CONTENTS

1. STRUCTURE

This service manual has been prepared as an aid to improve the quality of repairs by giving the serviceman an accurate understanding of the product and by showing him the correct way to perform repairs and make judgements. Make sure you understand the contents of this manual and use it to full effect at every opportunity.
This service manual mainly contains the necessary technical information for operations performed in a service workshop.
For ease of understanding, the manual is divided into the following sections

SECTION 1 GENERAL
This section gives the general information of the machine and explains the safety hints for maintenance.

SECTION 2 REMOVAL & INSTALLATION OF UNIT
This section explains the procedures and techniques of removal and installation of each component.

SECTION 3 POWER TRAIN SYSTEM
This section explains the structure of the transmission as well as control valve and drive axle.

SECTION 4 BRAKE SYSTEM
This section explains the brake piping, each component and operation.

SECTION 5 STEERING SYSTEM
This section explains the structure of the steering unit.

SECTION 6 HYDRAULIC SYSTEM
This section explains the structure of the gear pump, main control valve as well as work equipment circuit, each component and operation.

SECTION 7 ELECTRICAL SYSTEM
This section explains the electrical circuit and each component.
It serves not only to give an understanding electrical system, but also serves as reference material for troubleshooting.

SECTION 8 MAST
This section explains the structure of mast, carriage, backrest and forks

The specifications contained in this service manual are subject to change at any time and without any advance notice. Contact your HYUNDAI distributor for the latest information.

2. HOW TO READ THE SERVICE MANUAL

Distribution and updating

Any additions, amendments or other changes will be sent to HYUNDAI distributors. Get the most up-to-date information before you start any work.

Filing method

1. See the page number on the bottom of the page. File the pages in correct order.
2. Following examples shows how to read the page number.
   Example 1

   2 - 3
   - 2 : Item number (2, Removal & installation of unit)
   - 3 : Consecutive page number for each item.

3. Additional pages : Additional pages are indicated by a hyphen (-) and number after the page number. File as in the example.

   7 - 4
   7 - 4 - 1 ┐
   7 - 4 - 2 ┘ Added pages
   7 - 5

Revised edition mark (①②③…)

When a manual is revised, an edition mark is recorded on the bottom outside corner of the pages.

Revisions

Revised pages are shown at the list of revised pages on the between the contents page and section 1 page.

Symbols

So that the shop manual can be of ample practical use, important places for safety and quality are marked with the following symbols.

Symbols	Item	Remarks
	Safety	Special safety precautions are necessary when performing the work due to risk to human life
		Special safety precautions for work that might cause serious problem to equipment or surroundings.
※	Caution	Useful information to operator or work that might cause issues to equipment and function.

SECTION 1 GENERAL

GROUP 1 SAFETY HINTS

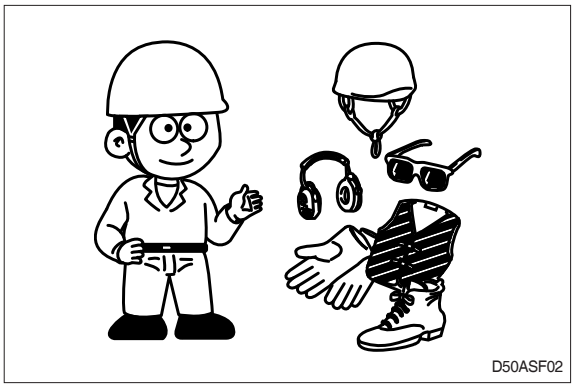
Careless performing of the easy work may cause injuries

Take care to always perform work safely, at least observing the following.

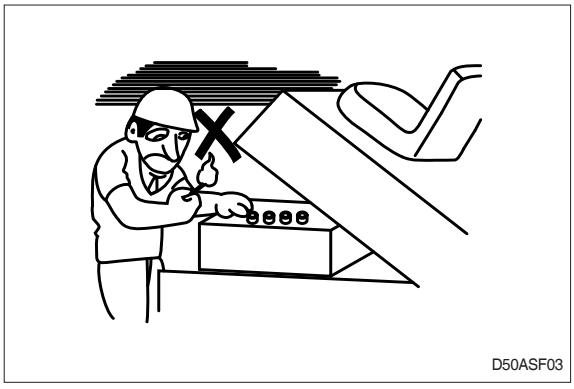
- Oil is a dangerous substance. Never handle oil, grease or oily clothes in places where there is any fire of flame.
  As preparation in case of fire, always know the location and directions for use of fire extinguishers and other fire fighting equipment.


D50ASF01

- Wear well-fitting helmet, safety shoes and working clothes. When drilling, grinding or hammering, always wear protective goggles.
  Always wear safety clothes properly so that they do not catch on protruding parts of truck.
  Do not wear oily clothes.
  When checking, always release battery plug.


D50ASF02

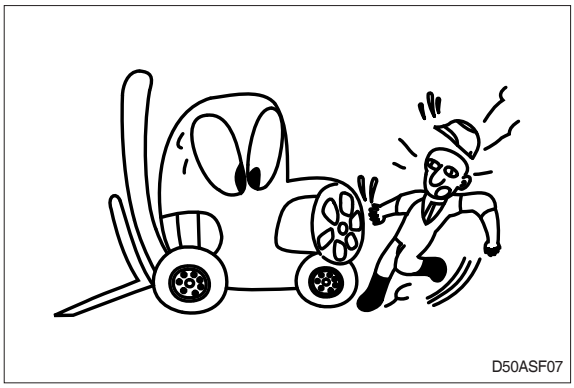
- Flames should never be used instead of lamps. Never use a naked flame to check leaks or the level of oil or electrolyte.


D50ASF03

- When working on top of the machine, be careful not to lose your balance and fall.

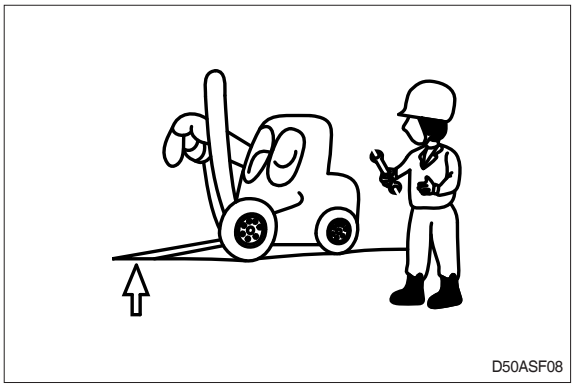

D50ASF06

· Place a caution sign in the operator's compartment
(For example Do not start or Maintenance in progress).
This will prevent anyone from starting or moving the machine by mistake.

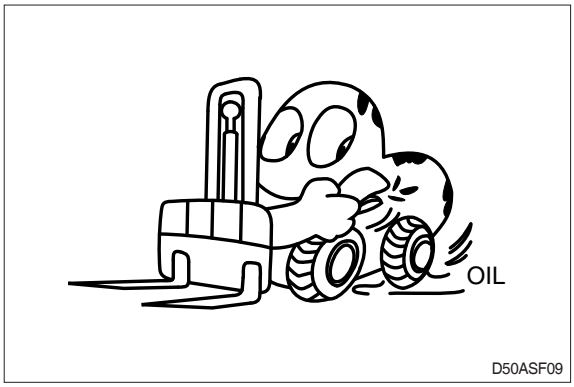

D50ASF07

When inspecting running parts or near such parts, always stop the machine first.
Before checking or servicing accumulator or piping, depress brake pedal repeatedly to release pressure.

· Park the machine on firm, flat ground.
Lower the fork to the ground and stop the engine.
Return each lever to NEUTRAL and apply the brake lock.

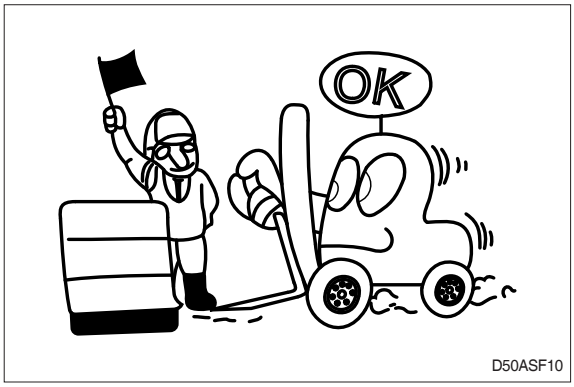

D50ASF08

· Immediately remove any oil or grease on the floor of the operator's compartment, or on the handrail. It is very dangerous if someone slips while on the machine.



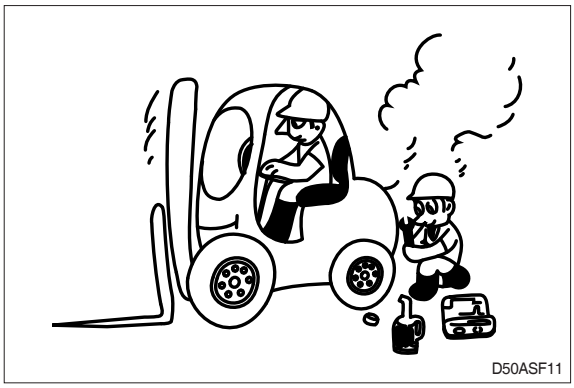
D50ASF09

· When working with others, choose a group leader and work according to his instructions. Do not perform any maintenance beyond the agreed work



D50ASF10

· Always remember that the hydraulic oil circuit is under pressure. When feeding or draining the oil or carrying out inspection and maintenance, release the pressure first.

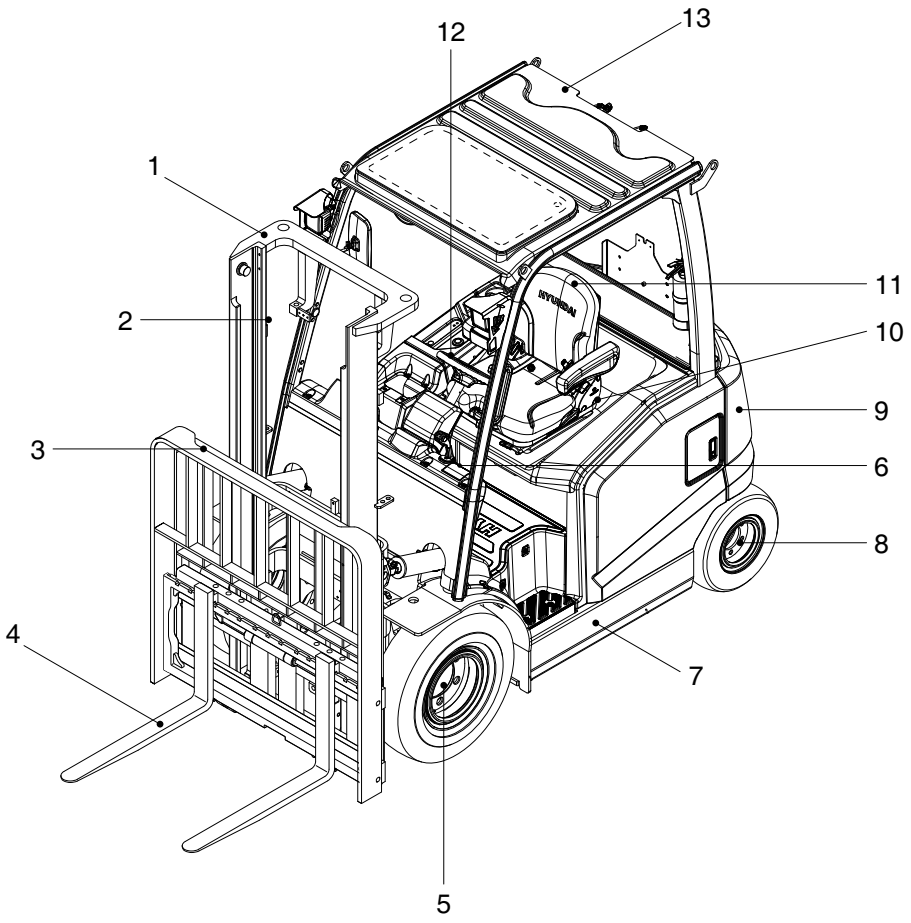

D50ASF11

· Unless you have special instructions to the contrary, maintenance should always be carried out with the machine stopped. If maintenance is carried out with the machine running, there must be two men present : one sitting in the operator's seat and the other one performing the maintenance. In such a case, never touch any moving part.
· Thoroughly clean the machine. In particular, be careful to clean the filler caps, grease fittings and the area around the dipsticks. Be careful not to let any dirt or dust into the system.
· Always use HYUNDAI Forklift genuine parts for replacement.
· Always use the grades of grease and oil recommended by HYUNDAI.
· Choose the viscosity specified for the ambient temperature.
· Always use pure oil or grease, and be sure to use clean containers.
· When checking or changing the oil, do it in a place free of dust, and prevent any dirt from getting into the oil.
· Before draining the oil, warm it up to a temperature of 30 to 40C.
· After replacing oil, filter element or strainer, bleed the air from circuit.
· When the strainer is located in the oil filler, the strainer must not be removed while adding oil
· When changing the oil filter, check the drained oil and filter for any signs of excessive metal particles or other foreign materials.
· When removing parts containing O-ring, gaskets or seals, clean the mounting surface and replace with new sealing parts.
· After injecting grease, always wipe off the oil grease that was forced out.
· Do not handle electrical equipment while wearing wet places, as this can cause electric shock.
· During maintenance do not allow any unauthorized person to stand near the machine.
· Be sure you fully understand the contents of the operation. It is important to prepare necessary tools and parts and to keep the operating area clean.
· When checking an open gear case there is a risk of dropping things in. Empty everything from your pockets before removing the covers to inspect such cases. Be particularly careful to remove wrenches and nuts
· Way to use dipstick
  Push the dipstick fully into the guide, and then pull out.

  Carrying out other difficult maintenance work carelessly can cause unexpected accidents.. If you consider the maintenance is too difficult, always request the HYUNDAI Forklift distributor for help.

GROUP 2 SPECIFICATIONS

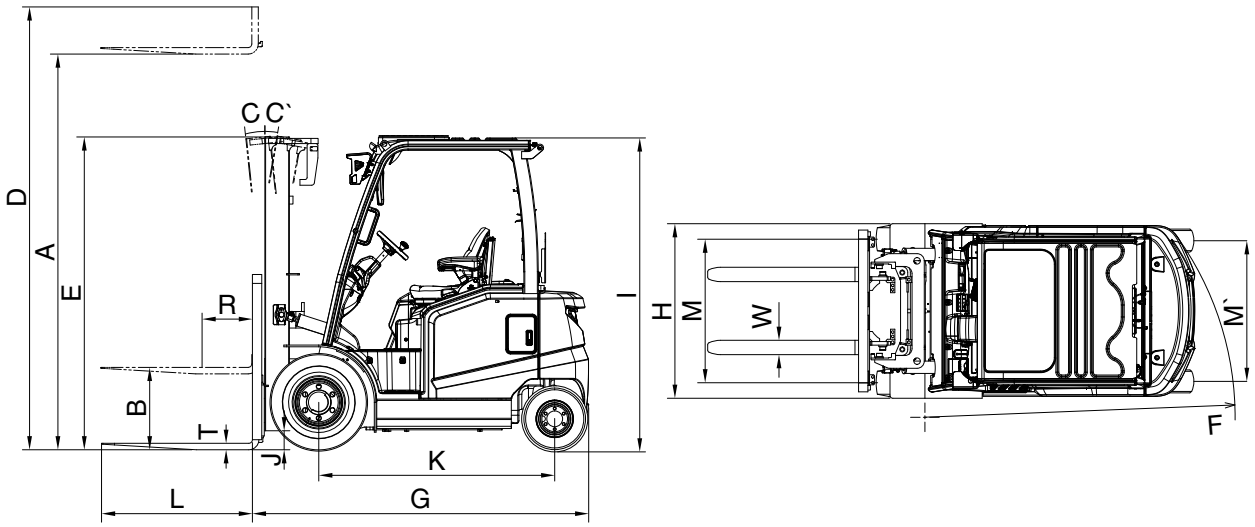
1. GENERAL LOCATIONS



25BX7PM01

1	Mast	6	Dash board	11	Seat
2	Lift cylinder	7	Frame	12	Steering wheel
3	Carriage and backrest	8	Steering axle	13	Overhead guard
4	Fork	9	Counterweight		
5	Drive axle	10	Battery cover		

2. SPECIFICATIONS



25BX8SP01

Model			Unit	25B-9X	30B-9X	32B-9X	35B-9X
Capacity			kg	2500	3000	3200	3500
Load center		R	mm	500	←	←	←
Weight			kg	4604	5043	5242	5486
Fork	Lifting height	A	mm	3300	←	←	←
	Free lift	B	mm	155	←	←	←
	Lifting speed [Load/Unload]		mm/sec	360/600	320/600	300/500	270/500
	Lowering speed [Load/Unload]		mm/sec	550/500	←	510/480	←
	Length × Width × Thickness	L×W×T	mm	1050×100×45	1050×122×45	←	←
Mast	Tilt angle forward/backward	C/C'	degree	6/10	←	←	←
	Max height	D	mm	4485	←	←	←
	Min height	E	mm	2182	←	2252	←
Body	Travel speed [Unload/Load]		km/h	16/17	←	←	←
	Gradeability [Load]		%	24	15.5	14.5	12.5
	Min turning radius [Outside]	F	mm	1940	2150	2165	2205
ETC	Max hydraulic pressure		kgf/cm^2	190	210	190	210
	Hydraulic oil tank		l	33	←	←	←
Overall length		G	mm	2349	←	2460	2505
Overall width		H	mm	1229	←	←	←
Overhead guard height		I	mm	2187	←	←	←
Ground clearance (Mast)		J	mm	135	←	←	←
Wheel base		K	mm	1572	1642	←	←
Wheel tread front/Rear		M/M'	mm	1005/980	←	←	←

2. SPECIFICATION FOR MAJOR COMPONENTS

1) CONTROLLER

Model	Unit	Traction motor controller	Pump motor controller
Model	-	CURTIS 1236SE-5621	←
Type	-	AC	←
Current limit	A	600A	←
Communication	-	CAN	←

2) MOTOR

Model	Unit	Traction motor controller	Pump motor controller
Type	-	ASRH4001	AMSR4001
Rated voltage	Vac	30	30
Output	kW	14	15
Insulator	-	FGrade	FGrade

3) BATTERY

Model	Unit	25B-X	30/32/35B-X
Type	-	Leadacid	←
Rated voltage	V	48	←
Capacity	AH/hr	600/5	700/5
Electrolyte	-	Wet	←
Size (W×L×H)	mm	984×466×744	984×536×744
Connector	-	SB 350	←
Weight	kg	1000	1150

LITHIUM-ION BATTERY (OPTION)

Model	Unit	25B-9X	30/32/35B-9X
Rated voltage	V	51.2	←
Capacity	AH	500	600
Size (W×L×H)	mm	984×466×750	984×536×750
Weight	kg	1000	1150
Connector	-	DIN 320	←

4) CHARGER

Model	Unit	Specification
Type	-	Constant current, constant voltage
Battery capacity for charge	V-AH	48V/660~740
AC input	V	Triple phase 410
		Single phase 220
		Triple phase 220/380
		Triple phase 440
DC output	V	64±1
Charge time	hr	6±2
Connector	-	SB 350 or SR 350

LITHIUM-ION BATTERY CHARGER (OPTION)

Model	Unit	25B-X	30/32/35B-X
Battery capacity for charge	V-AH	51.2-500	51.2-600
AC input	V	Triple phase 400	←
DC output	V	58.8	←
Charge time	hr	2	←
Connector	-	DIN 320	←

5) GEAR PUMP

Model	Unit	Specification
Type	-	Gear type hydraulic pump
Capacity	cc/rev	25.2
Max operating pressure	bar	250
Speed(max/min)	rpm	3000/100

6) MAIN CONTROL VALVE

Model	Unit	Specification
Type	-	3, 4 spool
Operating method	-	Mechanical
Main relief valve pressure	bar	210
Secondary relief valve pressure	bar	165

7) DRIVE AXLE

Model	Unit	Specification
Max. axle load	kg	9000
Max. input speed	rpm	4000
Gear ratio	-	24.34
Weight without fluid	kg	190
Oil quantity	l	7.0

8) WHEELS

Model	Specification
Type (front/rear)	Solid (option: Non-marking, pneumatic)
Quantity (front/rear)	2/2
Front-drive	8.15-15 (16PR)
Rear-steering	18×7-8 (16PR)

9) BRAKES & STEERING

Model		Specification
Brakes	Travel	Front wheel, hydraulic, wet disc brake
	Parking	Mechanical
Steering	Type	Hydraulic steering

3. TIGHTENING TORQUE FOR MAJOR COMPONENTS . TIGHTENING TORQUE FOR MAJOR COMPONENTS

No.	Model		Size	kgf·m
1	Electric system	Hydraulic pump motor mounting bolt	M8 × 1.25	3.4 ± 0.7
2		Traction motor mounting bolt	M10 × 1.5	6.9 ± 1.4
3	Hydraulic system	Hydraulic pump mounting bolt	M10 × 1.5	6.9 ± 1.4
4		MCV mounting bolt, nut	M8 × 1.25	2.5 ± 0.5
5		Steering unit mounting bolt	M10 × 1.5	4.0 ± 0.5
6		Priority valve mounting bolt	M6 × 1.0	1.0 ± 0.5
7		Tilt cylinder; rod-end bolt, nut	M12 × 1.75	9.5 ± 0.5
8		Tilt cylinder pin; mounting bolt	M10 × 1.5	6.9 ± 0.5
9	Power train system	Drive axle mounting bolt, nut	M20 × 2.5	55.5 ± 2.5
10		Steering axle mounting bolt, nut	M20 × 2.5	62 ± 3.0
11		Front wheel mounting nut	M20 × 1.5	40 ± 10
12		Rear wheel mounting nut	M14 × 1.5	23 ± 1.0
13	ETC	Counterweight mounting bolt	M24 × 3.0	199 ± 15
14		Mast mounting bolt	M16 × 2.0	24.5 ± 2.5
15		Operator's seat mounting nut	M8 × 1.25	3.4 ± 0.7
16		Head guard mounting bolt (front)	M12 × 1.75	12.8 ± 3
17		Head guard mounting bolt (rear)	M16 × 2.0	29.7 ± 4.5

4. TORQUE CHART

Use following table for unspecified torque

1) BOLT AND NUT

(1) Coarse thread

Bolt size	8.8T	10.9T	12.9T
	kgf·m	kgf·m	kgf·m
M 6 × 1.0	0.8 ~ 1.2	1.2 ~ 1.8	1.5 ~ 2.1
M 8 × 1.25	2.0 ~ 3.0	2.8 ~ 4.2	3.4 ~ 5.0
M10 × 1.5	4.0 ~ 6.0	5.6 ~ 8.4	6.8 ~ 10.0
M12 × 1.75	6.8 ~ 10.2	9.6 ~ 14.4	12.3 ~ 16.5
M14 × 2.0	10.9 ~ 16.3	16.3 ~ 21.9	19.5 ~ 26.3
M16 × 2.0	17.9 ~ 24.1	25.1 ~ 33.9	30.2 ~ 40.8
M18 × 2.5	24.8 ~ 33.4	34.8 ~ 47.0	41.8 ~ 56.4
M20 × 2.5	34.9 ~ 47.1	49.1 ~ 66.3	58.9 ~ 79.5
M22 × 2.5	46.8 ~ 63.2	65.8 ~ 88.8	78.9 ~ 106
M24 × 3.0	60.2 ~ 81.4	84.6 ~ 114	102 ~ 137
M30 × 3.5	120 ~161	168 ~ 227	202 ~ 272

(2) Fine thread

Bolt size	8.8T	10.9T	12.9T
	kgf·m	kgf·m	kgf·m
M 8 × 1.0	2.1 ~ 3.1	3.0 ~ 4.4	3.6 ~ 5.4
M10 × 1.25	4.2 ~ 6.2	5.9 ~ 8.7	7.0 ~ 10.4
M12 × 1.25	7.3 ~ 10.9	10.3 ~ 15.3	13.1 ~ 17.7
M14 × 1.5	12.4 ~ 16.6	17.4 ~ 23.4	20.8 ~ 28.0
M16 × 1.5	18.7 ~ 25.3	26.3 ~ 35.5	31.6 ~ 42.6
M18 × 1.5	27.1 ~ 36.5	38.0 ~ 51.4	45.7 ~ 61.7
M20 × 1.5	37.7 ~ 50.9	53.1 ~ 71.7	63.6 ~ 86.0
M22 × 1.5	51.2 ~ 69.2	72.0 ~ 97.2	86.4 ~ 116
M24 × 2.0	64.1 ~ 86.5	90.1 ~ 121	108 ~ 146
M30 × 2.0	129 ~ 174	181 ~ 245	217 ~ 294

2) PIPE AND HOSE (FLARE TYPE)

Thread (PF)	Hex. across flat (mm)	kgf · m
1/4"	19	4
3/8"	22	5
1/2"	27	9.5
3/4"	36	18
1"	41	21
1-1/4"	50	35

3) PIPE AND HOSE (ORFS TYPE)

Thread (UNF)	Hex. across flat (mm)	kgf · m
9/16-18	19	3
11/16-16	22	5
13/16-16	24	7
1-14	30	12
1-3/16-12	36	18
1-7/16-12	41	23
1-11/16-12	50	28
2-12	58	32

4) FITTING

Thread	Hex. across flat (mm)	kgf · m
1/4"	17	2
3/8"	19	3
1/2"	22	4
	24	6
5/8"	27	10
	30	12
3/4"	32	15
	36	18
1"	41	23
1-1/4"	50	28
1-1/2"	55	32

5) BAND CLAMP

Tag. No.	Hose size (㎜)	Band width (㎜)	kgf·m
S20-15	8 ~ 14	9	0.3
S20-17	11 ~ 17		
S20-22	13 ~ 20		0.35
S20-25	15 ~ 24		
S20-28	19 ~ 28		
S20-32	22 ~ 32	12	
S20-40	26 ~ 38	9	0.42
S20-45	32 ~ 44		

6) BAND CLAMP (IDEAL, FLEX-GEAR TYPE)

Tag. No.	Hose size (㎜)	Band width (㎜)	kgf·m
41-212	32 ~ 54	15.9	1.1
41-262	45 ~ 67		
41-312	57 ~ 79		
41-362	40 ~ 92		
41-412	83 ~ 105		
41-462	95 ~ 117		
41-512	108 ~ 130		

5. WRENCH AND SPANEER CHART

No.	Wrench & Spanner			Specification			Pipe and Hose	
	inch		mm	UNF/UN	M	PF/G	ORFS (UNF/UN)	FLARE (PF)
1	-	0.050	1.3	-	-	-	-	-
2	-	0.059	1.5	-	-	-	-	-
3	1/16	0.063	1.6	-	-	-	-	-
4	5/64	0.078	2	-	-	-	-	-
5	3/32	0.094	2.4	-	-	-	-	-
6	-	0.098	2.5	-	-	-	-	-
7	7/64	0.109	2.8	-	-	-	-	-
8	-	0.118	3	-	-	-	-	-
9	1/8	0.125	3.2	-	-	-	-	-
10	9/64	0.141	3.5	-	-	-	-	-
11	5/32	0.156	4	-	-	-	-	-
12	-	0.177	4.5	-	-	-	-	-
13	3/16	0.188	4.8	-	-	-	-	-
14	-	0.197	5	-	-	-	-	-
15	13/64	0.203	5.2	-	-	-	-	-
16	7/32	0.219	5.5	-	-	-	-	-
17	15/64	0.234	6	-	-	-	-	-
18	1/4	0.250	6.4	-	-	-	-	-
19	17/64	0.266	6.8	-	-	-	-	-
20	9/32	0.281	7	-	-	-	-	-
21	5/16	0.313	8	-	-	-	-	-
22	11/32	0.344	8.7	-	-	-	-	-
23	-	0.354	9	-	-	-	-	-
24	3/8	0.375	9.5	-	-	-	-	-
25	-	0.394	10	-	-	-	-	-
26	-	-	11	-	-	-	-	-
27	7/16	0.438	11.1	-	-	-	-	-
28	15/32	0.469	12	-	-	-	-	-
29	1/2	0.500	12.7	-	-	-	-	-
30	-	-	13	-	-	-	-	-
31	17/32	0.53	13.5	-	-	-	-	-
32	-	0.55	14	7/16-20	-	-	-	-
33	9/16	0.56	14.3	-	-	-	-	-
34	19/32	0.59	15	-	-	-	-	-
35	5/8	0.63	15.9	-	-	-	-	-
36	-	-	16	-	-	-	-	-
37	21/32	0.66	16.7	-	-	-	-	-

No.	Wrench & Spanner			Specification			Pipe and Hose	
	inch		mm	UNF/UN	M	PF/G	ORFS (UNF/UN)	FLARE (PF)
38	-	-	17	-	M12	-	-	-
39	11/16	0.69	17.5	-	-	-	-	-
40	-	-	18	-	-	-	-	-
41	3/4	0.75	19	9/16-18	M14	G1/4	9/16-18	PF1/4
42	25/32	0.78	19.8	-	-	-	-	-
43	-	-	20	-	-	-	-	-
44	13/16	0.81	20.6	-	-	-	-	-
45	-	-	21	-	-	-	-	-
46	-	-	22	-	M16	G3/8	11/16-16	PF3/8
47	7/8	0.88	22.2	-	-	-	-	-
48	29/32	0.91	23	-	-	-	-	-
49	15/16	0.94	23.8	-	-	-	-	-
50	-	-	24	3/4-16	M18	-	13/16-16	-
51	31/32	0.97	26.4	-	-	-	-	-
52	-	-	25	-	-	-	-	-
53	1	1.00	25.4	-	-	-	-	-
54	-	-	26	-	-	-	-	-
55	1 1/16	1.06	27	7/8-14	M22	G1/2	-	PF1/2
56	-	-	28	-	-	-	-	-
57	1 1/8	1.13	28.6	-	-	-	-	-
58	-	-	29	-	-	-	-	-
59	-	-	30	-	-	-	1-14	-
60	1 3/16	1.19	30.2	-	-	-	-	-
61	-	-	31	-	-	-	-	-
62	1 1/4	1.25	31.8	-	-	-	-	-
63	-	-	32	1-1/16-12	M24	G3/4	-	-
64	-	-	33	-	-	-	-	-
65	1 5/16	1.31	33.3	-	-	-	-	-
66	-	-	34	-	-	-	-	-
67	1 3/8	1.38	35	-	-	-	-	-
68	-	-	36	1-3/16-12	M27	G3/4	1-3/16-12	PF3/4
69	1 7/16	1.44	37	-	-	-	-	-
70	1 1/2	1.50	38	-	-	-	-	-
71	-	-	39	-	-	-	-	-
72	1 9/16	1.56	39.7	-	-	-	-	-
73	-	-	40	-	-	-	-	-
74	-	-	41	1-5/16-12	M33	G1	1-7/16-12	PF1
75	1 5/8	1.63	41.3	-	-	-	-	-

No.	Wrench & Spanner			Specification			Pipe and Hose	
	inch		mm	UNF/UN	M	PF/G	ORFS (UNF/UN)	FLARE (PF)
76	1 11/16	1.69	43	-	-	-	-	-
77	1 3/4	1.75	44	-	-	-	-	-
78	1 13/16	1.81	46	-	-	-	-	-
79	1 7/8	1.88	47.6	-	-	-	-	-
80	-	-	48	-	-	-	1-11/16-12	-
81	1 15/16	1.94	49.2	-	-	-	-	-
82	-	-	50	1-5/8-12	-	G1-1/4	-	PF1-1/4
83	2	2.00	50.8	-	-	-	-	-
84	-	-	51	-	-	-	-	-
85	2 1/8	2.13	54	-	-	-	-	-
86	-	-	55	1-7-8-12	-	G1-1/2	-	PF1-1/2
87	-	-	57	-	-	-	2-12	-
88	2 1/4	2.25	57.2	-	-	-	-	-
89	-	-	60	-	-	-	-	-

6. RECOMMENDED LUBRICANTS

Use only oils listed below or equivalent.
Do not mix different brand oil.

Service point	Kind of fluid	Capacity l	Ambient temperature ˚C -50 -30 -20 -10 0 10 20 30 40 (-58) (-22) (-4) (14) (32) (50) (68) (86) (104)
Axle	Gear oil	7.0	ATF DEXRON 3
Hydraulic oil tank	Hydraulic oil	33	★ISO VG 15 ISO VG 32 ISO VG 46 ISO VG 68
Brake system	Brake oil	0.5	★Hyd.OIL ISO VG10 (AZOLLA ZS10) Hyd. OIL ISO VG32 (AZOLLA ZS32)
Fitting (Grease nipple)	Grease	0.1	★NLGI No.1 NLGI No.2

· ATF : Automatic Transmission Fluid
· ISO : International Organization for Standardization
· NLGI : National Lubricating Grease Institute
★ : Cold region (Russia, CIS, Mongolia)

GROUP 3 PERIODIC REPLACEMENT

For operation safety, never fail to perform periodic maintenance or make periodic replacement of the consumable parts listed in the following. These parts may deteriorate in time and are susceptible to wear.

It is difficult to estimate the degree of wear at time of periodic maintenance; therefore, even if no apparent wear is found, always replace with new parts within the prescribed period of replacement (Or earlier if trouble is found).
Note that periodic replacement has nothing to do with guarantee service.

※ Replacement of consumable service parts is not covered under warranty.

No.	Description	Period of replacement
1	Master cylinder and wheel cylinder caps dust seals	Every 1 years
2	Lift cylinder hose	Every 1 years (harsh operation) Every 2 years (normal operation)
3	Tilt cylinder hos	
4	Side shift cylinder hose	
5	Brake hose or tube	
6	Hydraulic pump hose	Every 2 years
7	Pwer steering hose	
8	Coolant hose and clamp	
9	0 Packing, seal, and O-ring of steering cylinder	Every 2 years (harsh operation) Every 4 years (normal operation)
10	Lift chain	
11	Brake oil tank tube	
12	Hydraulic pump seal kit	Every 3 years
13	Pressure sensor	Every 5 years
14	Mast accumulator (piston type)	Every 10 years

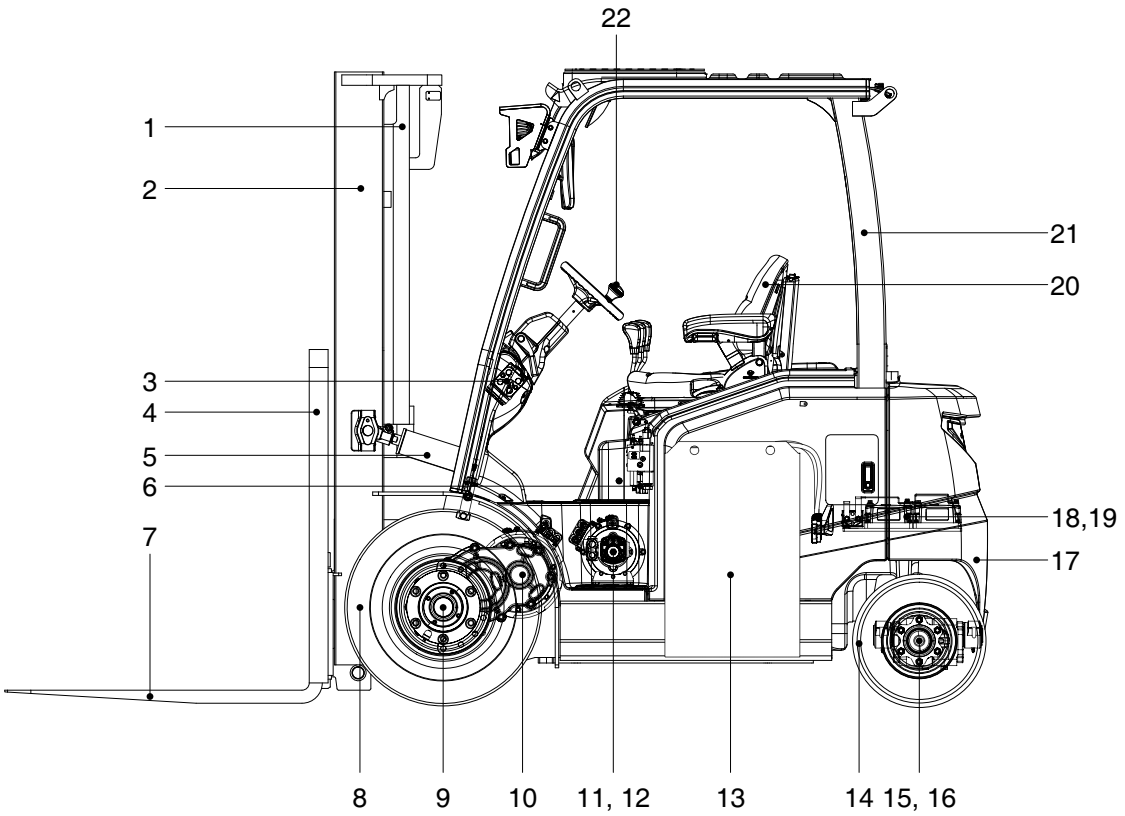
※ Replace the O-ring and gasket at the same time when replacing the hose.
※ Replace clamp at the same time if the hose clamp is cracked when checking and replacing hose.
※ Normal operation
- Eight hour material handling, mostly in buildings or in clean, open air on clean paved surfaces

※ Harsh operation
- All harsh working environment
- Long term heavy load operation
- High and low temperature working environment
- Sudden change in temperature
- Dusty or sandy working environment
- Highly corrosive chemical working environment
- Damp working environment

SECTION 2 REMOVAL & INSTALLATION OF UNIT

SECTION 2 REMOVAL & INSTALLATION OF UNIT

GROUP 1 MAJOR COMPONENTS



25BX2RE02

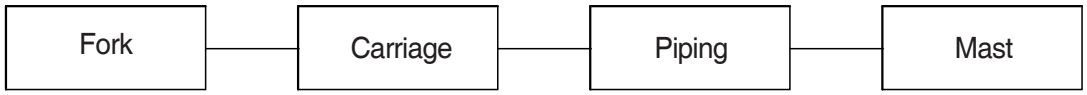
1	Lift cylinder	9	Drive axle	17	Counterweight
2	Mast	10	Drive motor	18	Traction control
3	Steering unit	11	Hydraulic gear pump	19	Pump control
4	Backrest	12	Pump motor	20	Seat
5	Tilt cylinder	13	Battery	21	Overhead guard
6	Main control valve	14	Rear battery	22	Steering wheel
7	Fork	15	Steering axle		
8	Front wheel	16	Steering cylinder		

GROUP 2 REMOVAL AND INSTALLATION OF UNIT

Remove and install following units as explained in the flow chart.

1. MAST

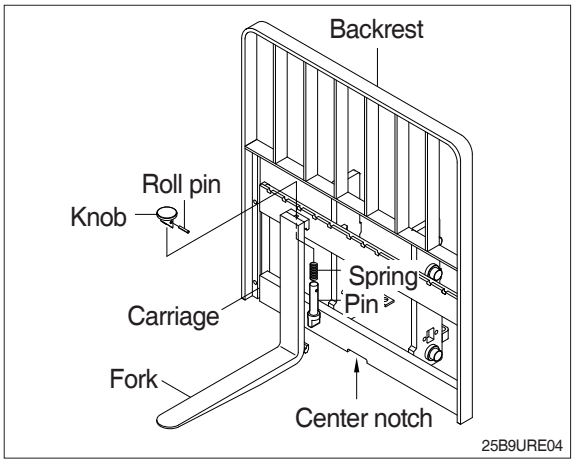
1) REMOVAL



L15C3RE001

(1) Forks

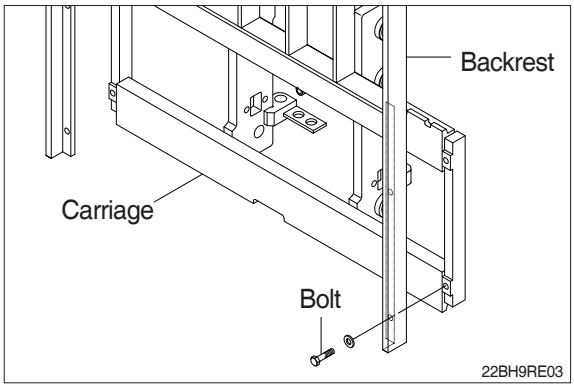
① Lower the fork carriage until the forks are approximately 25 mm from the floor.
② Turn knob up and slide one fork at a time toward the center of the carriage where a notch has been cut in the bottom plate for easy removal.
③ Remove only one fork at a time.
※ **On larger forks it may be necessary to use a block of wood.**



25B9URE04

(2) Bactrest (If necessary)

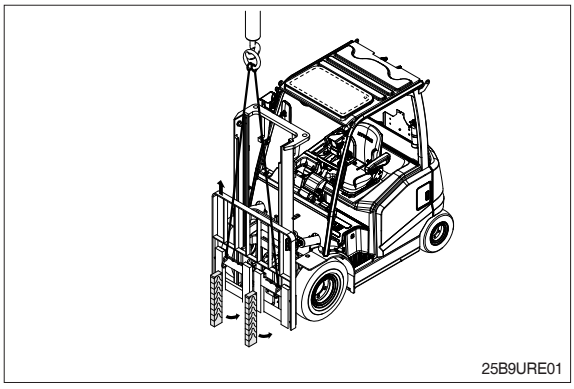
① Remove bolts securing backrest to fork carriage. Lift backrest straight up and remove it from carriage.



22BH9RE03

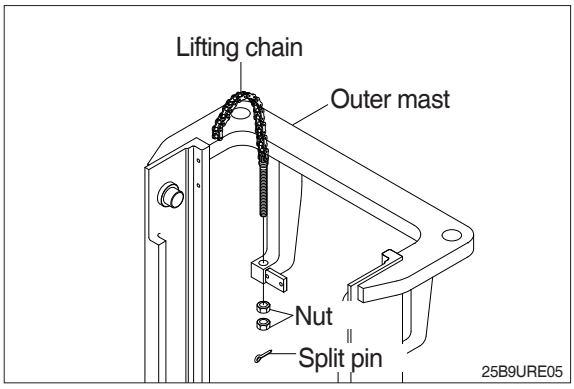
(3) Carriage

① With the mast vertical, raise the carriage high enough to place blocks under the carriage.
This is done to create slack in the load chains when the carriage is lowered.
Lower the carriage all the way down to the floor. Make sure the carriage is level, this will prevent any binding when the mast is raised.

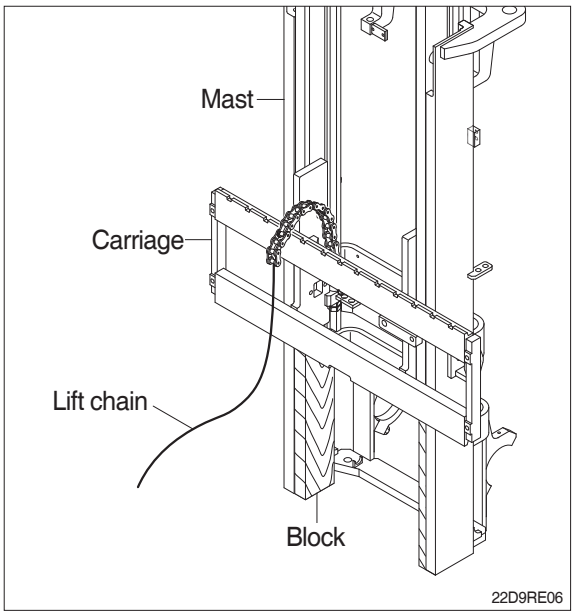


25B9URE01

② While supporting lift chains, remove the split pin and nuts from the chain anchor.



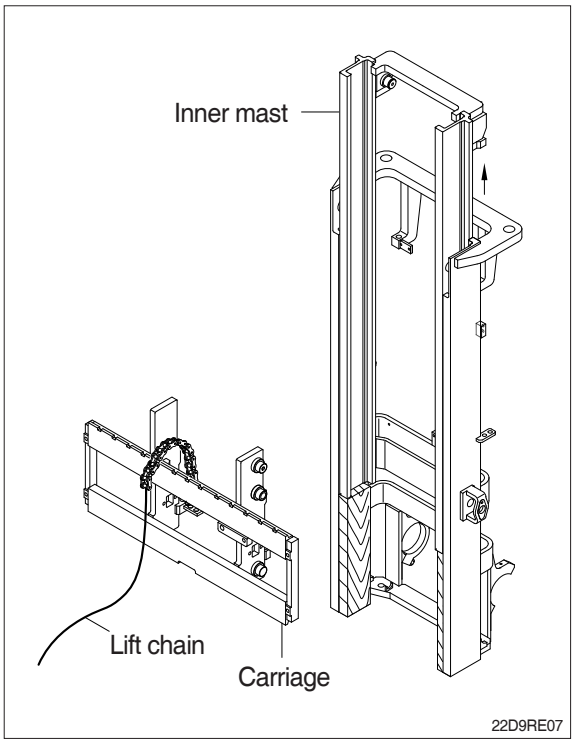
③ Pull the chains out of the sheaves and drape them over the front of the carriage.



④ Slowly raise inner mast upright until mast clears top of fork carriage. Move carriage to work area and lower the mast.

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

※ Inspect all parts for wear or damage. Replace all worn or damaged parts.

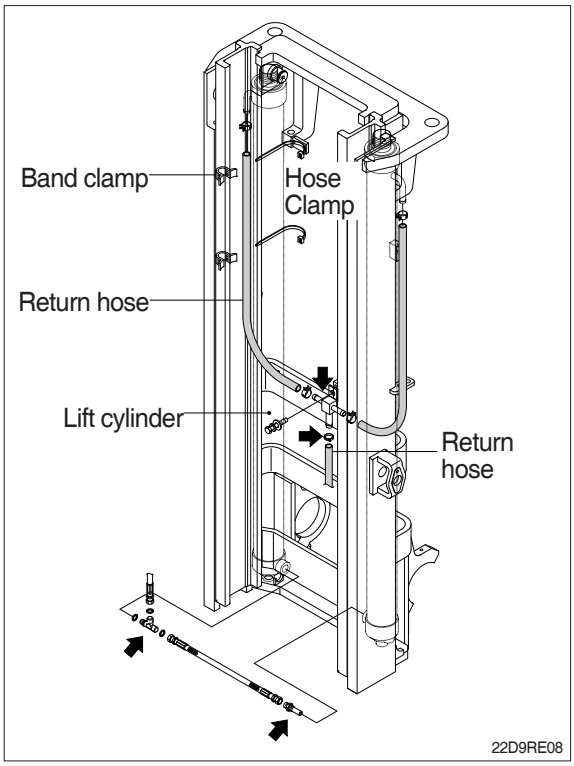


(4) Piping

① Remove the return hoses and clamps attached to the lift cylinder

② Remove hose assembly, valve and connector from the lift cylinder

※ Put blind plugs in the piping immediately after removing hoses to prevent the hydraulic oil from flowing out and also prevents dust and dirt from getting in.



(5) Lift cylinder

① Loosen and remove stud bolts and washers and secure lift cylinders to outer mast.

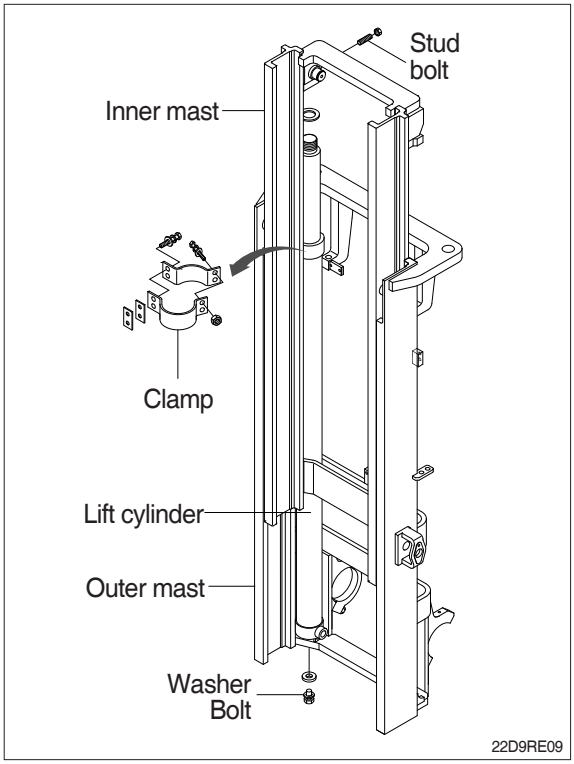
② Bind the lift cylinder with overhead hoist rope and pull up so that the rope has no slack or binding.

⚠ Make sure that the lift cylinder be tightened firmly for safety.

③ Loosen and remove hexagon bolts and nuts securing the cylinder.

④ Using an overhead hoist, slowly raise the inner mast high enough to clear lift cylinder.

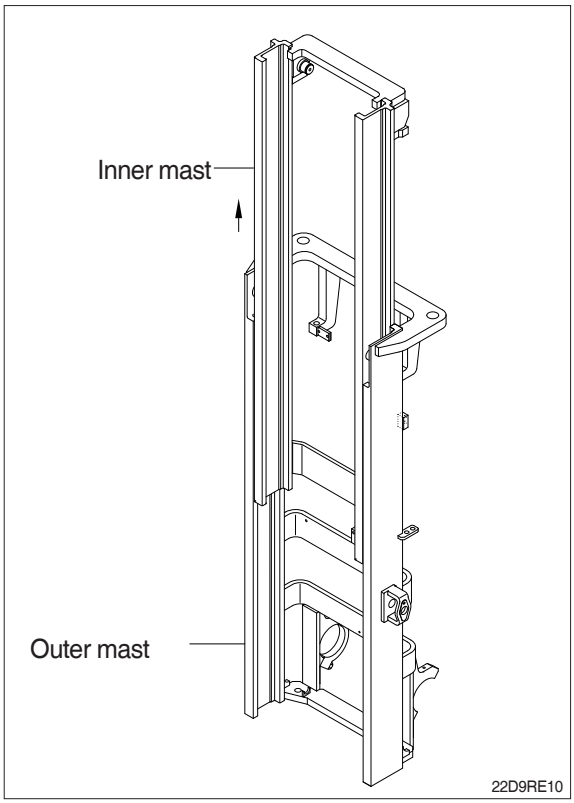
⑤ Using an overhead hoist, draw out lift cylinder carefully and put down on the work floor.



(6) Inner mast

① Using an overhead hoist raise the inner mast straight and carefully draw out of outer mast section

⚠ Be careful the mast not to swing or fall.



(7) Tilt cylinder pin

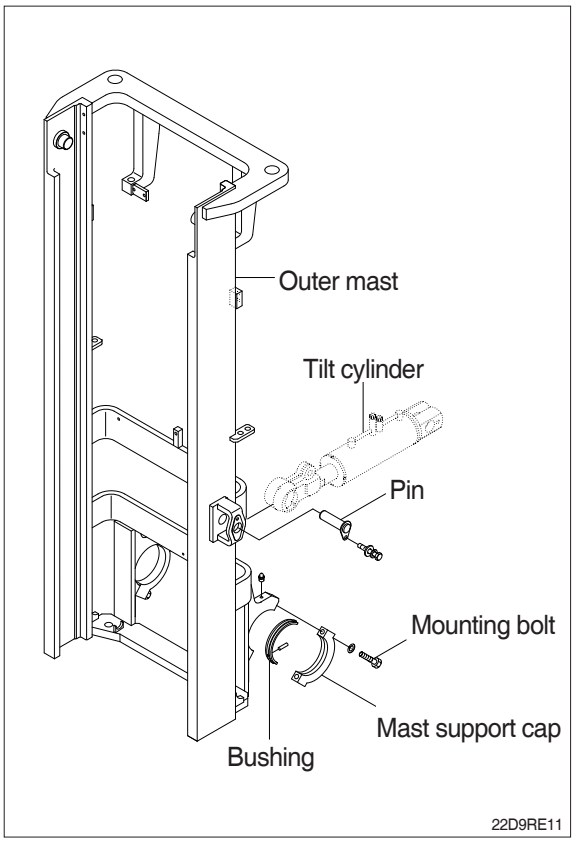
Loosen the bolt and remove the tilt cylinder pin.

