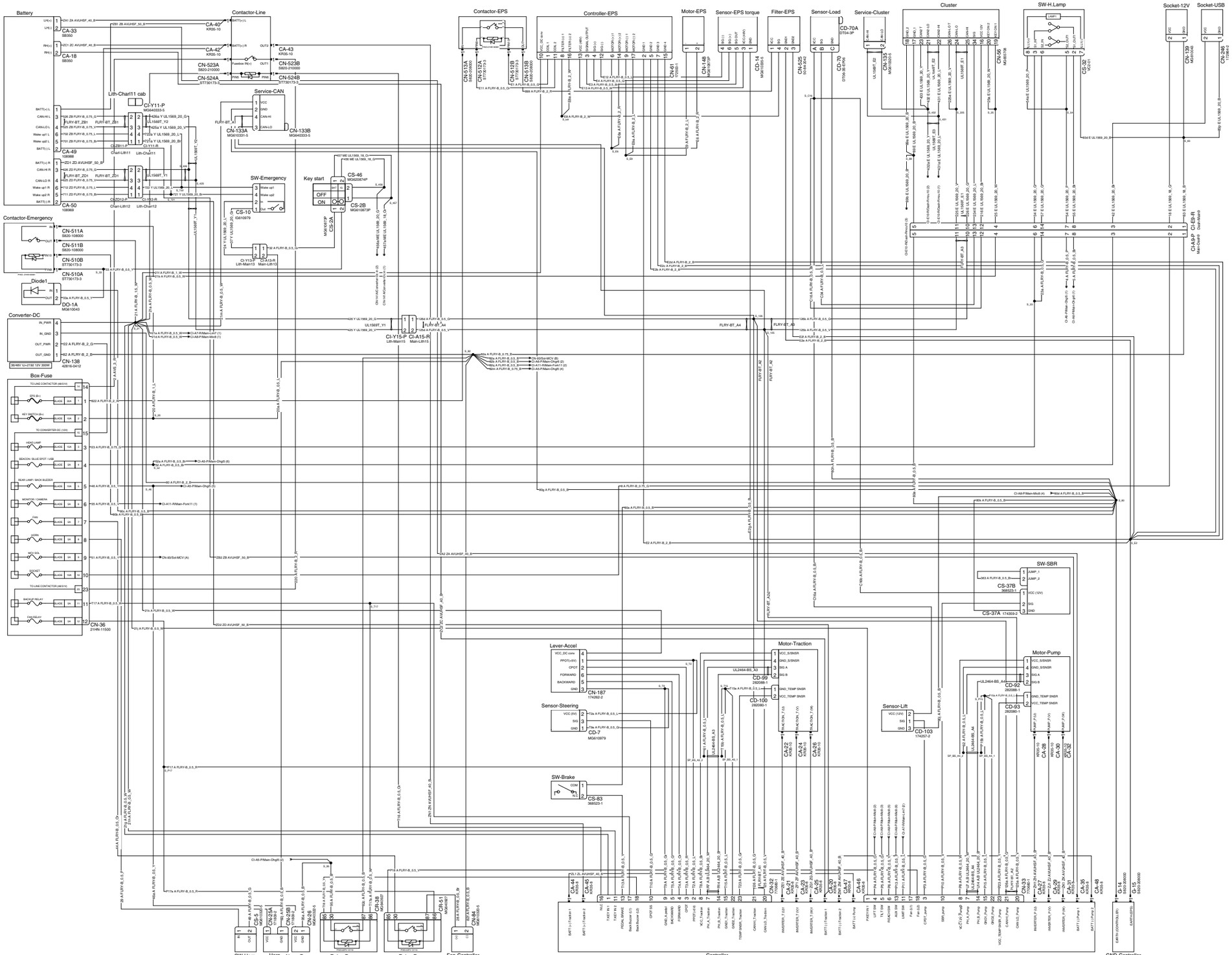


GROUP 2 ELECTRIC CIRCUIT DIAGRAMS

1. CODES IN ELECTRIC CIRCUIT DIAGRAMS

Item	Name
A	Main harness
B	Main harness (UL)
E	Dashboard harness
GA	Overhead guard left harness (Bulb)
GB	Overhead guard left harness (LED)
GC	Overhead guard right harness (Bulb)
GD	Overhead guard right harness (LED)
ME	RMCU harness
QA	Limit switch harness
QB	Micro switch harness (3-spool)
QC	Micro switch harness (4-spool)
Y	Lithium harness
Z1	Contactor cable (UL)
ZA	Charging cable (Left_Pb)
ZB	Charging cable (Left_Li)
ZC	Charging cable (Right_Pb)
ZD	Charging cable (Right_Li)
ZE	Driving motor cable (U)
ZF	Driving motor cable (V)
ZG	Driving motor cable (W)
ZH	Pump motor cable (U)
ZJ	Pump motor cable (V)
ZK	Pump motor cable (W)
ZL	Cable (BF_+)
ZM	Cable (B-)
ZN	Line contactor cable
ZO	Charging cable (Left_Pb, UL)
ZP	Charging cable (Left_Li, UL)
ZQ	Charging cable (Right_Pb, UL)
ZR	Charging cable (Right_Li, UL)
ZS	Driving motor cable (U, UL)
ZT	Driving motor cable (V, UL)
ZU	Driving motor cable (W, UL)
ZV	Pump motor cable (U, UL)
ZW	Pump motor cable (V, UL)
ZX	Pump motor cable (W, UL)
ZY	Cable (BF_+, UL)
ZZ	Cable (B-, UL)

2. OVERALL CIRCUIT DIAGRAM (1/2)



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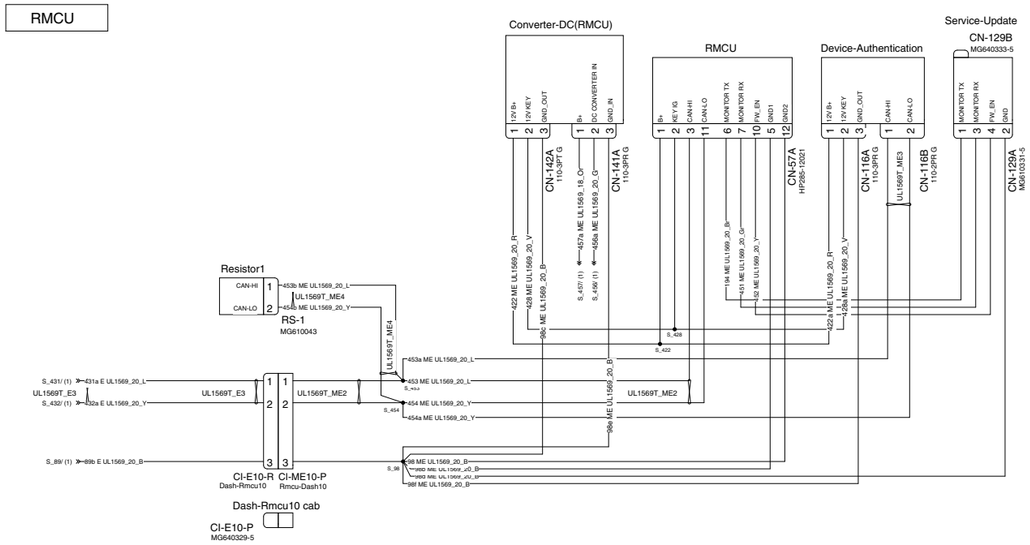
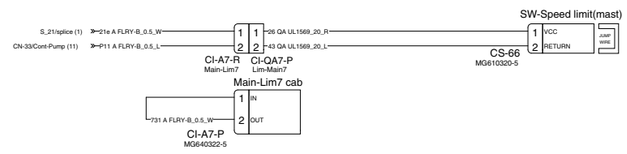
OVERALL CIRCUIT DIAGRAM (2/2)

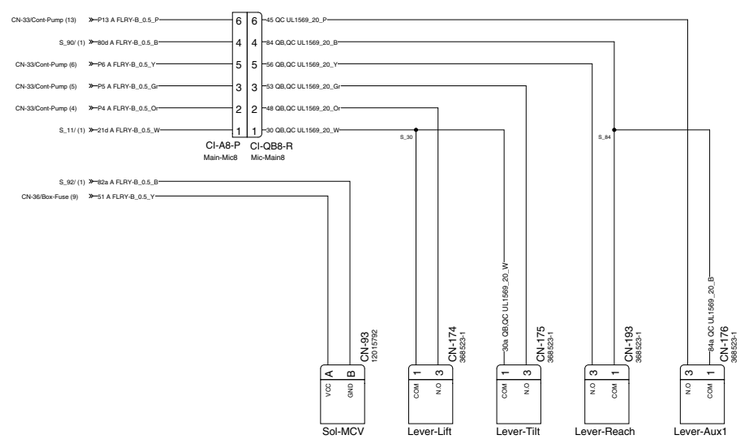
RMCU



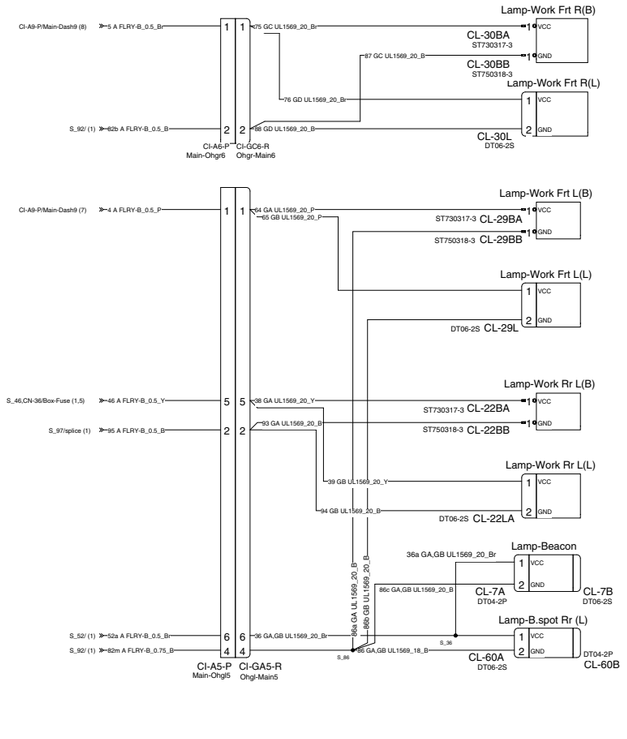
Speed Limit (MAST)



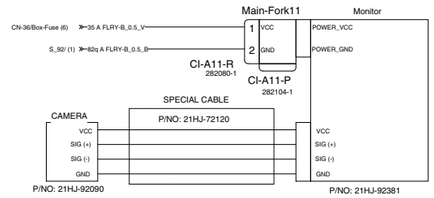
F/TIP-MCV



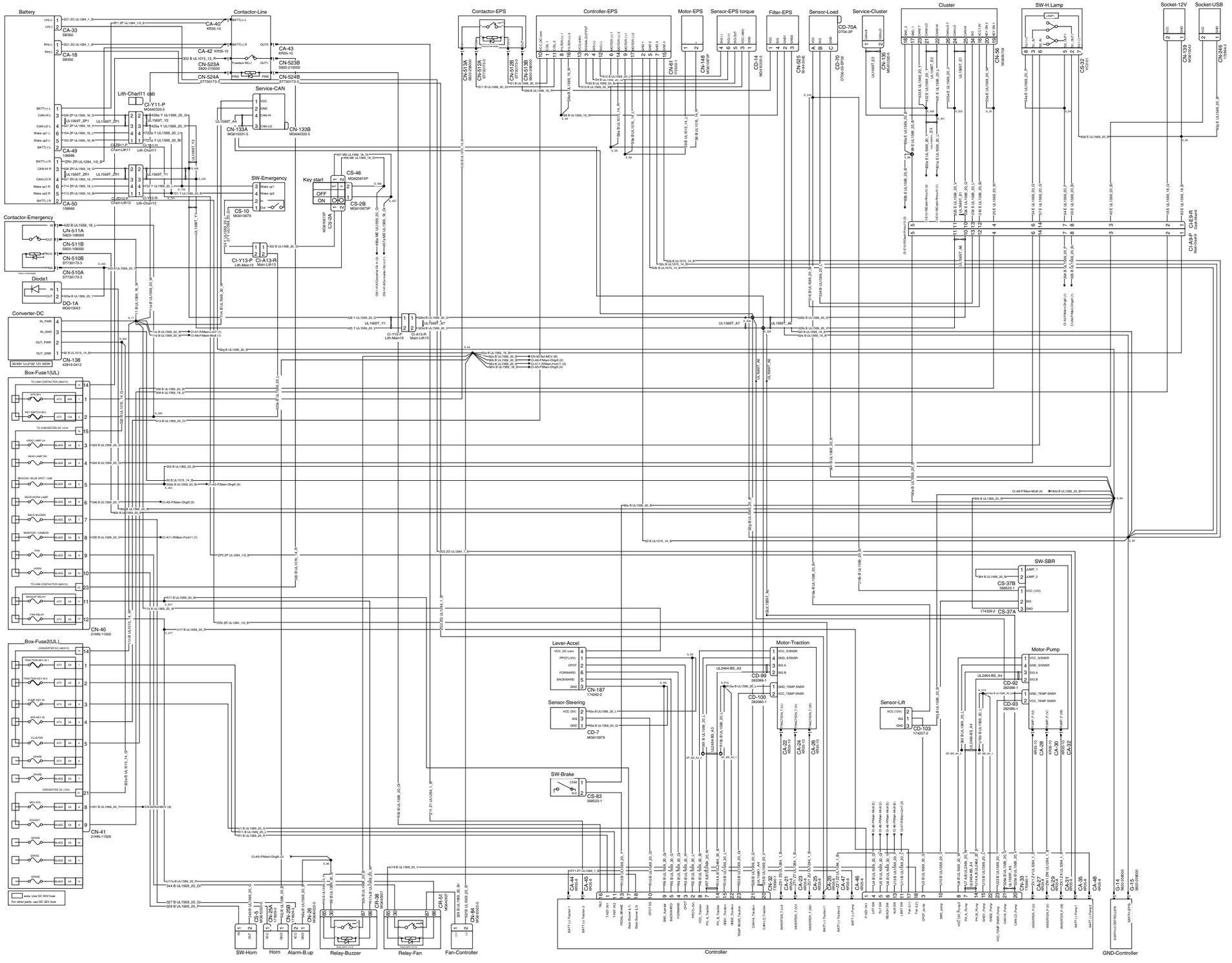
LAMP



Camera, Monitor



3. OVERALL CIRCUIT DIAGRAM (1/2, UL)



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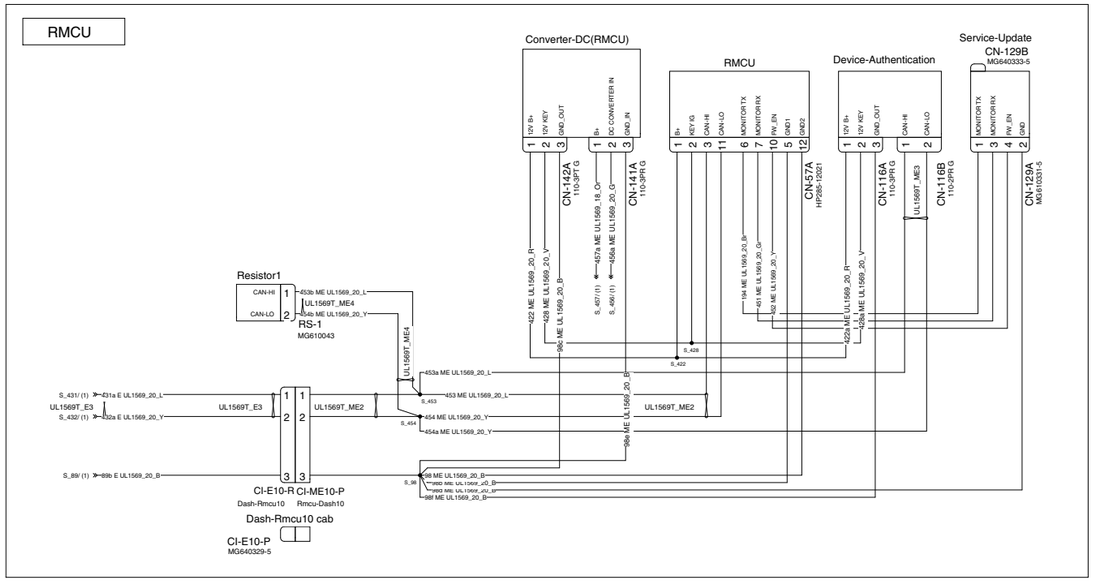
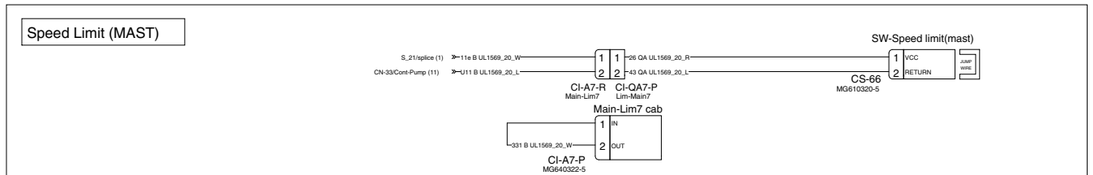
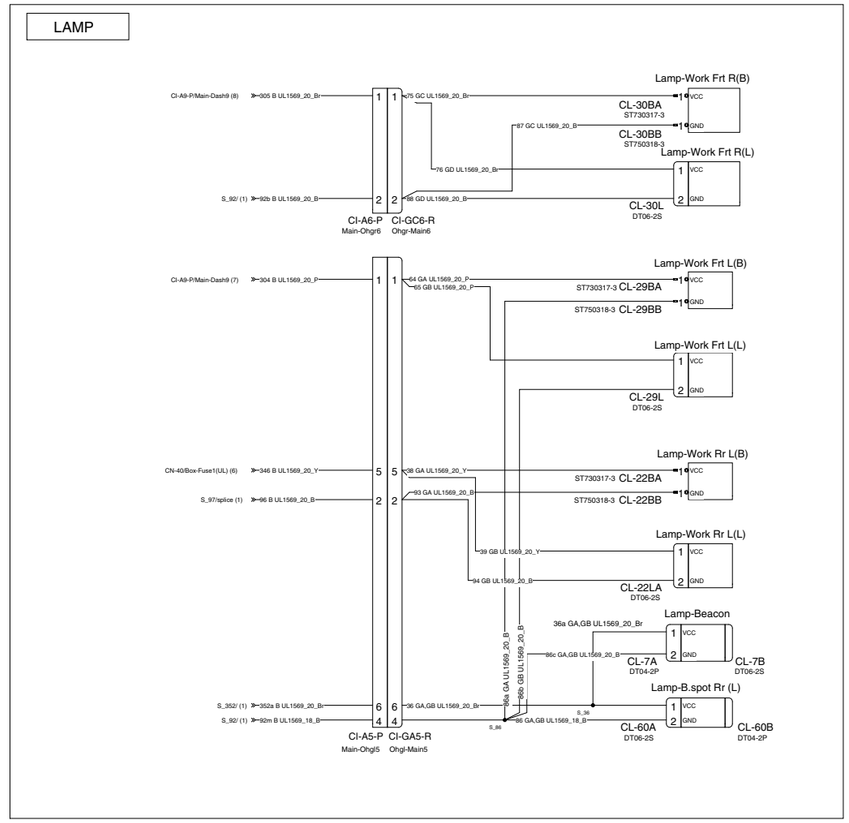
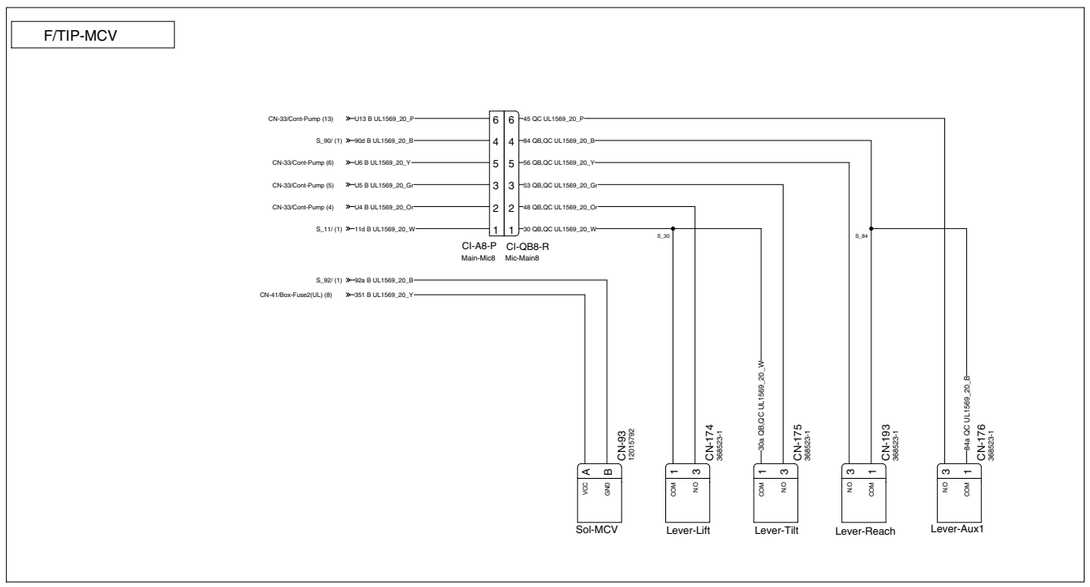
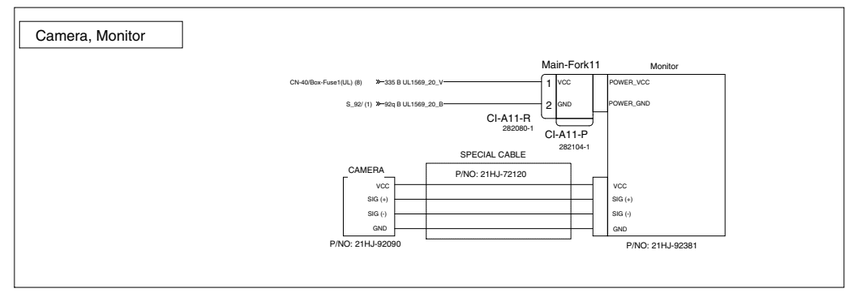
OVERALL CIRCUIT DIAGRAM (2/2, UL)



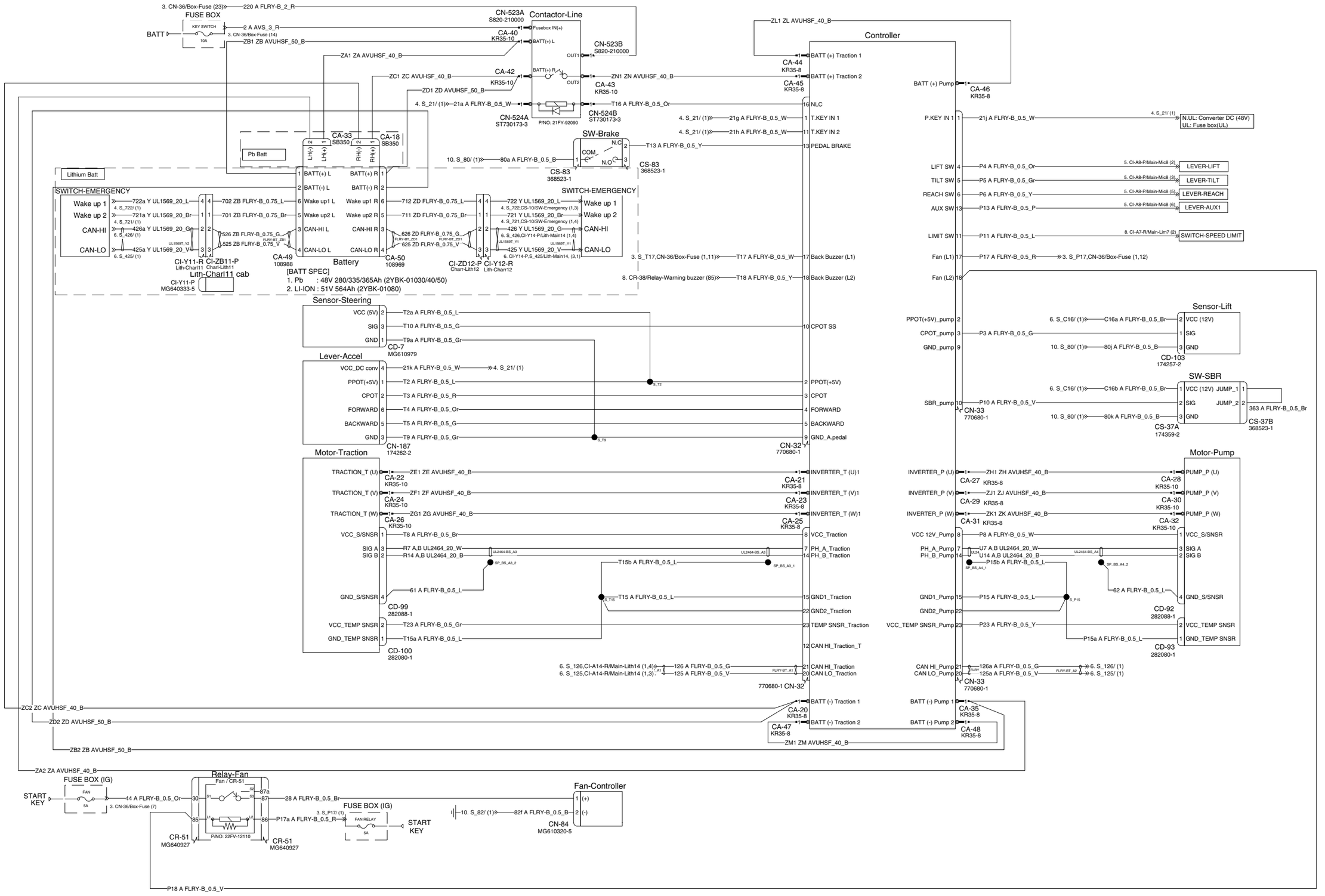








4. CONTROLLER AND MOTOR



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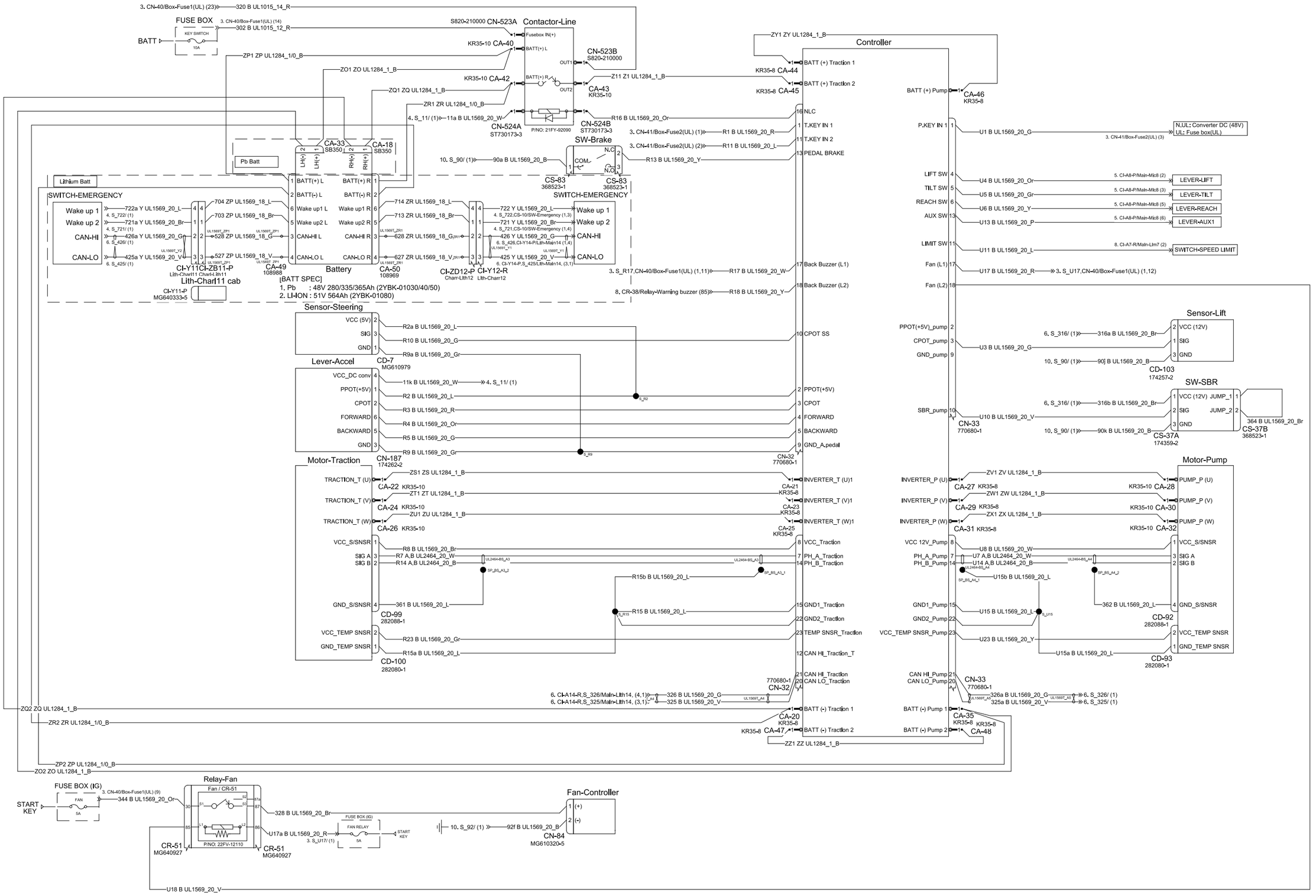
CONTROLLER AND MOTOR (UL)



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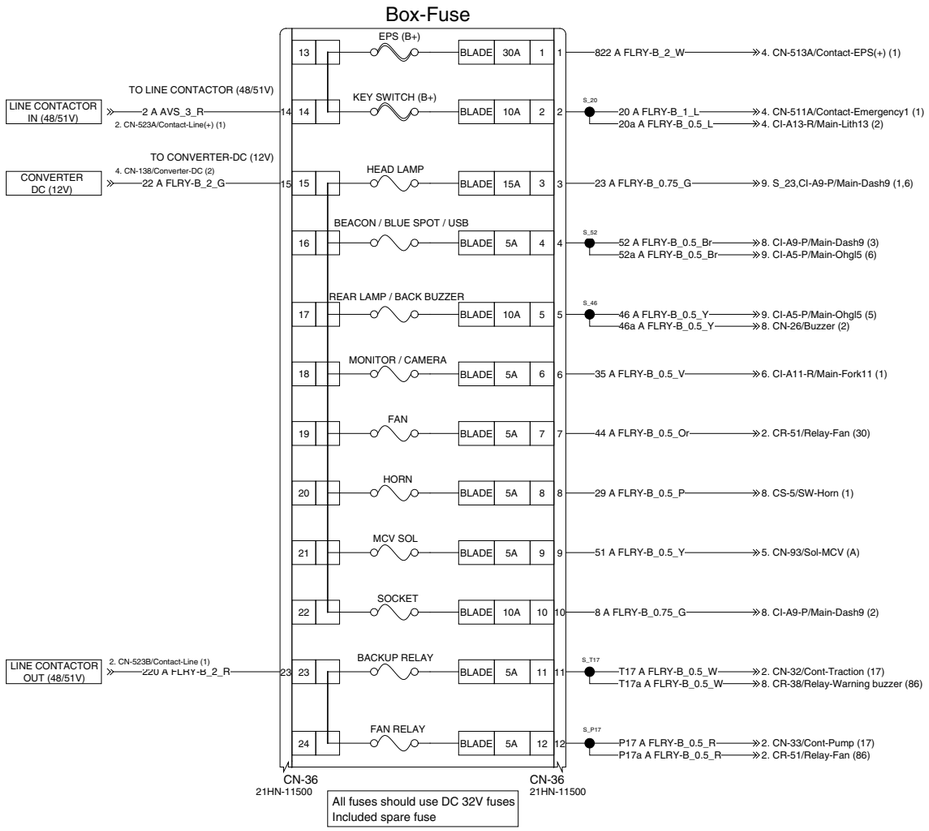
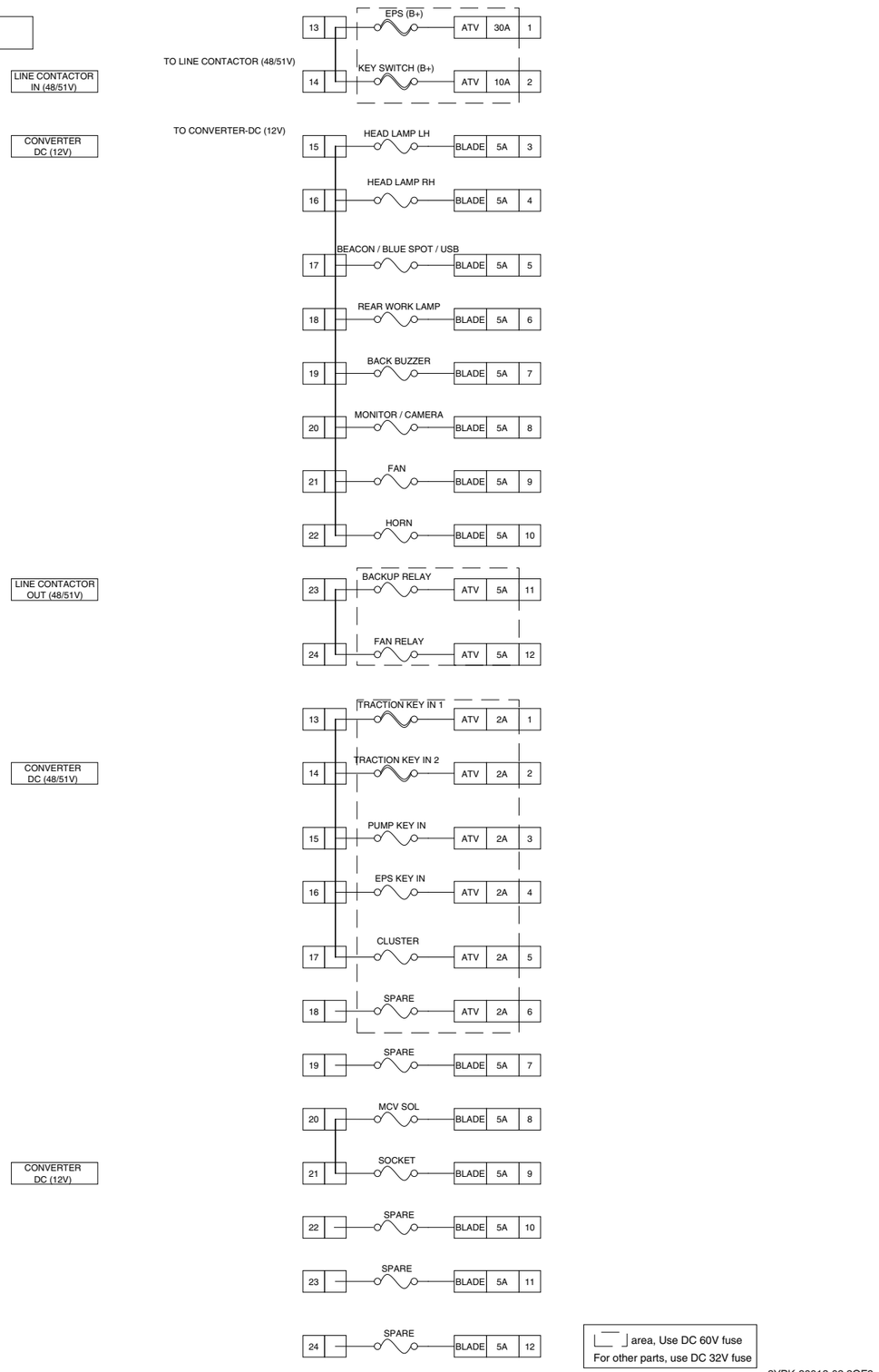
5. FUSE BOX

Non UL



UL



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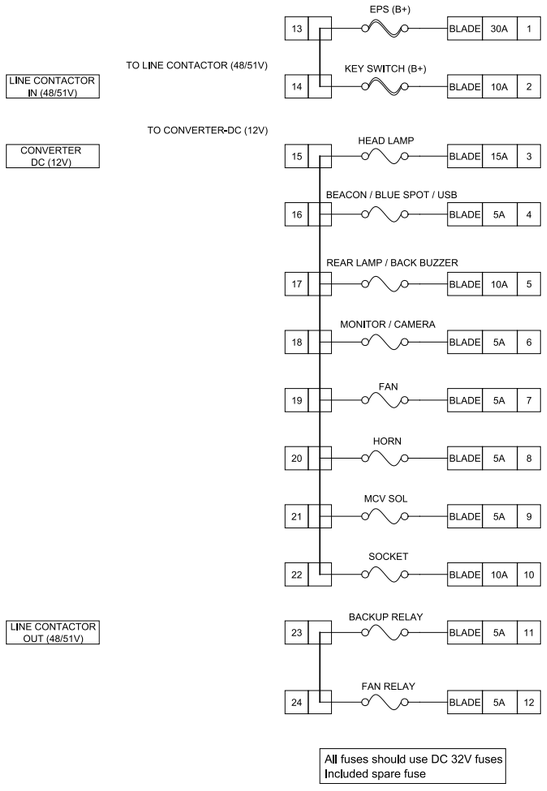
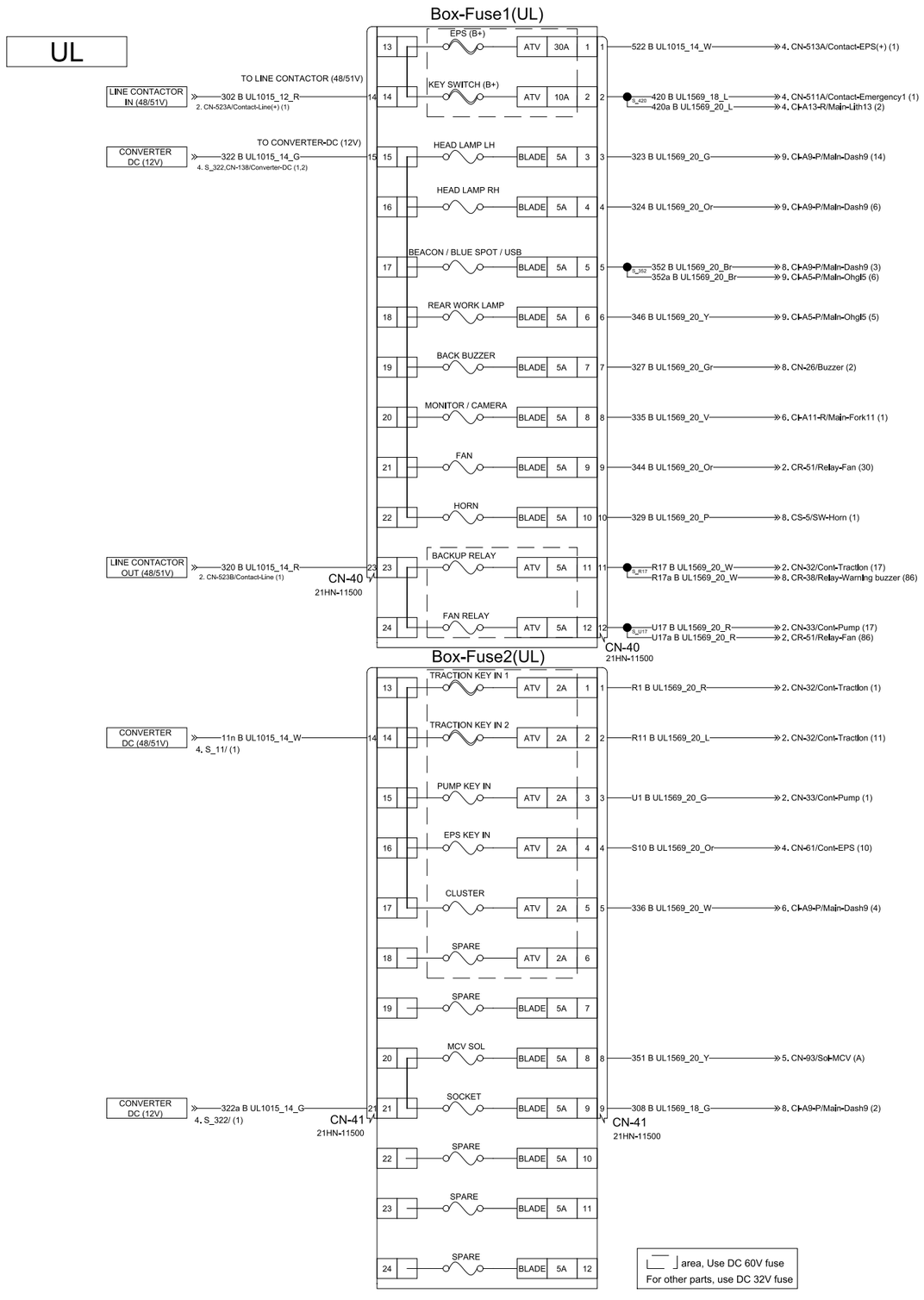
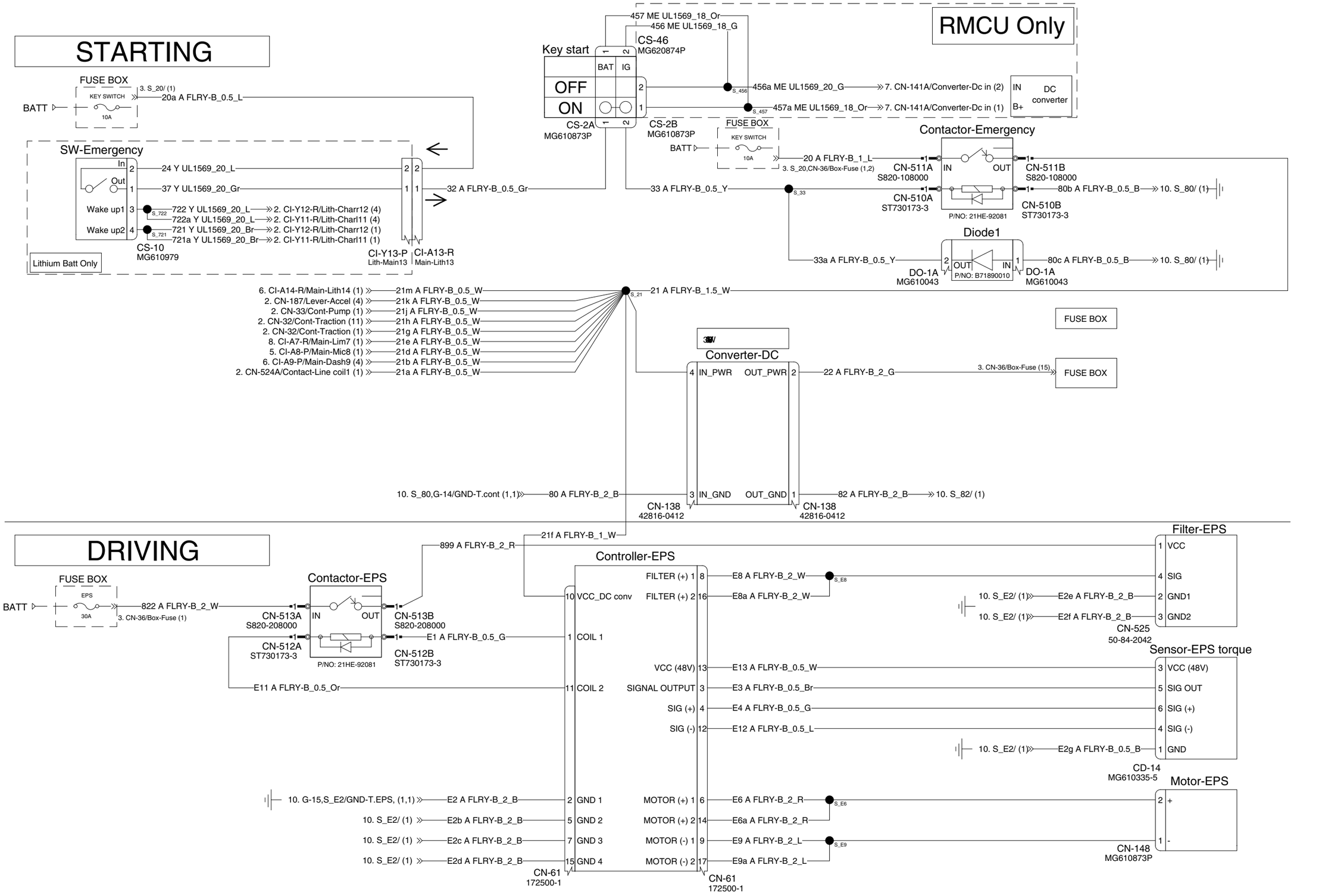
FUSE BOX (UL)

Non UL

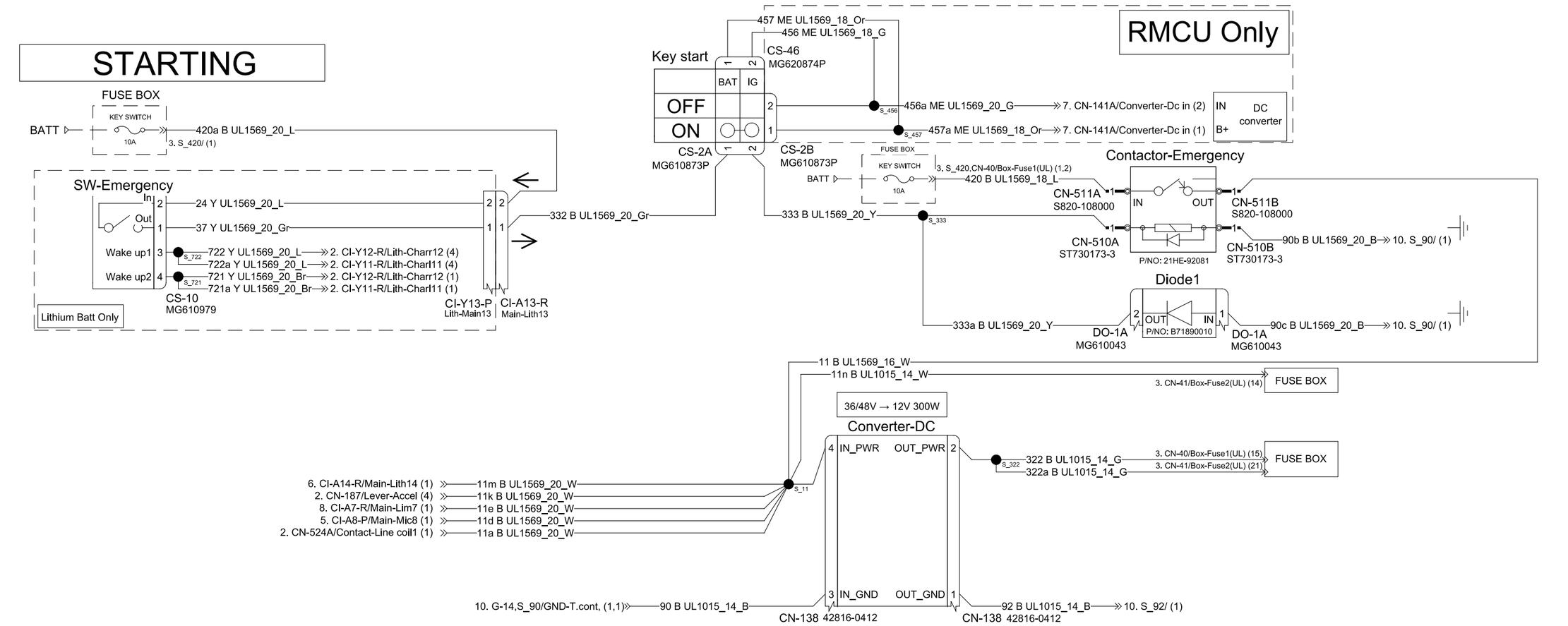


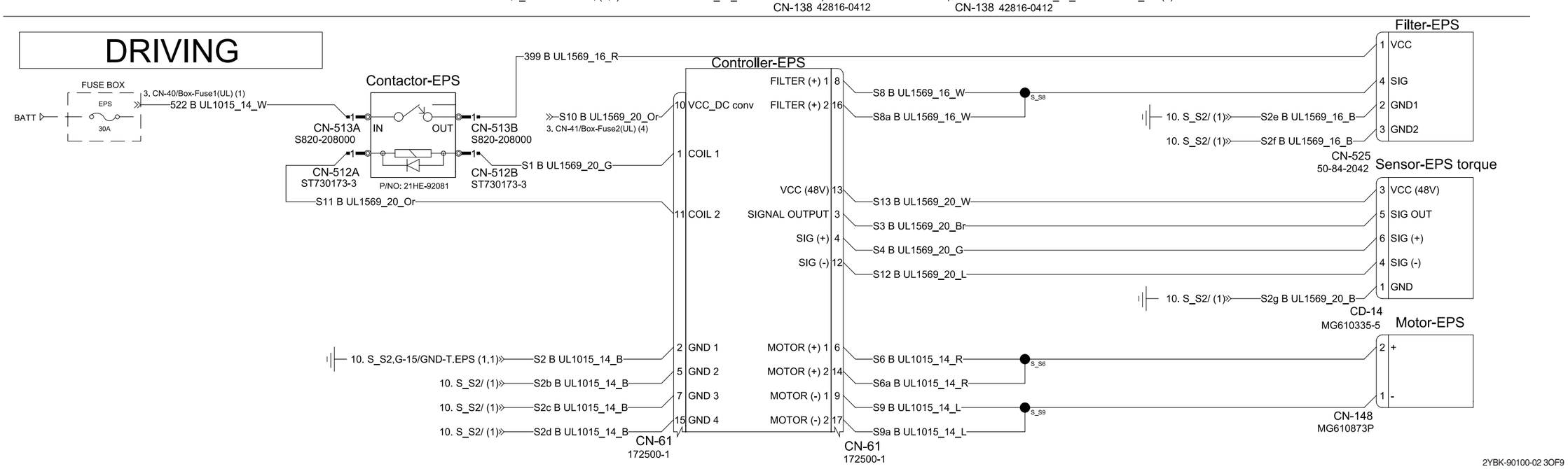
UL




STARTING
RMCU Only
FUSE BOX
KEY SWITCH
10A
BATT
3. S_20/ (1)
20a A FLRY-B_0.5_L
Key start
CS-46
MG620874P
BAT
IG
OFF
ON
457 ME UL1569_18_Or
456 ME UL1569_18_G
S_456
456a ME UL1569_20_G
7. CN-141A/Converter-Dc in (2)
S_457
457a ME UL1569_18_Or
7. CN-141A/Converter-Dc in (1)
IN
B+
DC converter
CS-2A
MG610873P
CS-2B
MG610873P
SW-Emergency
In
Out
Wake up1
Wake up2
24 Y UL1569_20_L
37 Y UL1569_20_Gr
722 Y UL1569_20_L
722a Y UL1569_20_L
721 Y UL1569_20_Br
721a Y UL1569_20_Br
2. CI-Y12-R/Lith-Charr12 (4)
2. CI-Y11-R/Lith-Charl11 (4)
2. CI-Y12-R/Lith-Charr12 (1)
2. CI-Y11-R/Lith-Charl11 (1)
CS-10
MG610979
Lithium Batt Only
CI-Y13-P
Lith-Main13
CI-A13-R
Main-Lith13
32 A FLRY-B_0.5_Gr
33 A FLRY-B_0.5_Y
S_33
Contactor-Emergency
CN-511A
S820-108000
CN-511B
S820-108000
CN-510A
ST730173-3
CN-510B
ST730173-3
P/NO: 21HE-92081
80b A FLRY-B_0.5_B
10. S_80/ (1)
Diode1
33a A FLRY-B_0.5_Y
DO-1A
MG610043
OUT
IN
P/NO: B71890010
80c A FLRY-B_0.5_B
6. CI-A14-R/Main-Lith14 (1)
2. CN-187/Lever-Accel (4)
2. CN-33/Cont-Pump (1)
2. CN-32/Cont-Traction (11)
2. CN-32/Cont-Traction (1)
8. CI-A7-R/Main-Lim7 (1)
5. CI-A8-P/Main-Mic8 (1)
6. CI-A9-P/Main-Dash9 (4)
2. CN-524A/Contact-Line coil1 (1)
21m A FLRY-B_0.5_W
21k A FLRY-B_0.5_W
21j A FLRY-B_0.5_W
21h A FLRY-B_0.5_W
21g A FLRY-B_0.5_W
21e A FLRY-B_0.5_W
21d A FLRY-B_0.5_W
21b A FLRY-B_0.5_W
21a A FLRY-B_0.5_W
S_21
21 A FLRY-B_1.5_W
FUSE BOX
Converter-DC
IN_PWR
OUT_PWR
22 A FLRY-B_2_G
3. CN-36/Box-Fuse (15)
FUSE BOX
10. S_80,G-14/GND-T.cont (1,1)
80 A FLRY-B_2_B
IN_GND
OUT_GND
82 A FLRY-B_2_B
10. S_82/ (1)
CN-138
42816-0412
CN-138
42816-0412
DRIVING
FUSE BOX
EPS
30A
BATT
822 A FLRY-B_2_W
3. CN-36/Box-Fuse (1)
Contactor-EPS
CN-513A
S820-208000
CN-513B
S820-208000
CN-512A
ST730173-3
CN-512B
ST730173-3
P/NO: 21HE-92081
E1 A FLRY-B_0.5_G
E11 A FLRY-B_0.5_Or
21f A FLRY-B_1_W
899 A FLRY-B_2_R
Controller-EPS
VCC_DC conv
COIL 1
COIL 2
GND 1
GND 2
GND 3
GND 4
CN-61
172500-1
FILTER (+) 1
FILTER (+) 2
VCC (48V)
SIGNAL OUTPUT
SIG (+)
SIG (-)
MOTOR (+) 1
MOTOR (+) 2
MOTOR (-) 1
MOTOR (-) 2
E8 A FLRY-B_2_W
E8a A FLRY-B_2_W
E13 A FLRY-B_0.5_W
E3 A FLRY-B_0.5_Br
E4 A FLRY-B_0.5_G
E12 A FLRY-B_0.5_L
E6 A FLRY-B_2_R
E6a A FLRY-B_2_R
E9 A FLRY-B_2_L
E9a A FLRY-B_2_L
CN-61
172500-1
Filter-EPS
VCC
SIG
GND1
GND2
CN-525
50-84-2042
10. S_E2/ (1)
E2e A FLRY-B_2_B
E2f A FLRY-B_2_B
Sensor-EPS torque
VCC (48V)
SIG OUT
SIG (+)
SIG (-)
GND
CD-14
MG610335-5
E2g A FLRY-B_0.5_B
Motor-EPS
+
-
CN-148
MG610873P
10. G-15,S_E2/GND-T.EPS, (1,1)
E2 A FLRY-B_2_B
E2b A FLRY-B_2_B
E2c A FLRY-B_2_B
E2d A FLRY-B_2_B

START AND DRIVING (UL)





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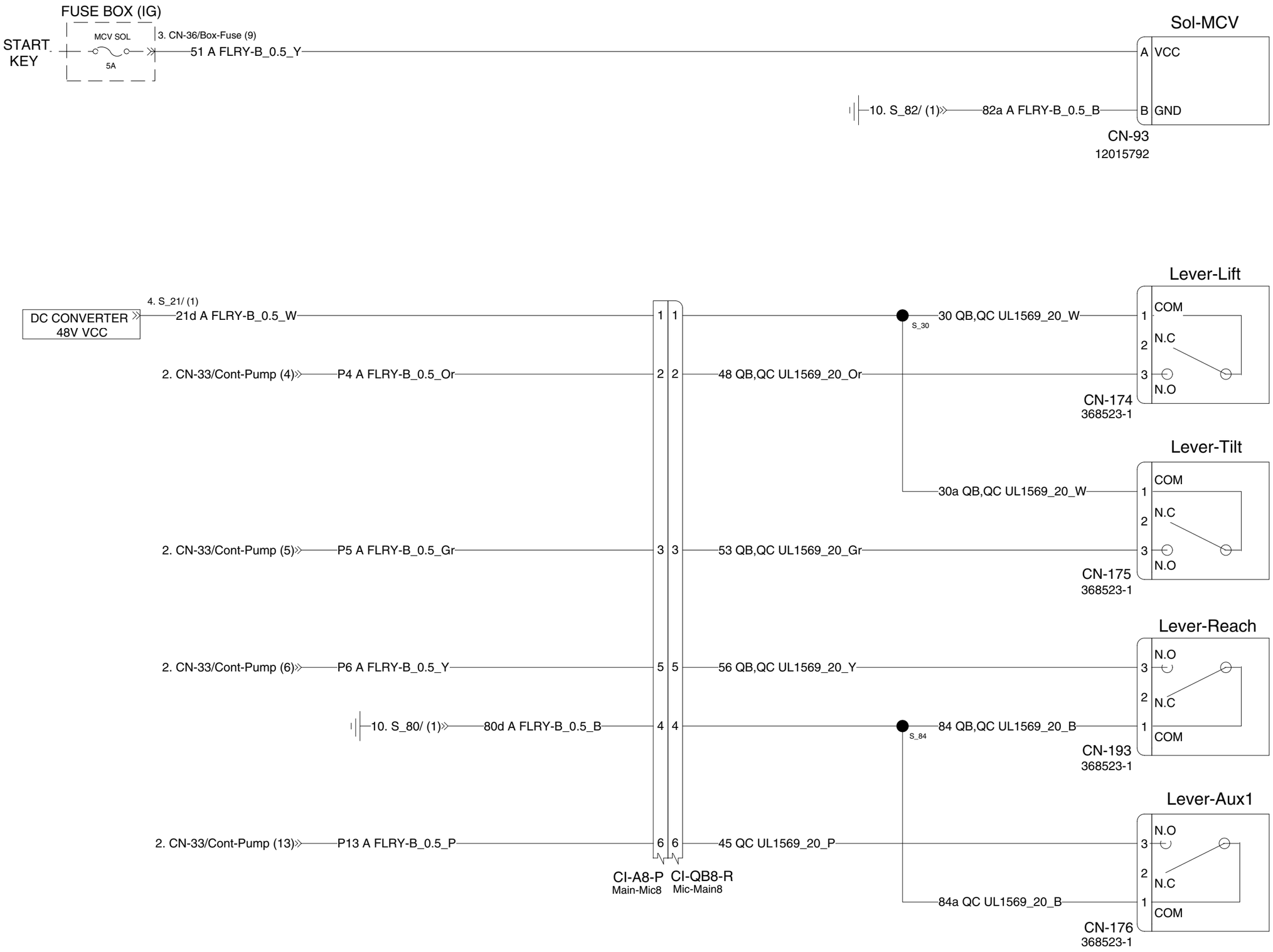
7. FINGERTIP