(8) Mast mounting pin

① Attach a crane to the stay at the top of the outer mast, and raise enough to sustain jacked up truck.

※ **This operation is carried out under the his operation is carried out under the truck, so use a pit, or if there is no pit, jack up the truck and loosen with an impact wrench.**

② Loosen the mounting socket bolts and remove the mast mounting pins. Then slowly raise the outer mast.



2) INSTALLATION

After assembling mast components totally without piping connections, install mast assembly to the equipment.

※ **Installation procedure for each of mast component is the reverse of the removal procedure.**

(1) Mast support cap

① Check mast mounting bolts and bushings for wear.

② Jack up the truck so that the front is raised and then using an overhead hoist assemble outer mast to drive axle unit.

③ Tighten mast support cap and mounting bolts to mast. Lubricate with GTP 600 or 1000 PASTE.

· Tightening torque : 24.5±2.5 kgf · m

(2) Tilt cylinder pin

Hold the mast with a crane, operate the tilt control lever and align the holes, then knock the pin

(3) Lift cylinder installation and adjustment

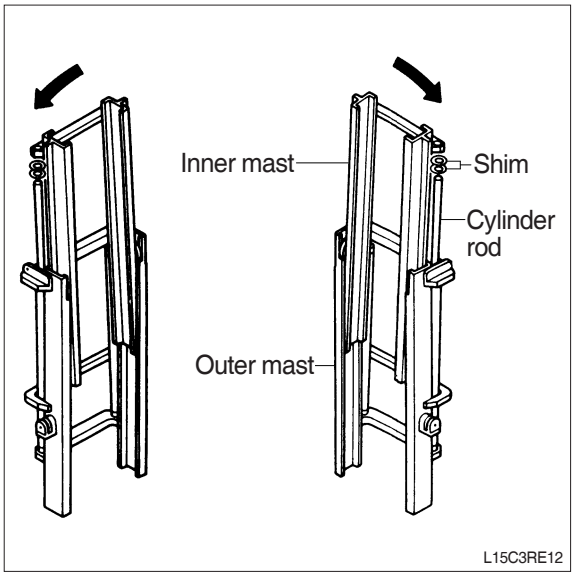
① Assemble the lift cylinder inside the outer mast, then tighten the stopper bolt. If the cylinder assembly has been replaced, adjust as follows so that the left and right cylinders are synchronized at the maximum lifting height.

② Assemble the cylinder rod to the inner mast, and check the left-to-right play of the mast at the maximum lifting height.

※ **If play is to LEFT, install adjustment shim to LEFT cylinder.**

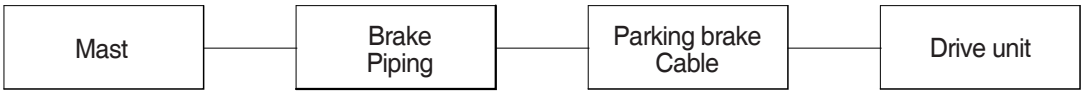
※ **If play is to RIGHT, install adjustment shim to RIGHT cylinder.**

· **Shim thickness : 1.0 mm**



2. POWER TRAIN ASSEMBLY

1) REMOVAL



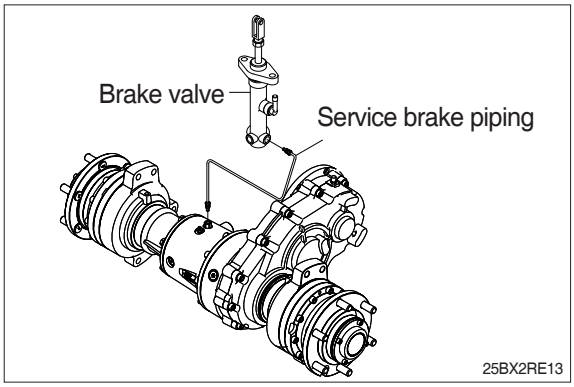
25B9U3RE00

(1) Mast

Refer to section on mast (Page 2-2) to remove mast.

(2) Service brake piping

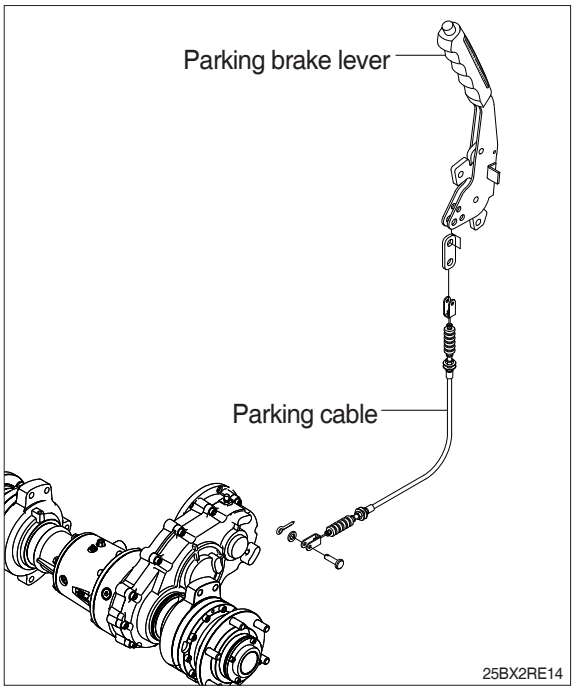
Disconnect the service brake piping from the brake housing of drive axle.



25BX2RE13

(3) Parking brake cable

Remove the Parking cable from the drive axle.

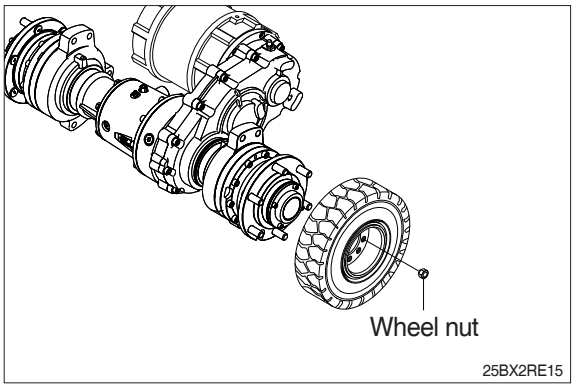


25BX2RE14

(4) Drive axle and drive motor

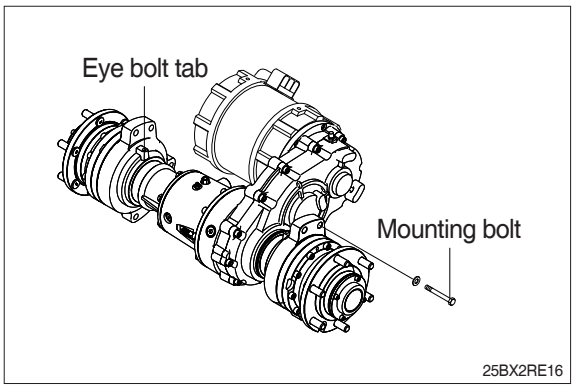
※ **Before removing the drive axle unit, drain all of the oil from the axle.**

① Unscrew 12 wheel nuts and remove the wheel.

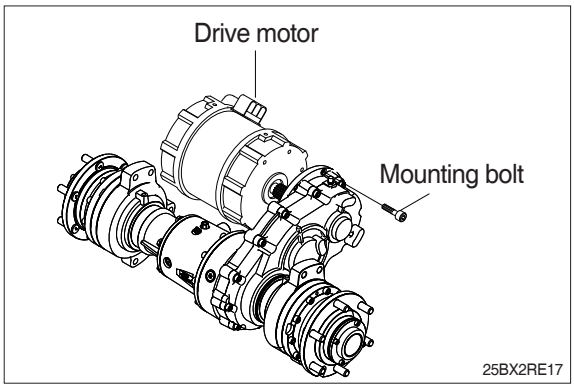


② Prepare to remove drive axle by using eye bolt tab of the drive axle.

③ Remove 12 mounting bolts fixing the axle to the frame and carefully remove the drive motor and axle from the vehicle.

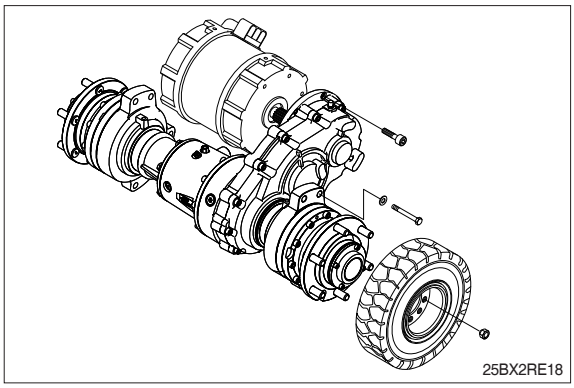


④ Remove 5 mounting bolts fixing the motor to the axle and carefully remove the drive motor from the drive axle.



2) INSTALLATION

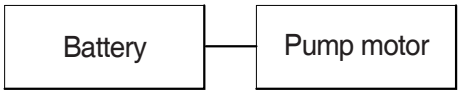
Installation is the reverse order of removal. Refer to Tightening torque for major components in 1-8.



3. ELECTRICAL COMPONENTS

Before removing each component, disconnect cables and earth lines attached to the component.

1) REMOVAL



25BX2RE36

(1) Battery

Battery can be replaced using Forklift, Pallet truck or exclusive jig. Make sure max capacity of the Forklift or Pallet truck is above the battery weight.

⚠ Using improper method may result in battery tip over accident so be cautious.

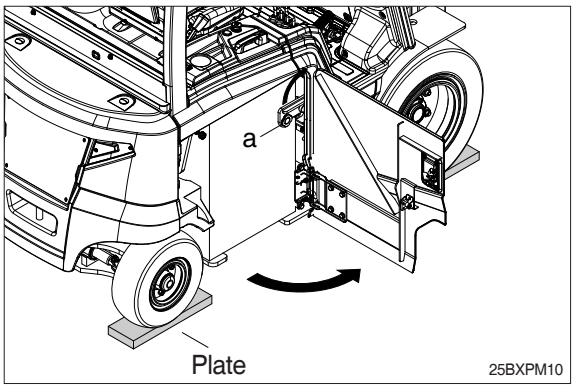
⚠ Change battery on flat ground.

⚠ Battery might fall off if equipment tip over while battery locking device is loose. Always operate equipment with battery locked.

① Park the truck horizontally and with 140mm or more road clearance, turn the engine off and open the right battery door. Then disconnect the connector and unlock battery locking device (a)

※ Make sure road clearance is over 140 mm by placing plate (10~20 t) under front and rear wheels.

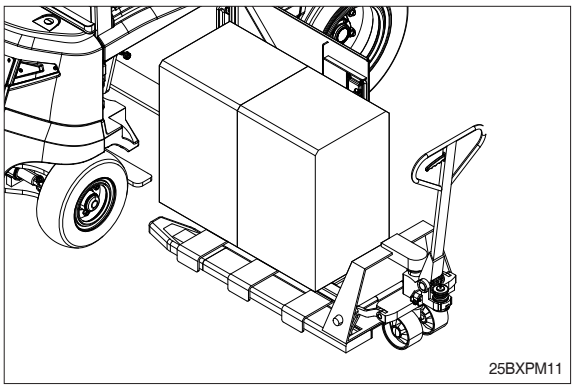
※ If manual unlocking procedure is impossible due to battery being too close to the locking device, push the battery in slightly with fork then unlock the locking device.



25BXPM10

② Place fork in a way that battery sits balanced, carefully remove battery from the frame.

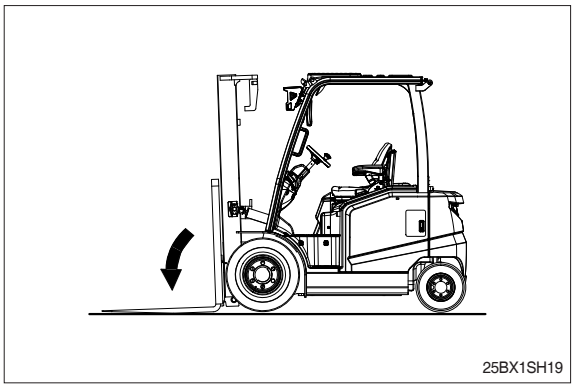
※ When carrying the battery, slow maneuver is required.



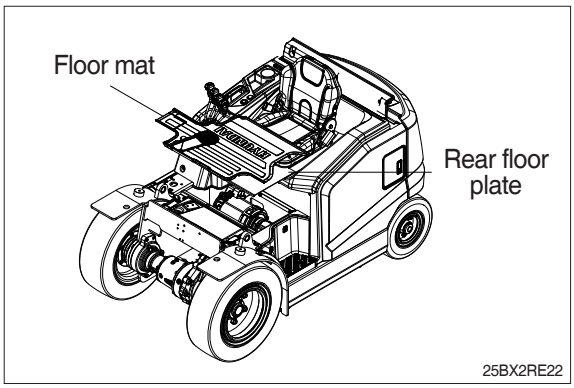
25BXPM11

(2) Pump motor

① Lower the fork to floor



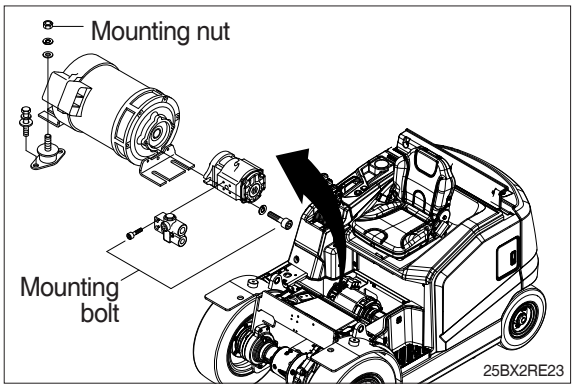
② Remove floor mat and rear floor plate.



③ Remove pump motor, gear pump, wiring for priority valve, rubber hose and hydraulic hose.

④ Loosen mounting nut and remove pump motor, gear pump, priority valve from the frame.

⑤ Loosen mounting bolt and remove priority valve ans pump motor.

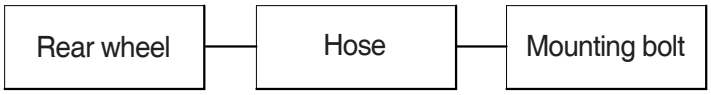


2) INSTALLATION

Installation is the reverse order of removal.
Refer to Tightening torque for major components in 1-8.

4. STEERING AXLE

1) REMOVAL



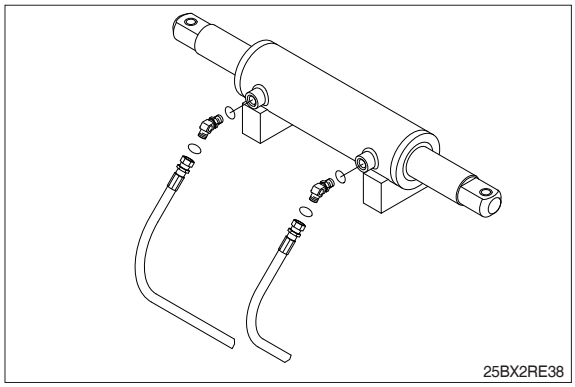
25BX2RE37

(1) Rear wheel

Refer to 5-17

(2) Hose

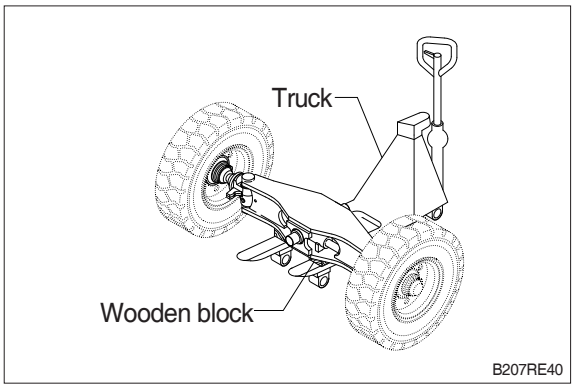
Disconnect the hoses from the steering cylinder.



25BX2RE38

(3) Mounting bolt

Put a block between the steering axle and support of a truck, and raise the frame with a crane. Remove the mounting bolts installing to the frame, and pull out to the rear There are shims and spacers between the trunnion block and steering axle to prevent play.

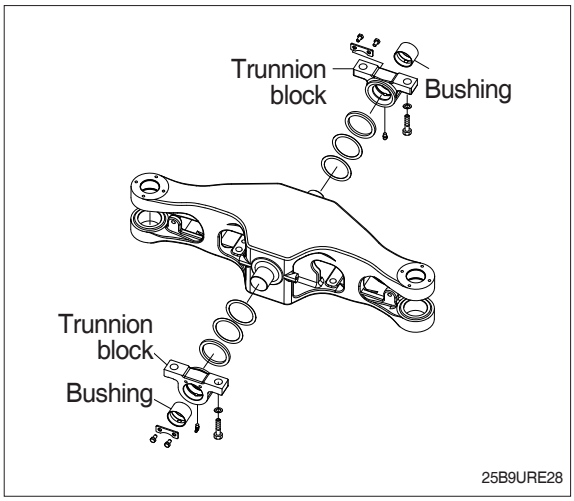


B207RE40

2) INSTALLATION

Installation is the reverse order of removal. Please refer to following :

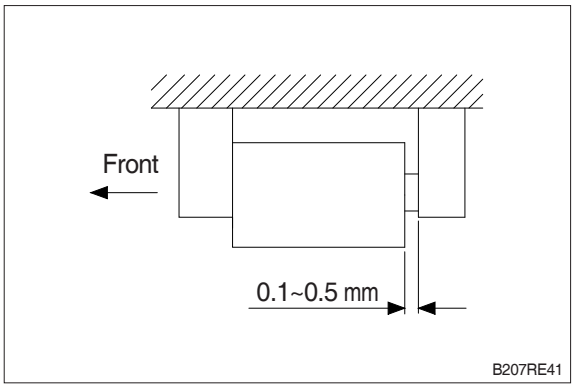
(1) When changing bushing of the trunnion block, make sure install the bushing with hole on the surface face down.



25B9URE28

(2) When installing trunnion block, make sure the space at the back in under 0.5 ㎜ when it was pushed completely.
Be aware of tightening torque for the mounting bolt of the trunnion block. Apply loctite #277.

· Tightening torque : 59~65 ㎏f · m



Apply molybden disulphide to hub bolt when installing rear wheel, and tighten nut at 22~24 ㎏f · m torque.
Balance with center of the frame when installing counterweight. Apply molybden disulphide to mounting bolt before
tightening.

GROUP 3 MAINTENANCE FOR HOSE

1) MAINTENANCE

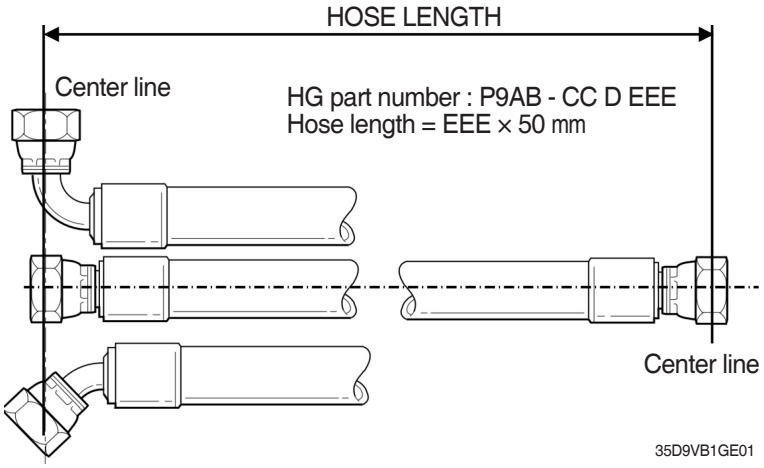
The function and service life of hydraulic components depend to a great extent on how they are maintained regularly. Therefore, it is very important to prevent dirt from entering the hydraulic system. Some simple advice to keep the hydraulic system clean:

- Always clean the area around parts before starting work. If possible, it is better to wash the the truck.
- Plug hose connections immediately after disconnecting. If possible, use correct plugs for the connection type. If plugs do not match, use clean plastic bags and cable ties or tape to seal the connection.
- Never reuse oil that has been drained from the truck.
- If possible, filter the oil before pouring it into the truck, oil barrels often contain impurities.

2) HOSE LENGTH

Connected hoses have HG part number, but if they have no information the hoses are measured as follows:

- The hose length is measured on a laid-out hose between the sealing surfaces
- On angled connections, measure from the sealing surface's center line according to the figure.



3) CAUTION FOR REPLACEMENT

When replacing hoses for maximum service life and functionality, the following must be observed:

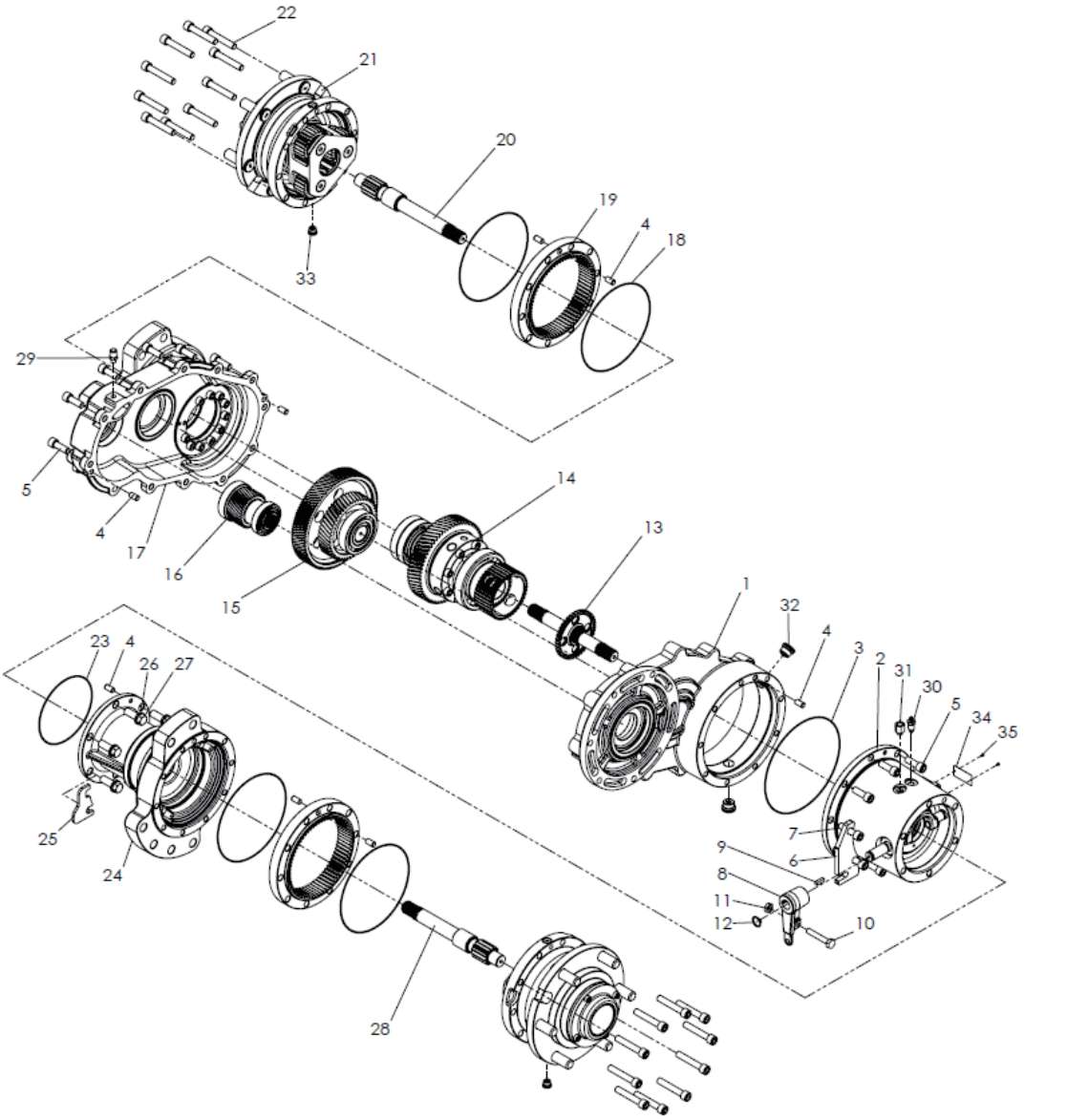
- To avoid stress when connecting, a straight hose length must be secured after connection.
- Do not kink the hose. 7% twist reduces the service life by 90%.
- Do not use hoses that are too short. It may cause leakage or damage
- Use the correct coupling to minimize the number of bends.
- Avoid sharp bending.
- When storing, keep the inside of the hose clean. When installing, keep the plug in place for as long as possible.

SECTION 3 POWER TRAIN SYSTEM

SECTION 3 POWER TRAIN SYSTEM

GROUP 1 STRUCTURE AND OPERATION

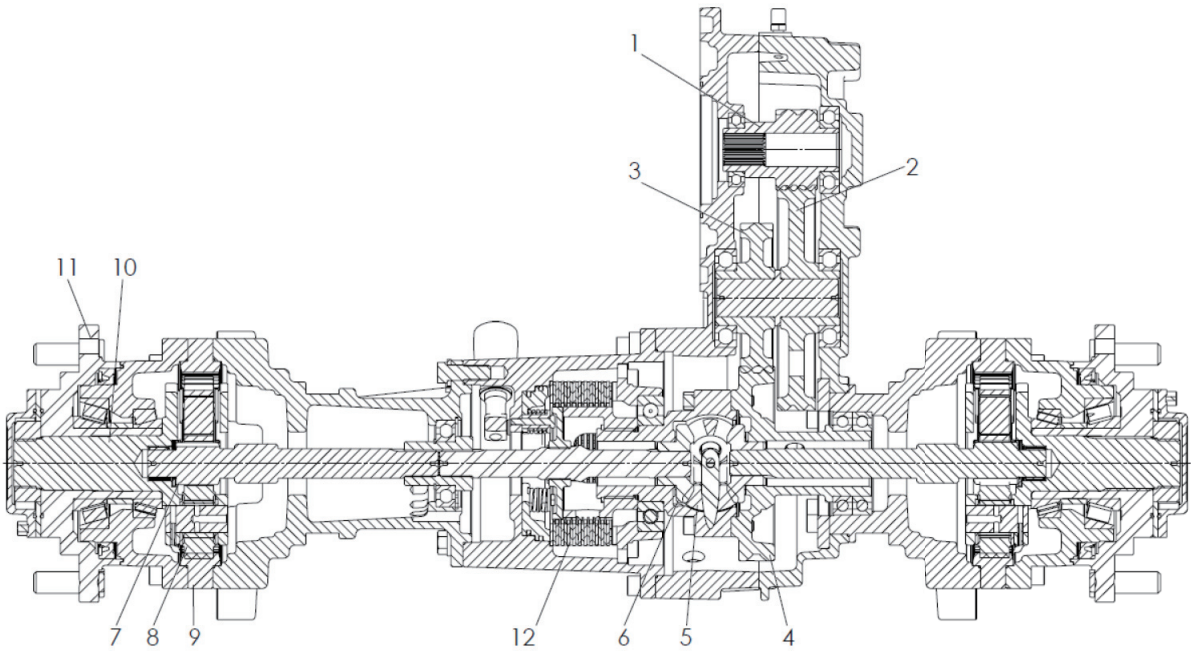
1. STRUCTURE



25BX3PS01

1	Motor case	13	Center axle assembly	25	Parking stopper plate
2	Brake assembly	14	Differential gear assembly	26	Spring washer
3	O-ring	15	Second gear assembly	27	Hexagonal bolt
4	Dowel pin	16	First gear assembly	28	RH axle shaft
5	Socket-head bolt	17	LH axle housing	29	Air breather
6	Bracket	18	O-ring	30	Air breather
7	Socket-head bolt	19	Gear ring	31	Brake port
8	Parking lever	20	LH axle shaft	32	Drain A plug
9	Key	21	Wheel assembly	33	Drain B plug
10	Hexagonal bolt	22	Socket	34	Axle name plate
11	Nut	23	O-ring	35	Rivet
12	Snap ring	24	RH axle housing		

2. OPERATION



25BX3PS02

The drive axle is a power train system consisted of a service brake and a parking brake, and assembled in the drive wheel of a battery-powered forklift truck.

Drive axle transfers torque of drive motor to drive wheel through the following procedures:
Gear trains of major gear box consist of helical gears (1) to (4). Torque is transferred from drive motor to helical gear (1). Torque is transferred to differential gear through helical gear (4), and further to planetary gears (7) and (8) through axle (9). Planetary gear plays a role of transferring torque to carrier shaft (10) and wheel adapter (11).

Service brake and parking brake (12) are configured on the shaft on one side of differential gear, and work in the wet disk mode.

3. SPECIFICATIONS

Item	Unit	Specifications
Max. axle load	kg	9000
Max. input speed	rpm	4000
Gear ratio	-	24.34
Weight (excluding oil)	kg	190
Oil volume	l	7.0

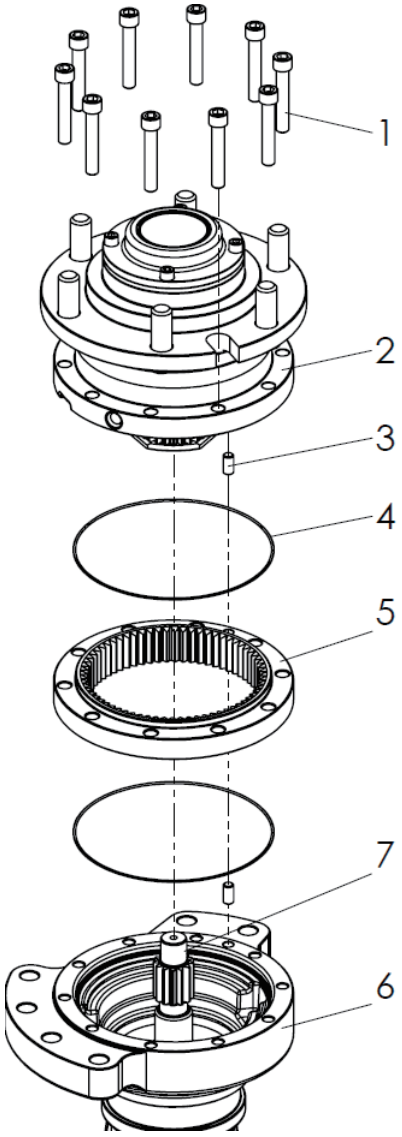
GROUP 2 FAILURE DIAGNOSIS AND CORRECTIVE ACTIONS

Trouble	Cause	Corrective action
1. Noise		
1) High frequency noise	· Misaligned mounting of input gear and drive motor	1. Remove the drive motor. 2. Check tooth face and helical gear of backlash for damage. 3. Check connection, and dimensions of spline. 4. Check input gear and drive motor for correct mounting.
2) Abnormal noise	· Incorrect connection of motor	- Check the motor connection.
	· Defective motor bearing	- Check bearings of motor and axle.
3) Internal grinding noise	· Defective wheel bearing	- Check bearing at the shop.
	- Low level of gear oil	
	- Extreme pre-stress of bearing	
	· Damage of planetary gear	- Check planetary gear and wheel bearing at the shop.
	- Low level of gear oil	
	- Excessive play of wheel bearing	
2. Oil leak		
1) Air breather valve	· Excessive level of gear oil	- Checking gear oil level
	· Valve trouble	- Checking valve for damage
	· High pressure inside gear box	- Checking inside pressure
2) Drive motor	· O-ring damaged	- Remove drive motor, and check O-ring and housing surface for damage.
	· Housing damaged	
3) Wheel adaptor and housing	· Damage on oil sealing and adaptor of wheel housing	- Replace oil seal between drive housing and adaptor.
4) Parking lever	· O-ring damaged	1. Remove parking lever, and check O-ring and housing surface.
	· Housing damaged	2. Contact the shop or your dealer.
2. High temperature		
1) High temperature of drive motor	· Excessively high or low level of gear oil	- Checking gear oil level
	· Excessive load on wheel bearing	- Checking play on wheel shaft
	· No play on brake disk	- Checking play on brake disk
	Parking brake being caught	- Checking parking brake conditions

GROUP 3 DISASSEMBLY AND ASSEMBLY

1. WHEEL ASSEMBLY

1) DISASSEMBLING



25BX3PS03

1	Socket-head bolt	4	O-ring	7	Axle shaft
2	Wheel hub assembly	5	Ring gear		
3	Dowel pin	6	Axle housing		

(1) Disassemble oil injection port, and three drain plugs from the bottom of axle to drain gear oil.

(2) Remove socket-head bolt (1) from axle housing (6).

(3) Remove wheel hub assembly (2) from axle housing (6).

(4) Remove axle shaft (7) from axle assembly.

※ **Care should be exercised to protect O-ring from damage after disassembling drain plug.**

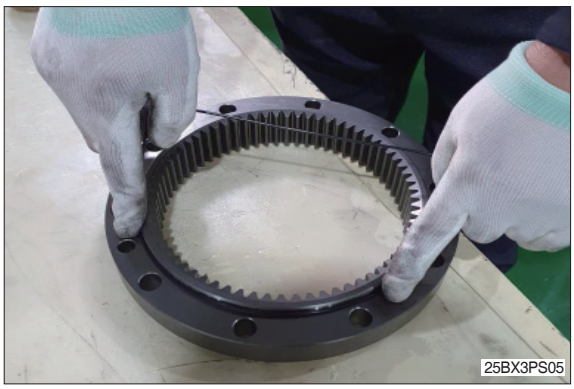
※ **Store LH and RH axle shafts respectively.**

2) ASSEMBLING

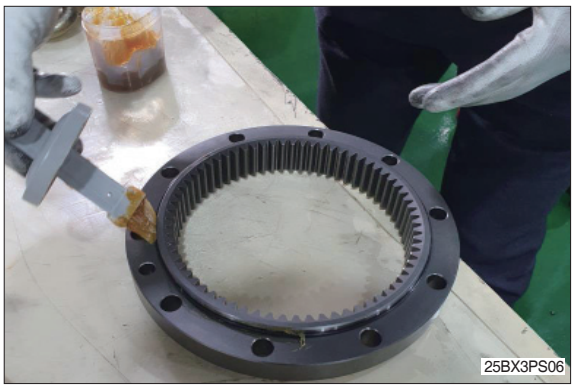
(1) Mount axle shaft (7) on spline hub.

※ **Assemble correct LH or RH axle shaft.**

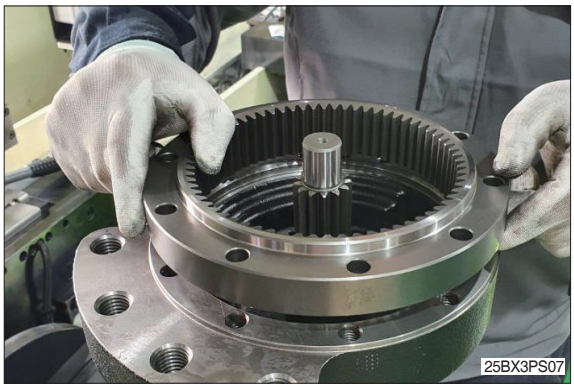
(2) Care shall be exercise to protect O-ring (4) from damage when assembling it on ring gear (5).



(3) Lubricate the surface of O-ring with grease.

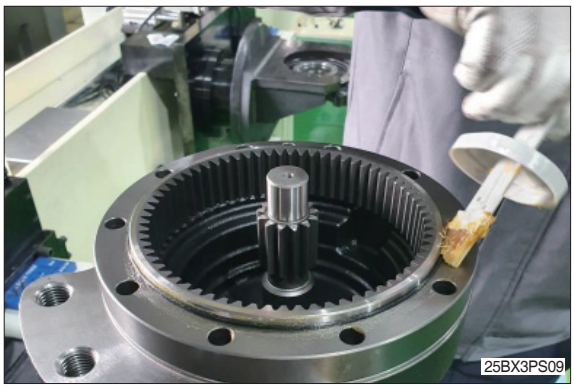


(4) Assemble ring gear assembly on axle housing (6).



(5) Care shall be exercise to protect O-ring (4) from damage when assembling it on ring gear (5).

(6) Lubricate the surface of O-ring with grease.



(7) Assemble dowel pin (3) on ring gear (5).

(8) Assemble wheel hub assembly (2) on axle housing (6).

(9) Never forget to coat 10 socket-head bolts (1) with Loctite 277.

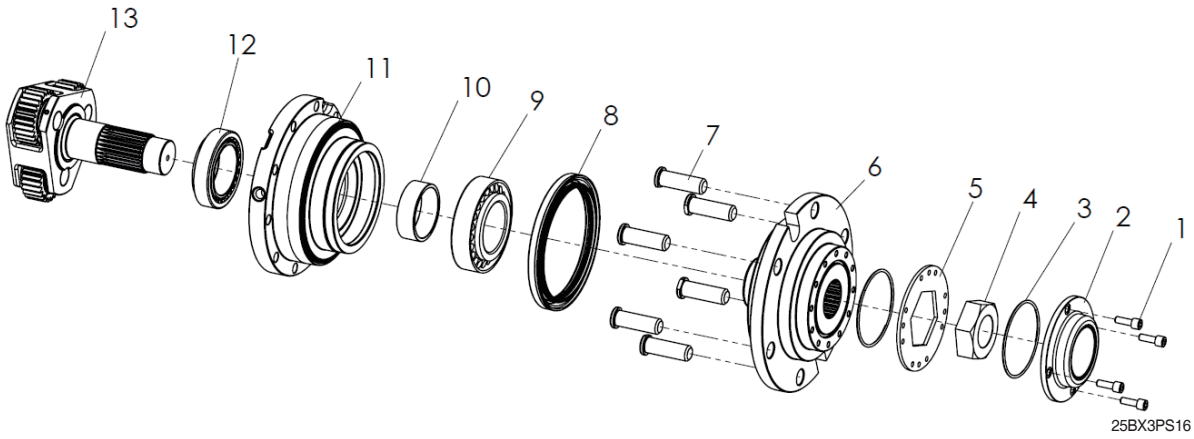
(10) Assemble socket-head bolt (1) on axle housing (6).

(11) Mark on bolt head and housing for checking correct assembling.

(12) Fasten socket-head bolt (1).
· Fastening torque : 9±0.5 kgf · m

2. WHEEL HUB ASSEMBLY

1) DISASSEMBLING



1	Socket-head bolt	6	Adaptor	11	Final housing
2	Wheel cap	7	Stud bolt	12	Taper roller bearing
3	O-ring	8	Oil seal	13	Carrier shaft assembly
4	Lock nut	9	Taper roller bearing		
5	Lock plate	10	Spacer		

(1) Remove socket-head bolt (1) from wheel cap (2).

(2) Remove wheel cap (2), O-ring (3), lock nut (4) and lock plate (5) in order.

(3) Press the top of carrier shaft down to remove carrier cap assembly (13).

(4) Remove final housing (11) from adaptor (6).

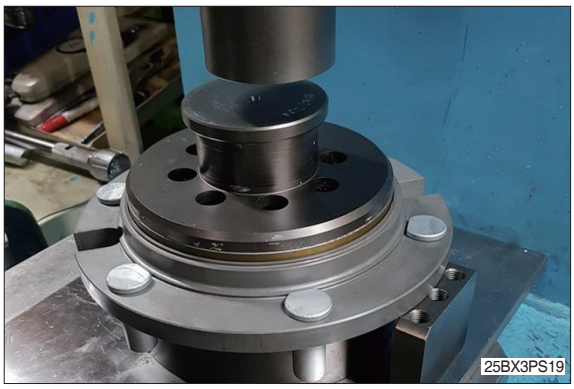
(5) Remove stud bolt (7) and oil seal (8) from adaptor (6).

2) ASSEMBLING

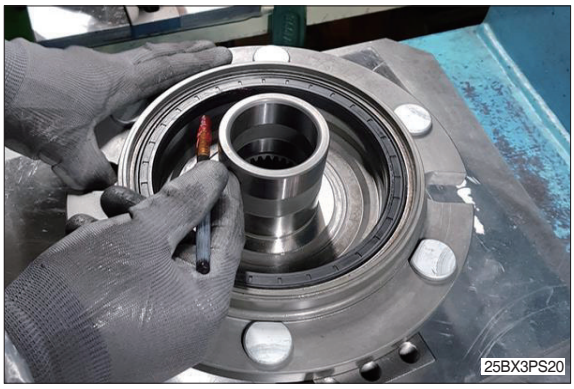
(1) Make use of jig and press to assemble stud bolt (7) on adaptor (6).

(2) Apply ThreeBond on the outer surface of oil seal (8).

(3) Make use of jig and press to assemble oil seal (8) on adaptor (6).



(4) Lubricate ring surface inside adaptor (6) with proper amount of grease.



(5) Make use of jig and press to assemble taper roller bearing (9) on adaptor (6).

(6) Assemble space (10) on adaptor (6).

(7) Make use of jig and press to assemble final housing (11) and taper roller bearing (12) on adaptor (6).

(8) Make use of jig and press to assemble carrier shaft assembly (13) on adaptor (6).

(9) Make use of push-pull gauge to check bearing preload.

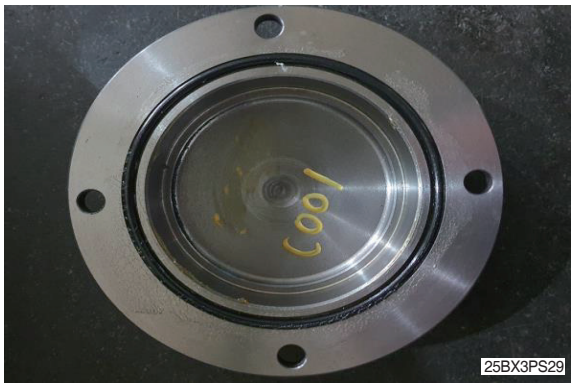
· Set preload : 0.12-0.16 kgf · m

(10) Assemble lubricated O-ring on adaptor (6).

(11) Assemble lock plate on carrier shaft, and then fasten lock nut lubricated with Loctite 277 on carrier shaft.
· Fastening torque : 15±0.5 kgf · m

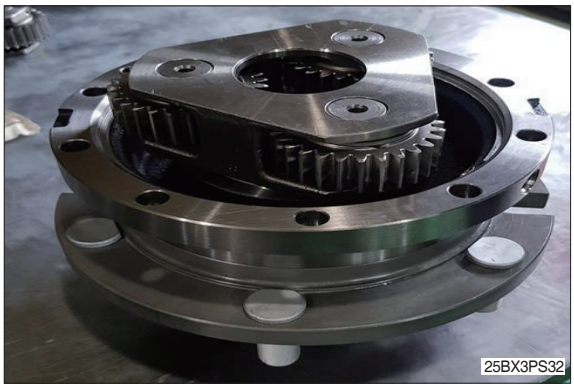
(12) Make use of push-pull gauge to check bearing preload.
· Set preload : 0.12-0.16 kgf · m

(13) Assemble O-ring (3) lubricated with grease on wheel cap (2).



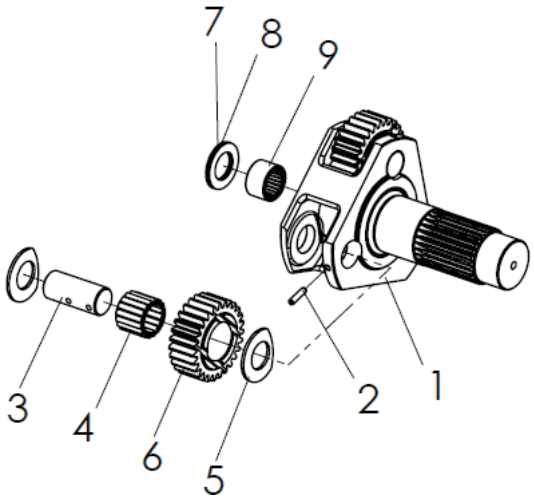
(14) Lubricate assembled O-ring with grease, and assemble wheel cap (2) on adaptor (6).

(15) Fasten socket-head bolt (1) lubricated with Loctite 277 on wheel cap (2).
· Fastening torque : 3.3±0.2 kgf · m



3. CARRIER SHAFT ASSEMBLY

1) DISASSEMBLING



25BX3PS16

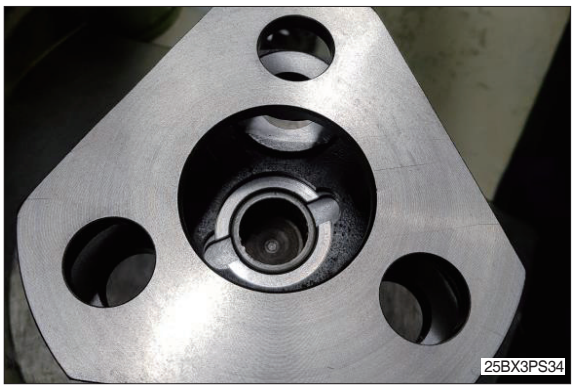
1	Carrier shaft	4	Needle roller bearing	7	Thrust washer
2	Spring pin	5	Thrust washer	8	Thrust needle roller bearing
3	Planetary gear shaft	6	Planetary gear	9	Needle roller bearing

(1) Strike spring pin (2) in vertical direction with round pin and mallet to remove planetary gear (6).

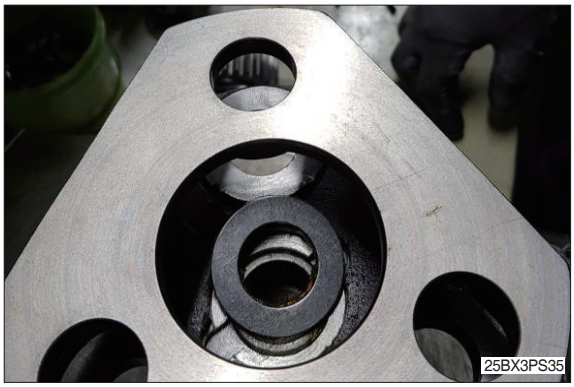
(2) Once planetary gear is removed, remove thrust washer (7) and thrust needle roller bearing (8).

2) ASSEMBLING

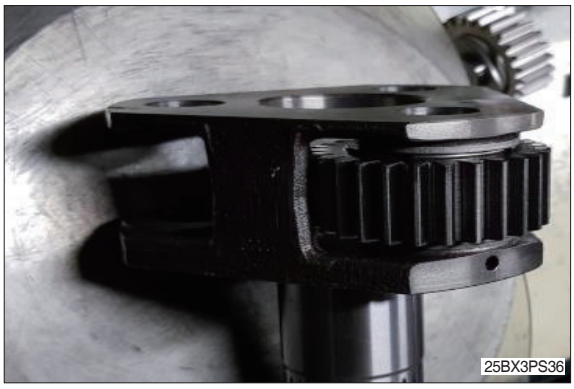
(1) Make use of jig and press to assemble needle roller bearing (9) on carrier adaptor (1).



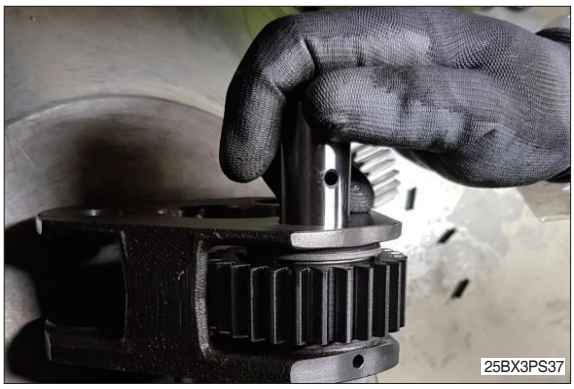
(2) Assemble thrust washer and needle valve bearing (7, 8) on grease-lubricated carrier shaft.



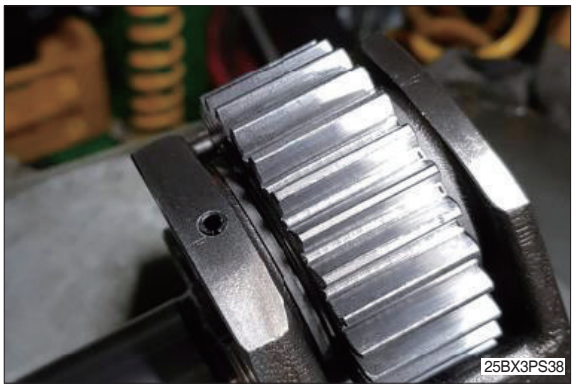
(3) Assemble 3 planetary gear assemblies on carrier shaft (1).



(4) Assemble planetary gear shaft (3) on carrier shaft (1) by aligning with hole of the latter.



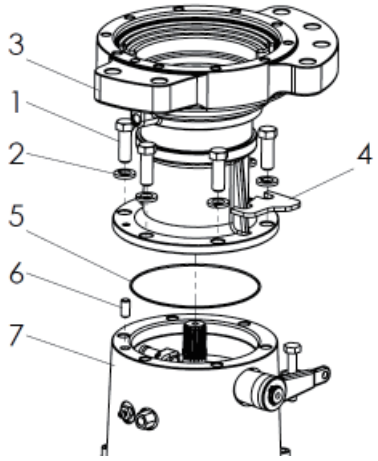
(5) Assemble 3 spring pins (2) on carrier shaft (1).



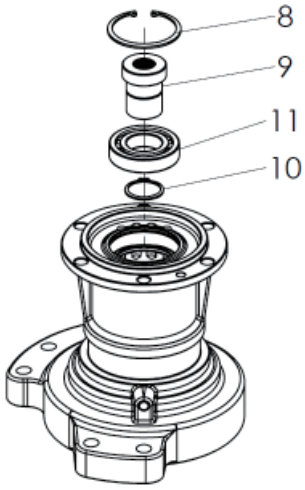
(6) Caulk with a tool to prevent spring pin from removal from carrier shaft.

4. RH AXLE HOUSING ASSEMBLY

1) DISASSEMBLING



25BX3PS40



25BX3PS41

1	Hexagonal bolt	5	O-ring	9	Spline hub
2	Spring washer	6	Dowel pin	10	Snap ring
3	RH axle housing	7	Brake housing	11	Ball bearing
4	Parking stopper plate	8	Snap ring		

(1) Loosen hexagonal bolt (1), and then remove RH axle housing assembly from brake housing.

(2) Turn RH axle housing assembly up side down, and remove snap ring (8).

(3) Remove spline hub (9), snap ring (1) and ball bearing (11) from RH axle housing (3).

(4) Remove snap ring (10) and ball bearing (11) from spline hub (9).

2) ASSEMBLING

(1) Assemble ball bearing (11) on spline hub (9).

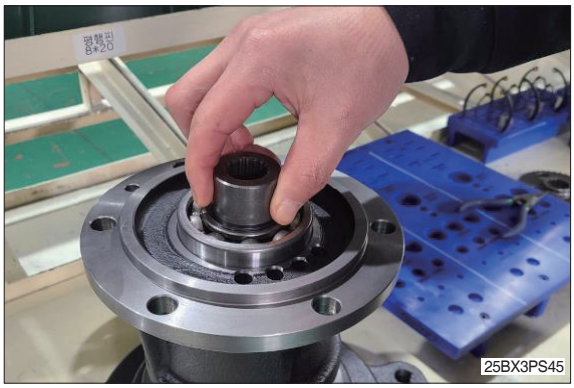
※ **Check ball bearing for smooth revolution.**

25BX3PS42

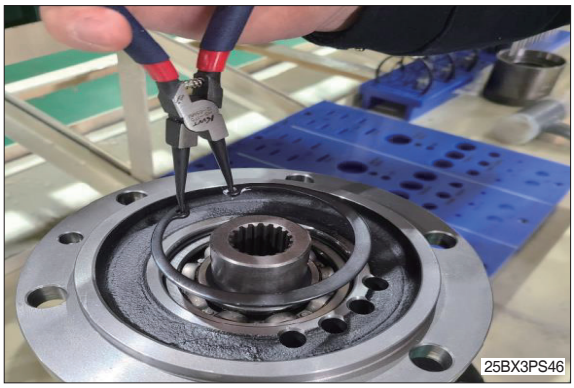
(2) Make use of snap ring puller to assemble snap ring (10) on spline hub (9).

(3) Mark a point on snap ring for checking for proper assembling.

(4) Assemble spline hub assembly on RH axle housing (3).

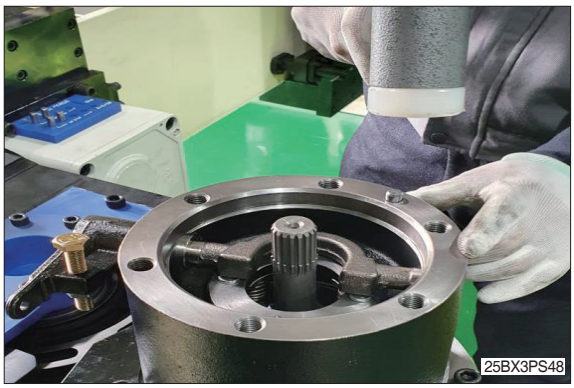


(5) Make use of snap ring puller to assemble snap ring (8) on RH axle housing (3).



(6) Assemble O-ring (5) on RH axle housing (3).

(7) Assemble dowel pin (6) on brake housing (7).

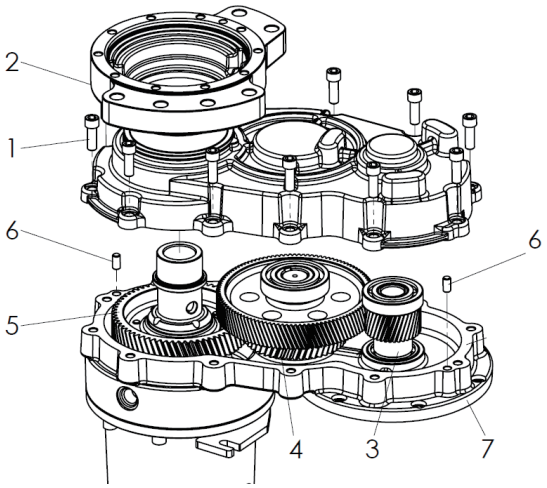


(8) Assembly RH axle housing assembly on brake housing (7).

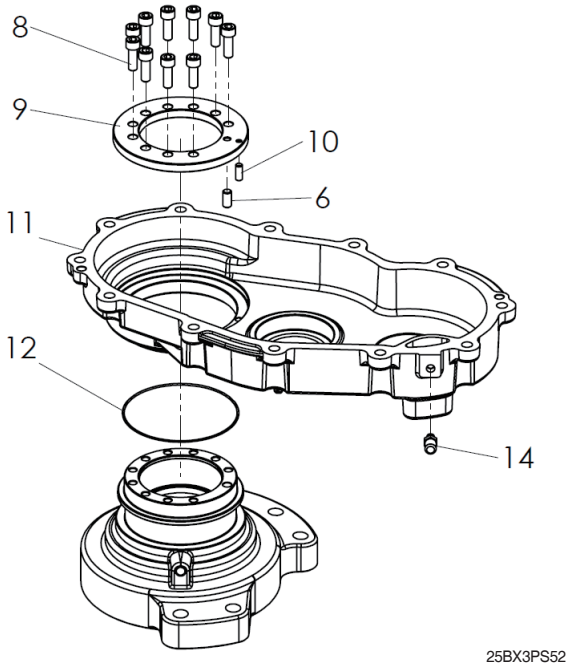
(9) Fasten 7 hexagonal bolts (1) and spring washers (2) lubricated each with Loctite 277 on the assembly.
· Fastening torque : 14±0.5 kgf · m

5. LH AXLE HOUSING ASSEMBLY

1) DISASSEMBLING



25BX3PS51



25BX3PS52

1	Socket-head bolt	6	Dowel pin	11	Gear case
2	LH axle housing	7	Motor case	12	O-ring
3	First gear assembly	8	Socket-head bolt	13	Air breather
4	Second gear assembly	9	Stopper plate		
5	Differential gear assembly	10	Dowel pin		

(1) Loosen socket-head bold (1), and remove LH axle housing from motor case.

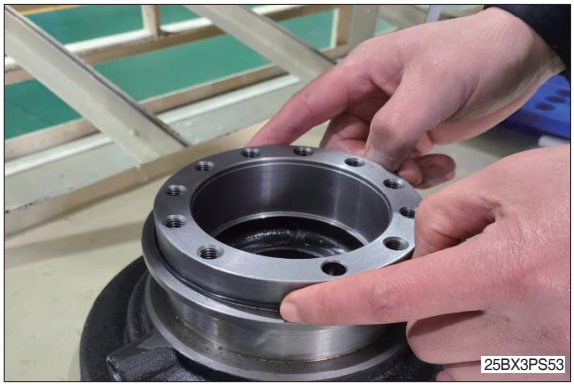
(2) Turn LH axle housing up side down, loosen socket-head bolt (8), and then remove stopper plate (9).

(3) Remove spline hub (9), snap ring (1) and ball bearing (11) from axle housing (3).

(4) Remove first and second assemblies (3, 4), and differential gear assembly (5).

2) ASSEMBLING

(1) Assemble O-ring (12) on LH axle housing (2).

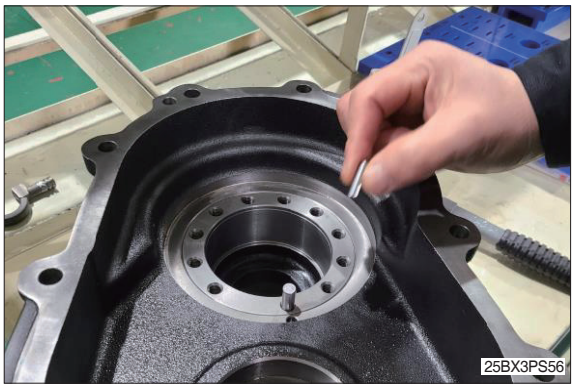


25BX3PS53

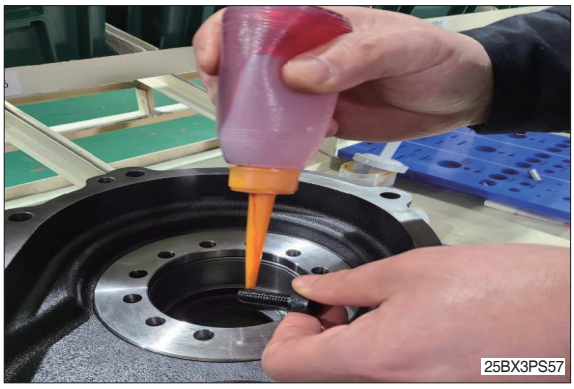
(2) Never forget to lubricate the surface of O-ring (12) with grease.

(3) Assemble differential gear case (11) on LH axle housing (2).

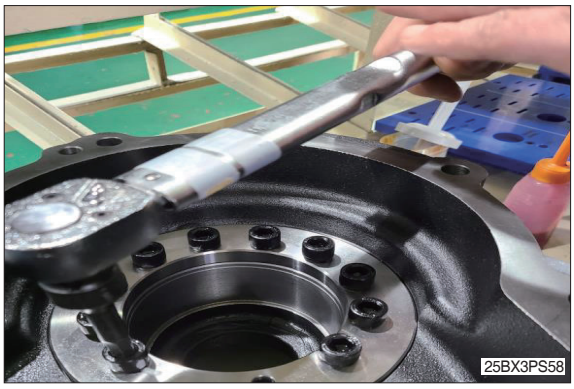
(4) Assemble 2 dowel pins (6, 10) on LH axle housing (2).



(5) Assemble stopper plate on gear case (11), and lubricate sock-head bolt (8) with Loctite 277.



(6) Fasten 10 socket-head bolts (8).
· Fastening torque : 6±0.5 kgf · m



(7) Mark points on LH axle housing and the heads of socket-head bolts for checking for proper assembling.

(8) Assemble first and second assemblies (3, 4), and differential gear assembly (5).

(9) Assemble dowel pin (6) on gear case (11) with a mallet.

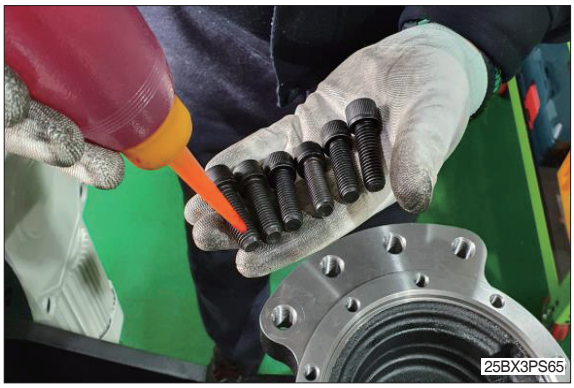
(10) Apply ThreeBond evenly on the surface of oil sealing of gear case (11).

※ **Uneven applying may cause oil leak.**

(11) Assemble guide bolt to prevent leak of ThreeBond.

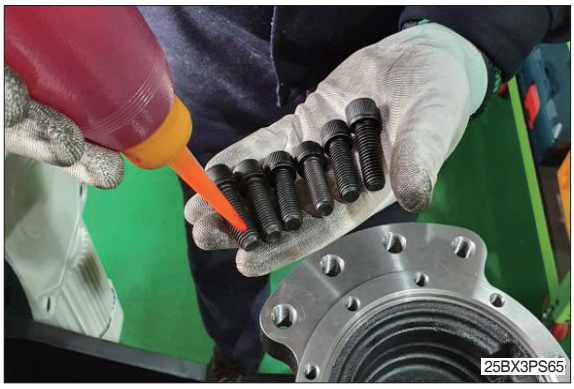
(12) Assemble LH axle housing assembly on differential gear assembly (5) while paying attention to ThreeBond-applied surface.

(13) Lubricate socket-head bolts (1) with Loctite 277.



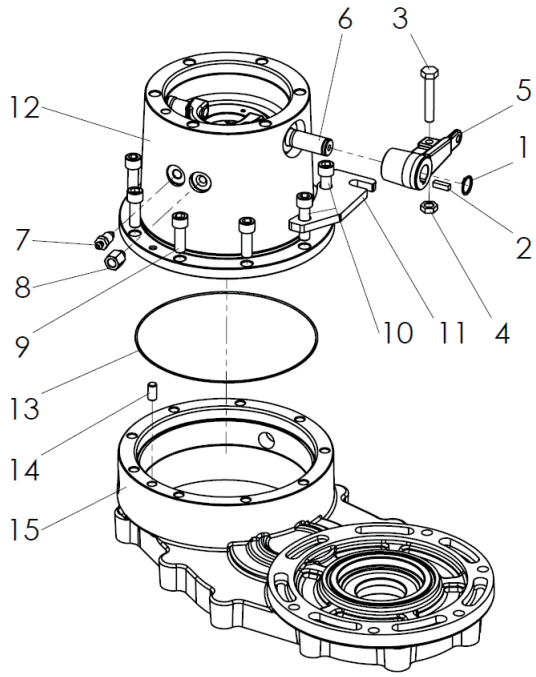
(13) Fasten 11 socket-head bolts.

· Fastening torque : 9±0.5 kgf · m



6. BRAKE HOUSING ASSEMBLY

1) DISASSEMBLING



25BX3PS76

1	Snap ring	6	Parking lever pushing	11	Parking cable bracket
2	Key	7	Brake air breather	12	Brake assembly
3	Hexagonal bolt	8	Brake port	13	O-ring
4	Nut	9	Socket-head bolt	14	Dowel pin
5	Parking lever pulling	10	Socket-head bolt	15	Motor case

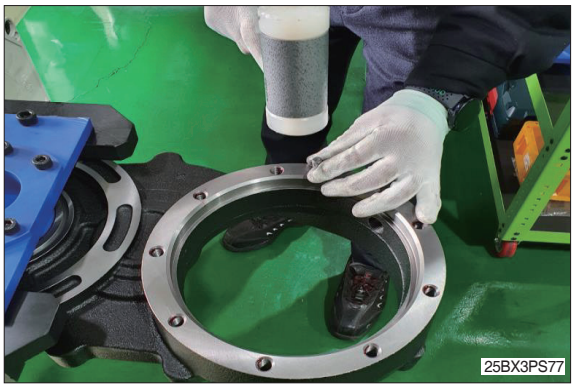
(1) Once snap ring (1) is removed, remove parking lever pulling (5) from parking lever pushing (6).

(2) Remove brake air breather (7) and port (8) from brake assembly (12).

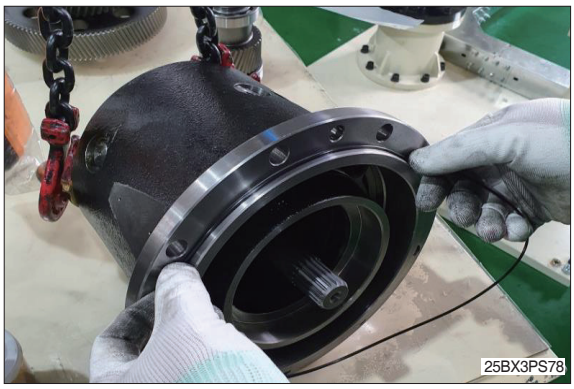
(3) Loosen socket-head bolt (10), and then remove parking cable bracket (11) from motor case (15).

(4) Loosen socket-head bolt (9), and then remove parking assembly (12) from motor case (15).

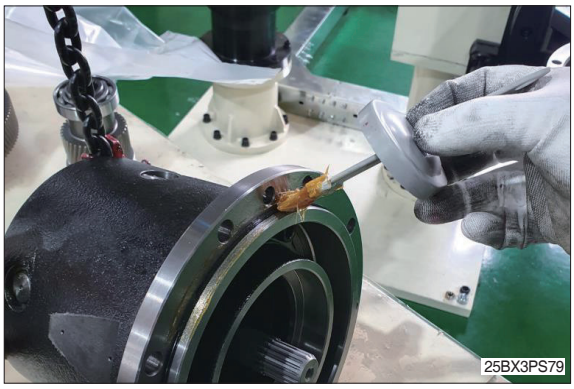
(1) Assemble dowel pin (14) on motor case (15) with a mallet.



(2) Assemble O-ring (13) on brake assembly (12).



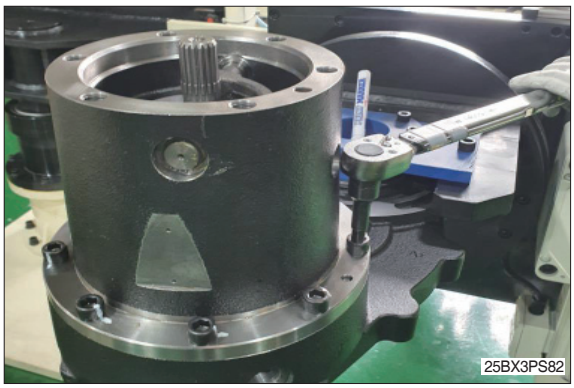
(3) Lubricate the surface of O-ring with grease.



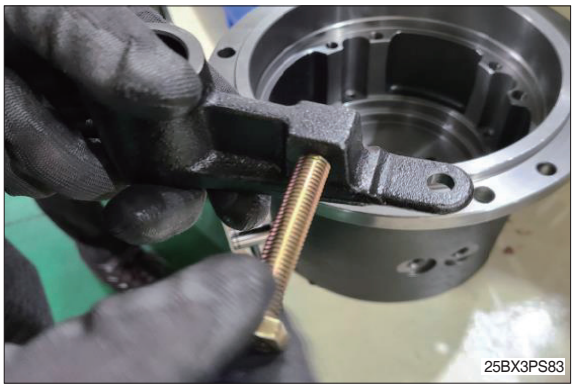
(4) Mount brake assembly on motor case (15).

(5) Fasten 2 socket-head bolts (10) lubricated with Loctite 277 on parking cable bracket (11) and brake assembly (12).
· Fastening torque : 9±0.5 kgf · m

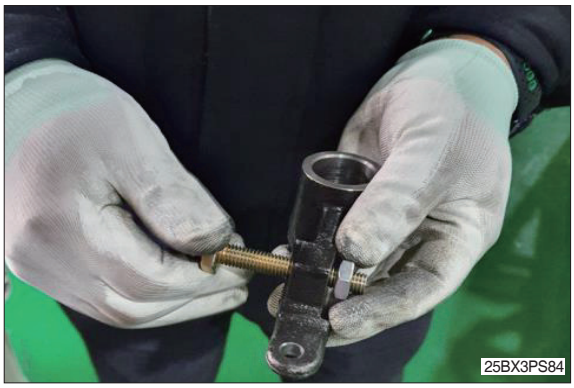
(6) Fasten 7 socket-head bolts (9) lubricated with Loctite 277 on brake assembly (12) and motor case (15).
· Fastening torque : 9±0.5 kgf · m



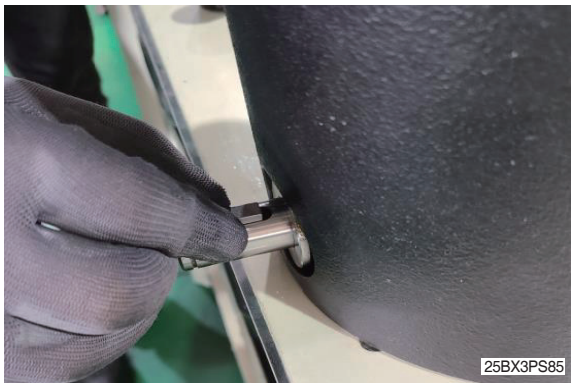
(7) Assemble hexagonal bolt (3) on parking lever pulling (6).



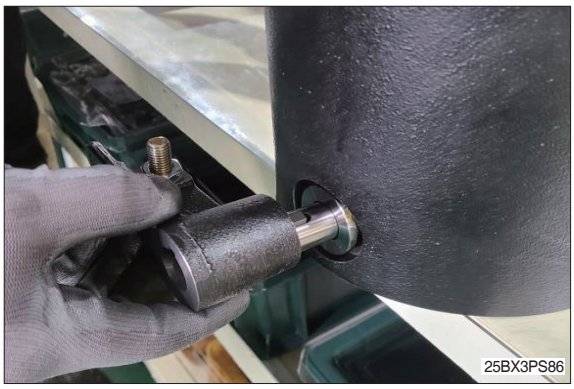
(8) Assemble nut (3) hexagonal bolt (3) assembled on parking lever pulling (6).



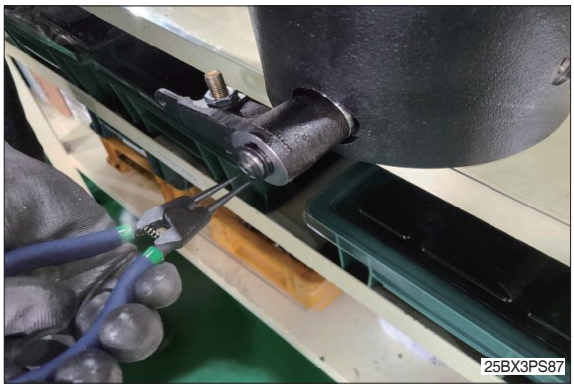
(9) Assemble key (2) on parking lever pushing (6).



(10) Assemble parking lever pulling assembly on parking lever pulling (6).

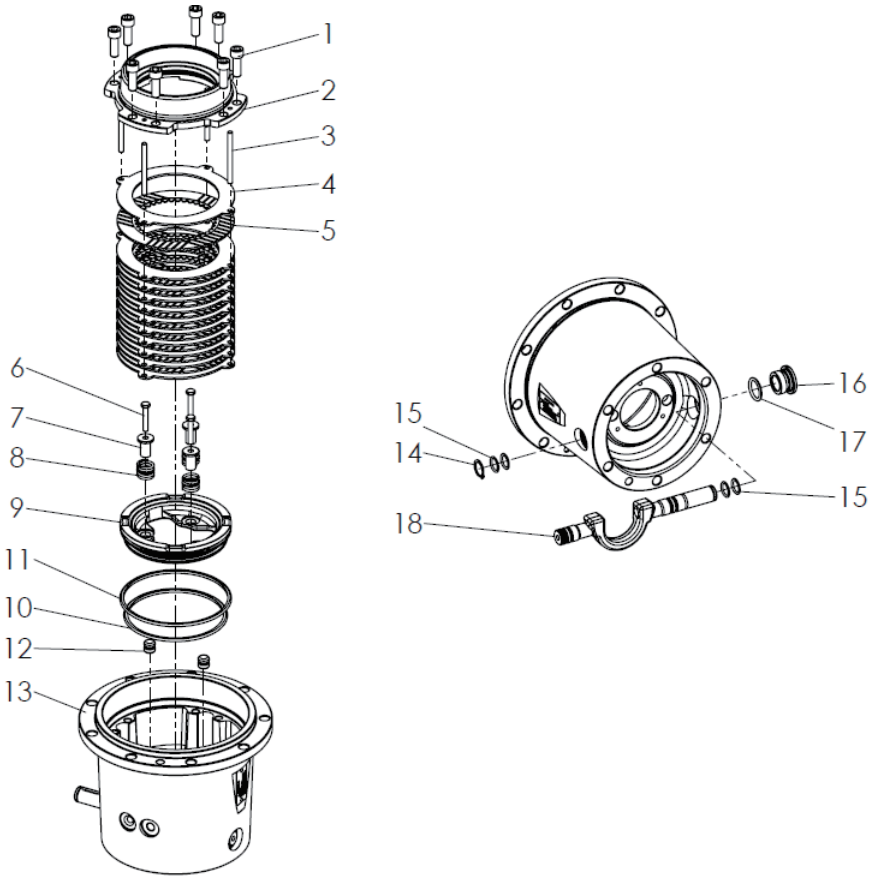


(11) Assemble snap ring (1) on parking lever pushing (6). Mark a point for checking proper assembling.



7. BRAKE ASSEMBLY

1) DISASSEMBLING



25BX3PS89

1	Socket-head bolt	7	Brake spring spacer	13	Brake housing
2	Bearing metal	8	Brake return spring	14	Snap ring
3	Guide pin	9	Brake Piston	15	O-ring
4	Brake reaction plate	10	D-ring (large)	16	Parking lever
5	Friction plate	11	D-ring (small)	17	O-ring
6	Hexagonal bolt	12	Parking pin	18	Parking lever pushing

(1) Loosen socket-head bolt (1), and then remove bearing metal (2) from brake housing (13).

(2) Once guide pin (3) is removed, remove brake reaction plate (4) and friction plate (5).

(3) Once hexagonal bolt (6) is loosened, remove brake piston (9).

(4) Remove snap ring (14) and O-ring (15) from brake housing (13).

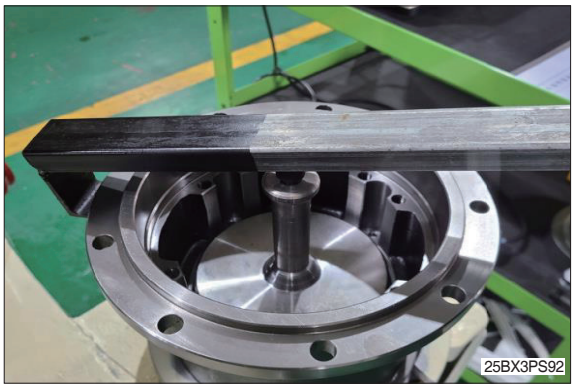
(5) Remove parking spacer (16) and O-ring (17) from brake housing (13).

(6) Remove parking lever pushing (18) from brake housing (13).

(1) Assemble D-rings (10, 11) on brake piston (9). Clean the contact surface of piston clear that is assembled on brake housing.

(2) Lubricate assembly surface with grease.

(3) Make use of jig and press to assemble brake piston assembly on brake housing (13).



(4) Assemble spring space (7) and return spring (8) on brake piston (9). Assemble 3 hexagonal bolts (6) lubricated with Loctite 277.

(5) Fasten hexagonal bolts (6) on brake piston (9).
· Fastening torque : 1.5±0.2 kgf · m

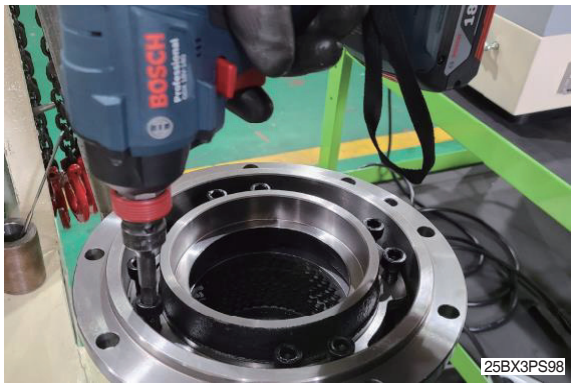
(6) Assemble friction plate (5) and brake reaction plate (4) on brake housing (13)

※ **Never forget to assemble reaction plate only after assembling friction plate.**

(7) Assemble bearing housing on brake housing (13).
· Brake play setting : 1.2 mm

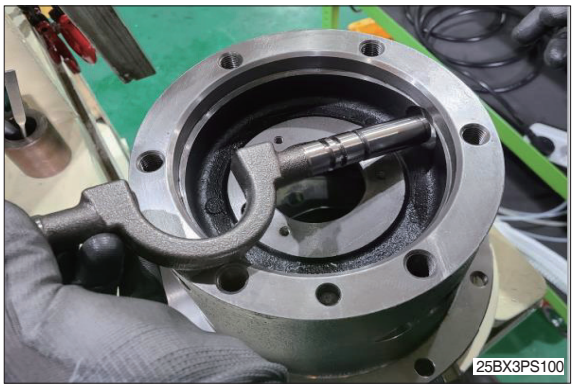
(8) Lubricate socket-head bolt (1) with Loctite 277.

(9) Fasten socket-head bolt (1) on brake housing (13).
· Fastening torque : 6±0.5 kgf · m

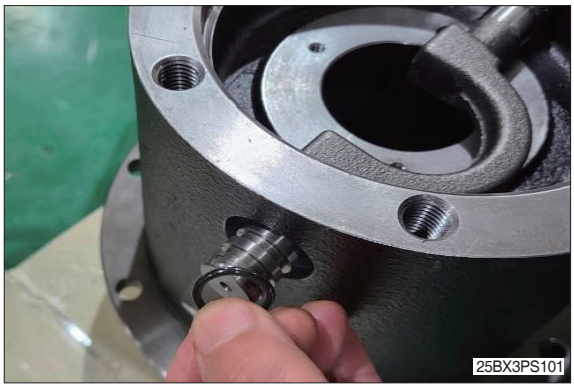


(10) Assemble parking pin (12) on brake housing (13).

(11) Assemble parking lever pushing (18) on brake housing (13).

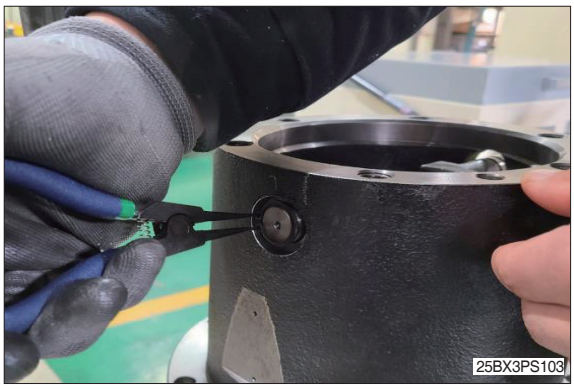


(12) Assemble 2 O-rings on parking lever pushing (18).



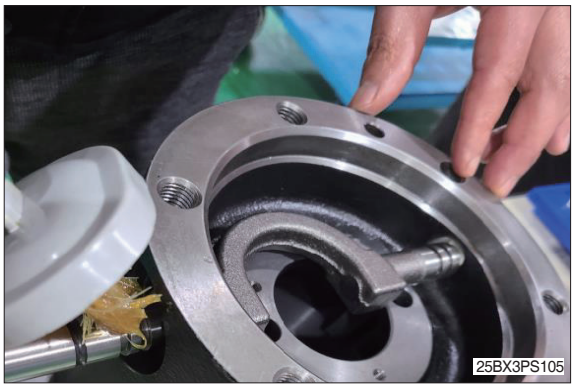
(13) Lubricate the surface of O-ring with grease.

(14) Assemble snap ring (14) on parking lever pushing (18). Mark a point for checking for proper assembling.

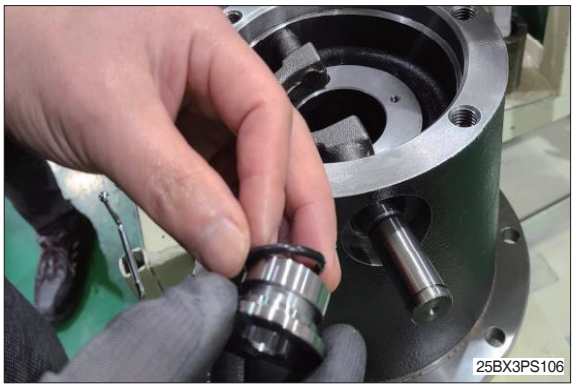


(15) Assemble 2 O-rings on parking lever pushing (18).

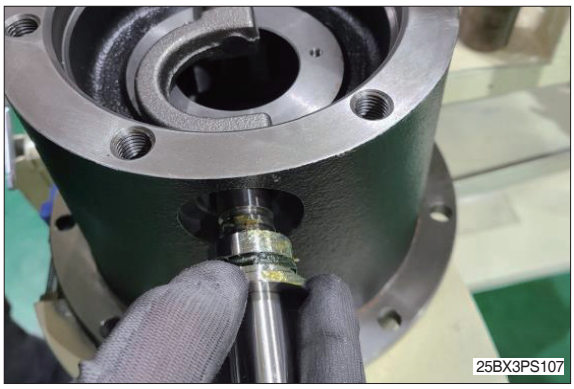
(16) Lubricate the surface of O-ring with grease.



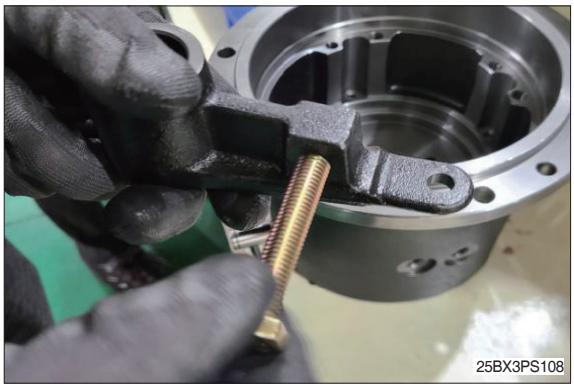
(13) Assemble O-ring (17) on parking space (16), and lubricate it with grease. Mark a point for checking for proper assembling.



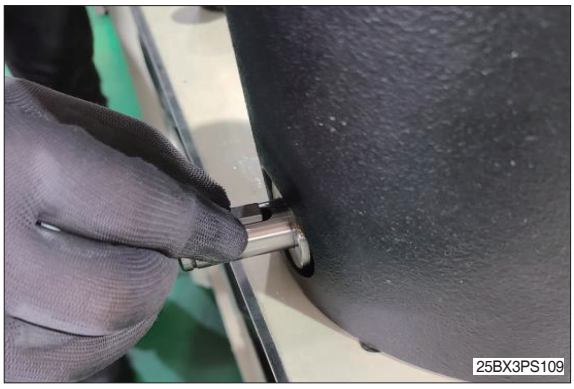
(14) Assemble assembly on brake housing (13).



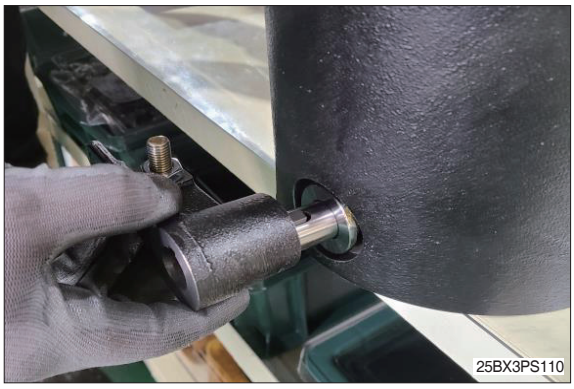
(15) Assemble hexagonal bolt on parking lever pulling.



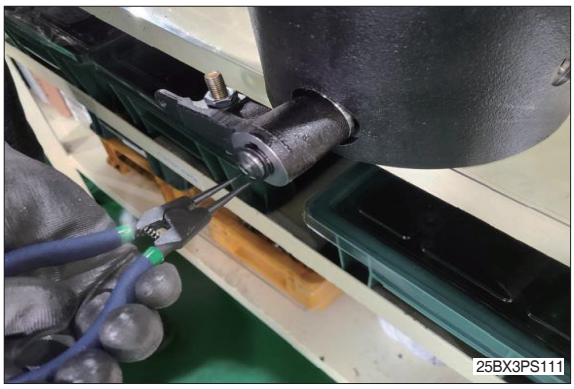
(16) Assemble key on parking lever pushing (18).



(17) Assemble parking lever pulling assembly on parking lever pulling (18).

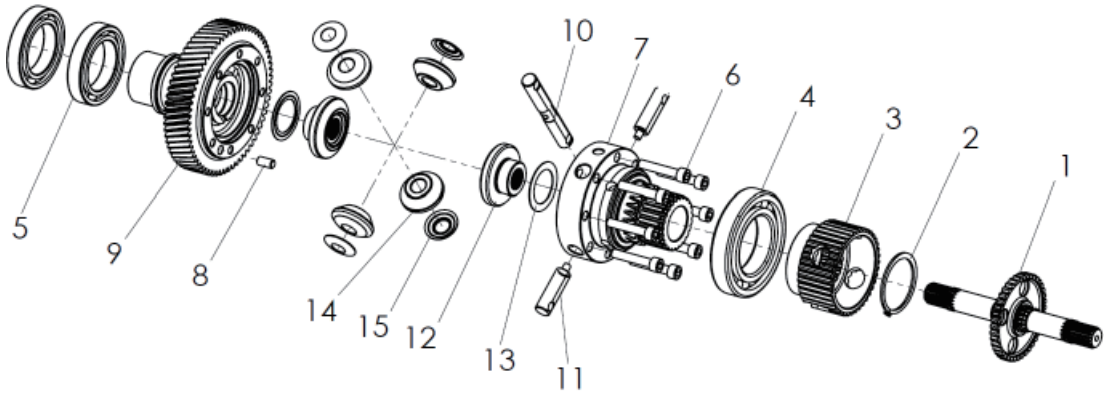


(18) Assemble snap ring on parking lever pushing (18). Mark a point for checking for proper assembling.



8. DIFFERENTIAL GEAR ASSEMBLY

1) DISASSEMBLING



25BX3PS112

1	Center axle assembly	6	Socket-head bolt	11	Differential pinion shaft (B)
2	Snap ring	7	Differential gear case	12	Differential side gear
3	Brake hub	8	Dowel pin	13	Thrust washer
4	Ball bearing	9	Differential cover gear	14	Differential pinion gear
5	Ball bearing	10	Differential pinion shaft (A)	15	Differential pinion washer

(1) Remove center shaft assembly (1) from differential gear assembly.

(2) Remove snap ring (2) and brake hub (3) from differential gear case (7).

(3) Remove ball bearing (4) from differential gear case (7).

(4) Remove ball bearing (5) from differential cover gear (9).

(5) Remove socket-head bolt (6) and differential gear case (7) from differential cover gear (9).

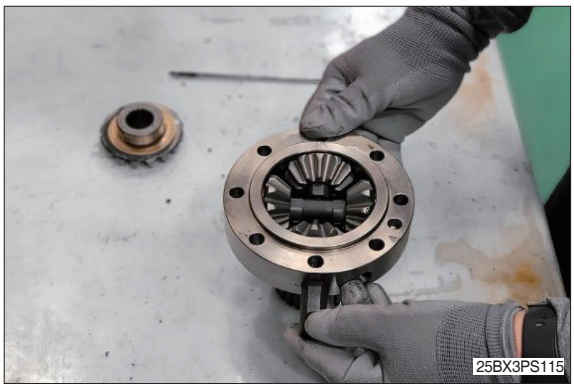
(6) Remove differential gear and pinion.

2) ASSEMBLING

(1) Lubricate differential gear case (7) with grease.

(2) Lubricate gear, washer and shaft with grease.

(3) Assemble pinion gear, shaft and washer on differential gear case (7) and differential cover gear (9).



(4) Assemble washer, differential side gear (12) and dowel pin (8) on differential gear case (7) and differential cover gear (9).

(5) Lubricate socket-head bolt (6) with Loctite 277.

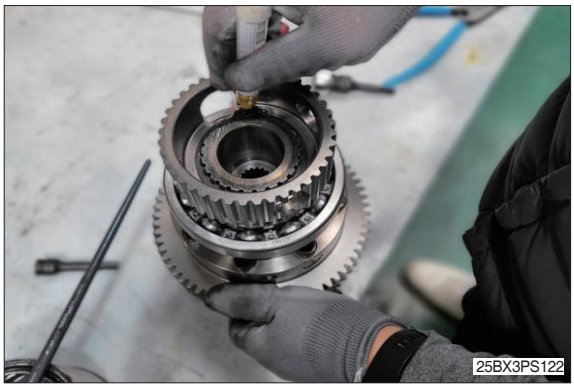
(6) Assemble 8 socket-head bolts (6) on differential gear case (7).

(7) Fasten 8 socket-head bolts (6) on differential gear case (7).
· Fastening torque : 6±0.5 kgf · m

(8) Assemble ball bearing (5) on differential cover gear (9).

(9) Assemble ball bearing (4) and brake hub (3) on differential case assembly.

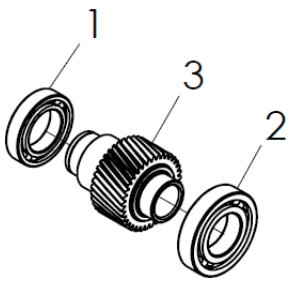
(10) Assemble snap ring (2), and then mark a point for checking proper assembling.



9. FIRST AND SECOND GEAR ASSEMBLIES

1) DISASSEMBLING

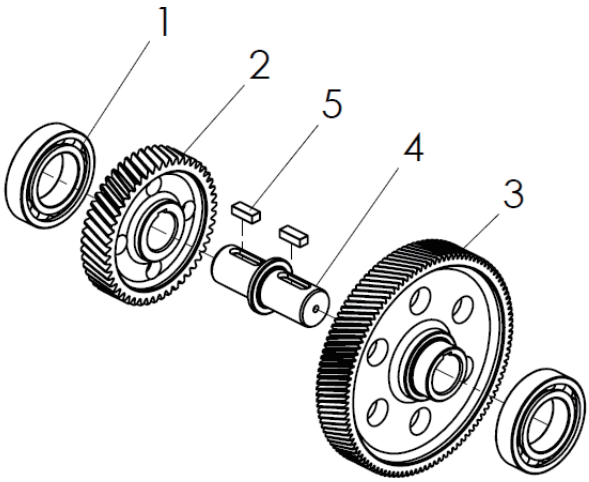
First gear



25BX3PS123

1 Ball bearing
2 Ball bearing
3 Input gear

Second gear



25BX3PS124

1 Ball bearing
2 Helical gear
3 Helical gear
4 Gear shaft
5 Key

(1) Disassembling first gear assembly

① Remove ball bearing (1) from input gear (3).
② Remove ball bearing (2) from input gear (3).

(2) Disassembling second gear assembly

① Remove ball bearing (1) from second gear assembly.
② Remove ball bearing (1) from second gear assembly.
③ Remove helical gear (2) and key (5) from gear shaft (4).
④ Remove helical gear (2) and key (5) from gear shaft (4).

2) ASSEMBLING

(1) Assembling first gear assembly

① Make use of heating device to assemble bearing on input gear (3).

(2) Assembling second gear assembly

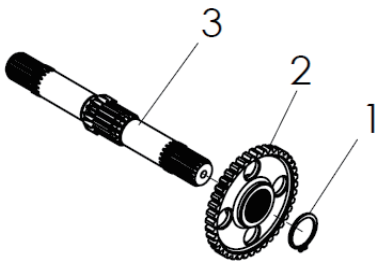
① Once key (5) is assembled on gear shaft (4), assemble helical gears (3, 4).

② Make use of heating device to assemble ball bearing (1) on gear shaft (4).

※ **Check ball bearing for smooth revolution.**

10. CENTER SHAFT ASSEMBLY

1) DISASSEMBLING



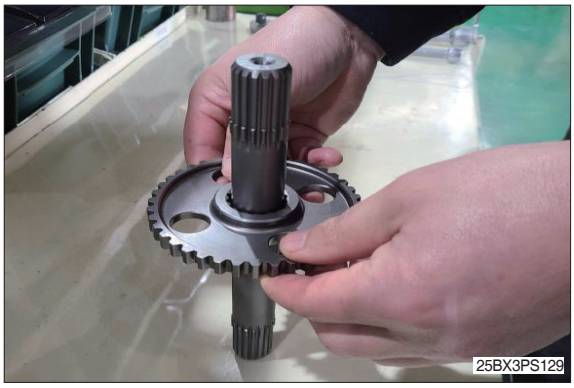
25BX3PS128

1 Snap ring
2 Brake hub
3 Center shaft

(1) Remove snap ring (1) and brake hub (2) from center shaft (3).

2) ASSEMBLING

(1) Assemble brake hub (2) on center shaft (3).



25BX3PS129

(2) Assemble snap ring (1) on center shaft (3).

25BX3PS130

SECTION 4 BRAKE SYSTEM

SECTION 4 BRAKE SYSTEM

GROUP 1 STRUCTURE AND FUNCTIONS

1. INTRODUCTION

There are two types of brake systems: Service brake and parking brake.

Pressing the service brake pedal generates hydraulic pressure in the master cylinder. This pressure lets the brake lever press the pressure pin to apply braking pressure on the disk carrier.

The parking brake lever operates with cable to make the pressure pin apply braking pressure on the disk carrier.

2. SPECIFICATIONS

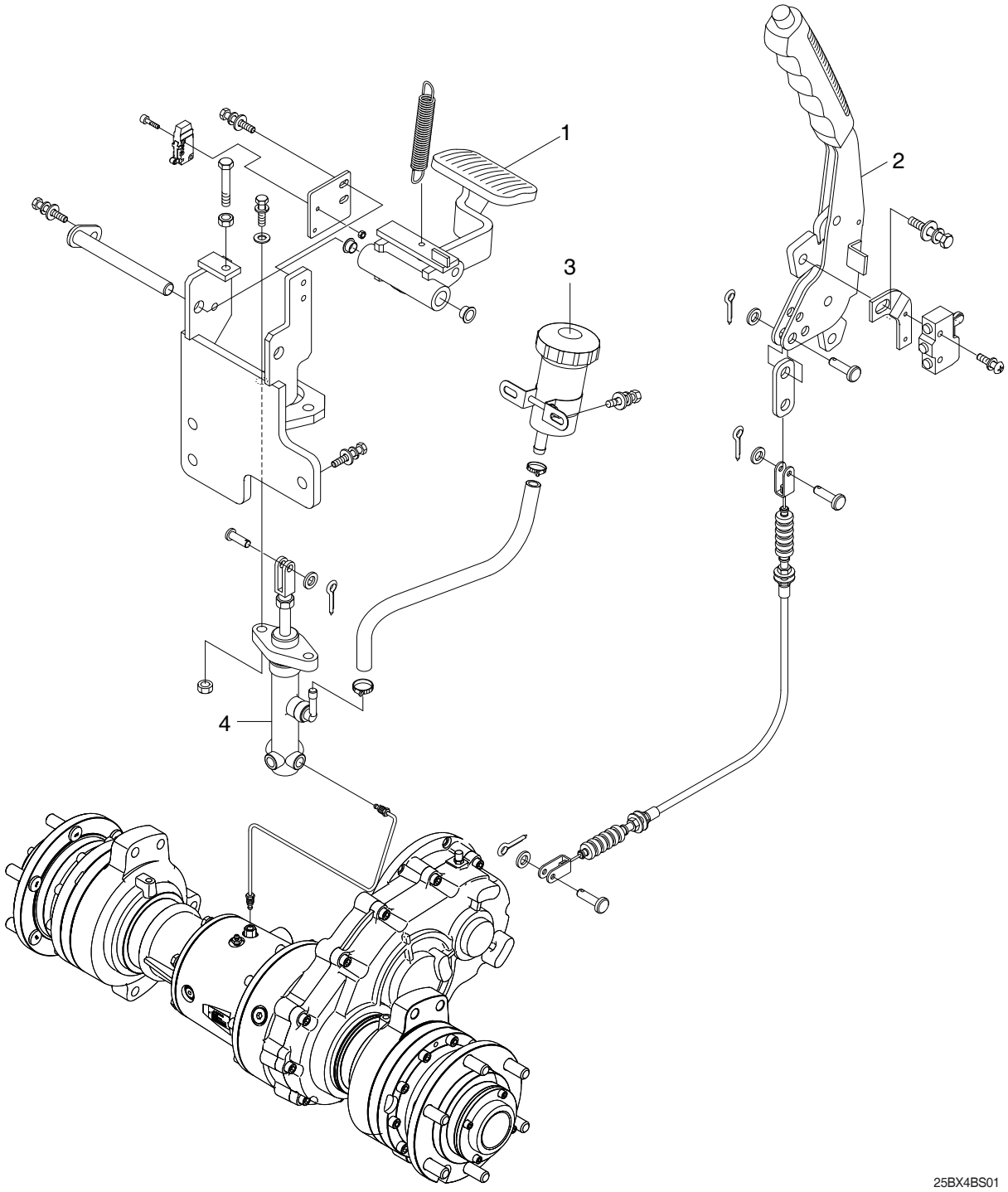
1) SERVICE BRAKE

Item	Unit	Specifications
Type	-	Wet disk brake
Brake fluid	-	Hydraulic oil ISO VG32 (AZOLLA ZS32)
Max. torque	N·m (at 30 bar)	3700

2) PARKING BRAKE

Item	Dimensions
Type	Latched, inner-expanding mechanical type
Parking lever stroke	13.5 deg.
Parking cable stroke	60 mm

3. BRAKE PEDAL AND PIPING



1 Brake pedal
2 Parking brake lever
3 Storage tank
4 Brake valve

4. BRAKE CONNECTION

It is recommended to use lever 2 output cylinder on the service brake. In such a case, it is possible to reduce pedal stroke to the minimal value comparing with the lever 1 cylinder.

Three M10×1 connections are provided for connecting the hydraulic pressure brake to the brake cable.

1) Connecting hydraulic brake

Connect air breather and brake hose (hydraulic line) to the connection points.

· Fastening torque : 1.4 - 1.8 kgf · m

Keep curvature radius maximum when installing hydraulic line to reduce resistance against restoration force of brake lifting to the largest extent.

2) Connecting parking brake cable

Fasten parking brake cable to lever with screws.

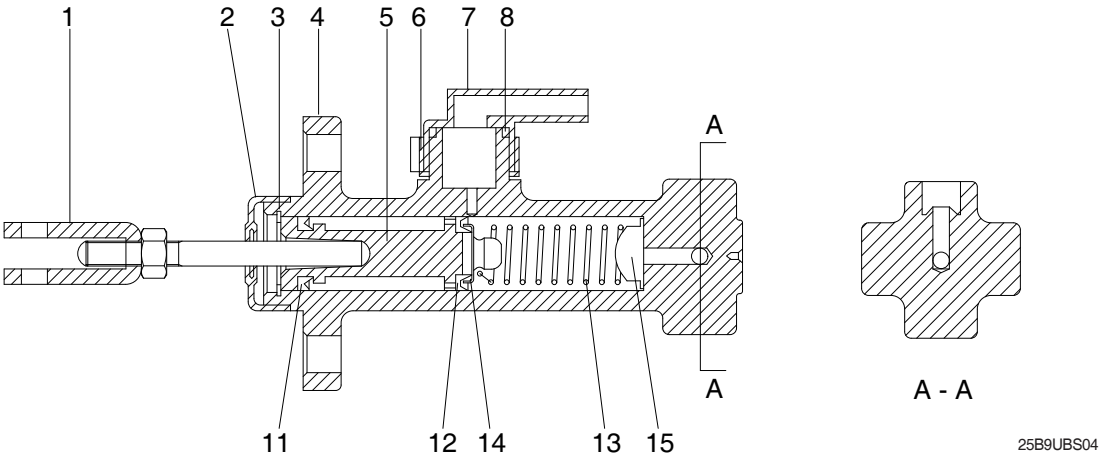
Once installation is complete, check installation footprint, and keep it intact.

Keep curvature radius maximum when installing brake line to reduce resistance against restoration force of brake lifting to the largest extent.

⚠ Once brake fluid is filled, bleed the brake (See Page 4-7).

5. BRAKE VALVE

1) STRUCTURE



1	Rod assembly	6	Union	13	Spring
2	Boot	7	Elbow	14	Spring sheet
3	Snap ring	8	O-ring	15	Spring sheet
4	Body	11	Second cup		
5	Piston	12	First cup		

2) DISASSEMBLING

(1) Remove boot (2) and rod assembly (1).

(2) Remove snap ring (3), and then disassemble piston (5), second cup (11), first cup (12), spring (13), and spring sheets (14, 15).

(3) Specifications of brake valve

· Cylinder bore diameter : 19.05 mm

· Piston stroke : 23.0 mm

3) INSPECTION

(1) Clean components, and check them for conditions.

※ Use isopropyl alcohol or brake fluid only. Never use gasoline, kerosene, or other mineral oil. Do not keep rubber component in alcohol in alcohol for 30 seconds or longer.

(2) If defect is found on the inner wall of the body, replace the brake valve assembly.

(3) If deformation or other defect is found, replace boot (2), second cup (11), first cup (12) and piston (5).

4) ASSEMBLING

※ Make sure again the parts are not contaminated before assembling. Apply thin film of brake oil on parts.

· Assembling is done in reverser order of disassembling.

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECK

1) BRAKE PIPING

(1) Check pipe, hose and joint for damage, oil leak or interference.
(2) Press brake pedal to check force required for pressing.
Check for any variation of operating force and pedal position with the pedal kept pressed.

2) BRAKING FORCE

(1) Drive the truck at max. speed on hard, flat and paved surface. If any signal is alarmed, immediately stop the truck, and measure the distance from signal alarming pint to stopped point (under no load).
· Stopping distance: 5 m or less
(2) Make sure that there is no inclination of steering wheel or bake, or no noise during sudden braking.

3) PARKING BRAKE

(1) Operating force of parking lever is 20-30 kgf · m.
(2) Make sure that the loaded truck is kept standstill on slope of 15% gradient when applying the parking brake.
If there is no slope, drive the truck at low speed and check operation of the parking brake.