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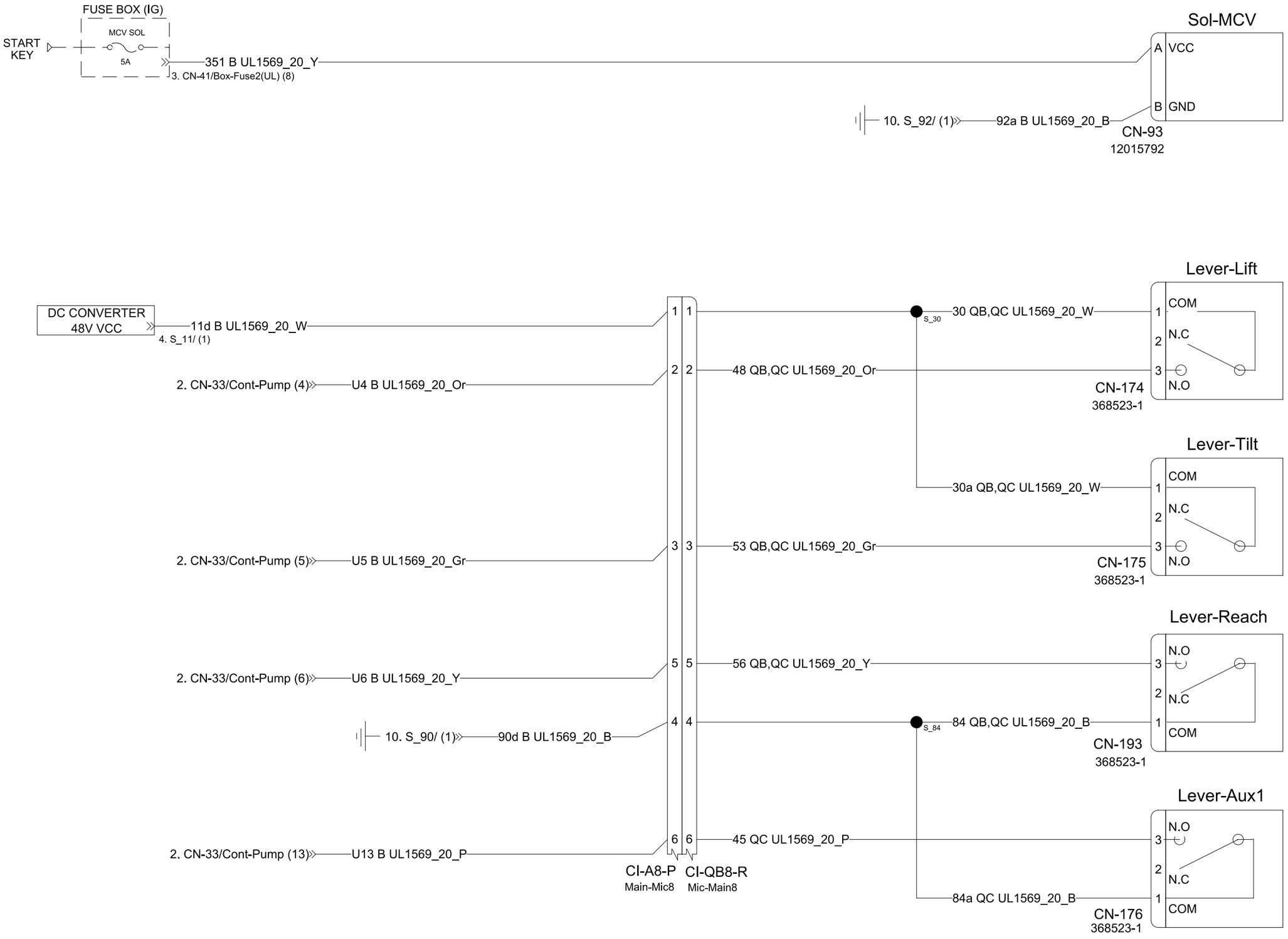
FINGERTIP (UL)



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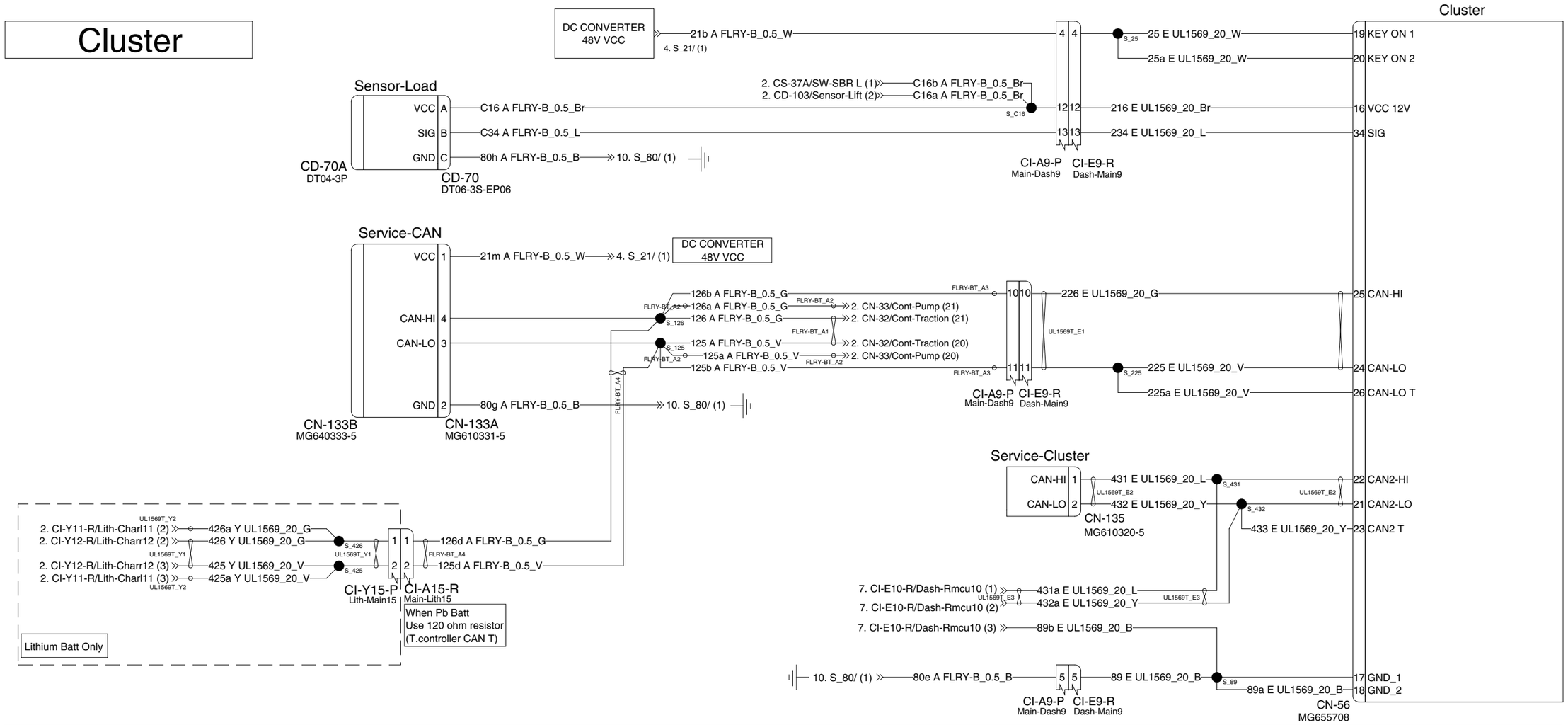
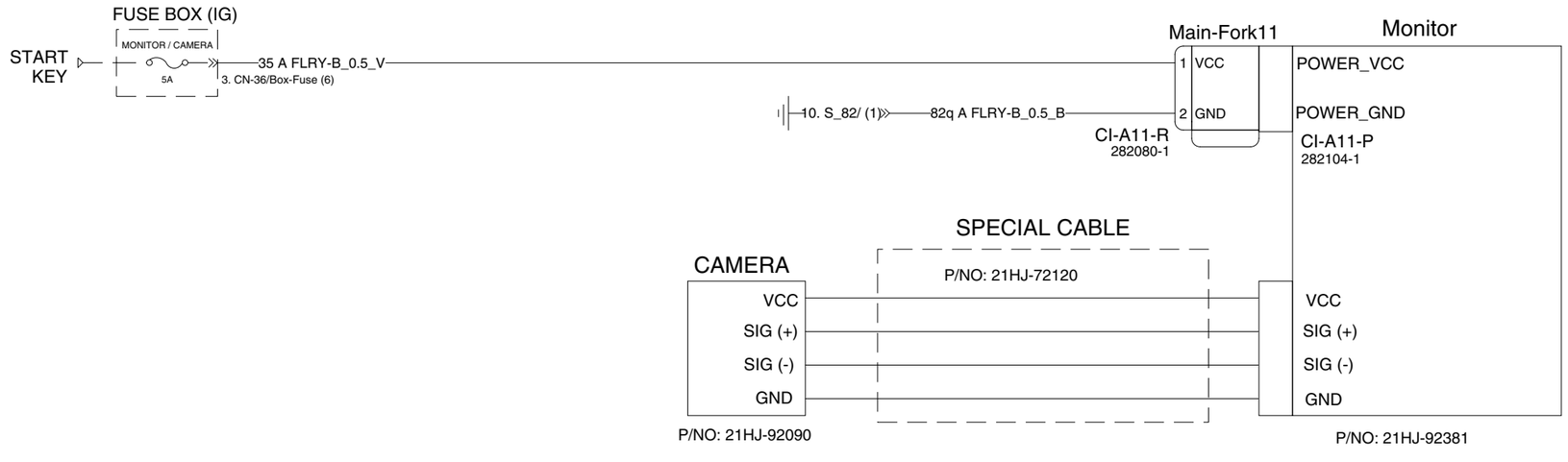
8. CLUSTER, CAMERA AND MONITOR

Cluster

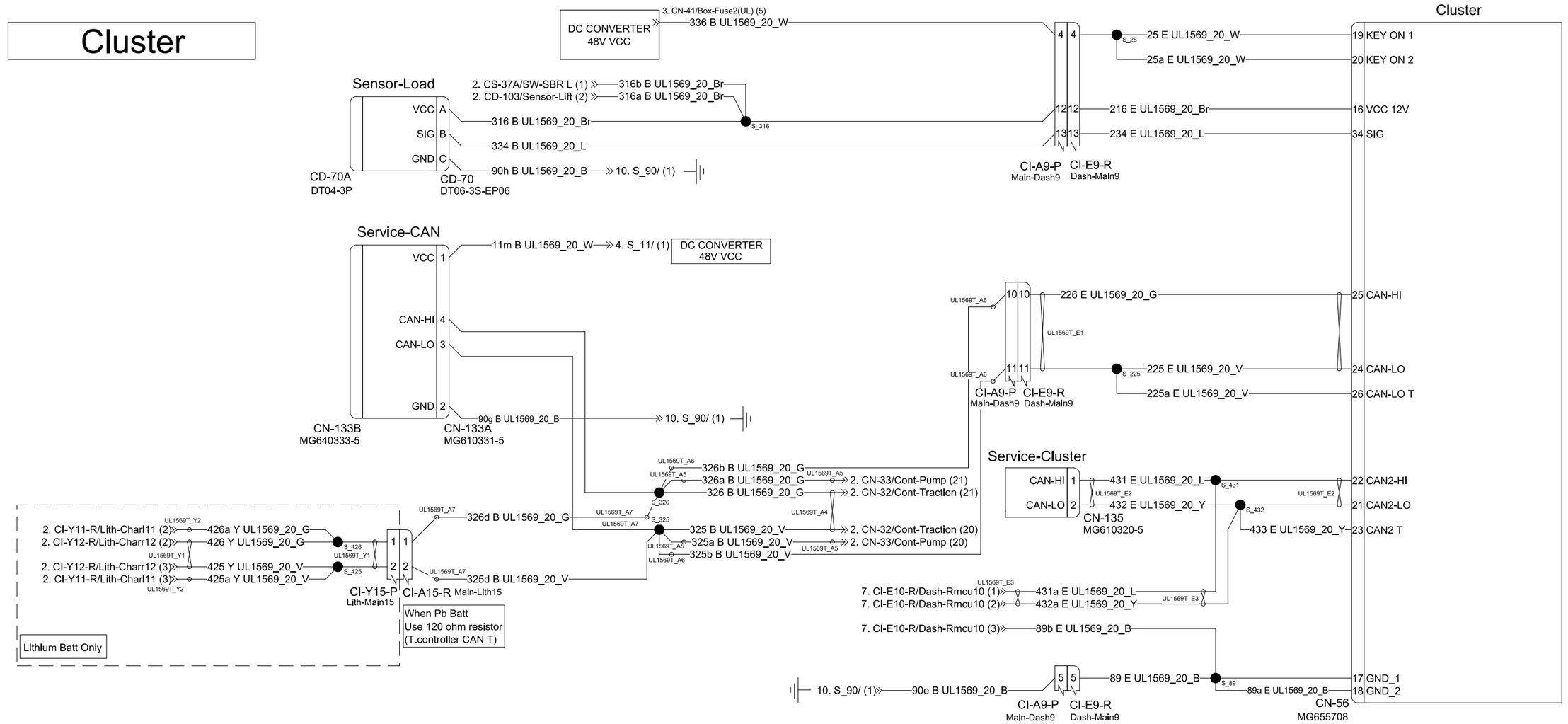


Camera,Monitor

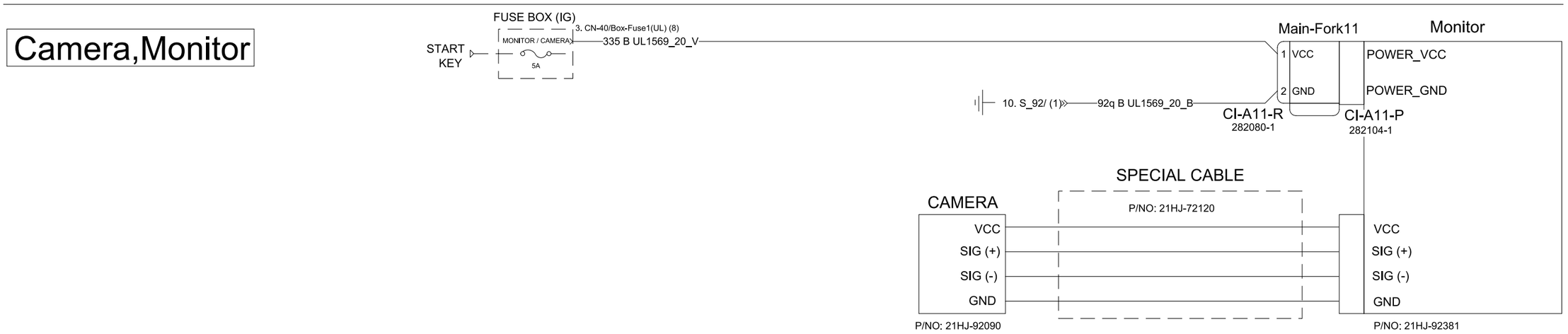


CLUSTER, CAMERA AND MONITOR (UL)

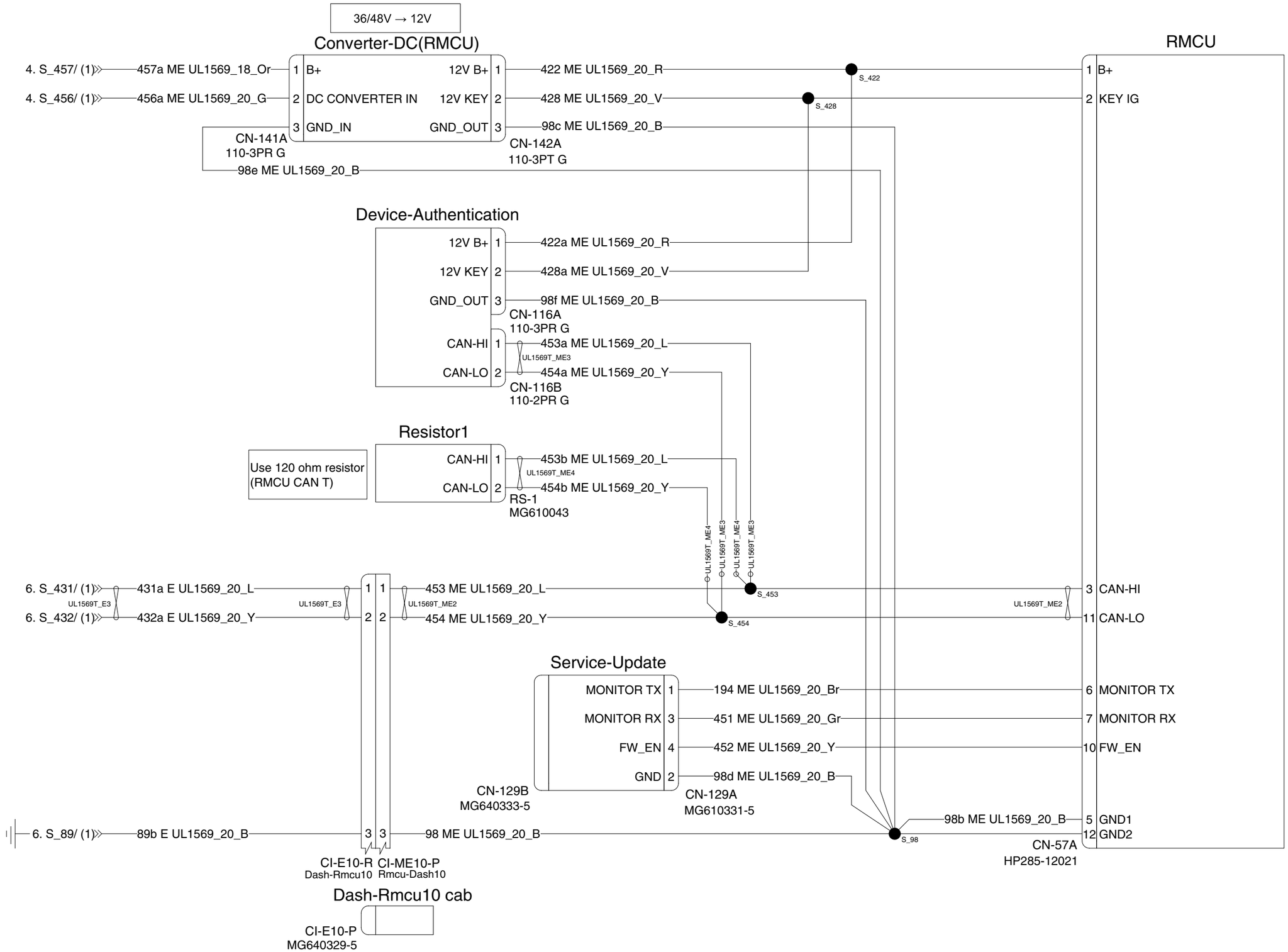
Cluster



Camera,Monitor



9. RMCU



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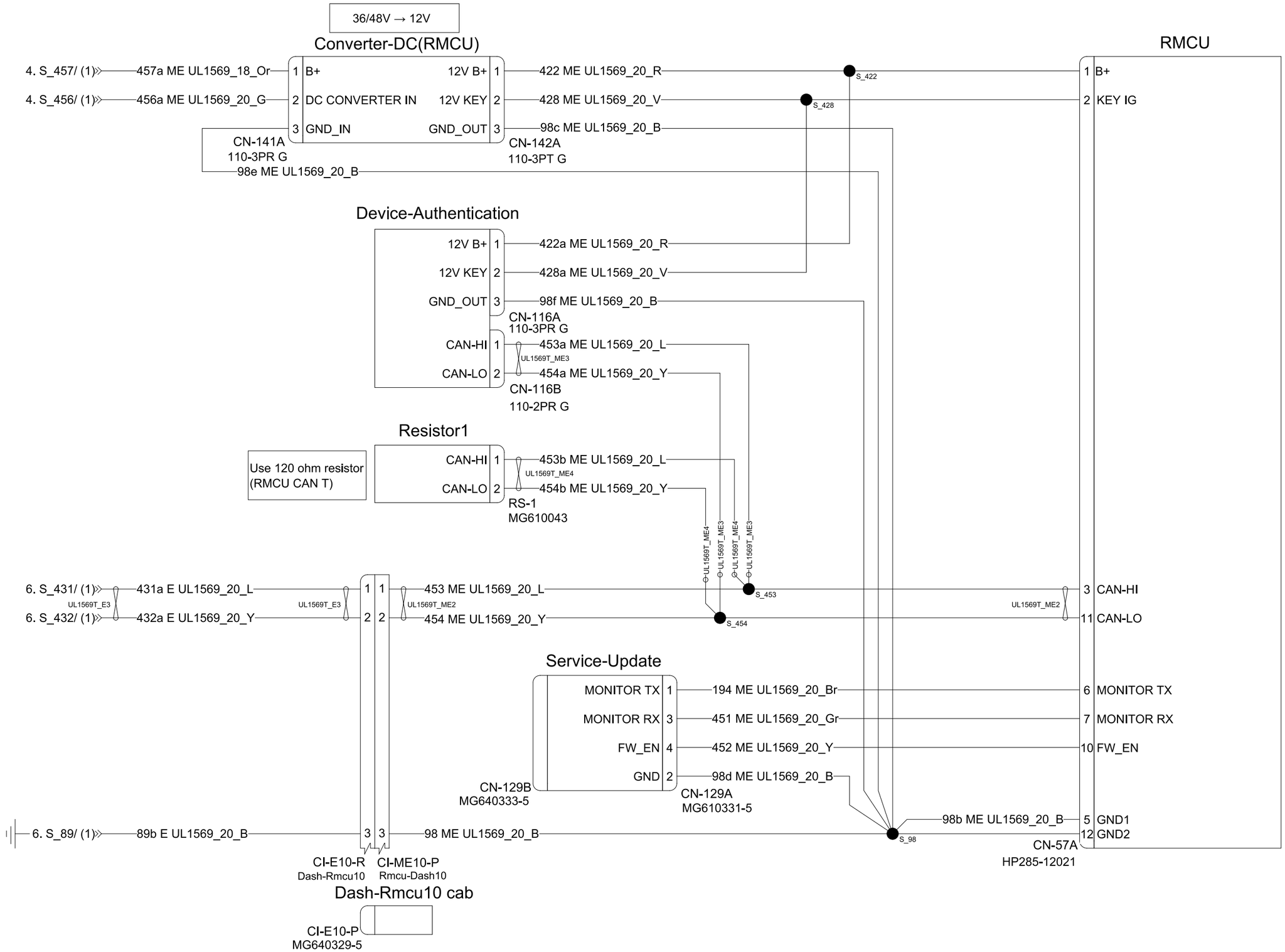
RMCU (UL)



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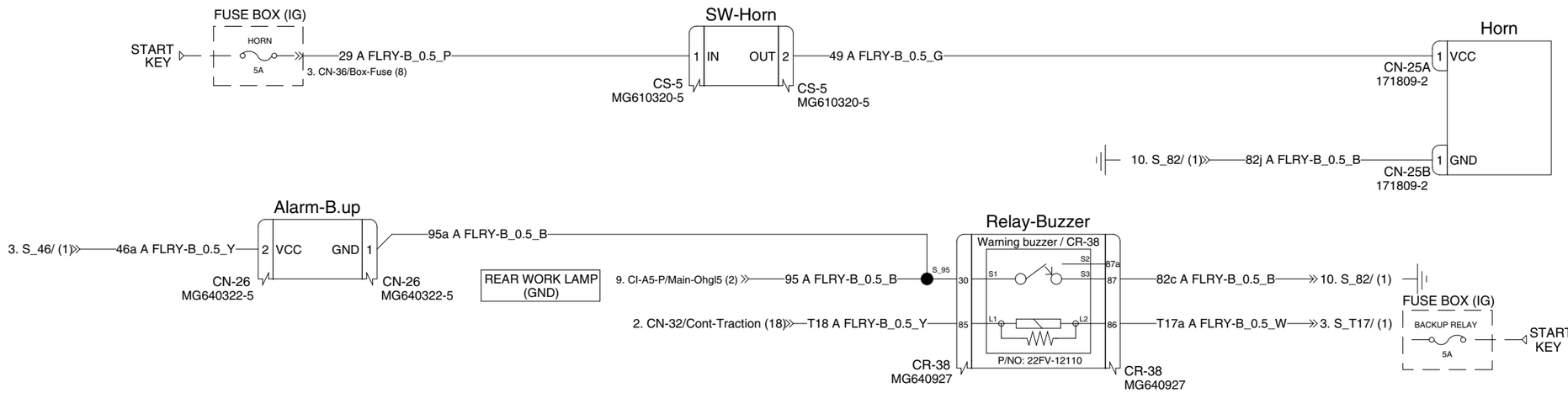
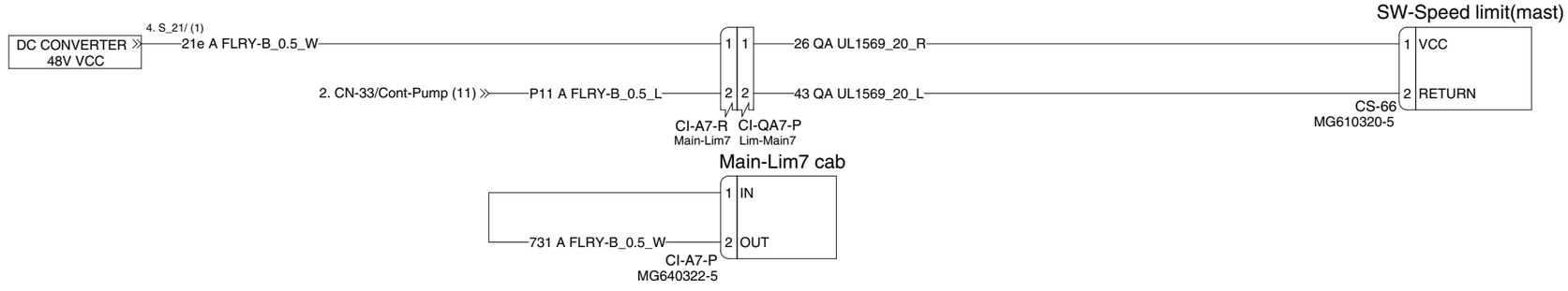
10. HORN, SOCKET, USB AND MAST

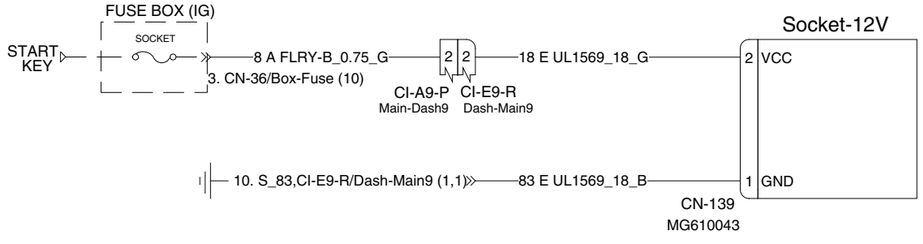
HORN



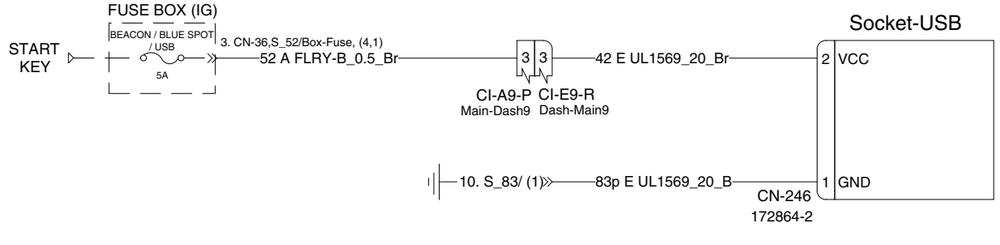
MAST



12V SOCKET

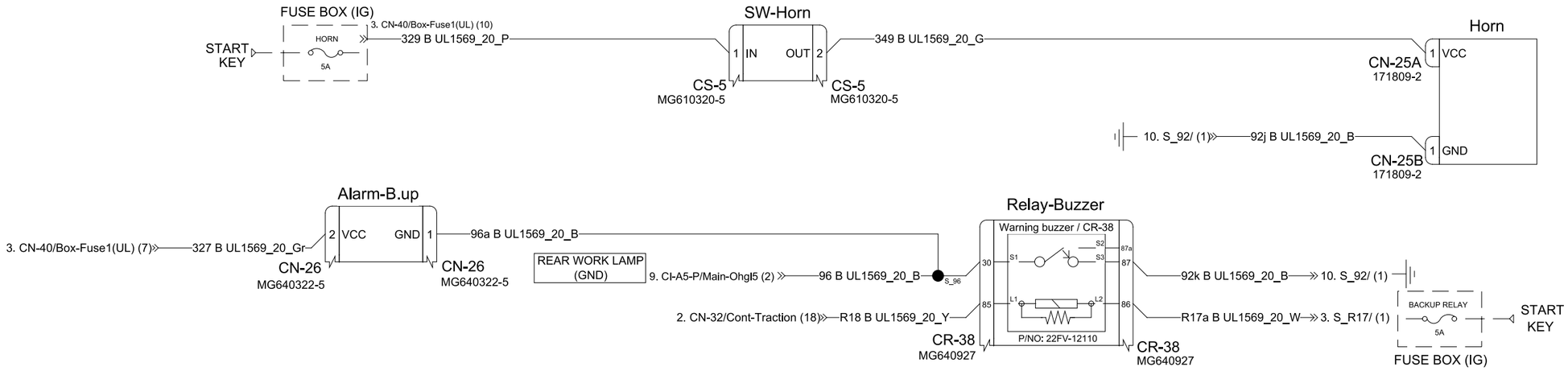


USB CHARGER

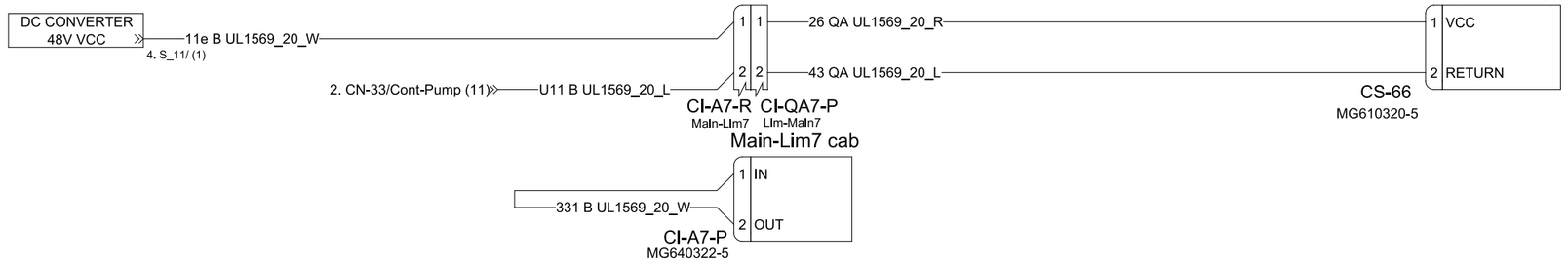


HORN, SOCKET, USB AND MAST (UL)

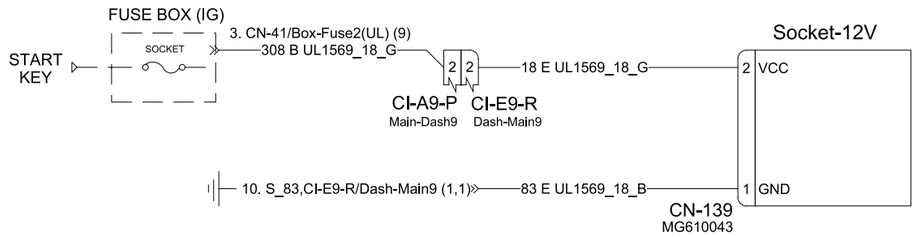
HORN



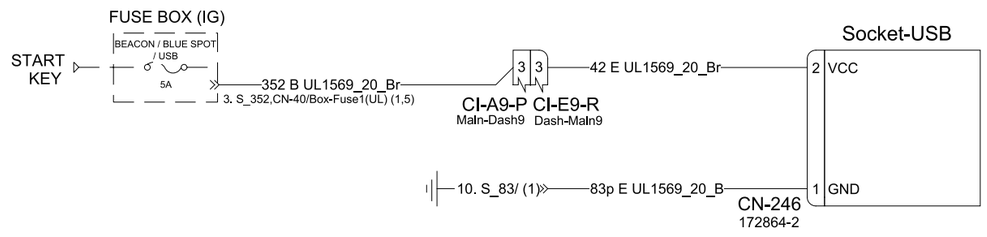
MAST



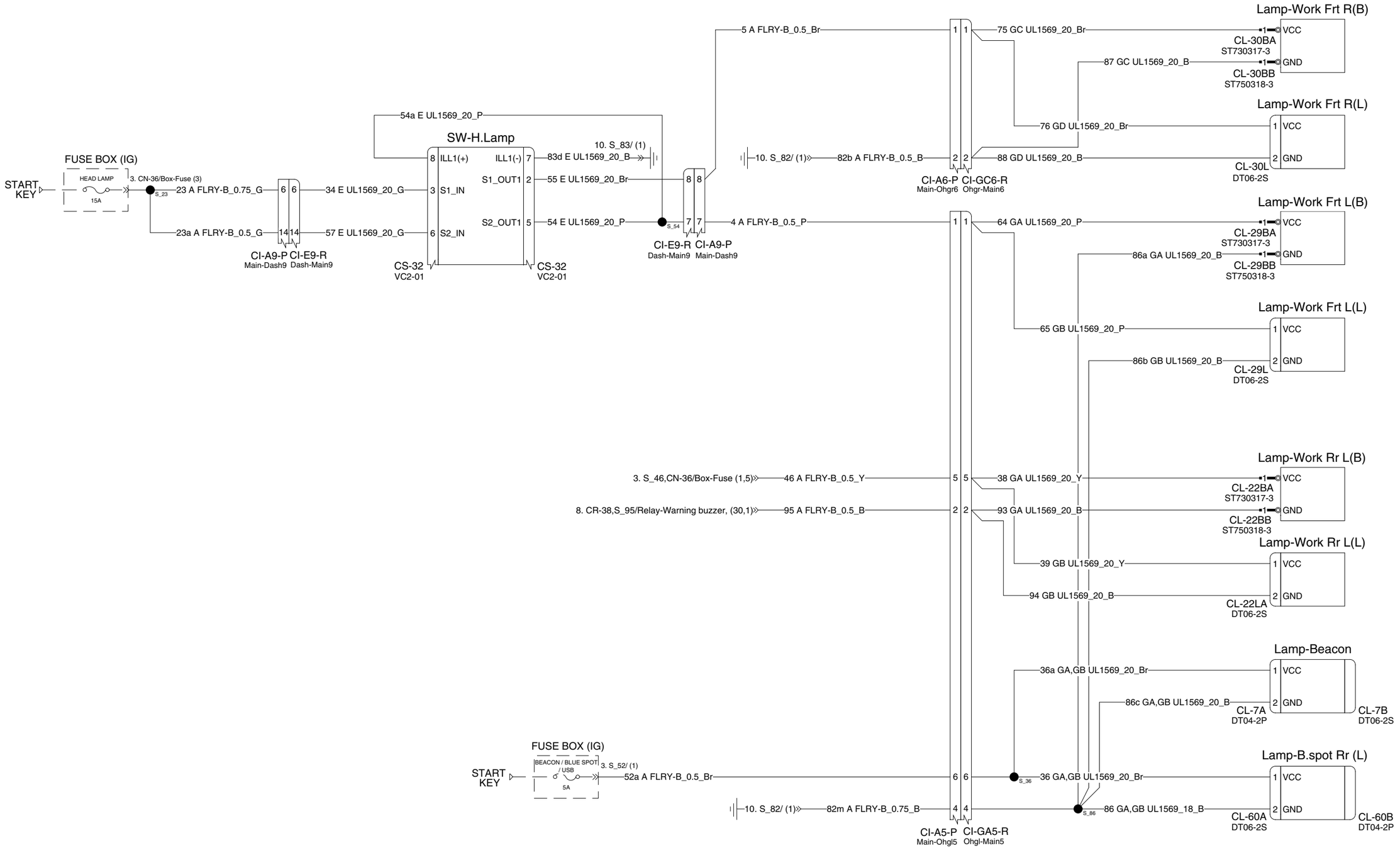
12V SOCKET



USB CHARGER



11. LAMP



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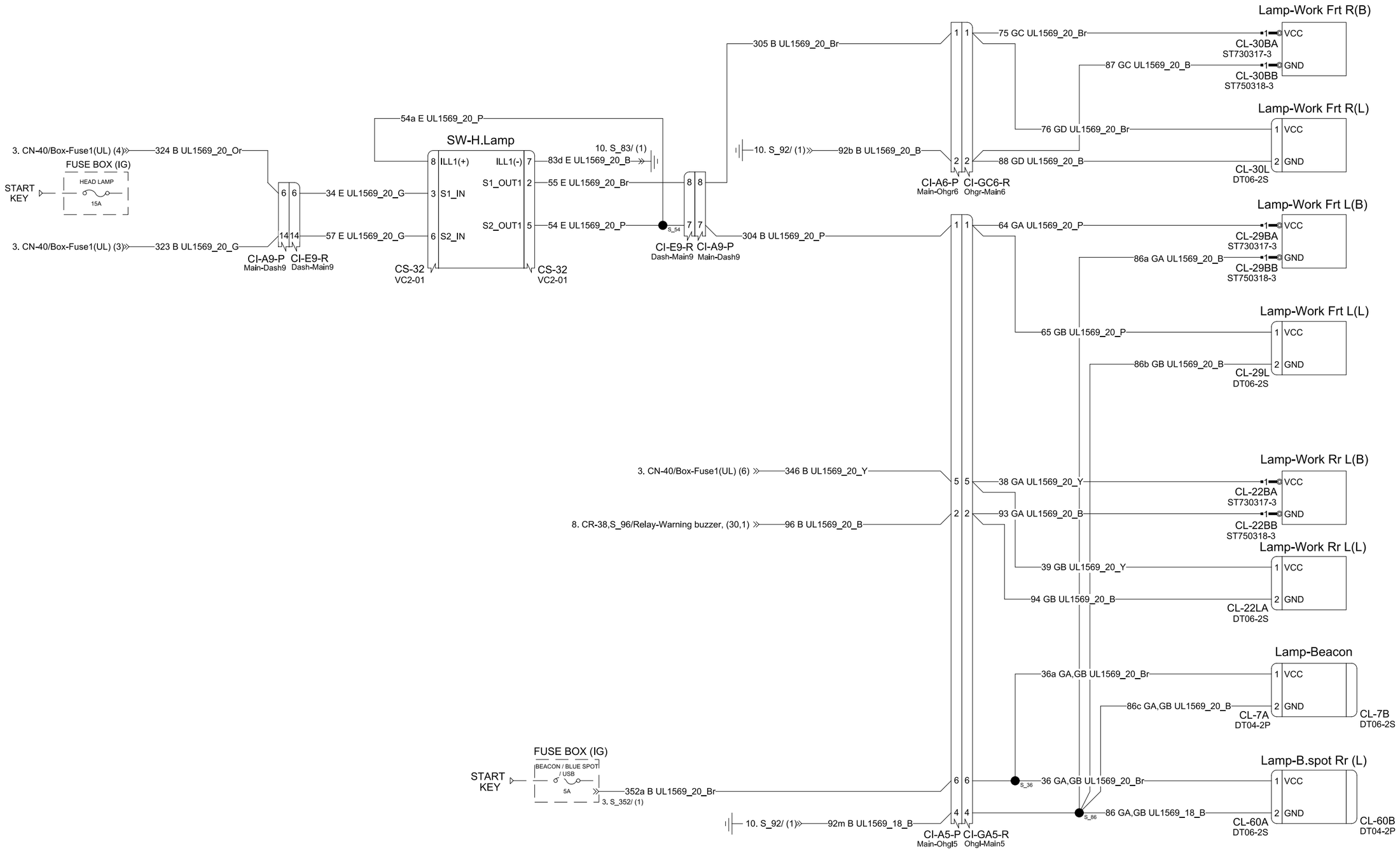
LAMP (UL)



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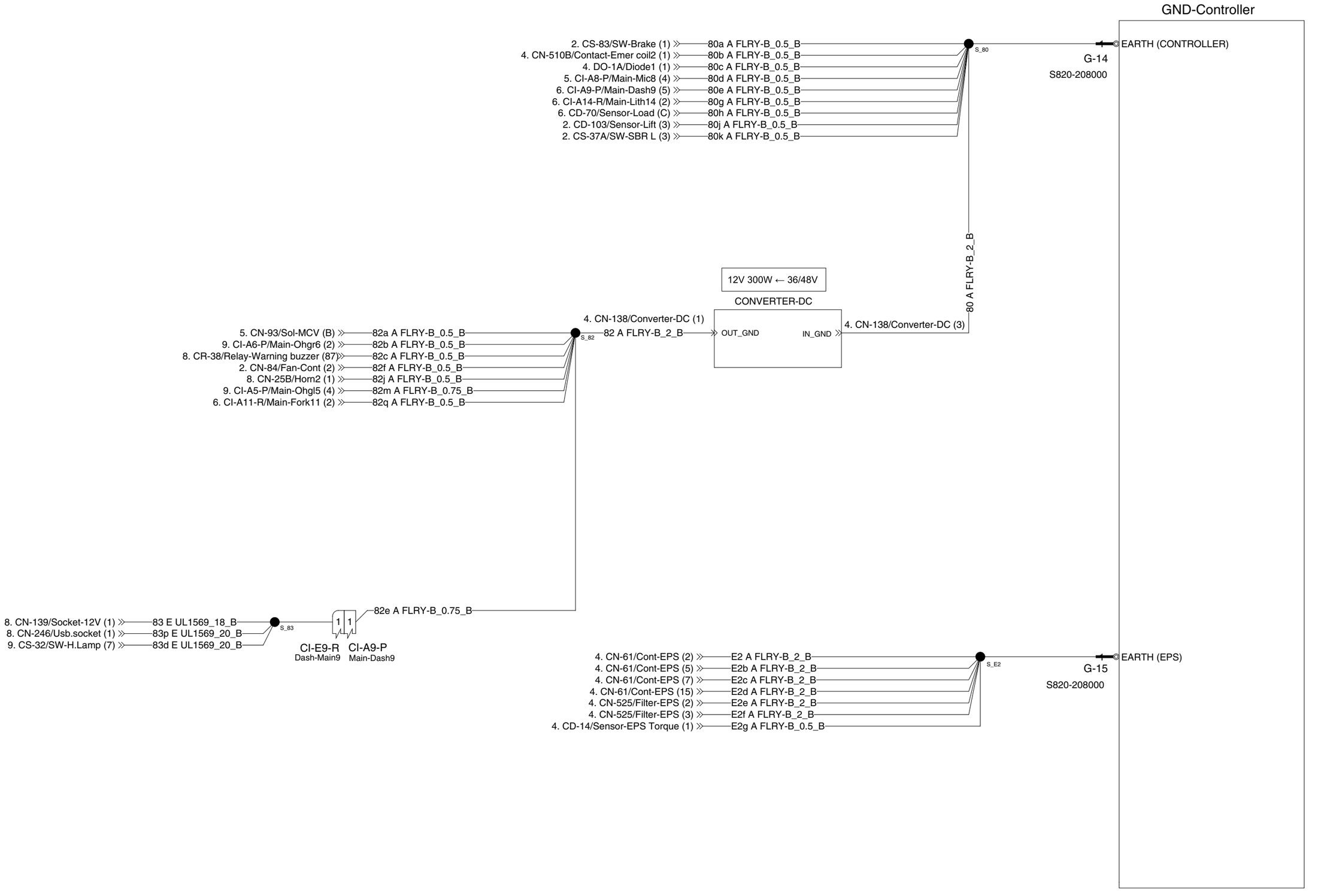
12. GROUNDING



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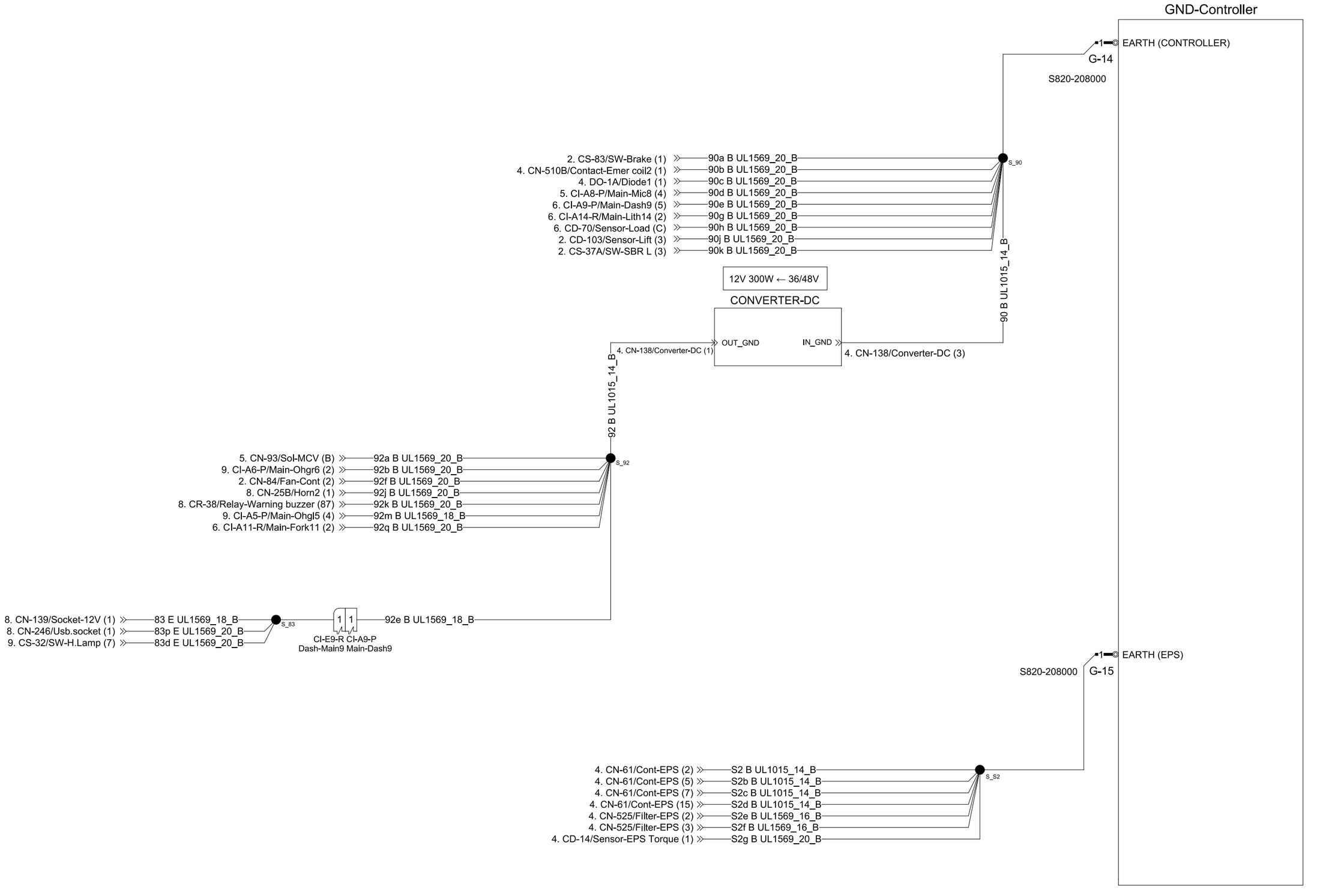
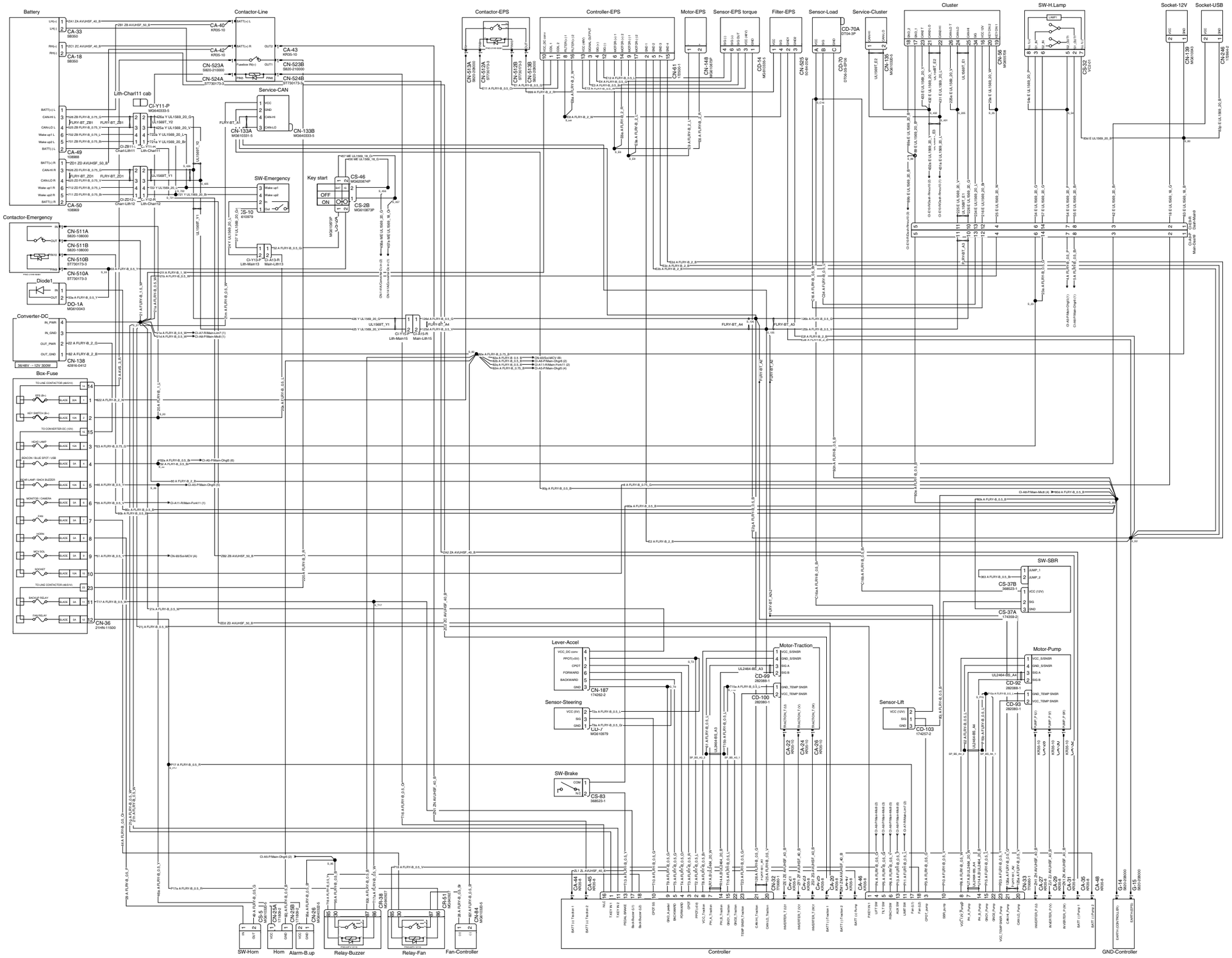
GROUNDING (UL)



2. OVERALL CIRCUIT DIAGRAM (1/2)



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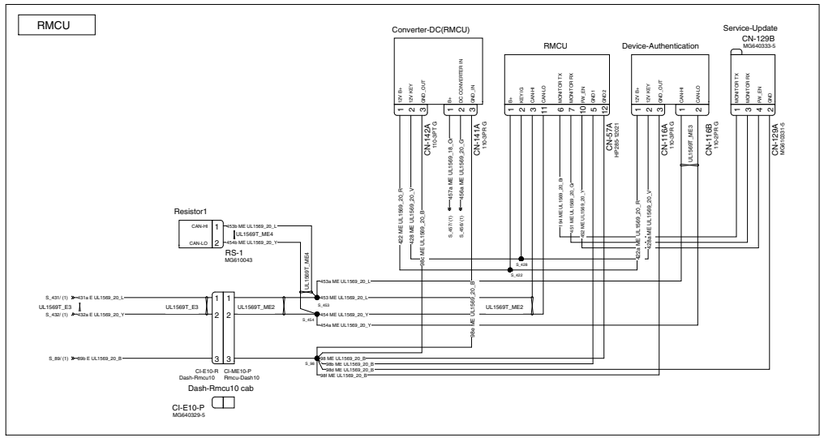
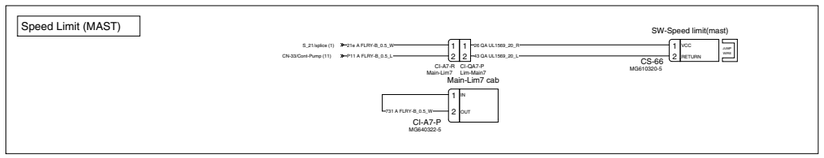
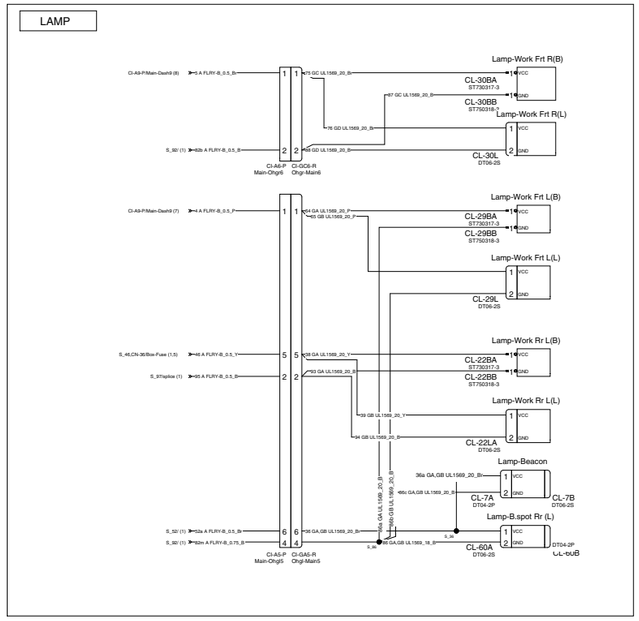
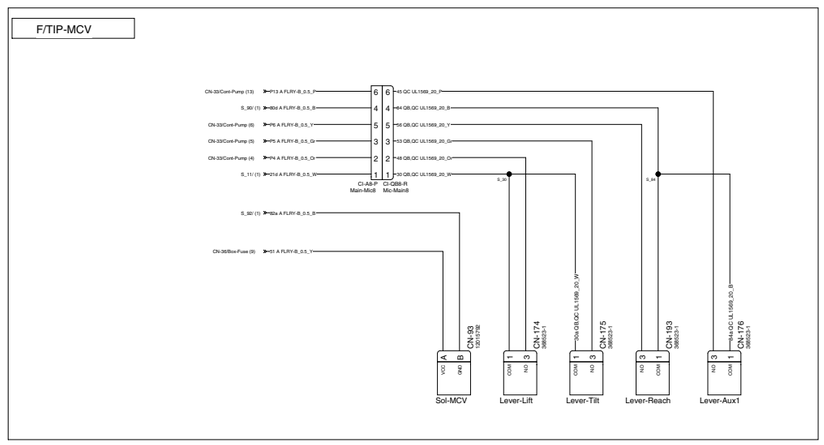
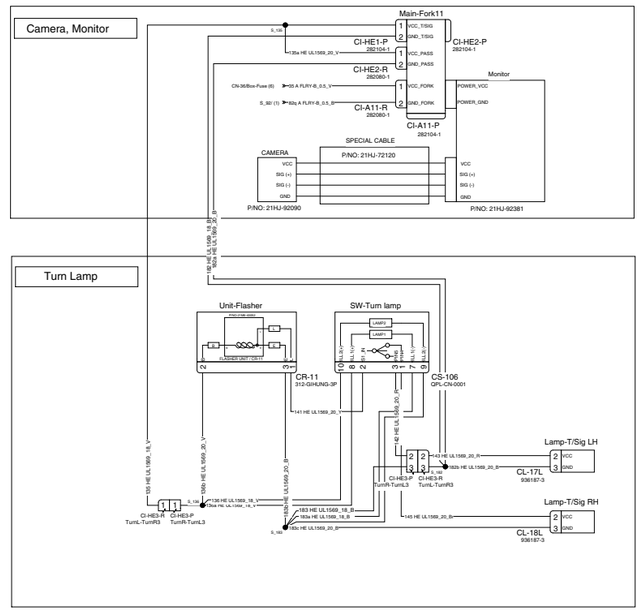
2. OVERALL CIRCUIT DIAGRAM (2/2)



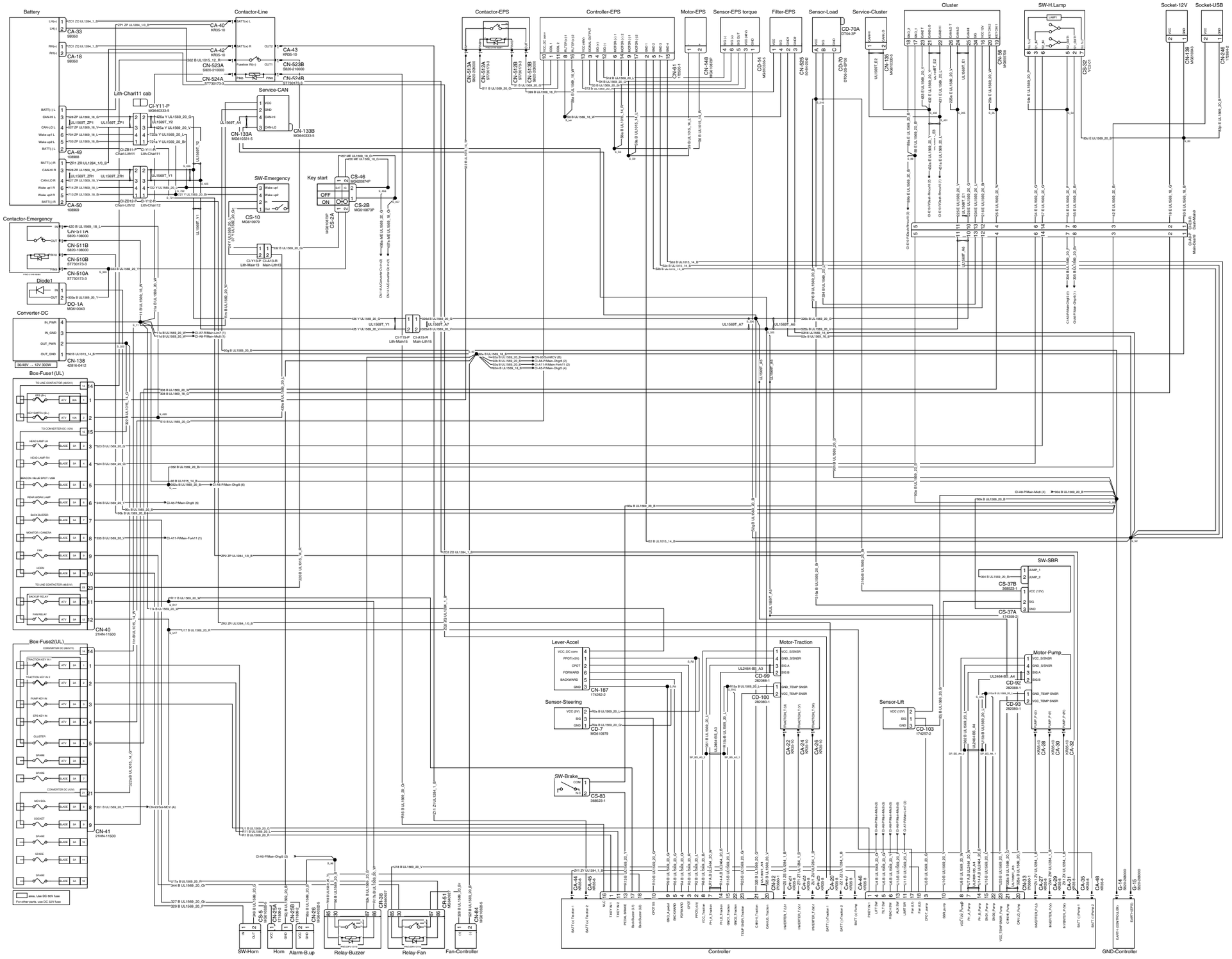




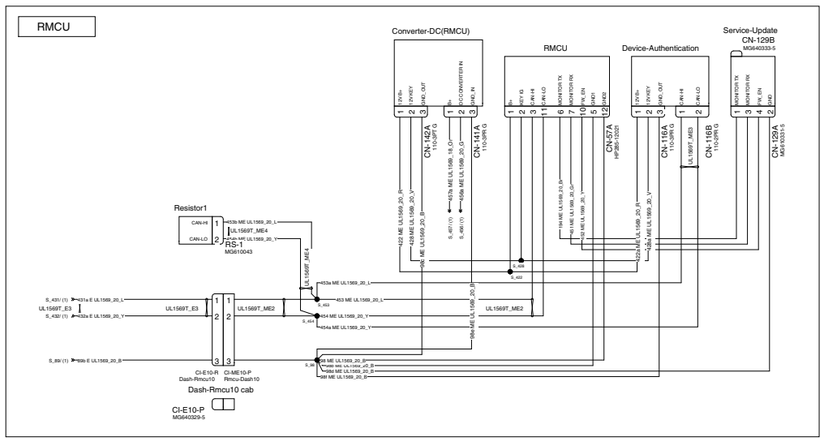


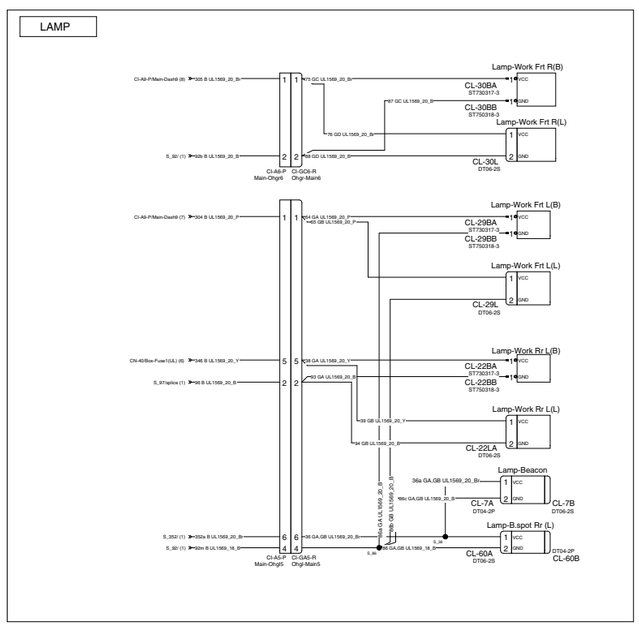


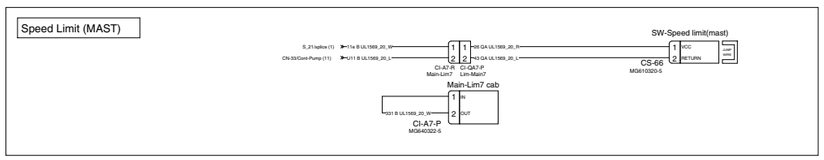
3. OVERALL CIRCUIT DIAGRAM (1/2, UL)