2. OPERATION INSPECTION, AND FAILURE DIAGNOSIS AND TROUBLESHOOTING

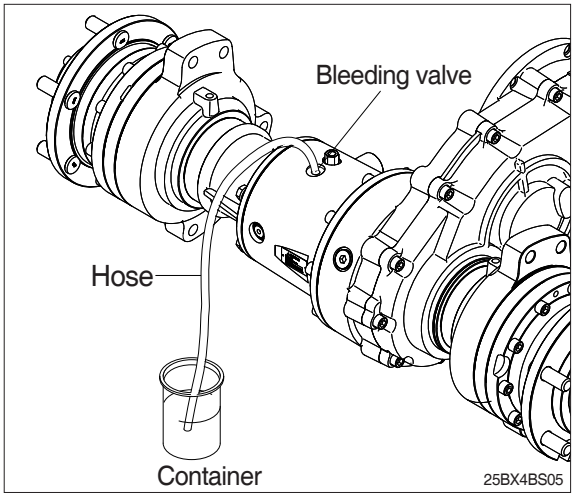
Trouble	Cause	Troubleshooting
Defective brake operation	· Oil leak inside system, or low level of brake oil in tank	· Repairing oil leak. Discharge remained oil, and fill the oil tank of the brake valve with brake oil to the specified level.
	· Air in the system.	· Fully bleed air from the brake lever.
	· Abraded and degraded piston cup of the body to cause oil leak.	· Check the body and piston for abrasion. If no defect is detected, replace the cup.
Excessive brake pedal operating distance	· Air in the system.	· Fully bleed the system. · Check the oil tube joint and connections for oil leak, and replace parts, if required.
Large wheel weight	· Return port of brake valve clogged by piston cup.	· Checking brake valve
	· Return spring	· Repair or replacement of pedal return spring.

GROUP 3 TESTING AND ADJUSTMENT

1. BRAKE BLEEDING

Bleeding should be performed on brake system after filling brake fluid.

1) Remove the cap from bleeding valve, and connect hose to the valve to put discharging fluid into a container.
2) Press brake pedal to apply pressure.
3) Rotate bleeding valve by a half turn with spanner while pressing brake pedal to bleed the brake.



※ Put discharged brake fluid into a container.
Do not spill brake fluid on the floor, or discharge it into drain.

⚠ Close bleeding valve before releasing brake pedal.

※ Repeat this process until brake fluid shows no bubble.
Check the level of brake fluid in a container, and make up the fluid, if required.

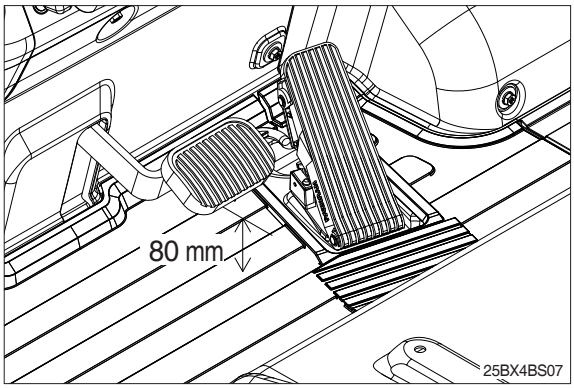
4) Once brake fluid is discharged without indication of bubble, fasten the bleeding valve, remove hose, and install dust prevention cap on bleeding valve.
   · Fastening torque : 1.5±0.2 kgf · m

2. ADJUSTMENT OF PEDAL

1) BRAKE PEDAL

(1) Adjust the height of pedal from the floor plate with a stopper bolt.
   · Pedal height : 80 mm

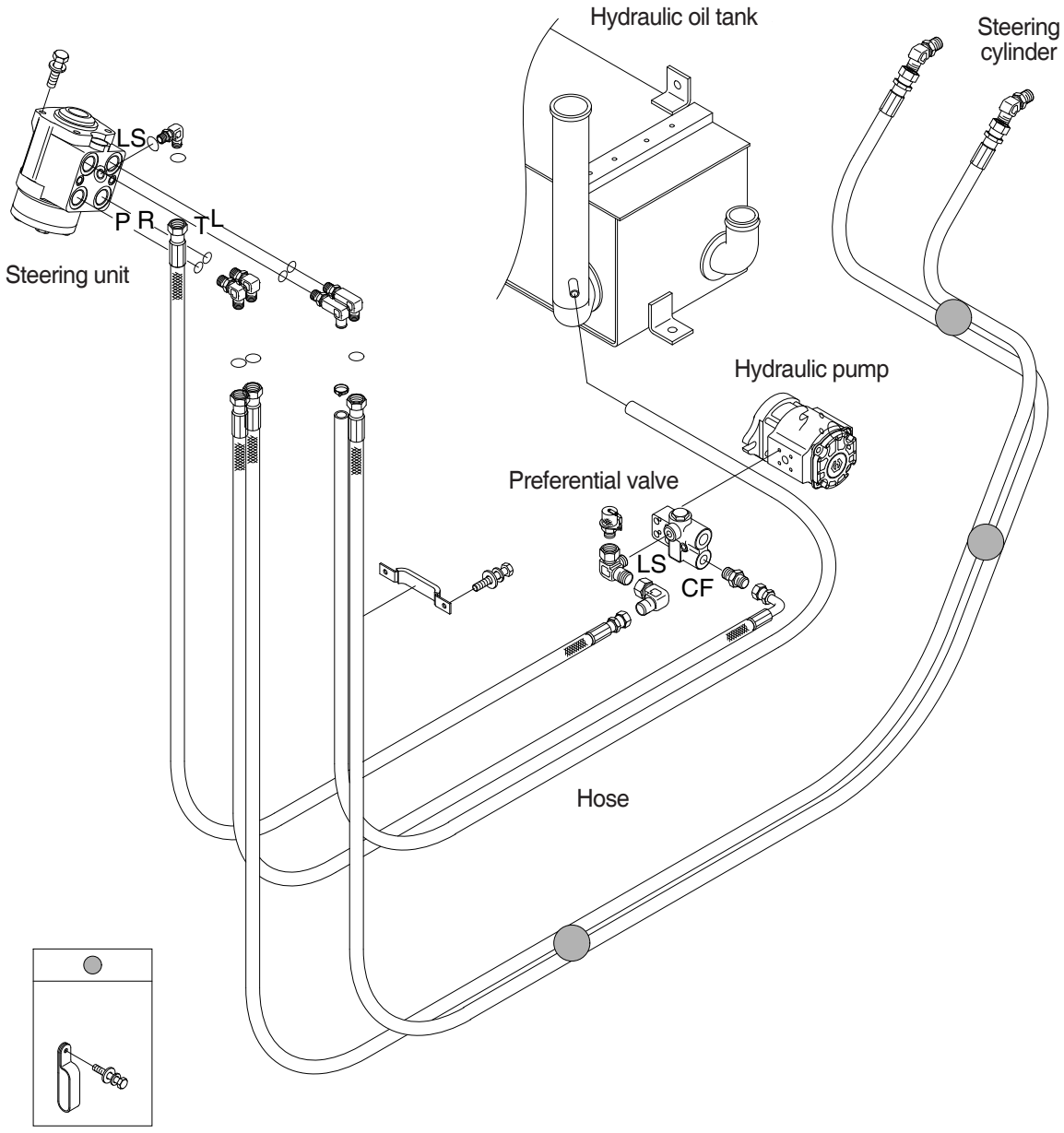
(2) Play
   Adjust play with rod of master cylinder.
   · Idle stroke : 1-2 mm



SECTION 5 STEERING SYSTEM

GROUP 1 STRUCTURE AND FUNCTIONS

1. INTRODUCTION



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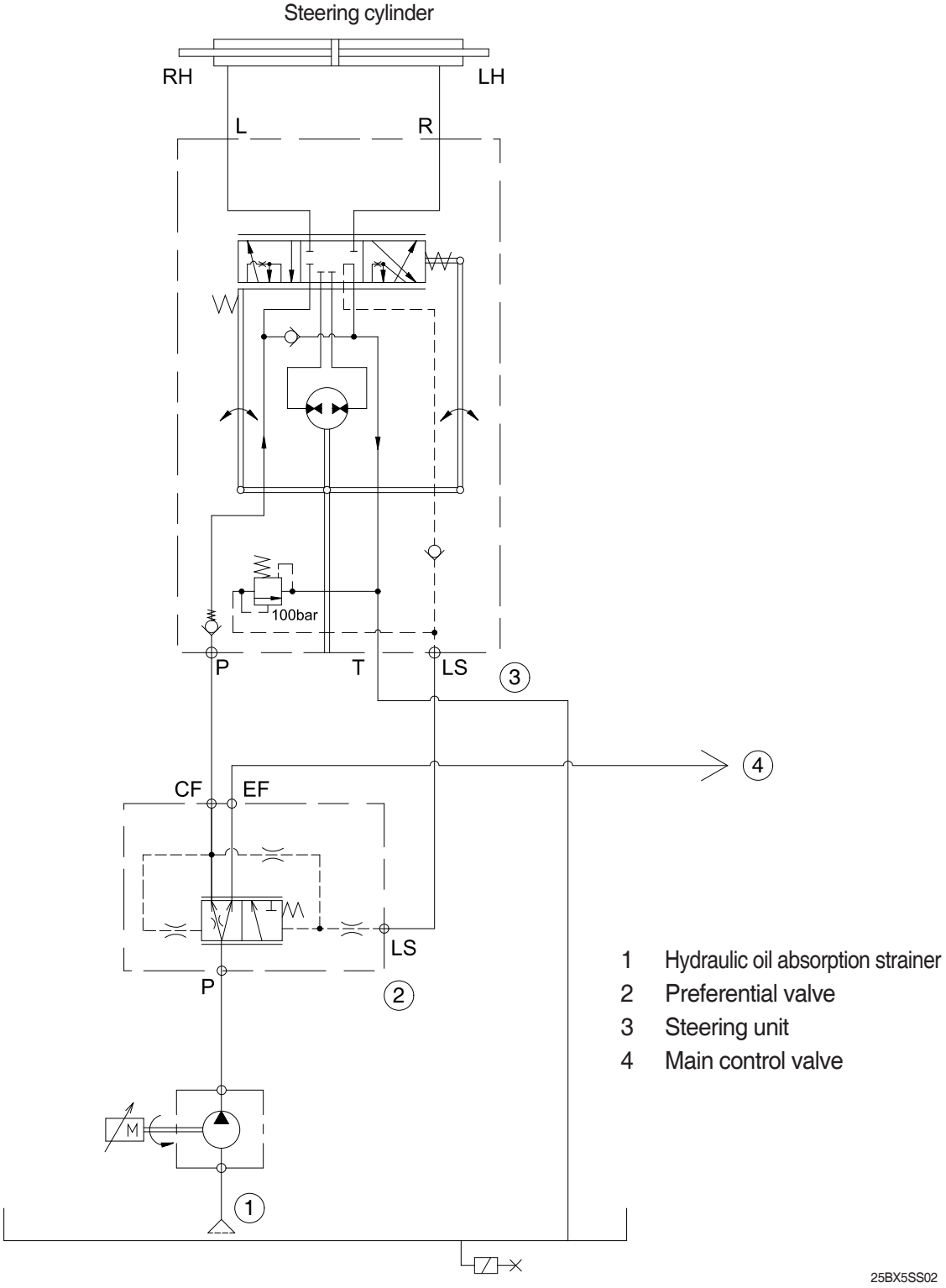
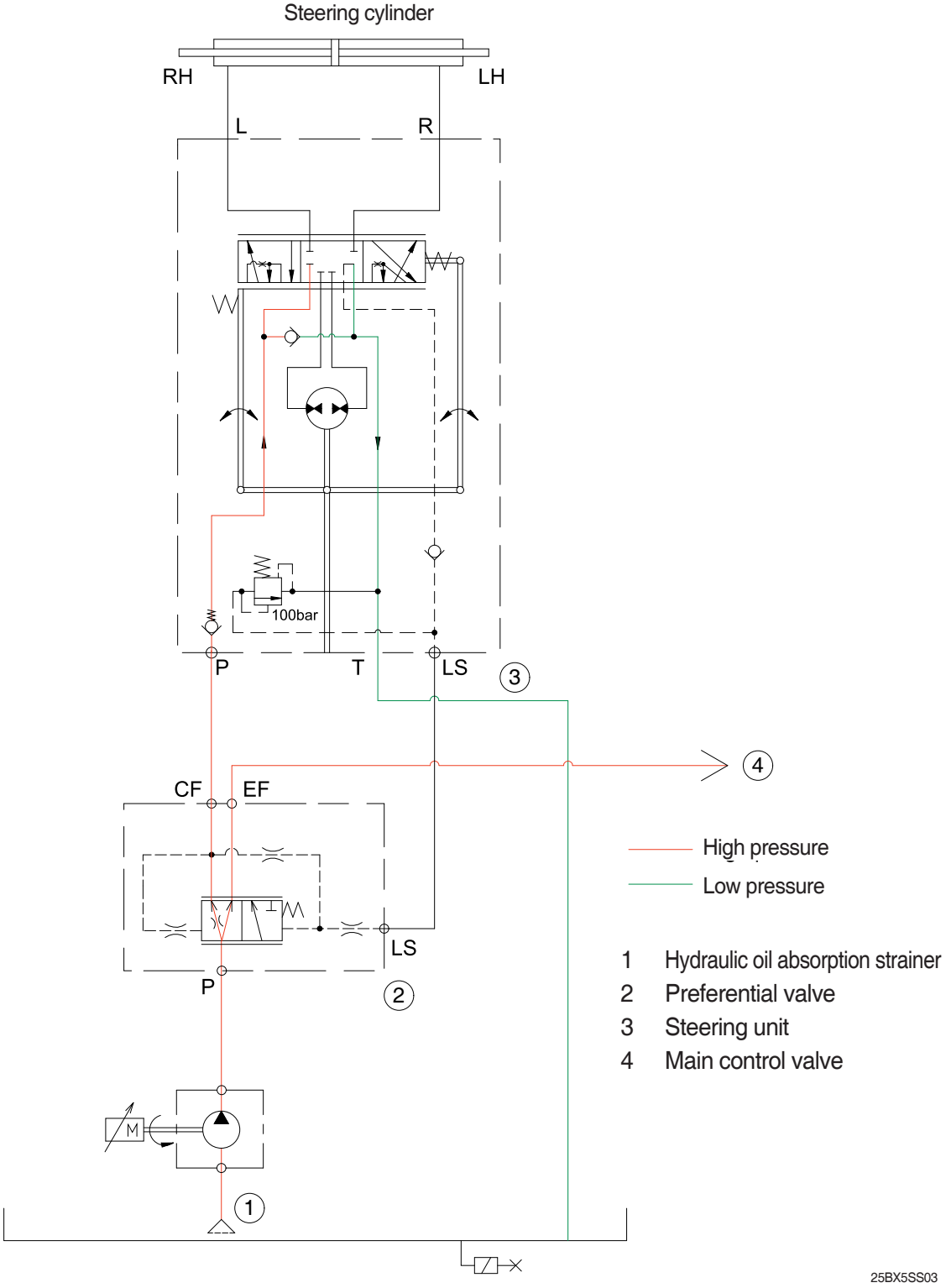
Steering system consists of hydraulic pump, steering wheel assembly, steering unit, preferential valve, steering cylinder, and piping. Steering axle with integrated rear wheel tire and cylinder supports the weight of forklift truck. Steering axle is of structure with steering knuckles installed on the both sides of king pin. Hubs and wheels are fastened on spindles of knuckles. When turning steering wheel to move forklift struck to the left or right, rotational torque is transferred to steering unit, and hydraulic oil in steering unit flows to steering axle hydraulic cylinder through hose. Force generated from steering cylinder moves knuckle of rear wheel through intermediate link. See the figure for locations of steering system components.

2. HYDRAULIC CIRCUIT



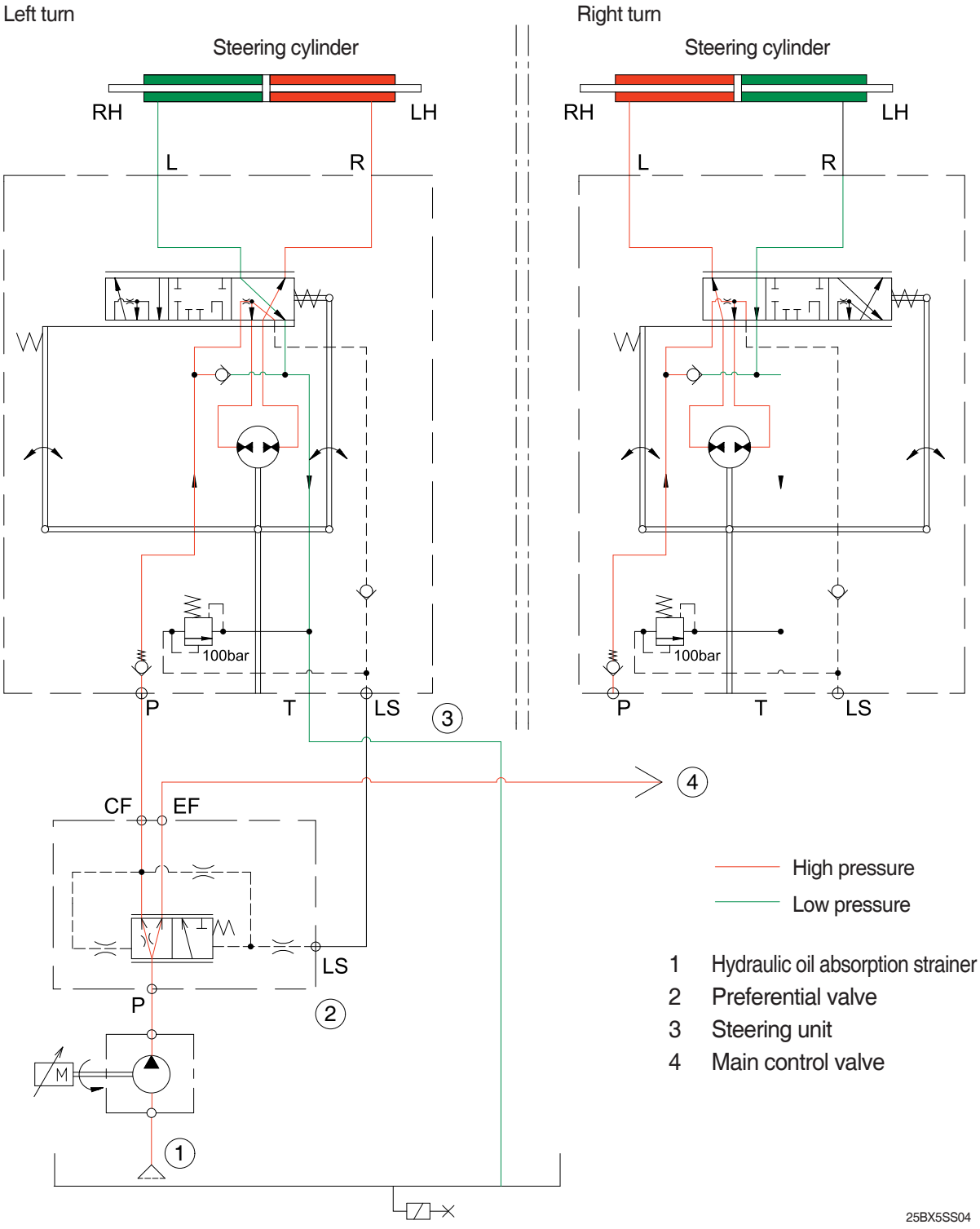
Hydraulic oil is supplied from hydraulic pump to preferential valve. When driver turns steering wheel, hydraulic oil is supplied first to steering unit by working circuit inside preferential valve. Hydraulic oil inside steering unit is expanded or shrunk, and then supplied to steering cylinder of forklift truck. hydraulic oil excessively discharged from hydraulic pump flows to hydraulic oil tank along main control valve and preferential valve EF port.

1) NEUTRAL



When hydraulic motor starts operating, and steering wheel is kept in neutral position, steering unit spool and sleeve are kept in neutral position. Flow of hydraulic oil through valve is blocked to the left and right steering ports. Pressure on pilot of preferential valve spool controls spool to move it to the opposite direction. Hydraulic oil flows to main control valve through EF port with this type of control. Small quantity of hydraulic oil in neutral position is continuously discharged through orifice. Hydraulic oil flows in through LS hose piping, and then is discharged to hydraulic oil tank through steering unit spool and sleeve. Upon sudden steering, dynamic flow of hydraulic oil prevents initial hard spot.

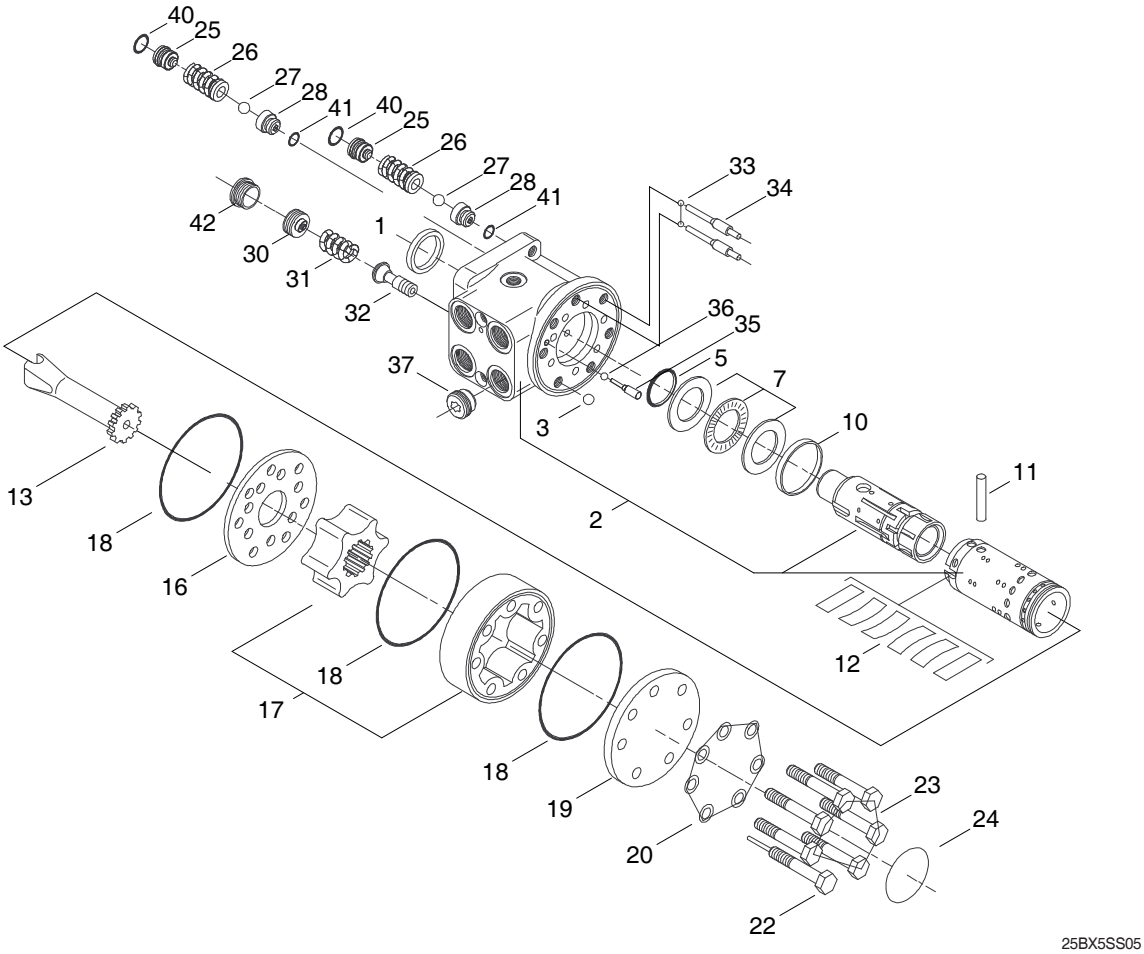
2) TURING LEFT OR RIGHT



When hydraulic motor starts operating, and steering wheel is turned, steering unit spool and sleeve rotate. Path opens to allow supply of hydraulic oil to gear inside steering unit. Hydraulic oil causes rotation of pump. Hydraulic oil returns to steering valve spool and sleeve, and is supplied to left or right steering port by turning of steering wheel. LS port circuit is connected to CF port, which blocks return of hydraulic oil to hydraulic oil tank, and senses pressure required for turning of steering wheel. When pressure required for LS circuit increases or decreases, preferential valve spool moves to satisfy conditions of hydraulic oil and pressure required for rotating tires. Once steering cylinder reaches the maximum stroke, relief valve supplies hydraulic oil to hydraulic oil tank to adjust pressure. Preferential valve spool moves to supply hydraulic oil to main control valve through EF port.

3. STEERING UNIT

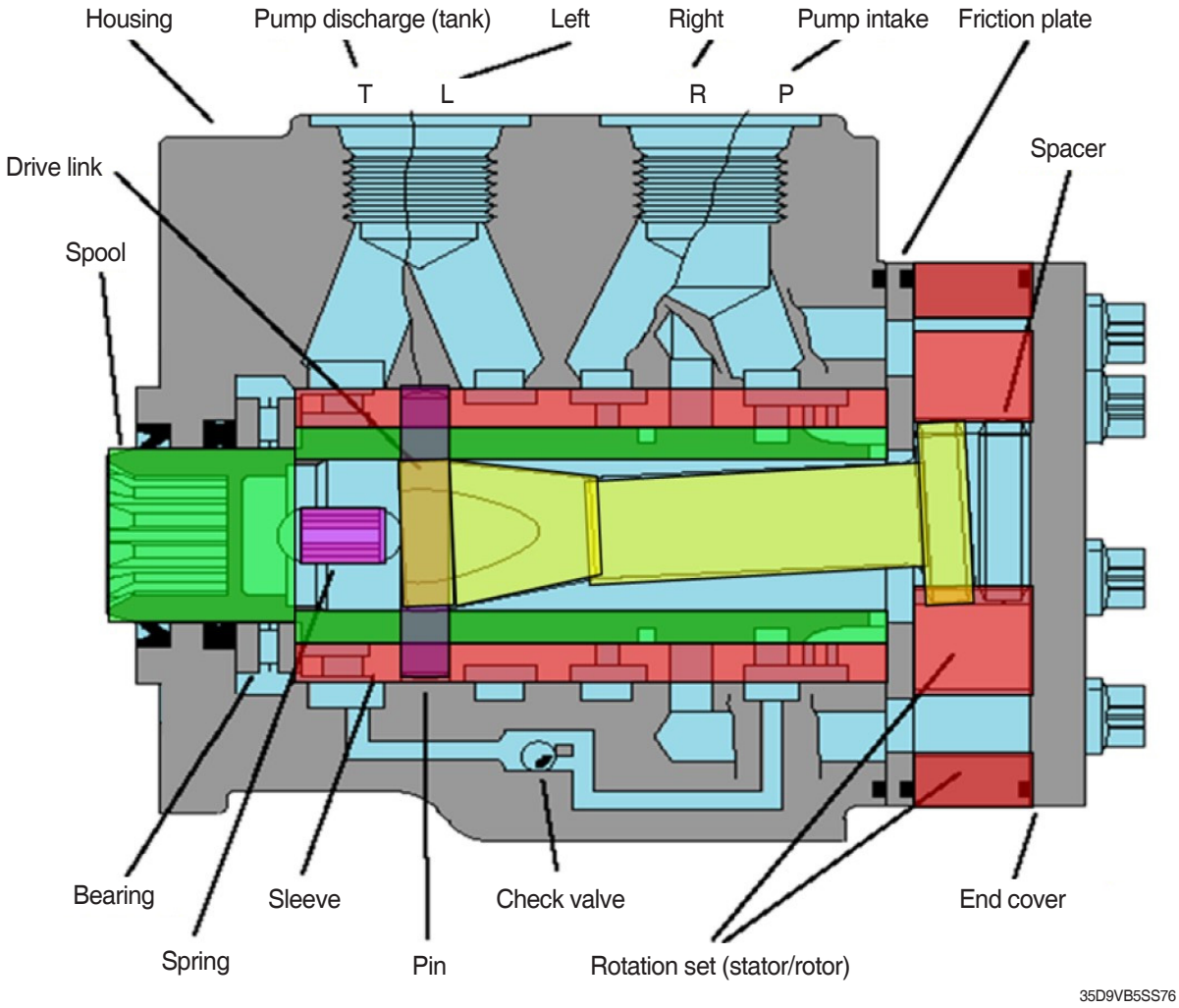
1) STRUCTURE



1	Dust sealing ring	19	End cover	33	Ball
2	Housing spool and sleeve	20	Washer	34	Bushing
3	Ball	22	Pin bolt screw	35	Ball stop thread
5	Shaft seal	23	Screw	36	Ball (Ø3)
7	Bearing assembly	24	Model/code label	37	Check valve
10	Ring	25	Adjusting screw	39	Sealing ring
11	Cross pin	26	Spring	40	O-ring
12	Spring set	27	Ball	41	O-ring
13	Cardan shaft	28	Seat	42	Plug
16	Distributor plate	30	Adjusting screw		
17	Gear wheel set	31	Spring		
18	O-ring	32	Piston		

※ **Seal kit: 1, 5, 18, 20, 40, 41**

2) OPERATION



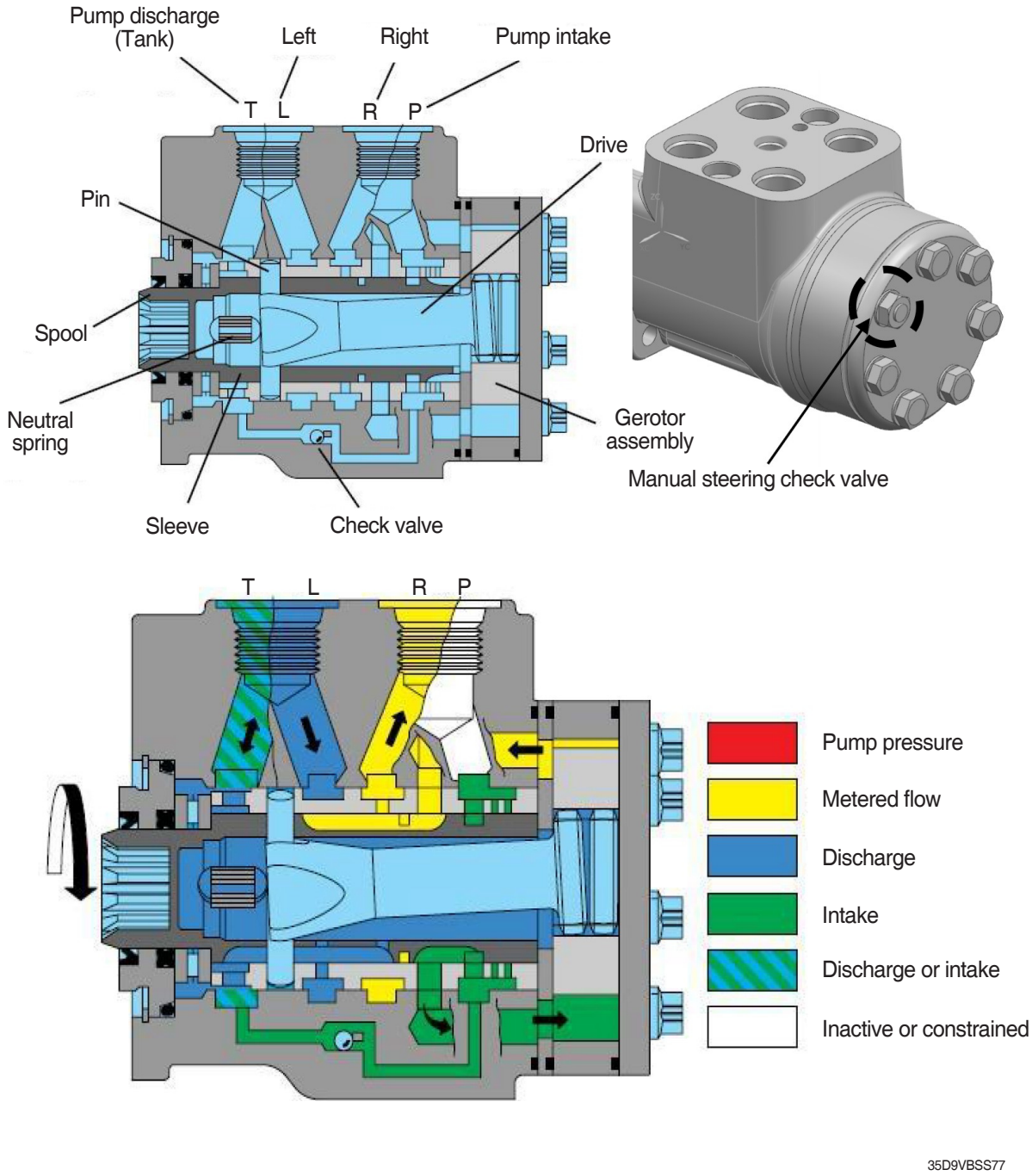
Steering unit is a closed neural circuit and a gauging gear set consisted of rotation valve (spool + sleeve set). Steering unit mitigates impact of sudden rotation or kickback of tire on steering wheel together with LS (load sensing) dynamic circuit to ensure smooth movement of steering wheel without interference when oil viscosity is low in winter season. LS circuit inside valve is used for control of operation of preferential valve spool. Steering relief valve supplies hydraulic oil to hydraulic oil tank return hose through inner path., Pressure of relief valve is set lower than pressure of relief valve inside main control valve.

· Manual steering check valve : Converts unit to manual operating pump for limited manual steering.

· Check valve (P port) : Used for blocking return of hydraulic oil to steering unit when pressure inside cylinder is higher than pressure inside the inlet for the purpose of preventing kickback of steering wheel.

· LS relief valve : Limits maximum pressure inside steering circuit.

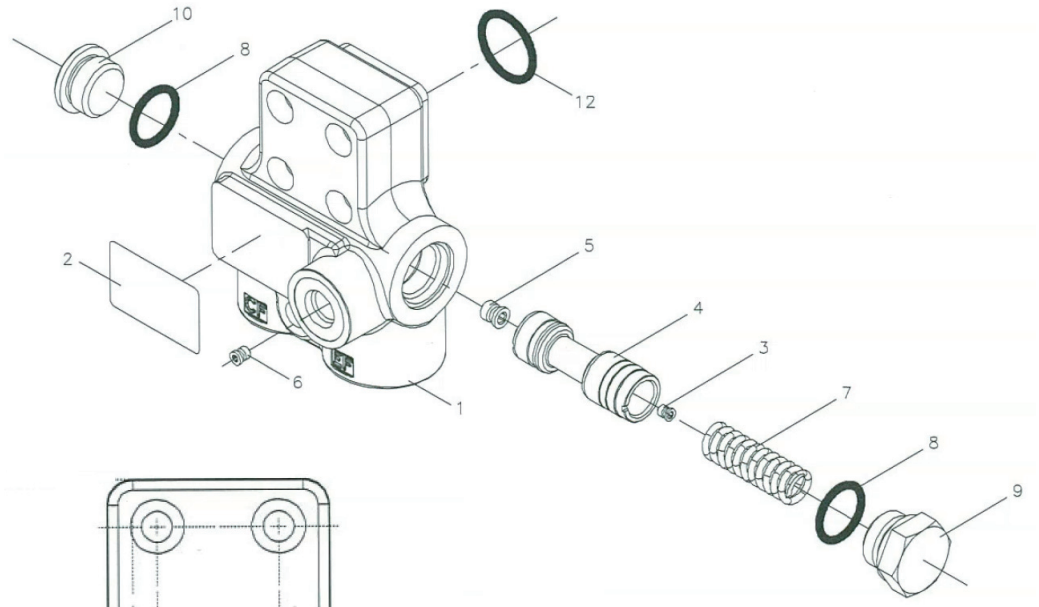
3) MANUAL STEERING IN EMERGENCY

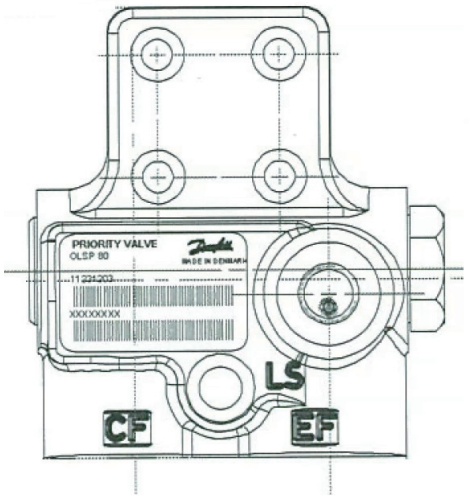


Hydraulic motor stops, and preferential valve spool is pushed to the end by spring force when turning steering wheel. In such a case, hydraulic oil flows to spool and sleeve set, and EF port is closed. Turing steering wheel forms vacuum in supply line between preferential valve and steering unit spool and sleeve set. Path is opened for allowing flow of hydraulic oil to gerotor gear inside steering unit to rotate spool and sleeve set. Hydraulic oil entrapped in steering port flows through manual steering check valve, and is supplied to opposite steering cylinder through gerotor gear.

4. PREFERENTIAL VALVE

1) STRUCTURE





Port	Port dimensions	Fastening torque	
		kgf · m	lbf · ft
EF	7/8-14UNF	10	72.3
CF	3/4-16 UNF	4	28.9
LS	7/16-20 UNF	2	14.5

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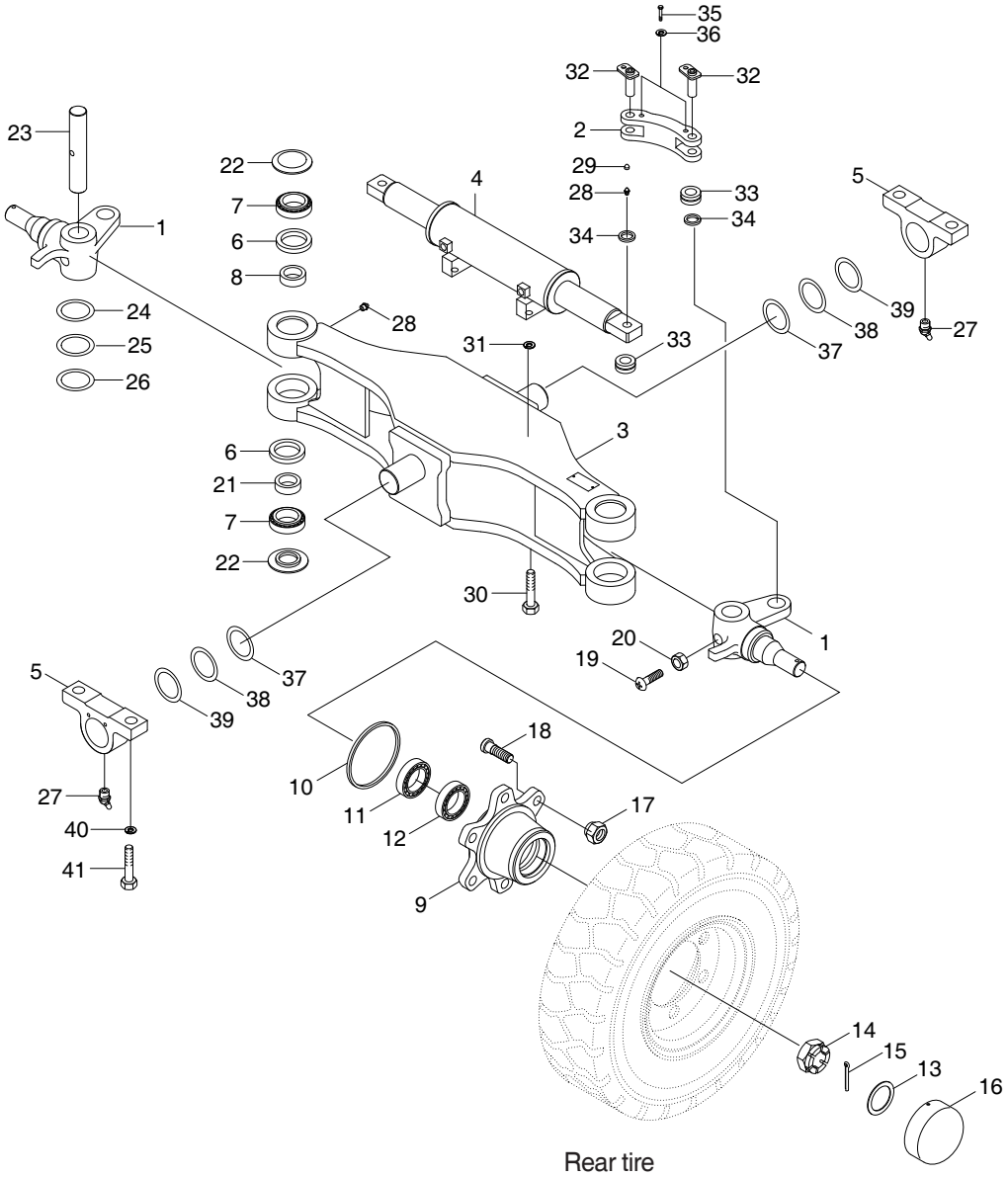
1	Housing	5	Orifice	9	Plug
2	Model/code label	6	Orifice	10	Plug
3	Orifice	7	Spring	12	O-ring
4	Spool	8	O-ring		

※ **Seal kit : 8, 12**

Preference valve is directly connected to discharge port of hydraulic pump. The valve is subject to effects from steering unit by LS signal for ensuring sufficient supply of oil to steering circuit. The valve keeps constant force and speed of steering against variation of supply flow of pump hydraulic oil, and supplies hydraulic oil to steering circuit first.

5. STEERING AXLE

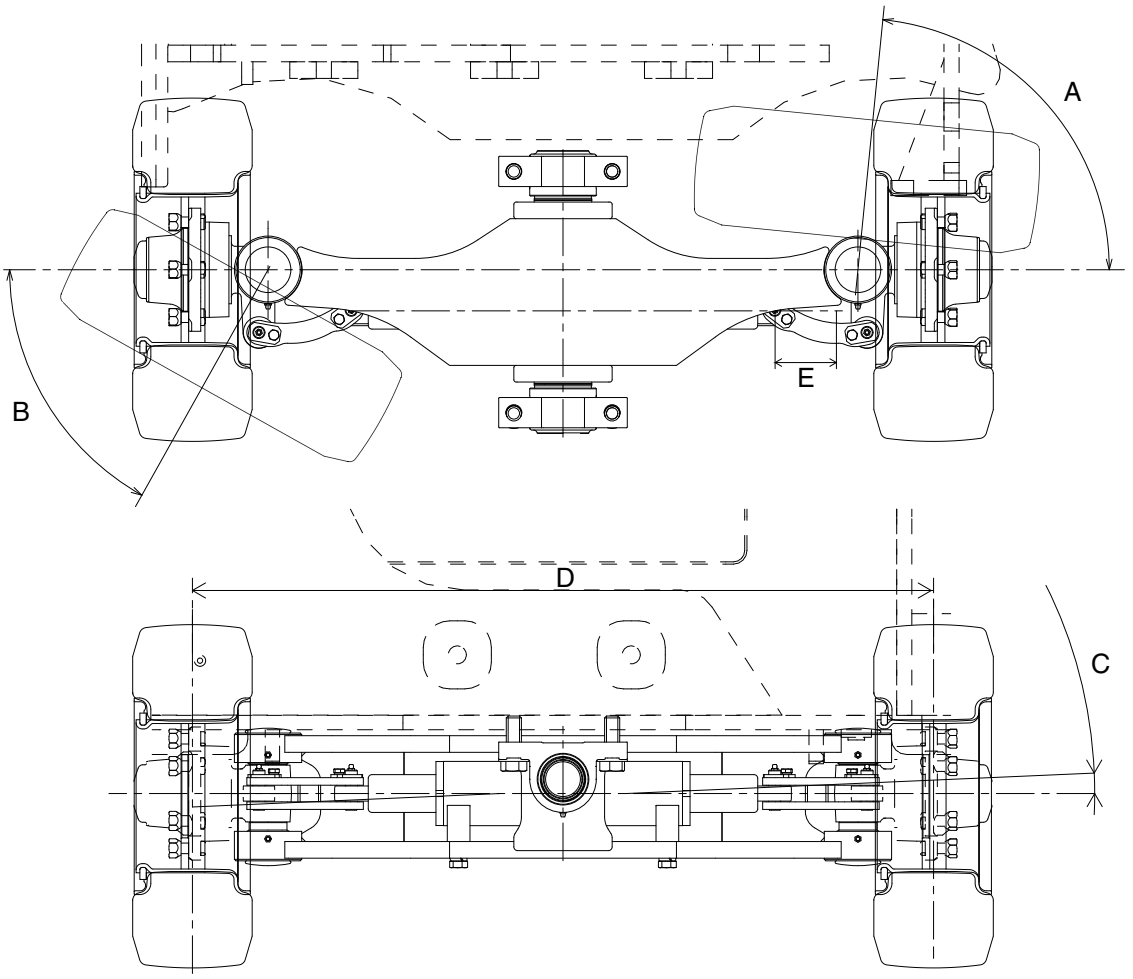
1) STRUCTURE



Rear tire

1	Steering knuckle	15	Hub pin	29	Dust cap
2	Steering link	16	Hub cap	30	Bolt
3	Axle frame	17	Hub nut	31	Washer
4	Steering cylinder	18	Hub bolt	32	Steering link pin
5	Trunnion block	19	Screw	33	Oscillating bearing
6	Oil seal	20	Nut	34	Bushing
7	Bearing	21	Rod ring	35	Bolt
8	Rod ring	22	Top cover	36	Washer
9	Wheel hub	23	King pin	37	Bushing
10	Oil seal	24	Shim (0.2 t)	38	Adjusting shim kit
11	Bearing	25	Shim (0.1 t)	39	Adjusting shim kit
12	Bearing	26	Shim (0.5 t)	40	Hardening washer
13	Washer	27	Nipple	41	Hexagonal bolt
14	Nut	28	Nipple		

2) SPECIFICATION TABLE



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Item			Unit	Specifications
Max. steering angle	Inner side	A	Degree	84.3
	Outer side	B		60.8
Reciprocating angle		C		2.5
Distance between wheels		D	mm	980
Stroke		E	mm	82

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECK

Inspection items	Inspection procedures
Knuckle	· Inspect knuckle with visual checking, or crack inspection method. Bent knuckle indicates non-uniform abrasion of tires. Check abrasion of tires.
Steering axle	· Make request to assistant to drive the truck in the min. turning radius. · Affix chalk on outer edge of counterweight for drawing turning radius. · Min. turning radium (outside): see Page 1-5 'Dimensions.'
Power steering pressure	· Install hydraulic pressure gauge on bidirectional pump. · Turn steering wheel as far as possible, and check hydraulic pressure. · Hydraulic pressure : 100 bar

2. TROUBLESHOOTING

1) STEERING UNIT

Trouble	Possible cause	Troubleshooting
Steering not allowed	· Incorrect installation or damage of steering unit column shaft	· Checking, repair or replacing
	· Oil pressure failed in reaching specified value	· Checking, relief pressure adjusting
	· Defect or non-closing of relief valve	· Checking, repair
	· Damage to piping	· Replacing
Unyielding turn of steering wheel	· Low tire pressure	· Pressure adjusting
	· Oil pressure failed in reaching specified value	· Checking, relief pressure adjusting
	· High pressure and low pressure hoses connected in wrong way	· Checking, repair
	· Steering cylinder rod damaged, or piston stuck	· Checking, repair or replacing
Oil pressure failed in reaching specified value	· High pressure and low pressure hoses connected in wrong way	· Checking, repair
	· Damage or non-closing of relief valve	· Checking, repair
	· Pump function degraded, or insufficient oil level	· Checking, repair or replacing
	· Damage of steering cylinder piston package	· Replacing
Steering wheel not restored to proper position	· Low tire pressure	· Pressure adjusting
	· Abnormal movement of steering unit spool	· Steering unit repair or replacing
	· Improper movement of steering knuckle	· Lubricating or repair
Steering wheel not returning or slowly returning to neutral position	· Abnormal movement of steering unit spool	· Steering unit repair or replacing
	· Damage of steering unit column shaft	· Steering unit replacing
	· Damage of neutral spring	· Replacing
	· Piping blocked (compressed or clogged)	· Checking, repair or replacing
Excessive or vibratory movement	· Flow of oil inside steering system	· Steering unit replacing
	· Abnormal movement of steering unit spool	· Steering unit repair or replacing
	· Air in piping	· Checking, repair or replacing
	· Defect of steering unit column shaft	· Checking, repair or replacing
Tire moving in opposite direction of steering wheel	· Cylinder piping connected in opposite direction	· Checking, repair

Trouble	Possible cause	Troubleshooting
unyielding turn of steering wheel during driving at low speed	· Flow of oil inside steering system · Relief valve function degraded · Air in piping · Piping blocked (compressed or clogged) · Fastening end cap screw with excessively high fastening torque	· Steering unit replacing · Inspecting, repair · Checking, repair or replacing · Checking, repair or replacing · Adjusting fastening torque to specified value
Abnormal noise	· Defects of relief valve · Air in piping · Piping blocked (compressed or clogged)	· Checking, repair or adjusting · Checking, repair or replacing · Checking, repair or replacing

2) PREFERENTIAL VALVE

Trouble	Item to check	Troubleshooting
Spring scratched, abraded, or stripped	· Replacing, if required	· Replacing
Spool surface scratched or abraded	· Removing minor scratch with sandpaper. · Replacing, if required	· Replacing
O-ring	· Replacing, if required	· Replacing

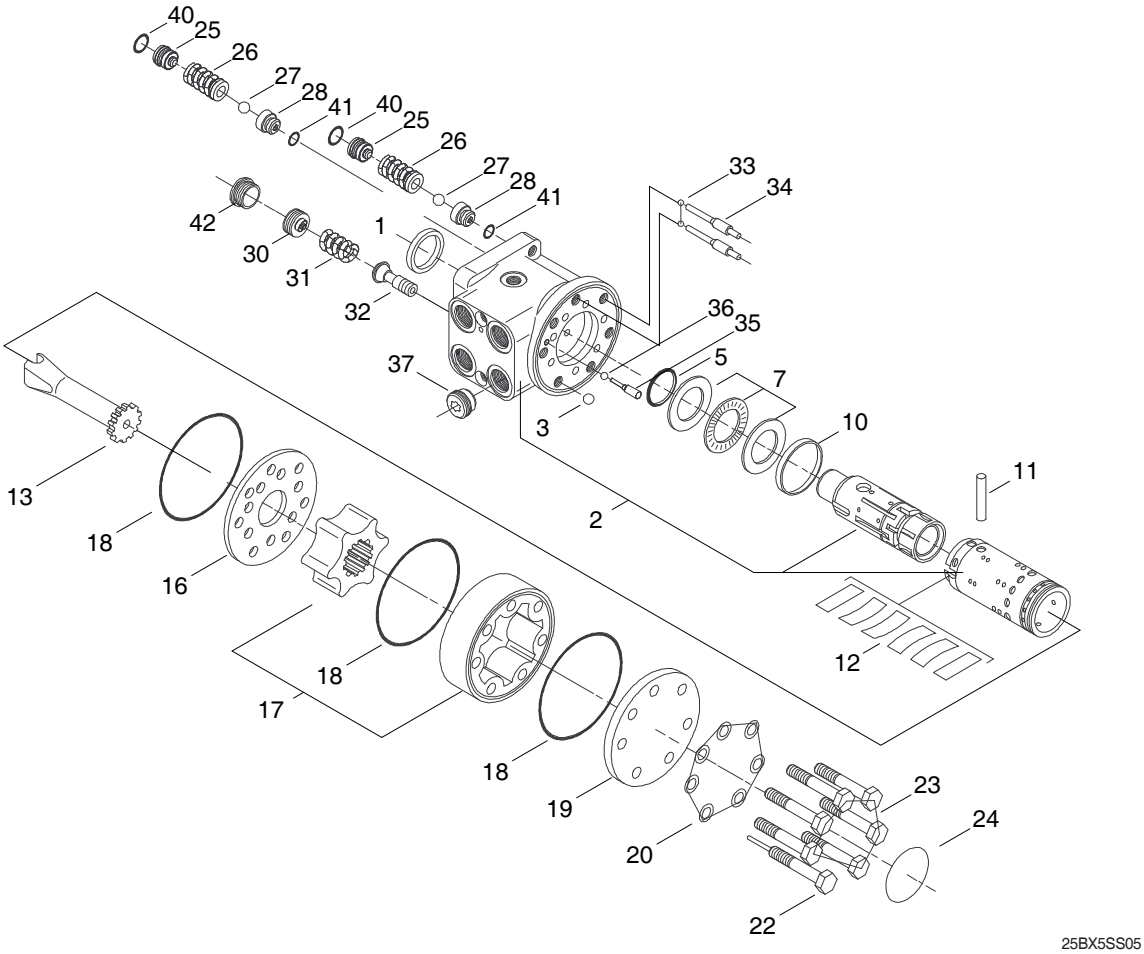
3) STEERING CYLINDER

Trouble	Possible cause	Troubleshooting
Oil leak from steering cylinder head (piston rod)	· Foreign substance packed · Damage of piston rod · Oil seal damaged and contaminated · Chromium plating damaged	· Replacing · Grinding surface with oil stone · Replacing · Grinding
Steering cylinder head thread (minute oil leak ignorable)	· O-ring damaged	· Replacing
Oil leak from welding point	· Damage in tube · Piston seal damaged and contaminated	· Grinding surface with oil stone · Replacing
Rod	· Damage in tube · Piston seal damaged and contaminated	· Grinding surface with oil stone · Replacing
Excessive gap of diameter inside piston rod bushing	· Bushing abraded	· Replacing

GROUP 3 DISASSEMBLY AND ASSEMBLY

1. STEERING UNIT

1) STRUCTURE

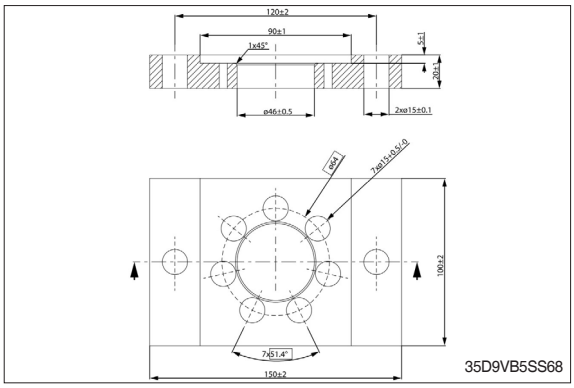


1	Dust sealing ring	19	End cover	33	Ball
2	Housing spool and sleeve	20	Washer	34	Bushing
3	Ball	22	Pin bolt screw	35	Ball stop thread
5	Shaft seal	23	Screw	36	Ball (Ø3)
7	Bearing assembly	24	Model/code label	37	Check valve
10	Ring	25	Adjusting screw	39	Sealing ring
11	Cross pin	26	Spring	40	O-ring
12	Spring set	27	Ball	41	O-ring
13	Cardan shaft	28	Seat	42	Plug
16	Distributor plate	30	Adjusting screw		
17	Gear wheel set	31	Spring		
18	O-ring	32	Piston		

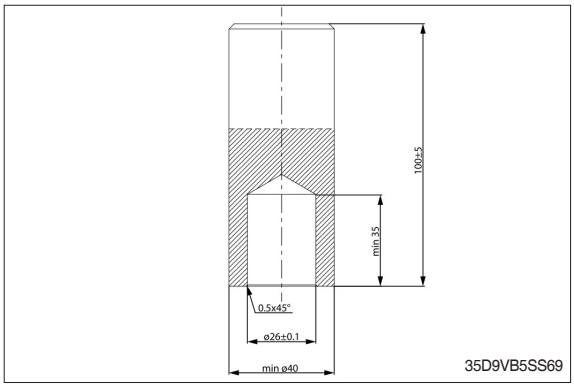
※ **Seal kit: 1, 5, 18, 20, 40, 41**

2) TOOL

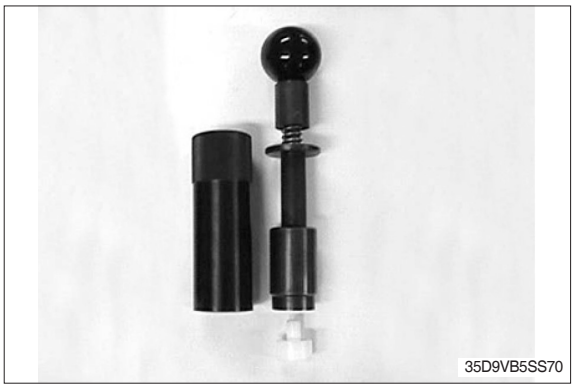
(1) Fastening tool for steering unit
Material : Metal or hard plastics



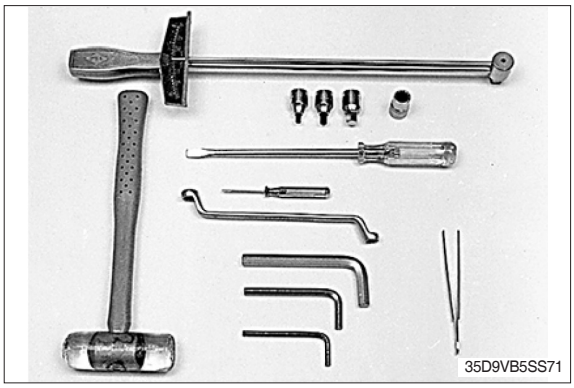
(2) Assembly tool for dust seal
Material : Free cutting steel



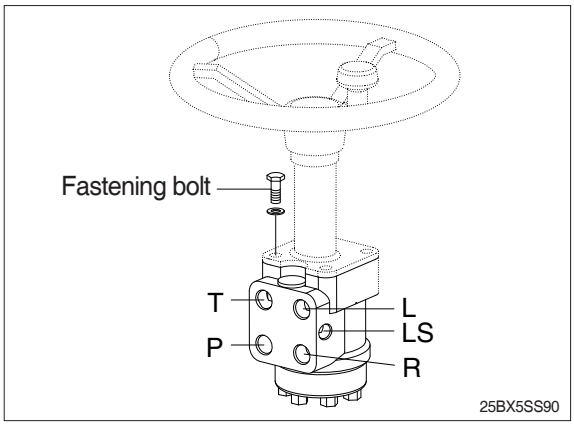
(3) Tool for shaft seal, O-ring, rotor glide
Code : 11092408.



(4) Torque wrenches 0 - 70 N·m.
- 13-mm socket spanner
- 2 - 2.75, 5 - 6 and 8 mm Allen keys
- Torx bit ; size of T50
- 12-mm screw driver
- 2-mm screw driver
- 13-mm ring spanner
- Plastic mallet
- Tweezers



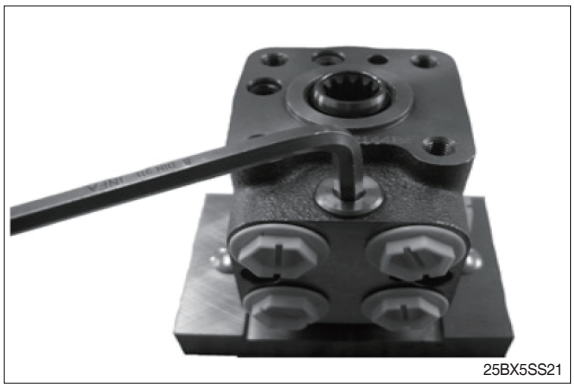
3) Fastening torque
   L : Left port
   R : Right port
   T : Tank port
   P : Pump port
   LS : Load sensing port



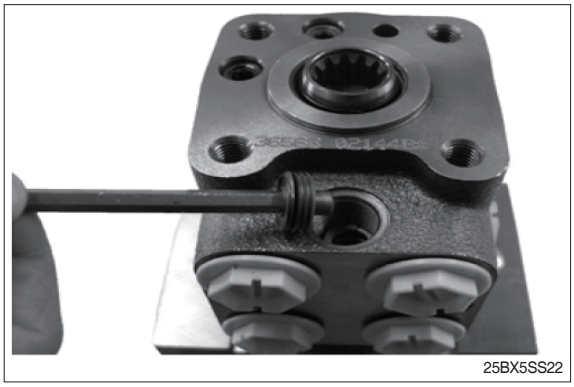
Port	Port dimensions	Fastening torque
		kgf · m
L, P, R, T	3/4-16 UNF	6
LS	7/16-20 UNF	2
Mounting bolt	M10	3

4) DISASSEMBLING

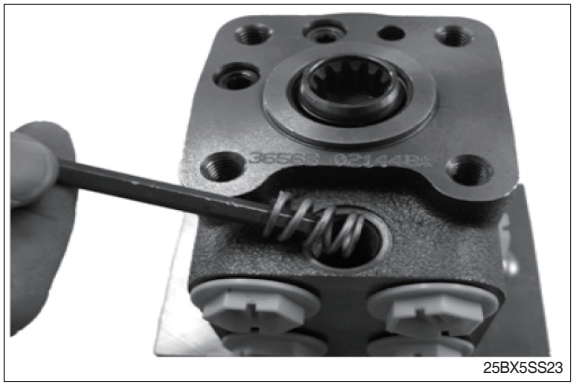
(1) As shown on the figure, put steering unit on fastening tool, and remove plug (42) with 8-㎜ Allen key.


25BX5SS21

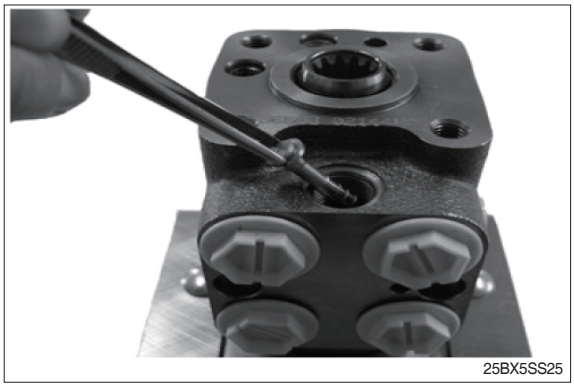
(2) Make use of 6-㎜ Allen key to remove adjusting screw (30).


25BX5SS22

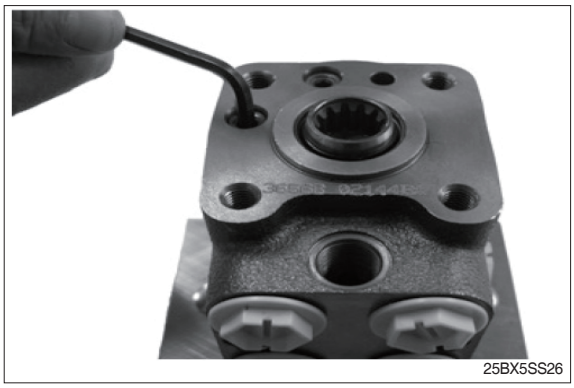
(3) Remove spring (31).


25BX5SS23

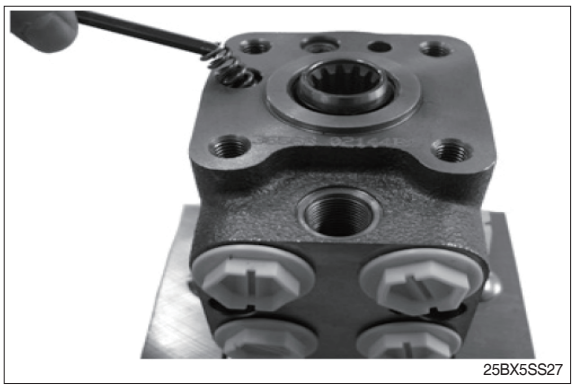
(4) Remove piston (32).


25BX5SS25

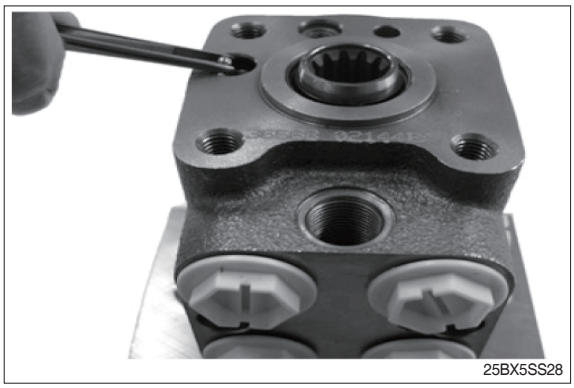
(5) Make use of 5-mm Allen key to remove adjusting screw (25) mounted with O-ring (40).


25BX5SS26

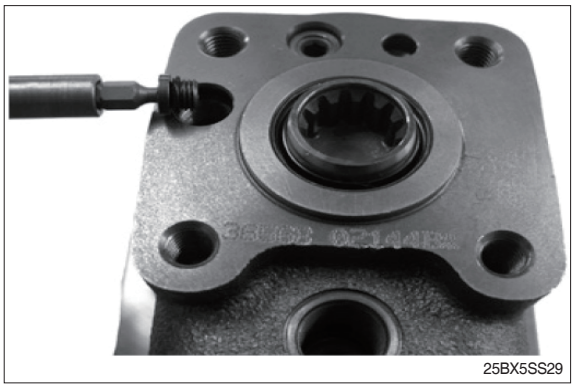
(6) Remove spring (26).


25BX5SS27

(7) Remove ball (27).


25BX5SS28

(8) Make use of 6-mm Allen key to remove seat (28).


25BX5SS29

(9) As shown on the figure, turn steering unit up side down, and put in on fastening tool. Make use of 13-mm ring or wrenches, remove screws (22, 23) and washer (20).

35D9VB5SS09

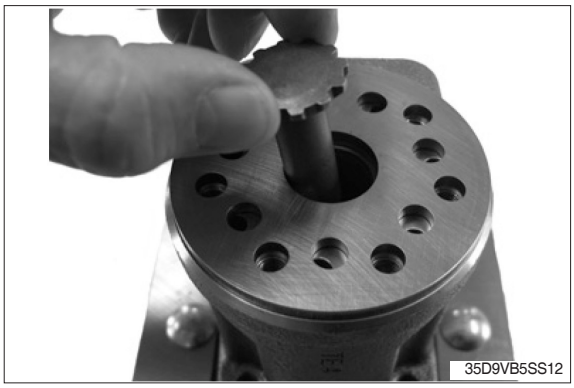
(10) Remove end cover (19).

35D9VB5SS10

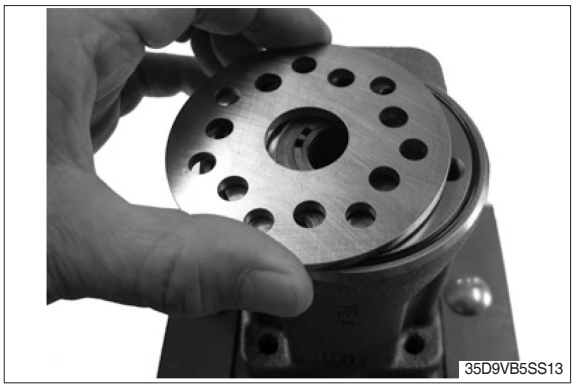
(11) Lift gear wheel set (17) up, and remove 2 O-rings (18).


35D9VB5SS11

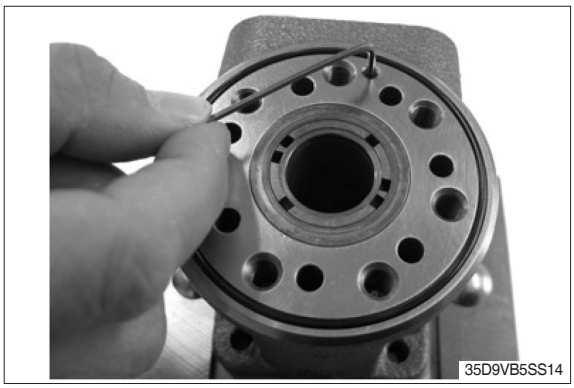
(12) Remove cardan shaft (13).


35D9VB5SS12

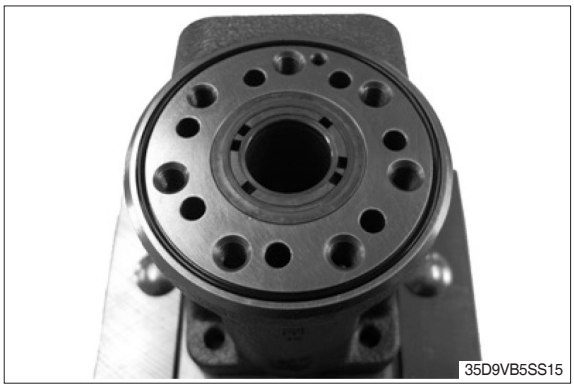
(13) Remove distributor plate (16).



(14) Make use of 2-mm Allen key to remove ball (35).

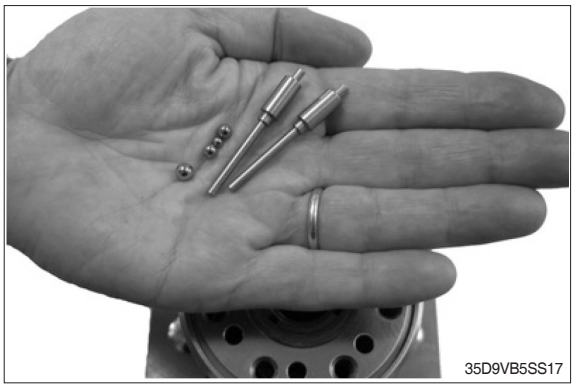


(15) Remove O-ring (18) from housing.

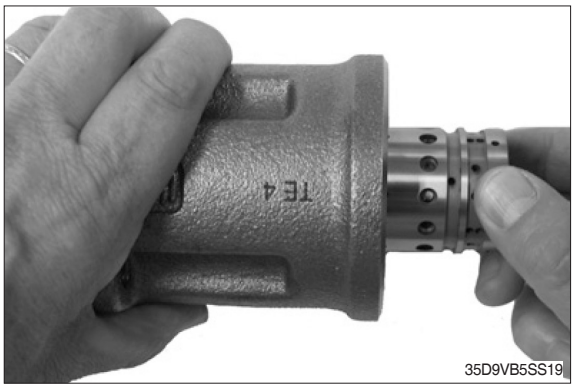


(16) Make use of Torx bit of size T50 to remove check valve (37).

(17) Shake housing to take check valve ball (3) and ball (36) out of housing.



(18) Put housing with the port kept on the bottom as shown on the figure. Make sure that cross pin (11) and sleeve set (2) are kept horizontal inside spool. You can check cross pin (11) when pulling the end of spool out. Pressing spool (2) inward out removes sleeve (2), ring (10) and bearing assembly (7) also.

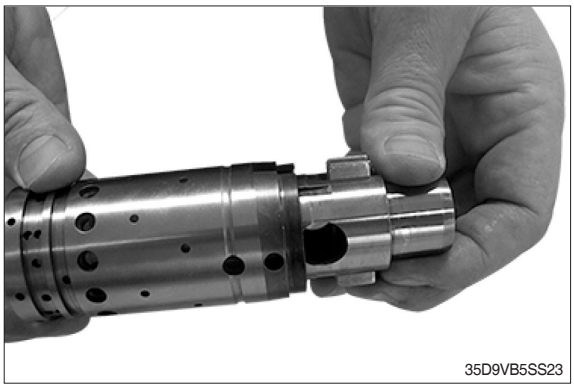


(19) Remove bearing assembly (7) from spool and sleeve (2). Outer bearing may be caught inside housing. Make sure that bearing is normally pulled out.

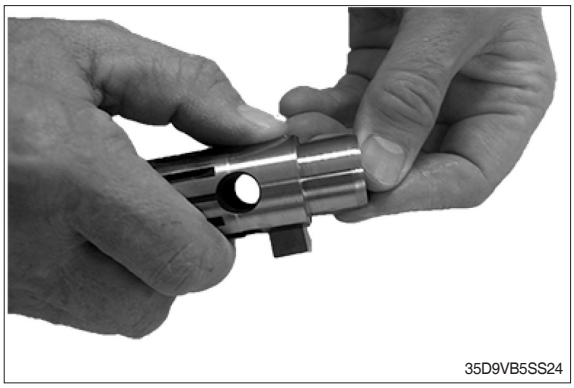
(20) Remove cross pin (11).

(21) Remove ring (10).

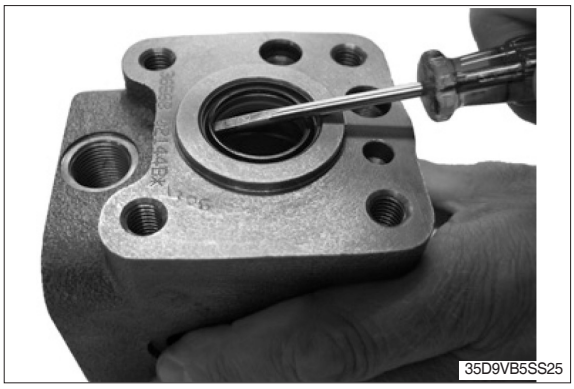
(22) Carefully remove spool from sleeve.



(23) Remove leaf spring (12) from slot of spool.



(24) Make use of screw driver to carefully remove dust seal ring (1) and shaft seal (5).



(25) Fully disassembled steering unit

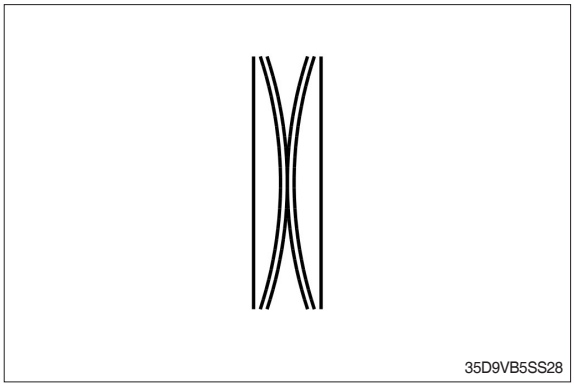
※ **Clean all of parts with solvent.**

※ **Replace seal and washer. Inspect all of parts, and replace parts, if required.**

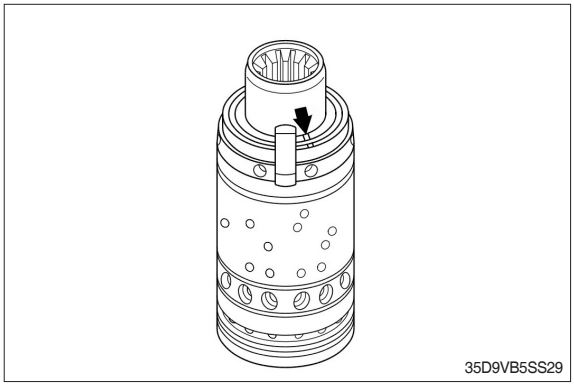
5) ASSEMBLING

(1) Put two leaf springs (12) on slot, and press curved spring down between flat springs to mount it.

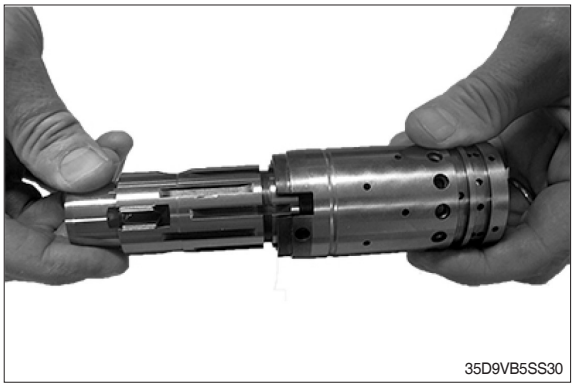
(2) Number of curved springs may vary dependent upon configuration of leaf spring set (12). There may be 2, 4 or 66 curved springs.



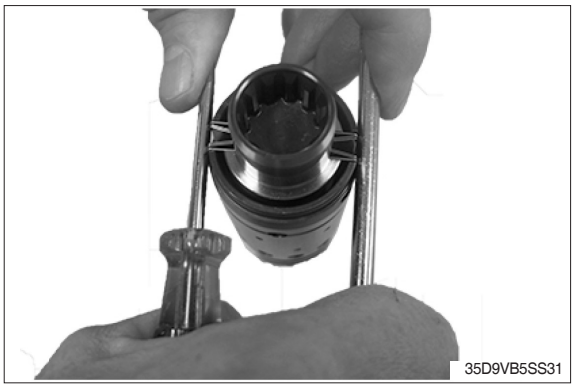
(3) Spool and sleeve set for steering unit should precisely be aligned to each other for mounting., Small marks are on the nearest slot of spring set, and all of sleeves. There are no marks on most of spools and sleeve sets. They are arranged facing each other on 1 of 2 available locations.



(4) Mount spool on sleeve, and make sure that leaf spring (12) is mounted on slot.



(5) Align leaf spring (12).

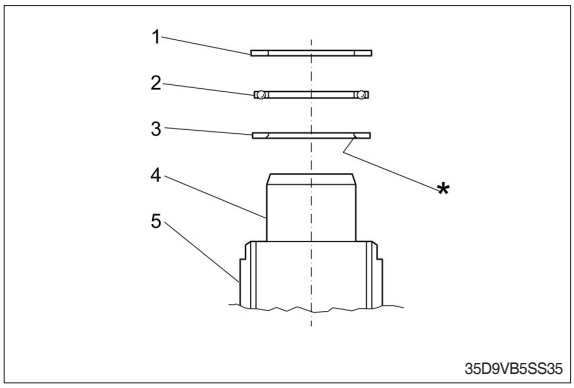


(6) Mount ring (10) on sleeve. Ring should move freely independent from spring.

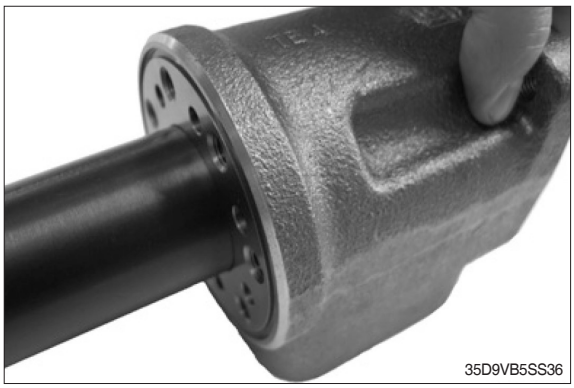
(7) Mount cross pin (11) on assembly.

(8) Mount bearing assembly (7).

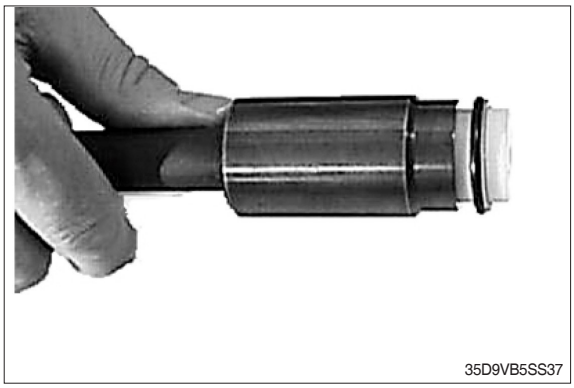
(9) Assemble parts in order as shown below:
1 Outer bearing race → 2 Needle bearing → 3 Inner bearing race → 4 Spool → 5 Sleeve.
The inside corner of inner bearing race should be aligned with the inside corner of spool.



(11) Put steering unit housing on worktable. Prepare assembling tools for mounting shaft seal (5) on spool and sleeve set (2).

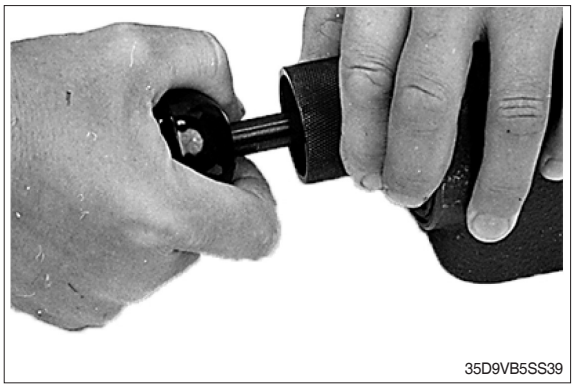


(10) Lubricate shaft seal (5) with hydraulic oil, and put it on tool. Make sure that shaft seal (5) is correctly positioned on insertion tool.

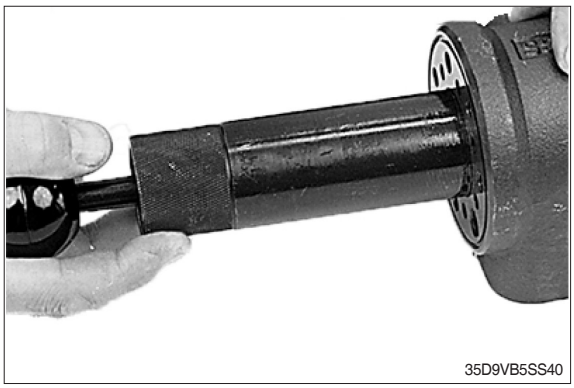


(13) Insert assembling tool into the bottom of steering unit.

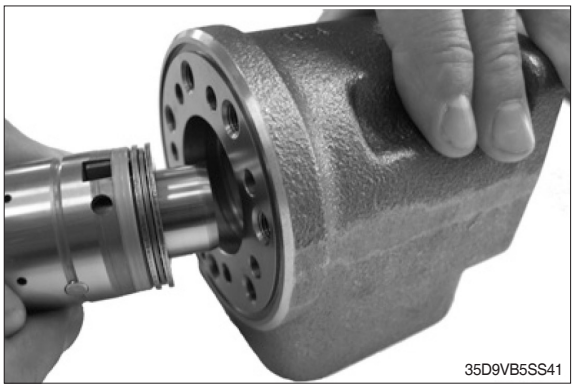
(14) Press the tool into housing, and rotate shaft seal (5).



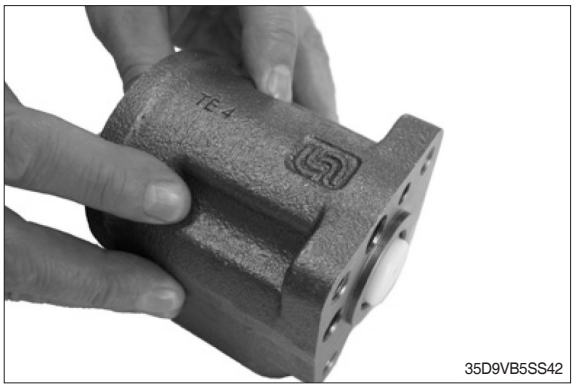
(15) Withdraw assembling tool from steering unit.



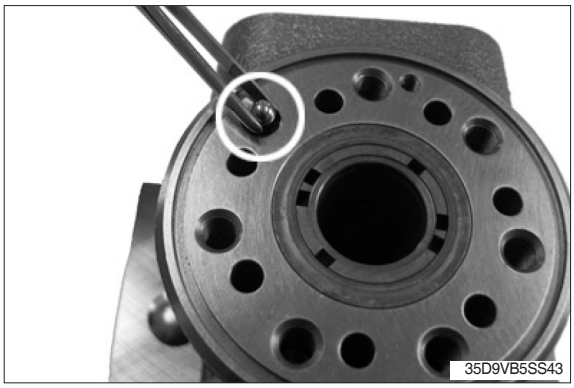
(16) Assemble spool and sleeve assembly on cross pin (11) in parallel direction while rotating the assembly a little.



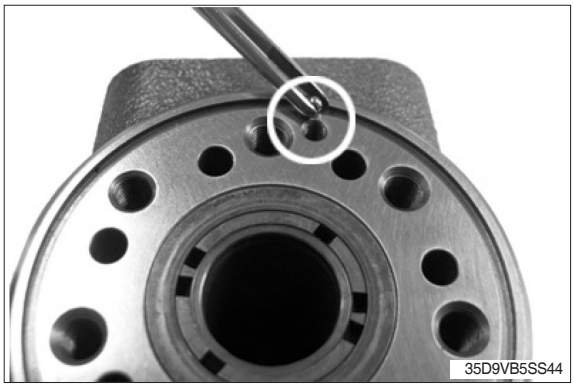
(17) Assembling tool is pulled out of spool assembly, and shaft seal (5) is mounted.



(18) Put steering unit housing on assembly fastening device toward the tip of steering column. Insert ball (3) into indicated hole.

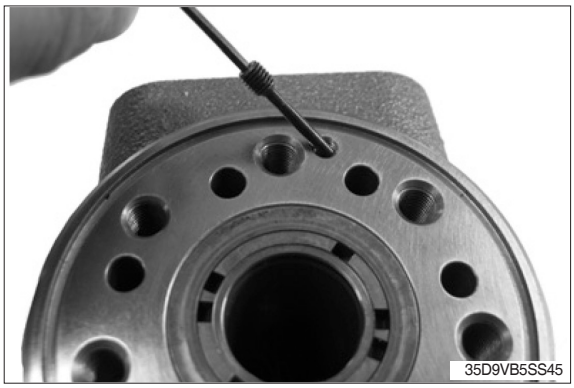


(19) Insert ball (36) into indicated hole.

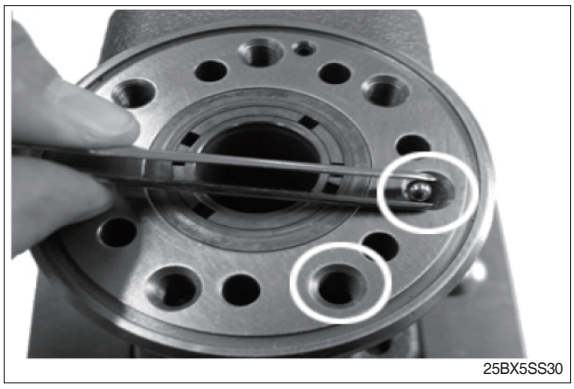


(20) Make use of 2-mm Allen key to insert ball stop thread toward ball (36), and then fasten the thread.

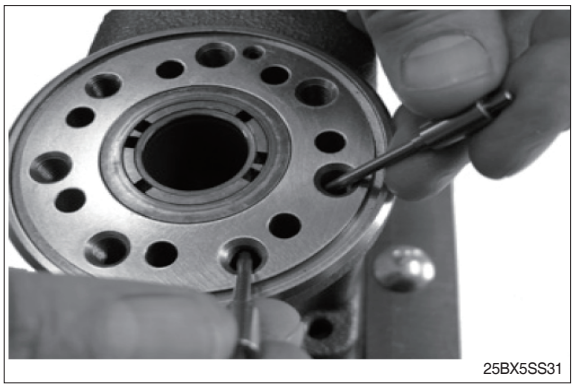
· Fastening torque : 0.1±0.01 kgf · m



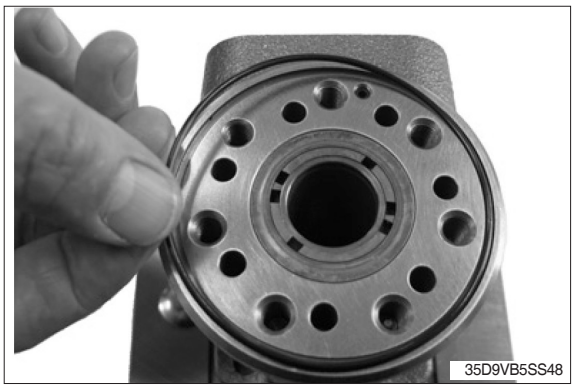
(21) Insert ball (33) into two indicated holes respectively.



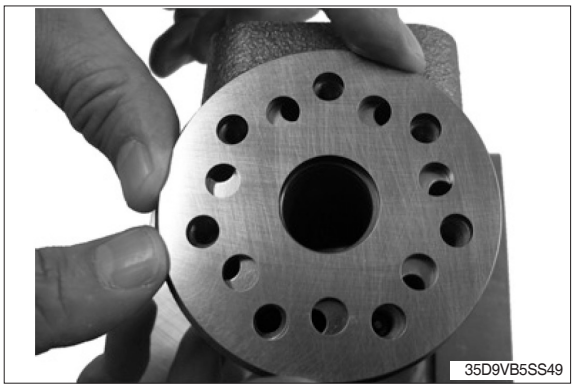
(22) Insert pin (34) into 2 identical holes respectively.



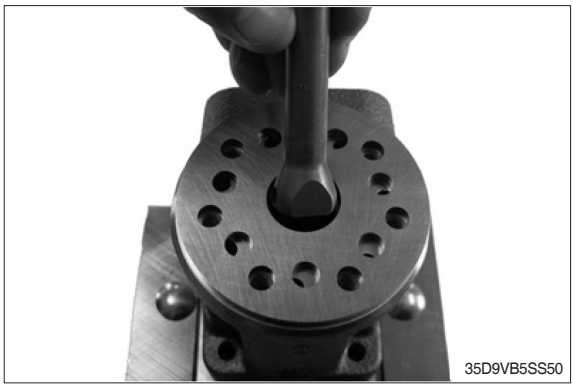
(23) Mount O-ring (18) on housing.



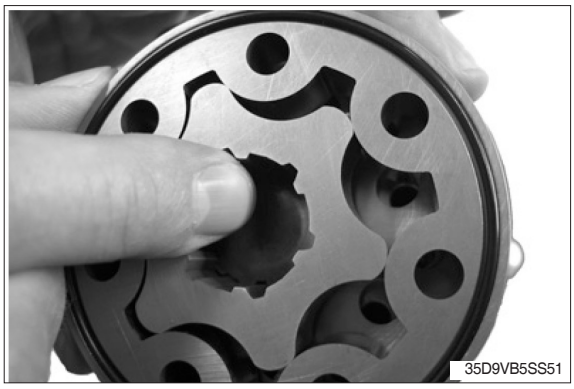
(24) Put distributor plate (16) on housing while aligning with thread holes.



(25) Put cardan shaft (13) inside slot for connecting circumference port, and aligning cross pin (11).

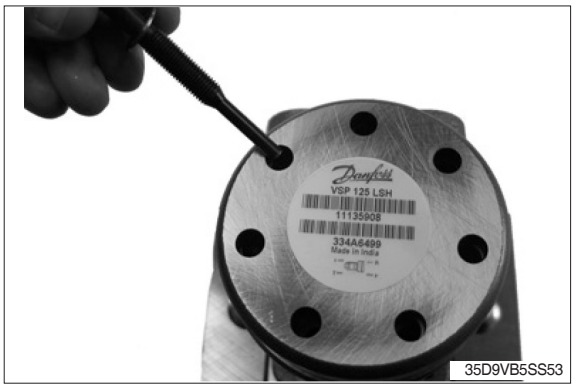


(26) Mount 2 O-rings (18) on gear wheel set (17), and put the set on cardan shaft (13). Align holes of gear wheel set with those of housing thread.



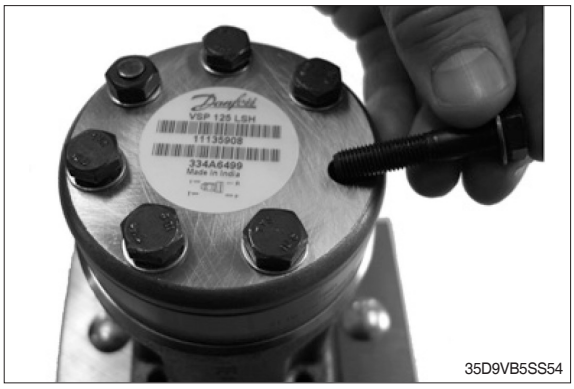
(27) Put end cover (19) on port while ensuring that product code is positioned parallel with port.

(28) Insert new washer (20) into the next position together with pin bolt screw (22).



(29) Insert new washer (20) and 6 screws (23), and make use of 13-㎜ wrench to fasten screws (22, 23).

· Fastening torque : 3.1±0.6 kgf · m

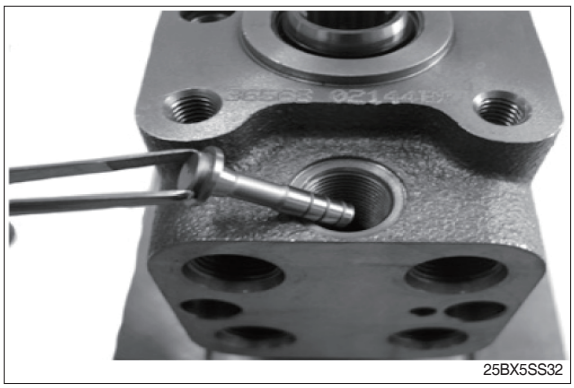


(30) Make use of Torx bit of size T50 to fasten check valve (37).
· Fastening torque : 2.6±0.5 kgf · m


35D9VB5SS55

※ **Manually test functional operation of VSP. Inner shaft should rotate at torque less than 3.5 N·m.**

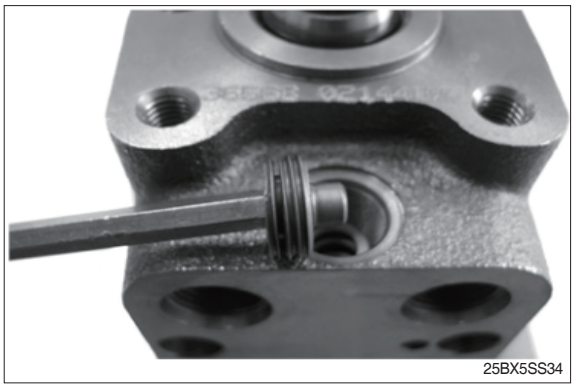
(31) Put steering unit assembly on assembling device on opposite side. Assemble piston (32) on housing.


25BX5SS32

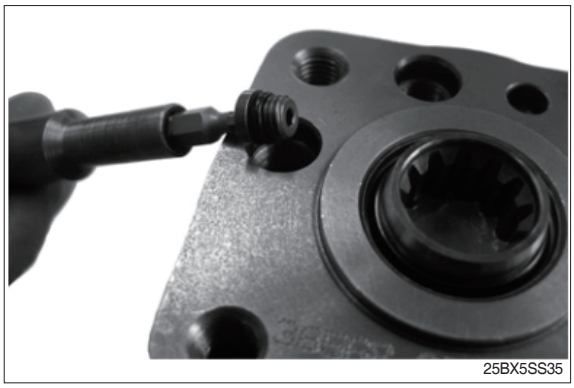
(32) Insert spring (31) into piston.


25BX5SS33

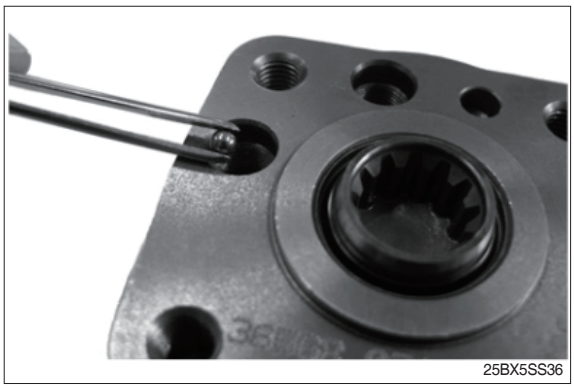
(33) Mount O-ring on adjusting screw (30), and fasten the screw with 6-㎜ Allen key. Set pressure on test panel in accordance with valve setup specifications.


25BX5SS34

(34) Mount O-ring (41) on seat (28).
Make use of 2.75-mm Allen key to insert seat (28) into hole, and fasten the seat.
· Fastening torque : 0.6±0.1 kgf · m


25BX5SS35

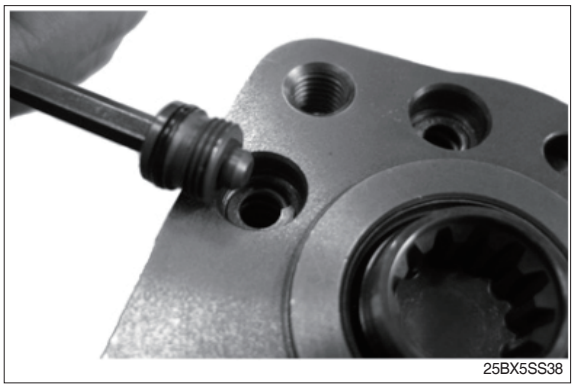
(35) Insert ball (27) into the same hole.


25BX5SS36

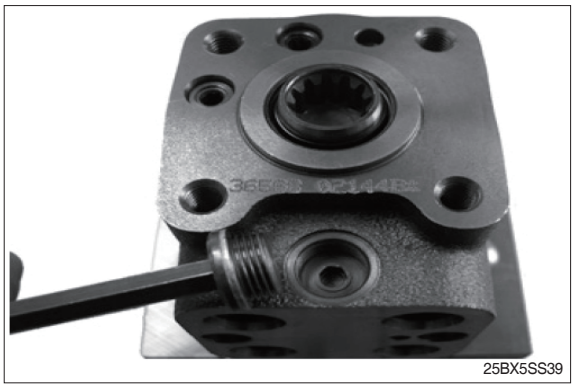
(36) Insert spring (26) onto ball.


25BX5SS37

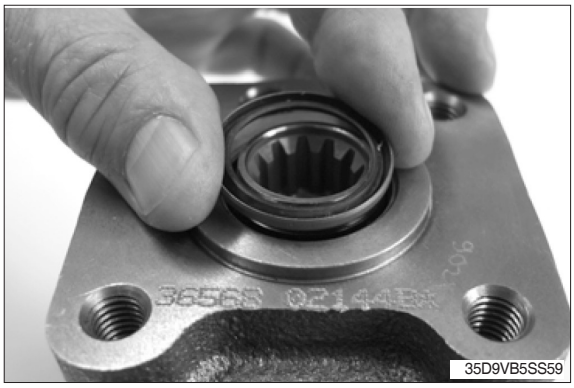
(37) Mount O-ring (40) on adjusting screw (25). Make use of 5-mm Allen key to fasten adjusting screw. Set pressure on test panel in accordance with valve setup specifications.


25BX5SS38

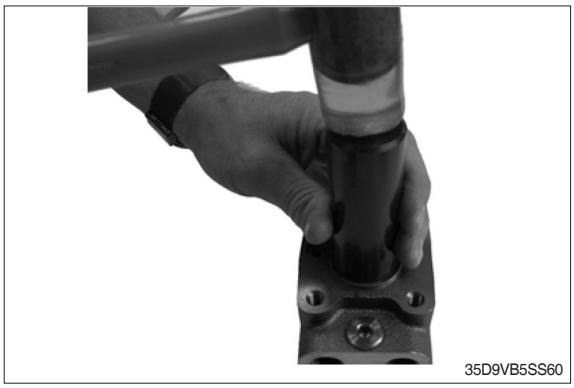
(38) Make use of 8-mm Allen key to fasten plug (42).
· Fastening torque : 6.6±0.5 kgf · m


25BX5SS39

(39) Put dust seal ring (1) on housing.


35D9VB5SS59

(40) Make use of tools and mallet for assembling dust seal to mount dust seal ring (1).

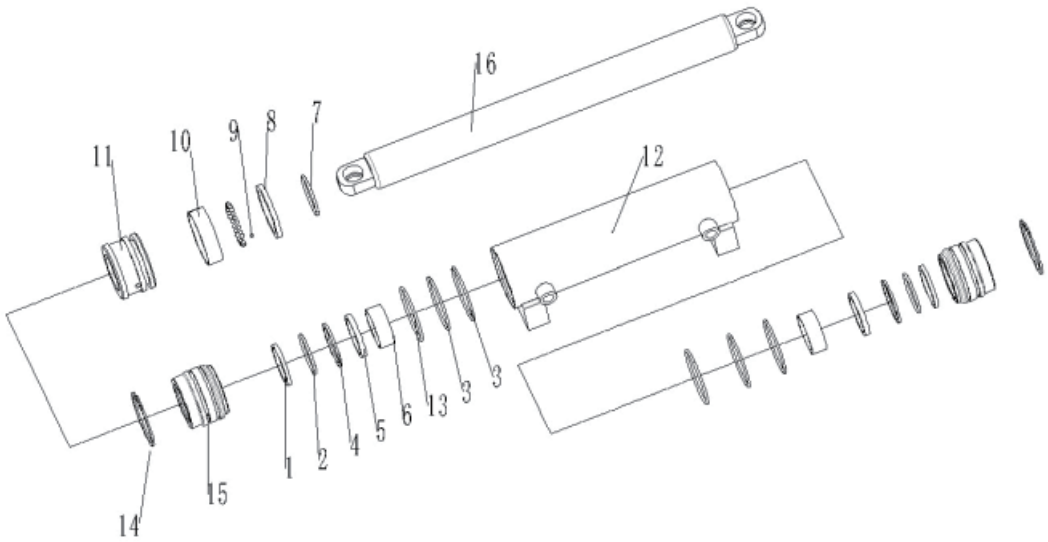

35D9VB5SS60

(41) Once assembling is complete, install plastic plugs for keeping inside of port clean.


25BX5SS40

2. STEERING CYLINDER

1) STRUCTURE



25BX5SS14

1	Dust wiper	7	O-ring	13	Snap ring
2	O-ring	8	Piston	14	Circlip
3	O-ring	9	Ball	15	Rod cover
4	Shaft seal	10	Ring	16	Piston rod
5	Slice block	11	Piston		
6	Bearing	12	Tube assembly		

2) Disassembling

※ Drain oil from cylinder before attempting disassembling steering cylinder.

(1) Remove circlip (14).

(2) Push rod cover (15) toward tube assembly (12), and remove snap ring (13).

(3) Remove rod cover (15).

(4) Repeat Steps (1) to (3) to remove rod cover on the opposite side.

(5) Remove piston rod (16) and piston (11) from tube assembly (12).

(6) Check seal part for abrasion. If abraded, replace the part.

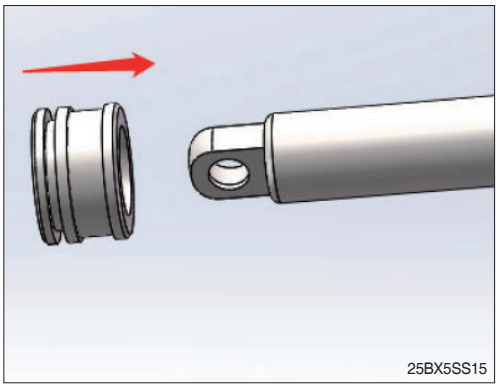
3) CHECKING AND INSPECTION

mm

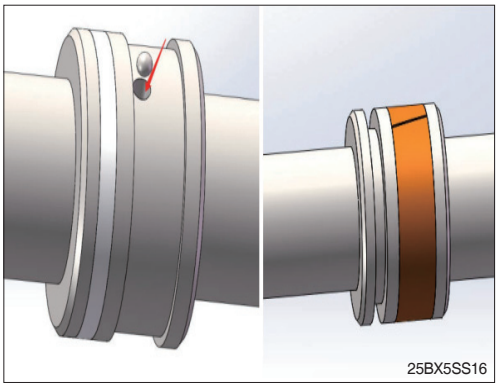
Inspection items	Criteria		Troubleshooting
	Standard dimensions	Limit on repair	
Play between cylinder tube and piston	0.080 - 0.220	0.3	Piston seal Replacing
Play between cylinder tube and bushing	0.024 - 0.174	0.2	Bushing Replacing
Seal, O-ring	Damaged		Replacing
Cylinder rod	Dented		Replacing
Cylinder tube	Corroded		Replacing

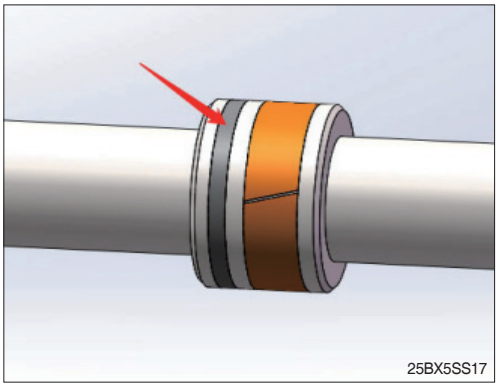
4) ASSEMBLING

(1) Insert piston (11) into piston rod (16).