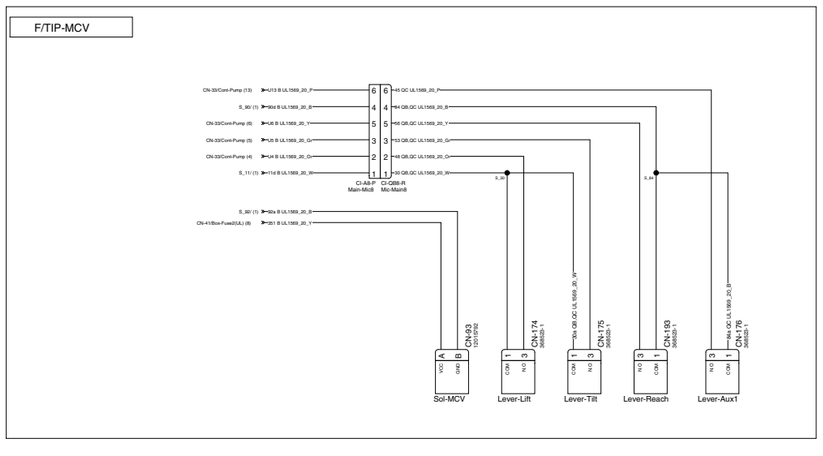


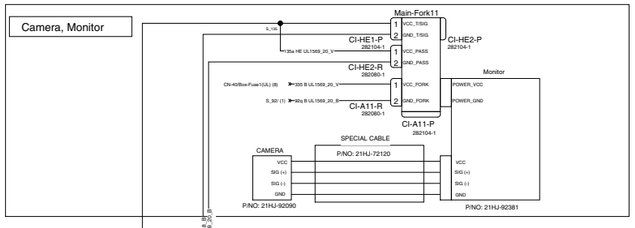
3. OVERALL CIRCUIT DIAGRAM (2/2, UL)

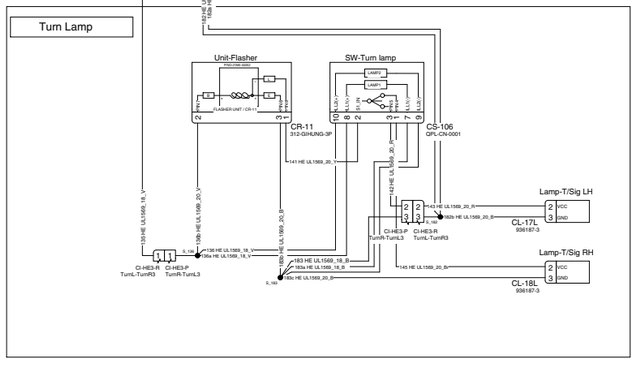




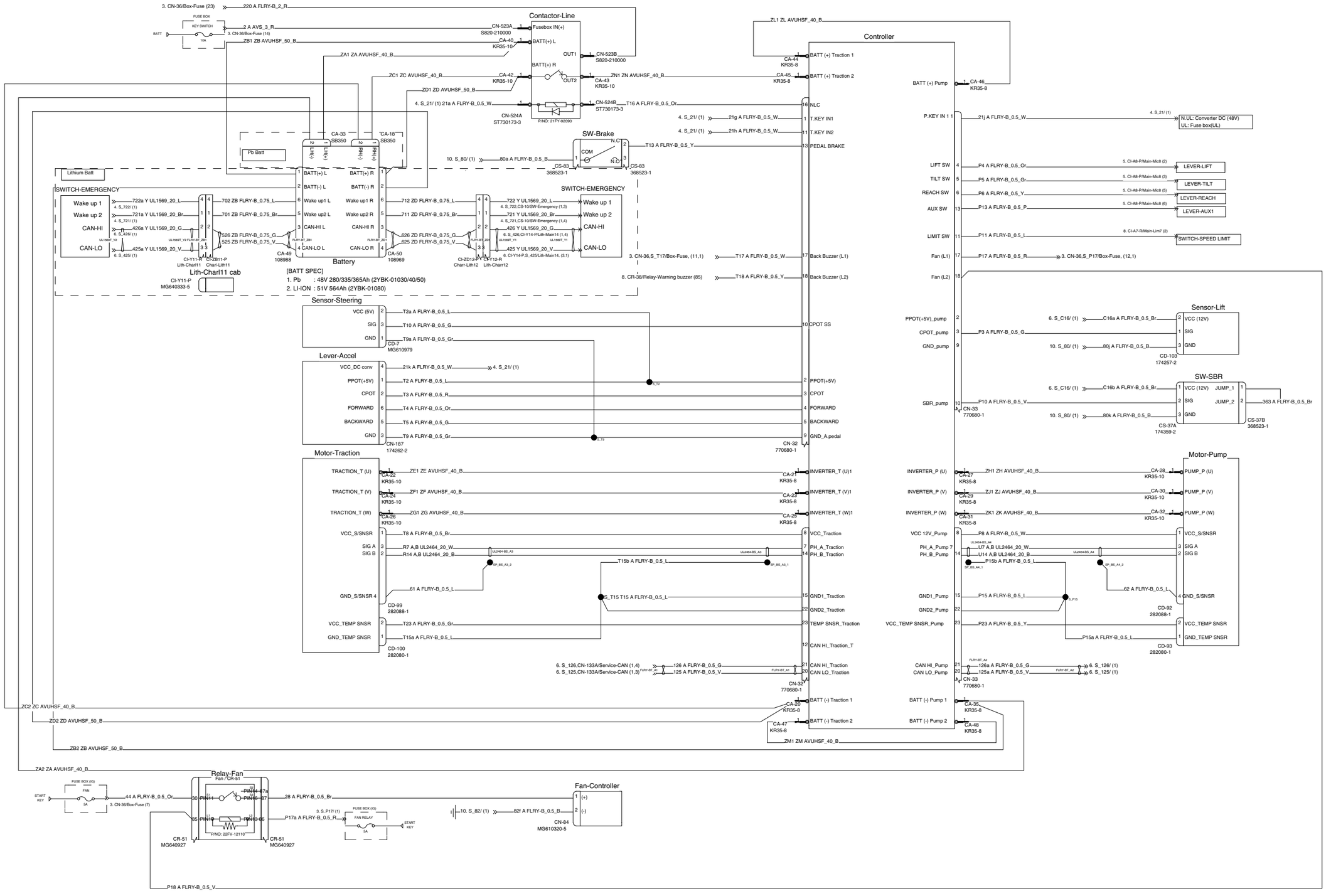








4. CONTROLLER AND MOTOR



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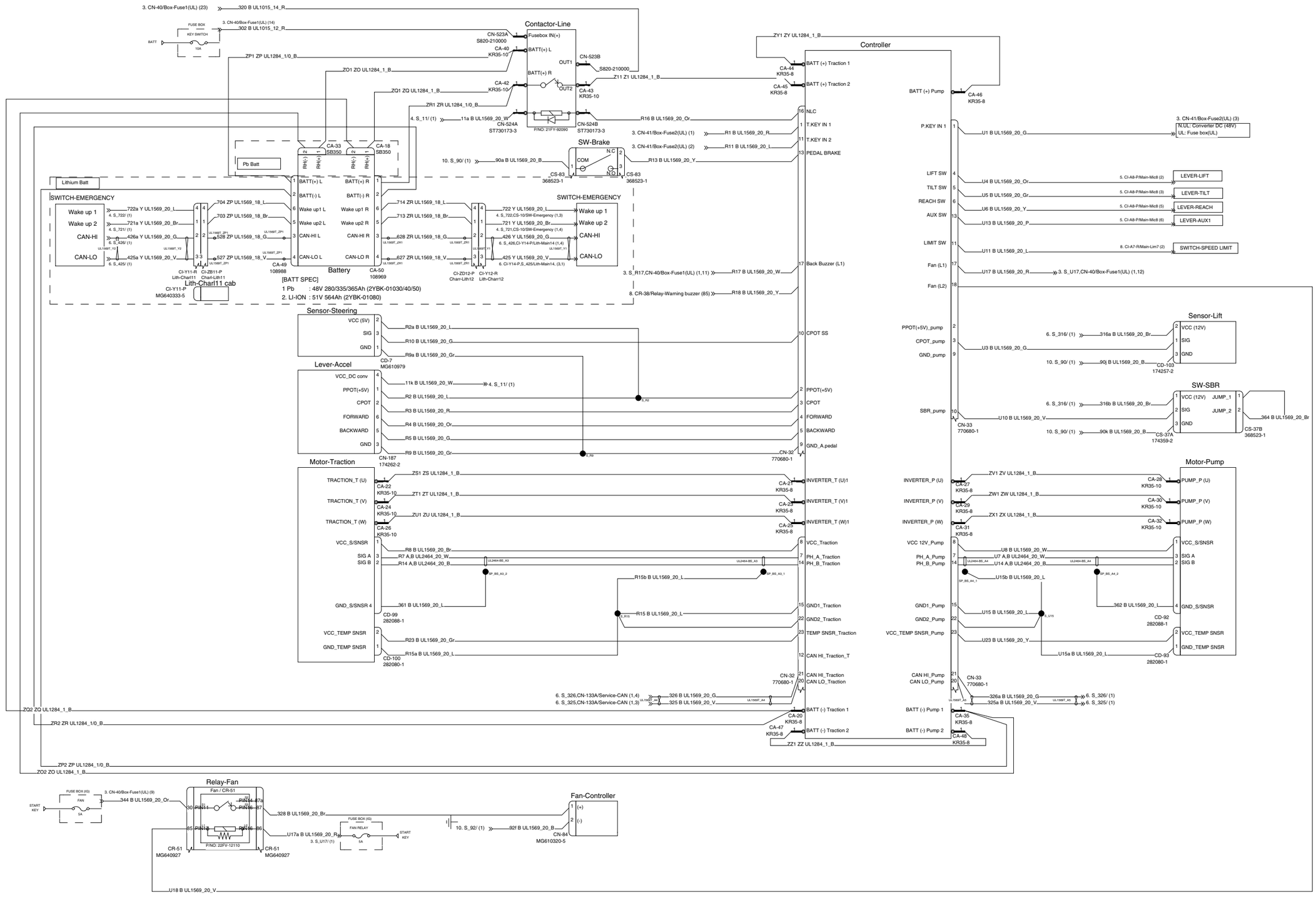
CONTROLLER AND MOTOR (UL)



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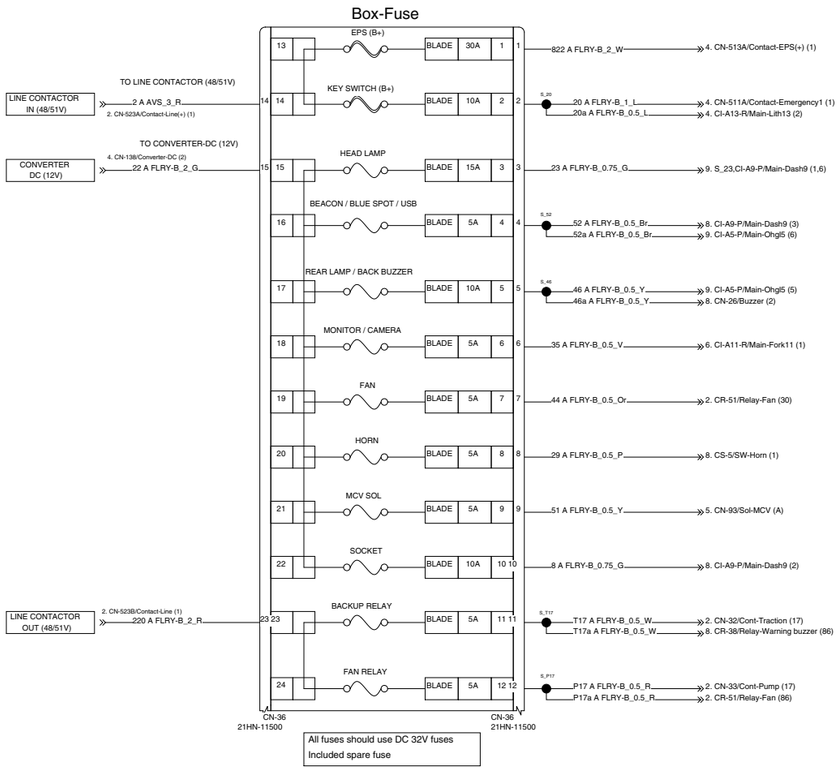
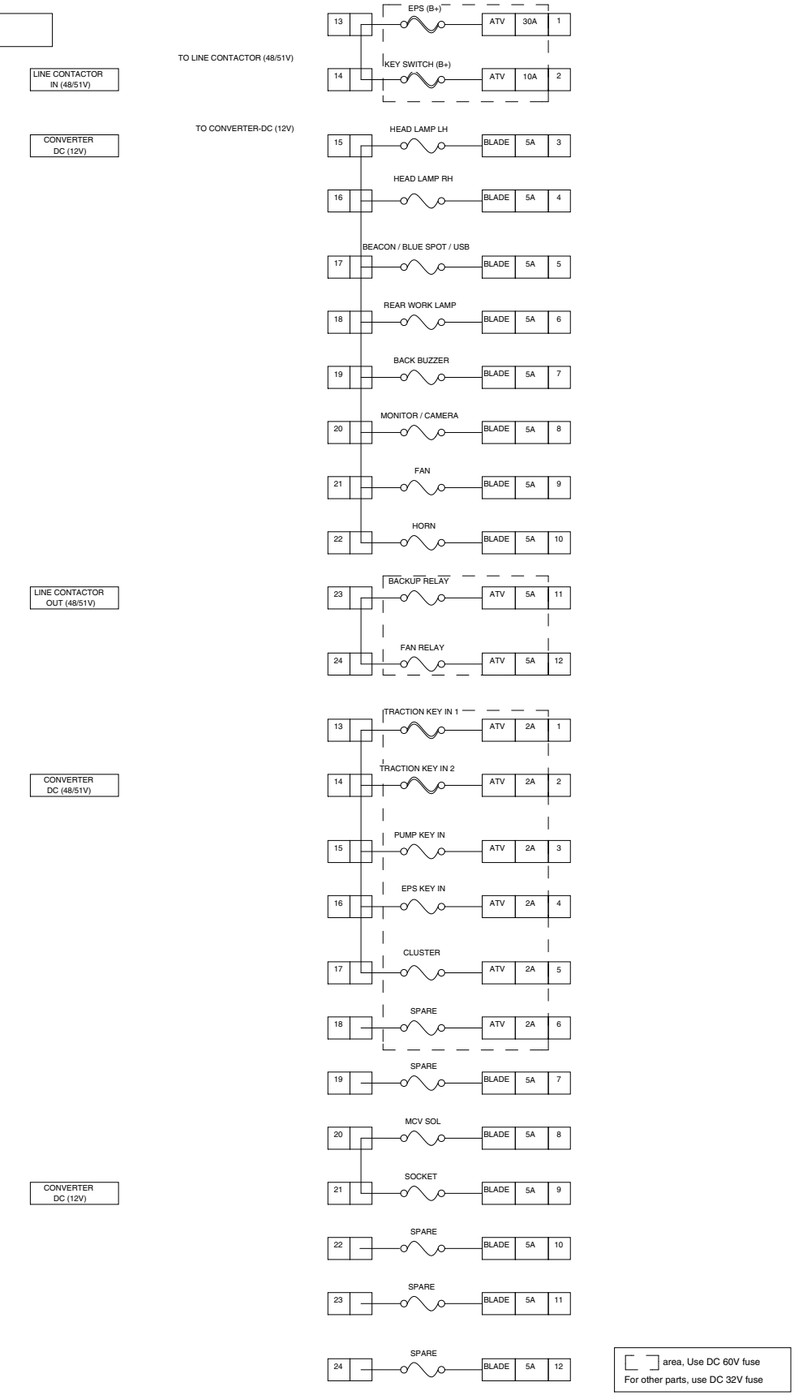
5. FUSE BOX

Non UL

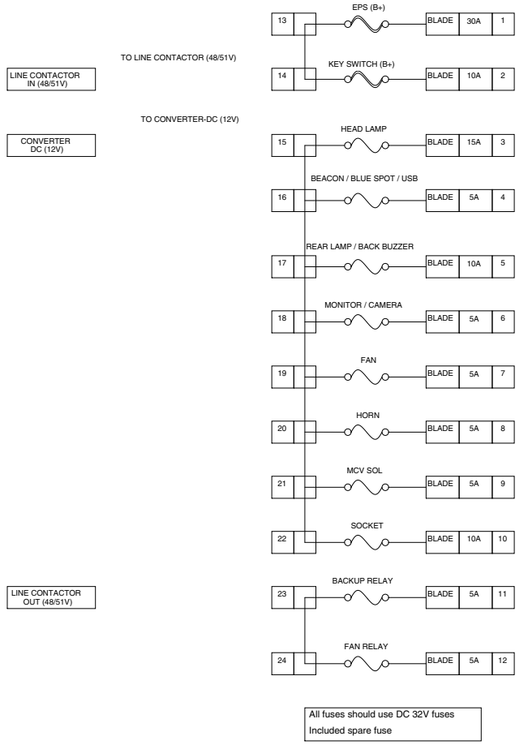


UL

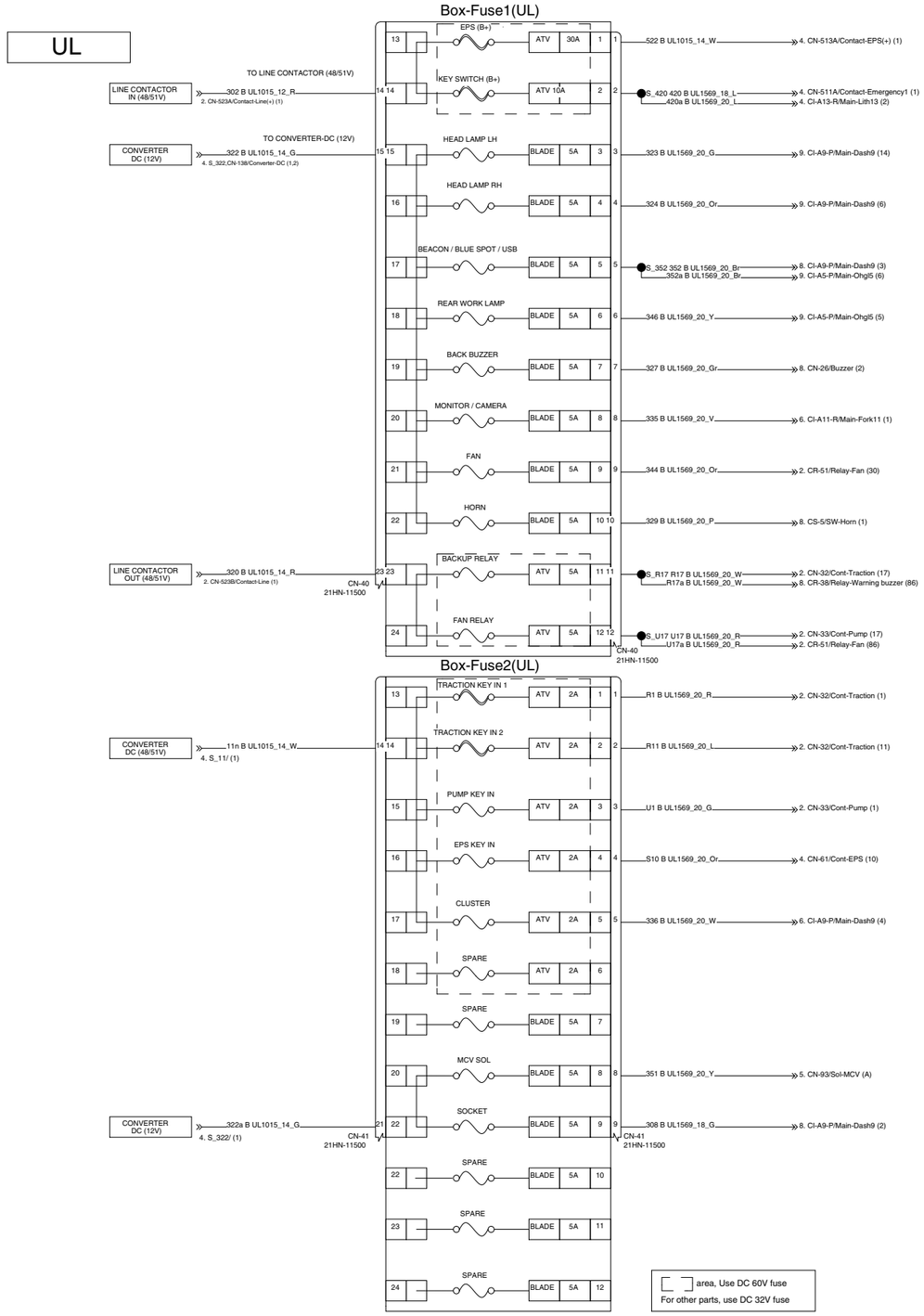


FUSE BOX (UL)

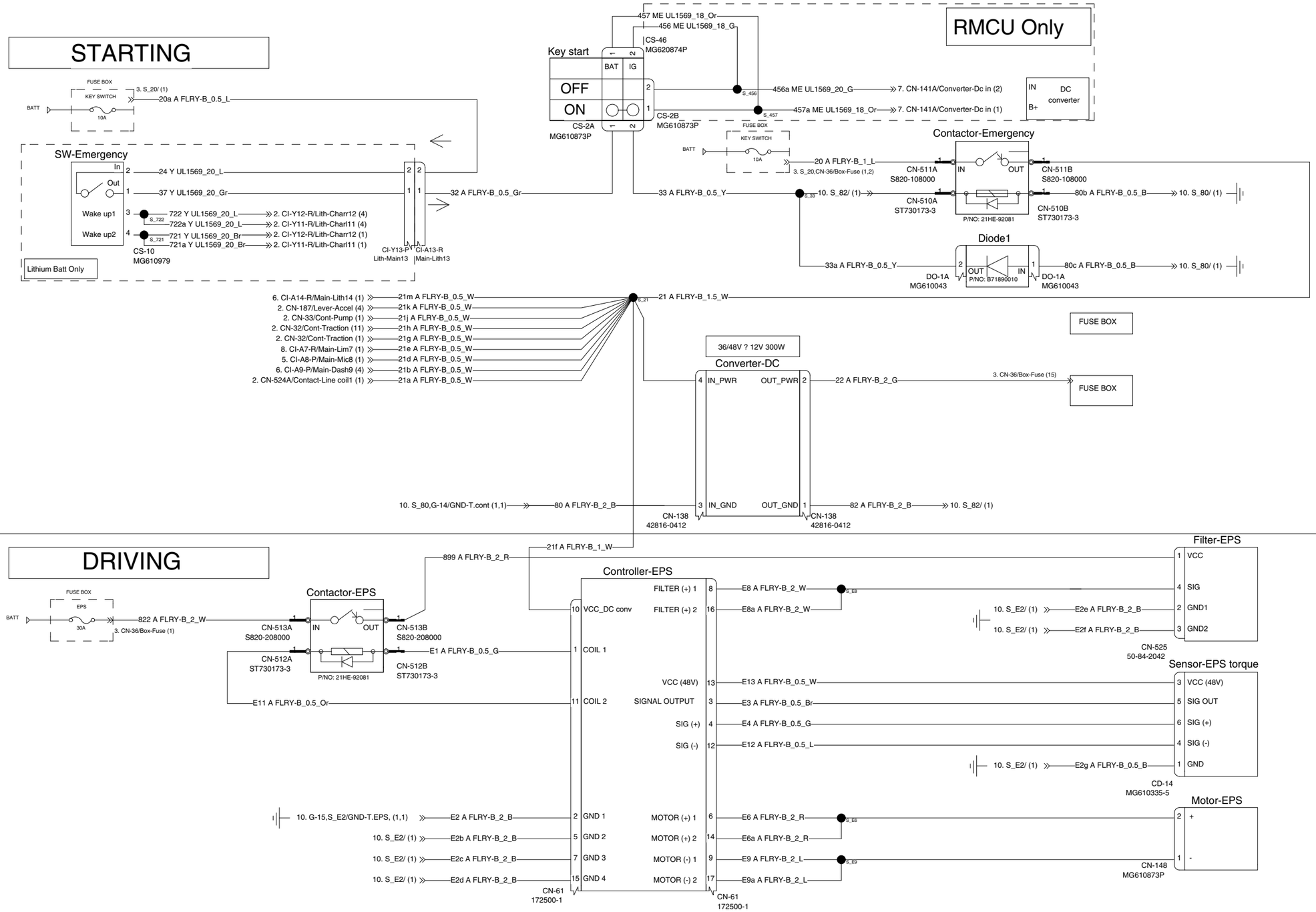
Non UL



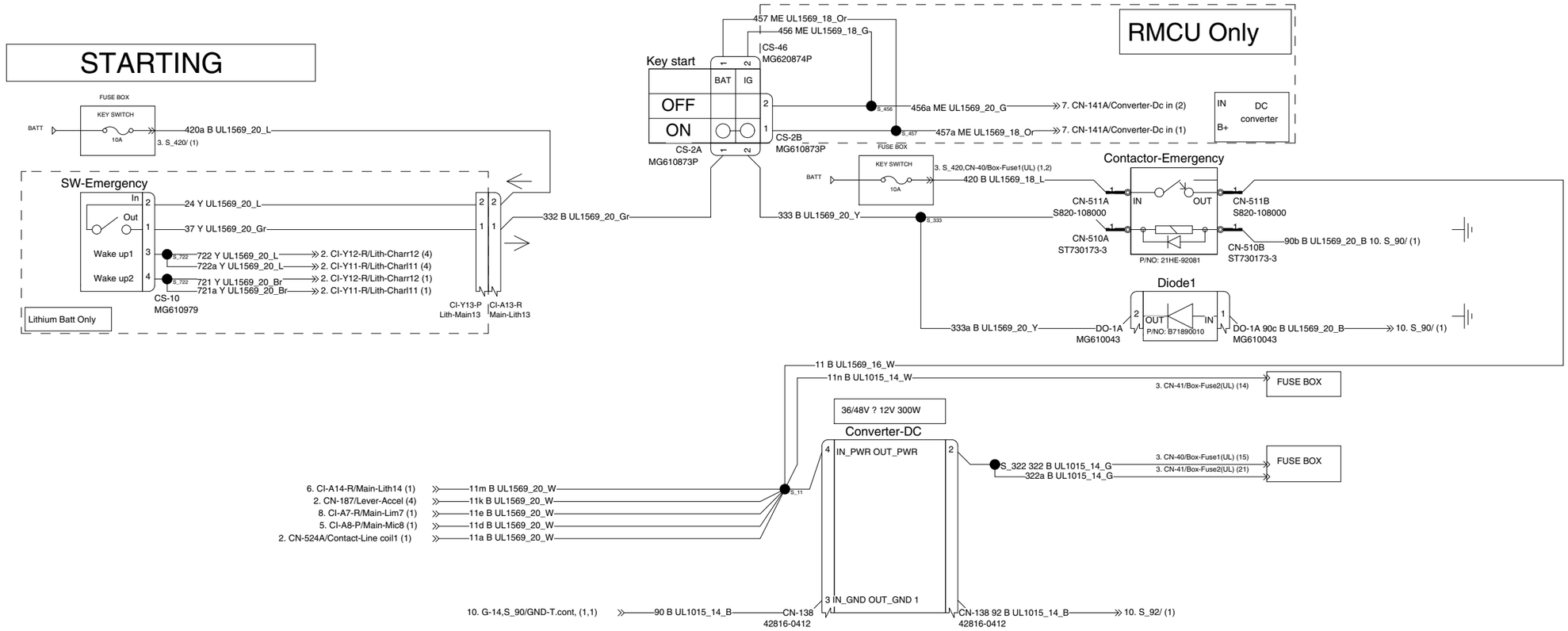
UL

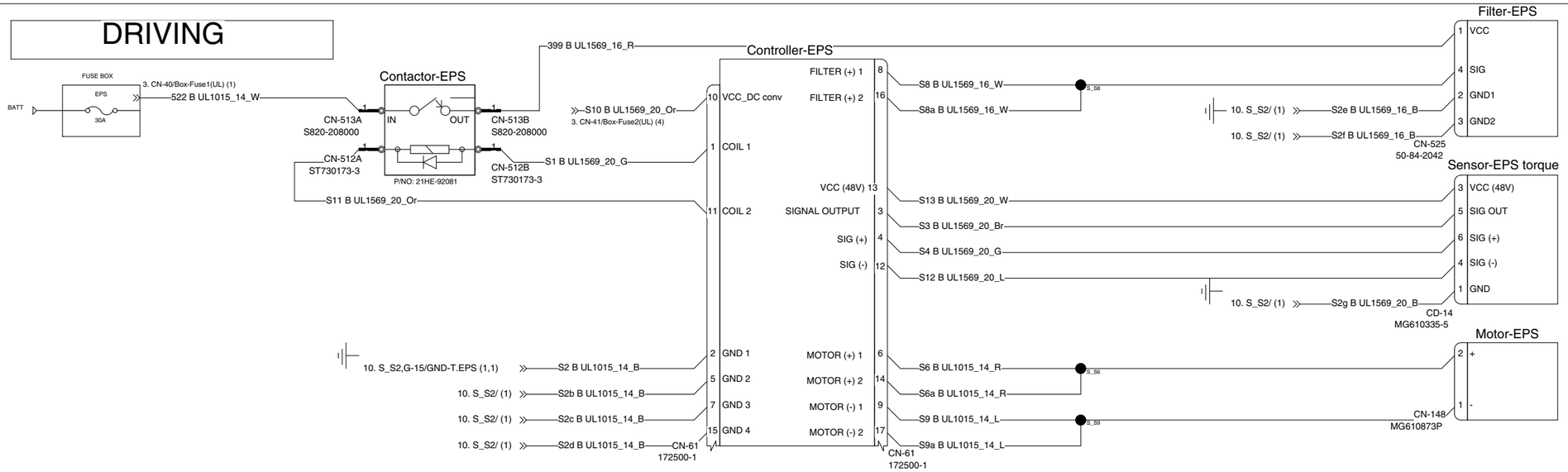


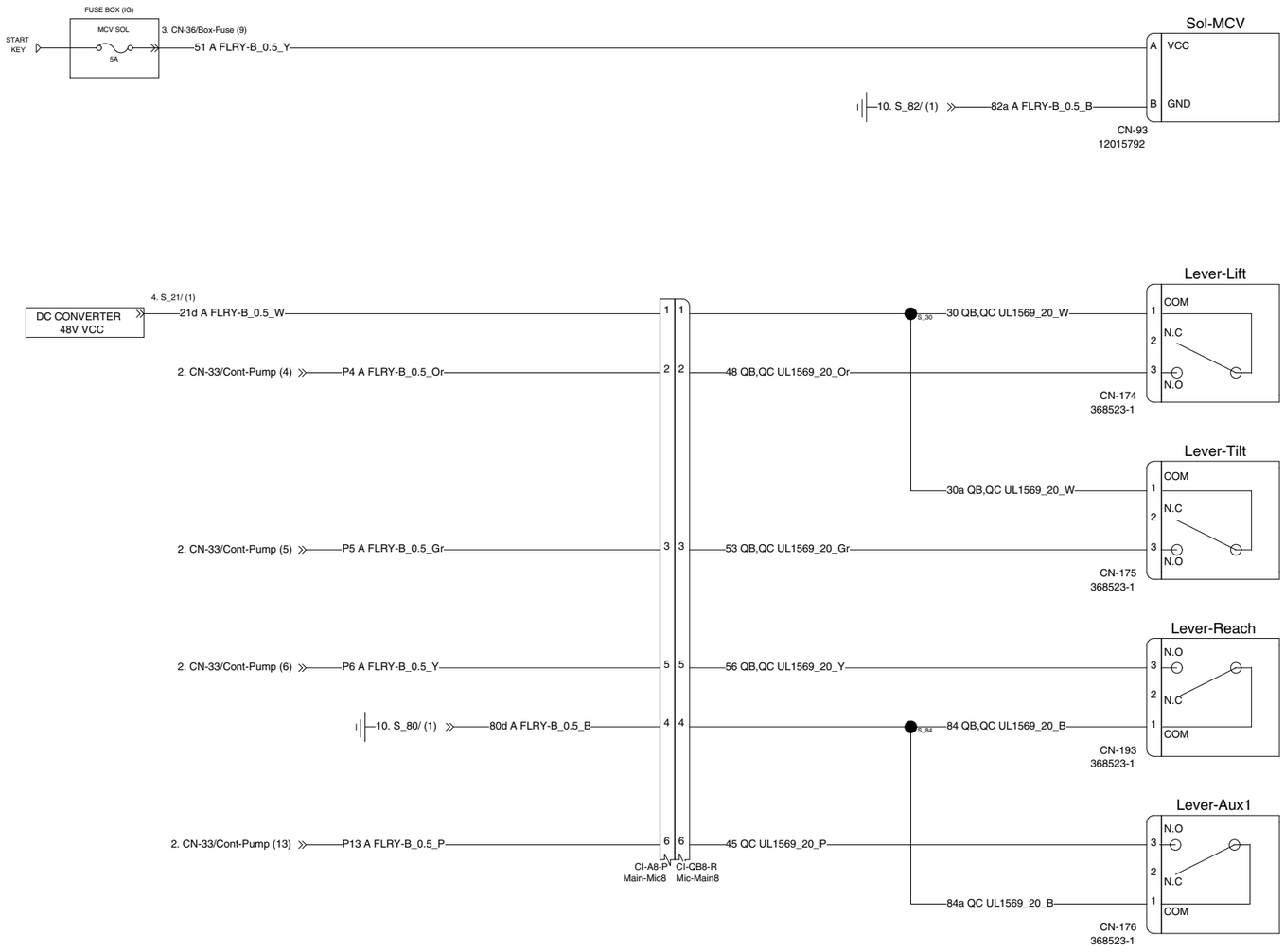
6. START AND DRIVING



START AND DRIVING (UL)







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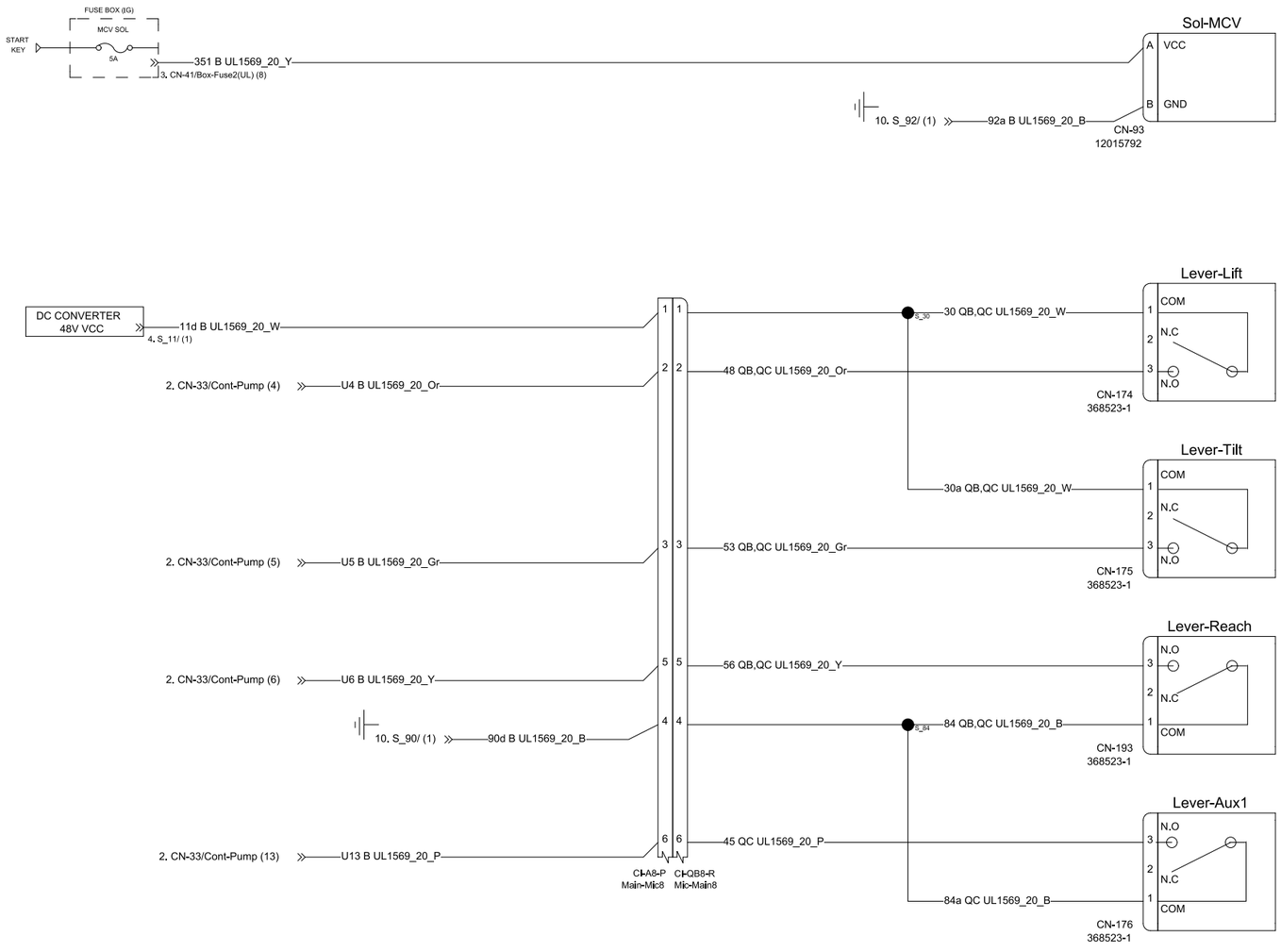
FINGERTIP (UL)



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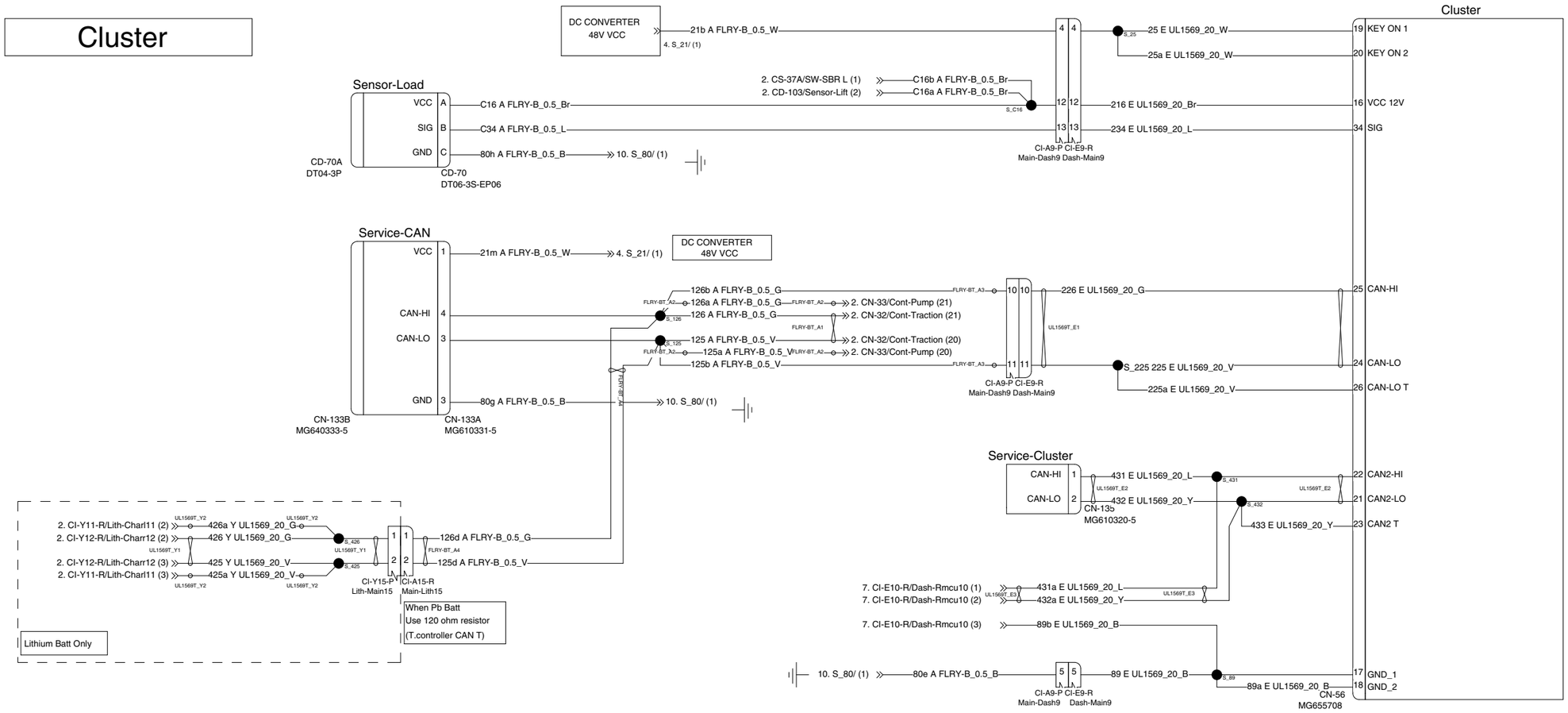
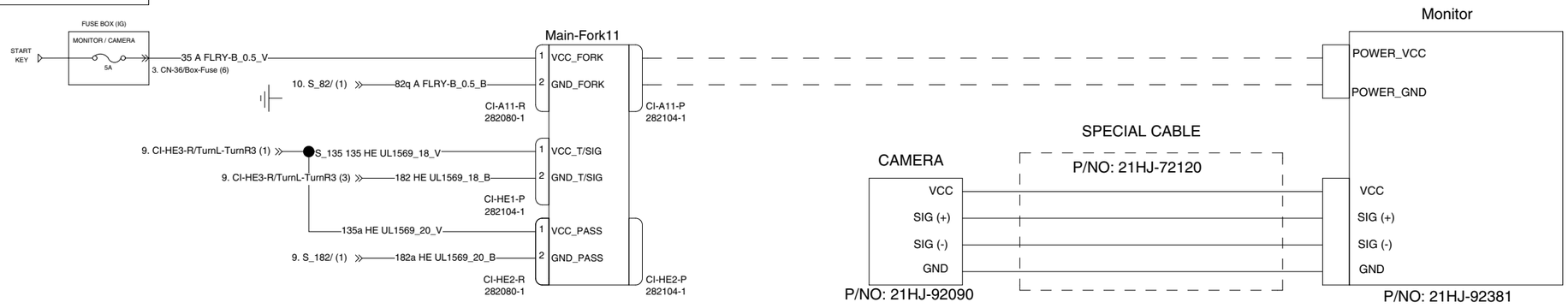
8. CLUSTER, CAMERA AND MONITOR

Cluster

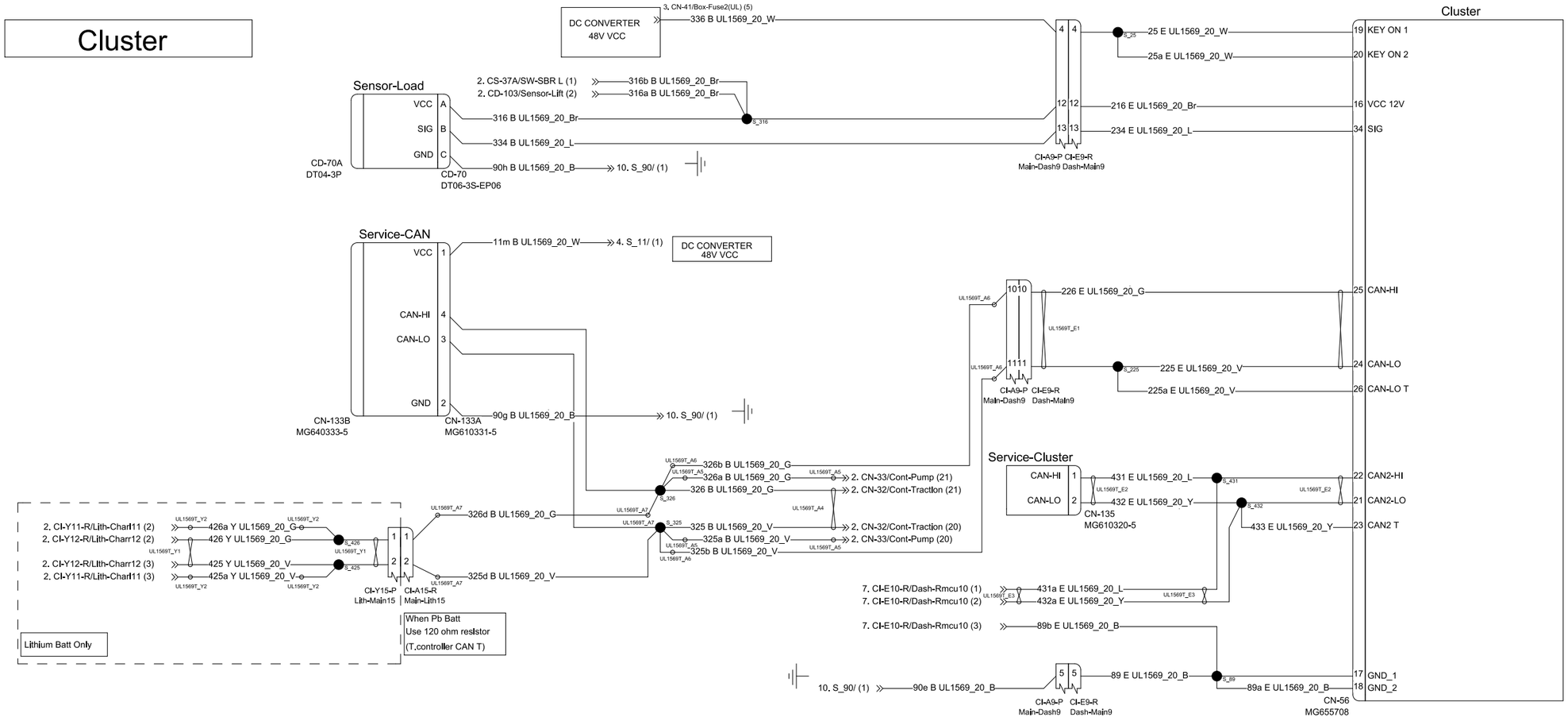


Camera,Monitor

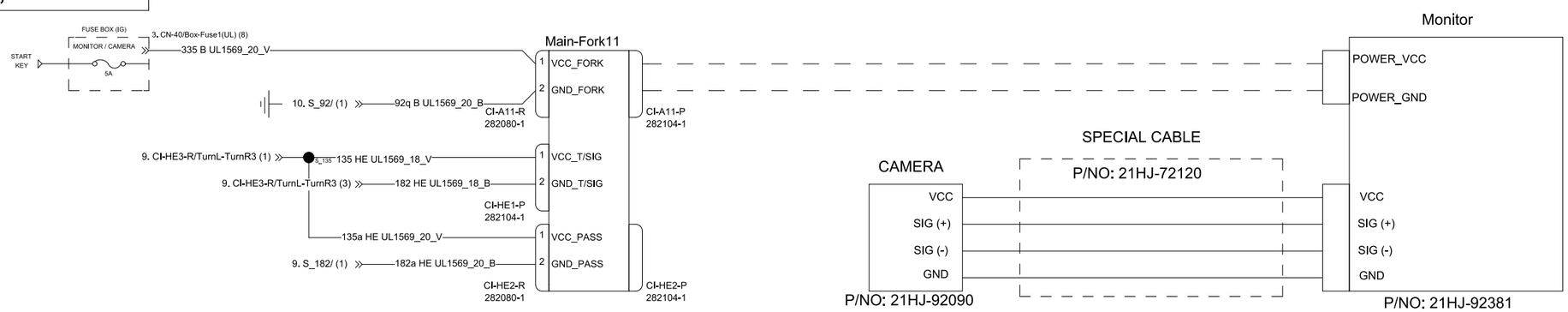


CLUSTER, CAMERA AND MONITOR (UL)

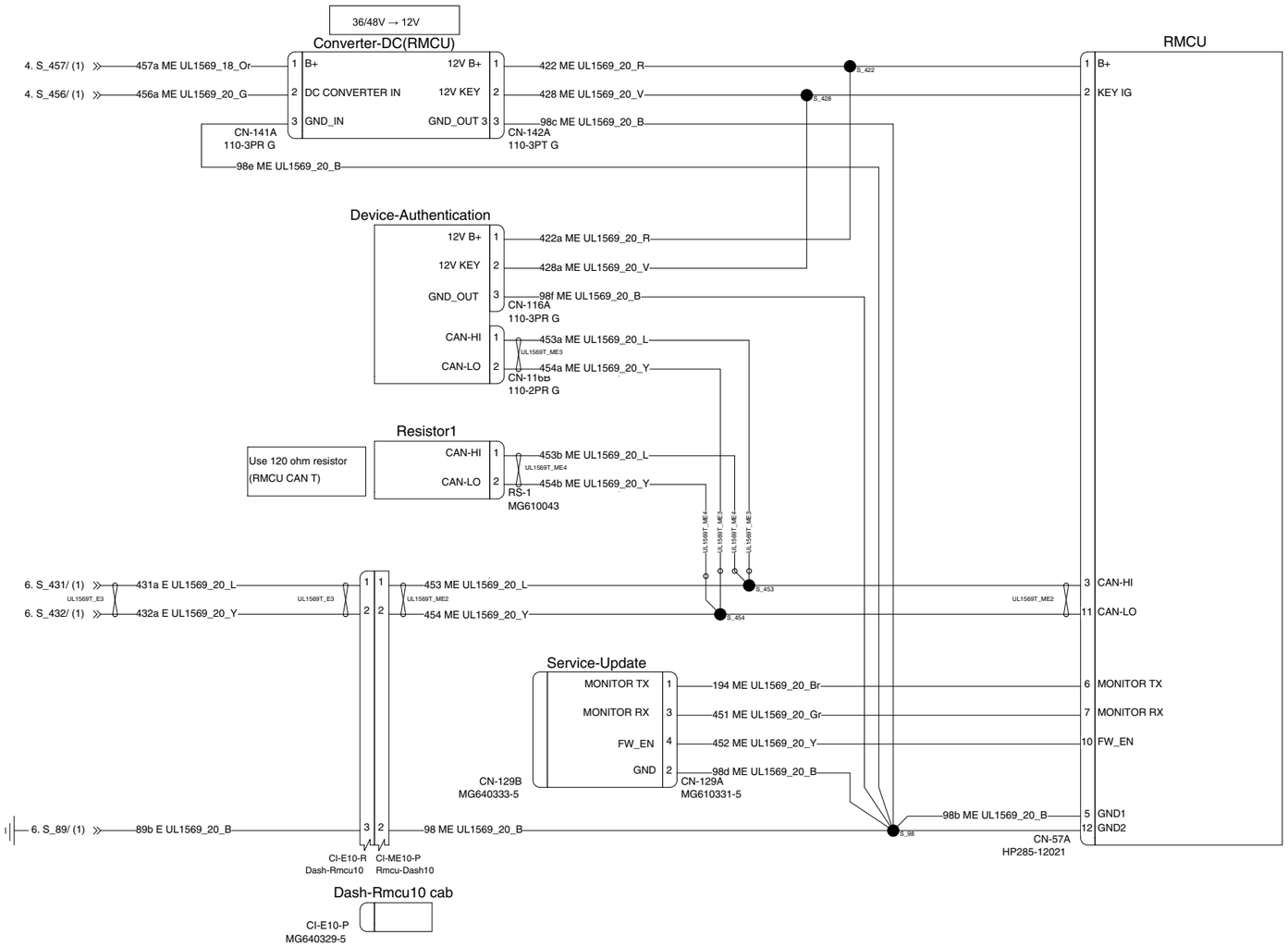
Cluster



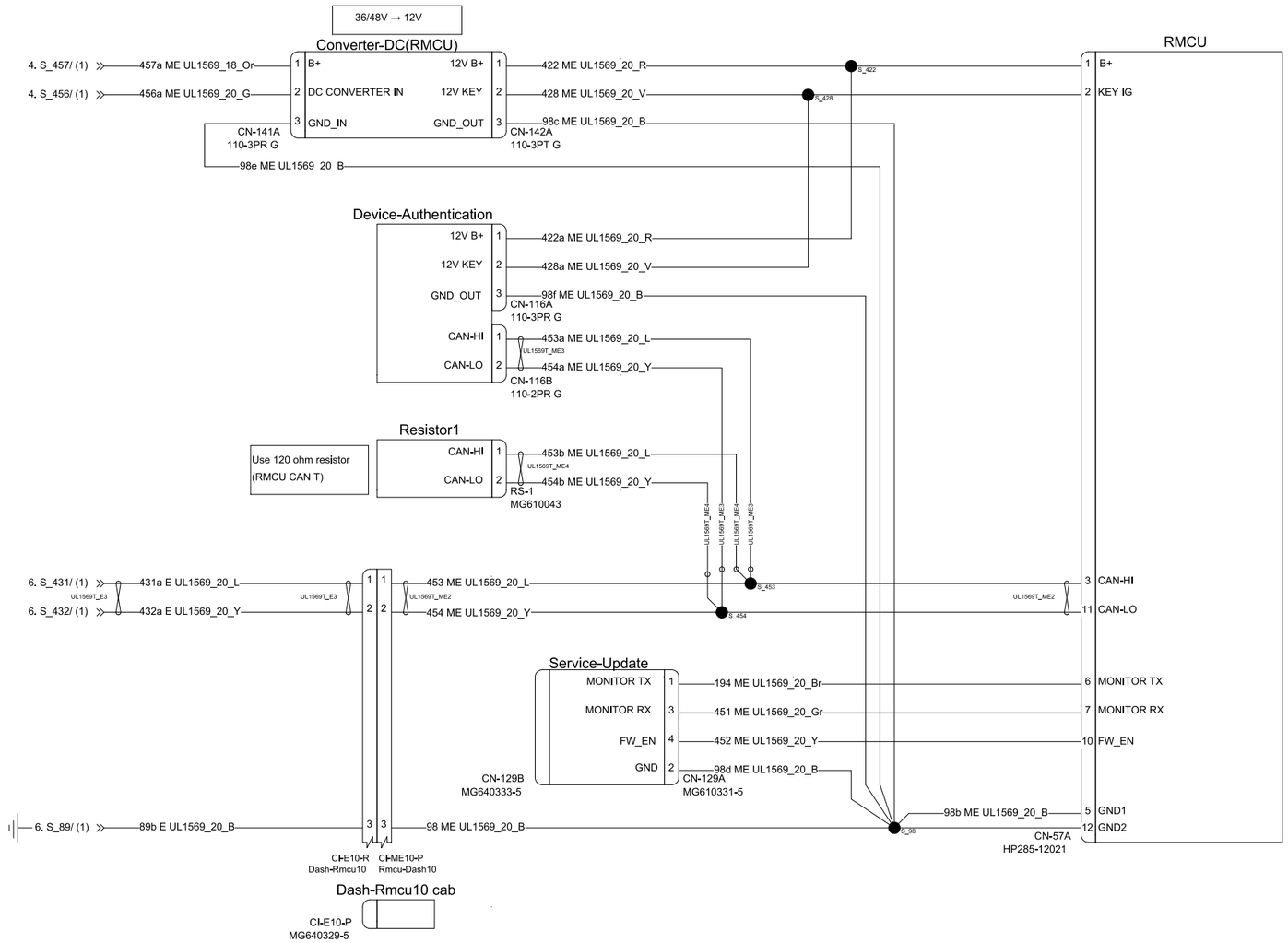
Camera,Monitor



9. RMCU


36/48V → 12V
Converter-DC(RMCU)
4. S_457/ (1)
457a ME UL1569_18_Or
1 B+
12V B+ 1
422 ME UL1569_20_R
S_422
4. S_456/ (1)
456a ME UL1569_20_G
2 DC CONVERTER IN
12V KEY 2
428 ME UL1569_20_V
S_428
3 GND_IN
GND_OUT 3
98c ME UL1569_20_B
CN-141A
110-3PR G
CN-142A
110-3PT G
98e ME UL1569_20_B
RMCU
1 B+
2 KEY IG
Device-Authentication
12V B+ 1
422a ME UL1569_20_R
12V KEY 2
428a ME UL1569_20_V
GND_OUT 3
98f ME UL1569_20_B
CN-116A
110-3PR G
CAN-HI 1
453a ME UL1569_20_L
UL1569T_ME3
CAN-LO 2
454a ME UL1569_20_Y
CN-11bB
110-2PR G
Resistor1
Use 120 ohm resistor
(RMCU CAN T)
CAN-HI 1
453b ME UL1569_20_L
UL1569T_ME4
CAN-LO 2
454b ME UL1569_20_Y
RS-1
MG610043
UL1569T_ME4
UL1569T_ME3
UL1569T_ME1
UL1569T_ME3
S_453
S_454
6. S_431/ (1)
431a E UL1569_20_L
UL1569T_E3
1 1
453 ME UL1569_20_L
UL1569T_ME2
3 CAN-HI
6. S_432/ (1)
432a E UL1569_20_Y
UL1569T_E3
2 2
454 ME UL1569_20_Y
UL1569T_ME2
11 CAN-LO
Service-Update
MONITOR TX 1
194 ME UL1569_20_Br
6 MONITOR TX
MONITOR RX 3
451 ME UL1569_20_Gr
7 MONITOR RX
FW_EN 4
452 ME UL1569_20_Y
10 FW_EN
GND 2
98d ME UL1569_20_B
CN-129B
MG640333-5
CN-129A
MG610331-5
98b ME UL1569_20_B
5 GND1
12 GND2
S_98
CN-57A
HP285-12021
6. S_89/ (1)
89b E UL1569_20_B
3 2
98 ME UL1569_20_B
CI-E10-R
Dash-Rmcu10
CI-ME10-P
Rmcu-Dash10
Dash-Rmcu10 cab
CI-E10-P
MG640329-5

RMCU (UL)


36/48V → 12V
Converter-DC(RMCU)
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457a ME UL1569_18_Or
1 B+
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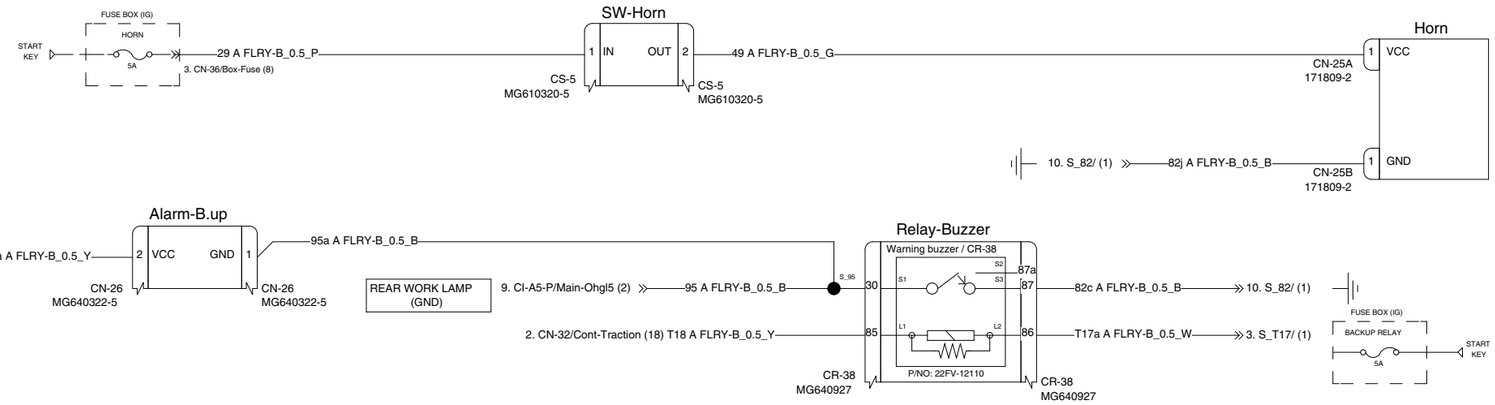
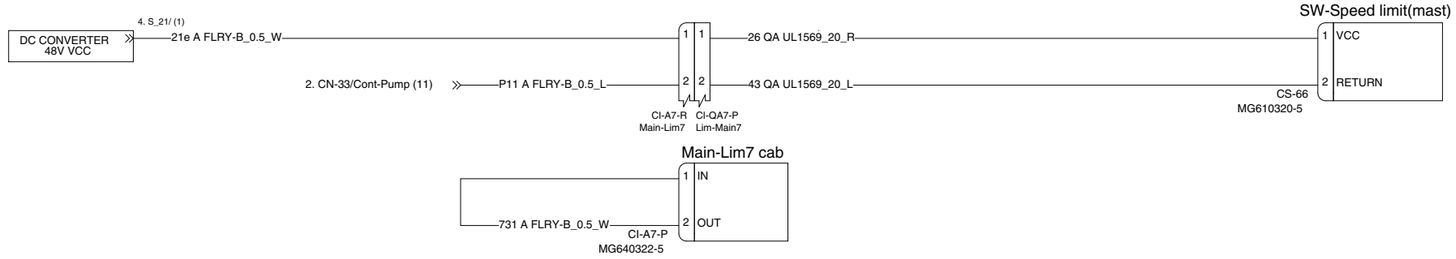
422 ME UL1569_20_R
S_422
4. S_456/ (1)
456a ME UL1569_20_G
2 DC CONVERTER IN
12V KEY 2
428 ME UL1569_20_V
S_428
3 GND_IN
GND_OUT 3
98c ME UL1569_20_B
CN-141A
110-3PR G
CN-142A
110-3PT G
98e ME UL1569_20_B
RMCU
1 B+
2 KEY IG
Device-Authentication
12V B+ 1
422a ME UL1569_20_R
12V KEY 2
428a ME UL1569_20_V
GND_OUT 3
98f ME UL1569_20_B
CN-116A
110-3PR G
CAN-HI 1
453a ME UL1569_20_L
UL1569T_ME3
CAN-LO 2
454a ME UL1569_20_Y
CN-116B
110-2PR G
Resistor1
Use 120 ohm resistor
(RMCU CAN T)
CAN-HI 1
453b ME UL1569_20_L
UL1569T_ME4
CAN-LO 2
454b ME UL1569_20_Y
RS-1
MG610043
UL1569T_ME4
UL1569T_ME3
UL1569T_ME1
UL1569T_ME2
6. S_431/ (1)
431a E UL1569_20_L
UL1569T_E3
1 1
453 ME UL1569_20_L
UL1569T_ME2
S_453
3 CAN-HI
6. S_432/ (1)
432a E UL1569_20_Y
2 2
454 ME UL1569_20_Y
S_454
11 CAN-LO
Service-Update
MONITOR TX 1
194 ME UL1569_20_Br
6 MONITOR TX
MONITOR RX 3
451 ME UL1569_20_Gr
7 MONITOR RX
FW_EN 4
452 ME UL1569_20_Y
10 FW_EN
GND 2
98d ME UL1569_20_B
CN-129B
MG640333-5
CN-129A
MG610331-5
98b ME UL1569_20_B
5 GND1
6. S_89/ (1)
89b E UL1569_20_B
3 3
98 ME UL1569_20_B
S_98
12 GND2
CN-57A
HP285-12021
CI-E10-R
Dash-Rmcu10
CI-ME10-P
Rmcu-Dash10
Dash-Rmcu10 cab
CI-E10-P
MG640329-5

10. HORN, SOCKET, USB AND MAST

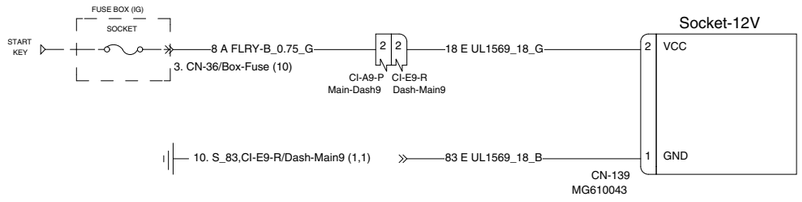
HORN



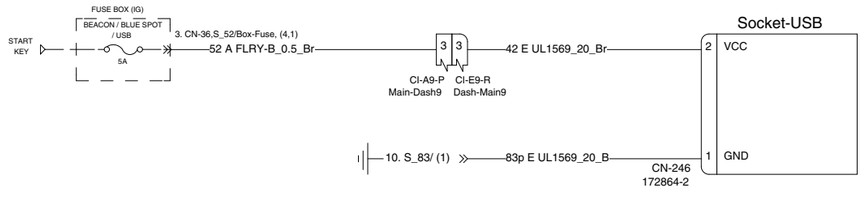
MAST



12V SOCKET

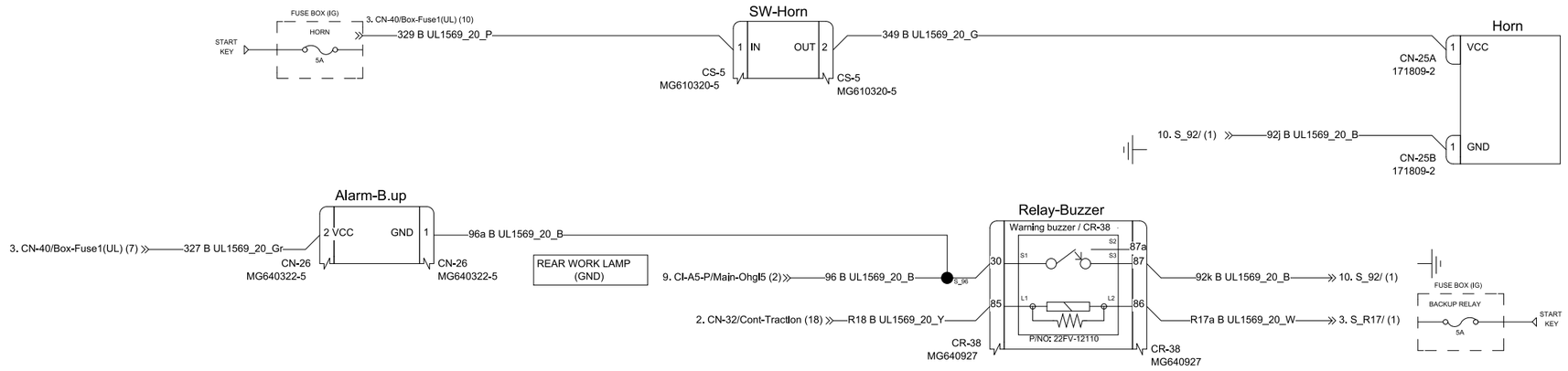


USB CHARGER

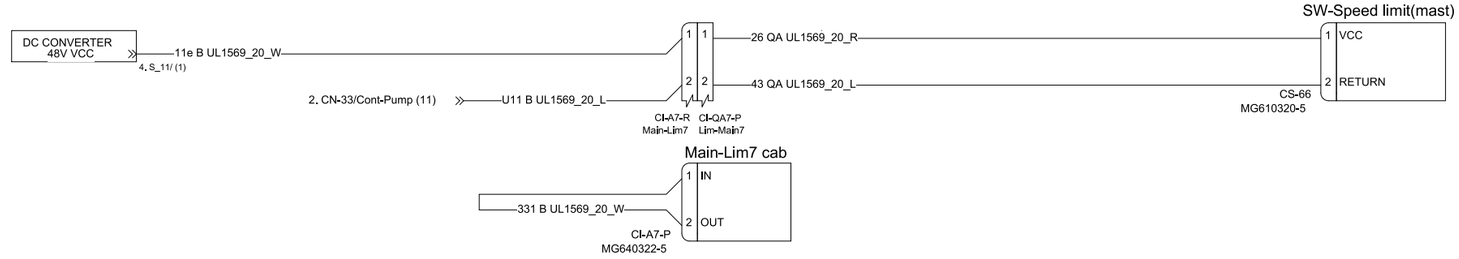


HORN, SOCKET, USB AND MAST (UL)

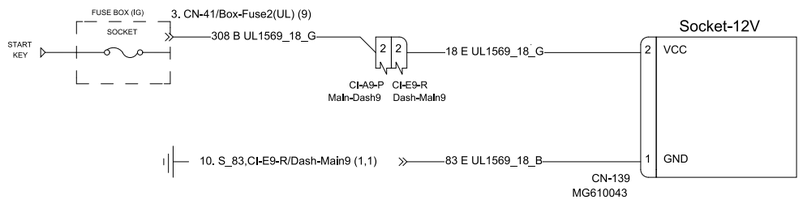
HORN



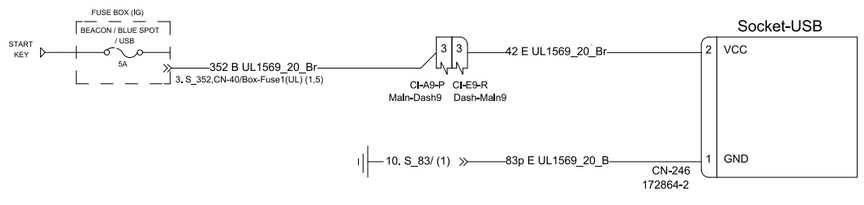
MAST



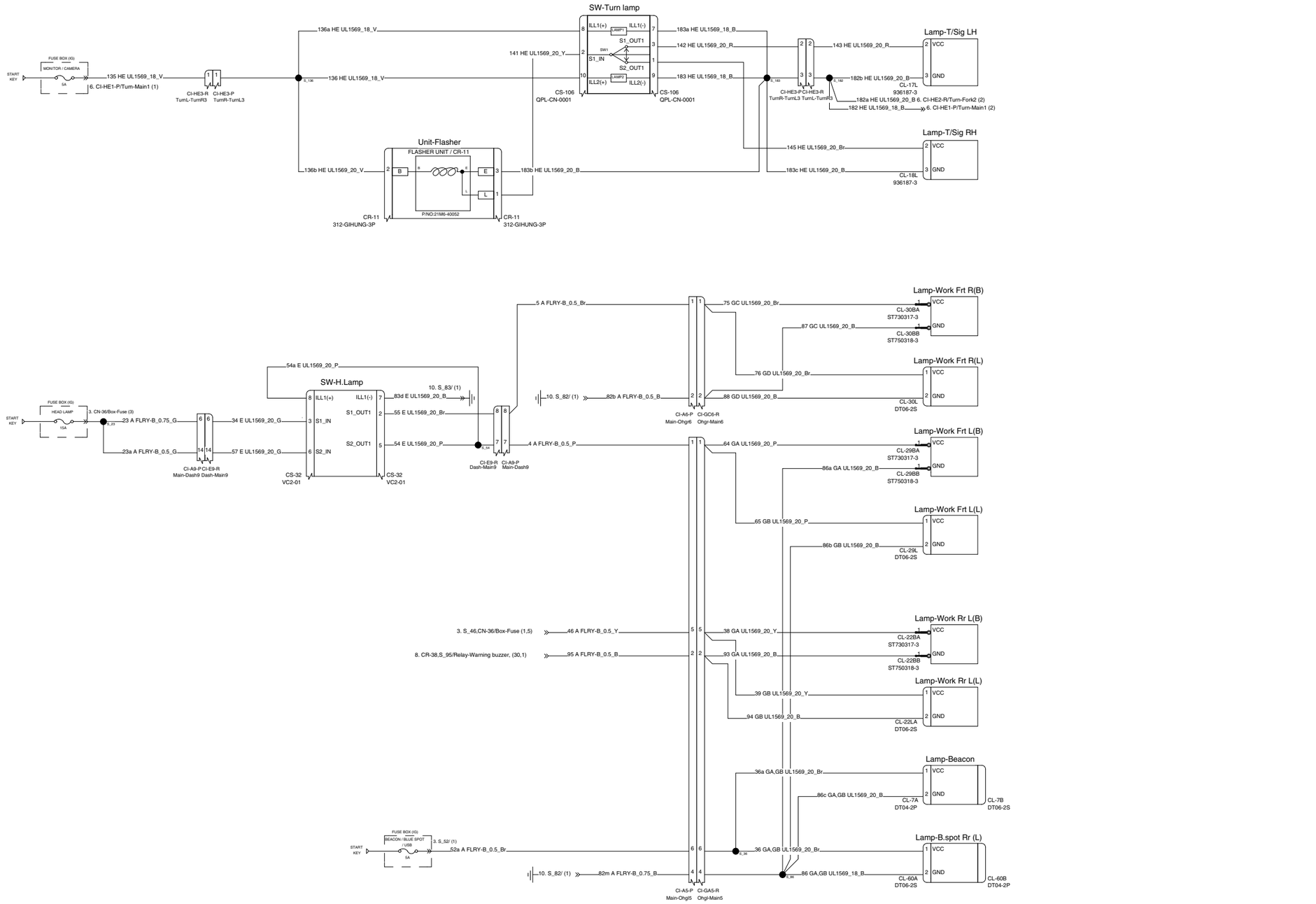
12V SOCKET



USB CHARGER



11. LAMP



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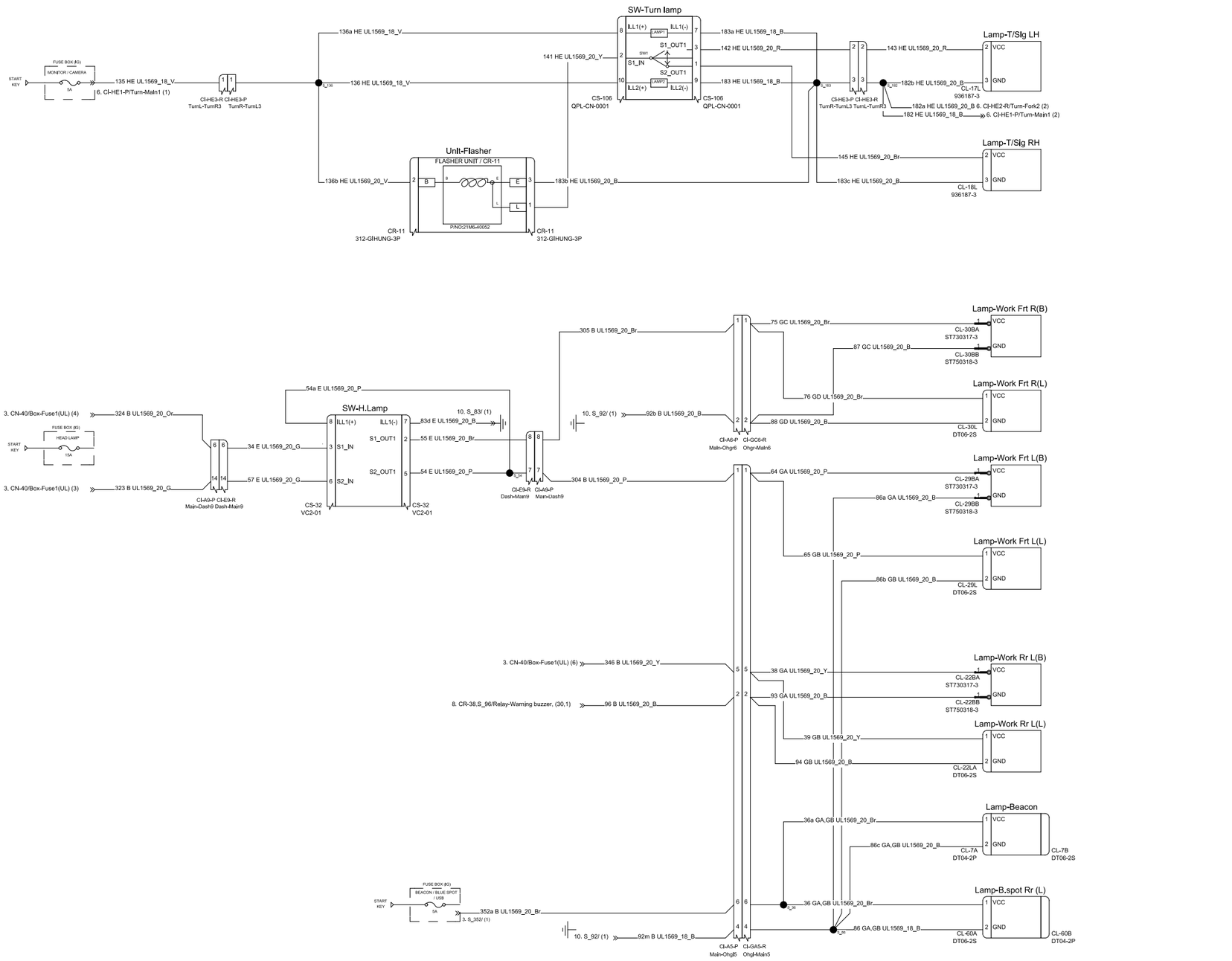
LAMP (UL)



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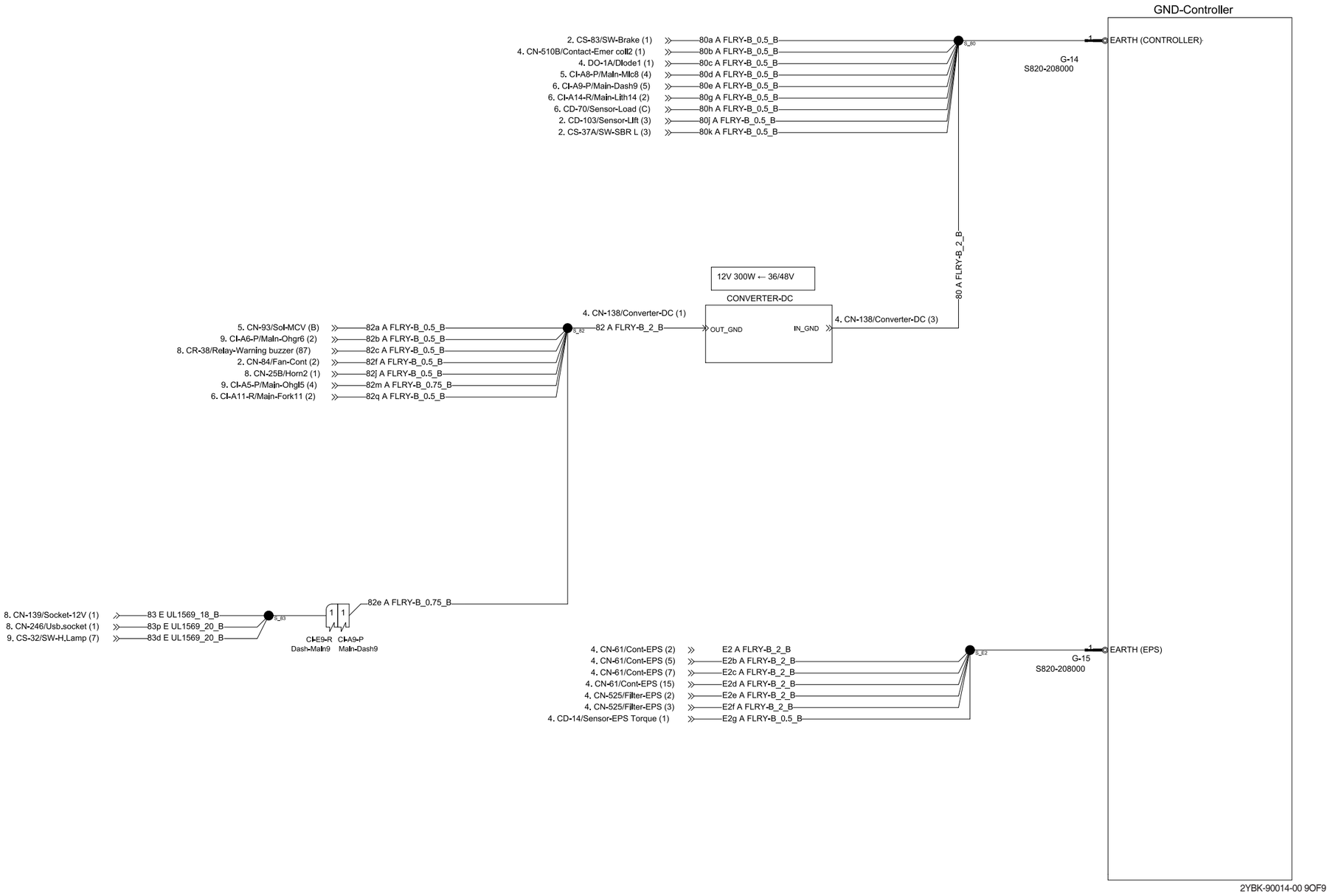
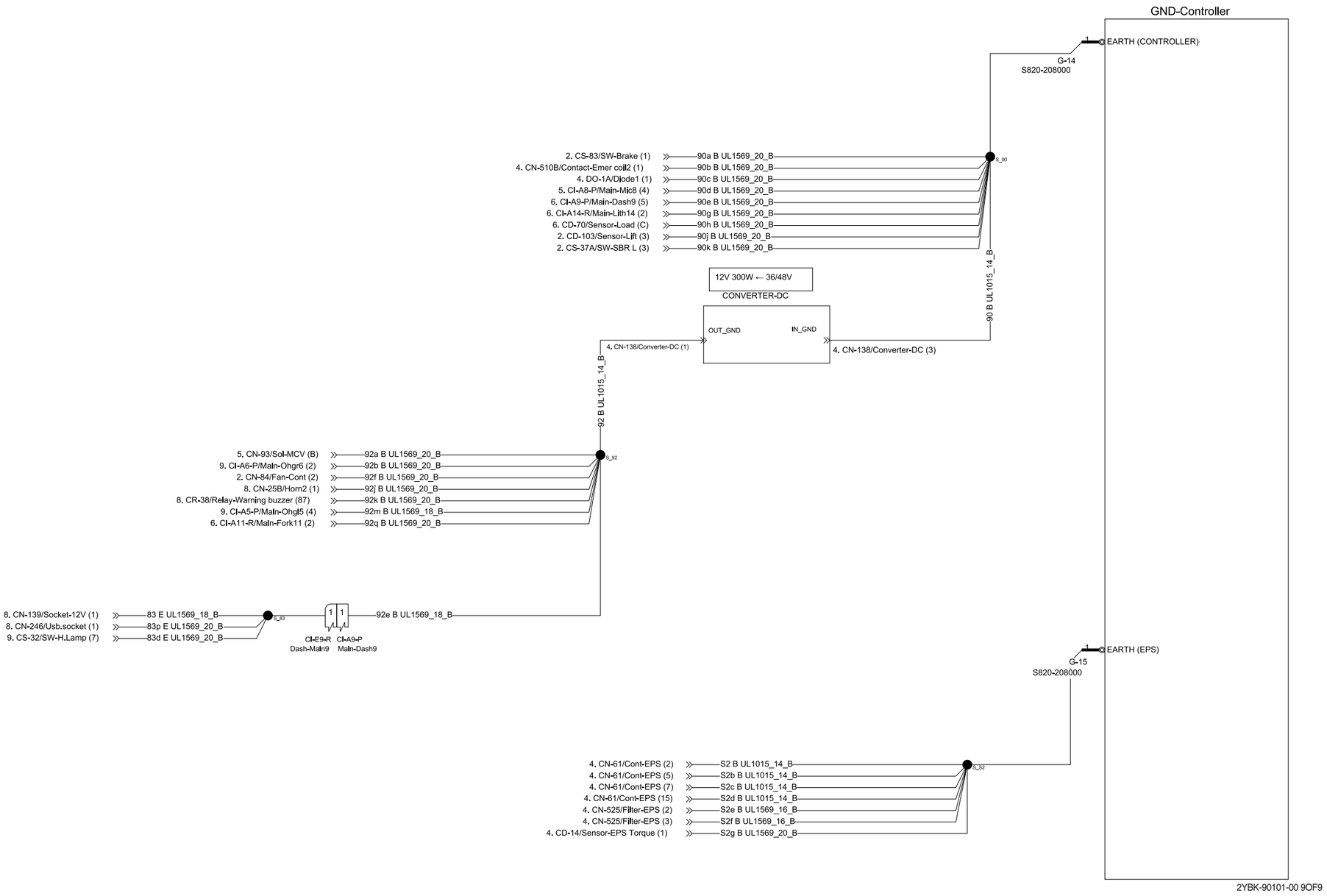
12. GROUNDING



GROUNDING (UL)



GROUP 3 ELECTRIC FUNCTIONAL PARTS

1. FUNCTIONS OF BATTERY LIFT TRUCK AND ELECTRIC COMPONENTS

The main function of the fork lift is classified into the driving function and loading and unloading function.

All components performing the driving, loading and unloading functions are operated by the AC motor. As the battery is the power source for the motor, a charging device is necessary.

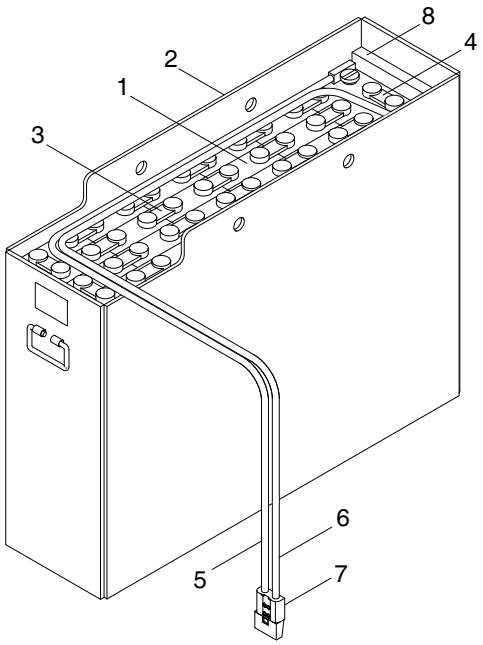
Driving direction shall be selected to drive the lift truck, and electrical components such as the driving control system for controlling the speed of the driving motor, lever for changing the direction (front/rear switch) and acceleration pedal are required.

The control system includes the protection circuit to prevent the malfunction of the fork lift and components.

The monitor system is mounted in the monitor panel to monitor the lift truck and work condition, and enables the worker to take appropriate measures. The monitor system is installed with many sensors such as the current sensor, hydraulic pressure sensor and temperature sensor. HYUNDAI motor lift truck series are installed with the latest world-class driving control system. The system has worker-friendly characteristics for conveniently adjusting the lift truck condition according to each working environment, and the self-diagnosis function indicates the current state of the lift truck in operation.

2. BATTERY

1) STRUCTURE



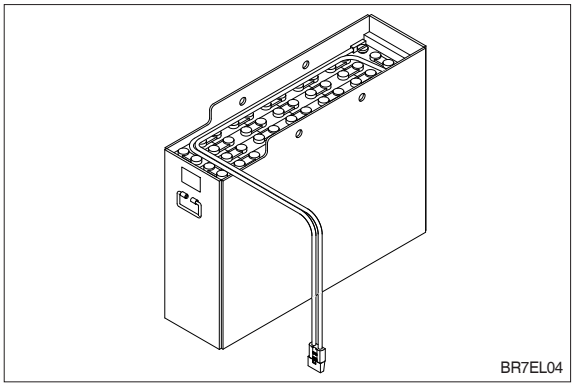
BR7EL03

1	Cell	5	Anode cable
2	Steel box	6	Cathode cable
3	Cell Connector	7	Plug
4	Low connector	8	Spacer

2) GENERAL

Battery is power source for batter-powered forklift truck, and careful handling of battery is very important. Service life and capabilities of lift truck largely vary dependent upon routine handling and maintenance.

It is, therefore, must to ensure correct inspection and maintenance to keep battery at the best conditions.



3) SPECIFICATIONS AND MAINTENANCE DATA

Item	Unit	15/18BR-X	20/25BR-X
Type	-	VCF 280	VCI 300
Rated voltage	V	48	
Capacity	AH/hr	280/5	300/5
Electrolyte	-	Wet	
Dimensions (W×D×H)	mm	994×378×582	
Connector	-	SB350	
Weight	kg	490	500

Specific gravity of fully charged battery	1.280 (25˚C)
Specific gravity of fully discharged battery	1.130 (25˚C)
Voltage at end of discharging	48 V
Electrolyte	Purified thin sulfuric acid
Makeup solution	Purified water (distilled water)
Insulation resistance	1MΩ or more

4) SAFETY PRECAUTIONS

(1) When sulfuric acid is in contact with the skin

When skin, eye or clothes contacts with sulfuric acid, immediately flush with flowing water. On intake, drink a lot of water or milk. Receive immediate medical treatment. Wear safety glasses, facial shield and rubber globes at all times when handling oxidative substances.

(2) Prevention of heat source, and ventilation

Use of fire is prohibited as the battery produces explosive hydrogen gas. Open the steel tray cover and check the ventilation condition when charging the battery. There is risk of explosion when charging in an enclosed space.

(3) Do not leave loose part on the battery.

It can result in “Short Circuit” (Especially dangerous when charging).
Spark can occur, and it is as dangerous as fire.

(4) Handling of charger

When the battery is connected/disconnected from the charger or performing maintenance, check that all switches are turned OFF. Check that the state of the charger and the battery is appropriate. When using the 300Ah battery on a charger for 500Ah battery charging, battery may be overcharged.

5) OPERATION PRECAUTIONS

(1) Avoid over-discharging

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 1.5 V.

(2) Avoid over-charging

If overcharged, the rise in battery temperature will become excessive, resulting in reducing the life of other parts and battery greatly.

(3) Avoid excessive elevation of temperature

Be sure to open the cover on the battery housing tray before charging. If there is possibilityof temperature to exceed 55˚C, discontinue the charge operation temporarily, or reduce the charge current.

6) INSTRUCTIONS

(1) UNPACKING

Electric traction storage battery (hereafter referred to as the "Battery") is delivered to the customers in the dry charged battery state. At unpacking, check whether the batteries and accessories have been damaged. At unpacking, check whether the batteries and accessories have been damaged. If there are observed defects, you should notify the condition to HYUNDAI branch office or agent. Never remove the sealing plug until the battery is put into service.

(2) Battery Performance and Maintenance

① Initial Charging

Battery gradually decreases its capacity during storage. Sufficient initial charging is required to provide sufficient discharge capacity during the primary discharging. The condition forinitial charging is as follows (indoor temperature).

a. By modified constant voltage charger
   Connect the battery to the charger and turn "ON" the equalized charging. Battery is turned OFF automatically when the charging is complete.

b. When using contant voltage or constant current charger
   Connect the battery to the charger and turn "ON" the equalized charging. Battery is turned OFF automatically when the charging is complete.

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. Charging shall be finished when satisfying one of the following conditions.
   · Maximum value is reached when the fixed value is indicated for 1 or more hours after the battery voltage reaches the maximum value.
   · When the charging is continued for 1 or more hours after the electrolyte specific gravity is increased completely and becomes constant

② Discharge and capacity

Battery capacity indicated with 5 hours means that in the discharge current divided with 5 on the capacity for 5 hours on the battery, the average voltage of the unit battery may be reduced to 1.7V in the 30˚C electrolyte temperature.

In other words, the capacity is indicated as AH (Ampere Hour) calculated with the amphere (A) and time (H). However, the capacity is changed according to the discharge condition (discharge current, battery temperature and electrolyte specific gravity) even in the same type of battery. Even when the total capacity of the battery is discharge, there is no adverse effect when the battery is charged to the complete capacity. Ideal charging amount (AH) is 110-125% of the previous discharge amount.

③ Specific Gravity of the Electrolyte

The specific gravity of the electrolyte is decreased while discharging, and increasing during the charging. The electrolyte becomes almost constant when the battery is completely charged, and there is no more increase. The specific gravity value varies with the change in temperature. Therefore, the specific gravity is measured from the same electrolyte temperature, and the specific gravity measurement value can be corrected in the standard temperature of 25˚C according to the following formula.

$$S25 = St + 0.0007 (t-25)$$

Specific gravity in S25 : 25˚C
Actual measurement specific gravity in St : t˚C
t : Electrolyte Temperature (˚C)

The standard specific gravity for this type of battery is 1.280±0.01 (25˚C). If the electrolyte is reduced naturally during the period of use, the distilled water shall be supplemented up to the defined level (supplementation of sulfuric acid prohibited).

If high amount of electrolyte is discharged due to the reasons such as leakage, diluted sulfuric acid shall be supplemented in the defined specific gravity.

④ **Normal charging**

Charge the discharged batter as quickly as possible. Before starting the charging, the temperature shall be 45˚C or less if possible, and the temperature shall not exceed 55˚C while charging (IN any case, the temperature shall not exceed 55˚C). The charging method is changed according to the type of charger used, and the standard charging method is described as shown below (if special charging method is adopted, the instructions shall be followed accordingly).

a. When using the remodeled constant voltage automatic charger

Recently, automatic charger not installed with the outer operation timer is used, where the charging is performed by simply connecting the plug between the battery and the charger. However, the charger installed with the outer operation timer is set with the timer for 3-4 hours, and the charger is turned ON. Through this setting, charging is performed automatically. Generally, change in time setting on the timer is not required regardless of the previous discharge amount. The recommended current value on this type of charger is "5-hour current ×1.0~1.5" when starting the charging, and "5-hour current × 0.15~0.25" in the last stage. Charging is normally finished autoamtically within 8-12 hours from charging.

b. When using the constant current or constant voltage automatic charger

After the switch is turned ON and passed with the defined charging time, charging is finished by turning OFF the switch. The charging time can be calculated by the following formula.

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

⑤ When the amount of previous discharge is not known, use the 5 hour capacity of the batteries. Charging current directly after the charging is permitted up to 3×5 hour current. For the charger installed with the timer, the charger will be turned OFF automatically when the tier is set in the defined time according to the instruction.

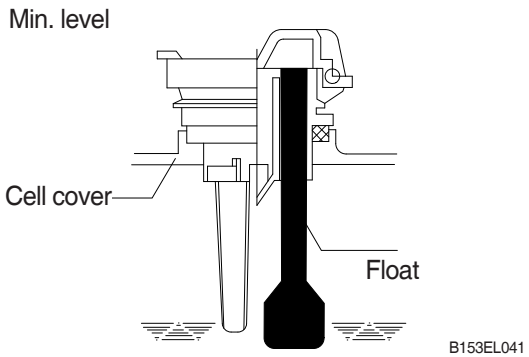
⑥ **Equal charging**

When many cells are used in one battery, there is tendency of having the voltage and specific gravity of each battery being uneual, and this will be result in having to charge all batteries in the appropriate time for equal charging. This is equal charging. General, equalized charging shall be performed once a month. For the normal type of charger, the method is performing complete charging in the current of final stage to charge additionally for 5 hours, and for the automatic charger installed with a timer, the set time shall be increased additionally for 3-6 hours.

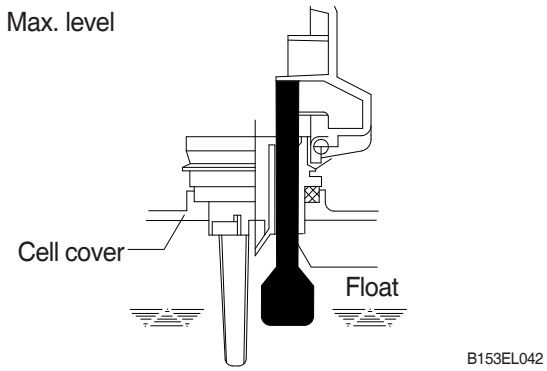
Replenishment of distilled water

Only the water content of electrolyte is decreased due to electrolysis of distilled water during charge and natural evaporation. If the electrolyte in the battery is reduced greatly, plate is corroded to result in considerable decrease in the life of the battery. The electrolyte level shall be checked every week. If the electrolyte level is low, distilled water shall be supplemented up to the defined level. In this case, supplementation of sulfuric acid or tap water is prohibited. Battery shall be supplemented with only distilled water. When the amount of distilled water for weekly supplementation on the unit battery of 100AH in battery capacity exceeds 45cc, battery is overcharged. Therefore, the charging amount shall be reduced slighly every day. The amount of distilled water to be supplemented in the normal condition is 45cc or less. Additionally, distilled water shall be supplemented before charging in the minimum level (to enable constant mixing of the electrolyte through charging). If the electrolyte level is inappropriate after the charging, the electrolyte shall be fully filled into the maximum level.

a. **Determination of the Supplementation Time and Method** (Battery installed with the one-touch cap)
The float of the one-touch cap is watched to check the electrolyte level. If the level is too low as shown in the figure, add distilled water. Replenishment shall be performed after opening the cover of the plug using the jug of a syringe. After replenishment, close each cover completely until there is a “Click” sound.



B153EL041



B153EL042

⑦ **Cleaning**

Current may be leaked when the electrolyte is spilled or when the battery is contaminated with dust or stain. Wipe off the dust and stain with wet cloth, and clean the battery in the dry state. For the plastic continer or cover, use of organic detergents such as paint diluent and gasoline is prohibited. When the organic detergents are used, crack may occur on the plastic container or cover. When use is required inevitably, white kerosene shall be used.

⑧ **Precautions on Charging**

The charging location shall be provided with appropriate ventilation for convenient discharge of the gas that is produced from the battery while charging. Work such as ironing or welding, etc. is prohibited in the charging location. In addition, hydrogen, oxygen, acid mist and even hydrogen sulfide may be rarely produced while charging. Special caution is required as the equipment and objects around the battery may be contaminated or damaged. Spark may occur when the charging cable is disconnected while charging. Hydrogen gas produced while charging may be filled around the battery, so fire or spark shall be prohibited near the charging location. For the counterbalance-type lift truck, open the battery cover before charging.

⑨ **Repair of Defective Battery**

a. Remove the connector between the cells to remove the cell from the circuit or the battery.
b. Open the one-touch cap for gas purification on all cells before the repair. Afterwards, the connector cover and one-touch cap shall be removed from the defective cell and from the surrounding cell. All vents removed with the one-touch cap shall be covered with four layers of wet cloth to continue the repair. Use acidic syringe to take out sufficient amount of electrolyte from the defective cell, and the solution level on the one-touch cap shall be in the minimum level.
c. The safest and most efficient method of removing the connector is to remove manually by hand from the defective cell or surrounding cells, or by using a electric drill (Ø25 mm).

⚠ Please keep in mind that explosive hydrogen gas must be removed before the repair. Unit shall not be damaged by drilling a hole the cell excessively. During drilling operation, make sure lead curls produced do not contact the opposite cell poles and cause a spark.

d. Removal is possible by drilling a hole on the connector of both cells.
e. Remove the connector of both cells, and take out the damaged cell from the circuit.
f. Mount the new cell and connector.
g. After cleaning, place the connector on the neutralized surface.
h. Place a wet cloth on each lead head. Fix the end of welding machine on the center of the post to turn the upper part of the pst completely with the welding machine, and move to the position where the post meets the connector. Return the welding machine to the center of the post, and fill the melted lead on the upper part of the connector. Put the upper part on the melted lead to turn again with the welding machine completely. Welding shall be more convenient if there is a jig.
i. Use a sulfuric acid in the same specific gravity as the batter balance when replacing the electrolyte in the repaired cell.
j. Finally, install the connector cover and one-touch cap on the cell.

⑩ **Daily Inspection Details**

a. Avoid overcharing. Charge the battery immediately after discharge. Charge the battery immediately. Standard cycle for equalized charging shall be one or more times a month.
b. Electrolyte level is checked once a week. When the electrolyte level is reduced, replenish with distilled water up to the defined level.
c. The surface on the upper part of the battery cell shall be clean and dry.
d. Be sure to open the cover on the battery housing tray while charging.
e. Fire such as lighted cigarette or burning match shall not be near the charging location while charging.

(3) Others

① **Storage of batteries**

Store the battery far away from the indoor heater or other heating instrument. It is appropriate to store the battery in the clean, cool and dry location without direct sunlight. It is important to charge the battery before the storage, and to maintain the electrolyte level to the set value. When the temperature of the storage location is 20˚C or more, specific gravity shall be checked once a month, and when the temperature is 20˚C or less, inspection shall be made once every two months. When the measurement value is lower than 1.230 (20˚C), battery must be charged in the method described in "Normal Charging".

② **Maintenance Records**

It is recommended to record the maintenance to identify the operating condition of the battery. Daily charging and discharging, required equal charging amount and required condition for supplementing the distilled water, etc. can be identified clearly at once. Measurement of the specific gravity and temperature once every 2-4 months after the equalized charging and maintenance will help diagnose the healthiness of the battery.

③ **Electrolyte Temperature**

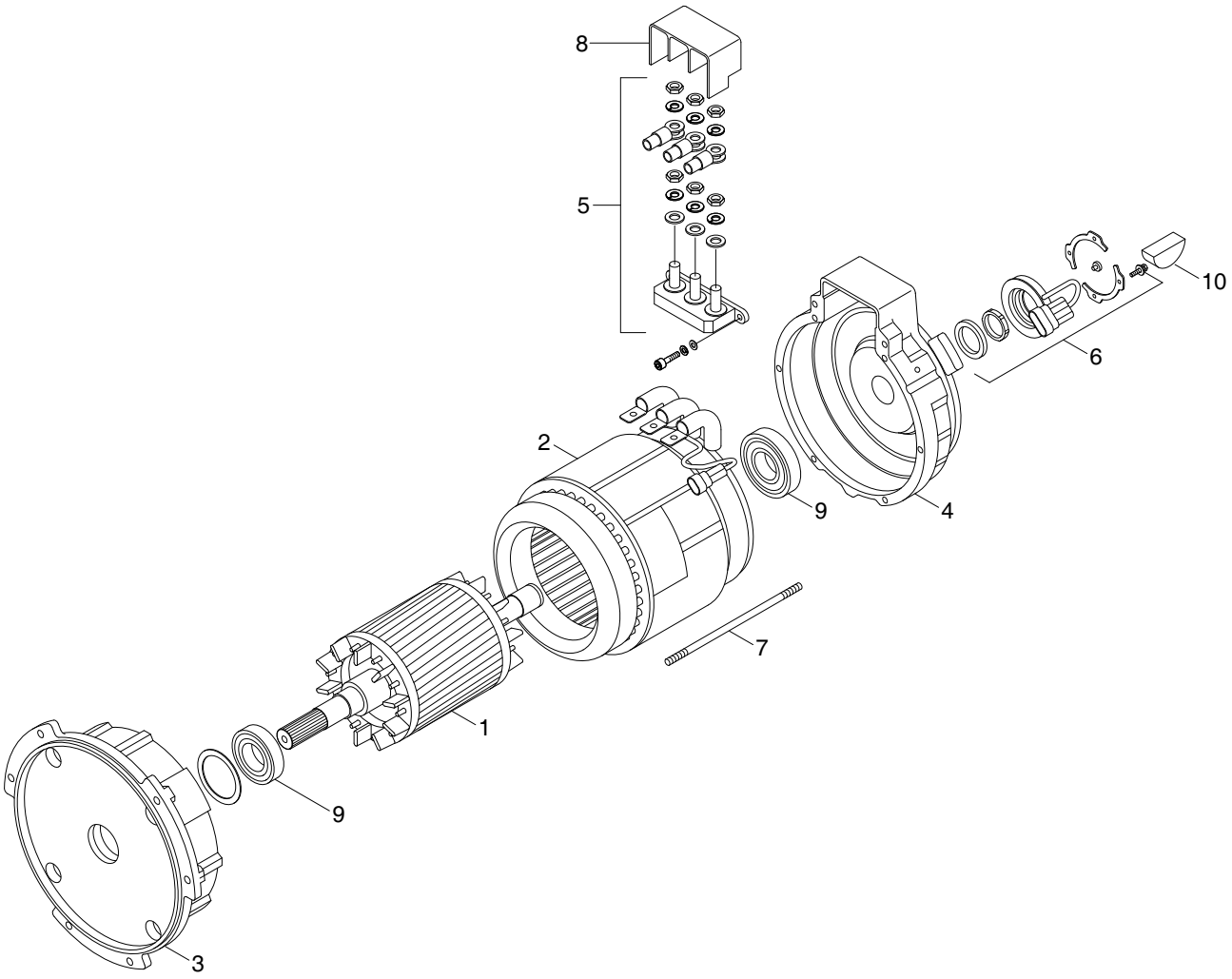
The operating temperature range of batteries is -10~45˚C (temperature of electrolyte). If the battery is exposed to the cold in the discharge state, the electrolyte will freeze, and the capacity may be reduced on excessive cold. However, life shortening will not occur from the reverse effect when the electrolyte is not frozen. On the other hand, the battery life will be reduced considerably when the temperature is especially higher than 55˚C. Caution is required on maintaining the temperature of 55˚C or less when charging the battery. Even in inevitable circumstances, the temperature must not exceed 55˚C or more.

7) TROUBLESHOOTING

Nature of trouble	Symptoms	Causes	Remedy
Deformation	· Deformation of container Cover, one-touch cap	· Excessive temperature rising or external impact	· Replace
Breakage	· Electrolyte leakage from the damage of the container, cover and one-touch cap · Termination of the connector or pole post, etc.	· External impact, improper operation, excessive vibration · Excessive temperature rising or vibration/external impact	· Replace or install new part · Replace
Sulfate	· Specific gravity drops and capacity is decreased · Rapid increase in charging voltage along with poor gassing in the previous stage, and specific gravity cannot be increased and charging not possible	· Discharged state neglected or left for long period without equalizing charging · Insufficient charging · Abnormal plate from excessive decrease in electrolyte · Increase in electrolyte concentration · Impurities mixed with the electrolyte	· Need equalizing charge · Need equalizing charge · Need equalizing charge · Adjust specific gravity. · Replace electrolyte
Decrease and falling of specific gravity	· Can be detected easily through the measurement value of specific gravity	· Rise of temperature due to such trouble · Neglected for long period without supplementing water · Short circuit	· Replace · Periodic water supplementation · Replace
Rise of specific gravity	· Can be detected easily through the measurement value of specific gravity	· Diluted sulfuric acid was supplemented. · Electrolyte level is excessively low.	· Adjust specific gravity after complete charging · Refill distilled water.
Mixing of impurities	· Decrease of capacity. · Drop in charging and discharging voltage. · Odor from the gas produced and discoloration of the electrolyte.	· Metals such as iron, copper nickel and manganese. · Impurities such as sea water, chloric acid and nitric acid, etc. · Dirty water filled.	· Supplement electrolyte on complete discharge condition. Fill in the specific gravity 0.03~0.05 higher than the acid discharged. Adjust specific gravity after complete charging and in the set value

3. DRIVING MOTOR

1) STRUCTURE



15BRXEL10

1	Rotor	5	Terminal block	9	Bearing
2	Stator	6	Speed sensor kit	10	Woodruff key
3	End bell	7	Stud bolt		
4	End bell	8	Terminal protector		

2) SPECIFICATION

Item	Unit	15/18BR-X	20/25BR-X
Type	-	AMDU6005	AMDG9001B
Rated voltage	Vac	30	30
Rated output	kW	4.5	6.0
Insulation	-	Grade F	Grade F
Speed	rpm	2290	2640
Frequency	Hz	78	90
P.F	-	0.848	0.900
Duty	min	S2-60	S2-60
Voltage	V	30	30
Current	A	123	150

3) CHECKING

(1) Rotor

Always clean the rotor with compressed air.

Apply gasoline on a cotton or a piece of soft cloth to wipe off when the dust is not removed.

Outer Diameter of the Rotor : Ø123.1± 0.05

Tools : Vernier calipers and standard tools

18BR9EL41

(2) Stator

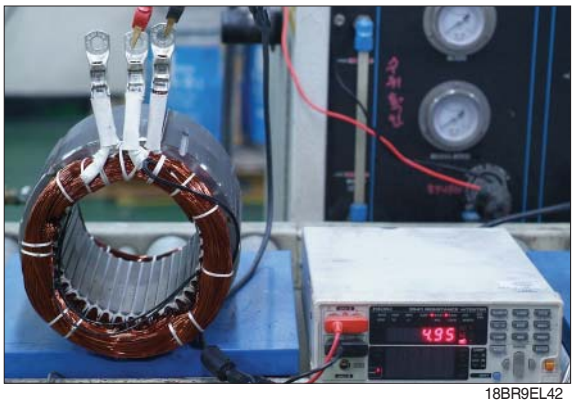
Always clean the stator with compressed air.

Take caution on not damaging the coil insulator to apply gasoline on a cotton or a piece of soft cloth to wipe off when the dust is not removed.

mmΩ tester is used to inspect two power lines (U-V, V-W, W-U) of the stator repeatedly.

Optimal Resistance

- 15/18BR-X : Approx. 6.3 mmΩ
- 20/25BR-X : Approx. 6.6 mmΩ

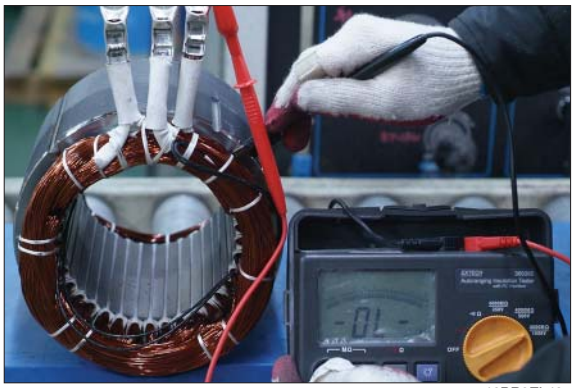


18BR9EL42

Insulation Test

Insulation Tester (1000 Vac, Min. 10 MΩ) is used to measure as shown in the figure.

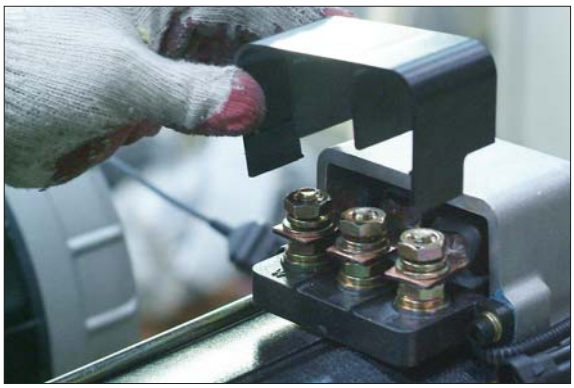
Replace with new part when the insulator is defective.



18BR9EL43

4) AC Motor Disassembly

(1) Remove the terminal protector from the motor before disassembling the motor to separate the thermistor and the speed sensor from the hanger.



18BR9EL44

18BR9EL45

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

18BR9EL46

(3) Remove 4 screws fixing the speed sensor on the end bell to disassemble the speed sensor, stop nut and tooth wheel on the motor.

18BR9EL47

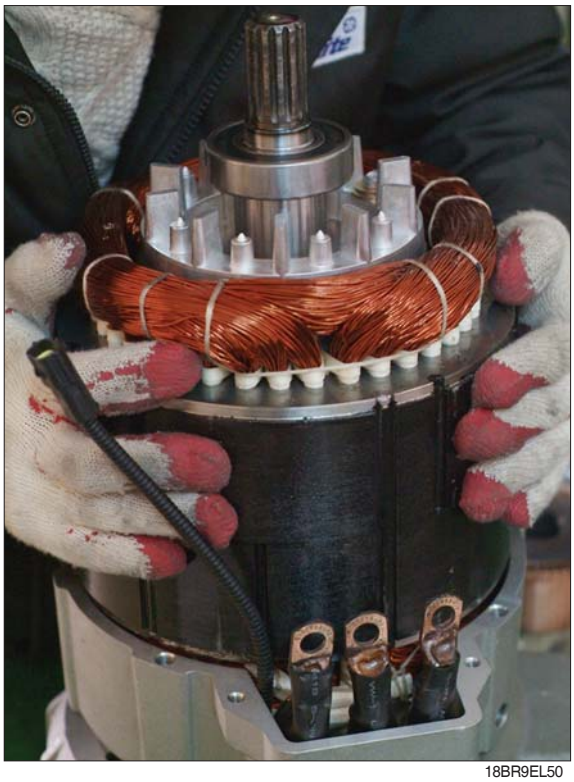
(4) Remove 4 flange nuts from the end bell driving side with a general tool possible for use.

18BR9EL48

(5) Remove the end bell and wave washer.

18BR9EL49

(6) Remove the stator manually be hand or by using an appropriate tool.

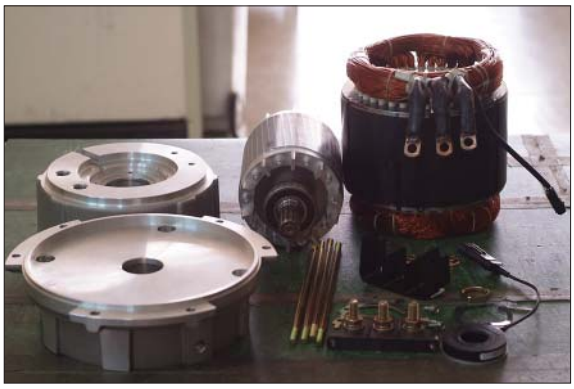


18BR9EL50

(7) As shown in the figure on the right, use a hand puller to remove the end bell from the rotor.

18BR9EL51

(8) Main Components of the Disassembled Motor



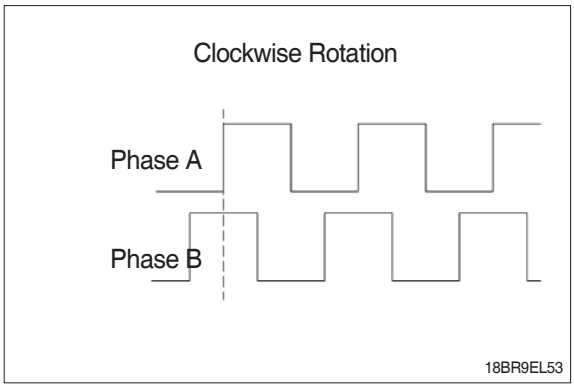
18BR9EL52

5) ASSEMBLY AND INSTALLATION

Perform assembly in the reverse order of disassembly.

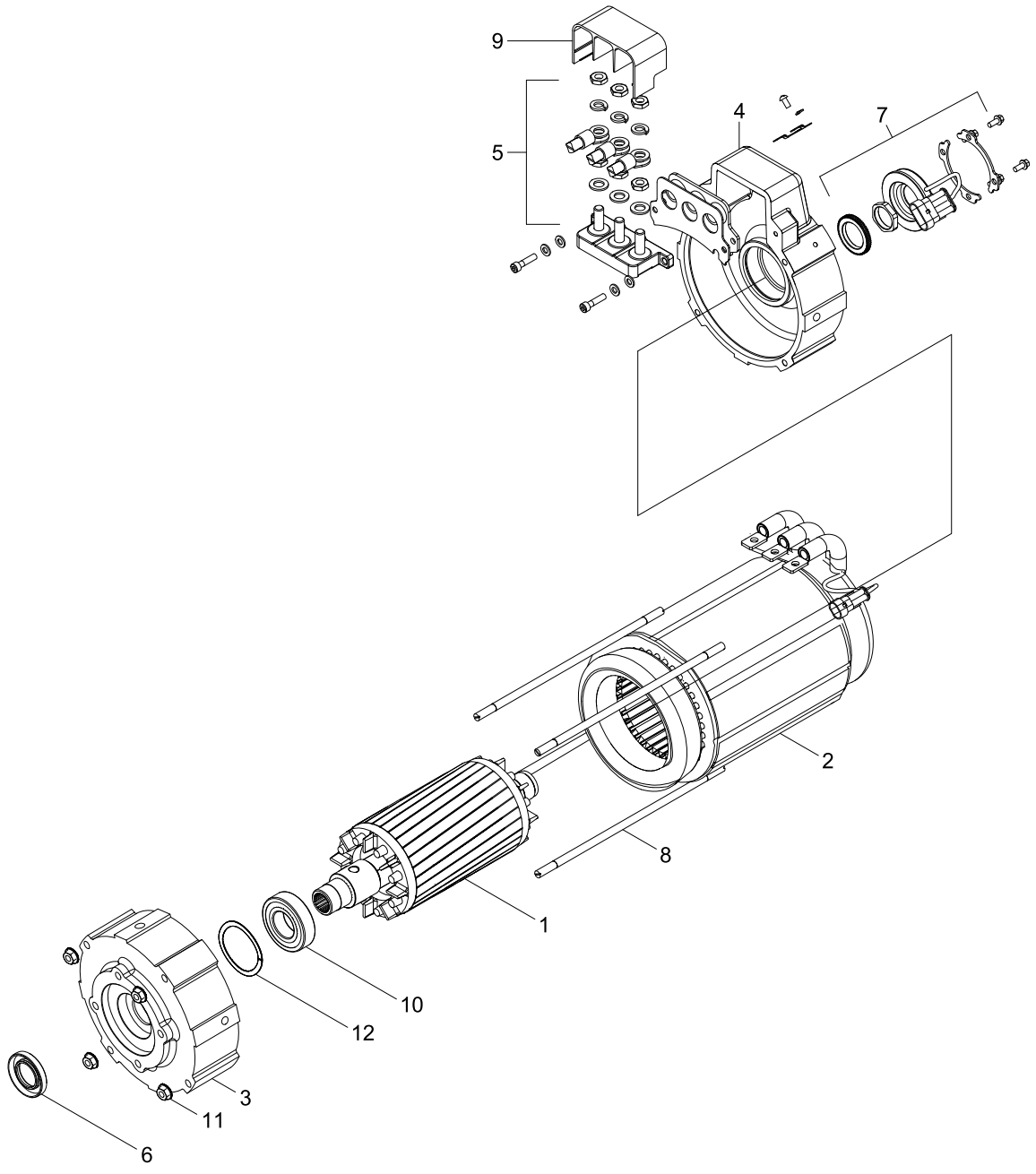
Inspect the speed sensor after assembly.