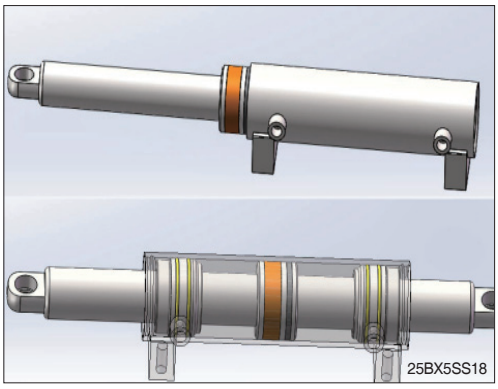


(2) Insert balls (9) until piston (11) is fully filled, and then mount ring (10) on piston groove and mount piston seal (8).

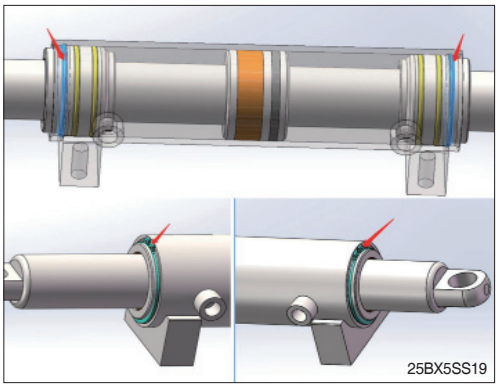




(3) Make use of tool to fasten piston rod (16), and insert piston rod into tube assembly (12). Mount rod covers (15) on the both sides of tube assembly.



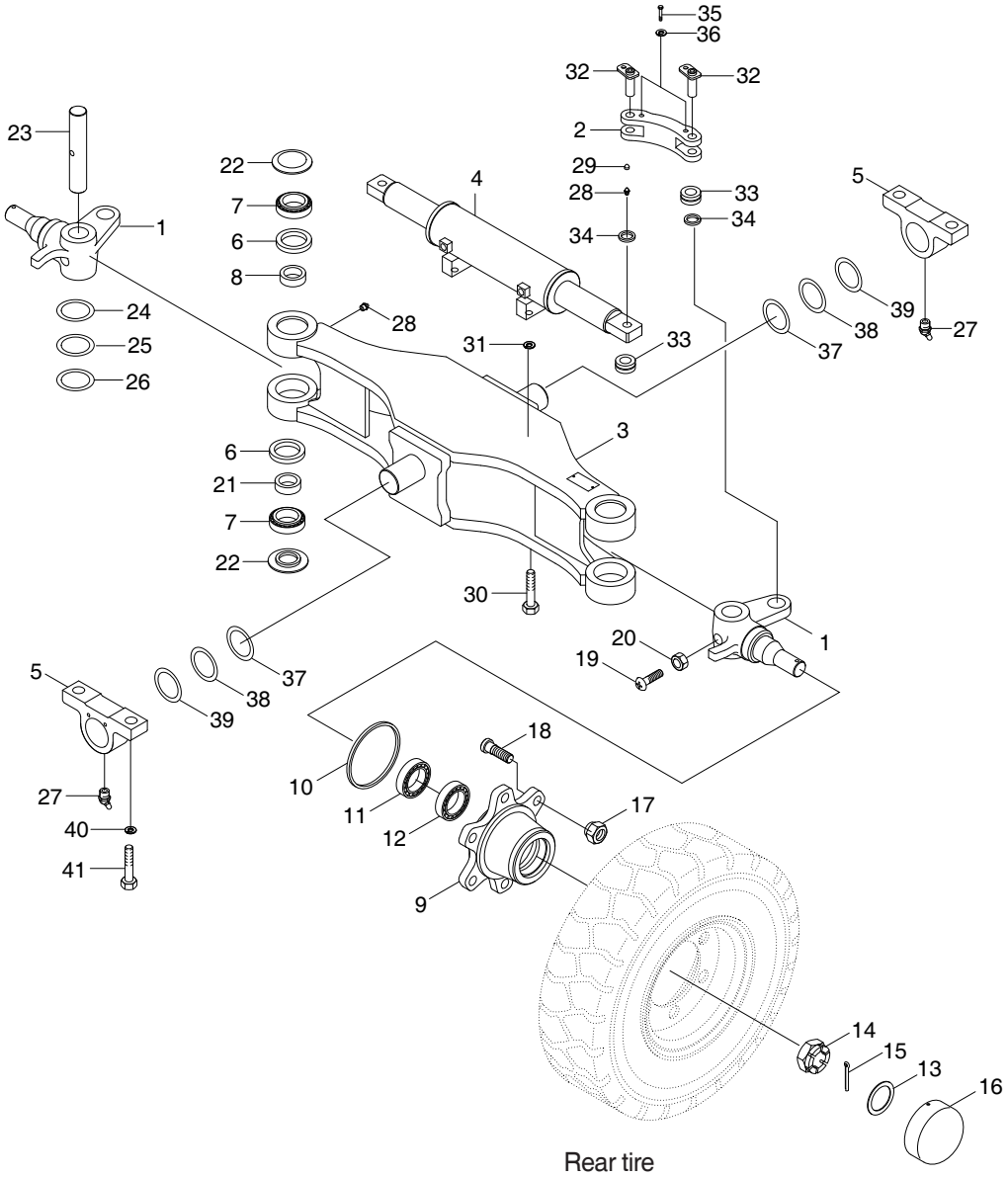
(4) Mount snap ring (13) on tube assembly (12) groove. Move piton rod (16) to the limited position. Mount circlip.



(5) Move piston rod several times for ensuring max. stroke. Mount O-rings and seals correctly before hydraulic oil plays on cylinder.

3. STEERING AXLE

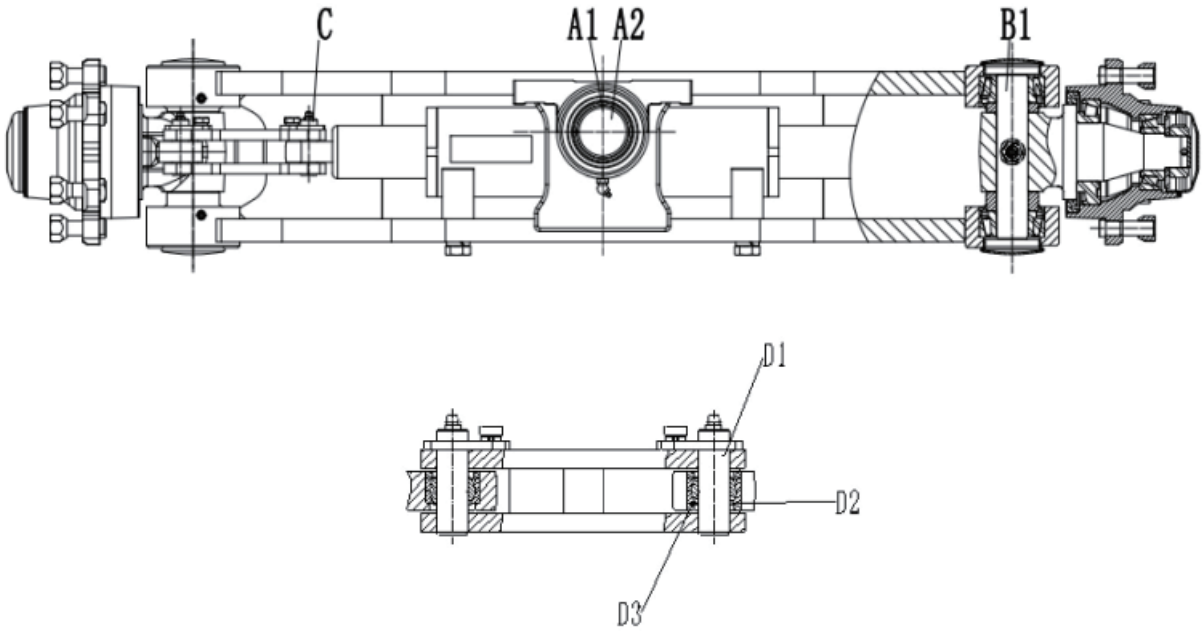
1) STRUCTURE



Rear tire

1	Steering knuckle	15	Hub pin	29	Dust cap
2	Steering link	16	Hub cap	30	Bolt
3	Axle frame	17	Hub nut	31	Washer
4	Steering cylinder	18	Hub bolt	32	Steering link pin
5	Trunnion block	19	Screw	33	Oscillating bearing
6	Oil seal	20	Nut	34	Bushing
7	Bearing	21	Rod ring	35	Bolt
8	Rod ring	22	Top cover	36	Washer
9	Wheel hub	23	King pin	37	Bushing
10	Oil seal	24	Shim (0.2 t)	38	Adjusting shim kit
11	Bearing	25	Shim (0.1 t)	39	Adjusting shim kit
12	Bearing	26	Shim (0.5 t)	40	Hardening washer
13	Washer	27	Nipple	41	Hexagonal bolt
14	Nut	28	Nipple		

2) CHECKING AND INSPECTION



25BX5SS20

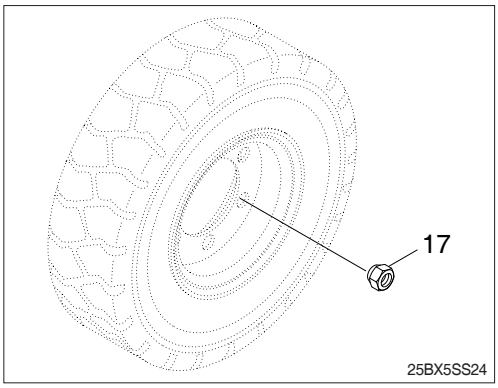
Unit : mm

Sequences	Inspection items			Criteria		Troubleshooting
				Standard dimensions	Limit on repair	
A	Shaft	A1	Shaft diameter	Ø50	Ø49.5	Replacing
		A2	Bushing inner diameter	Ø50	Ø49.5	
B	King pin diameter			Ø30	Ø29.8	
C	steering cylinder pin diameter			Ø16	Ø15.8	
D	Knuckle	D1	Pin diameter	Ø16	Ø15.8	
		D2	Vertical play	-	-	Adjusting with shim
		D3	Bushing inner diameter	Ø16	Ø16.2	Replacing

3) DISASSEMBLING

※ **It is allowed to repair knuckle part without removing shaft assembly from chassis.**
Lift up balance weight of system, and perform repair work.

(1) Loosen hub nut (17), and then remove tire.



(2) Remove hub cap (16).

(3) Pull dividing pin (15) out, and then remove washer (13) from slot nut (14).

(4) Make use of puller to remove wheel hub (9) together with taper roller bearings (11, 12).

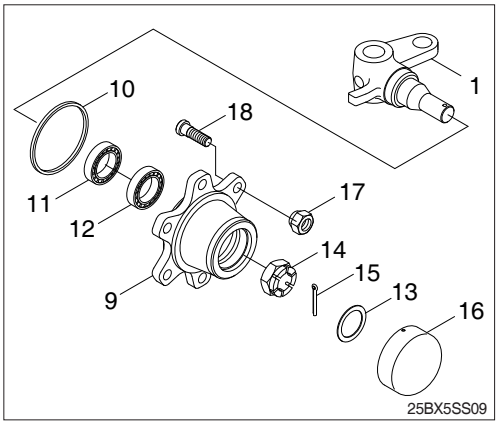
※ **Care should be exercised for preventing fall of taper roller bearings (11, 12) before removing wheel hub (9).**

(5) Remove inner wheel of bearings (11, 12) after removing wheel hub (9).

(6) Pull oil seal (10) out.

※ **Do not use same seal for twice or more.**

(7) Perform the same procedures on the opposite side.
Once disassembling is complete, assemble slot nut (14) on knuckle (1) for protecting threads.



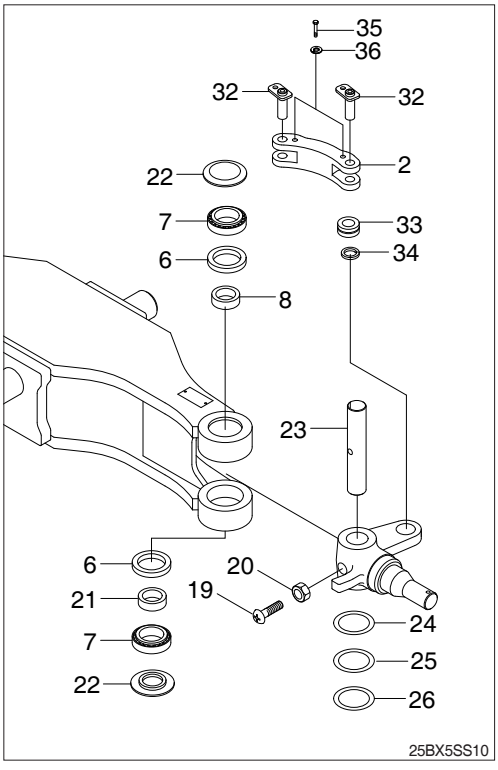
(8) Loosen bolt (19) and nut (20).

(9) Remove top cover (22).

(10) Push king pin (23) out while protecting knuckle from damage.

(11) Check bearing (7) for any damage, and pull it out if damaged.

(12) Loosen bolt (35), and remove steering link pin (32) and washer (36).



4) ASSEMBLING

※ **Before reassembling, clean all of parts, apply grease on lubrication parts, and replace dispensable parts such as oil seal and spring washer with new parts.**

(1) Assemble the parts in reverse order of disassembling.

※ **Fasten bolt (19), nut (20) and king pin (5).**

(2) There is groove on the center of king pin (5), and such groove should be toward bolt (19) during assembling.

(3) Always use dedicated tools. Fastening ring of bearing should be toward knuckle (1) when assembling bearing (7).

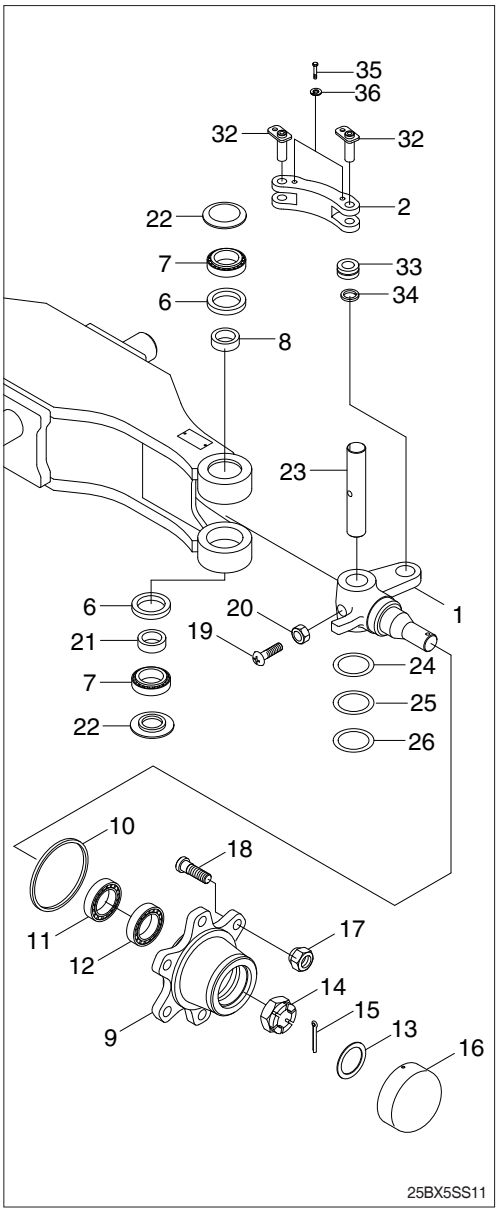
① Wheel hub

② Mount bolt (18) on wheel hub (9).

※ **Mount oil seal (10) and bearing races (11, 12) on wheel hub (9).**

③ Apply grease on bearing and oil seal before assembling.
Assemble wheel hub assembly on knuckle (1). Fasten slot nut (14) and washer (13), and lock them with division pin (15). When locking with division pin, rotate nut by one sixth turn to check hole for inserting division pin. Adjust preload of bearing.

④ Mount hub cap (16).

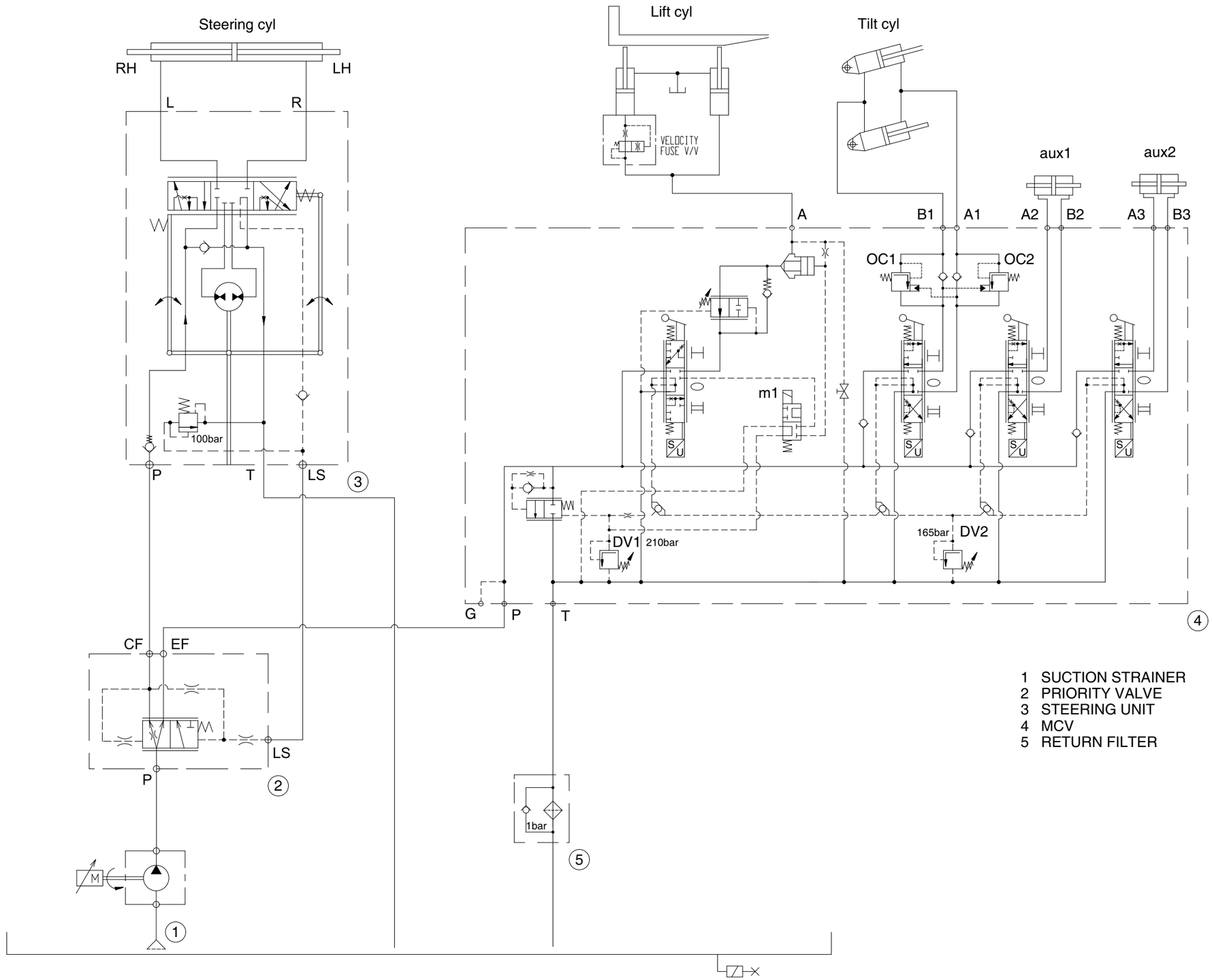


SECTION 6 HYDRAULIC SYSTEM

GROUP 1 STRUCTURE AND FUNCTIONS

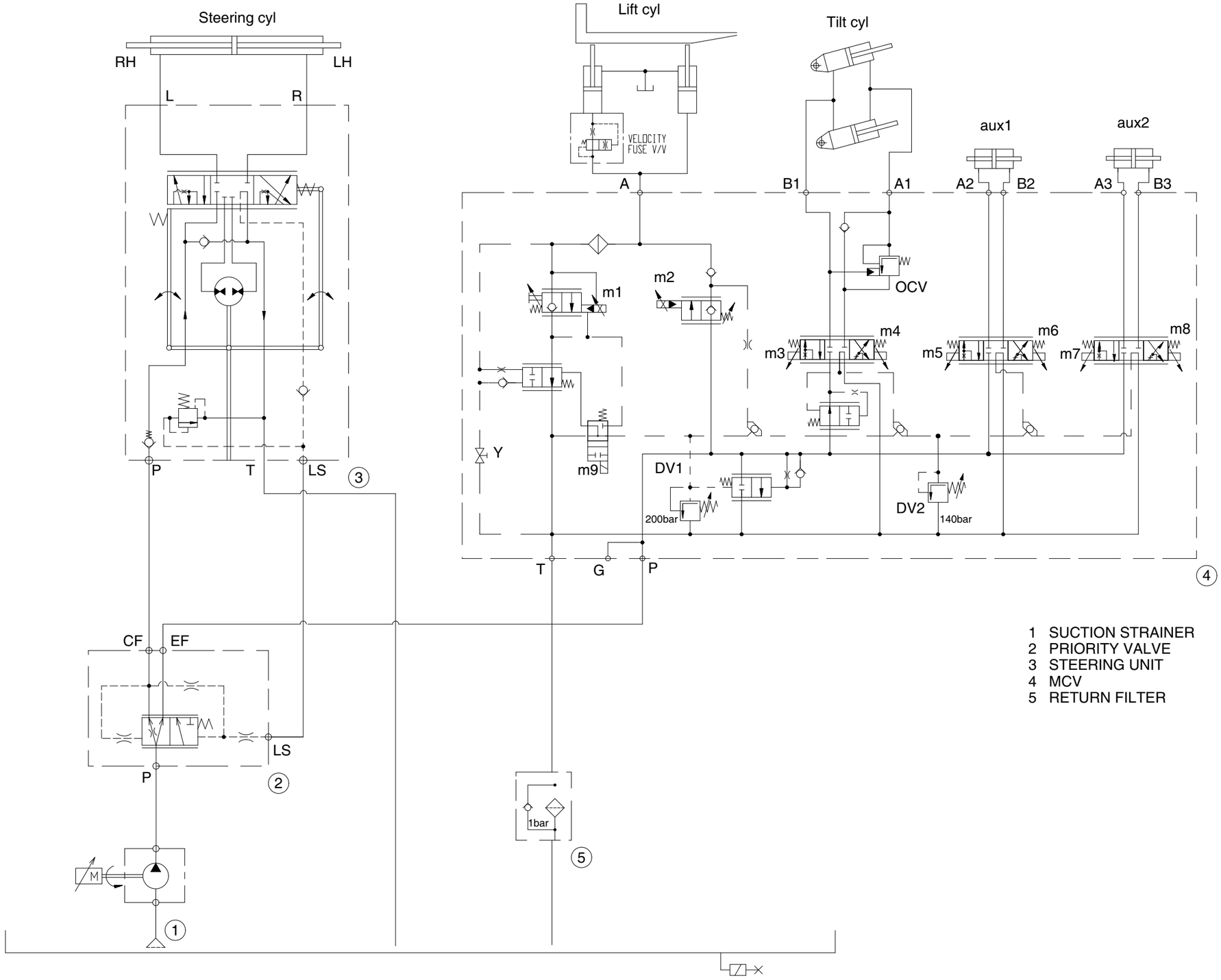
1. HYDRAULIC CIRCUIT

1) MANUAL TYPE



1 SUCTION STRAINER
2 PRIORITY VALVE
3 STEERING UNIT
4 MCV
5 RETURN FILTER

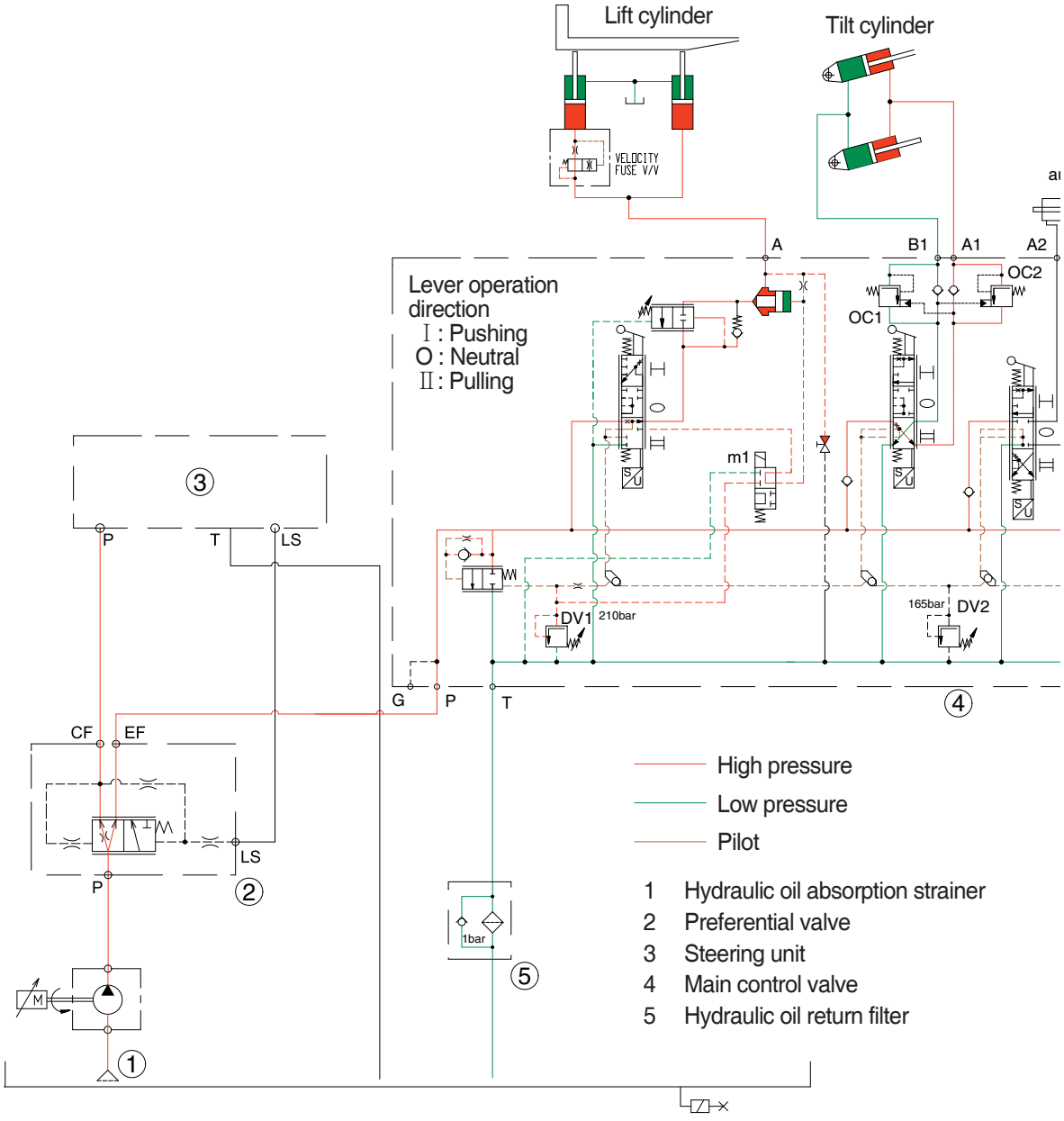
2) **FINGERTIP TYPE** (OPT)



1 SUCTION STRAINER
2 PRIORITY VALVE
3 STEERING UNIT
4 MCV
5 RETURN FILTER

3ZBD-02000-00

3) LIFT ASCENDING, TILTING REAR

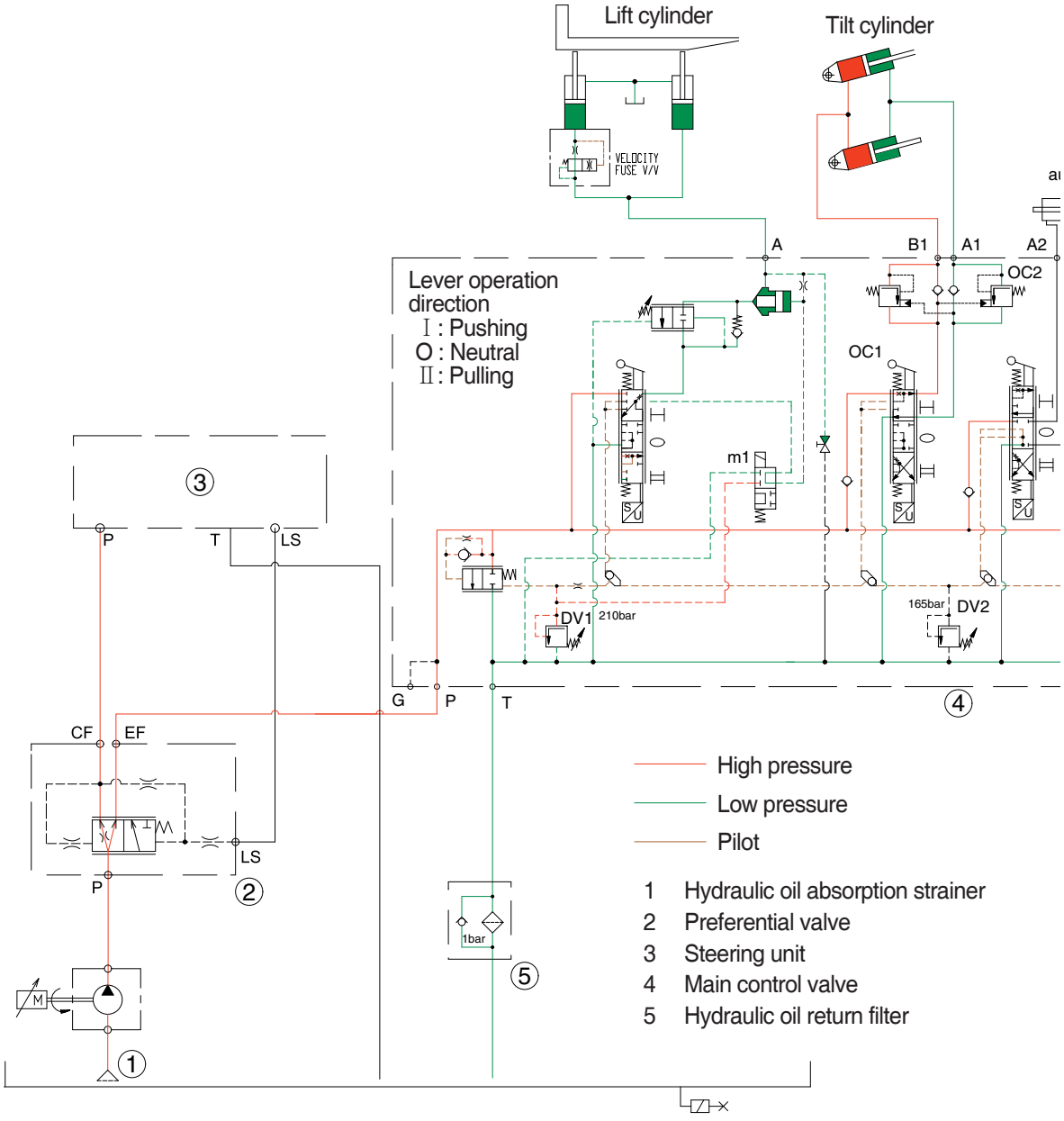


25BX6HS02

When pulling lift and tilt operation lever, spools of first and second blocks move to position of lift ascending tilting backward. Hydraulic oil of hydraulic pump (1) flows into main control valve (4) to push rod check valve of spool to large chamber of lift cylinder and small chamber of tilt cylinder.
At the same time, hydraulic oil from small chamber of lift cylinder and large chamber of tilt cylinder returns to hydraulic oil tank (5). This hydraulic oil flow forms lift ascending and tile backward.

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

4) LIFT DESCENDING, TILTING FORWARD



25BX6HS03

When pushing lift and tilt operation lever, spools of first and second blocks move to position of lift descending tilting forward. Hydraulic oil of hydraulic pump (1) flows into main control valve (4) to push rod check valve of spool to move to large chamber of tilt cylinder.

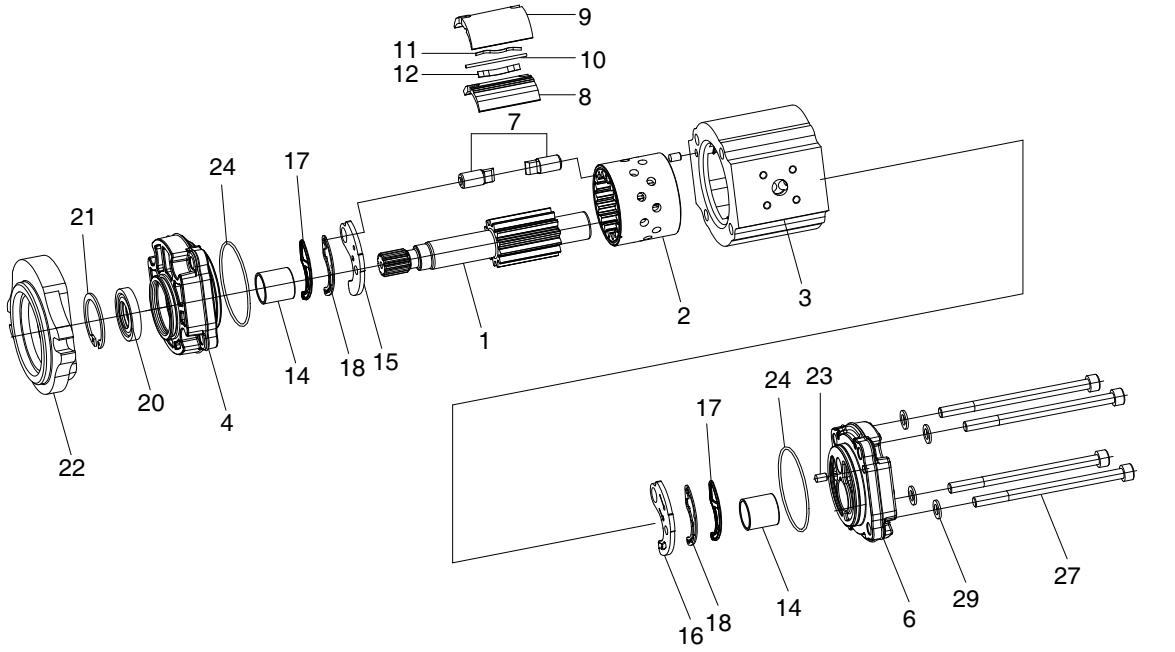
Large and small chambers of lift cylinder are connected to return path to let return of hydraulic oil, and mast descends with weight of forks.

Hydraulic oil from small chamber of tilt cylinder is returned to hydraulic oil tank (5). This hydraulic oil flow forms tilting forward.

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

2. HYDRAULIC GEAR PUMP

1) STRUCTURE



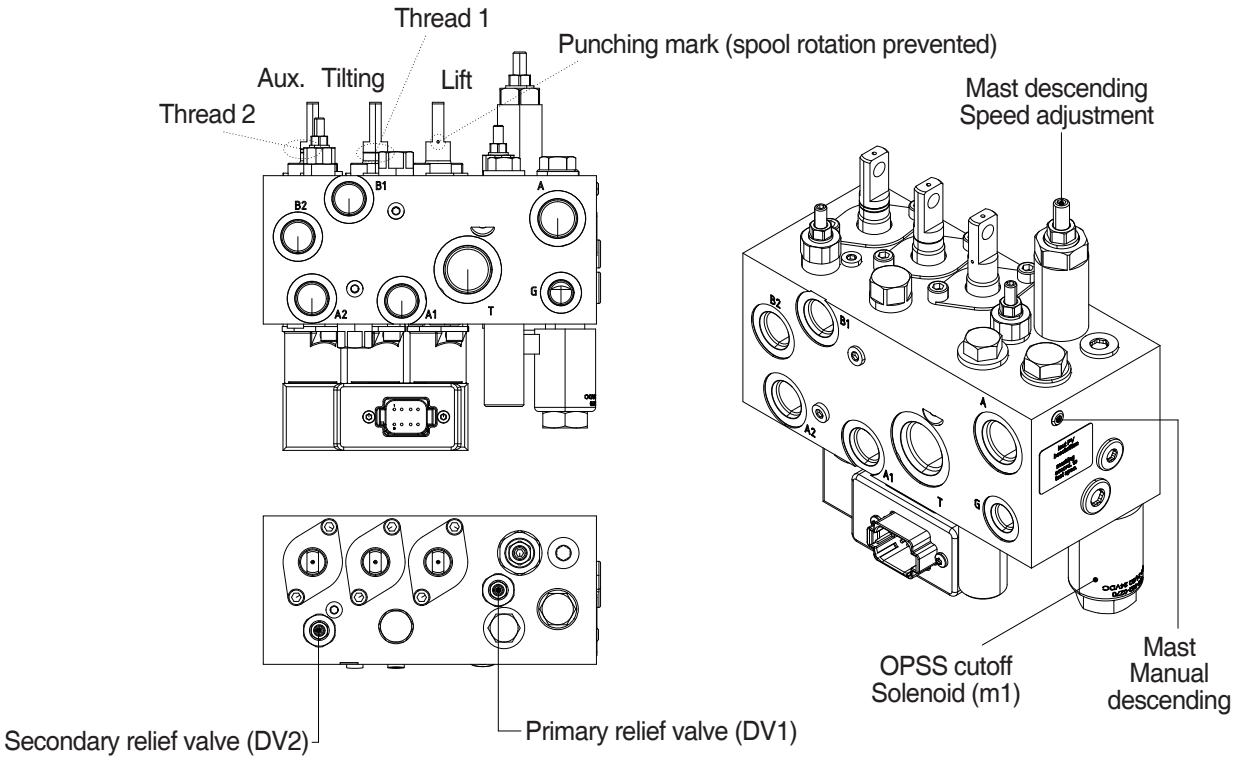
25BX6HS06

1	Piston shaft	10	Seal	20	Shaft seal
2	Internal gear	11	Segment spring	21	Retainer ring
3	Housing	12	Segment spring	23	Pin
4	Cover	14	Bearing bushing	24	O-ring
6	Cover plate	15	Plate	27	Screw
7	Pin	16	Plate	29	Washer
8	Pinion segment	17	Seal		
9	Internal gear segment	18	Backup ring		

3. MAIN CONTROL VALVE

1) STRUCTURE

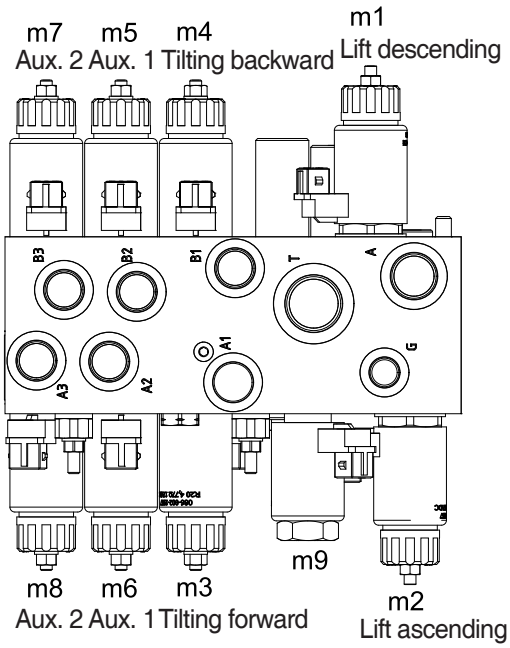
(1) 3 Spool (manual type)

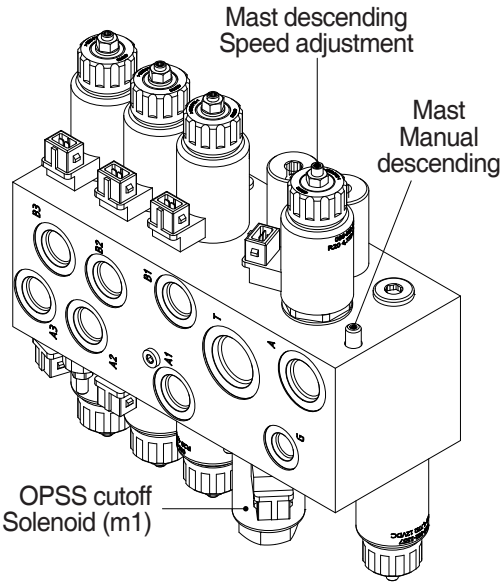


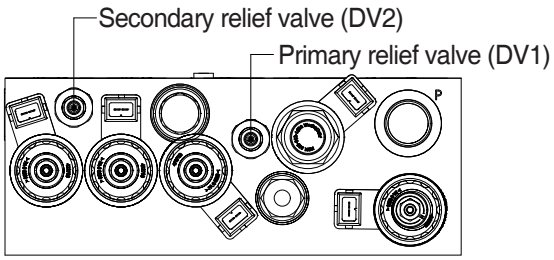
25BX6HS07

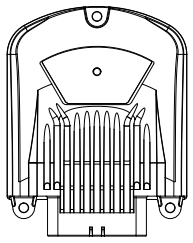
Port	Port name	Dimensions	Fastening torque
			kgf · m
A	Lift	7/8-14 UNF	7
A1, B1	Tilting	3/4-16 UNF	5
A-, B-	Aux.	3/4-16 UNF	5
P	Inlet	7/8-14 UNF	7
T	Outlet	1 1/16-12 UN	9.5
G	Gauge, pilot	9/16-18UNF	3
m1	Cutoff solenoid	-	4
	Coil	-	0.7

(2) Fingertip type (opt)








Fingertip controller

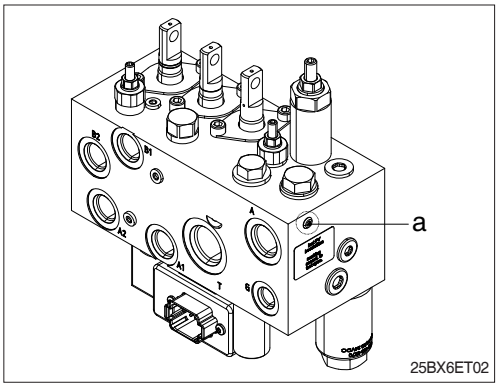
25D9V6HS09

Port	Port name	Port dimensions	Tightening torque
			kgf · m
A	Lift	7/8-14 UNF	7
A1, B1	Tilting	3/4-16 UNF	5
A-, B-	Aux.	3/4-16 UNF	5
P	Inlet	7/8-14 UNF	7
T	Outlet	1 1/16-12 UN	9.5
G	Gauge	9/16-18UNF	3

2) FUNCTIONS

(1) Emergency mast lowering

In case that the mast can't be lowered due to a problem in the controller, activate the emergency lowering valve on the MCV assy by rotating the valve (a).



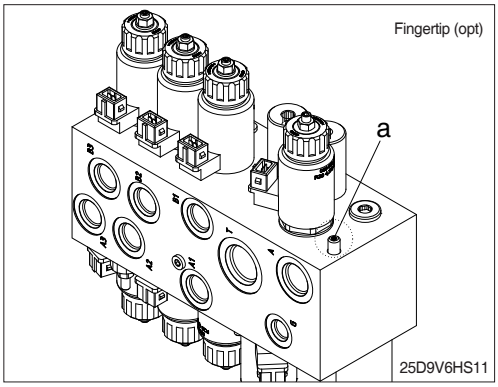
⚠ Manual override features are intended for emergency use, not for continuous-duty operation.

1) Loosen and remove the MCV cover connecting bolts.
   · Tightening torque : 0.8 - 1.2 kgf · m

2) Use the L-wrench (3 mm) to loosen the bolts counterclockwise until lowering of the mast begins.

※ Do not undo the bolts more than 1.5 turns.

※ If lowering still does not begin, there is a mechanical block . Do not under any circumstances continue to unscrew the emergency lowering feature.



3) After lowering is complete, the valve must be screwed back in again.

※ Do not exceed a tightening torque of maximum 0.25 kgf · m.

⚠ When operating the emergency lowering valve in order to lower the mast inevitably, always make certain that any person should not stand or pass under the mast, the fork and platform so as to avoid from unexpected accident such severe personal injury or death.

(2) Cutoff solenoid for blocking hydraulic pressure

This equipment is a mast interlock that preventing activation of hydraulic functions of main control valve until operator sits on the seat. The system is also a key-lowering interlock system that prevents fork descending while start key is kept on OFF position. This safety function is defined in ISO 3691-1, and should not discretionally be deactivated on main control valve.

(3) Relief valve

① Primary relief valve (DV1)

Primary relief valve limits max. pressure of lifting and tilting function. When lifting or tilting function operates simultaneously with aux. function, max. pressure of lifting or tilting function is limited by pressure setup of secondary relief valve. Primary relief valve does, typically, not require field adjustment. Refer to testing and adjustment of relief valve for further information of adjustment.

② Secondary relief valve (DV2)

Secondary relief valve limits max. pressure of aux. (attachment) function, and pressure setting of the valve is lower than primary relief valve. Secondary relief valve may require pressure adjustment dependent upon types of attachments. If it is required to adjust pressure, adjustment within 90% of primary relief valve pressure is recommended (e.g., 210 × 0.9=190 bar). If pressure of secondary relief valve is to close to pressure of primary relief valve, interference between circuits may take place. Refer to testing and adjustment of relief valve for further information of adjustment. Up to 2 optional functions are provided.

3) RELIEF VALVE PRESSURE TESTING AND ADJUSTMENT

(1) Test specifications

· Hydraulic motor speed : High rpm
· Oil temperature : 50±5˚C (122±9˚F)
· Relief valve pressure setting
  - Primary : 210±3 bar (3045±43 psi)
  - Secondary :165±3 bar (2393±43 psi)
· Tools : 10-mm spanner, 3-mm hexagonal wrench

⚠ Primary relief valve (DV1) should not be used for pressure boosting at field. When boosting pressure of primary relief valve higher than specified setting, system may be damaged.

⚠ Check relief valves in safe and clean environment.

⚠ Make sure there is no bystanders or other workers in the vicinity of system during operation and testing.

⚠ Pressurized hydraulic oil may remain in hydraulic system after turning off. Fully lower folks onto the ground to prevent personal safety accident. Loosened mast chain indicates fully lowering of forks.

⚠ Turn engine off before disassembling, fastening, removing or adjusting piping parts (e.g., fitting, plug and hose), and fully move main control valve lever forward and backward two or three times to fully discharge hydraulic oil from circuits. Open tank oiling cap to relieve pressure. When air breather filter inside hydraulic oil tank is clogged, pressure may reside inside tank.

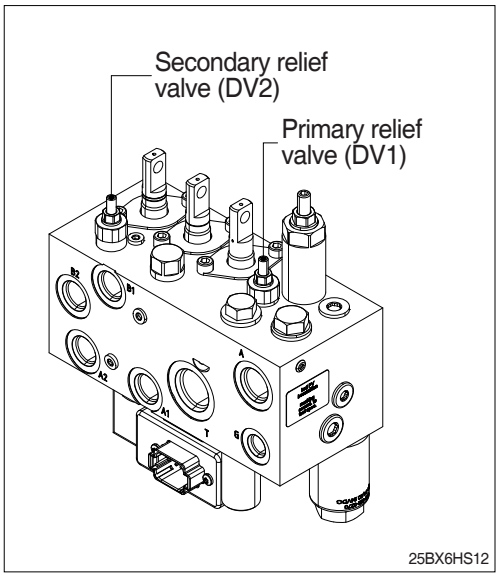
⚠ Hot hydraulic oil may cause severe burn. Never touch components or hydraulic oil during testing. Make sure that hydraulic oil is cooled down to safe temperature before installing or removing testing systems.

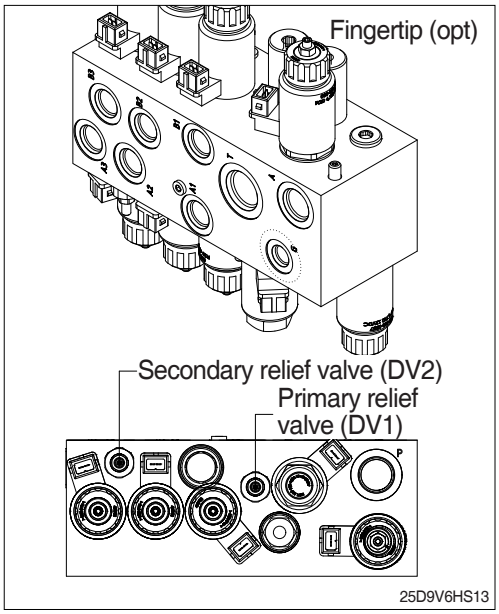
⚠ Your skin may make contact with pressurized hydraulic oil. Fully lower forks onto the ground before removing test plug from valve, and then relieve pressure from all of circuits.

① Operate hydraulic system until oil temperature reaches specified value in test specifications.
② Lower forks onto the ground, stop engine, and then apply parking brake.
③ Open cover of main control valve.
④ Connect pressure gauge to pressure check port (G) of main control valve.
⑤ Operate pump motor in accordance with test specifications.
⑥ Pull lift lever to raise forks to the top, and keep the conditions as they are.
⑦ Read pressure gauge. Compare value on the gauge with specifications.
⑧ Loosen lock nuts of main control valve and relief valve, and turn adjustment screw to adjust pressure.
  · Fastening torque : 0.25 kgf · m
  · If pressure is lower than specification, turn relief valve adjustment screw clockwise.
  · If pressure is higher than specifications, turn relief valve counterclockwise.

⚠ Adjustment screw of MCV relief valve is very sensitive. Rotate the screw by a quarter turn to prevent overpressure.

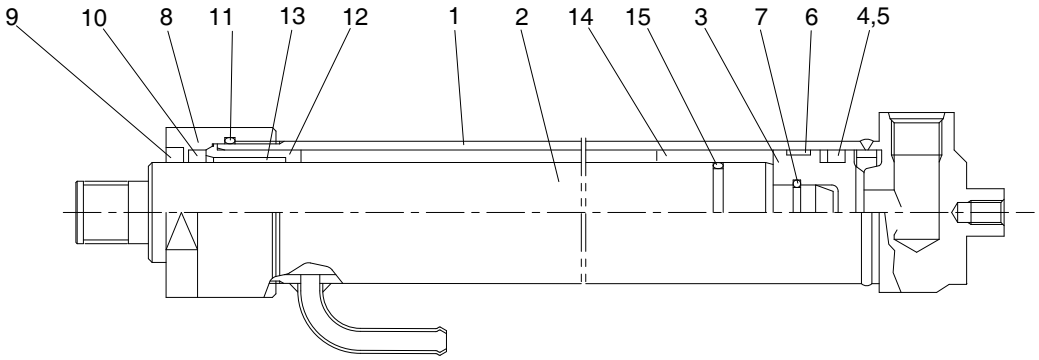
⑨ Repeat Steps ⑦ and ⑧. When pressure is compliant with the specifications, remove testing equipment.





4. LIFT CYLINDER

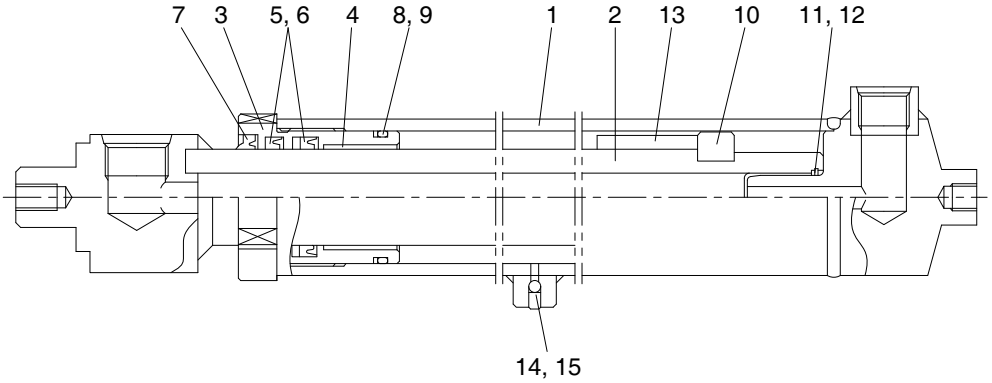
1) V MAST



D255HS18

1	Tube assembly	6	Abrasion ring	11	Gland
2	Rod	7	Retainer ring	12	Guide
3	Piston	8	Gland	13	DU bushing
4	Piston seal	9	Dust wiper	14	Spacer
5	Backup ring	10	Dust wiper	15	O-ring

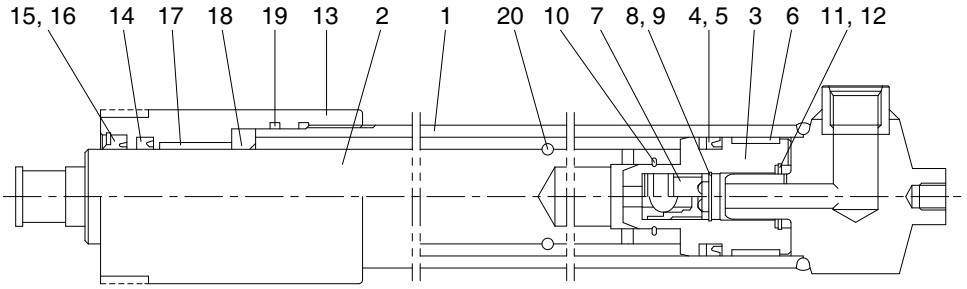
2) VF MAST



22B9FHS20

1	Tube assembly	6	Backup ring	11	Cushion seal
2	Rod assembly	7	Dust wiper	12	Retainer ring
3	Rod cover	8	O-ring	13	Spacer
4	Rod bushing	9	Backup ring	14	Steel ball
5	U packing	10	Backup ring	15	Set screw

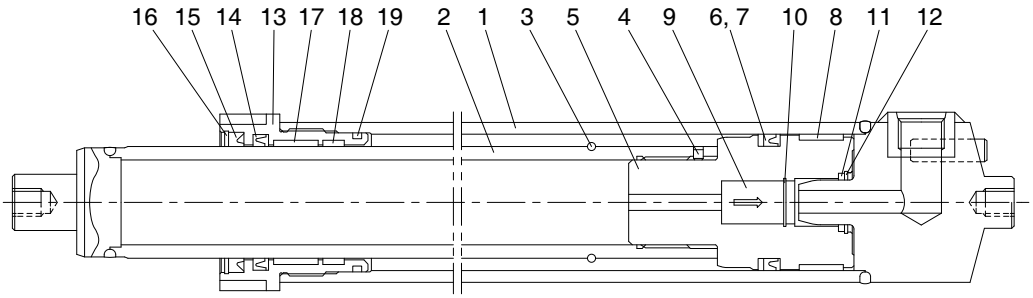
3) TF AND TS MASTS



22B9FHS21

1	Tube assembly	8	Spacer	15	Dust wiper
2	Rod	9	Retainer ring	16	Retainer ring
3	Piston	10	Stop ring	17	Rod bushing
4	U packing	11	Cushion seal	18	Spacer
5	Backup ring	12	Retainer ring	19	O-ring
6	Abrasion ring	13	Rod cover	20	Fastening ring
7	Check valve	14	U packing		

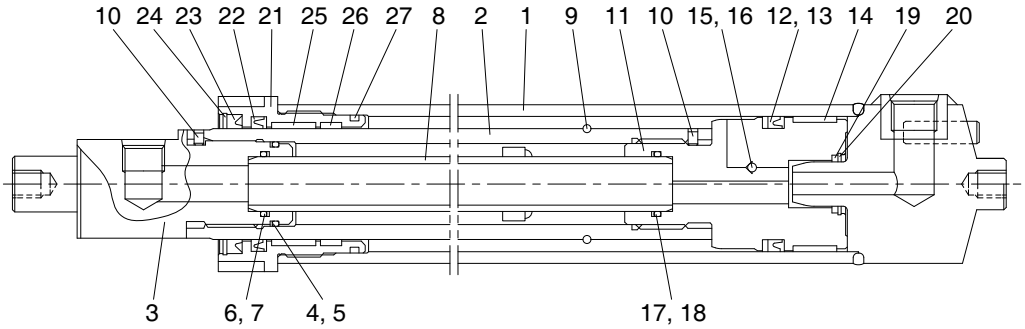
4) QF MAST (LEFT)



22B9FHS22

1	Tube assembly	8	Abrasion ring	15	Dust wiper
2	Rod assembly	9	Check valve	16	Fastening ring
3	Stop ring	10	Retainer ring	17	Abrasion ring
4	Set screw	11	Cushion seal	18	Dust ring
5	Piston	12	Retainer ring	19	O-ring
6	U packing	13	Rod cover		
7	Backup ring	14	U packing		

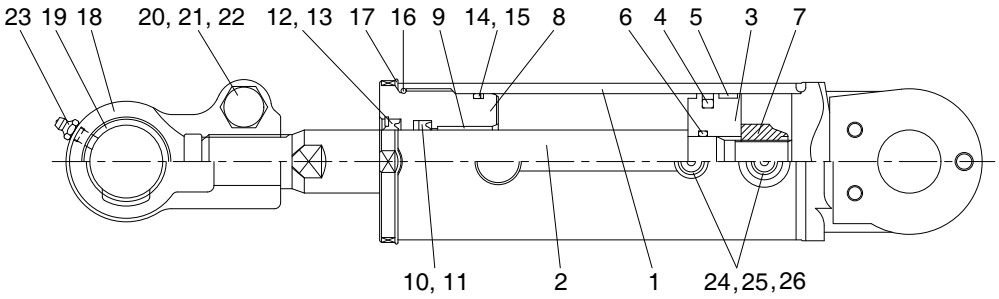
5) TF AND TS MASTS



22B9FHS23

1	Tube assembly	10	Set screw	19	Cushion seal
2	Rod	11	Piston	20	Retainer ring
3	Rod end	12	Backup ring	21	Rod cover
4	O-ring	13	U packing	22	U packing
5	Backup ring	14	Abrasion ring	23	Dust wiper
6	O-ring	15	Check valve	24	Retainer ring
7	Backup ring	16	Retainer ring	25	Abrasion ring
8	Inner rod assembly	17	O-ring	26	Dust ring
9	Stop ring	18	Backup ring	27	O-ring

6. TILT CYLINDER

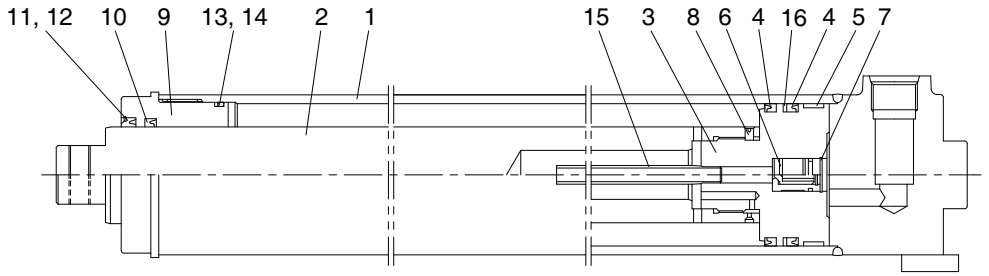


31FH-08771

1	Tube assembly	11	U packing	19	Spherical bearing
2	Rod	11	Backup ring	20	Hexagonal bolt
3	Piston	12	Dust wiper	21	Spring washer
4	Piston seal	13	Stop ring	22	Lock nut
5	Abrasion ring	14	O-ring	23	Grease nipple
6	O-ring	15	Backup ring	24	Dust cap
7	Nylon nut	16	O-ring	25	O-ring
8	Rod cover	17	Lock washer	26	O-ring
9	Rod bushing	18	Rod eye		

5. PRE-LIFT CYLINDER

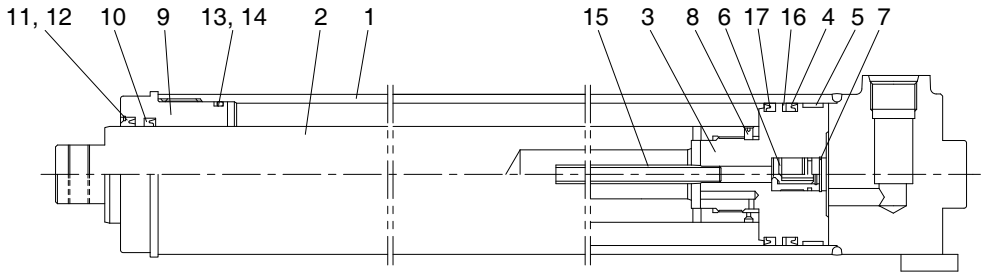
1) VF AND TF MASTS (30/32/35B-X)



37B1-07732

1	Tube assembly	7	Retainer ring	13	O-ring
2	Rod	8	Set screw	14	Backup ring
3	Piston	9	Rod cover	15	Pipe
4	U packing	10	U packing	16	Backup ring
5	Abrasion ring	11	Dust wiper		
6	Check valve	12	Retainer ring		

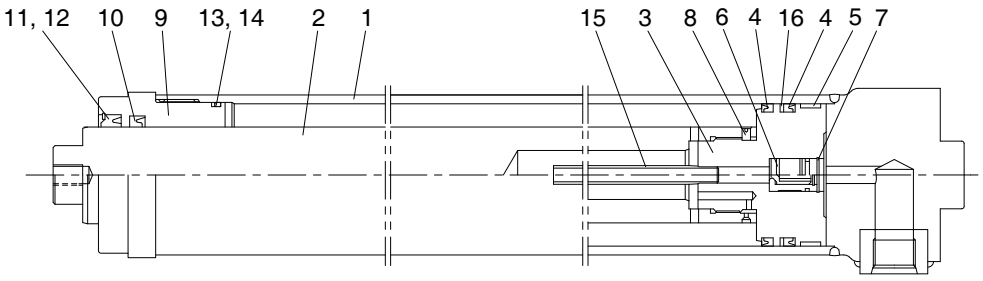
2) TF MAST (25B-X)



37B1-07612

1	Tube assembly	7	Retainer ring	13	O-ring
2	Rod	8	Set screw	14	Backup ring
3	Piston	9	Rod cover	15	Pipe
4	U packing	10	U packing	16	Backup ring
5	Abrasion ring	11	Dust wiper	17	U packing
6	Check valve	12	Retainer ring		

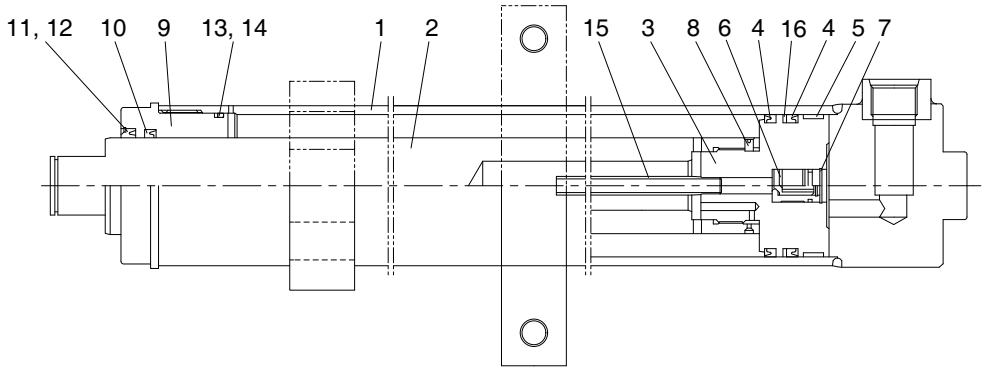
3) TS MAST



3AHN-80202

1	Tube assembly	7	Retainer ring	13	O-ring
2	Rod	8	Set screw	14	Backup ring
3	Piston	9	Rod cover	15	Pipe
4	U packing	10	U packing	16	Backup ring
5	Abrasion ring	11	Dust wiper		
6	Check valve	12	Retainer ring		

4) QF MAST



3CHN-07503

1	Tube assembly	7	Retainer ring	13	O-ring
2	Rod	8	Set screw	14	Backup ring
3	Piston	9	Rod cover	15	Pipe
4	U packing	10	U packing	16	Backup ring
5	Abrasion ring	11	Dust wiper		
6	Check valve	12	Retainer ring		

1. OPERATIONAL CHECK

1) INSPECTION ITEMS

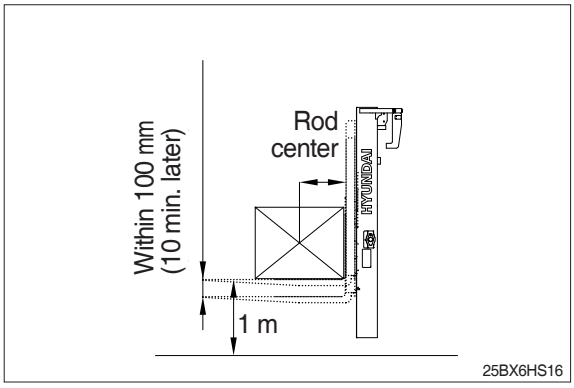
(1) Visually check rod for deformation, crack or destruction.

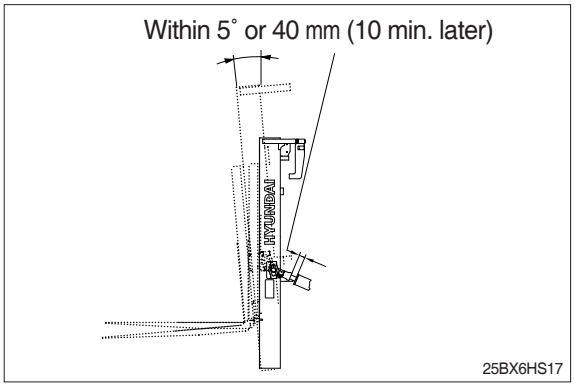
(2) Place mast in horizontal direction, and lift it from the ground by 1 m. Measure hydraulic drift (distance for fork lowering, and mast tilting forward) 10 minutes later.

· Inspection conditions
- Hydraulic oil temperature : 45±5˚C
- Rated load
- Mast kept vertical

· Hydraulic drift
- Lowering : Within 100 mm
- Tilting forward : Within 5˚ or 40 mm

(3) If hydraulic drift is greater than specified value, replace control valve or cylinder packing.

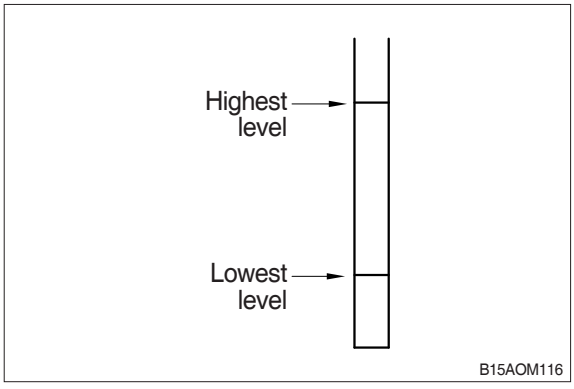




2) HYDRAULIC OIL

(1) Make use of dipstick to measure oil level, and make it up, if required.

(2) Clean suction strainer fixed on outlet port pipe with screw when exchanging hydraulic oil.



3) MAIN CONTROL VALVE

(1) Raise forks to the highest position, and measure hydraulic pressure. Make sure that pressure of hydraulic oil is 210 bar.

2. FAILURE DIAGNOSIS AND TROUBLESHOOTING

1) HYDRAULIC SYSTEM

Trouble	Possible cause	Troubleshooting
Sudden drop of forks	· Defective seal inside control valve · Oil leak from joint or hose. · Defective seal inside cylinder.	· Replacing spool or valve body. · Replacing · Packing exchange.
Large tilting angle by tare weight of mast	· Leaning backward : Defective check valve. · Leaning forward : Defective tilting lock valve. · Oil leak from joint or hose. · Defective seal inside cylinder.	· Cleaning or replacing. · Cleaning or replacing. · Replacing. · Seal replacing.
Slow speed of fork lifting or mast tilting	· Insufficient hydraulic oil. · Intrusion of air in hydraulic oil. · Oil leak from joint or hose. · Excessive restriction on oil flow on pump suction. · Relief valve failed in keeping at specified pressure. · Defective seal inside cylinder. · High viscosity of hydraulic oil · Mast not moving smoothly. · Oil leak on lift control valve spool. · Oil leak on tilting control valve spool.	· Oil making up. · Air bleeding · Replacing. · Filter cleaning. · Relief valve adjusting. · Packing exchange. · Replacing with ISO VG46. · Adjusting rolls in rail interval · Replacing spool or valve body. · Replacing spool or valve body.
Abnormal noise from hydraulic system	· Excessive restriction on oil flow on pump suction. · Defective hydraulic pump gear or bearing.	· Filter cleaning. · Gear or bearing replacing.
Control valve lever locked	· Foreign substance between spool and valve body. · Defective valve body.	· Cleaning. · Evenly tightening body mounting bolt.
Rise of oil temperature	· Insufficient hydraulic oil. · High viscosity of hydraulic oil. · Oil filter clogged.	· Oil making up. · Replacing with ISO VG46. · Filter cleaning.

2) HYDRAULIC GEAR PUMP

Trouble	Possible cause	Troubleshooting
Oil leak from oil seal	· Backlashing · Abnormally high pressure on suction port · Seal damaged by foreign substance · Damage or abrasion of seal of shaft · Defective centering of shaft	· Rotating pump in correct direction · Keeping pressure proper · Replacing oil seal with new part · Centering adjustment. · Pump replacing.
Oil leak on cover or body interface	· Bolt loosened or damaged on cover and body · Deterioration or damage of oil seal by thermosetting of gasket	· Bolt fastening or keeping pressure proper. · Replacing gasket with new part · Pump replacing.
Oil leak on port	· Port fitting damaged or loosened · Port seal damaged · Port damaged	· Port tightening and keeping design pressure intact · Port seal replacing · Pump replacing
Discharge flow insufficient, or pressure not established	· Insufficient oil in tank · Internal oil leak by abnormally high pressure, or improper oil viscosity · Capability degraded by oil contamination · Cavitation by negative pressure · Internal part destructed · Backlashing	· Suppling oil of proper type and capacity into tank, and cooling system replacing. · Exchanging contaminated oil. · Using suction pipe of proper length and width, and replacing filter to prevent negative pressure. · Suction valve opening · Pump replacing · Rotating pump in correct direction, and preventing abnormally high temperature on suction side.
Rise of tank or oil temperature	· Abnormal heat generated by frequent operation of pressure control valve · Internal part destructed	· Setting to proper pressure. · Pump replacing.
Noise and vibration	· Poor mounting · Cavitation · Air induced · Vibration of piping or mounted flange · Chattering of relief valve · Internal part destructed	· Centering adjustment · Using suction pipe of proper length and width, and replacing filter to prevent negative pressure. · Filling tank with oil, and preventing air inducing with suction pipe. · Reinforcing pipe and mounting flange, and preventing resonance. · Replacing relieve valve. · Pump replacing.

※ Capability of disassembled pump may not be restored after reassembling.

※ If pump is destructed, replace the assembly.

※ If it is inevitable to disassemble pump, consult with the authorized shop or dealer of Hyundai.

3) LIFT CYLINDER

Trouble	Possible cause	Troubleshooting
Oil leak on rod cover through rod	· Foreign substance on packing. · Severe flaw on rod. · Abnormal distortion of dust seal. · Chromium plating damaged	· Packing replacing. · Grinding rod surface with oil stone. · Dust seal replacing. · Rod replacing.
Oil leak on cylinder rod cover thread	· O-ring damaged.	· O-ring replacing.
Rod shrunken	· Flaw on internal surface of tube. · Very serious flaw on internal surface of tube. · Foreign substance into piston seal.	· Grinding rod surface with oil stone. · Cylinder tube replacing. · Piston seal replacing.
Abrasion (play between cylinder tube and abrasion ring)	· Serious play between cylinder tube and abrasion ring.	· Abrasion ring replacing.
Abnormal noise when tilting operation	· Insufficient lubricant on anchor pin or bushing or pin abraded. · Tilt cylinder rod bent.	· Applying lubricant or replacing. · Replacing.

GROUP 3 DISASSEMBLY AND ASSEMBLY

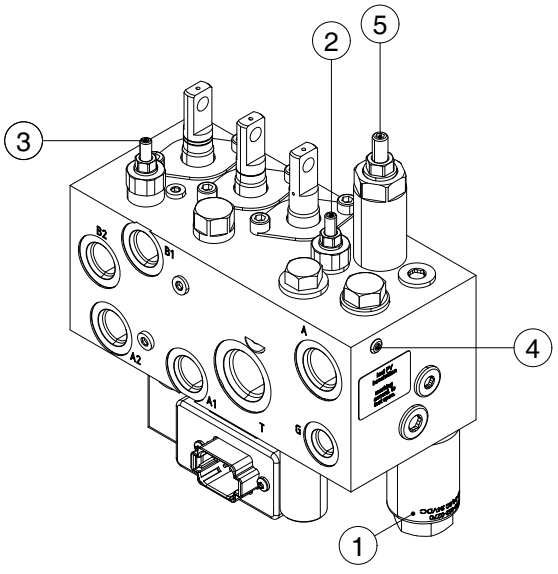
Always work in clean environment, and comply with the followings:

- Make sure that there is no damage of parts immediately after accepting them.
- All of components should be cleaned with solvent, and dried with compressed air before reassembling.
- Care should be exercised for protecting rubber seal from damage.
- Care should be exercised for protecting precise-machined surface from damage.
- Components should be inserted into housing not exercising large force. If large force is required, dimensional tolerances of parts are not complied with or misaligned.
- If force of hands is not sufficient, use press or rubber mallet.
- Never strike part with iron hammer.
- Proper press should be used for metal bushing.
- Do not use mallet for mounting bearings.
- Always pay attention to rotation direction when assembling parts.

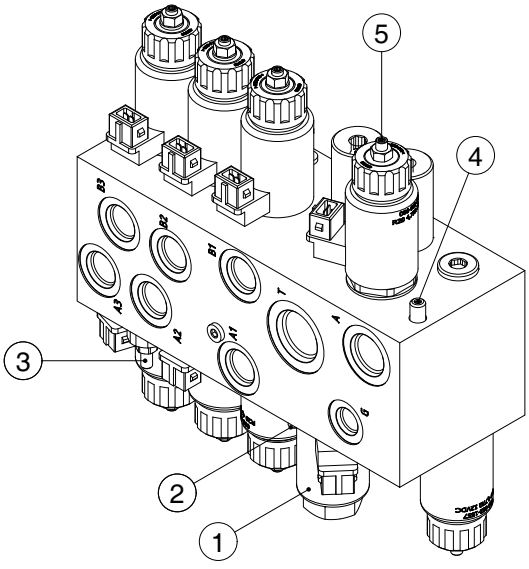
1. MAIN CONTROL VALVE

1) STRUCTURE

Manual type



Fingertip type (opt)



25BX6HS17

1 OPSS cutoff solenoid
2 Primary relief valve (DV1)
3 Secondary relief valve (DV2)
4 Manual descending of mast
5 Adjusting mast descending speed

2) DISASSEMBLING AND ASSEMBLING

(1) Cutoff solenoid

※ **The photos are for reference only. MCV shapes may vary.**

① Safety park forklift truck, and fully lower fork carriage onto the ground.

② Operate lever with engine turned off to discharge hydraulic oil from main control valve.

③ Open the cover of main control valve and loosen the nut of solenoid coil to remove coil from check valve.

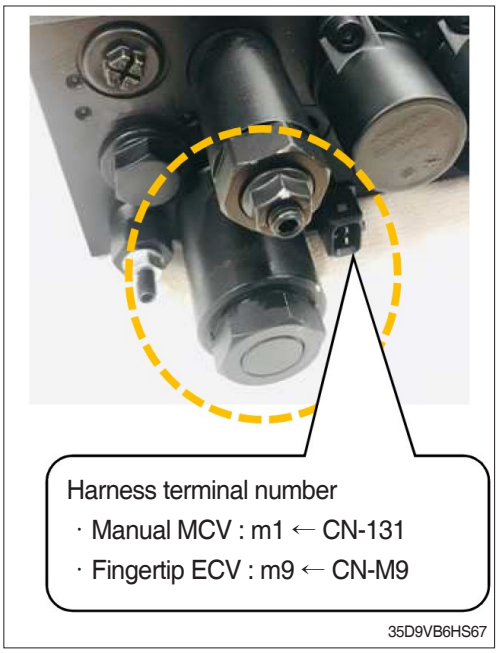
④ Clean check valve and valve block to protect open valve block from contamination.

⑤ Loosen check valve with 17-㎜ spanner. Apply thin film of lubricant on O-ring of new check valve. Insert new check valve, and fasten it at fastening torque.

· Fastening torque : 4 ㎏f · m

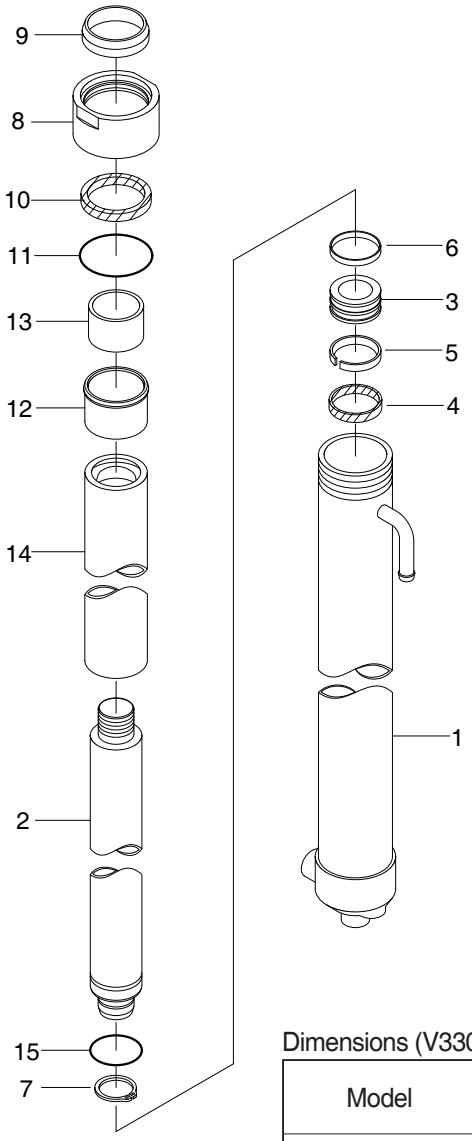
⑥ Mount solenoid coil in correct direction, and fasten the coil with O-ring of nut facing the coil.

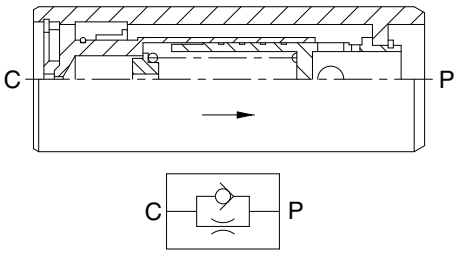
· Fastening torque : 0.7 ㎏f · m



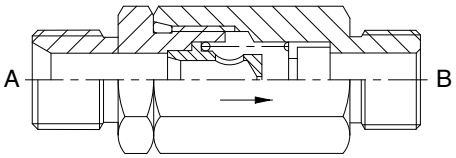
2. LIFT CYLINDER

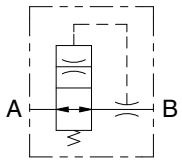
1) STRUCTURE





Descending control valve





Descending safety valve

Dimensions (V330, standard) Unit : mm

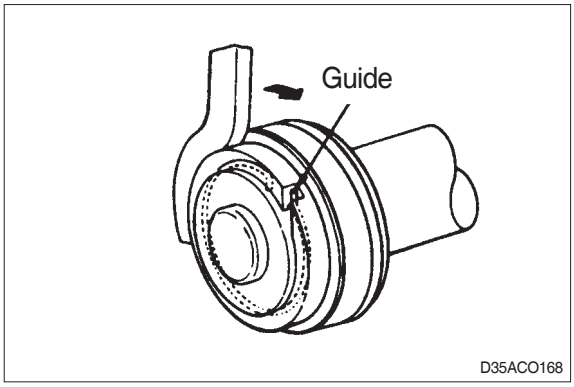
Model	Inner diameter	Outer diameter	Stroke	Rod (outer diameter)
25B-X	50	58	1630	40
30/32/35B-X	55	63	1630	45

25B9UHS26

1	Tube assembly	6	Abrasion ring	11	O-ring
2	Rod assembly	7	Retainer ring	12	Guide
3	Piston	8	Gland	13	DU bushing
4	Piston seal	9	Dust wiper	14	Spacer
5	Backup ring	10	Dust wiper	15	O-ring

2) DISASSEMBLING

(1) Hold cylinder tube in vice, and loosen and remove cylinder head.
Remove space from cylinder tube, and pull bushing out. Connect wrench to the hole of retainer at the end of piston, and turn the wrench. Lift the edge of guide and turn guide to move guide.



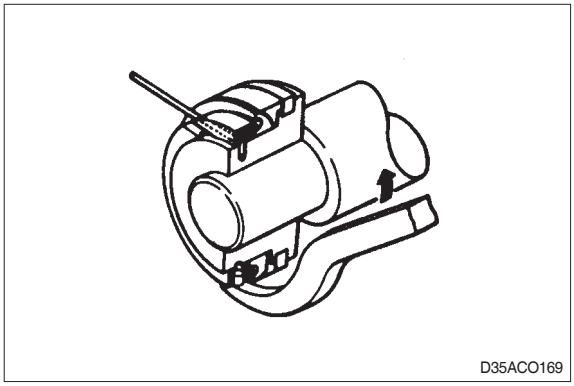
3) CHECKING AND INSPECTION

mm

Inspection items	Standard dimensions	Limit on repair	Troubleshooting
Gap between cylinder rod and bushing	0.072 - 0.288	0.5	Bushing Replacing
Gap between piston ring and tube	0.05 - 0.030	0.5	Piston ring Replacing

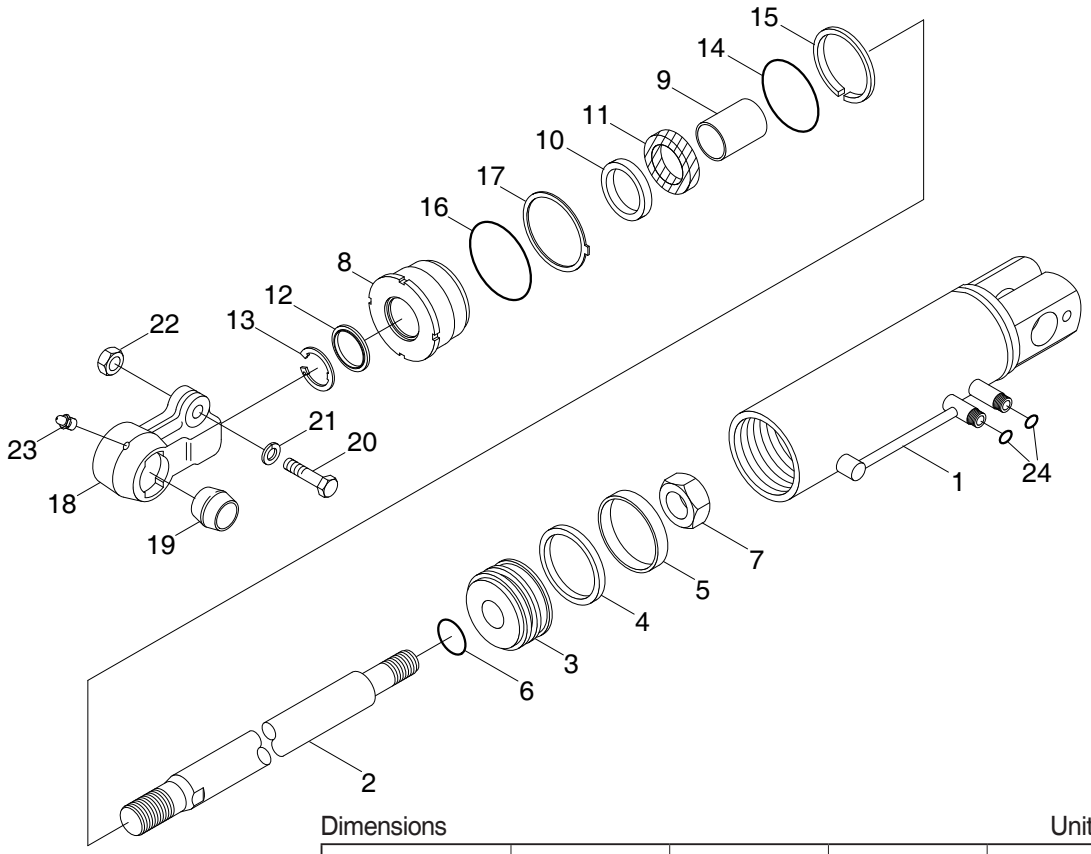
4) ASSEMBLING

(1) Put piston ring in hydraulic oil of 40-50˚C, and expand inner diameter of the ring, and assemble it on piston. Install piston seal.
Bend and turn the edge of guide install guide.



3. TILT CYLINDER

1) STRUCTURE



Dimensions Unit : mm

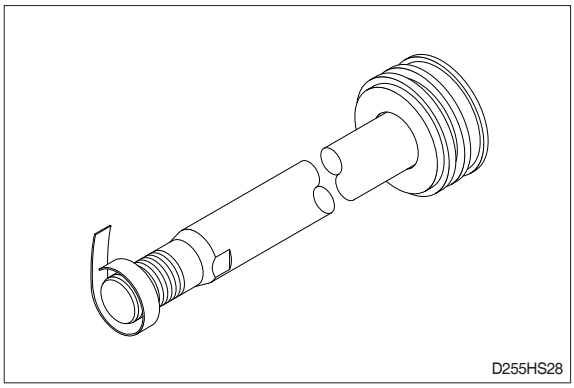
Model	Inner diameter	Outer diameter	Stroke	Rod (outer diameter)
All of models	75	88	148	35

22B7HS23

1	Tube assembly	10	U packing	19	Spherical bearing
2	Rod assembly	11	Backup ring	20	Hexagonal bolt
3	Piston	12	Dust wiper	21	Spring washer
4	Piston seal	13	Stop ring	22	Lock nut
5	Abrasion ring	14	O-ring	23	Grease nipple
6	O-ring	15	Backup ring	24	Dust cap
7	Nylon nut	16	O-ring	25	O-ring
8	Rod cover	17	Lock washer	26	O-ring
9	Rod bushing	18	Rod eye		

2) DISASSEMBLING

(1) Hold flat area on the bottom of cylinder tube in vice, mark fastening torque on the end of rod head, and then separate rod head. Hook wrench on the notch of cylinder head, and then separate cylinder head from cylinder tube.
Wind valleys of thread of rod with adhesive tape to protect dust seal and rod seal inside cylinder head from damage.

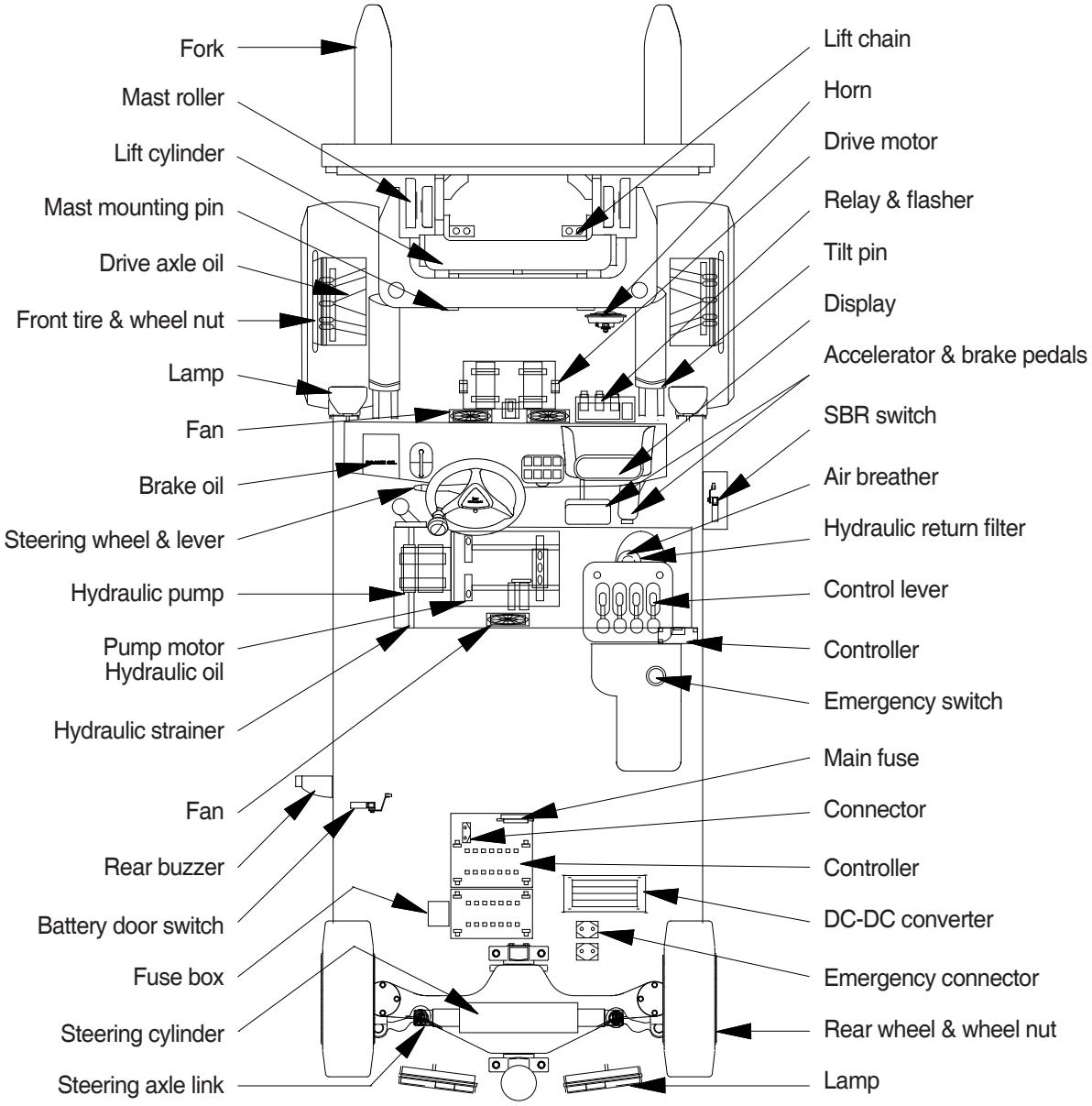


3) CHECKING AND INSPECTION

Inspection items	Standard dimensions	Limit on repair	Troubleshooting
Gap between cylinder rod and bushing	0.072 - 0.288	0.5	Replacing bushing
Gap between rod head bushing and pin	0.10 - 0.35	0.6	Replacing bushing

SECTION 7 ELECTRIC SYSTEM

GROUP 1 GENERAL LOCATIONS OF PARTS



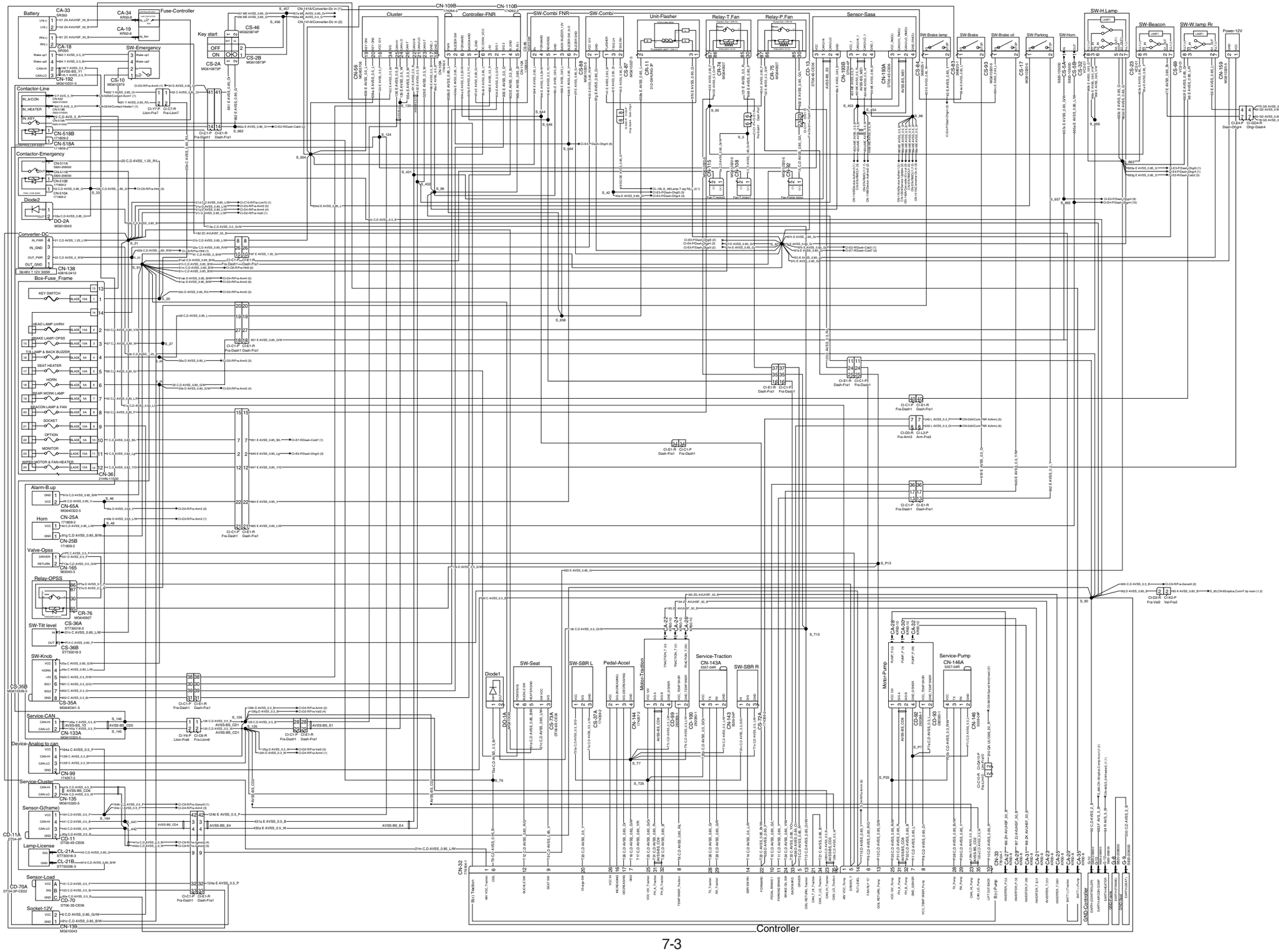
GROUP 2 ELECTRIC CIRCUIT DIAGRAMS

1. CODES IN ELECTRIC CIRCUIT DIAGRAMS

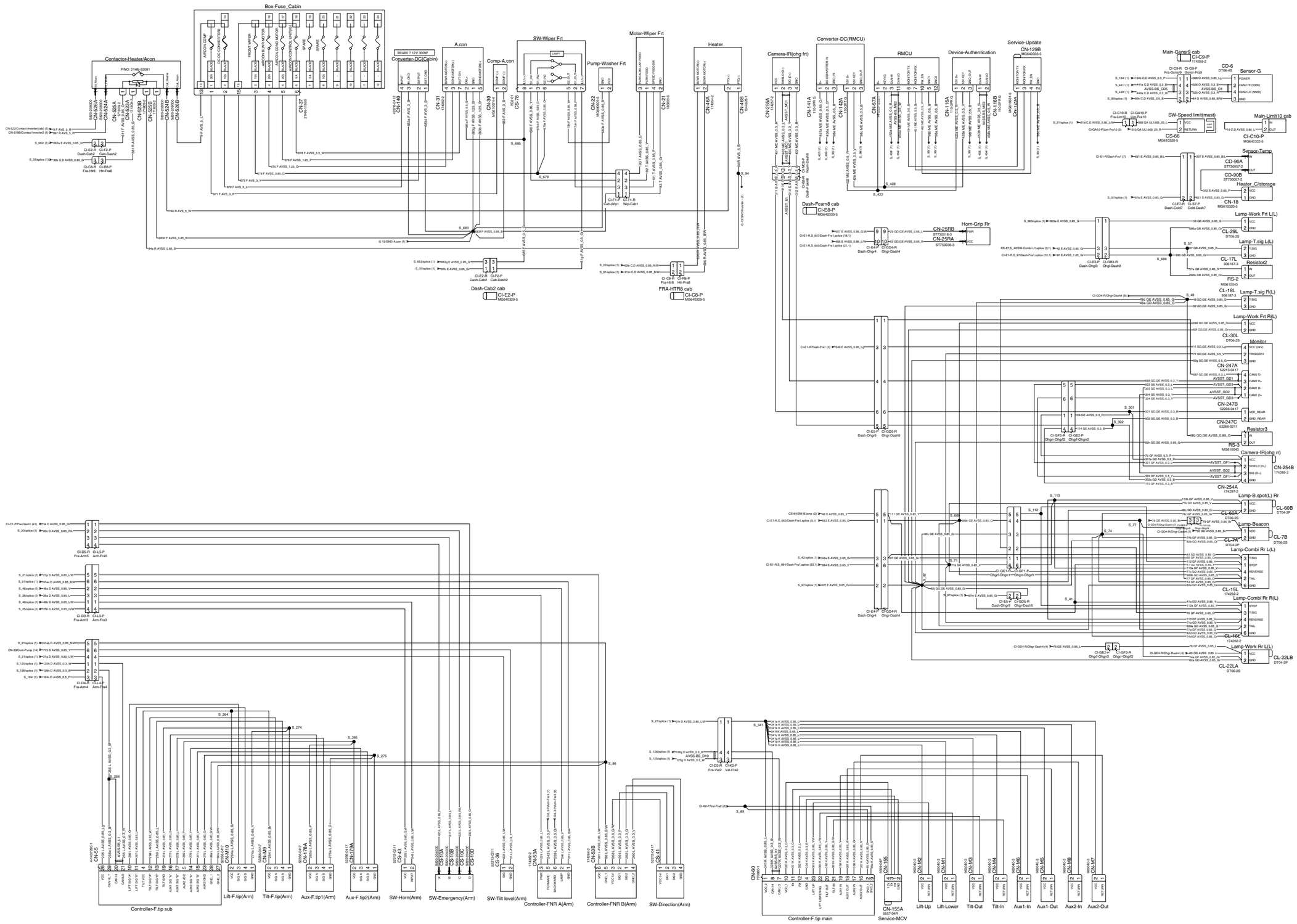
Code	Name
C	Frame harness (manual)
D	Frame harness (fingertip)
E	Dashboard harness
F	Cabin harness
GB	Overhead guard LH harness (LED)
GD	Overhead guard RH harness (LED)
GE	Overhead guard RH harness (LED, front)
GF	Overhead guard RH harness (LED, rear)
K	Main control valve harness
L	Armrest harness
MC	Front camera harness
ME	RMCU harness
O	G sensor harness
QA	Speed limit harness
R	Heater harness
S	Cold area harness
T	Wiper harness
Y	Lithium harness
ZA	Charging cable LH (Pb)
ZC	Charging cable RH (Pb)
ZE	Drive motor cable (U)
ZF	Drive motor cable (V)
ZG	Drive motor cable (W)
ZH	Pump motor cable (U)
ZJ	Pump motor cable (V)
ZK	Pump motor cable (W)

2. ELECTRIC CIRCUIT DIAGRAMS

1) INTERGRATED (1/2)

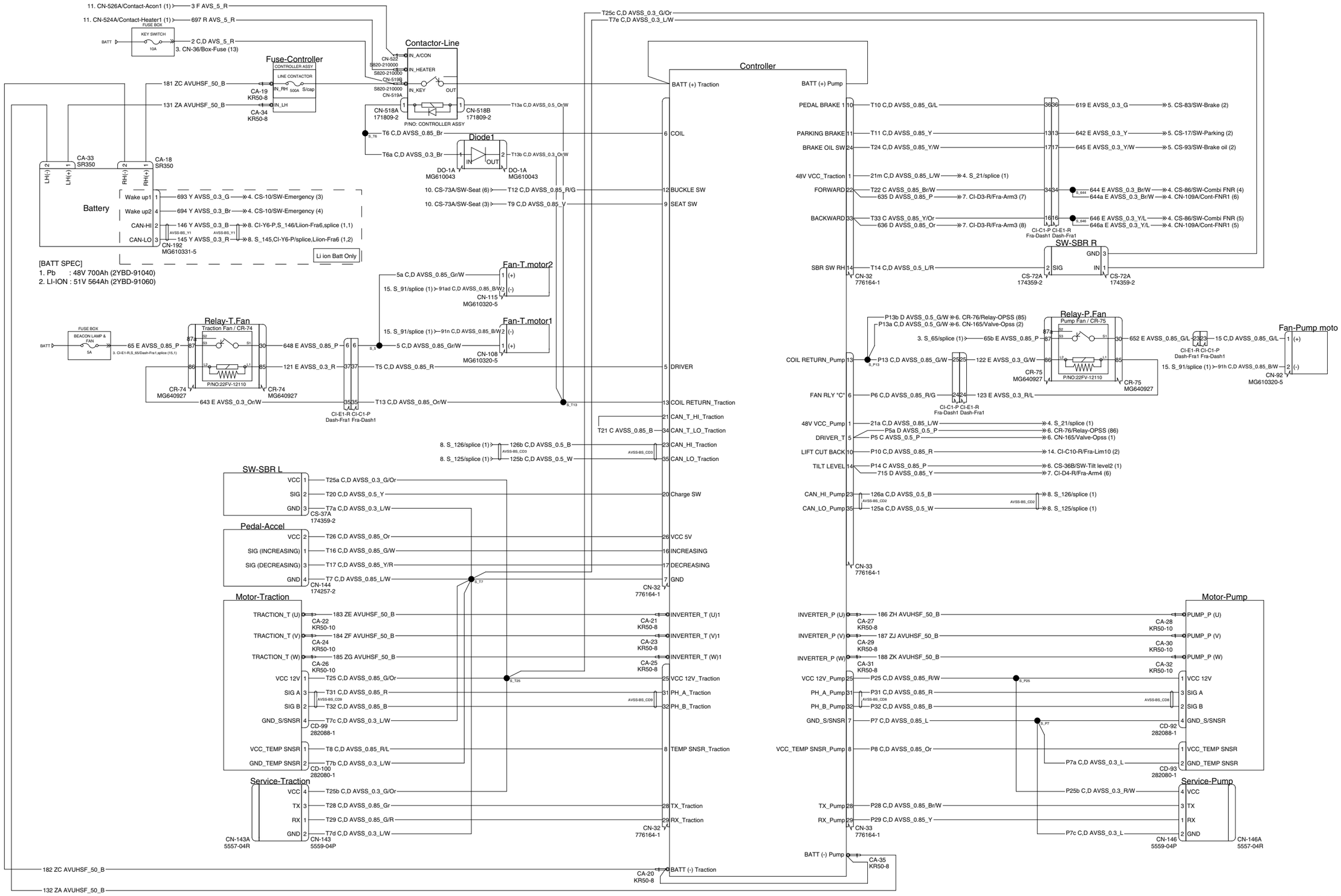


INTERGRATED (2/2)