The normal signal is as shown in ght figure on the right.



4. PUMP MOTOR

1) STRUCTURE



15BRXEL11

1	Rotor	5	Terminal block	9	Terminal protector
2	Stator	6	Oil seal	10	Bearing
3	End bell	7	Speed sensor kit	11	Flange nut
4	End bell	8	Stud bolt	12	Washer

2) SPECIFICATION

Item	Unit	15/18BR-X	20/25BR-X
Type	-	ABDK4001	ABDD4002
Rated voltage	Vac	30	30
Rated output	kW	9.0	14.0
Insulation	-	Grade F	Grade F
Speed	rpm	2190	2170
Frequency	Hz	75	75
P.F.	-	0.827	-
Duty	%	S3-15	S3-15
Voltage	V	30	30
Current	A	237	365

3) ROTOR INSPECTION

(1) Always clean the rotor with compressed air. Apply gasoline on a cotton or a piece of soft cloth to wipe off when the dust is not removed.
Outer Diameter of the Rotor : Ø104.1± 0.05
Tools: Vernier calipers and standard tools

18BR9EL54

(2) Stator

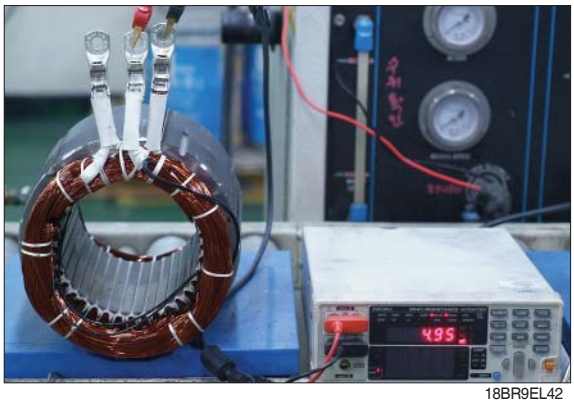
Always clean the stator with compressed air.

Take caution on not damaging the coil insulator to apply gasoline on a cotton or a piece of soft cloth to wipe off when the dust is not removed.

mmΩ tester is used to inspect two power lines (U-V, V-W, W-U) of the stator repeatedly.

Optimal Resistance

- 15/18BR-X : Approx 5.4 mmΩ
- 20/25BR-X : Approx. 3.4 mmΩ

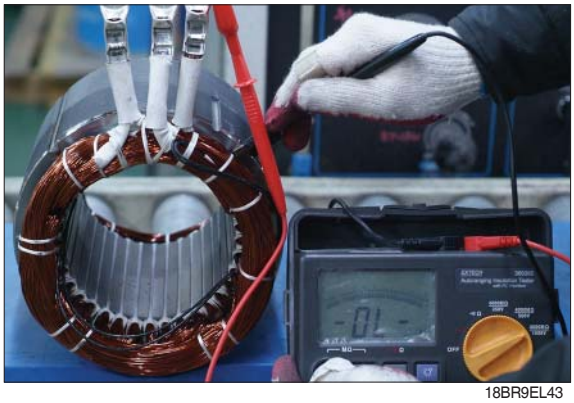


18BR9EL42

Insulation Test

Insulation Tester (1000 Vac, Min. 10 MΩ) is used to measure as shown in the figure.

Replace with new part when the insulator is defective.

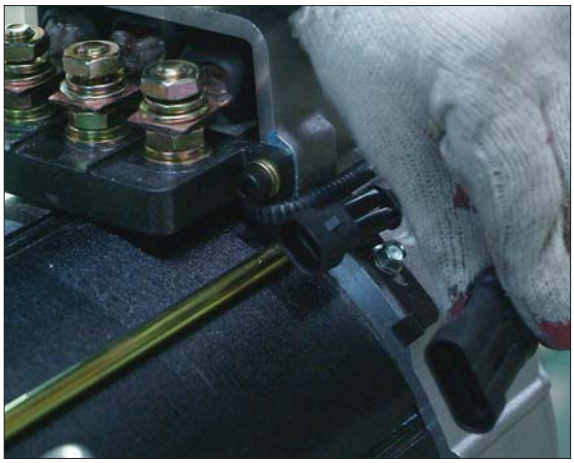


18BR9EL43

4) AC MOTOR DISASSEMBLY

(1) Remove the terminal protector from the motor before disassembling the motor to separate the thermistor and the speed sensor from the hanger.

18BR9EL44

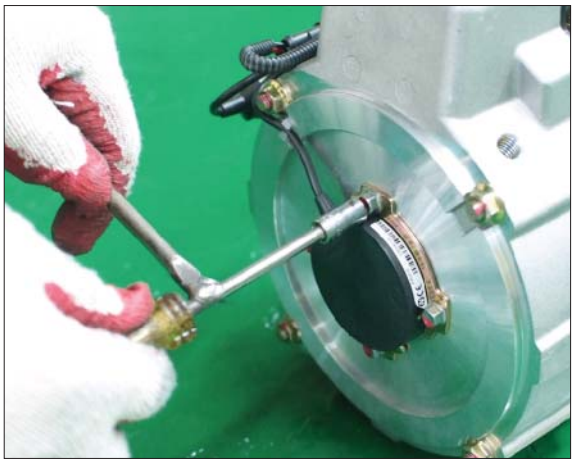


18BR9EL45

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

18BR9EL46

(3) Remove 4 screws fixing the speed sensor on the end bell to disassemble the speed sensor, stop nut and tooth wheel on the motor.

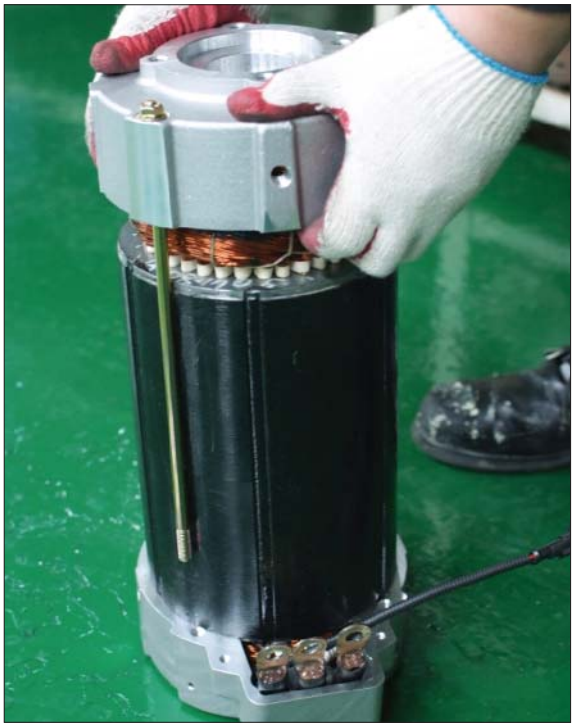


18BR9EL55

(4) Remove 4 flange nuts from the end bell driving side with a general tool possible for use.

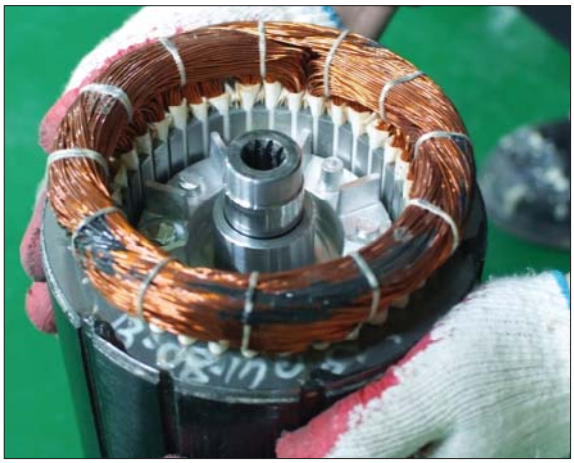
18BR9EL56

(5) Remove the end bell and wave washer.



18BR9EL57

(6) Remove the stator manually be hand or by using an appropriate tool.



18BR9EL58

(7) As shown in the figure on the right, use a hand puller to remove the end bell from the rotor.

18BR9EL51

(8) Main Components of the Disassembled Motor

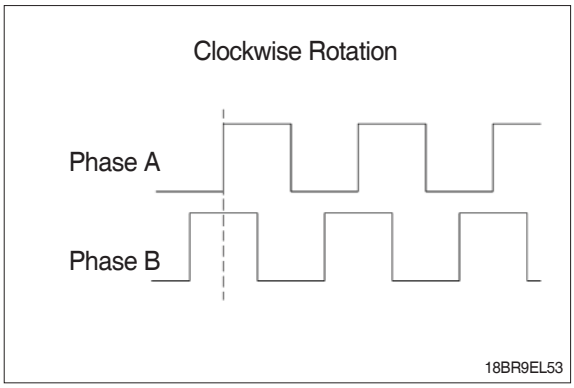
18BR9EL59

5) ASSEMBLY AND INSTALLATION

Perform assembly in the reverse order of disassembly.

Inspect the speed sensor after assembly.

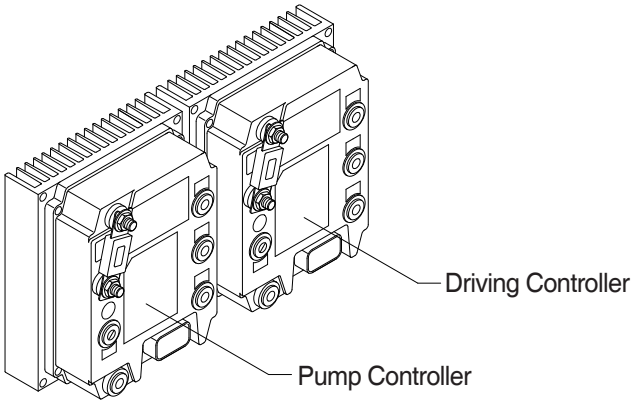
The normal signal is as shown in ght figure on the right.



18BR9EL53

5. CONTROLLER SYSTEM

1) STRUCTURE



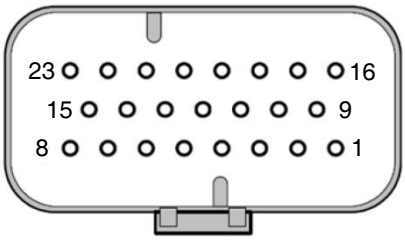
15BRXEL12

2) SPECIFICATION

Model	Inverter	Application	Power	Current limit
15/18BR-X	ACE2	Travel	36/48V, 350A	350A/2min
	ACE2	Pump	36/48V, 350A	350A/2min
20/25BR-X	ACE2	Travel	36/48V, 450A	450A/2min
	ACE2	Pump	36/48V, 450A	450A/2min

3) DESCRIPTION OF THE CONNECTORS

23-pin AMP seal connector as shownin the fiture is used on the ACE2. Each of the 23EA pins is indicated as "A#". Here, "A" is the connector name, and "#" is the pin number of 1~23.



15BRXEL13

(1) Driving Controller

Pin No.	Functions	Description
A1	KEY	Input the key switch signal.
A2	PPOT	Anode power supply on the potentiometer (Max. +5 V, 200 mA).
A3	ACC POT	Input accelerator signal
A4	FW	Digital input activated on connection to +B. It is the forward movement input request, and lift truck moves forward when receiving the input.
A5	BW	Digital input activated on connection to +B. It is the reverse movement input request, and lift truck moves backward when receiving the input.
A6	SEAT	Digital input activated on connection to +B. Request sheet input.
A7	CHA	Input motor encoder A channel.
A8	PENC	Anode power supply on other auxiliary system such as the encoder speed converter, potentiometer and sensor, etc. (Max. +12 V, 200 mA).
A9	NPOT	Cathode power supply on the potentiometer. Performed with internal short circuit and equivalent to A15.
A10	CPOT	Input steering sensor input
A11	FORK 300MM S/W	Digital input activated on connection to +B(Not used). Input detection switch on fork lifting height of 300mm.
A12	CANT	120 ohm of terminating resistance is introduced bewteen the CAN-L and CAN-H when connected with A21/
A13	PB	Digital input that is inactivated when connected to -B, and activated on disconnection of external switch. Pedal brake input request.
A14	CHB	Input motor encoder B channel.
A15	NENC	Cathode power supply on the encoder motor temperature sensor. Performed with internal short circuit and equivalent to A9.
A16	NLC	Driving output of the line connector (Drive to -B); PMW voltage control; Max. rated current 1 A.
A17	PEB	This pin is connected to the anode terminal of the induced load operating by the pin NEB A18 and NEVP A19. Anode power supply on the induced load immediately on line contact.
A18	NEB	Driving output of the backup buzzer (Drive to -B); PMW control; Max. rated current 2.5 A.
A19	NEVP	Driving output of the proportional control electronic valve (Drive to -B) (Not used); PWM Current control; Max. rated current 1.7 A. Basic function is performing the role as the descending valve.
A20	CAN L	CAN-bus Line Low
A21	CAN H	CAN-bus Line High
A22	NCAN	Connected to the CAN-bus line reference for CAN-bus interface cathode reference.
A23	PTHERM	Analog input on the temperature of drive motor. Internal pulling on the 2 mA power source. (Max. 5 V).

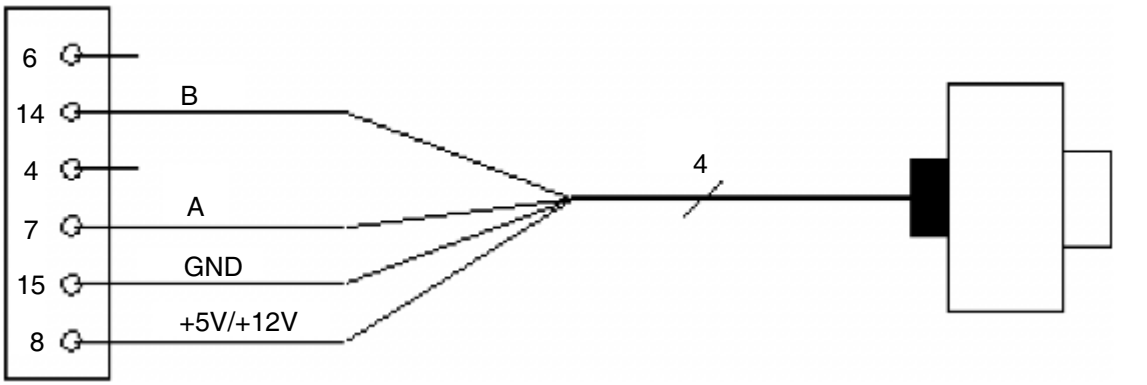
(2) Pump controller

Pin No.	Functions	Description
A1	KEY	Input the key switch signal.
A2	PPOT	Anode power supply on the potentiometer (Max. +5 V, 200 mA) (Not used).
A3	LIFT POT	Lift sensor signal input.
A4	LIFT	Digital input activated on connection to +B. Lift input request.
A5	TILT	Digital input activated on connection to +B. Tilting input request.
A6	REACH	Digital input activated on connection to +B. Reach input request.
A7	CHA	Input motor encoder A channel.
A8	PENC	Anode power supply on other auxiliary system such as the encoder or speed converter, potentiometer and sensor, etc. (Max. +12 V, 200 mA).
A9	NPOT	Cathode power supply on the potentiometer (Not used). Performed with internal short circuit and equivalent to A15.
A10	SBR	SBR (Side battery removed) input request
A11	LIMIT S/W	Digital input activated on connection to +B. Input speed limit switch.
A12	CANT	120 ohm of terminating resistance is introduced bewteen the CAN-L and CAN-H when connected with A21
A13	AUX	Digital input that is inactivated when connected to -B, and activated on disconnection of external switch. Auxiliary input request
A14	CHB	Input motor encoder B channel
A15	NENC	Cathode power supply on the encoder and motor temperature sensor. Performed with internal short circuit and equivalent to A9.
A16	NLC	Driving output of the line connector (Drive to -B); PMW voltage control; Max. rated current 1 A (Not used).
A17	PEB	This pin is connected to the anode terminal of the induced load operating by the pin NEB A18 and NEVP A19. Anode power supply on the induced load immediately on line contact.
A18	NEB	Driving output of the fan relay (Drive to -B); PMW control; Max. rated current 2.5 A.
A19	NEVP	Driving output of the proportional control electronic valve (Drive to -B) (Not used); PWM Current control; Max. rated current 1.7 A. Basic function is performing the role as the descending valve.
A20	CAN L	CAN-bus Line Low
A21	CAN H	CAN-bus Line High
A22	NCAN	Connected to the CAN-bus line reference for CAN-bus interface cathode reference.
A23	PTHERM	Analog input on the temperature of drive motor. Internal pulling on the 2 mA power source. (Max. 5 V).

(3) Encoder connection (drive and pump)

ACE2 can process various types of encoders. To control the AC motor, install two-phase incremental encoder on 90 degrees phase difference. The power supply of the encoder can be 5V or 12V, and incremental encoder generated with zero-position signal can be installed according to the purpose of use.

A8	:	+5V/+12V	:	Anode power supply on the encoder.
A15	:	GND	:	Cathode power supply on the encoder.
A7	:	ENC A	:	Phase A of the encoder.
A14	:	ENC B	:	Phase B of the encoder.



25B9UEL13

4) PROGRAMING AND ADJUSTMENT

Variables can be adjusted with the Smart console or display button.

Refer to Display Section for adjustment of variables through the display button. (Page 7-58)

※ Adjustment by using the Smart console (Option)

Smart console can be used to adjust the variables and inverter configuration.

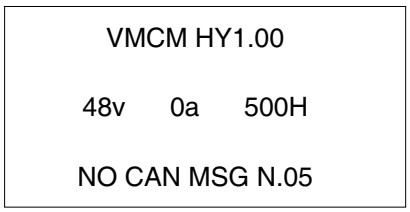
Connect to the main harness of the lift truck.
(HARNESS-EXT_SMART console is also required)

25B9UEL17

※ Turn OFF the key switch for connection and separation.

(1) Connected

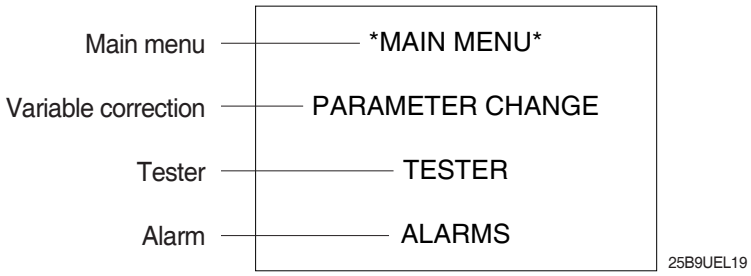
Once connection is made, the screen is displayed as shown below.



This mednu shows the basic information on the controller.

- The first line is the controller fimware information.
- The second line indicates the controller voltage, current and hour-meter.
- The last line is shown when indicating the current alarm code.

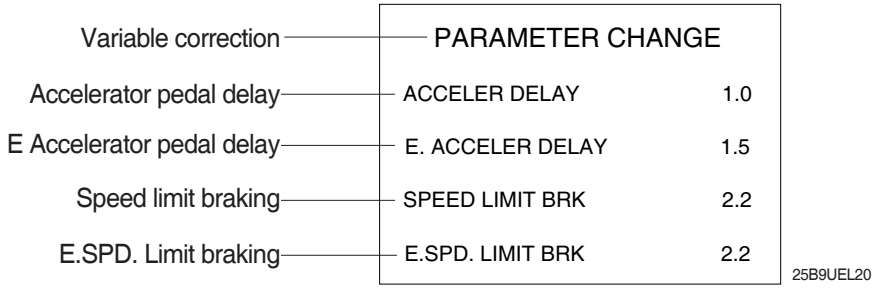
OK is pressed to open the MAIN MENU.



UP and DOWN key can be pressed to move from the list, and OK is pressed on the preferred menu for entry.

(2) How to adjust variables

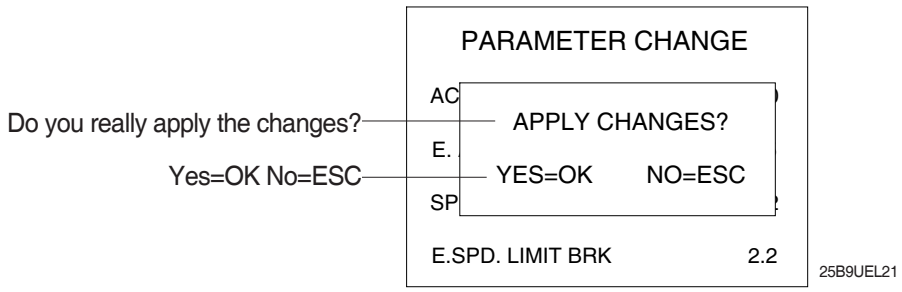
In the MAIN MENU, enter the preferred menu such as PARAMETER CHANGE



You can move inside the menu by using the UP and DOWN keys, and when the variable is highlighted, press the LEFT or RIGHT key to adjust the variable value.

Pressing the LEFT/RIGHT button is automatic repetition function to change the value continuously, and quick processing is possible when several variables must be changed.

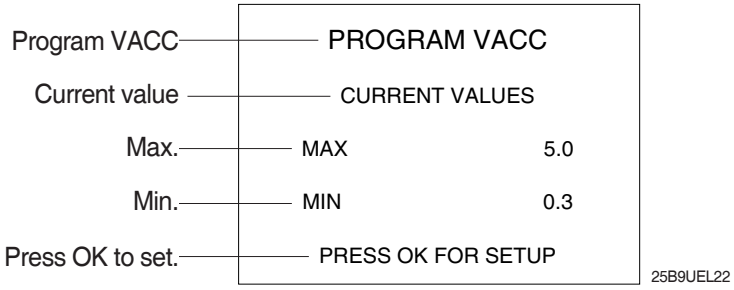
ESC key can be pressed anytime to exit from the menu. After changing the variables, request for saving or neglecting the changes on the console is indicated.



The above desription is value on all menus with the options and variables such as SET OPTIONS, ADJUSTMENT and HARDWARE SETTINGS, etc.

(3) Program Vacc

PROGRAM VACC menu was somewhat improved compared to the previous console. The value currently programmed on the console is displayed when entering this menu.

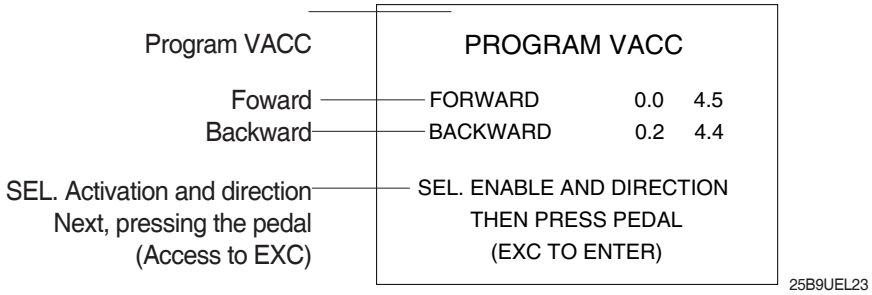


Press OK to start the PROGRAM VACC procedure. The following is possible in the console:

- Selection of Enable Switch
- Selection of Direction Switch, either forward or backword
- Maximum pressing of the pedal

The indicate value is changed according to the input by the user.

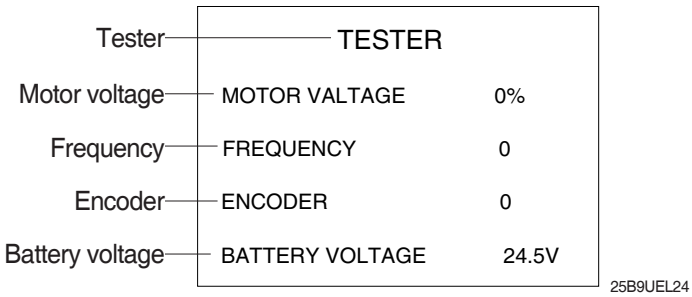
The above logic can be changed according to the fimware of the controller, but the logic is equal. Perform the necessary start procedure before programming the min./max. value, and press the pedal or the joystick.



When the ESC key is pressed, it is asked whether to save or ignore the value performed with programming on the console.

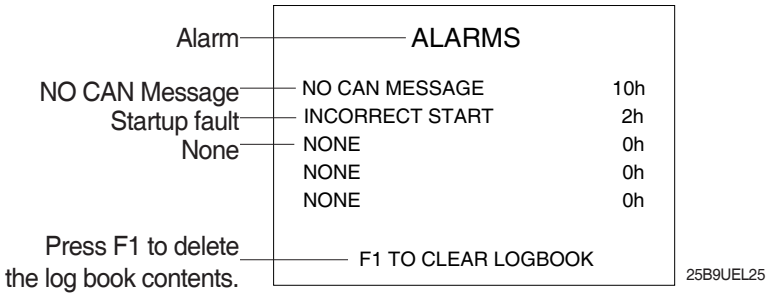
(4) Tester

4 variables are dispplayed at once, and UP/DOWN key can be used for movement.



(5) Alarm

All controller alarms are displayed.



The maximum number of alarms saved in the controller is 5EA.

Color is used to distinguish the repetitive alarm code and codes that are rarely used. The alarm name is set as follows to increase the frequency:

- White : Occurred maximum of 5 times
- Yellow : Occurred maximum of 20 times
- Orange : Occurred maximum of 40 times
- Red : Occurred over 40 times

Alarm is selected from the list by using the UP/DOWN key, and OK is pressed to display the additioanl information on the relevant alarm. F1 key can be pressed to delete the alrm log book of the controller. When F1 is pressed, te console checks this again.

5) GENERAL SAFETY

Caution must be taken on the following recommendations for appropriate installation.

⚠ The inside battery is kept charged for a certain period even when the key switch is kept open after starting operation. Separate the battery for safety drive, and use resistance of 10-100Ω to make short circuit between the power terminals of positive and negative electrodes of the inverter battery.

⚠ Do not connect the inverter on the battery with the nominal value different from the value indicated on the controller plate. High vattery value may result in MOS failure. Low battery value prevents power supply on the control unit.

⚠ Separate the controller from the battery while charging the battery.

⚠ DO not connect the controller to the battery with the nominal voltage different from the value indicated on the controller label. High battery voltage can cause failure to the power section. Low voltage can intrude with the logic operation.

⚠ Check whether the battery is separated before the operation, and when all installations are complete, lift the driving wheel from the ground to start the lift truck to prevent the threat to safety due to the installation error.

⚠ Caution is required on whether all guidance systems of the lift truck (horn sound, solenoid valve, coil and contactor) have appropriate instantaneous overvoltage suppression system.

6) EPS FAILURE DIAGNOSIS

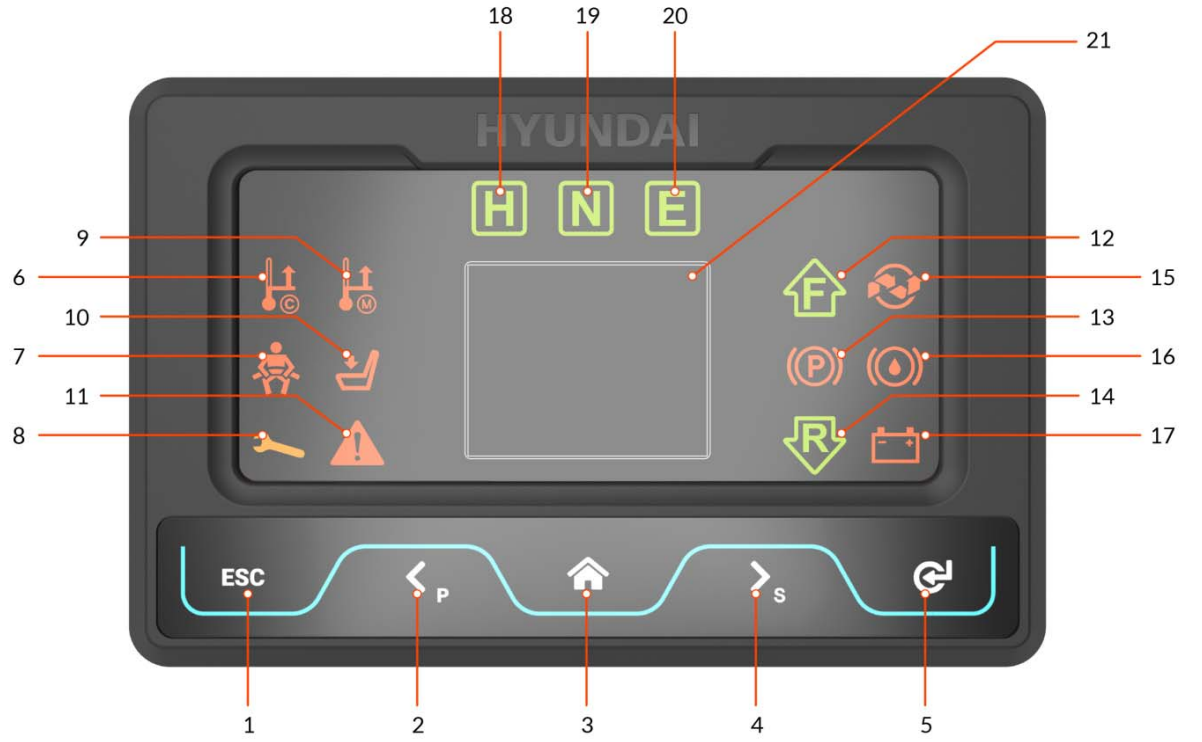
Nature of trouble	Cause	Remedy
Not operated	※ Not operating even when the key switch is turned.	
	· Check the power input.	→ Power is not turned ON.
	· Is 20~60V voltage verified on the Controller No. 2 (-) and No. 10 (+) terminal?	. Not an EPS issue, power charging state or the main connector is not operating, other system error
	↓ Not an issue of the power.	→ Operated intermittently depending on the contact.
	· Unstable connection of the connector on the torque sensor	· Repair or replace the connector pin.
	· Check the contact.	
	· Are there issues on the operation even when the connector part is moved or detached? (Repeate ON/OFF of the key switch to check for re-start)	
	↓ Irrelevant.	
	· Check whether the output of the torque sensor is normal. Check whether the voltage between controller No. 5 and No. 3 is within 3~9V.	→ Other value. · Defective motor, check the wiring on the motor. · Wiring issue related to the torque sensor
	· Within the measurement value.	· Defective torque sensor → Replace
	↓ Check for operation of the connector.	→ Voltage is near 0V.
	· Is the voltage between Control No. 1 and No.	· Defective contactor → Replace
	· 1 similar to the power voltage? (Key switch ON)	· Check incomplete connection of the contactor terminal
	↓ Similar to the power voltage.	· Check wiring related to the filter terminal.
	· Check for connection of the connector terminal.	
	· Is ther power voltage between the Controller No. 15 (-) and No. 16? (Key switch ON)	
	↓ Similar to the power voltage.	
	· Check the motor damage and wiring.	→ Changed to black and with grooves.
	· Remove the maintenance cover of the motor to check the commutator. (Key switch ON)	
	↓ Clean	
	· Defective controller → Replace.	
Heavy handle	※ Heavy handles while driving. (Heavy handles different from EPS OFF)	
	↓ Is it lighter when the handle is turned ot the opposite direction?	→ Yes.
	Still heavy.	· Normal mode of the controller reducing the current automatically to decrease the current when the handle is turned to one side and operated for long period
	· Is the handle lighter when the power key switch is turned OFF and ON?	→ Becomes light · Abnormal power voltage to return to normal.
	↓ Still heavy.	
	· Is it similar to the power voltage when measuring the voltage between controller No. 5 terminal (-) and No. 13 terminal (+)?	→ Near 0V. Defective parts inside the controller to require replacement or repair
	↓ Similar to the power.	→ Yes.
	· Does the torque sensor voltage on the controller No. 5 terminal (-) and No. 3 terminal change to 3~9V when the handle is turned to the left and right side except for the motor connector?	· Check motor damage.
	↓ Voltage is shown, but low to be about 4~8V. Defective torque sensor to require replacement	
	※ It is occurred intermittently while driving after normal restoration?	→ Yes. Abnormal power voltage to return to normal Check incomplete contact of the harness on the torque sensor Check motor damage
	※ Is the handle heavy in one direction and light other direction?	→ Yes. Replace the torque sensor when the phenomenon occurs in low speed on the handle, and replace the controller when the same symptom is shown also in high pseed (FET damage)

Nature of Trouble	Cause	Remedy
Handle locked	※ Handle is suddenly locked while driving. (EPS stopped) Does it operate normally when the power is turned OFF and ON? ↓ Yes, occurred again during use. · Check motor damage. · Remove the cover for visual check on the commutator ↓ Clean. · Unstable connecttion on the connector of the torque sensor. · Check the contact. Are there issues on the operation even when the connector part is moved or detached? (Repeate ON/OFF of the key switch to check for re-start)_ ↓ Same result. Check hether the torque sensor output is normal. Check whether the voltage between controller No. 5 and No. 3 is within 3~9V.	→ Not operated · Refer to the trouble table on 'Not operated'. → Changed to black and damaged. · Replace the motor → Operated intermittently depending on the contact. · Replace or repair the connector pin.
Handle locked instantaneously	※ Handle is suddenly stopped while driving. Operated again when the handle is turned by force. ↓ Yes, occurred again during use. Check motor damage. Remove the incpection cover for visual check on the commutator → Changed to black and damaged.	→ Not opeated. · Refer to the trouble table on 'Not operated' → Replace motor.
Handle shaking	※ There is noticeable shaking of the handle while driving. ↓ Is there only certain part shaking among the handle steering areas? Shaking continuously. Amplification ratio of the controller is too high. (Test is performed on th rotary switch inside the controller in one direction by reducing by each stage.)	→ Yes. · Is the ground condition of the vehicle parking location even? · Chain gear abrasion or chain tension is too high. · Is the spline axis of the torque sensor eccentric or bent due to external force?
Handle rotating	※ Handle is suddenly rotated to one direction automatically while driving.	· Defective manufacture of the torque sensor to require replacement · Limit life of the torque sensor to require replacement
Handle rotating slightly	※ Handle is rotated approximately 0~90 ˚C when the power is turned ON or OFF.	· Occurred when the ground parked with the vehicle is uneven · Used when the chain tension delivered from the handle is strong · Check the connection diagram (Torque sensor power must be connected independently from the controller.) (Check common connection with other lines)

6. CLUSTER

1) STRUCTURE

The cluster is installed with 15 red, green and yellow LEDs. The driver can identify the truck condition conveniently through this LED.



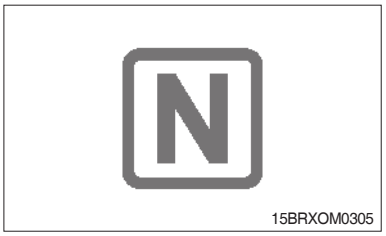
1	ESC button	8	Wrench warning lamp	15	Consumable exchange lamp
2	Left/power mode change button	9	Motor high-temperature warning lamp	16	Brake oil lamp
3	Home button			17	Battery level lamp
4	Right/speed mode button	10	Seat lamp	18	Hi mode lamp
5	Enter button	11	Warning lamp	19	Normal mode lamp
6	Controller high-temperature warning lamp	12	Forward driving lamp	20	ECO mode lamp
		13	Parking brake lamp	21	LCD function
7	Seat belt warning lamp	14	Reverse driving lamp		

2) WARNING LAMP

(1) Hi mode lamp

Lights up when Power Mode is HIGH.

(2) Normal mode lamp

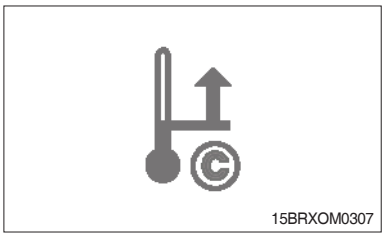


Lights up when Power Mode is NORMAL.

(3) ECO mode lamp

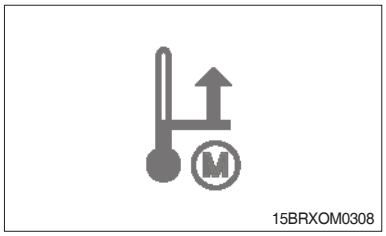
Lights up when the Power Mode is ECO.

(4) Controller high-temperature lamp



Lights up when the controller is in high temperature.

(5) Motor high-temperature lamp



Lights up when the motor is in high temperature.

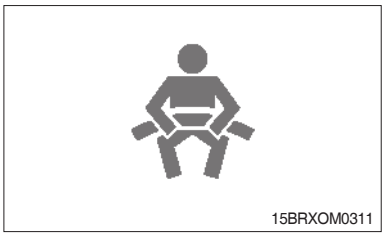
(6) 12 Forward driving lamp

Lights up when the truck is driving forward.

(7) Consumable exchange lamp

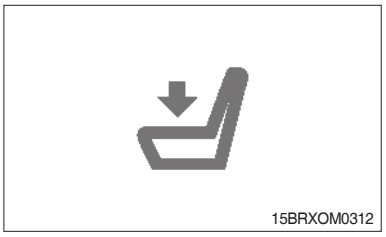
Lights up when the consumable must be replaced.

(8) Safety belt warning lamp



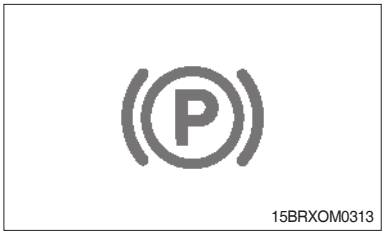
Lights up when the safety belt is not tightened.

(9) Seat lamp



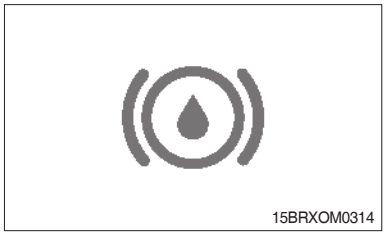
Lights up when the driver is not seated on the driver's seat.

(10) Parking brake lamp



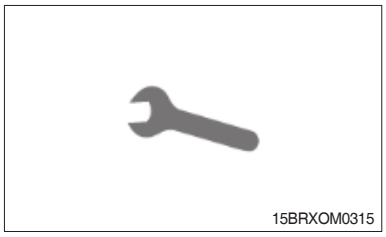
Lights up when parking brake is applied.

(11) Brake oil lamp



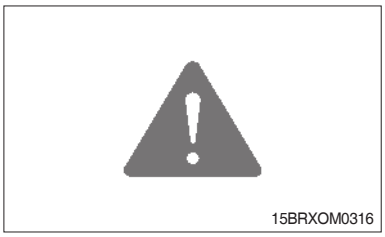
Lights up when brake oil level is low.

(12) Wrench lamp



Lights up when the truck is in abnormal state.

(13) Warning lamp

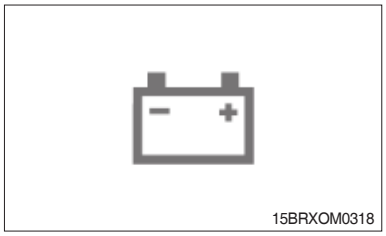


Lights up when the truck is in abnormal state.

(14) Reverse driving lamp

Lights up when the truck is driving in reverse.

(15) Battery level lamp

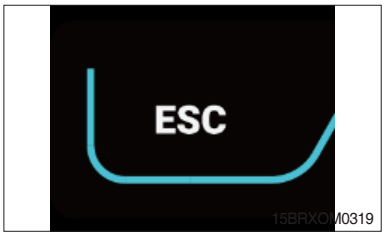


Lighted when the remaining battery amount is low.

3) BUTTON

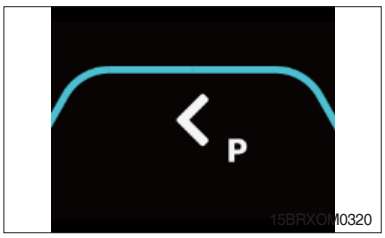
The buttons are used to change or select the cluster menu.

(1) ESC button



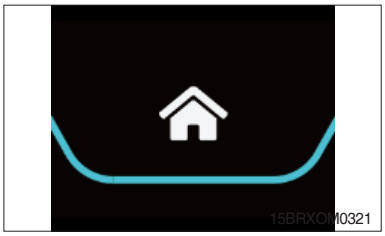
Pressed to cancel or to exit the menu.

(2) Left/power mode change button



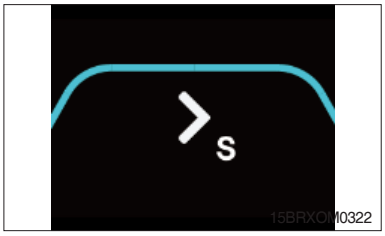
Pressed to move to the left or up.
Also used to change to the Power Mode. (H/N/E)

(3) Home button



Pressed to move to the menu from the Home screen.
Also used to move from the menu screen to Home.

(4) Right/speed mode change button

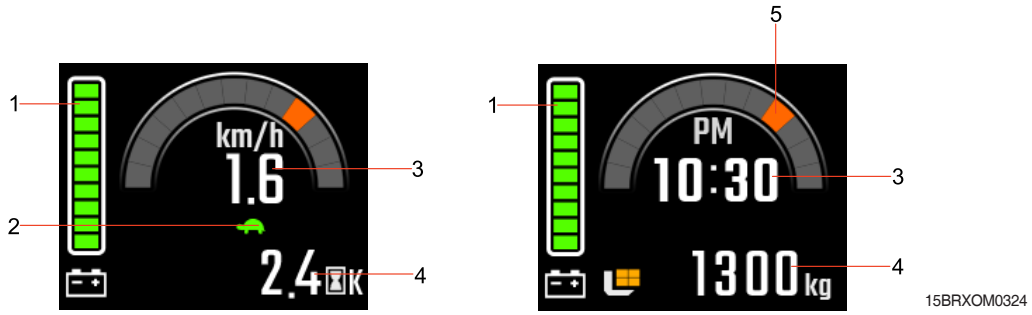


Press when moving to menus on the right or to the lower menu.
Also used to change to the speed mode.
(When changing to the Turtle Mode)

(5) Enter button

Pressed when entering the menu.

4) LCD function



1 BDI (Battery Discharge Indicator)
2 Speed mode (Turtle)
3 Truck speed / current time
4 Hour meter / weight indicator
5 Steering angle indicator

(1) BDI (Battery Discharge Indicator)

The battery charging state is indicated in 10 bars, and one bar shows 10% of battery charge. When the battery is discharged, the bar is turned OFF in order according to the charging ratio of the battery to indicate the remaining battery amount.

BDI %	Battery Bar	Color
91 - 100	10	Green
81 - 90	9	
71 - 80	8	
61 - 70	7	
51 - 60	6	
41 - 50	5	
31 - 40	4	Orange
21 - 30	3	
11 - 20	2	Red
1 - 10	1	

(2) Speed Mode

Turtle mode is normally in OFF state. When this symbol is shown, the Turtle mode is operated regardless of the Power mode on the lift truck to reduce the maximum speed to the set value. This mode is opearted by pressing the  button.

(3) Truck speed / current time

1. During operation - Truck speed is indicated in numbers. According to the cluster setting, the unit can be changed to km/h or mph.
2. Stopped - When the truck is stopped, the current time is indicated according to the cluster setting.

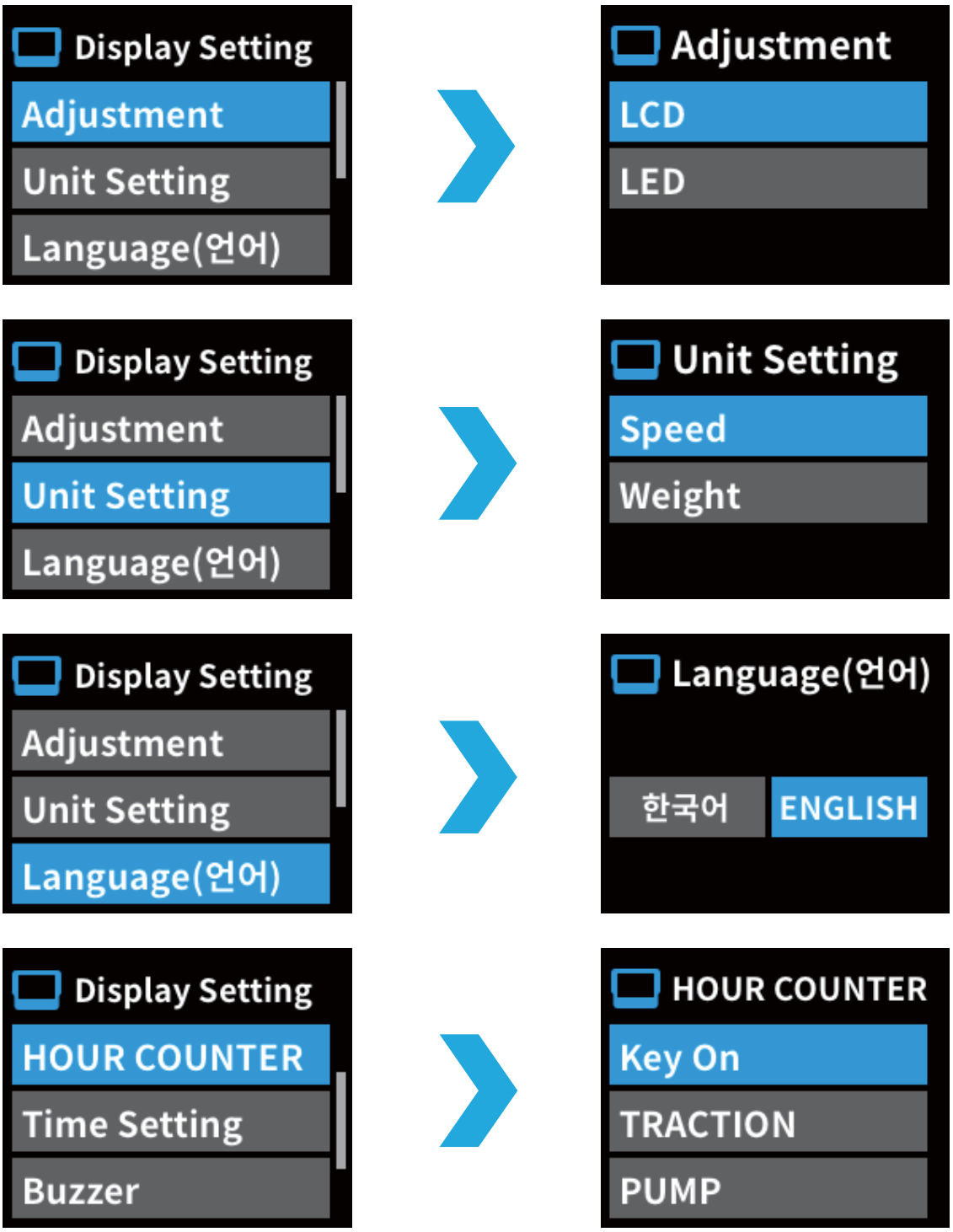
(4) Hour meter / weight indicator

1. Unloaded - Working time is indicated in numbers. The meaning of the alphabet next to the number is as shown below.
   K : Time from turning the key on the truck
   T : Driving time detected through the driving motor
   P : Pump use time detected through the pump motor
2. Loaded - The loaded weight is indicated

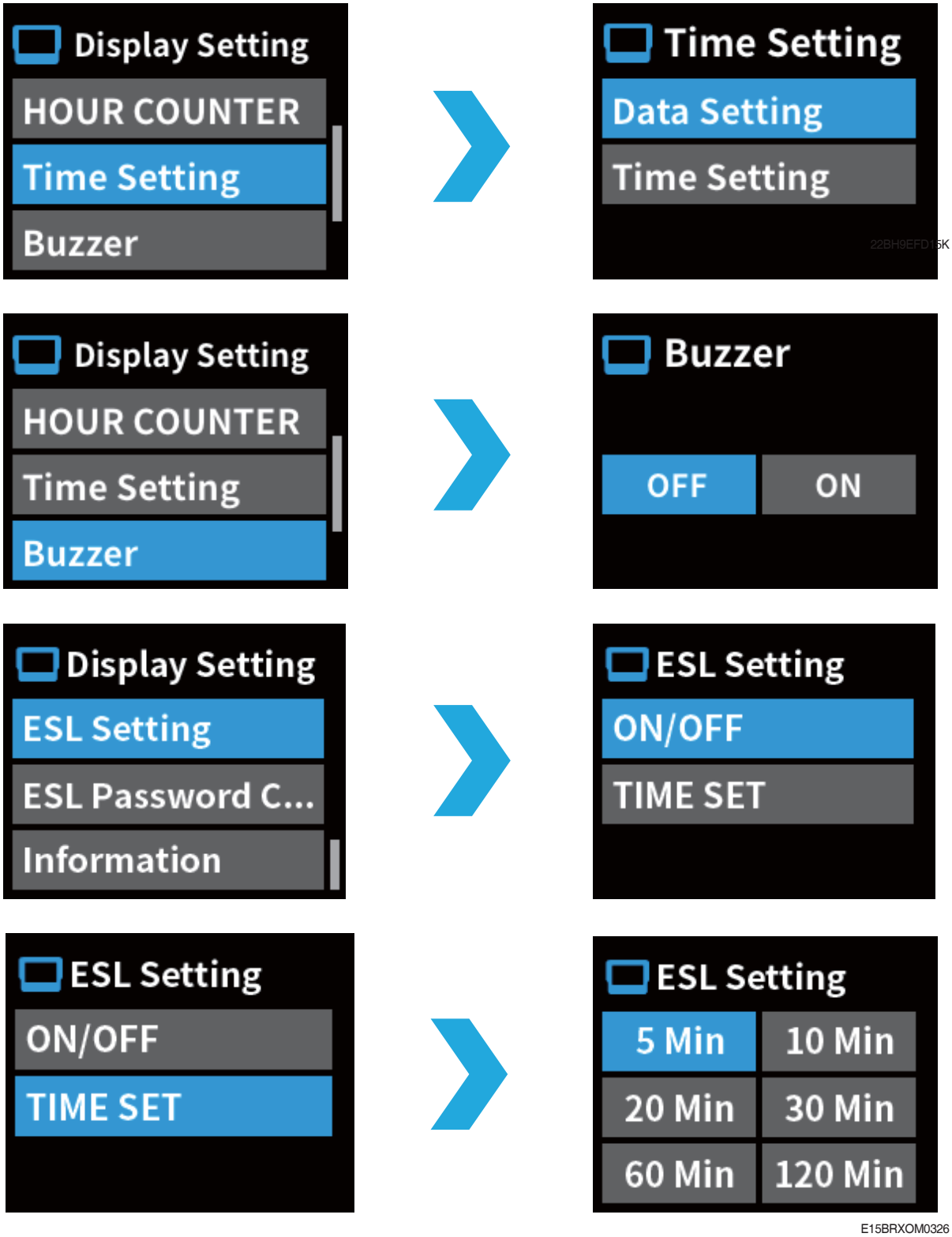
(5) Steering angle indicator

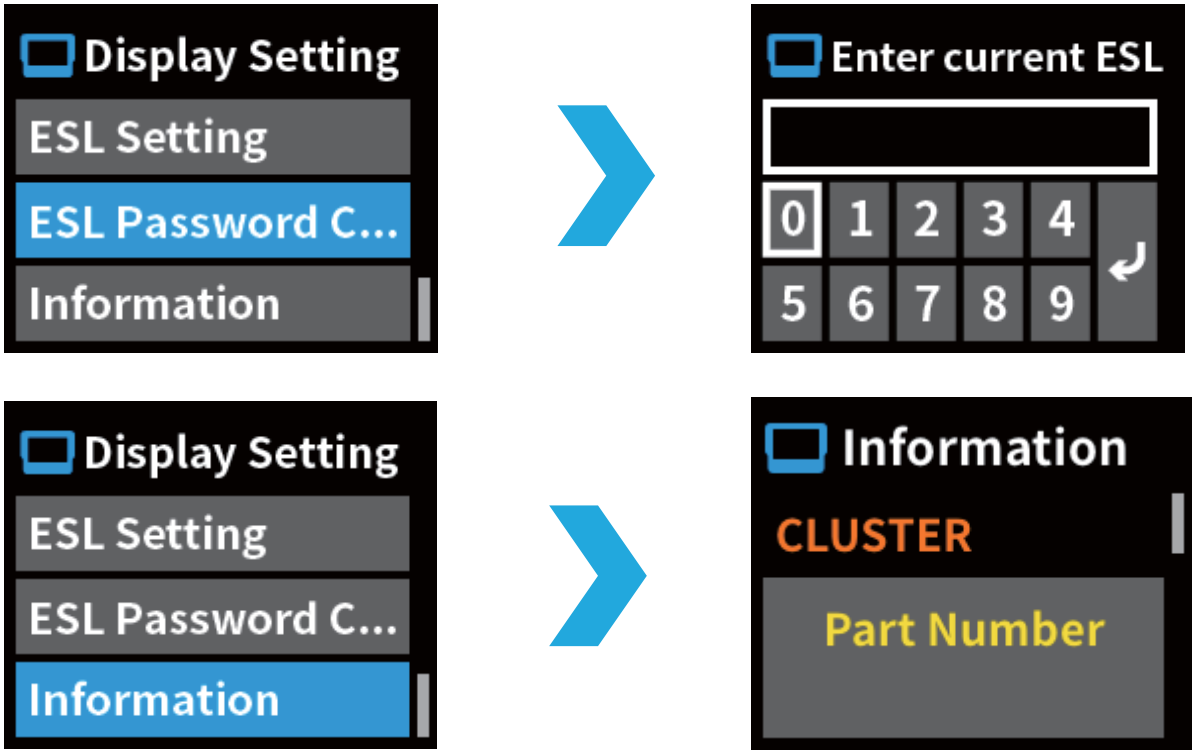
Steering angle of the truck is indicated.

5) CLUSTER MENU SETTING METHOD



E15BRXOM0325

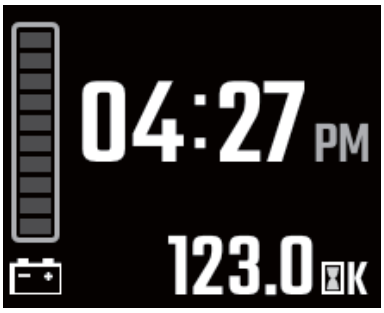
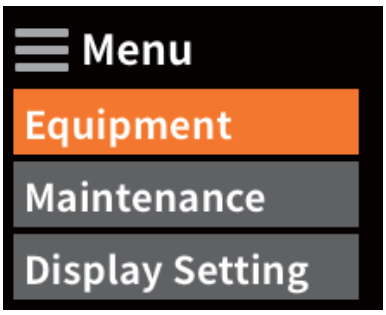

Display Setting
HOUR COUNTER
Time Setting
Buzzer
Time Setting
Data Setting
Time Setting
22BH9EFD15K
Display Setting
HOUR COUNTER
Time Setting
Buzzer
Buzzer
OFF
ON
Display Setting
ESL Setting
ESL Password C...
Information
ESL Setting
ON/OFF
TIME SET
ESL Setting
ON/OFF
TIME SET
ESL Setting
5 Min
10 Min
20 Min
30 Min
60 Min
120 Min
E15BRXOM0326



E15BRXOM0327

6) SERVICE MENU

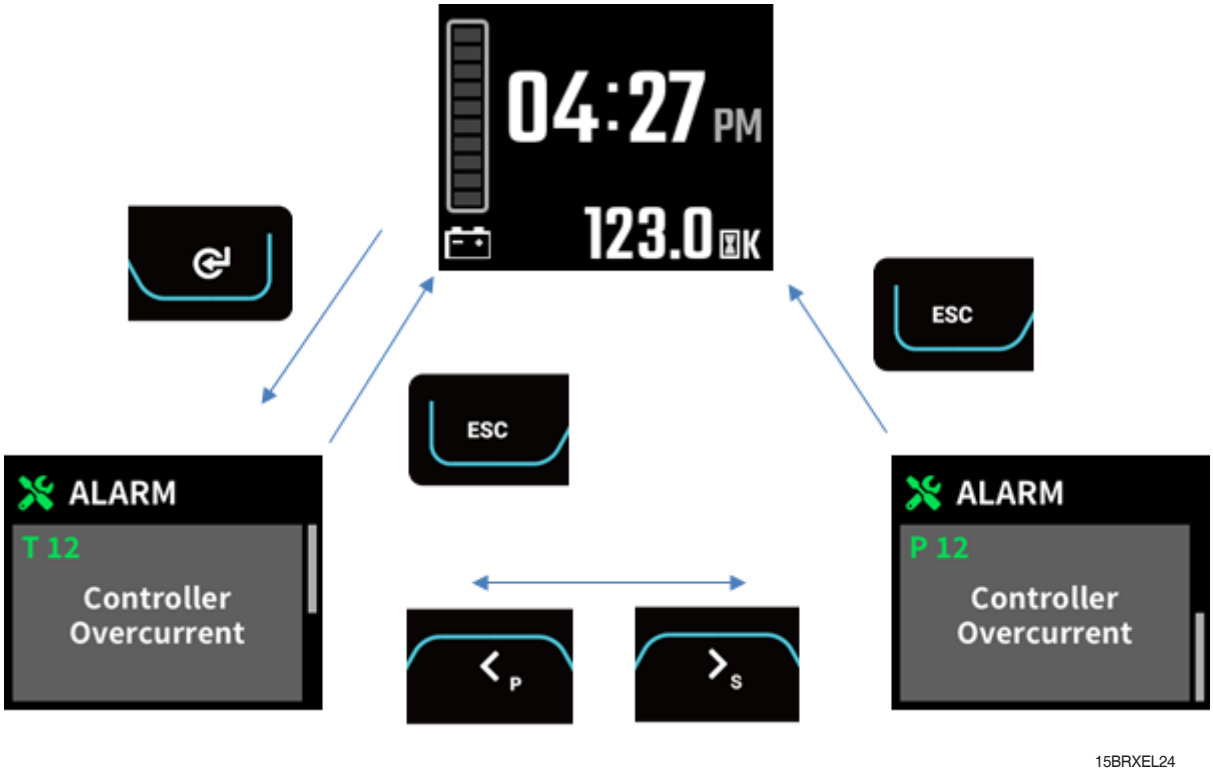
(1) How to enter the service menu

Step	Cluster	Description
1	 25BX7ES17	1. The left is shown when starting the lift truck. 2. On the first screen press ESC" button for one seconds or longer.
2	 25BX7ES18K	1. Password input screen is displayed as shown on the left. 2. Password is entered by using the Left/Right button and Enter button.
3	 25BX7ES17	1. Once password is entered, the first screen is displayed as shown on the left. 2. Press the home button.
4	 25BX7ES19K	1. Service Menus are displayed as shown on the left. 2. Press Left/Right button to select the desired menu, and press the Enter button to access the menu. 3. Press the ESC button to move to the previous menu.

4) ALARM AND ALARM HISTORY

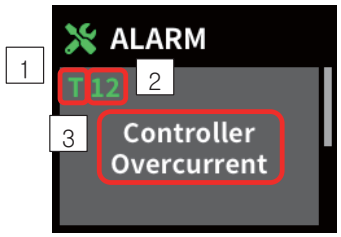
(1) How to check alarm

The alarm screen is displayed when occurred with alarm, and as shown below, the Enter and ESC button can be pressed to convert to the main screen and the alarm screen.



15BRXEL24

(2) How to check alarm

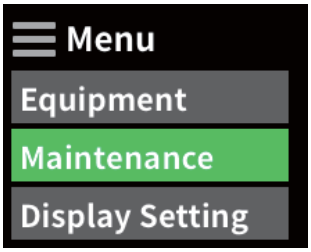


E15BRXEL25

① The capital letter in green indicates the controller (T: Travel, P: Pump) that occurred with the alarm.
② Two numbers indicate the alarm code.
③ Alarm name is displayed.

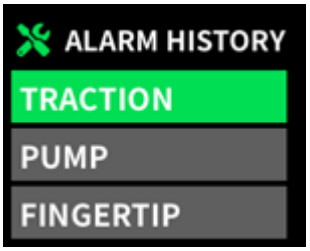
(3) Alarm history

You can check and delete alarm history as follows.

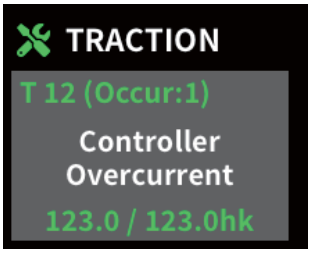


E15BRXEL26

E15BRXEL27



E15BRXEL28



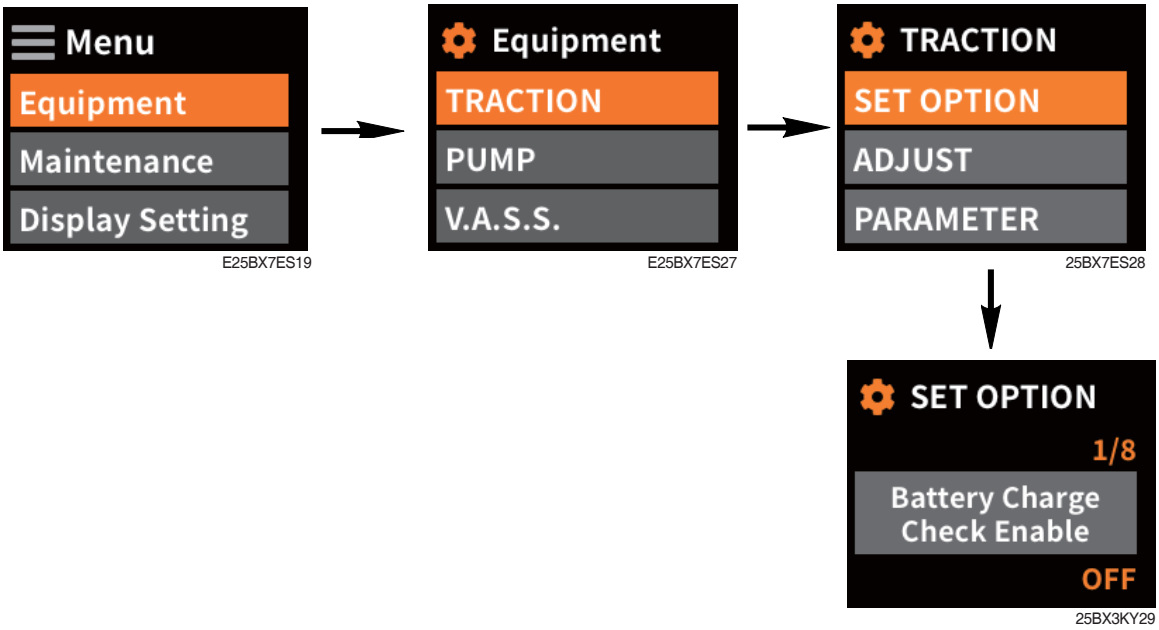
E15BRXEL29

15BRXEL30

① Access Maintenance menu from the Main menu.
② Enter the ALARM HISTORY MENU from the Maintenance menu.
③ Check alarm histories of the controllers.
④ Up to 20 alarm histories, and description of them are displayed.
⑤ Press "Enter" button to delete alarm history, or "ECS" to return to the previous screen.

8) EQUIPMENT SETTING

Variable value of the travel and pump controller can be changed.



E25BX7ES19 E25BX7ES27 25BX7ES28 25BX3KY29

(1) Drive inverter

① Set options

Item	Description
TRUCK MODEL	Lift truck can be selected among the 4 models of 15/18BR-X, 20BR-X and 25BR-X.
HM DISPLAY OPT.	Configuration of the hour meter (in other word, MDI) displayed on the dash-board is set. Possible settings are equal to the description on the HM CUSTOM 1 OPT variables.
HM CUSTOM 1 OPT.	Configuration is set on the Hour Meter No. 1 possible for access by the cus-tomer. Possible settings are shown below. 0 : The hour meter is calculated after turning ON the controller. 1 : The hour meter is calculated when the 3-phase power bridge is operated. 2 : Not used in the new ACE2 3 : The hour meter is calculated when one is opearted among the valve output. 4 : Not used in the new ACE2 5 : The hour meter is calcualted when one is opearted among the valve output. 6 : Not used in the new ACE2
HM CUSTOM 2 OPT.	Configuration is set on the Hour Meter No. 2 possible for access by the customer. Possible settings are equal to the HM CUSTOM 1 OPT variables.
TILL/SEAT SWITCH	It is related to the pin A6 EPS failure, and it is not used in this lift truck.
EB ON TILLER BRK	The method of electro-mechanical brake management is set according to the TILLER/SEAT input state. Electro-mechanical brake is applied immediately when the ON = TILLER input is OFF. Deceleration lamp setting from the TILLER BRAKING variable has no impact. When the OFF = TILLER input is returned to the OFF state, the TILLER BRAK-ING lamp is applied before the electro-mechanical brake is activated.

Item	Description
BATTERY CHECK	Management method on insufficient remaining battery amount shall be designated. The following 4 methods are possible: - 0 : Remaining battery amount is checked, but ignored to have no measure taken even when the battery is completely discharged. - 1 : BATTERY LOW alarm is occurred when the remaining battery amount is in the BATTERY LOW THRESHOLD or less. When occurred with BATTERY LOW alarm, the controll unit reduces the maximum speed by 24%, and also reduces the maximum current by 50%. - 2 : BATTERY LOW alarm is occured when the remaining battery amount is in the BATTERY LOW THRESHOLD or less. - 3 : BATTERY LOW alarm is occured when the remaining battery amount is in the BATTERY LOW THRESHOLD or less. When occurred with BATTERY LOW alarm, the controll unit reduces the maximum speed by 24%. Refer to BATT.LOW TRESHLD in the adjustment setting.
STOP ON RAMP	Slope stop characteristics can be set to stop the lift truck electrically on the inclined plane. - ON : Inclined plane stop characteristics are performed on each stop of the lift truck. Electro-mechanical brake is operated on those occurred first among the stopping of the lift truck or elapse of the AUXILIARY TIME (started from the point of the motor speed decreasing to 1 Hz or less). As the safety measure on the possibility of brake failure, the power bridge is started from the point of the power bridge decreasing to 1 Hz or less to maintain the operation in AUXILIARY TIME No. 2. - OFF : Included plane stop characteristics are not performed. Instead, rollback control is performed in the speed specified in the ROLLING DW SPEED in Page 7-76 until reaching the flat surface. In this case, the AUXILIARY TIME is started from when the motor speed is decreased to 1 Hz or less to avoide the bridge inactivation while the lift truck is not completely stopped, and it is the control standby time until the power bridge is inactivated. Generaly, when there is an electro-mechanical brake, the best setting is STOP ON RAMP = ON, or STOP ON RAMP = OFF when there is no electro-mechanical brake. Refer to AUX OUT FUNCTION.
PULL IN BRAKING	The function is possible or not possible on providing torque continuously even when the driving (or lift) request is released. ON = When the driver releases the request for driving, the inverter resists the friction force of stopping the lift truck to maintain the travel. Similarly when the pump is applied, the inverter operates the pump to prevent the unwanted falling of the fork when the driver cancels the lift request. OFF = When the driver cancelled the driving (lift) request, the inverter no longer supplies power to the motor. This setting is especially useful on the travelling unit. When the lift truck is driving excessively on a ramp or wanting to stop by the gravity of the driver, the motor is no longer supplied with the power until the lift truck is stopped.

<table>
<tr><th>Item</th><th>Description</th></tr>
<tr><td>SOFT LANDING</td><td>When the accelerator is released, the control of the deceleration ration on the lift truck is possible or not possible.
ON = When the accelerator is released, the inverter controls the deceleration ration of the lift truck by applying the linear deceleration torque curve. When travelling up the slope, the lift truck may stop quickly, or go into reverse instantaneously to result in dangerous situation.
OFF = When the accelerator is released, the interver does not control the deceleration ratio of the lift truck, but stops the motor.</td></tr>
<tr><td>QUICK INVERSION</td><td>Quick inversion function is set.
NONE = Quick inversion function is not managed.
BELLY = Quick inversion function is managed, but there is not set time. According to the QI request, the controller operates the motor in the opposite direction until the request is cancelled.
TIMED = Quick inversion function is set. According to the QI request, the motor is operated in the opposite direction during the set time (basically 1.5 sec.).
BRAKE = Motor is stopped by the quick inversion request.</td></tr>
<tr><td>PEDAL BRK ANALOG</td><td>Type of applied brake pedal is set.
ON = The brake pedal sends out analog signal, and brake is linear.
OFF = The brake pedal sends out digital signal, and the brake is ON/OFF.</td></tr>
<tr><td>HARD & SOFT</td><td>Hard-and-soft function is enabled or disabled. When the H&S is mounted, it is possible to reduce the lift truck speed simply by activating the H&S switch and accelerator without the TILLER input.
OFF = H&S function not possible
ON = H&S function possible</td></tr>
<tr><td>HB ON / SR OFF</td><td>Function related to the pin A13 input is set.
ON = Hand Brake
OFF = Deceleration</td></tr>
<tr><td>MAIN POT. TYPE</td><td>Characteristics of the main potentiometer connected to the pin A3 are set.
<table>
<tr><th>#</th><th>Pot. type</th><th>Low to High / High to Low</th><th>Direction switches</th><th>Enable switch</th><th>En. dead band</th></tr>
<tr><td>0</td><td></td><td>L to H</td><td>X</td><td></td><td></td></tr>
</table>
* V-type potentiometer without the direction switch: Rotated always in the direction equal t othe motor.
** Only relevant to the pump controller. Use only those possible without the potentiometer. When the rotation is operated, the controller operates the pump motor in maximum speed.</td></tr>
<tr><td>AUX POT. TYPE</td><td>Type of the auxiliary potentiometer connected to the pin A10 are set.
<table>
<tr><th>#</th><th>Pot. type</th><th>Low to High / High to Low</th><th>Direction switches</th><th>Enable switch</th><th>En. dead band</th></tr>
<tr><td>0 ÷ 11</td><td colspan="5">Same as for MAIN POT. TYPE, see the previous parameter.</td></tr>
<tr><td>12</td><td>No</td><td>H to L</td><td>X</td><td>X</td><td></td></tr>
<tr><td>13</td><td colspan="5">Crossed twin together with the main potentiometer.</td></tr>
<tr><td>14</td><td colspan="5">Free for future uses.</td></tr>
<tr><td>15</td><td>No</td><td>H to L</td><td>X</td><td></td><td></td></tr>
</table></td></tr>
</table>

Item	Description
SET MOT. TEMPERAT	Type of the motor temperature sensor connected to the pin A23 is set. NONE = Does not exist. DIGITAL = Temperature sensor of the digital (ON/OFF) motor. KTY84 = KTY84-130. KTY83 = KTY83-130. PT1000 = PT1000. KTY81 = KTY81-110/120.
STEERING TYPE	Type of the steering unit connected to the controller is set. NONE = No steering module on the lift truck. New ACE2 is not applied with the steering module on the EPS, and steering cutback brake is applied without waiting for the CAN message by the EPS. There is OPTION#1 = EPS, and set with the ENCODER + TOGGLE SWITCHES. These signals are delivered to the new ACE2 through the CAN-bus. There is OPTION#2 = EPS, and set with the POT + ENCODER. These signals are delivered to the new ACE2 through the CAN-bus. ANALOG = Hydraulic steering is used on the lift truck, and new ACE2 decodes through one of the analog input signals from the wheel potentiometer for reading the wheel rotation.
M.C. FUNCTION	Configuration of A16 NLC output that is exclusively for the line contactor is set. OFF = No line contactor. Diagnosis is not performed, and MC is not operated. ON = Line contactor is set independently. When the diagnosis is performed and passed, the MC is closed after the key is turned ON. OPTION#1 = One main contactor is used on two controllers for driving and pump setting. When the diagnosis is performed and passed, the MC is closed after the key is turned ON. OPTION#1 = Two main contactors are used for driving and pump setting. Each controller operates the own MC. When the diagnosis is performed and passed, the MC is closed after the key is turned ON.
M.C. OUTPUT	The load coil connected or disconnected on the A16 NLC output is set. ABSENT = NLC output is not connected to any load coil. PRESENT = NLC output is connected to the load coil (basically connected to the main contactor).
EBRAKE ON APPL.	Inclusion of the electro-mechanical brake is set.
AUX OUT FUNCTION	Possibility of A18 NEB output exclusive of electro-mechanical brake is set. NONE = Diagnosis is not performed, and EB is not operated according to the travel request. BRAKE = EB is operated according to the travel request when all relevant diagnoses are passed. Reaction on the slope complies with the STOP ON RAMP setting. This setting is not used when there is no electro-mechanical brake. When two controllers operate two driving motors and EB is applied with one, EB is set with the BRAKE only on the manual controller.
COMP.VOLT. OUTPUT	On the dependency of the battery voltage, voltage compensation of the MC and EB driver is set. 0 = None. 1 = Only MC. 2 = Only EB. 3 = MC and EB.

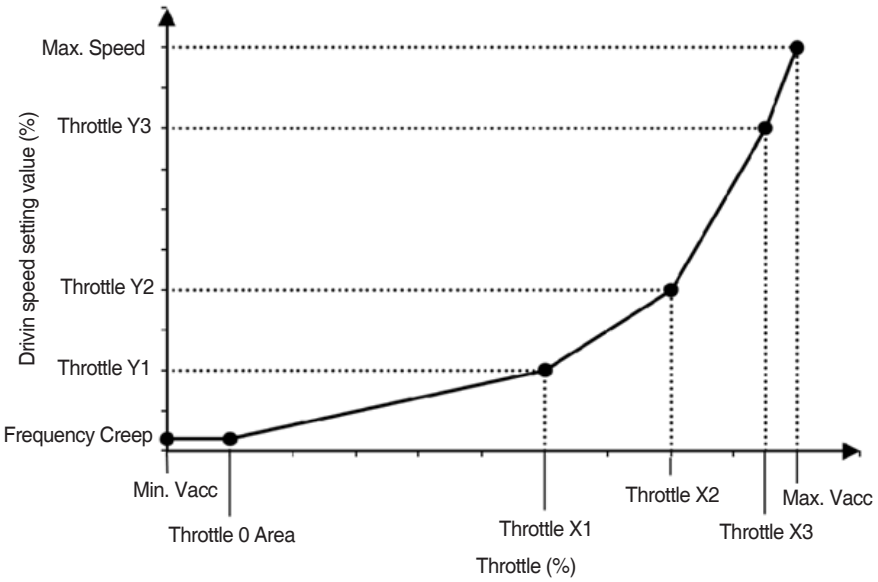
Item	Description
ACCEL MODULATION	Acceleration modulation function is possible or not possible. OFF = Acceleration ratio is in inverse proportion to the ACCELER. DELAY variable. ON = Has inverse proportion to the ACCELER. DELAY variable when the speed setting value of the acceleration lamp exceeds 100 Hz. 100 Hz or less is proportional to the speed change on the acceleration lamp to have the speed change of the acceleration duration result to be equal to the ACCELER. DELAY.
HIGH DYNAMIC	High acceleration function is possible or not possible. ON = All acceleration and deceleration profiles set by the exclusive variable is ignored, and the controller performs the maximum performance at all times. OFF = Standard performance.
BUZZER DIRECTION	- None : Buzzer not operating. - Option #1 : Buzzer operated when the reverse direction switch is turned ON. - Option #2 : Buzzer operated when the reverse direction switch is turned ON and lift truck is moving. - Option #3 : Buzzer operated when the forward or reverse direction switch is turned ON. - Option #4 : Buzzer operated when the forward or reverse direction switch is turned ON and lift truck is moving.
INVERSION MODE	A11 quick inversion input reaction is set. ON = Quick inversion switch is closed constantly (Function is operated when the switch is open). OFF = Quick inversion switch is opened constantly (Function is operated when the switch is closed).
DISPLAY	Communication check between the travel and dashboard is set. ON = Communication check possible. When the dashboard communication signal cannot be detected during the travel, CAN BUS KO DISP is occurred, and the driving speed is cutback to the Turtle speed. OFF = Communication check is not possible.
DISPLAY TYPE	Dashboard type connected to the inverter is set. 0 = None. 1 = MDI PRC. 2 = ECO DISPLAY. 3 = SMART DISPLAY. 4 = MDI CAN. 5 ÷ 9 = Extra.
PERFORMANCE	Selection of the performance mode is possible. OFF = Normal performance level is selected and locked. ON = The user can change the performance level from normal to ECO or HIGH.
BMS	Battery monitoring plan is set. OFF = The controller monitors the battery voltage and battery charging state. ON = The controller receives the information on the battery charging status from the BMS.
EPS ERROR CHECK	EPS error check ON = The driving inverter checks the EPS failure signal (A6). The driving function is stopped when the EPS failure signal is detected. (Normal : B-, EPS Failure : 11V) OFF = The driving inverter does not check the EPS failure signal.

② Variable Setting

Item	Description
ACC. TORQUE DEL.	When the TORQUE CONTROL is turned ON, the required time is set on the acceleration lamp, in other words, the time required for the torque to increase from the minimum value to the maximum value.
DEC. TORQUE DEL.	When the TORQUE CONTROL is turned ON, the required time is set on the deceleration lamp, in other words, the time required for the torque to decrease from the Max. value to the Min. value.
ACCELER. DELAY	The time required for increasing the acceleration lamp, in other words, the motor speed from 0 Hz to 100 Hz is set.
RELEASE BRAKING	The time required for decreasing the deceleration lamp performed after releasing the operation request, in other words, the motor speed from 100 Hz to 0 Hz is set.
REL BRK IN CTB	The time required for decreasing the deceleration lamp performed in the activated state of the cutback switch, in other words, the motor speed from 100 Hz to 0 Hz is set.
TILLER BRAKING	The time required for decreasing the deceleration lamp performed after releasing the TILLER/SEAT switch, in other words, the motor speed from 100 Hz to 0 Hz is set.
INVERS. BRAKING	The time required for decreasing the deceleration lamp performed when the direction switch is converted during the operation, in other words, the motor speed from 100 Hz to 0 Hz is set.
DECEL. BRAKING	The time required for decreasing the deceleration lamp performed when the acceleration is released, in other words, the motor speed from 100 Hz to 0 Hz is set.
PEDAL BRAKING	The time required for decreasing the deceleration lamp performed when the brake is pressed, in other words, the motor speed from 100 Hz to 0 Hz is set.
SPEED LIMIT BRK.	The time required for decreasing the deceleration lamp performed according to the deceleration request, in other words, the motor speed from 100 Hz to 0 Hz is set.
STEER BRAKING	The time required for decreasing the deceleration lamp related to the steering angle, in other words, the motor speed from 100 Hz to 0 Hz is set.
ACC. MIN MODUL.	When ACCEL MODULATION = ON, change in minimum speed setting value having impact to the acceleration modulation is set. When the change in speed setting value is smaller than the ACC. MIN MODUL, acceleration is reduced compared to the ACCELER. DELAY time. It is indicated as the percentage of 100 Hz on the change in maximum speed setting value having impact to the gas modulation. Refer to the ACCEL MODULATION and ACCELER. DELAY variables in setting the options.
REL. MIN MODUL.	Change in minimum speed setting value having impact to the brake modulation on release is set. When the change in speed set value is smaller than REL. MIN MODUL., deceleration is reduced compared to the DECEL. BRAKING time. It is indicated as the percentage of 100 Hz on the change in maximum speed setting value having impact to the braking modulation. Refer to the DECEL. BRAKING variables on changing the variables.
MAX SPEED FORW	Max. speed in the forward direction is set.
MAX SPEED BACK	Max. speed in the reverse direction is set.
CUTBACK SPEED 1	Maximum speed performed when operating with cutback input 1 is set. It is relevant to the percentage of the TOP MAX SPEED.
TURTLE SPEED	Max. speed in the in low speed mode is set.
H&S CUTBACK	Maximum speed performed during the Hard-and-Soft operation is set.

Item	Description
CTB. STEER ALARM	Maximum drivin speed is set when the alarm is generated from the EPS that is read by the micro-controller on the alarm not related to safety.
MOT.HT MAX SPEED	The maximum speed when the motor temperature reaches "MAX. MOTOR TEMP." setting.
CURVE SPEED 1	When the steering angle is equal to the STEER ANGLE 1 angle, the maximum driving speed is set.
CURVE CUTBACK	When the steering angle is equal to the STEER ANGLE 2 angle, the maximum driving speed is set.
FREQUENCY CREEP	The forward or reverse request switch is closed but the minimum speed is set when the accelerator is in the minimum position.
TORQUE CREEP	Torque control is set, and forward or reverse request switch is closed, but the minimum torque is set when the accelerator is in the minimum position.
ACC SMOOTH	Acceleration type is set: 1 is occurred in the linear lamp, and the parabola becomes smoother than the value is higher.
INV SMOOTH	Type of acceleration performed when converting the lift truck direction is set: 1 is occurred in the linear lamp, and the parabola becomes smoother than the value is higher.
STOP SMOOTH	Frequency for stopping the smoothing effect on the acceleration type is set.
BRK SMOOTH	Acceleration type is set: 1 is occurred in the linear lamp, and the parabola becomes smoother than the value is higher.
STOP BRK SMOOTH	Frequency for stopping the smoothing effect on the deceleration type is set.
BACKING SPEED	Maximum speed performed on operation of the inching function is set.
BACKING TIME	Duration of the inching function is set.
EB. ENGAGE DELAY	Delay time introduced between the travel request and actual operation of the driving motor is set. Delay time occurred between the activation of EB output (in other words, after the travel request) and valid EB release is calculated to enable the motor to maintain the stop state until the electro-mechanical brake is actually released. Delay in brake release can be measured or verified through the data sheet.
AUXILIARY TIME	Generally when the motor is stopped, the controller option of timing level on the lamp stop function is set. STOP ON RAMP. Refer to the variables.
ROLLING DW SPEED	Maximum speed of the rolling down function is set.
BMS WRN1 CUTBACK	Maximum speed is set when the BMS warning 1 is activated.

③ Adjustment setting

Item	Description
SET BATTERY	Nominal battery voltage is set. Possible options are as shown below: 24V, 36V, 48V, 72V, 80V, 96V
ADJUST KEY VOLT.	Fine adjustment of the key voltage measured by the controller. Correction is performed on the Zapi side when finishing the outgoing test.
ADJUST BATTERY	Fine adjustment of the battery voltage measured by the controller. Correction is performed on the Zapi side when finishing the outgoing test.
SET POSITIVE PEB	Value of the supply voltage connected to PEB A17 is set. Possible values are as shown below: 12V, 24V, 36V, 40V, 48V, 72V, 80V, 96V
SET PBRK. MIN	The minimum value of the brake potentiometer is recorded when the brake is analog.
SET PBRK. MAX	The maximum value of the brake potentiometer is recorded when the brake is analog.
THROTTLE 0 ZONE	Accelerator input curve is set. Refer to the accelerator input cover on the THROTTLE Y3 MAP description)
THROTTLE X1 MAP	Accelerator input curve is set. Refer to the accelerator input cover on the THROTTLE Y3 MAP description)
THROTTLE Y1 MAP	Accelerator input curve is set. Refer to the accelerator input cover on the THROTTLE Y3 MAP description)
THROTTLE X2 MAP	Accelerator input curve is set. Refer to the accelerator input cover on the THROTTLE Y3 MAP description)
THROTTLE Y2 MAP	Accelerator input curve is set. Refer to the accelerator input cover on the THROTTLE Y3 MAP description)
THROTTLE X3 MAP	Accelerator input curve is set. Refer to the accelerator input cover on the THROTTLE Y3 MAP description)
THROTTLE Y3 MAP	Accelerator input curve is set.  The speed is maintained in the FREQUENCY CREEP value when the voltage of the accelerator potentiometer is lower than the THROTTLE 0 ZONE. Basically, dead zone is set near the center.

Item	Description
BAT. MIN ADJ.	Lower level of the battery discharge table is adjusted. Discharge algorithm of the used battery is applied to correction.
BAT. MAX ADJ.	Upper level of the battery discharge table is adjusted. Discharge algorithm of the used battery is applied to correction.
BDI ADJ STARTUP	The level of the battery discharge table is adjusted on the starting point for calculating the battery discharge when the key is turned ON.
BDI RESET	Minimum change of the battery discharge table is adjusted to update the battery % on the starting point. Discharge algorithm of the used battery is applied to correction.
BDI RESET 2	When the BDI is less than 30% (29~0%), the minimum change in the battery discharge table is adjusted to update the battery % on the starting point. Discharge algorithm of the used battery is applied to correction.
BATT.LOW TRESHLD	Percentage of the lower minimum charging occurred with BATTERY LOW alarm is set.
BAT.ENERGY SAVER	When the battery charging is decreased to 10% or less, the percentage of the maximum output torque delivered is set. BAT.ENERGY SAVER is set to 100% when the battery saving characteristics are not required.
VOLTAGE THR LOW	The voltage limit of the working voltage range indicated in the percentage of the nominal voltage is set. Basically, it is checked whether the battery voltage is within the range of VOLTAGE THR LOW to VOLTAGE THR HIGH on the controller in the starting point. When the inspection is failed, the message of WRONG KEY VOLT. is displayed.
VOLTAGE THR HIGH	
MAX ANGLE RIGHT	Maximum steering wheel angle of right turn is set.
MAX ANGLE LEFT	Maximum steering wheel angle of left turn is set.
STEER DEAD ANGLE	Maximum steering wheel angle is set when the permissible driving speed is 100%.
STEER ANGLE 1	The steering wheel angle is set when the driving speed is decreased to the limited value on the CURVE SPEED 1. When the steering wheel angle is between the STEER DEAD ANGLE and STEER ANGLE 1, the driving speed is reduced linearly to CURVE SPEED 1 in 100%.
STEER ANGLE 2	The steering wheel angle is set when the driving speed is decreased to the CURVE CUTBACK or higher. When the steering wheel angle is between the STEER ANGLE1 and STEER ANGLE 2, the driving speed is reduced linearly from the CURVE SPEED 1 to CURVE CUTBACK.
SPEED FACTOR	For setting the coefficient used to evaluate the driving speed (km/h) with the motor frequency (Hz), the calculation formula is as shown below. $Speed\ [km/h] = 10 \cdot \frac{frequency\ [Hz]}{Speed\ factor}$ The following calculation formula is also used. $Speed\ factor = \frac{88 \cdot rr \cdot pp}{ø}$ rr : Total gear deceleration ratio pp : Motor pull pair ø : ① Driving wheel diameter (cm)

Item	Description
SPEED ON MDI	Speed visualization on the MDI dashboard is enabled or disabled. ON = Driving speed is indicated on the MDI when the lift truck is moving. Speed display in the stopped state is replaced by the hour meter display. OFF = Standard MDI function.
LOAD HM FROM MDI	It is used to load the hour meter calculation value to the controller from the MDI CAN connected to the CAN-bus network. It cannot be used when there is no MDI CAN on the lift truck. OFF = The controller hour meter is increased normally according to the elapse of time. ON = On the next key ON, the controller loads the hour meter stored in the MDI CAN, and the value is stored automatically when turned OFF. This can be used to match the controller hour meter with the hour meter of the MDI CAN. For example, after the controller is replaced with the new component.
CHECK UP DONE	To cancel the CHECK UP NEEDED warning, this variable is set to ON after the check and maintenance service is required.
CHECK UP TYPE	CHECK UP NEEDED warning is set. NONE = No CHECK UP NEEDED warning. OPTION#1 = CHECK UP NEEDED is displayed on the handset and MDI after 300 hours. OPTION#2 = Along with the OPTION#1, decrease in speed is occurred after 340 hours. OPTION#3= Along with the OPTION#2, lift truck clearly stopped after 380 hours.
MC VOLTAGE	Operating cycle (tON-TPWM) of the PWM applied to the main contactor output A16 during 1 second after the activation signal of closing the main contactor is defined.
MC VOLTAGE RED.	The percentage of the MC VOLTAGE variable is set to determine the rate of use applied after 1 second from activation of the contactor.
EB VOLTAGE	the rate of use on the PWM (tON-TPWM) applied to the electro-mechanical brake output A18 during 1 second after the activation signal becoming the cause of releasing the electro-mechanical brake is defined.
EB VOLTAGE RED.	Percentage of the EB VOLTAGE variable is set to determine the rate of use after 1 second from releasing the electro-mechanical brake.
START TEMP FAN	The cooling fan is operated when the inverter temperature exceeds the value indicated in this variable.
MAX. MOTOR TEMP.	The motor temperature exceeding the maximum current applied with 50% cut-back is set. For the cutback, 100% of the maximum current by the temperature is valid only when the motor is operating for independent and useful braking at all times.
STOP MOTOR TEMP.	Maximum permissible motor temperature is set for the controller to stop the motor operation.
MOT.T. T.CUTBACK	Motor temperature cutback is set. The control system reduces the motor torque linearly based on the motor temperature. For the limit of linear decrease, MAX MOTOR TEMP and TEMP. MOT. STOP are referred.

(2) Pump Inverter

① Set options

Item	Description
TRUCK MODEL	Lift truck can be selected among the 4 models of 15/18BR-X, 20BR-X and 25BR-X.
HM DISPLAY OPT.	Configuration of the hour meter (in other word, MDI) displayed on the dash-board is set. Possible settings are equal to the description on the HM CUSTOM 1 OPT variables.
HM CUSTOM 1 OPT.	Configuration is set on the Hour Meter No. 1 possible for access by the customer. Possible settings are shown below. 0 : The hour meter is calculated after turning ON the controller. 1 : The hour meter is calculated when the 3-phase power bridge is activated. 2 : Not used in the new ACE2 3 : The hour meter is calculated when one is activated among the valve output. 4 : Not used in the new ACE2 5 : The hour meter is calculated when one is activated among the valve output. 6 : Not used in the new ACE2
HM CUSTOM 2 OPT.	Configuration is set on the Hour Meter No. 2 possible for access by the cus-tomer. Possible settings are equal to the HM CUSTOM 1 OPT variables.
TILL/SEAT SWITCH	It is related to the pin A6 reach switch. This must be set on the SEAT.
BATTERY CHECK	This variable must be set to 0.
STOP ON RAMP	This variable must be set to OFF.
PULL IN BRAKING	The function is possible or not possible on providing torque continuously even when the driving (or lift) request is released. ON = When the driver releases the request for driving, the inverter resists the friction force of stopping the lift truck to maintain the travel. Similarly when the pump is applied, the inverter operates the pump to prevent the unwanted falling of the fork when the driver cancels the lift request. OFF = When the driver cancelled the driving (lift) request, the inverter no longer supplies power to the motor. This setting is especially useful on the travelling unit. When the lift truck is driving excessively on a ramp or wanting to stop by the gravity of the driver, the motor is no longer supplied with the power until the lift truck is stopped.
SOFT LANDING	When the accelerator is released, the control of the deceleration ration on the lift truck is possible or not possible. ON = When the accelerator is released, the inverter controls the decelera-tion ration of the lift truck by applying the linear deceleration torque curve. When travelling up the slope, the lift truck may stop quickly, or go into reverse instantaneously to result in dangerous situation. OFF = When the accelerator is released, the interver does not control the deceleration ratio of the lift truck, but stops the motor.
QUICK INVERSION	Quick inversion function is set. NONE = Quick inversion function is not managed. BELLY = Quick inversion function is managed, but there is not set time. Ac-cording to the QI request, the controller operates the motor in the opposite direction until the request is cancelled. TIMED = Quick inversion function is set. According to the QI request, the motor is operated in the opposite direction during the set time (basically 1.5 sec.). BRAKE = Motor is stopped by the quick inversion request.

<table>
<tr><th>Item</th><th>Description</th></tr>
<tr><td>MAIN POT. TYPE</td><td>Characteristics of the main potentiometer connected to the pin A3 lift are set.
This variable must be set to 15.</td></tr>
<tr><td>LIFT POT.</td><td>Use of the lift potentiometer is set.
ON = Lift potentiometer is used. Pin A3 is used on the analog input signal.
OFF = Lift potentiometer is not used.</td></tr>
<tr><td>AUX POT. TYPE</td><td>Type of the auxiliary potentiometer connected to the pin A10 are set.
<table>
<tr><th>#</th><th>Pot. type</th><th>Low to High / High to Low</th><th>Direction switches</th><th>Enable switch</th><th>En. dead band</th></tr>
<tr><td>0 ÷ 11</td><td colspan="5">Same as for MAIN POT. TYPE, see the previous parameter.</td></tr>
<tr><td>12</td><td>No</td><td>H to L</td><td>X</td><td>X</td><td></td></tr>
<tr><td>13</td><td colspan="5">Crossed twin together with the main potentiometer.</td></tr>
<tr><td>14</td><td colspan="5">Free for future uses.</td></tr>
<tr><td>15</td><td>No</td><td>H to L</td><td>X</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>SET MOT. TEMPERAT</td><td>Type of the motor temperature sensor connected to the pin A23 is set.
NONE = Does not exist.
DIGITAL = Temperature sensor of the digital (ON/OFF) motor.
KTY84 = KTY84-130.
KTY83 = KTY83-130.
PT1000 = PT1000.
KTY81 = KTY81-110/120.</td></tr>
<tr><td>M.C. FUNCTION</td><td>Configuration of A16 NLC output that is exclusively for the line contactor is set.
OFF = No line contactor. Diagnosis is not performed, and MC is not operated.
ON = Line contactor is set independently. When the diagnosis is performed and passed, the MC is closed after the key is turned ON.
OPTION#1 = One main contactor is used on two controllers for driving and pump setting.
When the diagnosis is performed and passed, the MC is closed after the key is turned ON.
OPTION#1 = Two main contactors are used for driving and pump setting. Each controller operates the own MC.
When the diagnosis is performed and passed, the MC is closed after the key is turned ON.</td></tr>
<tr><td>M.C. OUTPUT</td><td>The load coil connected or disconnected on the A16 NLC output is set.
ABSENT = NLC output is not connected to any load coil.
PRESENT = NLC output is connected to the load coil (basically connected to the main contactor).</td></tr>
<tr><td>EBRAKE ON APPL.</td><td>Inclusion of the electro-mechanical Brake fluid is set.</td></tr>
</table>

Item	Description
AUX OUT FUNCTION	Possibility of A18 NEB output exclusive of electro-mechanical brake is set. NONE = Diagnosis is not performed, and EB is not operated according to the travel request. BRAKE = EB is operated according to the travel request when all relevant diagnoses are passed. Reaction on the slope complies with the STOP ON RAMP setting. This setting is not used when there is no electro-mechanical brake. When two controllers operate two driving motors and EB is applied with one, EB is set with the BRAKE only on the manual controller.
COMP.VOLT. OUTPUT	On the dependency of the battery voltage, voltage compensation of the MC and EB driver is set. 0 = None. 1 = Only MC. 2 = Only EB. 3 = MC and EB.
ACCEL MODULATION	Acceleration modulation function is possible or not possible. OFF = Acceleration ratio is in inverse proportion when the speed setting value of the acceleration lamp exceeds 100 Hz. ON = Has inverse proportion to the ACCELER. DELAY variable when the speed setting value of the acceleration lamp exceeds 100 Hz. 100 Hz or less is proportional to the speed change on the acceleration lamp to have the speed change of the acceleration duration result to be equal to the ACCELER. DELAY.
HIGH DYNAMIC	High acceleration function is possible or not possible. ON = All acceleration and deceleration profiles set by the exclusive variable is ignored, and the controller performs the maximum performance at all times. OFF = Standard performance.
COOLING FAN	Cooling fan is installed near the motor, and the controller is operated as shown below. None = Fan is not operated. Option #1 = Fan is operated at all times. Option #2 = Fan is operated when the controller or motor temperature exceeds the temperature set in the START TEMP FAN menu. Option #3 = Fan is operated when the motor is operated.
DISPLAY TYPE	Dashboard type connected to the inverter is set. 0 = None. 1 = MDI PRC. 2 = ECO DISPLAY. 3 = SMART DISPLAY. 4 = MDI CAN. 5 ÷ 9 = Extra.
PERFORMANCE	Selection of the performance mode is possible. OFF = Normal performance level is selected and locked. ON = The user can change the performance level from normal to ECO or HIGH.
CUTBACK MODE	Driving, lift and reach speed are cutback when the pin A11 is open. NONE = Cutback is not performed. OPTION #1 = Driving and lift cutback are performed. OPTION #2 = Driving cutback is performed. OPTION #3 = Lift cutback is performed. OPTION #4 = Driving, lift and reach cutback are performed.

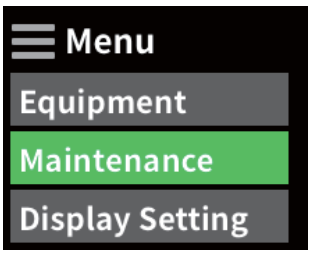
② Variable Setting

Item	Description
ACC. TORQUE DEL.	When the TORQUE CONTROL is turned ON, the required time is set on the acceleration lamp, in other words, the time required for the torque to increase from the minimum value to the maximum value.
DEC. TORQUE DEL.	When the TORQUE CONTROL is turned ON, the required time is set on the deceleration lamp, in other words, the time required for the torque to decrease from the Max. value to the Min. value.
ACCELER. DELAY	Required time for increasing the acceleration lamp of the pump motor except for the reach in/out, in other words, the motor speed from 0 Hz to 100 Hz is set.
ACC. DEL. REACH	Required time for increasing the acceleration lamp of the pump motor reach in/out, in other words, the motor speed from 0 Hz to 100 Hz is set.
RELEASE BRAKING	The time required for decreasing the deceleration lamp performed after releasing the operation request, in other words, the motor speed from 100 Hz to 0 Hz is set.
REL BRK IN CTB	The time required for decreasing the deceleration lamp performed in the activated state of the cutback switch, in other words, the motor speed from 100 Hz to 0 Hz is set.
DECEL. BRAKING	The time required for decreasing the deceleration lamp performed when the acceleration is released, in other words, the motor speed from 100 Hz to 0 Hz is set.
SPEED LIMIT BRK.	The time required for decreasing the deceleration lamp performed according to the deceleration request, in other words, the motor speed from 100 Hz to 0 Hz is set.
ACC. MIN MODUL.	When ACCEL MODULATION = ON, change in minimum speed setting value having impact to the acceleration modulation is set. When the change in speed setting value is smaller than the ACC. MIN MODUL, acceleration is reduced compared to the ACCELER. DELAY time. It is indicated as the percentage of 100 Hz on the change in maximum speed setting value having impact to the acceleration modulation. Refer to the ACCEL MODULATION ACCELER. DELAY variables in setting the options.
REL. MIN MODUL.	Change in minimum speed setting value having impact to the brake modulation on release is set. When the change in speed setting value is smaller than REL. MIN MODUL., deceleration is reduced compared to the DECEL. BRAKING time. It is indicated as the percentage of 100 Hz on the change in maximum speed setting value having impact to the braking modulation. Basic value is 30%. Refer to the DECEL. BRAKING variables on changing the variables.
MAX SPEED LIFT	When LIFT POT. = ON, maximum speed of the pump motor is set when the lift estimate is requested.
LIFT SPEED	LIFT POT. = OFF, speed of the pump motor is set when the lift speed is requested.
TILT SPEED	Speed of the pump motor is set when tilt estimate is requested.
REACH SPEED	Speed of the pump motor is set when reach estimate is requested.
AUX SPEED	Speed of the pump motor is set when auxiliary estimate is requested.
HYD PUMP SPEED	Speed of the pump motor used on steering is set when the HYDRO FUNCTION is ON. It is indicated as the percentage of the maximum pump speed.
CUTBACK SPEED 1	The maximum lift speed performed on activation of the cutback input is set.

Item	Description
REACH CB SPEED 1	The maximum reach speed performed on activation of the cutback input is set.
TURTLE SPEED	Max. speed in the in low speed mode is set.
MOT.HT MAX SPEED	The maximum speed when the motor temperature reaches "MAX. MOTOR TEMP." setting.
FREQUENCY CREEP	Minimum speed is set when the lift request switch is closed and when the lift is in the minimum position.
TORQUE CREEP	Applicable minimum torque is set when the torque control is possible, and when the lift is in the minimum position even though the lift request switch is closed.
ACC SMOOTH	Acceleration type is set: 1 is occurred in the linear lamp, and the parabola becomes smoother than the value is higher.
STOP SMOOTH	Frequency for stopping the smoothing effect on the acceleration type is set.
EB. ENGAGE DELAY	Delay time introduced between the travel request and actual operation of the driving motor is set. Delay time occurred between the activation of EB output (in other words, after the travel request) and valid EB release is calculated to enable the motor to maintain the stop state until the electro-mechanical brake is actually released. Delay in brake release can be measured or verified through the data sheet.
AUXILIARY TIME	Generally when the motor is stopped, the controller option of timing level on the lamp stop function is set. STOP ON RAMP. Refer to the variables.
ROLLING DW SPEED	Maximum speed of the rolling down function is set.
BMS WRN1 CUTBACK	Maximum speed is set when the BMS warning 1 is activated.

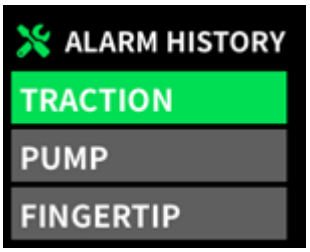
9) MONITORING

You can check the conditions of the driving and pump controllers.



E15BRXEL26

E15BRXEL27



15BRXEL28

15BRXEL37

(1) Drive inverter

Model	Description
KEY VOLTAGE	Key voltage A1 value measured in real-time.
BATTERY VOLTAGE	Battery voltage measured in real-time on the overall DC-bus.
DC BUS CURRENT	Evaluation of the battery current based on the working point.
BATTERY CHARGE	Evaluation on the battery charging based on the battery voltage.
MOTOR VOLTAGE	Theoretical interphase voltage applied to the motor terminal in the percentage of the supply voltage.
FREQUENCY	Frequency of the current sine wave supplied by the inverter to the motor.
MEASURED SPEED	It is the motor speed measured through the encoder, and displayed in the unit equal to the FREQUENCY (Hz).
SLIP VALUE	Motor slip, in other words, the difference between the current frequency and motor speed (Hz unit).
CURRENT RMS	Effective value of the line current supplied to the motor.
IMAX LIM. TRA IMAX LIM. BRK	Instantaneous value of the maximum current that can be applied to the motor to satisfy the driving or braking request by the inverter. This value is evaluated based on the actual conditions such as the temperatures of the inverter and the motor, etc.
ID FILTERED RMS IQ FILTERED RMS	Estimated value of each current vector on the d or q axis expressed as the current of effective value.
FLAGS LIMITATION	Indication on the activation of a current limit such as the terminal current cutback and maximum current reached.

Model	Description
MOT. POWER WATT	Evaluation on the power supplied to the motor.
STATOR FLUX MWB	Evaluation on the magnetic flux of the motor.
MOTION TORQUE NM	Evaluation of the motor torque.
STEER ANGLE	Steering angle of the steering wheel or steering axle sensor. STEER ANGLE is 0 when the steering direction is straight.
TEMPERATURE	Temperature measured from the inverter base plate This temperature is used for warning on HIGH TEMPERATURE.
MOTOR TEMPERAT.	Motor winding temperature. Normally, the sensor is PTC Phillips KTY84-130. The temperature is used on the MOTOR OVERTEMP alarm.
DI3 TILLER SW	State of pin A6 TILLER/SEAT input.
CNA11 FORK 300MM	State of pin A11 FORK 300MM input.
CNA4 FW SW	State of pin A4 forward request input.
DI0 ENABLE	Not in use.
CNA5 BW SW	State of pin A5 reverse request input.
CNA13 PEDAL BRK.	State of pin A13 PEDAL BRAKE input.
CNA6 EPS FAULT	State of pin A6 EPS FAULT input.
POT#1	Voltage of the pin A3 analog input 1.
POT#2	Voltage of the pin A10 analog input 2.
MAIN CONT.	Voltage applied to the main contactor coil. Corresponds to the rate of use on the applicable PWM, and indicated in percentage.
CNA18 RELAY PWM	State of pin A18 REALY PWM request input.
CTRAP HW	Indicates the number of occurrence on the overcurrent detection on the hardware.
CTRAP THRESOLD	Limit voltage of the overcurrent detection circuit.
SUPPLY SENSOR 1	Current supplied to the pin A8 auxiliary supply PENC.
SUPPLY SENSOR 2	Current supplied to the pin A2 auxiliary supply PPOT.
TRUCK SPEED	Speed of the lift truck (Gear ratio and wheel diameter requires custom software embedding).
ODOMETER KM	Odometer: Total distance travelled by the lift truck
CPU TIME F US	Reserved internal use of Zapi
CPU TIME M US	Reserved internal use of Zapi

Model	Description
PERFORMANCE	Performance Level : 0 = ECO 1 = NORMAL 2 = HIGH

(2) Pump Inverter

Model	Description
KEY VOLTAGE	Key voltage A1 value measured in real-time.
BATTERY VOLTAGE	Battery voltage measured in real-time on the overall DC-bus.
DC BUS CURRENT	Evaluation of the battery current based on the working point.
BATTERY CHARGE	Evaluation on the battery charging based on the battery voltage.
MOTOR VOLTAGE	Theoretical interphase voltage applied to the motor terminal in the percentage of the supply voltage.
FREQUENCY	Frequency of the current sine wave supplied by the inverter to the motor.
MEASURED SPEED	It is the motor speed measured through the encoder, and displayed in the unit equal to the FREQUENCY (Hz).
SLIP VALUE	Motor slip, in other words, the difference between the current frequency and motor speed (Hz unit).
CURRENT RMS	Effective value of the line current supplied to the motor.
IMAX LIM. TRA IMAX LIM. BRK	Instantaneous value of the maximum current that can be applied to the motor to satisfy the driving or braking request by the inverter. This value is evaluated based on the actual conditions such as the temperatures of the inverter and the motor, etc.
ID FILTERED RMS IQ FILTERED RMS	Estimated value of each current vector on the d or q axis expressed as the current of effective value.
FLAGS LIMITATION	Indication on the activation of a current limit such as the terminal current cutback and maximum current reached.
MOT. POWER WATT	Evaluation on the power supplied to the motor.
STATOR FLUX MWB	Evaluation on the magnetic flux of the motor.
MOTION TORQUE NM	Evaluation of the motor torque.
TEMPERATURE	Temperature measured from the inverter base plate This temperature is used for warning on HIGH TEMPERATURE.
MOTOR TEMPERAT.	Motor winding temperature. Normally, the sensor is PTC Phillips KTY84-130. The temperature iss used on the MOTOR OVERTEMP alarm.
DI0 SEAT SW	State of pin A6 TILLER/SEAT input.
CNA4 LIFT SW	State of pin A6 lift request switch input when the LIFT POT is OFF.
DI2 L/T CBK SW	State of pin A11 lift and driving cutback input.
CNA4 LFT/E SW	State of pin A4 lift enable switch input when the LIFT POT is ON.
CNA5 TILT SW	State of pin A5 tilt request input.
CNA6 REACH SW	State of pin A6 reach request input.
CNA13 AUX SW	State of pin A13 auxiliary request input.

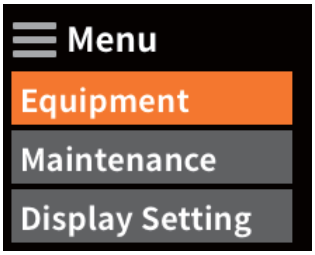
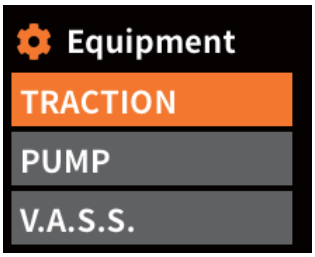
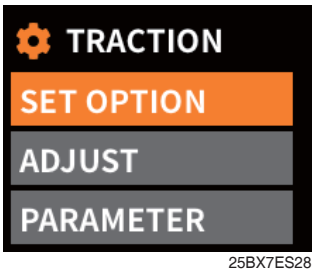
Model	Description
CNA10 DOOR LOCK	State of pin A10 switch input.
POT#1	Voltage of the pin A3 analog input 1
POT#2	Not in use.
MAIN CONT.	Voltage applied to the main contactor coil. Corresponds to the rate of use on the applicable PWM, and indicated in percentage.
CNA18 RELAY PWM	State of pin A18 REALY PWM request input.
CTRAP HW	Indicates the number of occurrence on the overcurrent detection on the hardware.
CTRAP THRESOLD	Limit voltage of the overcurrent detection circuit.
SUPPLY SENSOR 1	Current supplied to the pin A8 auxiliary supply PENC.
SUPPLY SENSOR 2	Current supplied to the pin A2 auxiliary supply PPOT.
CPU TIME F US	Internal use of Zapi
CPU TIME M US	Internal use of Zapi
PERFORMANCE	Performance Level: 0 = ECO 1 = NORMAL 2 = HIGH

10) SETTING

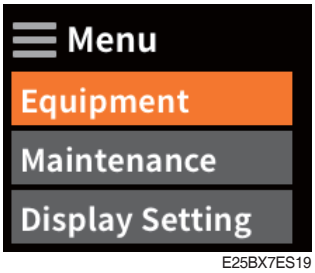
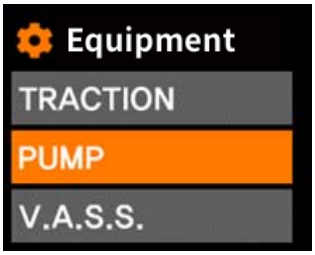
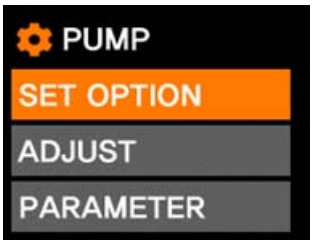
(1) Model setting

Relevant model/ton number is set to enable the controller parameter value to be changed.

※ **Refer to 6) Service Menu for the method of accessing into the menu.**

Step	Display Screen	Work Performance
1	 E25BX7ES19	1) In the menu screen, use the "Left/Right" button to select the equipment setting menu, and press the "Enter" button.
2	 E25BX7ES27	1) In the equipment setting menu screen, use the "Left/Right" button to select the TRACTION menu, and press the "Enter" button.
3	 25BX7ES28	1) In the TRACTION menu screen, use the "Left/Right " button to select the SET OPTION menu, and press the "Enter" button.
4	 15BRXEL39	1) In the TRACTION menu screen, use the "Left/Right" button to select the MODEL SELECT menu, and press the "Enter" button. 2) Select the model appropriate for the releavnt equipment to press the "Enter" button to save.

※ **In the 15/18/20/25BR-X model, when the MODEL SELECT is changed on the cluster, the driving/hydraulic controller variables are all initialized as the relevant model variable. Therefore, it is recommended to perform the MODEL SELECT setting first before other settings.**

Step	Display Screen	Work Performance
5	 E25BX7ES19	1) In the menu screen, use the "Left/Right" button to select the equipment setting menu, and press the "Enter" button.
6	 E15BRXEL38	1) In the equipment setting menu screen, use the "Left/Right" button to select the PUMP menu, and press the "Enter" button.
7	 15BRXEL32	1) In the TRACTION menu screen, use the "Left/Right " button to select the SET OPTION menu, and press the "Enter" button.
8	 15BRXEL33	1) In the TRACTION menu screen, use the "Left/Right" button to select the TRUCK MODEL menu, and press the "Enter" button. 2) Select the model appropriate for the releavnt equipment to press the "Enter" button to save.

※ **In the 15/18/20/25BR-X model, when the MODEL SELECT is changed on the cluster, the driving/ hydraulic controller variables are all initialized as the relevant model variable.**
Therefore, MODEL SELECT setting is performed first before other settings.

(2) Accelerator Setting

Setting as shown below must be performed before the lift truck shipment, and on replacing the driving controller and the accelerator lever.

※ **Refer to 6) Service Menu for the method of accessing into the menu.**

※ **VASS (ACCEL, LIFT, STEER) setting is possible only when the lift truck is stopped to prevent the lift truck operation during the setting, so the foward/reverse lever is put in neutral while the lift truck is stopped, and setting is performed when the driving/hydraulic motor is not in operation.**

Step	Display Screen	Work Performance
1	 15BRXEL41	1) Enter Menu → Equipment Setting → V.A.S.S. → ACCEL Menu.
2	 15BRXEL42	1) Go to the initial screen of setting, and press the "Enter" button for setting.
3	 15BRXEL43	1) As shown in the figure on the right, the READY state is indicated. 2) Move the accelerator lever in the order of Forward (to the end) → Neutral → Reverse (to the end) → Neutral. 3) Press the "Enter" button to save.

(3) Lift Lever Setting

Setting as shown below must be performed before the lift truck shipment, and on replacing the driving controller and the accelerator lever.

※ **Refer to 6) Service Menu for the method of accessing into the menu.**

※ **VASS (ACCEL, LIFT, STEER) setting is possible only when the lift truck is stopped to prevent the lift truck operation during the setting, so the foward/reverse lever is put in neutral while the lift truck is stopped, and setting is performed when the driving/hydraulic motor is not in operation.**

Step	Display Screen	Work Performance
1	 15BRXEL44	1) Enter Menu ▯ Equipment Setting ▯ V.A.S.S. ▯ LIFT Menu.
2	 15BRXEL45	1) Go to the initial screen of setting, and press the "Enter" button for setting.
3	 15BRXEL46	1) As shown in the figure on the right, the READY state is indicated. 2) Move the lift lever in the order of Neutral → Pull (to the end) → Neutral. 3) Press the "Enter" button to save.

(4) Steering Sensor Setting

Setting as shown below must be performed before the lift truck shipment, and on replacing the driving controller and the accelerator lever.

※ **Refer to 6) Service Menu for the method of accessing into the menu.**

※ **VASS (ACCEL, LIFT, STEER) setting is possible only when the lift truck is stopped to prevent the lift truck operation during the setting, so the foward/reverse lever is put in neutral while the lift truck is stopped, and setting is performed when the driving/hydraulic motor is not in operation.**

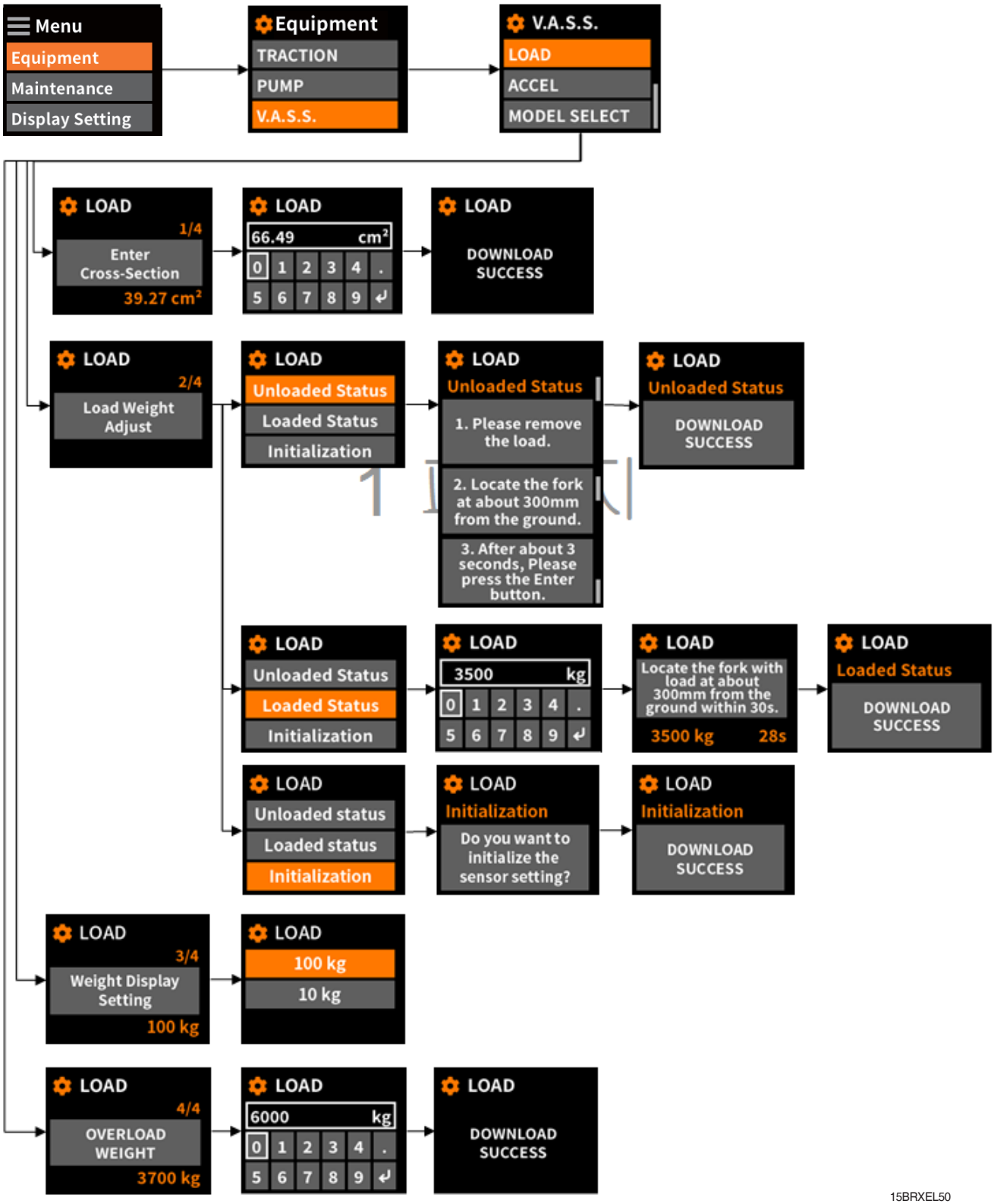
Step	Display Screen	Work Performance
1	 15BRXEL47	1) Enter Menu → Equipment Setting → V.A.S.S. → STEERING Menu.
2	 15BRXEL48	1) Go to the initial screen of setting, and press the "Enter" button for setting.
3	   15BRXEL49	1) As shown in the figure on the right, the READY state is indicated. 2) Steering → Turn the steering handle to the end in clockwise direction. Press the "Enter" button to save the SET RIGHT VOLT value . 3) Steering → Turn the steering handle to the end in counter-clockwise direction. Press the "Enter" button to save the SET LEFT VOLT value . 4) Steering → Turn the steering handle to set the wheels in the forward direction. Press the "Enter" button to save the SET ZERO VOLT value .

(5) LOAD SENSOR Option Setting

The lift truck applied with the LOAD WEIGHT option must be enabled with the LOAD WEIGHT setting as shown below.

※ Refer to 6) Service Menu for the method of accessing into the menu.

※ Menu tree for reference on LOAD setting

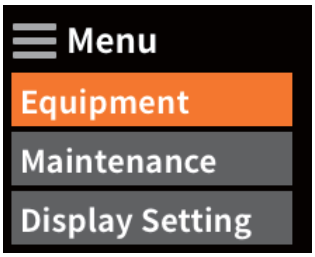
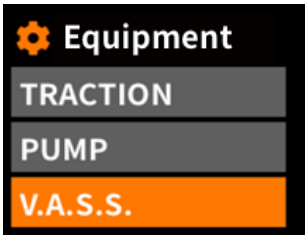
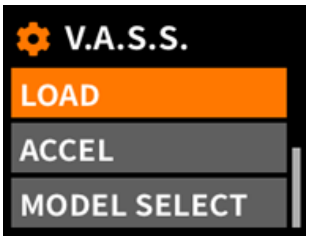
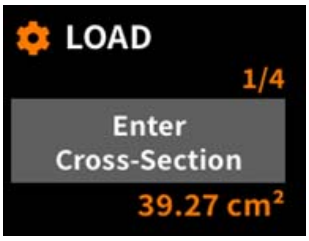
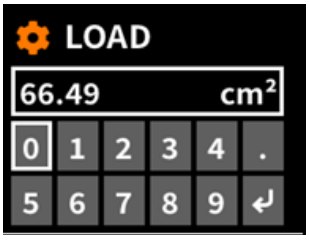


15BRXEL50

(6) LOAD SENSOR Option Setting

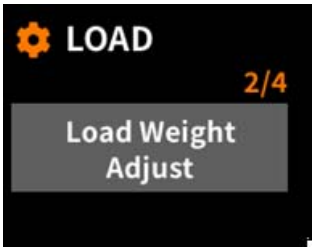
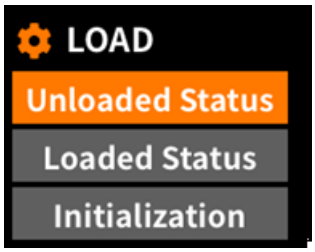
The lift truck applied with the LOAD WEIGHT option must be enabled with the LOAD WEIGHT setting as shown below.

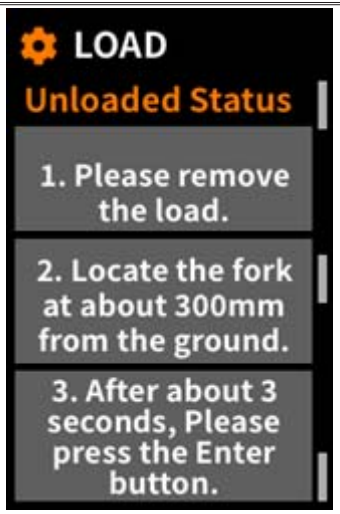
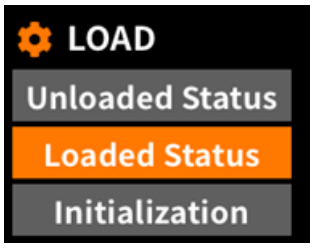
※ **Refer to 6) Service Menu for the method of accessing into the menu.**

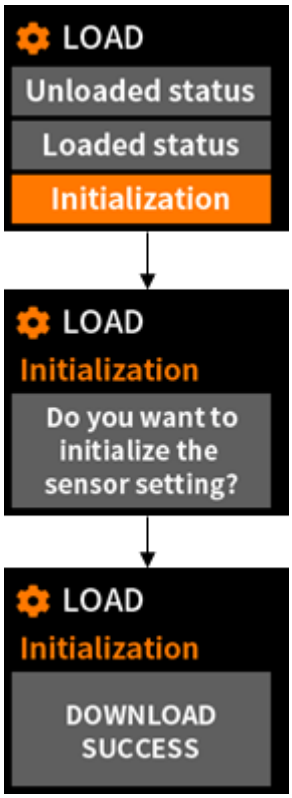
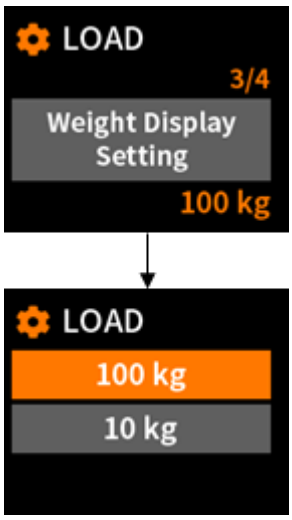
Step	Display Screen	Work Performance
1	 E25BX7ES19	1) In the menu screen, use the "Left/Right" button to select the equipment setting menu, and press the "Enter" button.
2	 15BRXEL51	1) Select VASS menu by pressing the "Left/ Right" button on the equipment setting menu screen, and press the "Enter" button.
3	 15BRXEL52	1) V.A.S.S. In the menu screen, use the "Left/Right" button to select the LOAD menu, and press the "Enter" button.
4	 15BRXEL53	1) In the LOAD menu screen, use the "Left/Right" button to select the Enter Cross-Section (Cylinder Cross-Section Input Menu), and press the "Enter" button.
5	 15BRXEL54	1) A screen for entering cylinder cross-section is displayed as shown on the left. 2) Refer to the table of cylinder cross-sections to enter cross section, and press "Enter" image button to save the input.

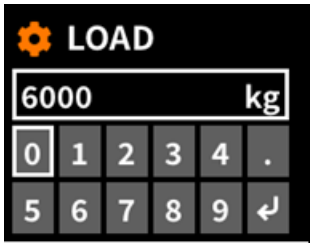
※ Cylinder Cross-Section Table

Model	Mast	Cross-section (cm^2)
15/18BR-X	V	31.809
	TF	31.809
20/25BR-X	V	39.270
	TF	39.270

Step	Display Screen	Work Performance
6	 15BRXEL55	1) Make sure that setting has been complete as shown on the left.
7	 15BRXEL56	1) In the LOAD menu screen, use the "Left/Right" button to select the Load Wieght Adjust Menu, and press the "Enter" button.
8	 15BRXEL57	1) In the LOAD menu screen, use the "Left/Right" button to select the Unloaded Status Menu, and press the "Enter" button.

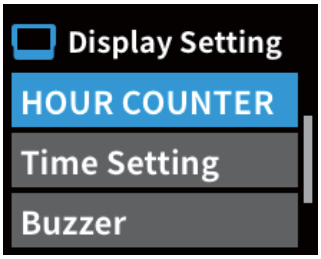
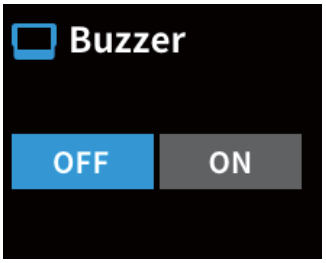
Step	Display Screen	Work Performance
9	 15BRXEL58	1) A screen for setting is displayed as shown on the left. 2) Press the "Right" button to move to the page. 3) Do not lift the load to position the fork 300 ㎜ from the ground, and standby for 3 seconds to press the "Enter" button.
10	 15BRXEL59	1) Make sure that setting has been complete as shown on the left.
11	 15BRXEL60	1) In the LOAD menu screen, use the "Left/Right" button to select the Loaded Status Menu, and press the "Enter" button.
12	 15BRXEL61	1) A screen for entering load weight is displayed as shown on the left. 2) Enter load weight to be used for setting, and select the "Enter" button image.
13	 15BRXEL62	1) A screen for setting is displayed as shown on the left. 2) Pick the load to position the fork 300㎜ from the ground, and standby for 3 seconds to press the "ENTER" button.

Step	Display Screen	Work Performance
14	 15BRXEL63	1) Make sure that setting has been complete as shown on the left.
15	 15BRXEL64	1) It is allowed to initialize Non-load/Load set value by pressing "Left/ Right" button on LOAD menu screen, and then pressing "Enter" button in the Initialization Menu. ※ The screen is used if setting is erroneous due to sensor failure.
16	 15BRXEL65	1) It is possible to change unit of weight in the third menu of Weight Display Setting. ① 100kg : Weight rounded off from the second digit is indicated ② 10kg : Weight rounded off from the first digit is indicated 2) Press "Enter" button to check weight indication functions of respective settings, and change the value to default 100kg (round off from the second digit).

Step	Display Screen	Work Performance
17	 15BRXEL66	1) In the LOAD menu screen, use the "Left/Right" button to select the OVERLOAD input menu, and press the "Enter" button.
18	 15BRXEL67	1) A screen for entering load weight is displayed as shown on the left. 2) Refer to Attachment #9 OVER LOAD Table to enter, and select the "Enter" button image.
19	 15BRXEL68	1) Make sure that setting has been complete as shown on the left.

■ Buzzer Function Verification Method

※ Refer to 6) Service Menu for the method of accessing into the menu.

Step	Display Screen	Work Performance
20		1) Press "Left/ Right" button in the SCREEN SET menu to select the Buzzer Menu. 2) Press the "Enter" button to access to Language Setting.
21		1) Check operation upon Buzzer OFF/ON respectively. ① OFF : Buzzer does not sound even if sensing weight higher than standard overload weight. ② ON : Buzzer sounds if sensing weight higher than standard overload weight. 2) Once checking is complete, press OK to store the results.

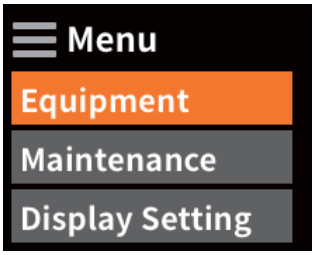
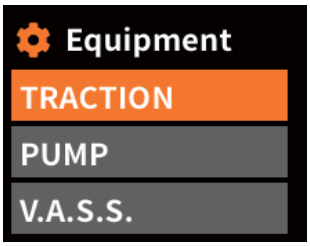
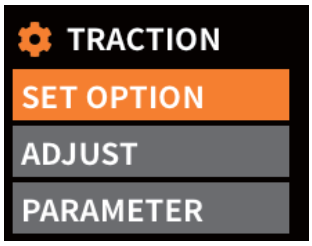
(7) OVERLOAD WEIGHT FOR EACH MODEL/MAST (GENERAL MAST)

Model	15BR-X		18BR-X		20BR-X		25BR-X	
	Rated	OVERLOAD WEIGHT	Rated	OVERLOAD WEIGHT	Rated	OVERLOAD WEIGHT	Rated	OVERLOAD WEIGHT
V250	1500	1575	1800	1890	2000	2100	2500	2625
V270	1500	1575	1800	1890	2000	2100	2500	2625
V300	1500	1575	1800	1890	2000	2100	2500	2625
V330	1500	1575	1800	1890	2000	2100	2500	2625
V350	1500	1575	1800	1890	2000	2100	2500	2625
V370	1500	1575	1800	1890	2000	2100	2500	2625
V400	1450	1525	1750	1840	2000	2100	2500	2625
V430	-	-	-	-	1900	1995	2430	2555
V450	1350	1420	1700	1785	1880	1975	2400	2520
V470	-	-	-	-	1850	1945	2350	2470
V500	1250	1315	1500	1575	1800	1890	2100	2205
V550	850	895	900	945	-	-	-	-
TF370	1500	1575	1800	1890	2000	2100	2500	2625
TF400	1450	1525	1700	1785	2000	2100	2500	2625
TF430	1400	1470	1650	1735	1950	2050	2430	2555
TF450	1350	1420	1600	1680	1900	1995	2400	2520
TF470	1300	1365	1500	1575	1850	1945	2350	2470
TF500	1200	1260	1400	1470	1800	1890	2300	2415
TF550	1050	1105	1150	1210	1750	1840	2200	2310
TF600	850	895	900	945	1600	1680	1850	1945
TF650	700	735	750	790	1040	1095	1200	1260
TF700	450	475	500	525	700	735	850	895
TF750	-	-	-	-	400	420	600	630

(8) Lithium-Ion Battery Option Setting

The lift truck applied with the Lithium-Ion Battery option must be enabled with the setting as shown below.

※ **Refer to 6) Service Menu for the method of accessing into the menu.**

Step	Display Screen	Work Performance
1	 E25BX7ES19	1) In the menu screen, use the "Left/Right" button to select the equipment setting menu, and press the "Enter" button.
2	 E25BX7ES27	1) A screen for selecting controller in the Equipment Setting menu is displayed as shown on the left. 2) Use the "Left/Right" button to access to the TRACTION menu.
3	 25BX7ES28	1) Use the "Left/Right" button to access to the SET OPTION menu.
4	 15BRXEL73	1) Use the "Left/Right" button to find the BMS variable. 2) When you desire to change the setting, press "Enter" button, and make use of "Left/ Right" button to select ON, and then press "Enter" button.
5	 15BRXEL74	1) BMS parameter is changed to ON as shown on the left. 2) Turn Lift Truck Key to OFF and then ON position once.

7. ALARM CODE

① Drive and pump MAST

Code	Alarm	Traveling	Pump	Cause and Troubleshooting
8	WATCHDOG	●	●	Cause Test related to safety. It is the self-diagnosis test using the logic between the master and supervisor micro-controller. Troubleshooting This alarm may occur from the CAN-bus failure, and communication between the master and the supervisor may be inappropriate accordingly.
17	LOGIC FAILURE #3	●	●	Cause Hardware issue on the logic board due to the high current (overload). Overcurrent can also occur when the power bridge is not operated. Troubleshooting This failure is occurred on the controller hardware. Replace the controller.
18	LOGIC FAILURE #2	●	●	Cause It is the problem inside the hardware section of the logic board handling the voltage feedback on the motor. Troubleshooting This failure is occurred on the controller hardware. Replace the controller.
19	LOGIC FAILURE #1	●	●	Cause The controller detects the low-voltage state in the KEY Input A3 (A1). The low-voltage limit acn be different depending on the controller version. Nominal Voltage **24 V, 36V, 48 V** **80 V, 96 V** Low-voltage Limit 10 V 30 V Troubleshooting (Failure on startup or standby state) - Problem can occur by the key input signal with the pulse lower than the low-voltage limit as the characteristic that can occur from the external load such as DC/DC converter startup, relay or contactor during the switching, solenoid current carrying and power failure. These methods of removing the load can be considered. - When the transient voltage is not detected on the supply line and occurred with alarm each time that the key switch is turned ON, and relevant problem can be due to the controller hardware. Replace the logic board.
30	VMN LOW	●	●	Cause 1 During the startup, high phase failure not possible for operating one motor among the 3 legs on the power bridge was discovered. Troubleshooting 1 Check the connection inside the motor. Check the motor power cable connection. Replace the controller when the problem is continued. Cause 2 During the motor operation, one of the 3-phase was detected to be outside the estimate. Troubleshooting 2 Check the motor connection. Check whether the LC power point contact is closed properly, and whether the contact point is appropriate. Replace the controller when the problem is continued.

Code	Alarm	Traveling	Pump	Cause and Troubleshooting
31	VMN HIGH	●	●	Cause 1 During the startup, low phase failure not possible for operating one motor among the 3 legs on the power bridge was discovered. Troubleshooting 1 Check the connection inside the motor. Check the motor power cable. Replace the controller when the problem is continued. Cause 2 Power bridge is operating as estimated during the startup. After the main contactor is closed, one of the phase voltage is higher than half of the battery voltage. Troubleshooting 2 Check the motor connection. Check whether the LC power point contact is closed properly, and whether the contact point is appropriate. Replace the controller when the problem is continued.
37	CONTACTOR CLOSED	●	●	Cause Check whether the controller is closed with the contactor before operating the LC coil. The controller operates the power bridge during tens of milliseconds to discharge the capacitor bank. Alarm is sounded when the capacitor voltage is not reduced to fixed % or higher on the key voltage. Troubleshooting It is recommended to check the power contact point of the LC: Replace the LC when there is power contact point.
38	CONTACTOR OPEN	●	●	Cause Check whether the controller is not closed with the contactor before operating the LC coil. To detect this state, the controller sends the DC current to the motor, and the voltage of the power capacitor is checked. Main contactor is disconnected when the power capacitor is not discharged. Troubleshooting LC contact point is not operated. Replace the LC. Send inquiry to the HYUNDAI Dealer when the LC contact point is operating properly.
53	STBY I HIGH	●	●	Cause In the standby mode, the current sensor detects the current value instead of 0. Failure occurred on the current sensor or current feedback circuit. Troubleshooting Replace the controller.

Code	Alarm	Traveling	Pump	Cause and Troubleshooting
60	CAPACITOR CHARGE	●	●	This is related to the capacitor charging system. Cause On startup, the inverter attempts to charge the power capacitor through connection of the PTC and power resistance, and it is checked whether the capacitor is charged within the fixed period. When the capacitor voltage is lower than the fixed % of the nominal battery voltage, alarm is occurred, and main contactor is not closed. Troubleshooting - Check the external load that uses the current from the capacitor charging circuit by connecting in parallel with the capacitor bank, and check whether the capacitor is not charged properly. Check whether the lamp, DC/DC converter or the auxiliary load is in parallel with the capacitor bank. - The charging resistance or the PTC may be damaged. When the alarm is not occurred by inserting the power resistance throughout the line contactor power connector, it specifies that the charging resistance is damaged. - There may be failure on the charging circuit, or there may be problems on the power section. Replace the controller.
62	TH. PROTECTION	●	●	Cause The temperature of the lower plate on the controller exceeds 85°C. The maximum current is reduced in proportion when the temperature is increased from 85 degrees to maximum of 105°C. In 105°C, the current is limited to 0 A. Troubleshooting The controller cooling must be improved. For the pin-type heat sink, air flow and cooling air temperature are important to enable appropriate cooling. When the heat dispersion is enabled by using the lower plate of the controller on the truck frame, important factors are the thickness of the frame, and the flatness and roughness of the relevant surface. When the alarm is occurred while the controller is cooled down, it may be due to the failure of the heat sensor or the logic board. In the latter case, replace the controller.
65	MOTOR TEMPERAT.	●	●	Cause This alarm is occurred when the temperature sensor is disconnected (for digital) or when exceeding the limit specified by the MAX. MOTOR TEMP. (for analog). Troubleshooting Check the temperature in the MOTOR TEMPERATURE measurement value on the TESTER function of the heat sensor installed inside the motor. Check the sensor resistance and sensor wiring. Improve the cooling of the motor when the sensor is normal. Replace the controller when the alarm is occurred continuously even when the motor is cooled.
66	BATTERY LOW	●	●	Cause This is when the BATTERY CHECK variable (option setting) is not 0, and when the remaining battery amount is lower than the BATT.LOW TRESHLD (adjustment). Troubleshooting - Check the remaining battery amount to charge if required. - The battery must be actually charged, checked on the battery voltage with the voltmeter, and compared with the BATTERY VOLTAGE value of the TESTER function. When the two values are different, adjust the ADJUST BATTERY variable (adjustment) according to the value measured with the voltmeter. - Replace the logic board when the problem is still occurred.

Code	Alarm	Traveling	Pump	Cause and Troubleshooting
74	DRIVER SHORTED	●	●	Cause Short-circuit has occurred on the driver of the LC coil. Troubleshooting - Check whether the short-circuit between the NLC (A16) and -B has occurred, or whether the low impedance path has occurred. - The drive circuit is damaged, and logic board must be replaced.
75	CONTACTOR DRIVER	●	●	Cause Load cannot be operated by the LC coil driver. The equipment or the driver circuit is damaged. Troubleshooting This issue is irrelevant to the external components: Replace the logic board.
78	VACC NOT OK	●	●	Cause ACC POT Input A5 (A3) is detected with the minimum value or higher found during the PROGRAM VACC procedure. Troubleshooting - Check the wiring. - Check the mechanical correction and function of the accelerator potentiometer. - Calculate the maximum and minimum potentiometer values through the PROGRAM VACC function. - Replace the logic board when the problem is still occurred.
79	INCORRECT START	●	●	Cause Startup procedure is inappropriate. The cause of occurring with this alarm is as follows: - Activation of the driving request during the startup. - Activation of the sheet or tiller input during the startup. Troubleshooting - Check the input state during the startup. - Check whether there are issues on the wiring and micro-switch. - Check through the TESTER function whether the input state complies with the micro-switch state. - Replace the logic board when the problem is still occurred.
80	FORW + BACK	●	●	Cause This alarm is occurred when both the driving requests (FW and BW) are activated simultaneously. Troubleshooting - Check whether the driving request is not activated simultaneously. - Check the FW and BW input state through the TESTER function. - Check the wiring related to the FW and BW input. - Check for any issues on the micro-switch. - Replace the logic board when the problem is still occurred.
139	DOOR LOCK OPEN	●	●	Cause The door locking sensor is disconnected. Troubleshooting Check the sensor to eliminate the cause of the alarm.
143	EPS DC ERROR	●		This alarm is not used in this lift truck.

Code	Alarm	Traveling	Pump	Cause and Troubleshooting
144	BMS WARNING 1	●	●	Cause Battery monitoring system in Warning 1 state. This is received through the CAN mgs. Troubleshooting Check the BMS (Battery Monitoring System).
145	BMS WARNING 0	●	●	Cause Battery monitoring system in Warning 0 state. This is received through the CAN mgs. Troubleshooting Check the BMS (Battery Monitoring System).
146	BMS NOT READY	●	●	Cause Battery monitoring system is in the BMS NOT READY state. This is received through the CAN mgs. Troubleshooting Check the BMS (Battery Monitoring System).
147	BMS FAULT	●	●	Cause Battery monitoring system is in the FAULT state. This is received through the CAN mgs. Troubleshooting Check the BMS (Battery Monitoring System).
148	DISPLAY ENABLE	●	●	Cause Display activation signal for operating the lift truck is not received. Troubleshooting -
149	WRONG PERFORM.	●	●	Cause This alarm is occurred when the PERFORMANCE variable is set in the option setting. Three performance levels (ECO, NORMAL, HI) are not set as the ascending order performance. Troubleshooting PERFORM. ECONOMY and PERFORM. POWER list of performance setting is checked. In the variable related to the performance, ECO mode must be set to be weakest, and the HI mode shall be set in the strongest method. Send inquiry to the HYUNDAI dealer.
152	SENSOR SUPPLY XX	●	●	Cause Current supplied to the pin PENC A10 (A8) or PPOT A4 (A2) is deviating 200mA on the MIN.CURR.SUPPLY1/2. Hexadecimal value "XX" is defined as the following cases. Troubleshooting 01 : Less than MIN.CURR.SUPPLY1 on the PENC A10 (A8) 02 : Exceeding 200 mA on the PENC A10 (A8) 03 : Less than MIN.CURR.SUPPLY2 on the PPOT A4 (A2) 04 : Exceeding 200 mA on the PPOT A4 (A2)
163	ED SLIP MISMATCH	●	●	Cause The control unit detected that the estimated slip value does not match the actual measurement value. This diagnosis is occurred only in ED COMPENSATION = TRUE.

Code	Alarm	Traveling	Pump	Cause and Troubleshooting
168	SPEED FB.ERR. XX	●	●	Cause This alarm is occurred when the absolute position sensor is used also on calculating the speed. When the signal is occurred, it specifies that the controller measured that the motor is operating in high speed. Troubleshooting - Check whether the software version is correct on the sensor used. - Check the mechanical installation state of the sensor and proper operation. - Electromagnetic noise on the sensor may also be cause of this alarm. - When there is no issue on the motor or speed sensor, there may be issue inside the controller, and in this case, replace the logic board.
169	EMERGENCY	●	●	Cause This alarm is occurred when the EMERGENCY input variable is set to be 1, and when the EMERGEN-CY input is activated. Troubleshooting EMERGENCY input is activated. Standby until the EMERGENCY state is stopped and to restore with the EMERGENCY input.
170	WRONG KEY VOLT.	●	●	-
171	ACQUIRING A.S.	●	●	Cause The controller is collecting the data from the absolute feedback sensor. Troubleshooting Alarm is turned OFF when the data collection is complete.
172	ACQUIRE ABORT	●	●	Cause Relevant collection process is stopped on the absolute feedback sensor.
173	ACQUIRE END	●	●	Cause The absolute feedback sensor completed the collection.
175	SPEED OVERHEAD	●	●	Cause The motor speed exceeded 100 Hz or more in maximum value specified by the TOP MAX SPEED (hardware setting) variable. Troubleshooting Check the motor variable. Send inquiry to the HYUNDAI dealer.
177	COIL SHOR. EB.	●	●	Cause This alarm is occurred when overload is applied to the pin NEB (A18). Troubleshooting - Typical source is on the wiring harness or load coil. Check the connection between the controller output and load. - Send inquiry to the HYUNDAI dealer to collect information on the coil characteristics and to verify whether complying with the driver specification.

Code	Alarm	Traveling	Pump	Cause and Troubleshooting
178	MOTOR TEMP. STOP	●	●	Cause The temperature sensor exceeded the limit set by the MOTOR TEMP. STOP. Troubleshooting Check the temperature in the MOTOR TEMPERATURE measurement value on the TESTER function of the heat sensor installed inside the motor. Check the sensor ohm value and sensor wiring. Improve the cooling of the motor when the sensor is normal. Replace the controller when the alarm is occurred continuously even when the motor is cooled.
179	STEER SENSOR KO	●		Cause The voltage read by the micro-controller of the steering sensor input (Pin A10) is deviating from the STEER RIGHT VOLT ÷ STEER LEFT VOLT range programmed through the STEER ACQUIRING function. Troubleshooting - STEER ACQUIRING function is used to obtain the maximum and minimum values accessed by the steering potentiometer. Check the mechanical correction and function of the potentiometer when the alarm is continued. - Replace the logic board when the problem is still occurred.
180	OVERLOAD	●	●	Cause The motor current exceeded the limit set on the hardware. Troubleshooting Send inquiry to the HYUNDAI dealer when the alarm is occurred again. This failure state may be occurred even when the motor variables are adjusted inappropriately.
181	WRONG FBSENS. SET	●	●	Cause ENCODER PULSES 1 and ENCODER PULSES 2 variables are incorrect. Troubleshooting Set two variables into the same value according to the encoder used.
185	TILLER ERROR	●	●	Cause Input error between the H&S input and TILLER/SEAT input (Pin A1) : Two inputs are activated simultaneously. Troubleshooting - Check whether there are any inappropriate connections on the external wiring. - Use the TESTER function on the controller to verify whether the value related to the input complies with the actual state of the external input switch. - Check for short-circuit between the pin A6 and A1. - When failure or issues are not discovered, replace the controller as there is a problem on the controller.
193	SMARTDRIVER KO	●	●	This alarm is not used in this lift truck.

Code	Alarm	Traveling	Pump	Cause and Troubleshooting
194	AUX BATT. SHORT.	●	●	Cause High even when not permitted while the voltage of the PEB output (A17) is high. POSITIVE E.B. Setting is required according to the variable hardware configuration. The software is diagnosed appropriately according to the variable, so false failure can be occurred by the incorrect setting. This alarm is shown only when POSITIVE E.B. = 1 (TILLER/SEAT in PEB). Troubleshooting Verification is required whether the POSITIVE E.B. variable comply-ing with the actual coil anode power is set. - When failure or issues are not discovered, replace the controller as there is a problem on the controller.
195	POS. EB. SHORTED	●	●	Cause The voltage of the PEB output (A17) terminal is high even when the smart driver is turned OFF. Troubleshooting - Verification is required whether the POSITIVE E.B. variable comply-ing with the actual coil anode power is set. - The software is diagnosed appropriately according to the variable, so false failure can be occurred by the incorrect setting. This alarm is shown only when POSITIVE E.B. = 1 (TILLER/SEAT in PEB). - Check whether the short-circuit between the PEB (PIN A17) and battery anode terminal +B has occurred, or whether the low imped-ance path has occurred. When failure or issues are not discovered, replace the controller as there is a problem on the controller.
196	MOT.PHASE SH.	●	●	Cause Short-circuit has occurred between two phases of the motor. One pair of short-circuit phase can be identified through the hexadecimal value of "XX" : 36 : U - V 37 : U - W 38 : V - W Troubleshooting - Verify the phase of the motor connected to the inverter. - Check the motor power cable. - Replace the controller. - When the alarm is not stopped, there is an issue on the motor, so replace the motor.
197	WRONG SLAVE VER.	●	●	Cause The software versions of the master and supervisor are not equal. Troubleshooting Upload the software with the proper version, or send inquiry to the HYUNDAI dealer.
198	M/S PAR CHK MISM	●	●	Cause Sum of variable inspection between the marter and the supervisor micro-controller is not matching during the startup. Troubleshooting Restore the variable list to save again.

Code	Alarm	Traveling	Pump	Cause and Troubleshooting
199	PARAM TRANSFER	●	●	Cause The master micro-controller is transmitting the variables to the supervisor. Troubleshooting Standby until the procedure is finished. Reactivate the key when the alarm is not stopped.
200	VDC OFF SHORTED	●	●	Cause The voltage value on the DC link of the logic board is measuring that the maximum permissible value range is exceeded consistently. Troubleshooting - Check whether the nominal voltage of the battery is equal to the nominal voltage of the inverter. - Check the battery voltage, and replace the battery when deviating from the range. - Replace the logic board when there is an issue on the battery voltage.
201	CURRENT PROFILE	●	●	Cause There is an error on selecting the current type variable. From the points of P0 to P3, description in the descending order is estimated. Troubleshooting Check the value on the CURRENT PROFILE list.
202	VDC LINK OVERV.	●	●	Cause This issue is indicated when the controller detects the overvoltage state. The overvoltage limit is different depending on the nominal voltage of the controller. Nominal Voltage **24 V** **36 V, 48 V** **80 V** **96 V** Overvoltage Limit 35 V 72.5 V 115 V 125 V Power bridge and MC are opened immediately when occurred with the issue. This state is occurred by using the HW interrupt equal to those used on low-voltage detection, and the micro-controller classified as follows on two types for identifying the voltage existing throughout the DC link capacitor: - High Voltage Overvoltage State - Low/Normal Voltage Low Voltage State
203	HW FAULT MC	●	●	Cause During the startup, it was discovered that there was an issue partially on the hardware circuit for activating and inactivating the output NLC 16 (A16) of the power bridge or LC driver. The HYUNDAI dealer can debug the issue through the hexadecimal value of "XX". Troubleshooting This error is related to the internal components. Replace the logic board.
204	BRAKE RUN OUT	●	●	Cause The CPOT BRAKE input values read by the micro-controller are SET PBRK MIN and SET PBRK. MAX variables (adjustment list), and the specified range is deviated. Troubleshooting - Check the mechanical correction and function of the brake potentiometer. - Minimum and maximum potentiometer values are obtained. - Replace the logic board when the alarm is still occurred.
205	EPS RELAY OPEN	●	●	Cause Information on the safety contact point opened with the controller is received from the EPS. Troubleshooting Check the EPS function.

Code	Alarm	Traveling	Pump	Cause and Troubleshooting
206	INIT VMN HIGH	●	●	Cause Before the main contactor is closed and before operating the power bridge, one or more motor phase voltages are sending higher voltage than expected. Short-circuit of the anode rail or low impedance path is having impact to the power unit. Phase with issue is checked through the hexadecimal value of "XX" : 81 : U phase 82 : V phase 83 : W phase Troubleshooting - Check the motor power cable. - Check the impedance between the U, V and W terminal and +B terminal of the controller. - Check whether short-circuit is occurred on the lift truck frame from the motor. - When there is no issue on the motor connection and has no external low impedance path, there is an issue inside the controller; Replace the controller.
207	INIT VMN LOW	●	●	Cause Before the main contactor is closed and before operating the power bridge, one or more motor phase voltages are sending lower voltage than expected. Short-circuit of the cathode rail or low impedance path is having impact to the power unit. Phase with issue is checked through the hexadecimal value of "XX" : 01 : U phase 02 : V phase 03 : W phase Troubleshooting - Check the motor power cable. - Check the impedance between the U, V and W terminal and -B terminal of the controller. - Check whether short-circuit is occurred on the lift truck frame from the motor. - When there is no issue on the motor connection and has no external low impedance path, there is an issue inside the controller; Replace the controller.
208	EEPROM KO	●	●	Cause Hardware or software defect on the non-volatile embedded memory stored with the controller variables. It doesn't mean that the truck cannot be used due to this alarm, but the lift truck is operated only in the basic value. Troubleshooting Perform the CLEAR EEPROM procedure (refer to the console manual). Turn OFF and ON the start switch to check the result. The controller must be replaced when the alarm is still not stopped. When the alarm is stopped, the existing variables stored are replaced with the basic value.
209	PARAM RESTORE	●	●	Cause The controller is restored to the basic setting. When the CLEAR EEPROM is performed before the last key restart, this alarm indicates that the EEPROM is cleared appropriately. Troubleshooting The driving request or pump request cancels the alarm. Replace the controller when alarm is shown through key startup without performing the CLEAR EEPROM.

Code	Alarm	Traveling	Pump	Cause and Troubleshooting
210	WRONG RAM MEM.	●	●	Cause The algorithm executed to check the main RAM resistor is discovered with the incorrect contents; Error occurred on the resistor. This alarm prohibits the lift truck operation. Troubleshooting Replace the logic board when the alarm is still occurred after the start key is turned OFF and ON again.
211	STALL ROTOR	●	●	Cause The driving rotor is fixed, or the controller cannot receive the encoder signal properly. Troubleshooting - Check the encoder state. - Check the wiring. - Check through the TESTER function whether the signals of the FREQUENCY and ENCODER are equal, and whether it is not 0 during the driving request. - Replace the logic board when the problem is still occurred.
212	POWER MISMATCH	●	●	Cause Error of the power setting value and estimated power deviating from the range. Troubleshooting SEnd inquiry to the HYUNDAI dealer for the proper adjustment of the motor.
213	POSITIVE LC OPEN	●	●	Cause The voltage feedback of the LC driver NLC (A16) output is different from those predicted. Troubleshooting - Check whether the LC coil is connected appropriately. - Check whether the CONF. POSITIVE LC variables are set to be complying with the anode supply of the actual coil. - When the problem/failure are not verified, it is the issue of the controller, so the controller must be replaced.
214	EVP COIL OPEN	●	●	Cause State of not connected with the load was detected on the proportional control valve output NEVP (A19). Troubleshooting - Check the EVP coil. - Check the wiring. - Replace the logic board when the problem is still occurred.

Code	Alarm	Traveling	Pump	Cause and Troubleshooting
215	EVP DRIV. SHORT.	●	●	Cause - Short-circuit has occurred on the EVP driver NEVP (A19) output. - The micro-controller detected the nonconformance between the valve set value and EVP output feedback. Troubleshooting - Check whether the short-circuit between the cathode of the coil and -B has occurred, or whether the low impedance conduction path has occurred. - Identify the information on the following: · Voltage applied to the overall EVP coil. · Current on the coil. · Coil characteristics. Send inquiry to the HYUNDAI dealer whether the software diagnosis is appropriate for the coil used. - Replace the controller when the issue is not solved.
216	EB. COIL OPEN	●	●	Cause State of not connected with the load was detected on the proportional control valve output NEVP (A18). Troubleshooting - Check the coil. - Check the wiring. - Check the anode terminal possible on the pin PEB A27 or main contactor down stream. - Replace the logic board when the problem is still occurred.
217	PEV NOT OK	●	●	Cause The terminal pin A24 is not connected to the battery or the voltage is different from those specified in the SET POSITIVE PEB variable (adjustment list). This alarm is one output of the EVP, EV1, EV2 and EV3, but the alarm can also occur when the AUX OUT FUNCTION is activated. Troubleshooting - Check the terminal pin A24: This must be connected to the battery voltage (after the main connector). - Nominal voltage for output is set on the SET POSITIVE PEB variable of the ADJUSTMENTS list.
218	SENS MOT TEMP KO	●	●	Cause The output of the motor heat sensor deviated from the range. Troubleshooting - Check whether the sensor resistance is the estimated value of measurement. - Check the wiring. - Replace the logic board when the problem is still occurred.
220	VKEY OFF SHORTED	●	●	Cause The voltage value of the key on the logic board that is in the minimum permissible value or less consistently is measured. Troubleshooting - Check whether the nominal voltage of the battery used is equal to the inverter. - Check the battery voltage, and replace the battery when deviating from the range. - When the issue is continued, there is a problem on the logic board, so replace the logic board.

Code	Alarm	Traveling	Pump	Cause and Troubleshooting
222	SEAT MISMATCH	●	●	Cause This alarm is occurred only in the driving and pump configuration or multi-motor configuration. Nonconformance is detected between the two TILLER/SEAT input A8 (A6) of two controllers. Troubleshooting - Check whether there are any inappropriate connections on the external wiring. - Use the TESTER function to check whether the input from the driver's seat complies with the actual external switch state. - Replace the controller when the problem is occurred continuously.
223	COIL SHOR. MC	●	●	Cause This alarm is occurred when the main contractor driver NLC (A16) is in overload. Troubleshooting - Typical source is on the wiring harness or rod coil. - Check the connection between the controller output and load. - Send inquiry to the HYUNDAI dealer to collect information on the coil characteristics and to check whether complying with the driver specification.
224	WAITING FOR NODE	●	●	Cause The controller receives the message from the CAN-bus on having issues on another controller, and the controller itself cannot access to the operating state. Therefore, standby is required until other nodes are deviating from the error state. Troubleshooting Check which other device of the CANbus is in failure state.
226	VACC OUT RANGE	●	●	Cause - The ACC POT input (A3) read by the micro-controller is deviating from the MIN VACC and MAX VACC range programmed through the PROGRAMM VACC function. - Minimum and maximum values obtained have no consistency. Troubleshooting - Calculate the maximum and minimum potentiometer values through the PROGRAM VACC function. Check the mechanical correction and function of the accelerator potentiometer when the alarm is continued. - Replace the logic board when the problem is still occurred.
227	HW FAULT	●	●	Cause During the startup, it was discovered that there are issues on some hardware circuits that can activate and inactivate the power bridge. The HYUNDAI dealer can debug the issue through the hexadecimal value of "XX". Troubleshooting This error is related to the internal components. Replace the logic board.

Code	Alarm	Traveling	Pump	Cause and Troubleshooting
228	TILLER OPEN	●	●	Cause TILLER/SEAT input was inactivated for 120 seconds or more. Troubleshooting - Activate the TILLER/SEAT input. - Use the TESTER function to check the TILLER/SEAT input state. - Check the wiring. - Check for failure on the micro-switch. - Replace the logic board when the problem is still occurred.
229	HW FAULT EB.	●	●	Cause During the startup, it was discovered that there are issues the hard-ware circuits exclusively for activating and inactivating the NEB output (A18). The HYUNDAI dealer can debug the issue through the hexa-decimal value of "XX". Troubleshooting This error is related to the external components. Replace the logic board.
230	LC COIL OPEN	●	●	Cause State of not connected with the load was detected on the proportional control valve output NLC (A16). Troubleshooting - Check the LC coil. - Check the wiring. - Check the LC anode terminal possible on the key line. - Replace the logic board when the problem is still occurred.
232	CONT. DRV. EV	●	●	Cause One or more ON/OFF valve drivers cannot operate the load. Refer to ## for the meaning of the code XX. Troubleshooting Device or its operating circuit was damaged. Replace the controller.
233	POWERMOS SHORTED	●	●	Cause DC link voltage is dropped to 0 when the MOSFET is turned ON from the HI or LOW side. Troubleshooting - Check for proper connection of the motor phase. - Check whether dispersion has occurred due to the grounding on each motor phase. - Replace the controller when the problem is continued.
234	DRV. SHOR. EV	●	●	Cause One or more ON/OFF valve drivers are resulted in short-circuit. Refer to ## for the meaning of the code XX. Troubleshooting Check for short-circuit between the coil and -B cathode terminal, or occurrence of the low impedance path. - Replace the logic board when the problem is still occurred.

Code	Alarm	Traveling	Pump	Cause and Troubleshooting
235	CTRAP THRESHOLD	●	●	Cause This alarm is occurred when nonconformance is detected between the overcurrent detection circuit (due to the DUTY PWM CTRAP variable) set value and actual limit feedback. Troubleshooting This failure is occurred on the controller hardware. Replace the logic board.
236	CURRENT GAIN	●	●	Cause When the current gain variable is the default value, it specifies that the maximum current adjustment procedure is not executed yet. Troubleshooting Send inquiry to the HYUNDAI dealer on the procedure for adjusting the current gain variable.
237	ANALOG INPUT	●	●	Cause This alarm is occurred when the A/D conversion of the analog input becoming the freeze value of all converted signal is 400 s or more. The purpose of this diagnosis is to detect the issue of the code flow excluding the A/D converter error or refresh on the analog signal conversion. Troubleshooting Replace the logic board when the issue is occurred continuously.
238	HW FAULT EV.	●	●	Cause During the startup, it was discovered that there are issues on the hardware circuits exclusively for activating and inactivating the Ev driver. Refer to ## for the meaning of the code XX. Troubleshooting This error is related to the external components. Replace the logic board.
239	CONTROLLER MISM.	●	●	Cause The software is inappropriate for the hardware. Each controller is produced with the specific code mark stored in the EEPROM according to the part number complying with the orderer requirements, and "Signature" is applied when finishing the line test. According to this "Signature" only the firmware according to the orderer requirements can be uploaded. Troubleshooting Upload the proper firmware.
240	EVP DRIVER OPEN	●	●	Cause The EVP driver output NEVP (A19) cannot operate the EVP coil. Device or its operating circuit was damaged. Troubleshooting This error is related to the external components. Replace the logic board.
241	COIL SHOR. EVAUX	●	●	Cause This alarm is occurred when there is overload on the auxiliary voltage output (NEV1 A25, NEV2 A34 and NEV3 A35). Troubleshooting - Typical source is on the wiring harness or rod coil. - Check the connection between the controller output and load. - Send inquiry to the HYUNDAI dealer to collect information on the coil characteristics and to check whether complying with the driver specification.
242	OPEN COIL EV.	●	●	This alarm is not used in this lift truck.

Code	Alarm	Traveling	Pump	Cause and Troubleshooting
243	THROTTLE PROG.	●	●	Cause Inappropriate profile is set on the throttle profile. Troubleshooting Set the appropriate variable related to the throttle.
244	WARNING SLAVE	●	●	Cause This is a warning on the supervisor controller. Troubleshooting Connect the console to the supervisor controller to check whether the alarm is occurred.
245	IQ MISMATCHED	●	●	Cause It is an error of the estimated q-axis current and relevant set values deviating from the range. Troubleshooting
246	EB. DRIV.OPEN	●	●	Cause Load cannot be operated by the EB driver. Device or its operating circuit was damaged. Troubleshooting This error is not related to the external components. Replace the logic board.
247	DATA ACQUISITION	●	●	Cause The controller is in corrected state. Troubleshooting Alarm is stopped when data collection is completed.
248	NO CAN MSG.	●	●	Cause CAN-bus communication is not operating properly. Check the failure node through the hexadecimal value of "XX" Troubleshooting - Check the device connected to the CAN-bus network. - Check the impedance between the CANH and CANL with the multimeter. The value is 60Ω. Replace the logic board when the alarm is still occurred.
249	CHECK UP NEEDED	●	●	Cause This warning shows that it is the scheduled maintenance time. Troubleshooting After performing the maintenance service, turn ON the CHECK UP DONE option.
250	THERMIC SENS. KO	●	●	Cause The output of the controller heat sensor deviated from the range. Troubleshooting This error is not related to the external components. Replace the controller.

Code	Alarm	Traveling	Pump	Cause and Troubleshooting
251	WRONG SET BAT.	●	●	Cause On startup, the controller checks the battery voltage measured during the key input, and verifies whether ±20% range of the nominal value. Troubleshooting - Check whether the SET BATTERY variables of the ADJUSTMENTS list complies with the battery nominal voltage. - SPECIAL ADJUST when the nominal voltage of the battery is not in the SET BATTERY variables of the ADJUSTMENTS list. Record the stored value on the HARDWARE BATTERY RANGE variable in the list, and send inquiry to the HYUNDAI dealer. - Use the TESTER function to check whether the KEY VOLTAGE value shows the value equal to the key voltage measured with the voltmeter on the pin A3 (A1). When the two voltages are different, the ADJUST BATTERY variable is adjusted with the voltmeter value. - Replace the battery.
253	FIELD ORIENT. KO	●	●	Cause It is an error of the estimated Id (d-axis current) and relevant set values deviating from the range. Troubleshooting Send inquiry to the HYUNDAI dealer for appropriate adjustment of the motor variable.
254	EB. DRIV.SHRT.	●	●	Cause - Short-circuit has occurred on the pin A18 driver. - The micro-controller detected the nonconformance between the set value and pin A18 output feedback. Troubleshooting - Check whether the short-circuit between the cathode terminal of the coil and -B has occurred, or whether the low impedance conduction path has occurred. - Check whether the voltage used is complying with the pin A18 related variable setting. - Replace the controller when the problem is continued.

2) DRIVING AND PUMP SLAVE

Code	Alarm	Traveling	Pump	Cause and Troubleshooting
8	WATCHDOG	●	●	Cause Test related to safety. It is the self-diagnosis test using the logic between the master and supervisor micro-controller. Troubleshooting This alarm may occur from the CAN-bus failure, and communication between the master and the supervisor may be inappropriate accordingly.
17	LOGIC FAILURE #3	●	●	Cause Hardware issue on the logic board due to the high current (overload). Overcurrent can also occur when the power bridge is not operated. Troubleshooting This failure is occurred on the controller hardware. Replace the controller.
19	LOGIC FAILURE #1	●	●	Cause The controller detects the low-voltage state in the KEY Input A3 (A1). The low-voltage limit acn be different depending on the controller version. Nominal Voltage **24 V, 36V, 48 V** **80 V, 96 V** Low-voltage Limit 10 V 30 V Troubleshooting (Failure on startup or standby state) - Problem can occur by the key input signal with the pulse lower than the low-voltage limit as the characteristic that can occur from the external load such as DC/DC converter startup, relay or contactor during the switching, solenoid current carrying and power failure. These methods of removing the load can be considered. - When the transient voltage is not detected on the supply line and occurred with alarm each time that the key switch is turned ON, and relevant problem can be due to the controller hardware. Replace the logic board.
196	NO CAN MSG DISP	●	●	Cause The dashboard and the CAN-bus communication are not operating properly. The ECO mode is activated basically by this alarm. Troubleshooting - Check the on dashboard connected to the CAN-bus network. - Check the impedance between the CANH and CANL with the multimeter. The value is 60Ω. Replace the logic board when the alarm is still occurred.
200	STEER SENSOR KO	●	●	Cause The voltage read by the micro-controller of the steering sensor input is deviating from the STEER RIGHT VOLT ÷ STEER LEFT VOLT range programmed through the STEER ACQUIRING function. Troubleshooting - STEER ACQUIRING function is used to obtain the maximum and minimum values accessed by the steering potentiometer. Check the mechanical correction and function of the potentiometer when the alarm is continued. - Replace the logic board when the problem is still occurred.
201	WRONG FBSENS. SET	●	●	Cause ENCODER PULSES 1 and ENCODER PULSES 2 variables are incorrect. Troubleshooting Set two variables into the same value according to the encoder used.

Code	Alarm	Traveling	Pump	Cause and Troubleshooting
202	VDC LINK OVERV.	●	●	Cause This issue is indicated when the controller detects the overvoltage state. The overvoltage limit is different depending on the nominal voltage of the controller. Nominal Voltage **24 V** **36 V, 48 V** **80 V** **96 V** Overvoltage Limit 35 V 72.5 V 115 V 125 V Troubleshooting Power bridge and MC are opened immediately when occurred with the issue. This state is occurred by using the HW interrupt equal to those used on low-voltage detection, and the micro-controller classified as follows on two types for identifying the voltage existing throughout the DC link capacitor: - High Voltage Overvoltage State - Low/Normal Voltage Low Voltage State
208	EEPROM KO	●	●	Cause Hardware or software defect on the non-volatile embedded memory stored with the controller variables. It doesn't mean that the truck cannot be used due to this alarm, but the lift truck is operated only in the basic value. Troubleshooting Perform the CLEAR EEPROM procedure (refer to the console manual). Turn OFF and ON the start switch to check the result. The controller must be replaced when the alarm is still not stopped. When the alarm is stopped, the existing variables stored are replaced with the basic value.
209	PARAM RESTORE	●	●	Cause The controller is restored to the basic setting. When the CLEAR EEPROM is performed before the last key restart, this alarm indicates that the EEPROM is cleared appropriately. Troubleshooting The driving request or pump request cancels the alarm. Replace the controller when alarm is shown through key startup without performing the CLEAR EEPROM.
210	WRONG RAM MEM.	●	●	Cause The algorithm executed to check the main RAM register is discovered with the incorrect contents; Error occurred on the register. This alarm prohibits the lift truck operation. Troubleshooting Replace the logic board when the alarm is still occurred after the start key is turned OFF and ON again.
212	W.SET. TG-EB XX	●	●	Cause The supervisor micro-controller detected that the master micro-controller performed the main contactor output and pin A18 output setting incorrectly. Troubleshooting - Check whether the variables between the master and supervisor are correct. - Send inquiry to the HYUNDAI dealer. - Replace the logic board when the problem is still occurred.

<table>
<tr><th>Code</th><th>Alarm</th><th>Traveling</th><th>Pump</th><th>Cause and Troubleshooting</th></tr>
<tr><td>213</td><td>INPUT MISMATCH</td><td>●</td><td>●</td><td>Cause
The input value of the supervisor micro-controller different from the master micro-controller is recorded. The HYUNDAI dealer can debug the issue through the hexadecimal value of "XX".

Troubleshooting
- Use the TESTER function so compare tih the value read through the master and slave.
- Send inquiry to the HYUNDAI dealer.
- Replace the logic board when the problem is still occurred.</td></tr>
<tr><td>221</td><td>SPEED FB.ERR.
XX</td><td>●</td><td>●</td><td>Cause
This issue is occurred when detected on the speed or location feed-back sensor. Hexadecimal value "XY" is useful on verifying the es-sence of the issue : The first number is the type of feedback sensor, and the second number is the type of issue.
<table><tr><th>X</th><th>Sensor</th></tr><tr><td>0</td><td>Encoder</td></tr><tr><td>1</td><td>Sin/cos</td></tr><tr><td>3</td><td>Encoder + index</td></tr><tr><td>5</td><td>Resolver</td></tr><tr><td>6</td><td>3-Hall</td></tr><tr><td>7</td><td>PWM</td></tr></table><table><tr><th>Y</th><th>Issue</th></tr><tr><td>1</td><td>Generic error 1</td></tr><tr><td>2</td><td>Generic error 2</td></tr><tr><td>3</td><td>Generic error 3</td></tr><tr><td>4</td><td>Generic error 4</td></tr><tr><td>5</td><td>Signals off</td></tr><tr><td>6</td><td>Swapped signals</td></tr><tr><td>7</td><td>Shorted signals or one is absent</td></tr><tr><td>8</td><td>Signal amplitude</td></tr><tr><td>9</td><td>Signal amplitude (supervisor µC)</td></tr><tr><td>A</td><td>Too large speed step</td></tr><tr><td>B</td><td>SSL (sensorless speed loop)</td></tr><tr><td>C</td><td>Signals are filtered out</td></tr><tr><td>D</td><td>Free</td></tr><tr><td>E</td><td>Free</td></tr><tr><td>F</td><td>Free</td></tr></table>Troubleshooting
- Check two electrical and mechanical functions of the sensor.
- Check the wiring crimping.
- Check the mechanical installation of the sensor; It is an issue of the sensor slipping inside the housing.
- Electromagnetic noise on the sensor can become the cause of the alarm. In this case, replace the sensor.
- Send inquiry to the HYUNDAI dealer for the error indicated above.
- When the issue is continued even after replacing the sensor, it has high possibility that there is problem on the controller, so replace the controller.</td></tr>
<tr><td>227</td><td>OUT MISMATCH
XX</td><td>●</td><td>●</td><td>Cause
Test related to safety. The supervisor micro-controller detects that the master micro-controller is operating the driving motor in the incorrect method (not satisfying the request of the driver).
The HYUNDAI dealer can debug the issue through the hexadecimal value of "XX".

Troubleshooting
- Check whether the variables between the master and supervisor are correct.
- Send inquiry to the HYUNDAI dealer.
- Replace the logic board when the problem is still occurred.</td></tr>
<tr><td>229</td><td>NO CAN WR MSG.
XX</td><td>●</td><td>●</td><td>Cause
CAN-bus communication is not operating properly. Check the node with issue through the hexadecimal value of "XX":

Troubleshooting
- Check the CAN-bus network (external issue).
- Replace the logic board. (internal issue).</td></tr>
</table>

Code	Alarm	Traveling	Pump	Cause and Troubleshooting
230	SOFTWARE ERROR	●	●	Cause - This alarm is occurred only by the DEBUG CANMESS-AGE = 15 setting on the SPECIAL ADJUSTMENTS. The alarm returns to the code related to the failure on the specific software part. - Send inquiry to the HYUNDAI dealer for debugging of the software.
237	ANALOG INPUT	●	●	Cause This alarm is occurred when the A/D conversion of the analog input that is becoming freeze value on all converted signal is 400 ms or more. The purpose of this diagnosis is to detect the issue of the code flow excluding the A/D converter error or refresh on the analog signal conversion. Troubleshooting Replace the logic board when the issue is occurred continuously.
239	CONTROLLER MISM.	●	●	Cause The software is inappropriate for the hardware. Each controller is produced with the specific code mark stored in the EEPROM according to the part number complying with the orderer requirements, and "Signature" is applied when finishing the line test. According to this "Signature" only the firmware according to the orderer requirements can be uploaded. Troubleshooting Upload the proper firmware. Send inquiry to the HYUNDAI dealer for verifying whether the firmware is appropriate.
242	SP MISMATCH XX	●	●	Cause Test related to safety. The supervisor micro-processor detected that the speed setting is not complying with the contents of the master micro-controller. The HYUNDAI dealer can debug the issue through the hexadecimal value of "XX". Troubleshooting - Check whether the variables between the master and supervisor are correct. - Send inquiry to the HYUNDAI dealer. - Replace the logic board when the problem is still occurred.
248	NO CAN MSG.	●	●	Cause CAN-bus communication is not operating properly. Check the failure node through the hexadecimal value of "XX" Troubleshooting - Check the device connected to the CAN-bus network. - Check the impedance between the CANH and CANL with the multi-meter. The value is 60Ω. Replace the logic board when the alarm is still occurred.

8. BATTERY CHARGER

Here, the basic information related to the charger is described for convenience in understanding and use. The installation method of the charger includes the top on emergencies. The focus is made on utilizing conveniently in the field.

1) BASICS OF THE CHARGER

(1) Charger

The charger is a device that receives the external AC power (mostly from KEPCO) to convert to DC for supplying the power for accepting the DC power.
As the IUla and IUlaua method of SCR-type charger, it has the following advantages.

① The AC input voltage is changed irregularly within ±10% of the rated voltage (220/380/410/440V) to have stable charging voltage and current supplied to the battery.

② Temperature increase of the battery while charging is minimized to reduce the evaporation of the distilled water on the batter as much as possible.

③ Noise on the charger is very small, and the charging efficiency is good.

④ Short charge and over-charge are prevented.
Therefore, it helps the battery to maintain its performance for longer time and to prolong the life of the battery.

(2) Precautions on Handling the Charger

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 will be strictly prohibited.

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

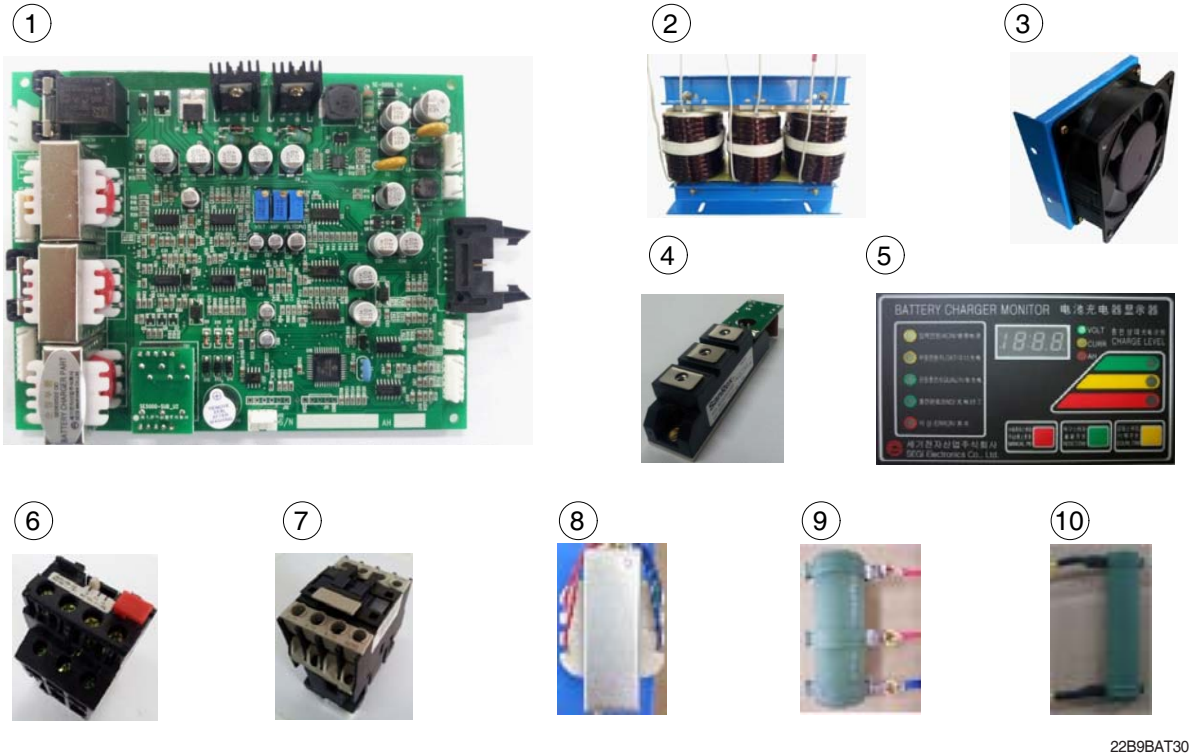
④ Check the electrolyte of the battery every week and provide distilled water immediately if it is required (Electrolyte has to be provided between 10-12 mm level on the positive plate inside storage battery).

⑤ If battery liquid temperature becomes over 55°C charging should be stopped should.
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 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 Component (Single Part)



22B9BAT30

1	Main PCB Board	5	PCB Monitor	9	Resistance (RD)
2	Main Transformer (Class H)	6	Overload	10	Resistance (DR)
3	Cooling Fan	7	MG Switch		
4	SCR Module	8	Auxiliary Transformer		

2) CHARGER INSTALLATION METHOD

(1) Location for charger installation

① Location without moisture and with good ventilation

② Location far away from flammable substances and fire

③ Safe location without possibility of collision from movement of workers and lift trucks

(2) Check points before installing charger

① The AC input power must be sufficient capacity to operate the charger

② Standard wire is used for power supply per charger capacity

(3) Table for capacity of charger input cable

48V battery	Cable capacity	Input Voltage	Remark
200-365 AH	4P - 2.5 mm^2	Criteria 3Ø380 V 3Ø440 V	For 3Ø220V, one step higher capacity cable should be used (2.5 mm^2 → 4mm^2)
400-580 AH	4P - 4 mm^2		
600-800 AH	4P - 6 mm^2		
850-1000 AH	4P - 10 mm^2		
24 V battery	-		
200-600 AH	4P - 2.5 mm^2		
700-1000 AH	4P - 4 mm^2		
80V battery	-		
500-600 AH	4P - 6 mm^2		
700-800 AH	4P - 10 mm^2		

3) METHOD OF USING THE CHARGER

(1) General charging method (Floating charging)

① Operate the external input AC power switch on the charger to supply power to the charger.

② Connect the battery connecter and the charger connector.

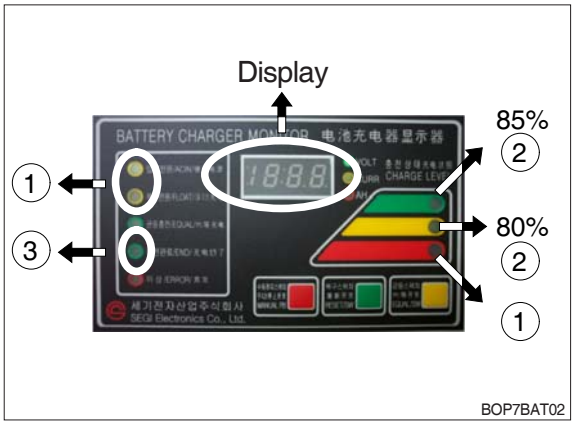
For each charging state

① When there is no issue after the self-diagnosis for 3~4 seconds after applying the AC input power, the charger is slowly increased with the charging current, and bottom lamp on the "Input" floating charge state is lighted on the front panel.

② Charging voltage, current, amount and time are indicated in order on the monitor display.

③ When the charging is performed approximately 80%, yellow lamp is turned ON on the center of the front panel to indicate that the charging is in progress, and green lamp is lighted when the charging is performed 85% or more and until the charging is complete.

④ When the charging is complete, "Charging Complete" lamp is lighted on the monitor, and other all lamps on the monitor are turned OFF.



(2) Equalizing 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.

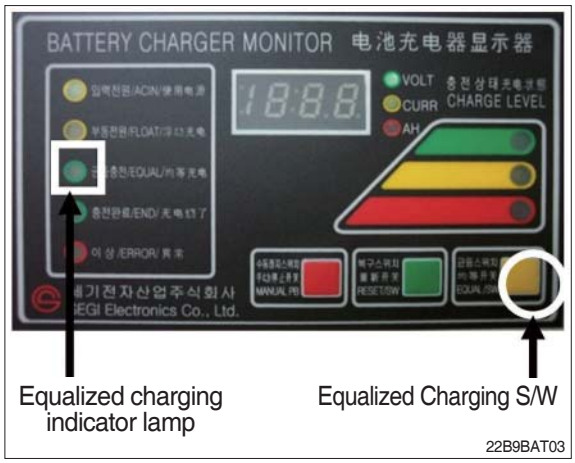
When equalized charging must be performed.

- When the battery is left for long period and re-operating
- When the battery is over-discharged
- When there is large deviation of voltage and specific gravity between battery cells.
- On replacement or replenishment of the battery electrolyte

② **Tips for equalized charging**

Equalized charging on the monitor is pressed once initially during the charging to light the equalized charging lamp on the monitor to start the charging.

※ **When the green light is turned ON for the charging state (85% charging state), equalized charging switch is locked, and it is not operated even when the relevant switch is pressed.**



22B9BAT03

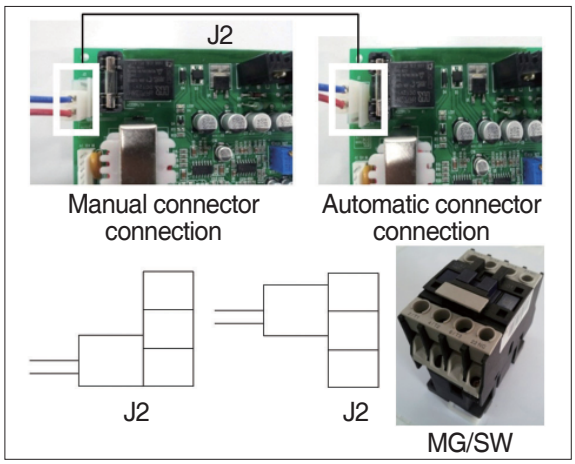
(3) Automatic/Manual switching method

The manual conversion connector of the AUTO connector (J2) is located on the upper left corner of the PC B.

※ **The battery connector must be separated in advance when converting to manual for checking the charger.**

⊙ **MG/SW operation**

(This swith is operated automatically.)



22B9BAT04

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

① When this is inserted to the manual connector and input, floating charge is performed after 5 seconds to have the red LED turned ON for the charging state.

② After 15 seconds, the yellow LED is turned ON for the charging state.

③ After the green LED is turned ON, the output voltage of the battery connector is measured with the multi-meter, and measurement voltage of lulua63V ~ lula64V specifies that it is in the normal state.

④ After converting to manual connector, the buzzer sounds for 10 seconds after 30 seconds, and it is normal when the LED indicating the completion is turned ON.

⑤ After checking that the charger is operating normally after inspecting the manual conversion of the charger, the charger must be converted automatically.

BOP7BAT10

⑥ It is abnormal when the output voltage of the charger is 60V or less.
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.

22B9BAT11

※ Abnormal display function on the front panel

No	Code	Error
1	E.F	EPROM fail
2	O.V	Overvoltage - Refer to Page 7-134
3	O.C	Overcurrent- Refer to Page 7- 133 and 133
4	F.B	Battery error (When failing to increase to 52V or more for 2 hours after starting the charging) Request for battery check
5	O.T	Transformer overheating (Charging is stopped when the temperature is 160˚C or more) - Pressure voltage is high or output current is in the reference value or higher, abnormal SCR control part to occur with heat on the transformer - Check the output current for correction and check the PCB control part
6	O.H	Heat sink overheating (Charging is stopped when the temperature is 100□ or more) - Check the cooling fan along with the SCR connection cable contact point and control part
7	A.O	Refer to power error (input power 220/380V connected inappropriately), page 7-131
8	A.F	Power Error (Open Phase) → Check input cable disconnection
9	A.C	AC Failure (Power Failure) → Check input cable disconnection
10	L.C	Low current (Charging finished when the set value is maintained for 60sec.)
11	F	Manual stop

4) MATTERS FOR VERIFICATION BEFORE REQUESTING A/S ON THE CHARGER

(1) Check whether the AC input power switch is turned ON.

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

(3) Matters for verification when the "Error" lamp is lighted on the front monitor of the charger

(4) Check front indicator of the charger

① A.F : Open phase on the input 3-phase power=Check with the AC voltmeter whether the input 3-phase power is normal.

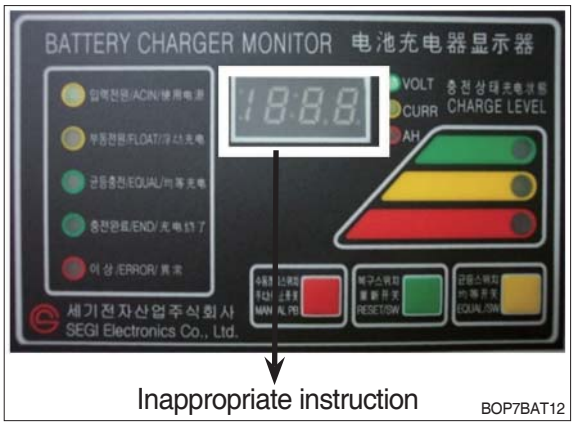
② A.O : Voltage selection error on the input power 220V or 380V-Check whether complying with the 3-phase.

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

④ O.C : The charging current of the battery is exceeding the standard, so the current is measured.

⑤ O.V : The charging voltage of the battery is in over-voltage (66V) state, so the voltage is measured.
Normally, this value is 64V±1.0V.

(5) Check for other abnormal state. Request for A/S when the measures cannot be taken in the field.



5) ERROR DETECTION

(1) Error list

① Only the floating charging lamp is lighted on the monitor, and charging is not performed.

② After initiating the charging, ON/OFF is repeated in several minutes of interval.

③ Charger TRIP after error lamp is lighted on the monitor (When the error code is "O.V")

④ Charger TRIP after error lamp is lighted on the monitor (When the error code is "O.C")

⑤ After starting the charging and with "O" mark and lighting with charging complete lamp, TRIP has occurred

⑥ When there is no response from the charger after connecting the battery connector SCR module checking method

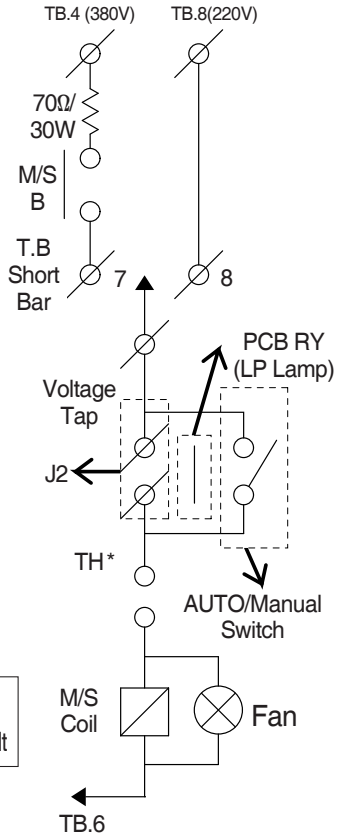
(2) TROUBLESHOOTING

① Only the floating charging lamp is lighted on the monitor, and charging is not performed after indicating "A.O".

· (Equal to 220V/380V) Measure the voltage between the input voltage conversion TAB 2-4 2-6 4-6
· For 220, 380, 410 and 440V exclusive model, measure in the front ot AC INPUT MS switch

MS electric plug

Manual/AUTO TAP(J2)



M/S Electrical Circuit Diagram

Rated voltage checking — YES → After separating the battery connector, put the AUTO/Manual selection switch to manual on the bottom of the PCB.

AC INPUT MS Switch ON — YES → PCB LP Lamp ON — YES → CN4 contact fault / PCB RY contact point fault

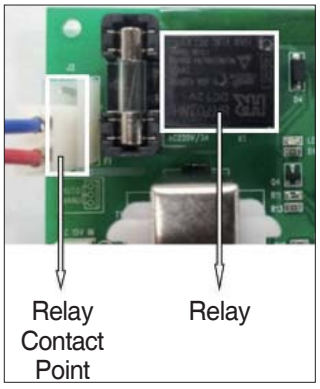
AC INPUT MS Switch ON — NO → Insert the black lead wire of the multi-tester into the input voltage switch No. 6, and with the red lead wire, measure the voltage between the No.8,PCB CN4,TH contact points.

PCB LP Lamp ON — NO → PCB replacement

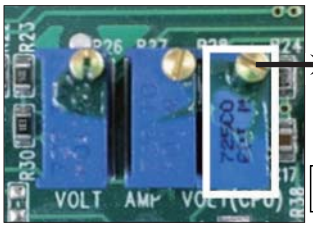
Rated voltage checking — NO → Input power supply is not supplied.
· Check external lead-in cable
· Check external input connector contact
· Check external NFB TRIP

Voltage 220V — NO → TH contact fault / CN4 contact fault / PCB relay fault / TH manual Restoration release

Voltage 220V — YES → MSCoil Fault



② After starting the charging, MS switch is repeated with ON/OFF in the interval of several minutes
- TH is operated
When the error code is "O.C" (AC Input Over-current TRIP)



Output Current

Decrease Increase

Transformer Noise is high in the MS ON state.

NO

DC Current (Clamp Meter) Output Charging Current Measurement

Measurement current Measurement value: 10~16A /100AH

NO

Specified Current Exceeded

In the PCB, output current AMP and VR are adjusted
VR is used to readjust the charging electric shock current

YES

· TH setting error
· TH setting value Re-adjust

TH. TRIP

YES

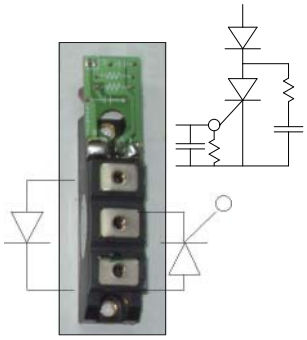
TH replacing

NO

Adjustment Complete

YES

* SCR module Refer to inspection method



Rated Current Setting

YES

NO

Complete

PCB replacing

Batter connector is separated to turn OFF the charger

SCR Module Inspection

NO

SCR module replacement

YES

Voltage Check

NO

PCB replacing

Check normal operating condition of the charger

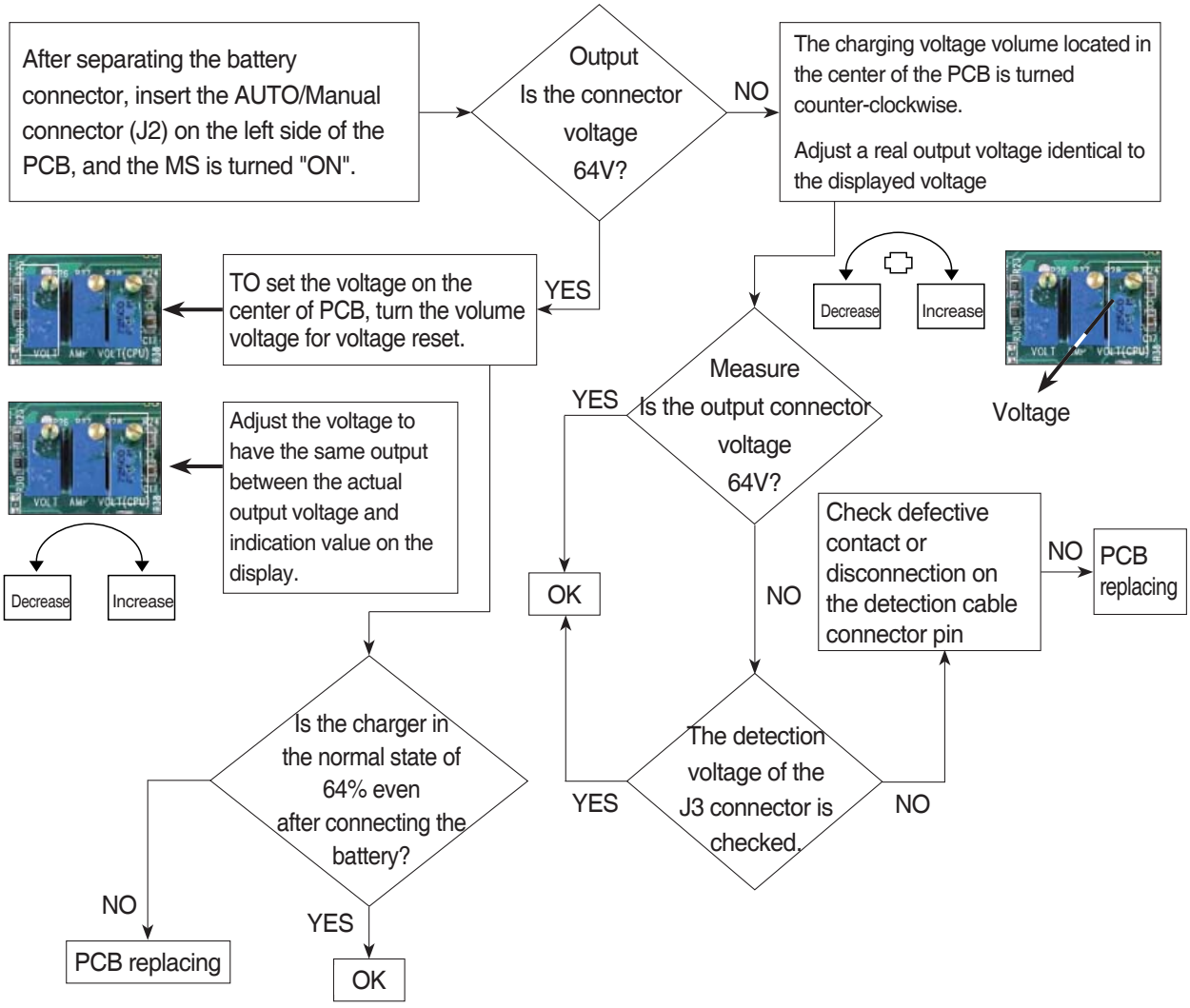
YES

③ Charger TRIP after the error lamp is lighted on the monitor

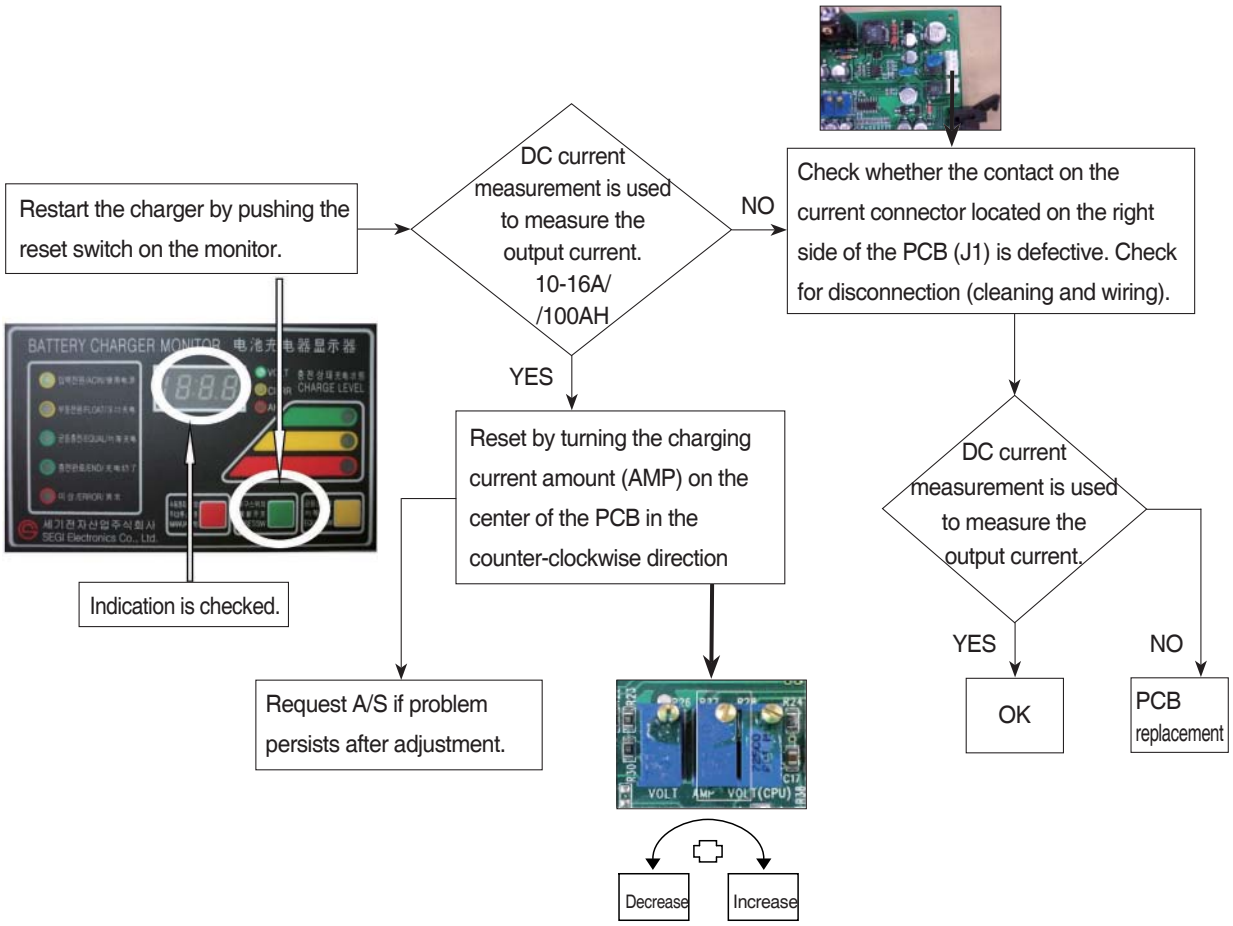
When the error code is "O.V" → Over-voltage output / 66V setting (When BATT is 48V)

Set to 34V (When BATT is 24V)

Set to 108V (When BATT is 80V)



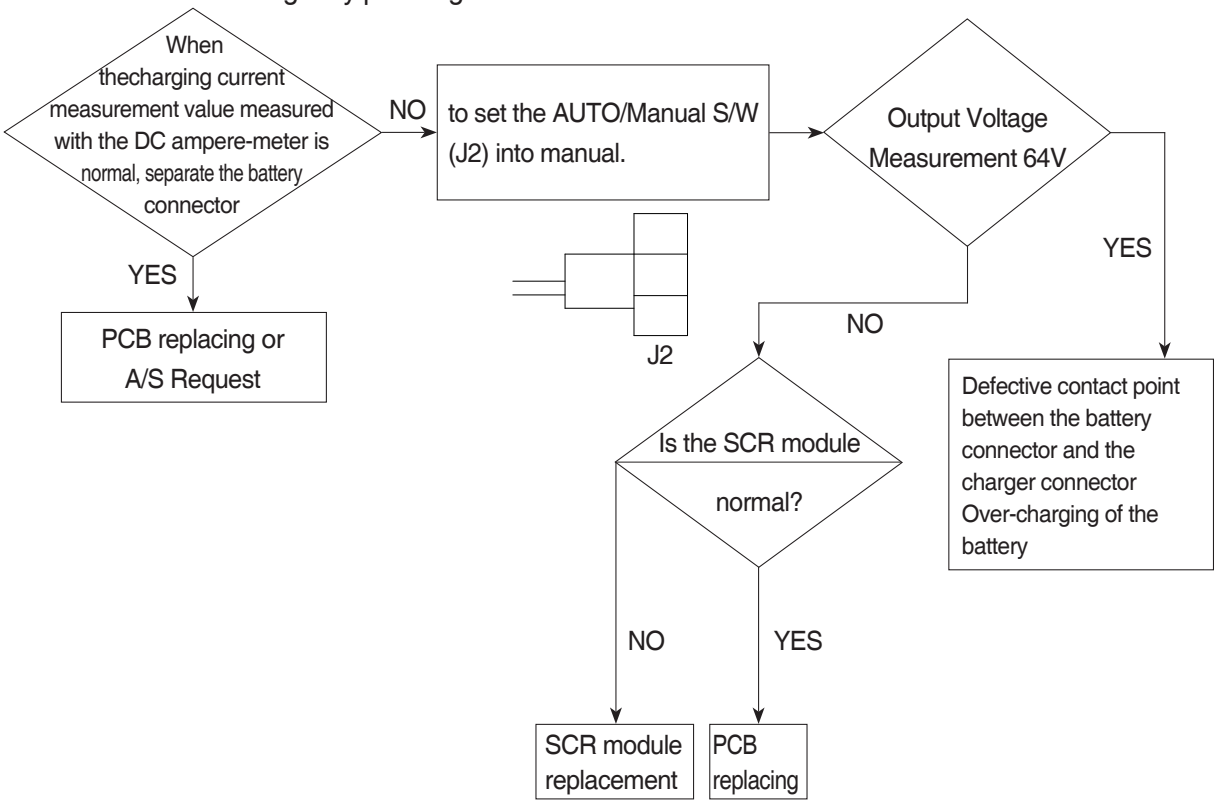
④ Charger TRIP after the error lamp is lighted on the monitor
After opening the cover located on the lower front side of the charger.
When the error code is "O.C" → Output over-current set as 110~120% of the rated current.



⑤ After starting the charging and with "O" mark and lighting with charging complete lamp, TRIP has occurred

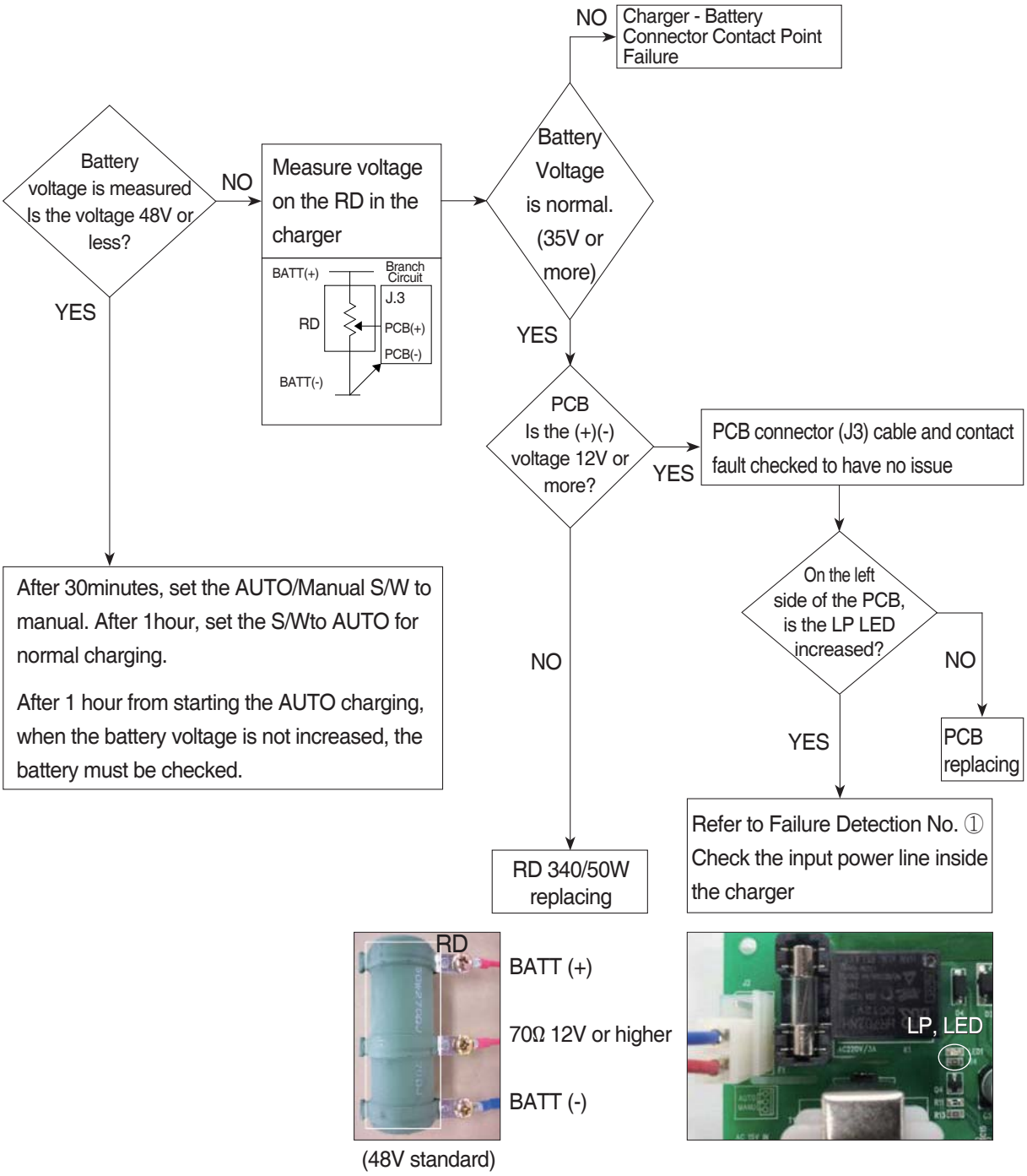
(When the input voltage is normal - Refer to the error detection No. 1.)

Restore the charger by pressing the reset switch.



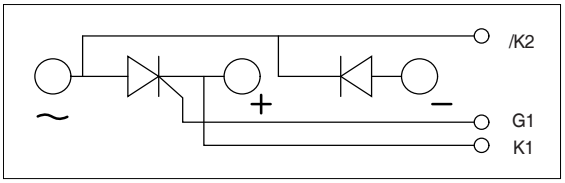
⑥ No response from the charger even when the battery connector is connected.

- When only the floating LED is lighted, the charger input current is blocked or not connected. (When the input voltage is normal - Refer to Error Detection No. ①.)

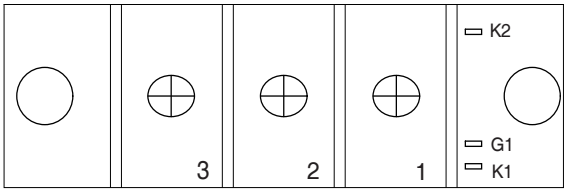


7) SCR MODULE CHECKING METHOD

Positive terminal on the circuit contactor output

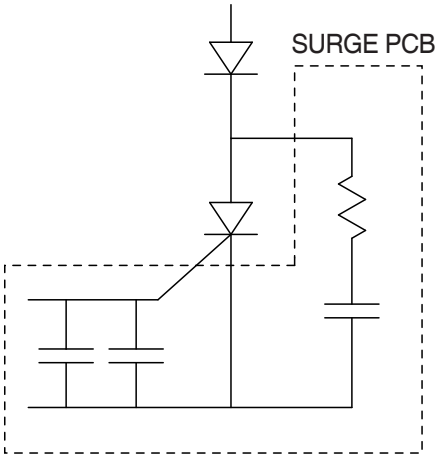


Real diagram

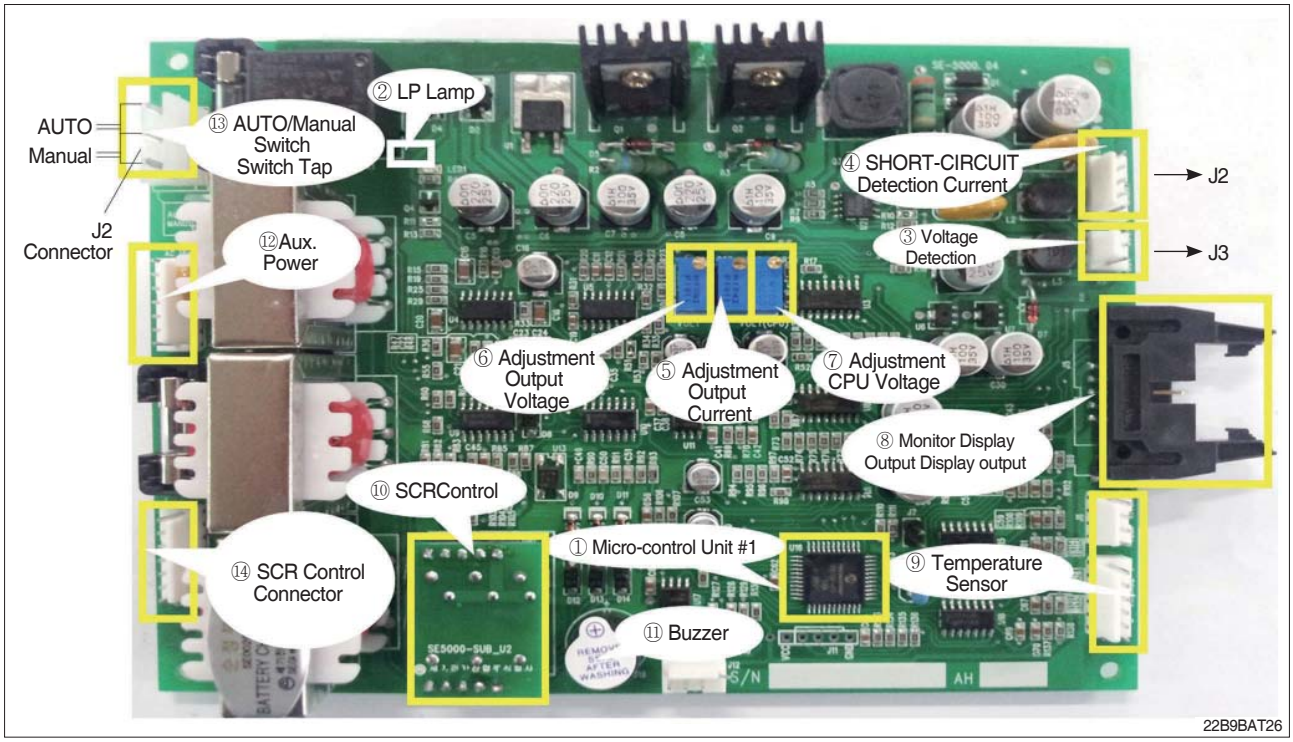


* Before checking the SCR module, the bus bar and wires connected to the terminal must be separated and removed completely.

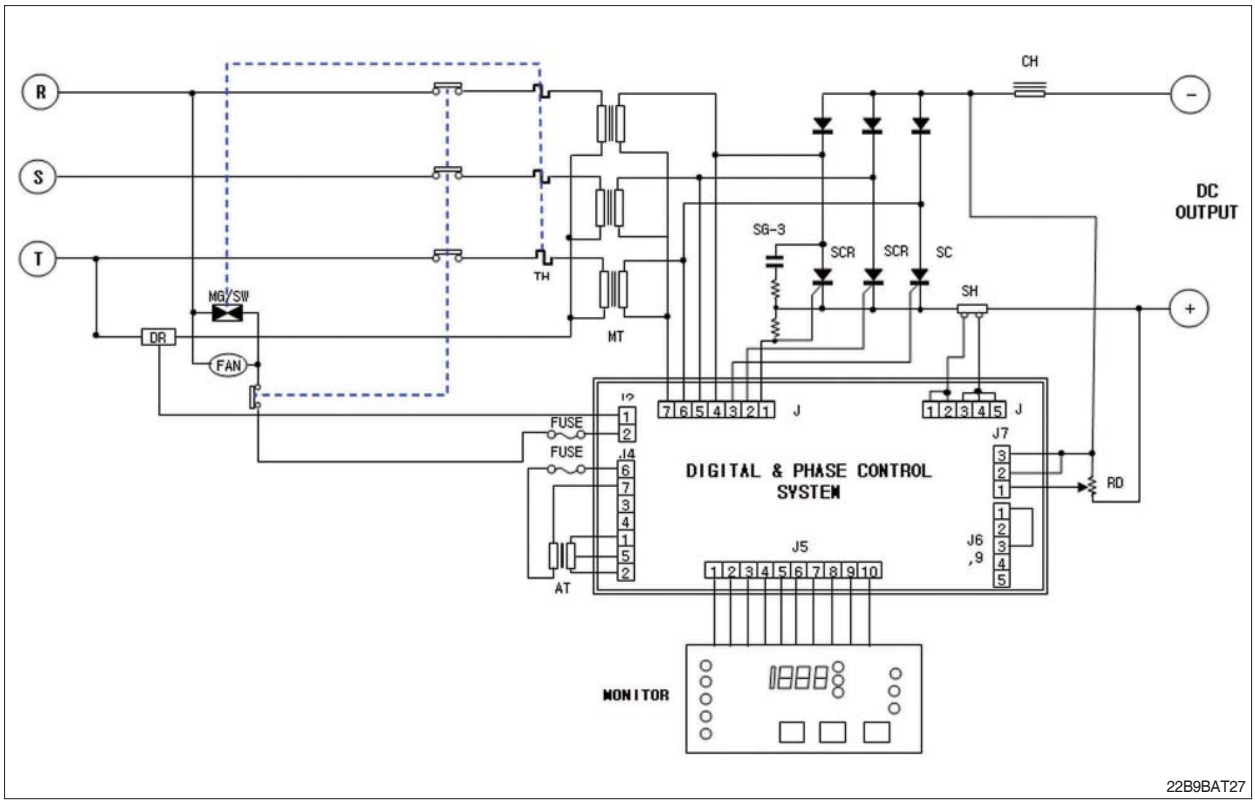
No.	Measurement Sites (Real diagram)	Measurement Value (Digital test number)
1	No.1 - No.3	Forward Direction : 100kΩ or less Reverse Direction : Infinite (∞)
2	No.2 - No.3	Forward Direction : Infinite (∞) Reverse Direction : Infinite (∞)
3	G1 - K1	Forward Direction : 100Ω or less Reverse Direction : 100Ω or less However, the value may be differed according to the module. The value is normal when it is not 0Ω.
4	G1 - K2	Forward Direction : Infinite (∞) Reverse Direction : Infinite (∞)



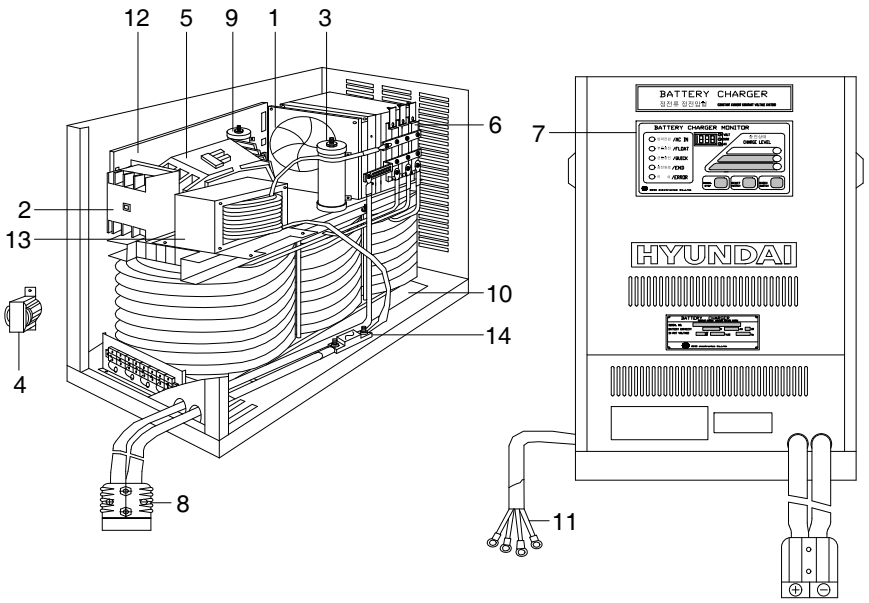
8) PCB MAJOR COMPONENT NAMES AND LOCATION



1	Micro-control Unit #1	6	Adjustment Output Voltage	11	Buzzer
2	LP Lamp	7	Adjustment PCU Voltage	12	Auxiliary Power Supply
3	Voltage Detection	8	Monitor Display Output	13	AUTO/Manual Switch Tab
4	SHORT-CIRCUIT Detection Current	9	Temperature Sensor	14	SCR Control Connector
5	Adjustment Output Current	10	SCR Control		


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

CHARGER INTERIOR PARTS



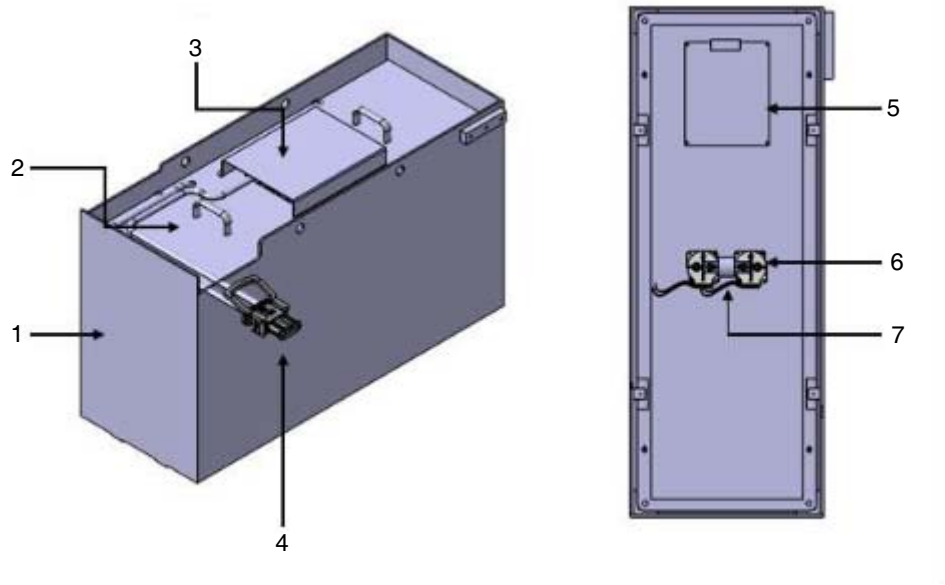
22B9BAT28

1	AC fan	6	SCR Module	11	AC input cable
2	Overload	7	Monitor board assembly	12	Main board
3	Resistance - RD	8	DC output cable	13	Choke filter
4	Auxiliary transformer	9	DR resistor	14	Fuse
5	Magnet switch	10	Main transformer		

9. LITHIUM-ION BATTERY (OPTION)

1) STRUCTURE

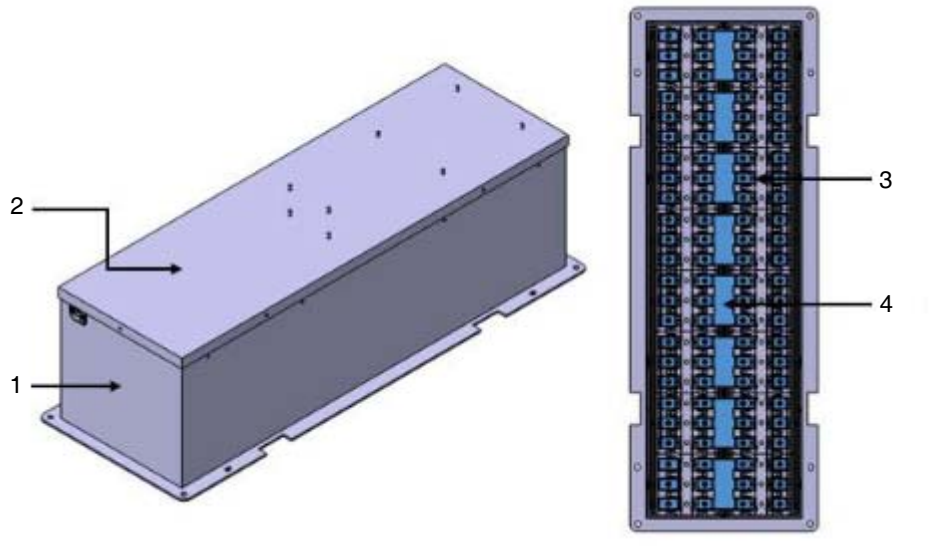
(1) Battery pack



15BRXEL95

1	Housing	4	Connector	7	Fuse
2	Top case	5	BMS		
3	Relay case	6	Relay		

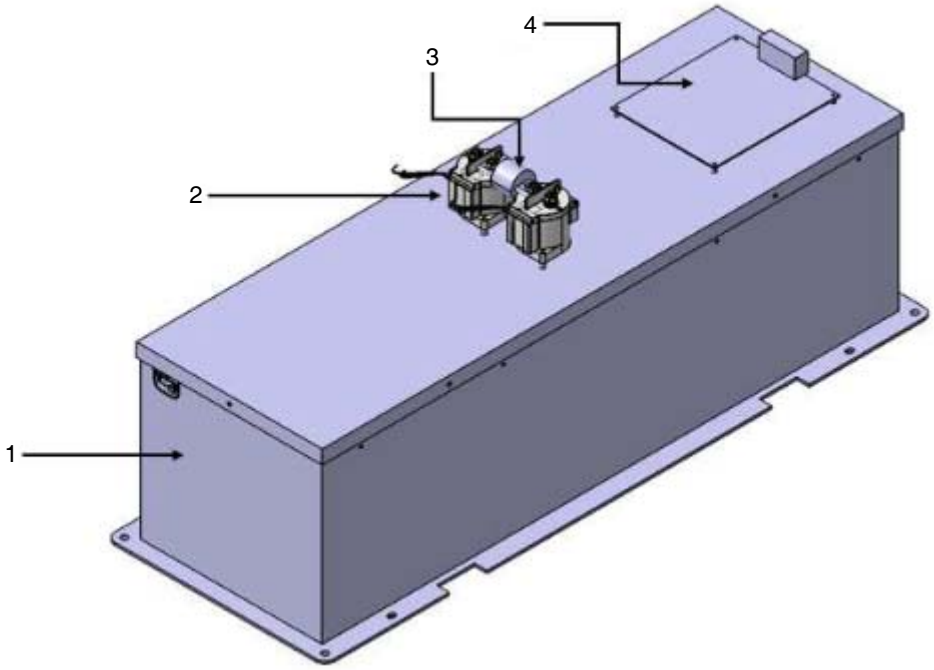
(2) Battery module



15BRXEL96

1	Module frame	3	Cell
2	Top cover	4	Module bus bar

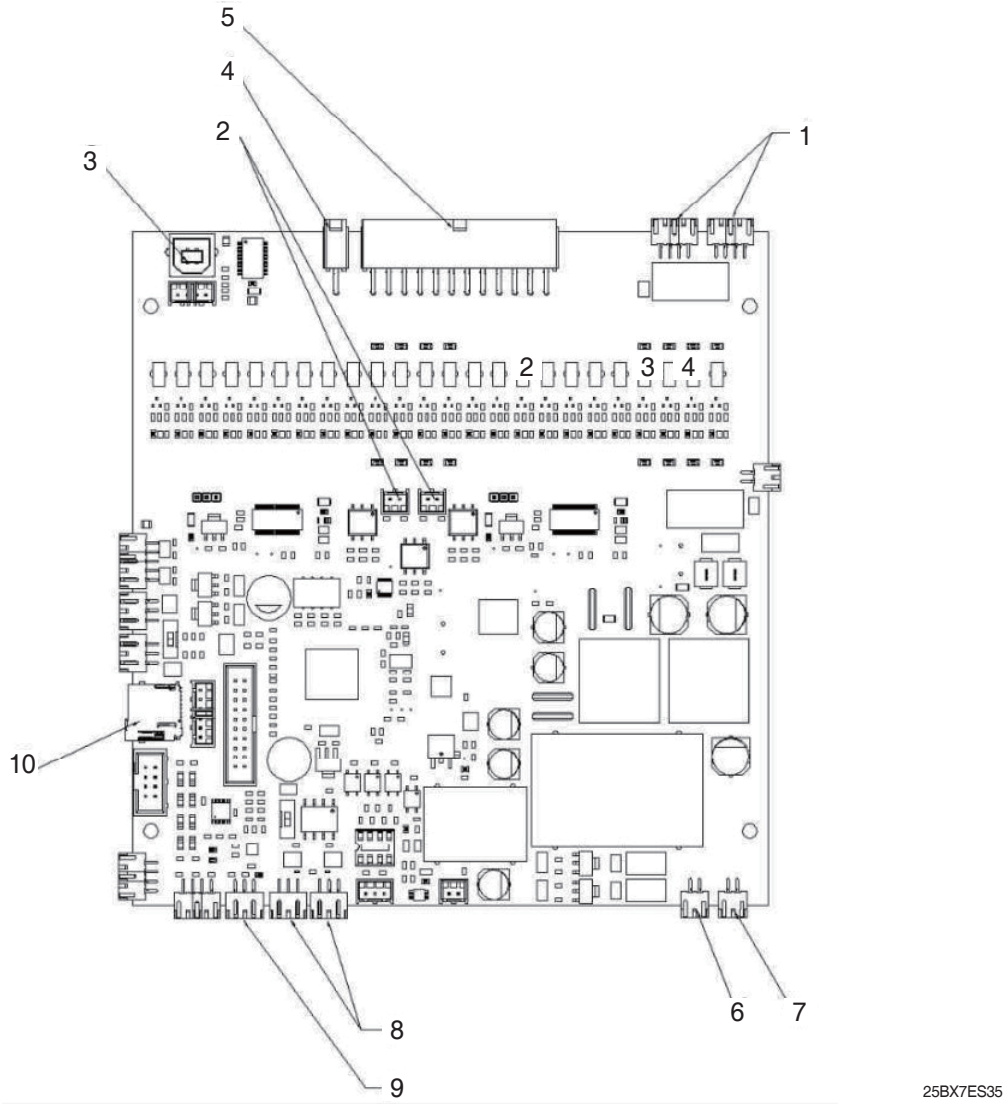
(3) BMS



15BRXEL97

1	Battery Module	3	Fuse
2	Relay	4	BMS

(4) Names and functions of BMS parts



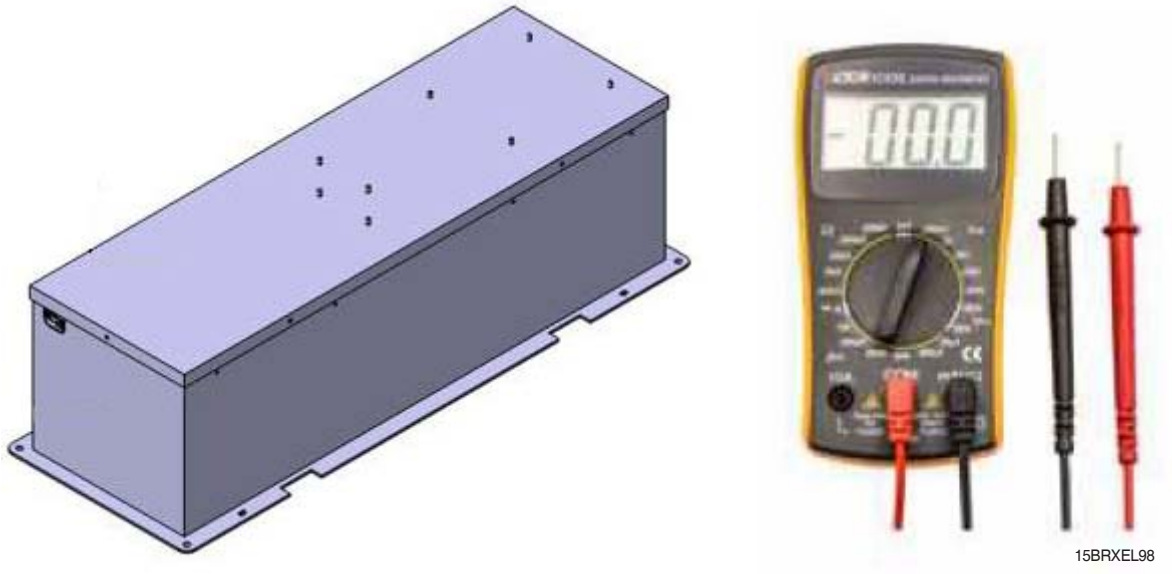
1	Switch	5	Cell cable	9	Current sensor port
2	Temperature sensor	6	CHA relay port	10	SD card slot
3	USB port	7	DIS relay port		
4	Ground cable	8	CAN port		

LED	Name	Functions
Power (Green)	Power LED indicator	The indicator lights when power is normally supplied when turning the power switch on.
CHA (Green)	Charging protection LED indicator	The indicator lights when the charging protection function does not operate, but is in normal conditions (normal). The indicator is turned off when the charge protection relay contact is off by operation of charging protection function in case of over-charging, over-current, or overheating.
DIS (Green)	Discharge protection LED indicator	The indicator lights when the discharging protection function does not operate, but is in normal conditions (normal). The indicator is turned off when the discharge protection relay contact is off by operation of discharge protection function in case of over-charging, over-current, or overheating.

2) SPECIFICATIONS

Item	Unit	Spec.
Rated voltage	V	51.2
Capacity	AH	300
Size (W×L×H)	mm	994×378×582
Weight	kg	560
Connector	-	DIN 320

3) CHECKING BEFORE REPLACING



(1) Battery Pack Voltage Measurement

Measure voltage between the positive electrode terminal (+) and the negative electrode terminal (-) of the module with the voltage meter.

- · Module shipping voltage: 48.0 - 53.0 V
- · Criteria for judging normal conditions: Within shipping voltage, and within Min./Max. 0.02V on the voltage deviation between modules
- · Measurement points: Positive and negative electrode terminals

(2) Insulation resistance measuring

Measure the positive (+) and the negative electrode terminals, and the case of the battery pack with an insulation meter.

- · Criteria for judgment of normal conditions: 500V applied/100 MΩ or higher
- · Measurement points: Positive electrode terminal - Battery pack case, or negative electrode terminal - Battery pack case

⚠ **Do not measure the positive electrode terminal with method used for voltage measuring.**

4) Part replacement

⚠ PRECAUTION

- · Check the battery for crack, breakage, and oil leak before replacement. Using defective products may cause faults on product circuits, or fire by leakage.
- · Replace the battery with product of capacity same as those mounted product. Using battery of different capacity may cause restriction on use and hazard such as capacity deviation.
- · Wear insulated gloves when moving and handling the battery. Injury may take place during moving, or electrolyte contacting with skins may cause burn.
- · When mounting two batteries, the batteries should be of capacity same as those of mounted batteries, and from same lot. Using batteries different to each other may cause fault.

※ Fastening torque

- · M4 bolt : 0.15±0.01 kgf·m
- · M8 bolt : 1.2±0.1 kgf·m

(1) Fuse exchange

① Remove the relay case of the battery pack.
② M8 nut above the fuse is removed by using the 13 ㎜ box socket. (Care should be exercised for preventing short-circuit resulted from movement of the main cable.)
③ Replace the fuse.
④ Assemble the parts in reverse order of disassembling.

(2) Relay replacement

Remove the top cover of the battery pack.
① Make use of a 13-mm box spanner to remove M8 nuts from the both sides of Relays A1 and A2. (Care should be exercised for preventing short-circuit resulted from movement of the main cable.)
② Make use of a screw driver to remove M4 bolt for fastening the relay.
③ Replace the relay.
④ Assemble the parts in reverse order of disassembling.

(3) BMS replacement

① Remove the top case of the battery pack.
② Remove the cell cable from the top of BMS. (Connector specifications: MOLEX 5557-24P, -2P)
③ Remove cables from BMS.
④ Remove M4 bolts from 4 points on BMS. (Be careful not to cause falling of BMS when disassembling BMS not holding it; Short-circuit may take place.)
⑤ Replace BMS.
⑥ Assemble BMS in reverse order of disassembling

(4) Battery module replacement

① Remove the top case of the battery pack.
② Remove 4 M4 bolts connecting the enclosure and module shown in vertical direction.
③ Connect the sling bar and hook on the i-bolt fastened on the module end.
④ Perform hoisting on the i-bolt fixed on the top to separate the battery module from the battery pack.
⑤ Replace the module.
⑥ Assemble the parts in reverse order of disassembling.

(5) Handle

① Remove the top case of the battery pack.
② Use the driver to remove the M6 bolt on the opposite side of the upper case on the battery pack.
③ Replace the handle.
④ Assemble the parts in reverse order of disassembling.

(6) Checking before startup after replacement

· Voltage should not be sensed when checking voltage on the both ends of the battery pack terminal (DIN320 Connector) after mounting on the system.
· Make sure that (+) and (-) terminal directions of the discharge terminal (JOT95-8 ring terminal) are identical with those of system load.
· Make sure that the cable connectors are correctly connected on the battery pack for communication with the system.

5) BATTERY DIAGNOSIS AND TROUBLESHOOTING

⚠ Extreme adjustment or change of parameters may cause unstable operation. Neve attempt such actions. Turn power off immediately after alarm, if any.

(1) When startup is not allowed

· Relay malfunction : Relay signal fault, or electric part failure → Check the both ends of the relay for short-circuit. If no power is supplied, replace the relay.
· Fuse breakage : Check the both ends of the fuse for short-circuit. If no power is supplied, replace the fuse.
· BMS malfunction/failure : Monitoring with BMS inspection program → When monitoring results show no fault, make request for A/S, or replacement of BMS if the program does not read battery information.

(2) Trouble during part replacement

· Spark and melting caused by short-circuit of main cable

- Though risk of fire is small, provide fire extinguisher for fire, if any.
- If spark only takes place, make use of insulated tools to hold and remove the main cable.
- If it is hard to remove the main cable because of melting, remove the cable in the following sequences :

① Remove the cell cable (MOLEX 5557 connector) connected to BMS.

② Remove M8 bolts from (+) and (-) terminals of the battery module, and also remove connected main cable.

③ Remove molten main cable.

· If circuit is burnt or smoldered during BMS replacement ;

- Make a request for A/S for BMS.
- Replace BMS with new BMS.
- Check the cell cable for being burnt. If so, stop operation, remove the battery module from battery pack, and make a request for A/S.

10. LITHIUM ION BATTERY CHARGER (OPT)

※ Before connecting the battery charger to the power supply and the battery, carefully read the instructions below :

1) USE AND OPERATION

(1) To use this battery charger you must comply with safety requirements contained in laws and regulations and in the provisions set out by the local authorities.

(2) The user should make sure that the use of charging equipment complies with current regulations, and that any action that may endanger the life and health of the user or any third party is avoided, as well as avoiding any damage to property.

INSTALLATION AND SAFETY WARNINGS

(1) Before connecting the battery charger to the power supply and the battery, carefully read the instructions below :

① For correct functioning and improved yield, the battery charger must be fixed. Pay attention not to obstruct the ventilation slots holes.

② Only specialized and authorized staff can carry out jobs that require the battery charger to be opened.

③ Before operating the battery charger, the insulation of mains connection cables and of the battery connectors must be verified.

④ It is necessary to intervene on electrical equipment, thoroughly trained personnel only.

⑤ Disconnect the mains connection before connecting or disconnecting the battery.

⑥ The battery being charged generates explosive gases, therefore it is prohibited to smoke in proximity of the machinery;
avoid naked flames and or sparks and proximity with other machinery that lead to hazardous circumstances for people or property.

⑦ The charger is installed with the electrical components which can generate electric arcs and sparks, so arrangement in appropriate location is required when using in the enclosed area. anyhow the standard battery charger should be used in enclosed and well ventilated areas and not exposed to rain and/or splashing water, placed on sound, levels floors. Dusty areas or areas with water sources, sources of heat and humidity should be particularly avoided. DO NOT place the battery charger on surfaces and/or shelves made with wood or other flammable materials or accumulate various materials near the battery charger and place any items or containers with liquids on the lid.

⑧ To prevent dangers of shock, the battery charger should be connected to a current socket connected to earth. Moreover, the current socket to which the battery charger will be connected must be proportionate to the power of the same and must be protected by appropriate electric equipment in compliance with Standards (fuses automatic switch). The protection should have calibration of at least 10 % over the equipment current absorption.

⑨ Always use special bipolar connector (DIN 320 REMA).

⑩ DO NOT use additional cables to extend the existing electrical connections.

⑪ Before starting to clean the appliance, disconnect the power supply cable from the mains and the connection cables to the battery.

3) CONNECTION TO POWER SUPPLY

It is essential to connect to the power of the installed battery charger. Connect the grounding appropriately.
Check the voltage state of the main power during the installation or transportation. to check the mains voltage and the presence of all 3 phases present on the position where the battery charger works.

Battery voltage (V)	Charger current (A)	Module power (kW)	Active input power (kW)	Input LAC norm (A)	Fuse AC (A)	DC fuse code
48	200	12	12.26	19.98	25	LMT250
48	250	16	15.32	24.97	32	LMT315

4) Battery connection

Anode connector is used according to the standard when connecting the battery. Also check the current connection of the cables in the connector contacts. This operation has to be performed by skilled personnel only.

※ The USB port is a service port to be used only for programming the charging parameters and downloading of historical data and graphs. You must disconnect the charger from USB cable during charging to prevent EMI noise from interference with the charging process with unpredictable consequences for the battery charger and battery.