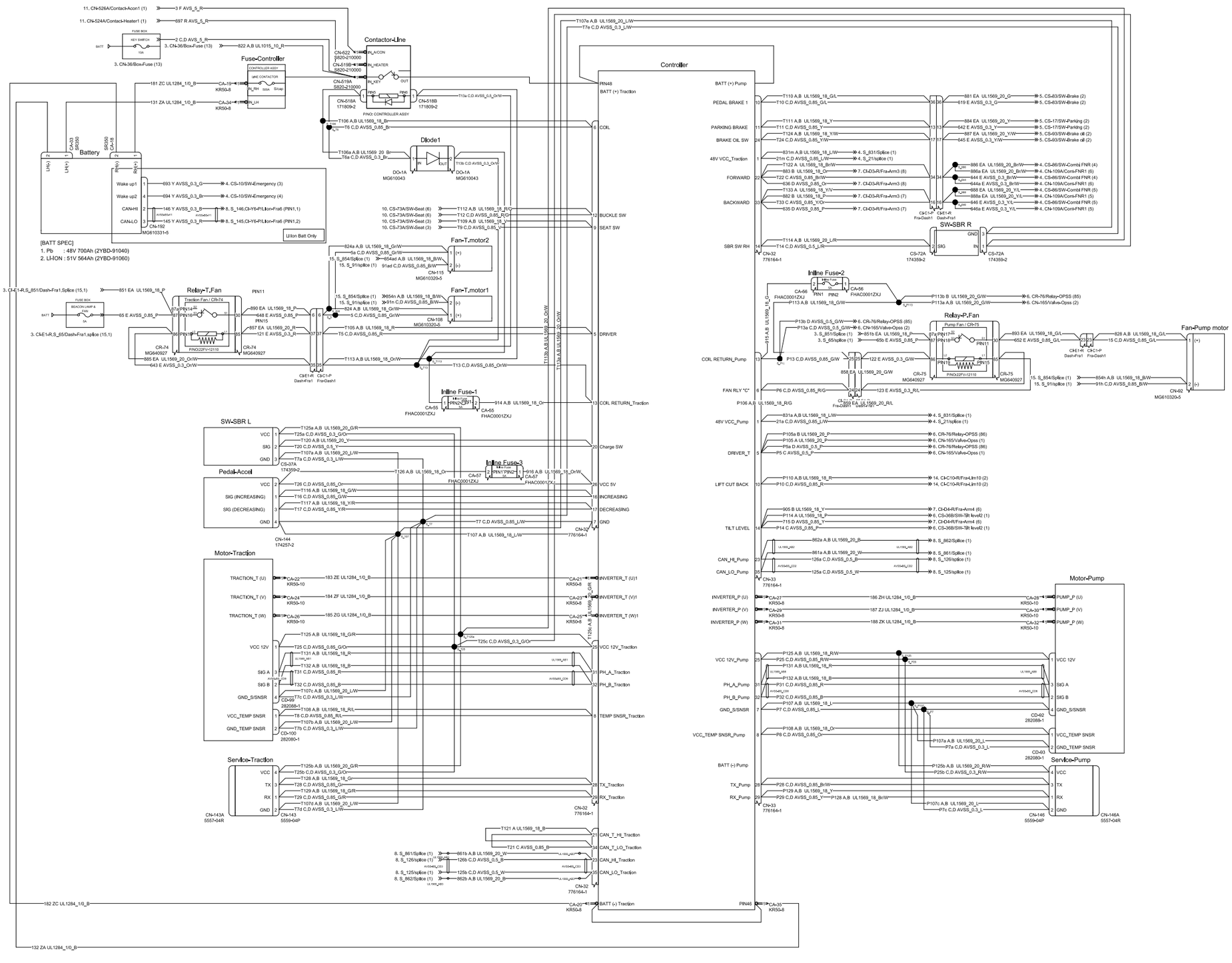


2YBD-00013-00

2) CONTROLLER, MOTOR (25B-X : -#0250, 30B-X : -#0186, 32B-X : -#0042, 35B-X : -#0087)

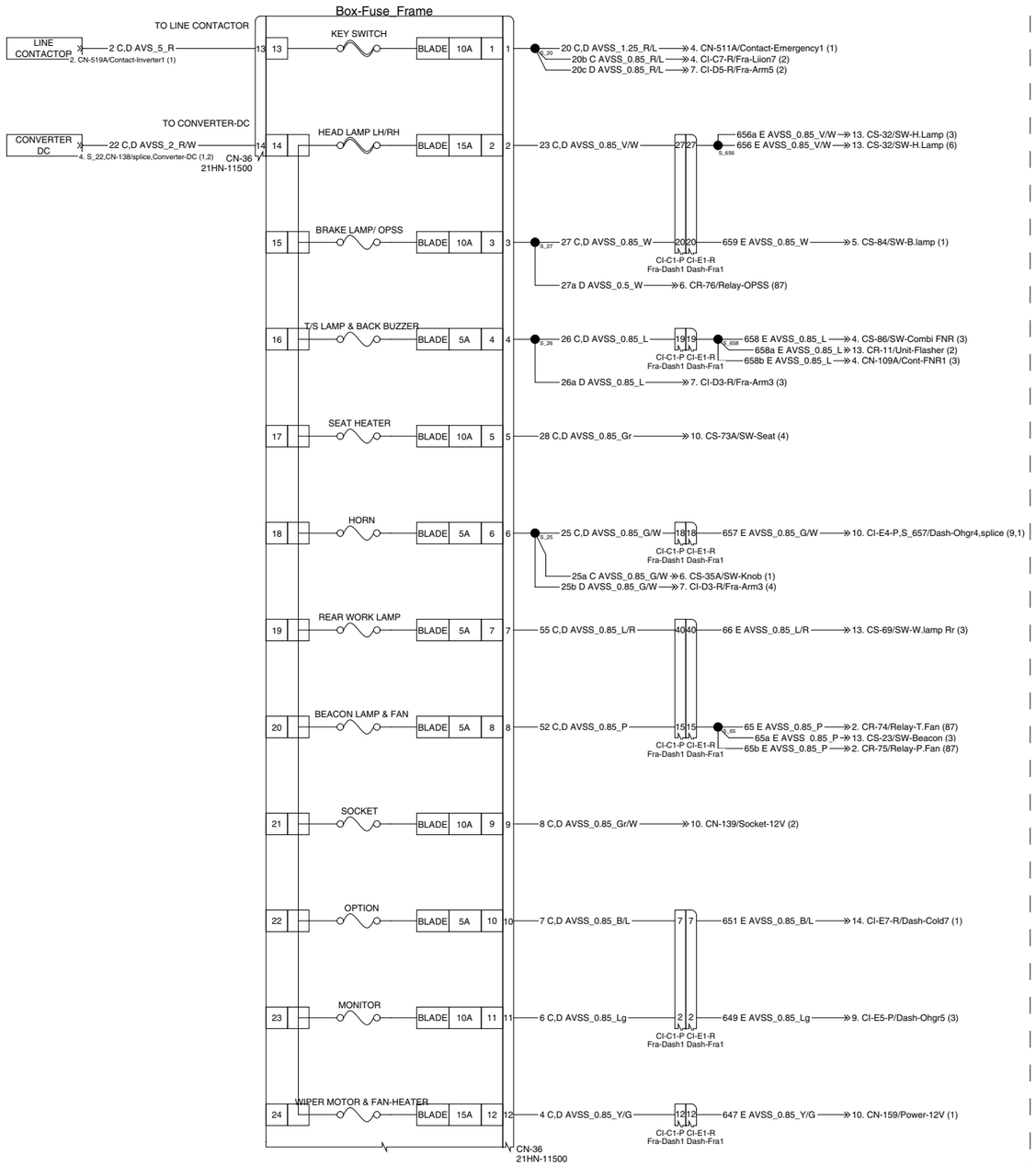


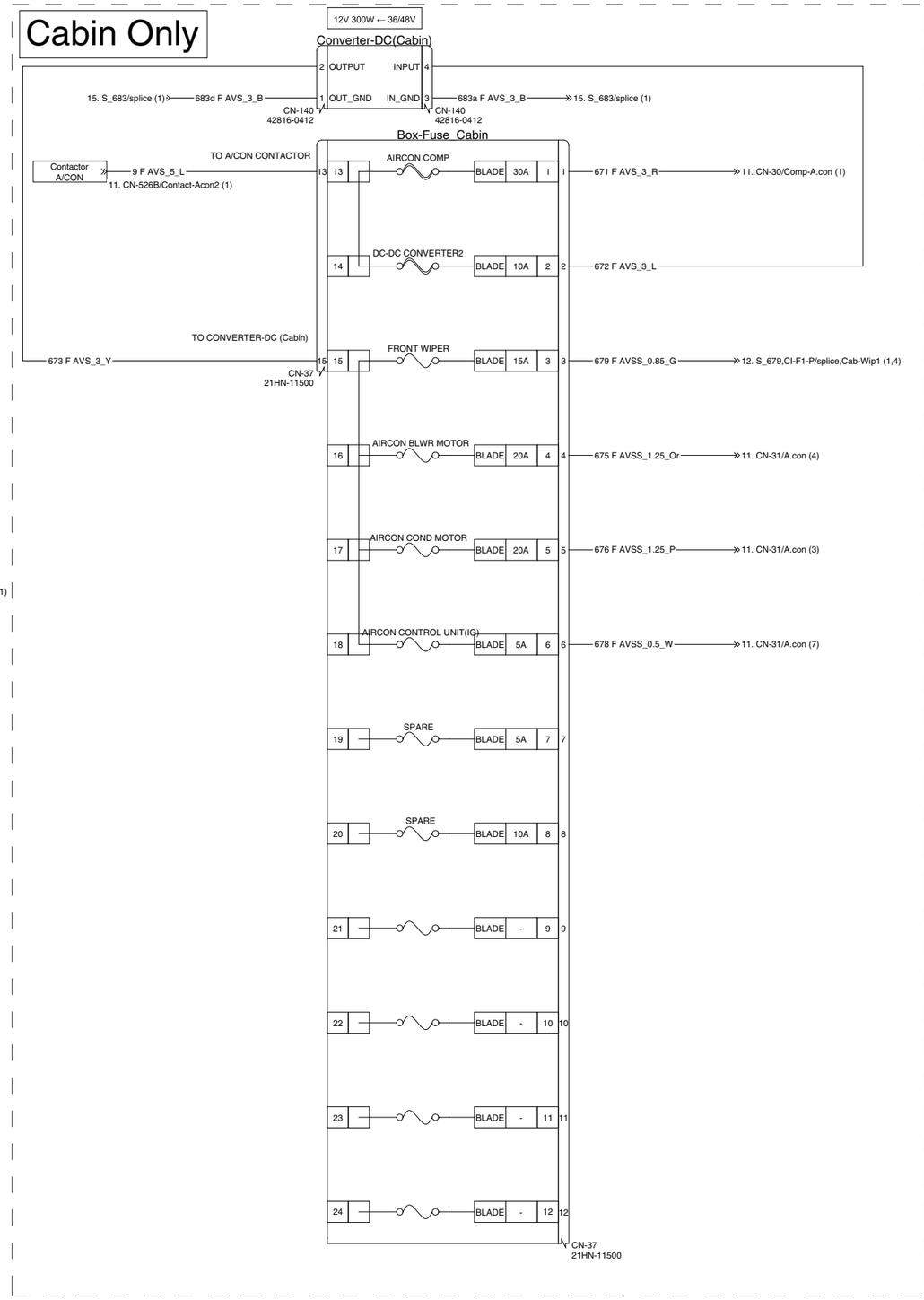
CONTROLLER, MOTOR (25B-X : #0251-, 30B-X : #0187-, 32B-X : #0043-, 35B-X : #0088-)



2YBD-00014-00-2

3) FUSE BOX (25B-X : -#0250, 30B-X : -#0186, 32B-X : -#0042, 35B-X : -#0087)





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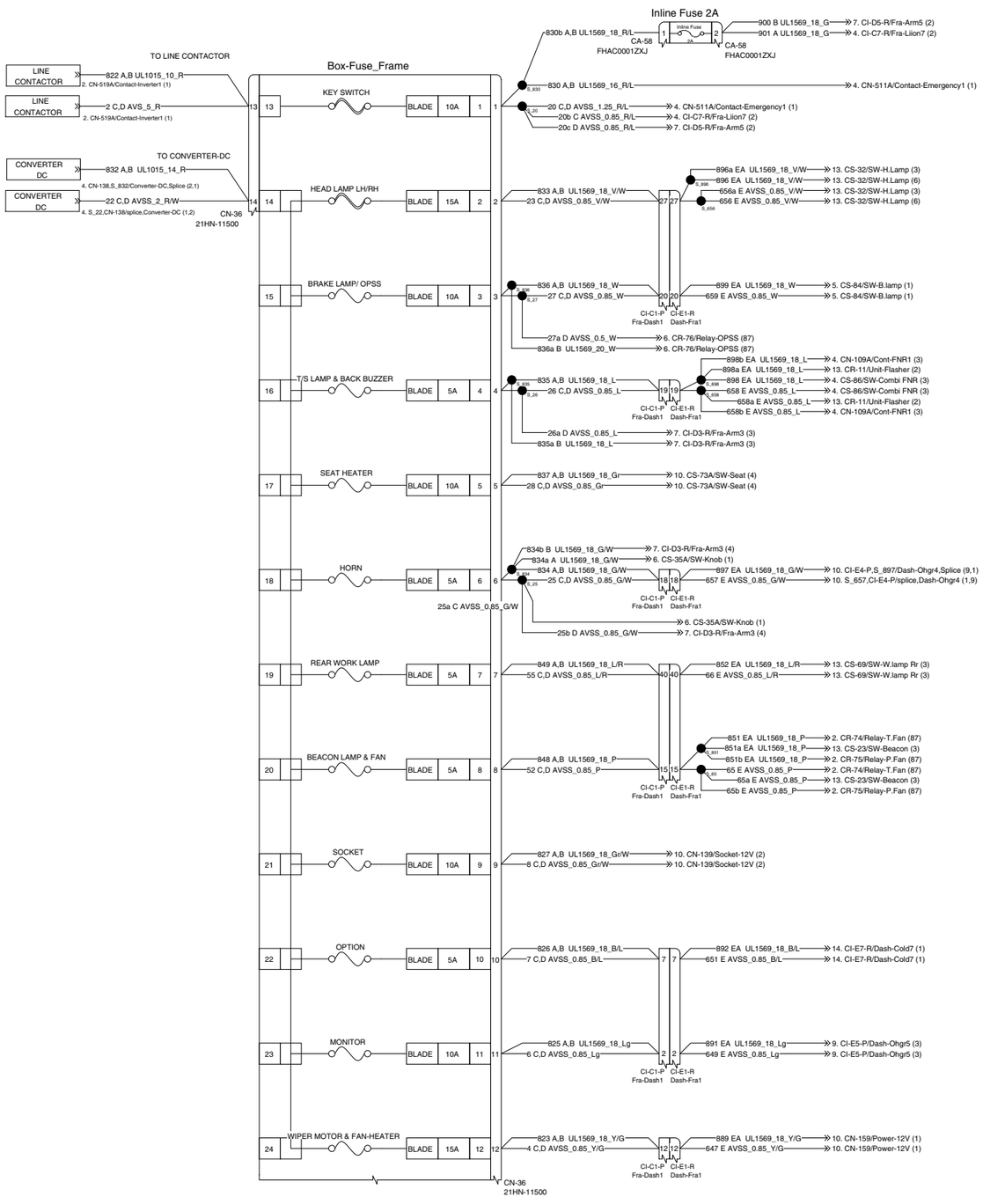
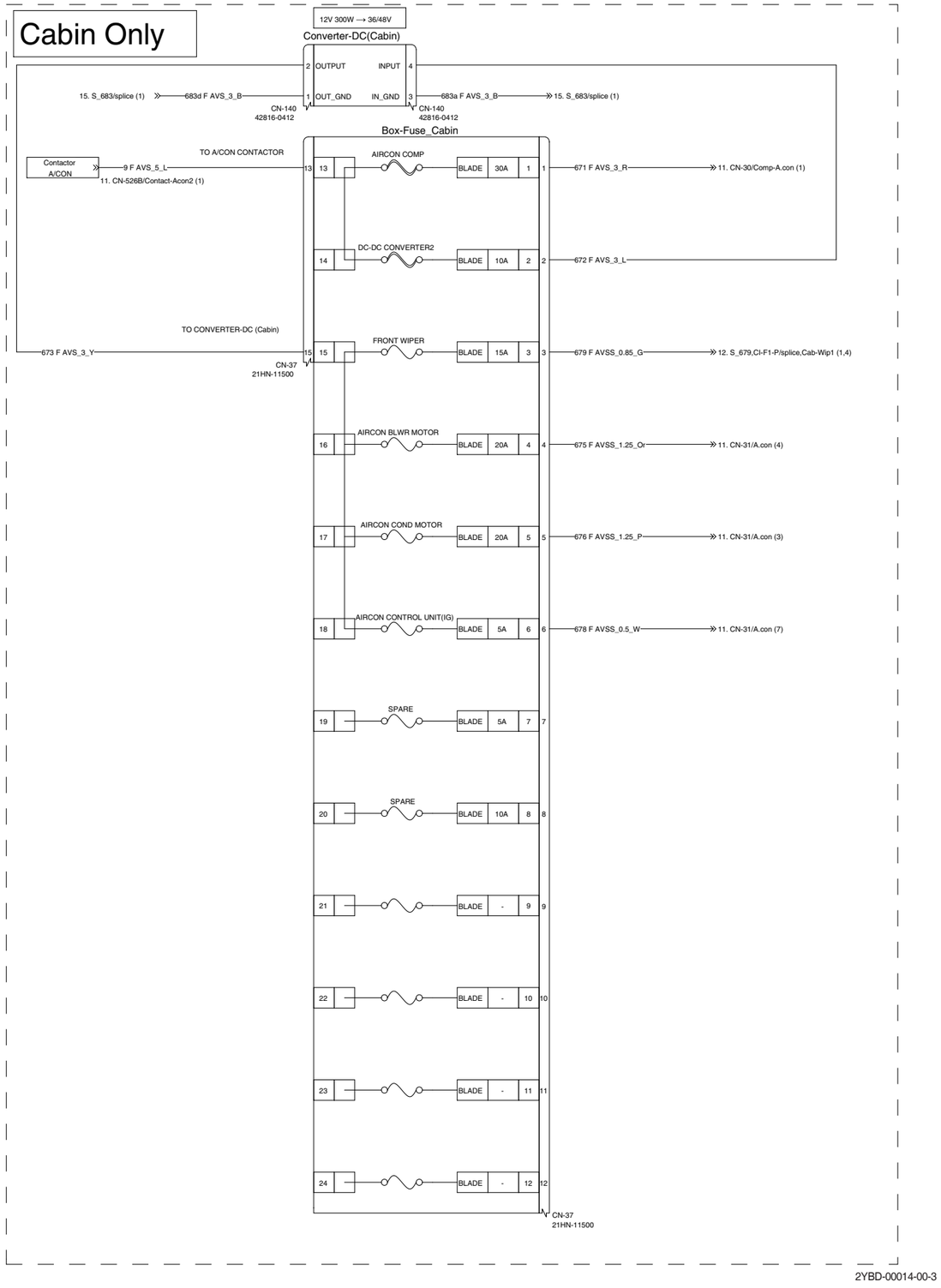
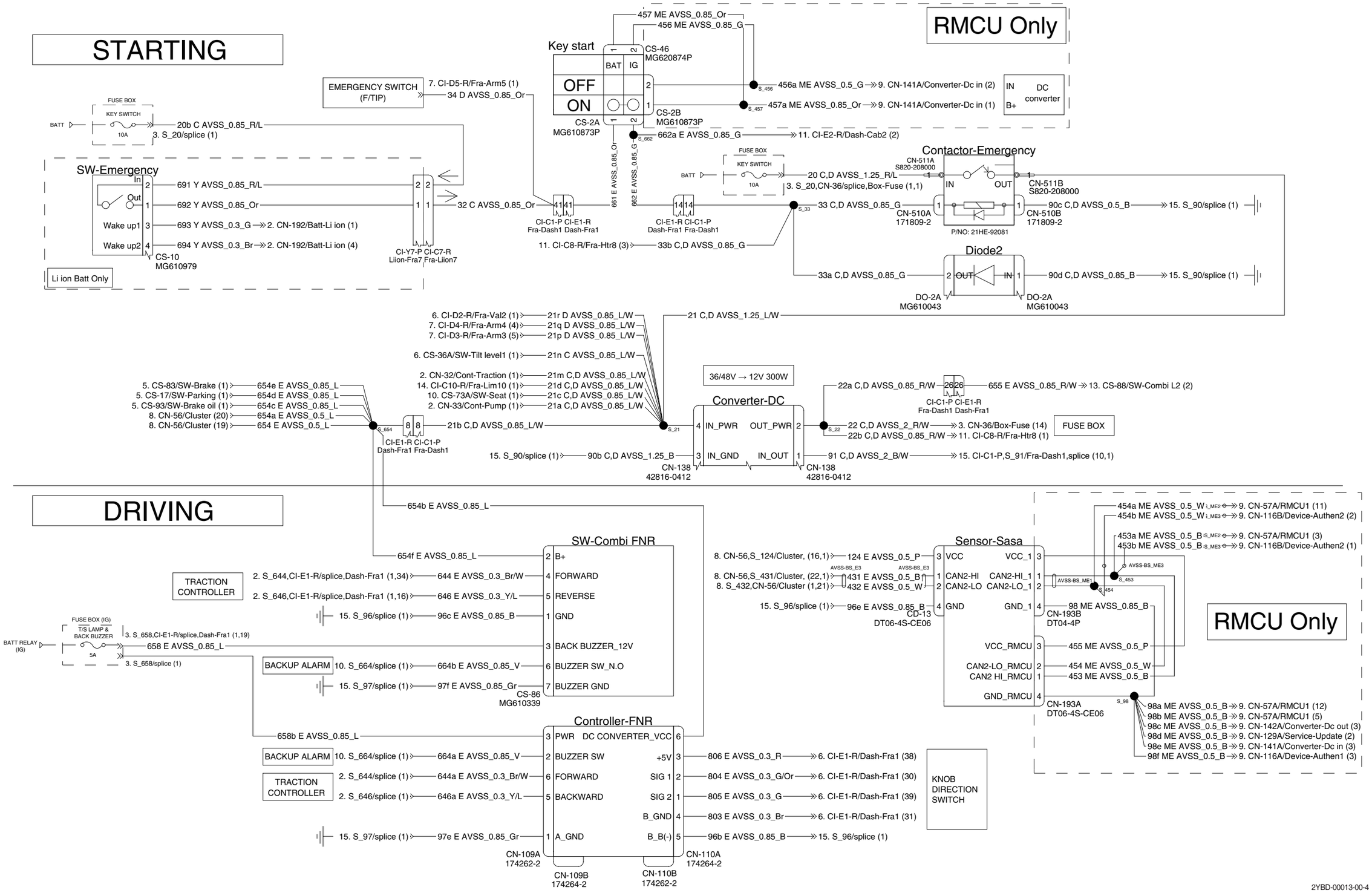
FUSE BOX (25B-X : #0251-, 30B-X : #0187-, 32B-X : #0043-, 35B-X : #0088-)



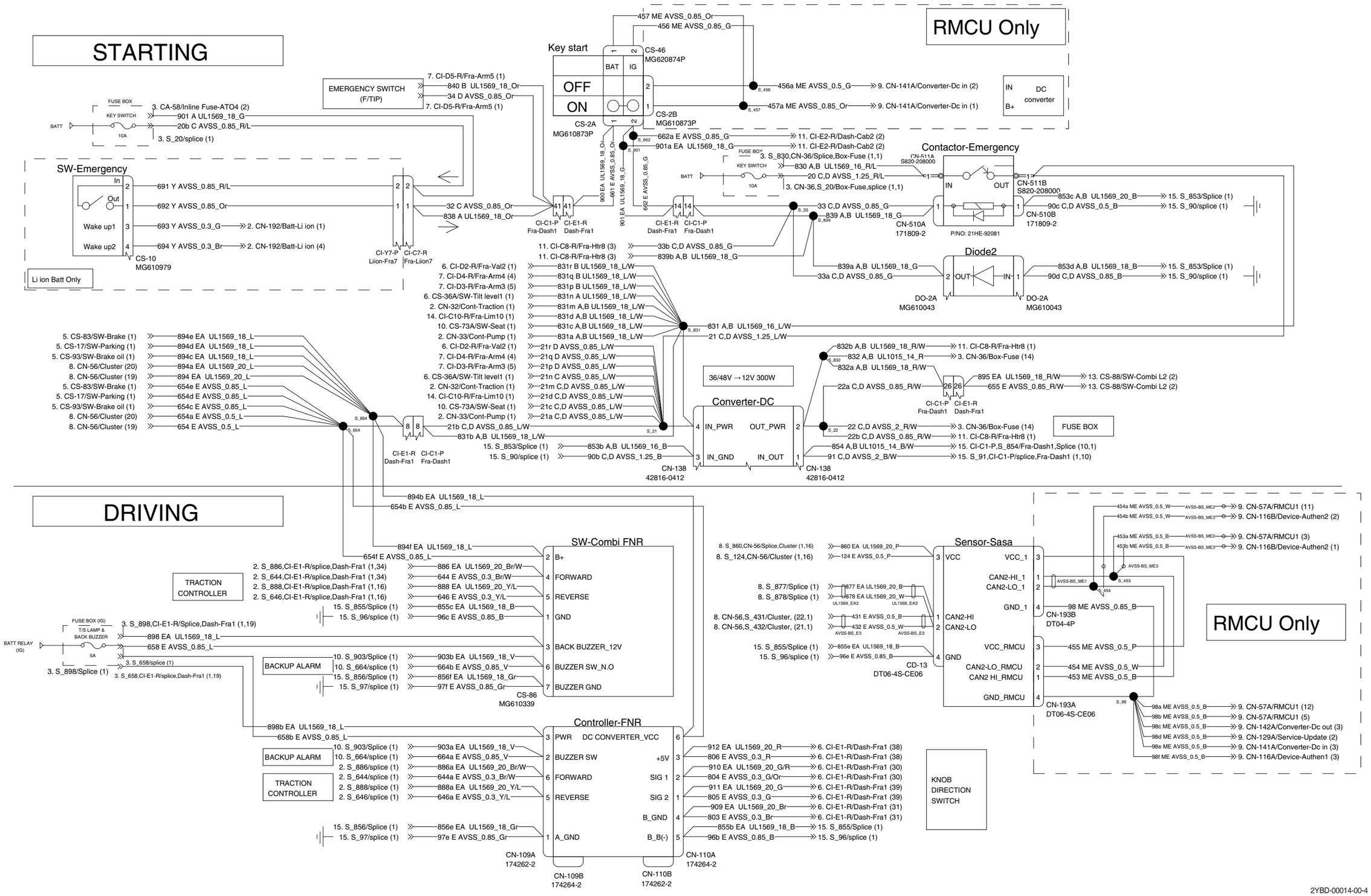


2YBD-00014-00-3

4) START, DRIVE (25B-X : -#0250, 30B-X : -#0186, 32B-X : -#0042, 35B-X : -#0087)

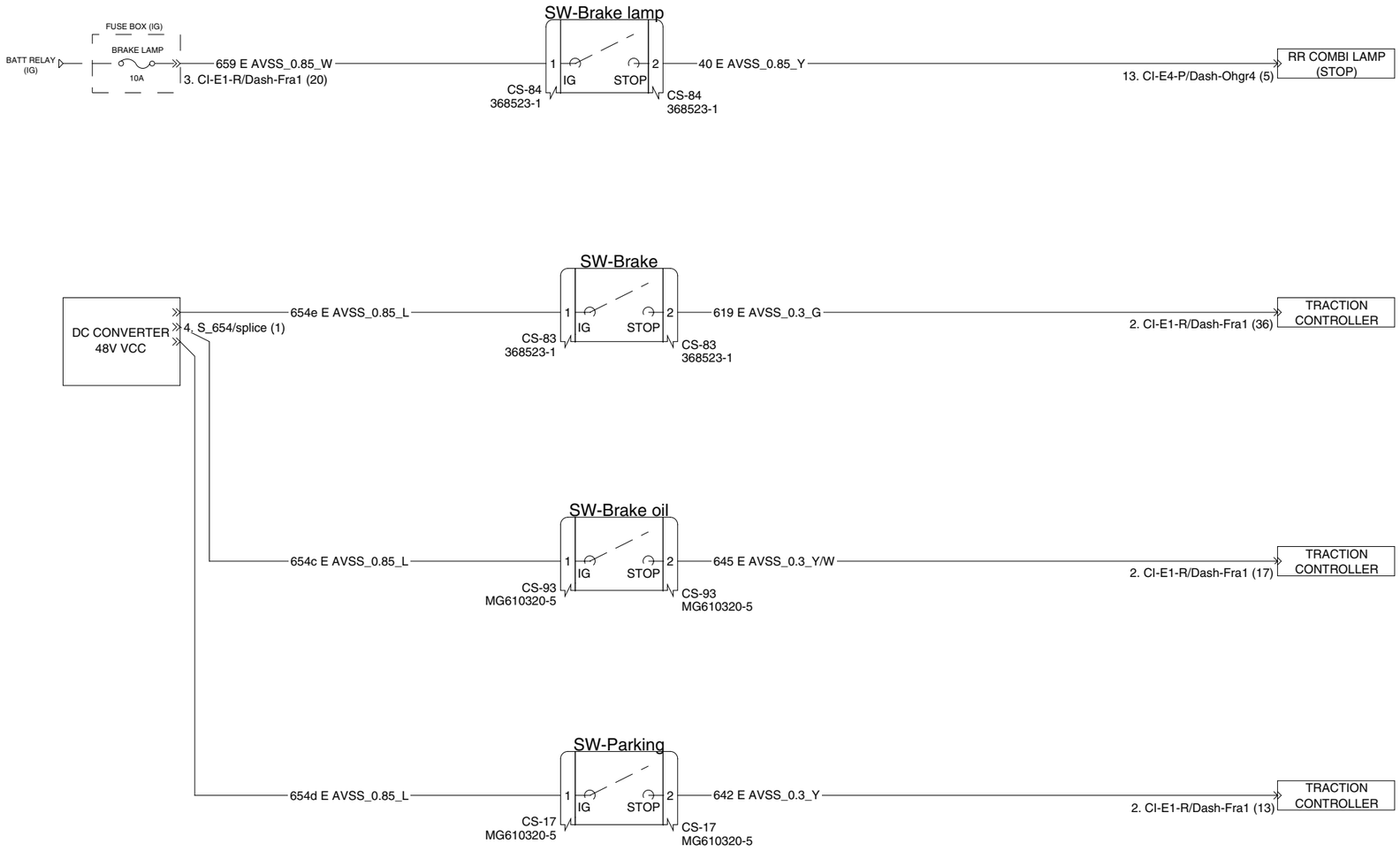


START, DRIVE (25B-X : #0251-, 30B-X : #0187-, 32B-X : #0043-, 35B-X : #0088-)



2YBD-00014-00-4

5) PARKING, BRAKES (25B-X : -#0250, 30B-X : -#0186, 32B-X : -#0042, 35B-X : -#0087)



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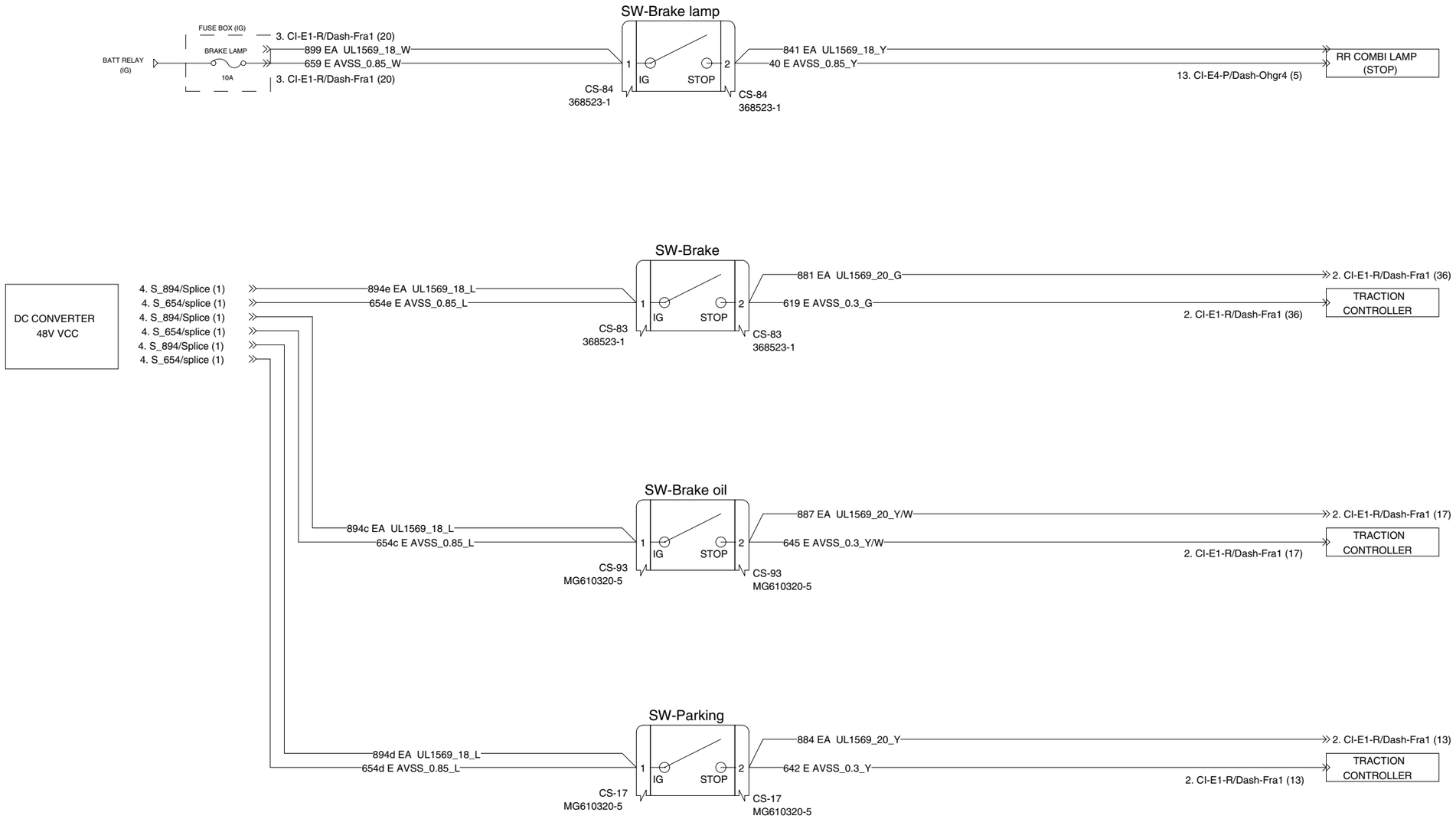
PARKING, BRAKES (25B-X : #0251-, 30B-X : #0187-, 32B-X : #0043-, 35B-X : #0088-)

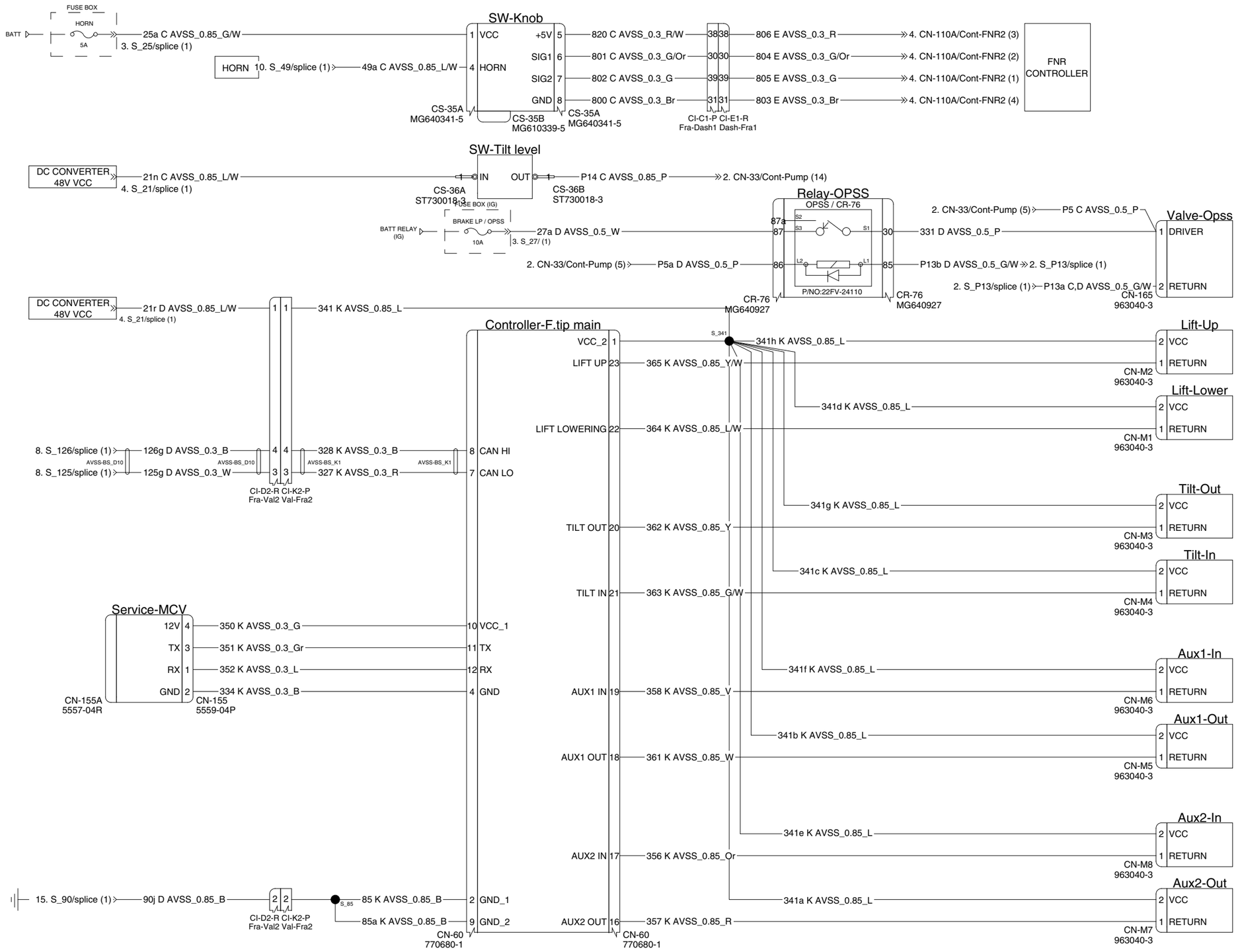


2YBD-00014-00-5

6) F/TIP, MCV (25B-X : -#0250, 30B-X : -#0186, 32B-X : -#0042, 35B-X : -#0087)

MANUAL

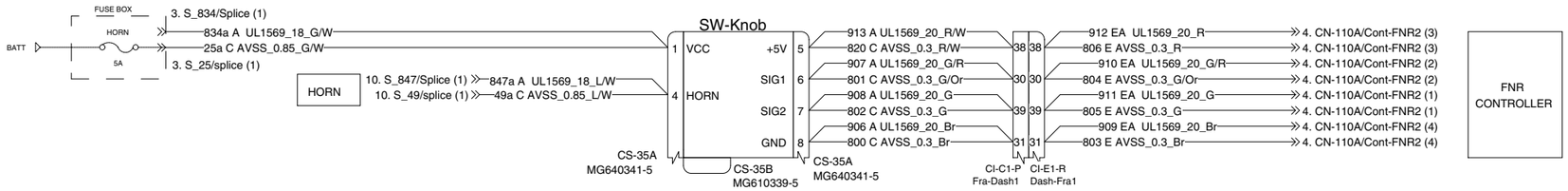
F/TIP



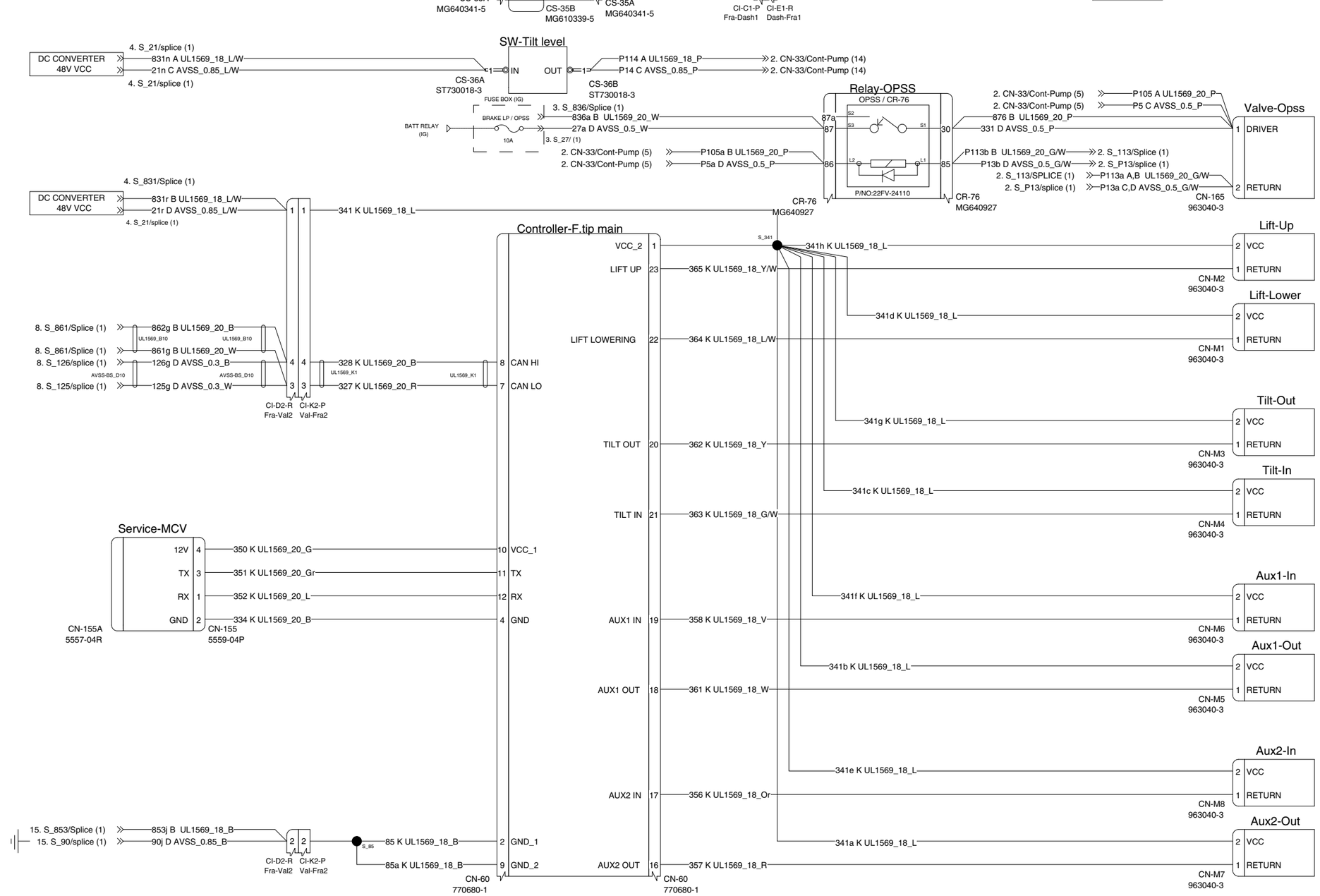
2YBD-00013-00-6

F/TIP, MCV (25B-X : #0251-, 30B-X : #0187-, 32B-X : #0043-, 35B-X : #0088-)

MANUAL

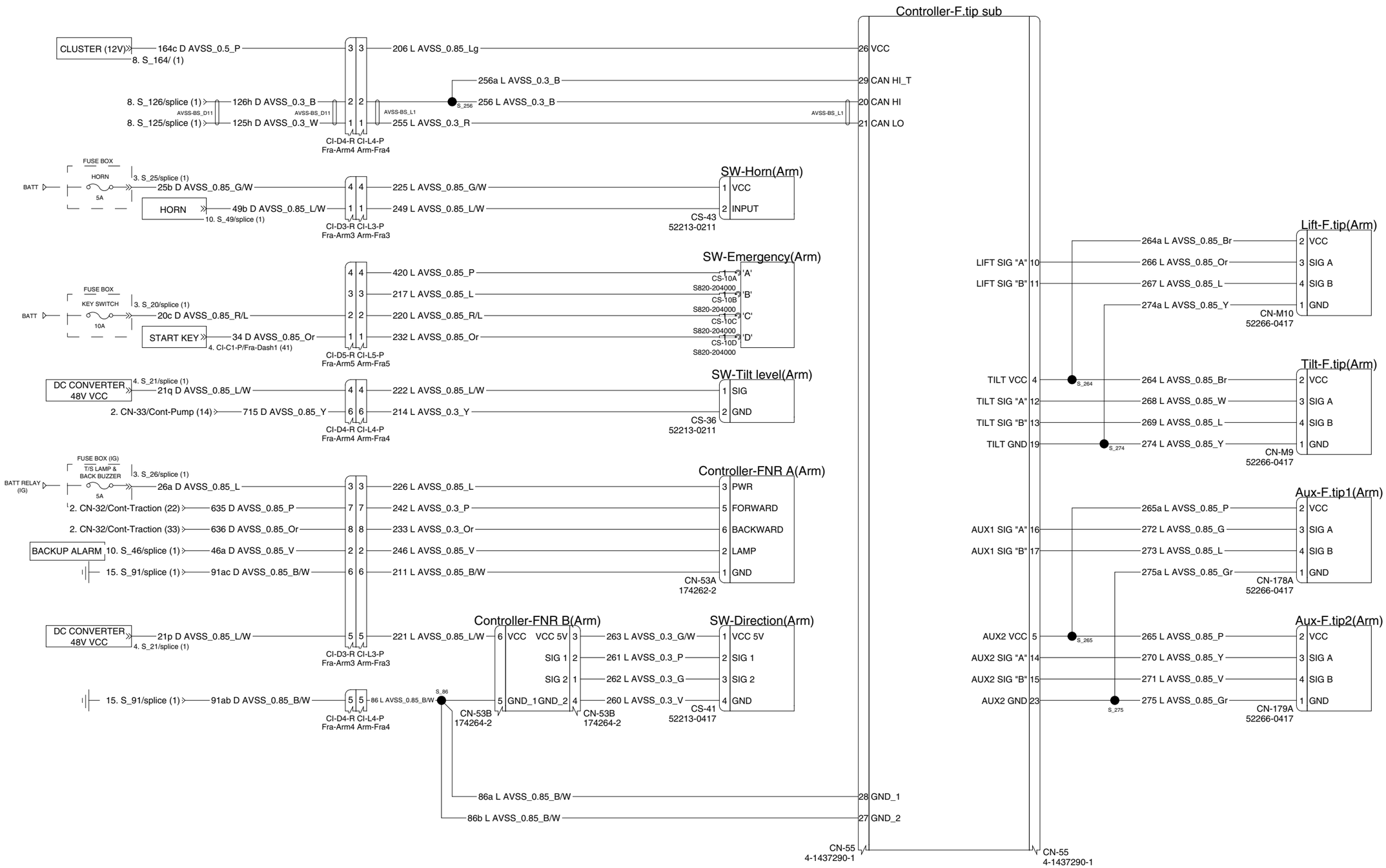


F/TIP



2YBD-00014-00-6

7) F/TIP-ARMREST (25B-X : -#0250, 30B-X : -#0186, 32B-X : -#0042, 35B-X : -#0087)



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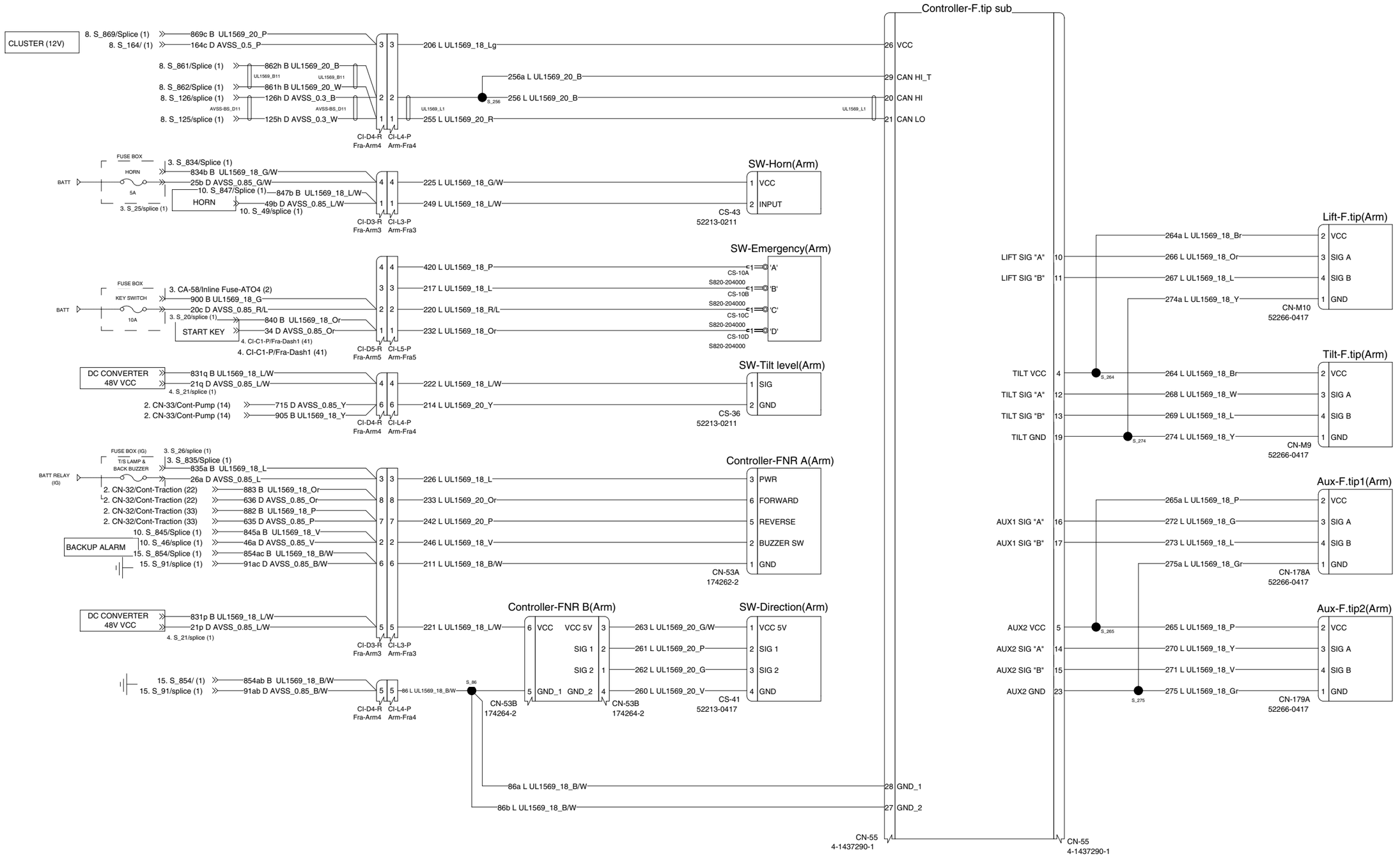
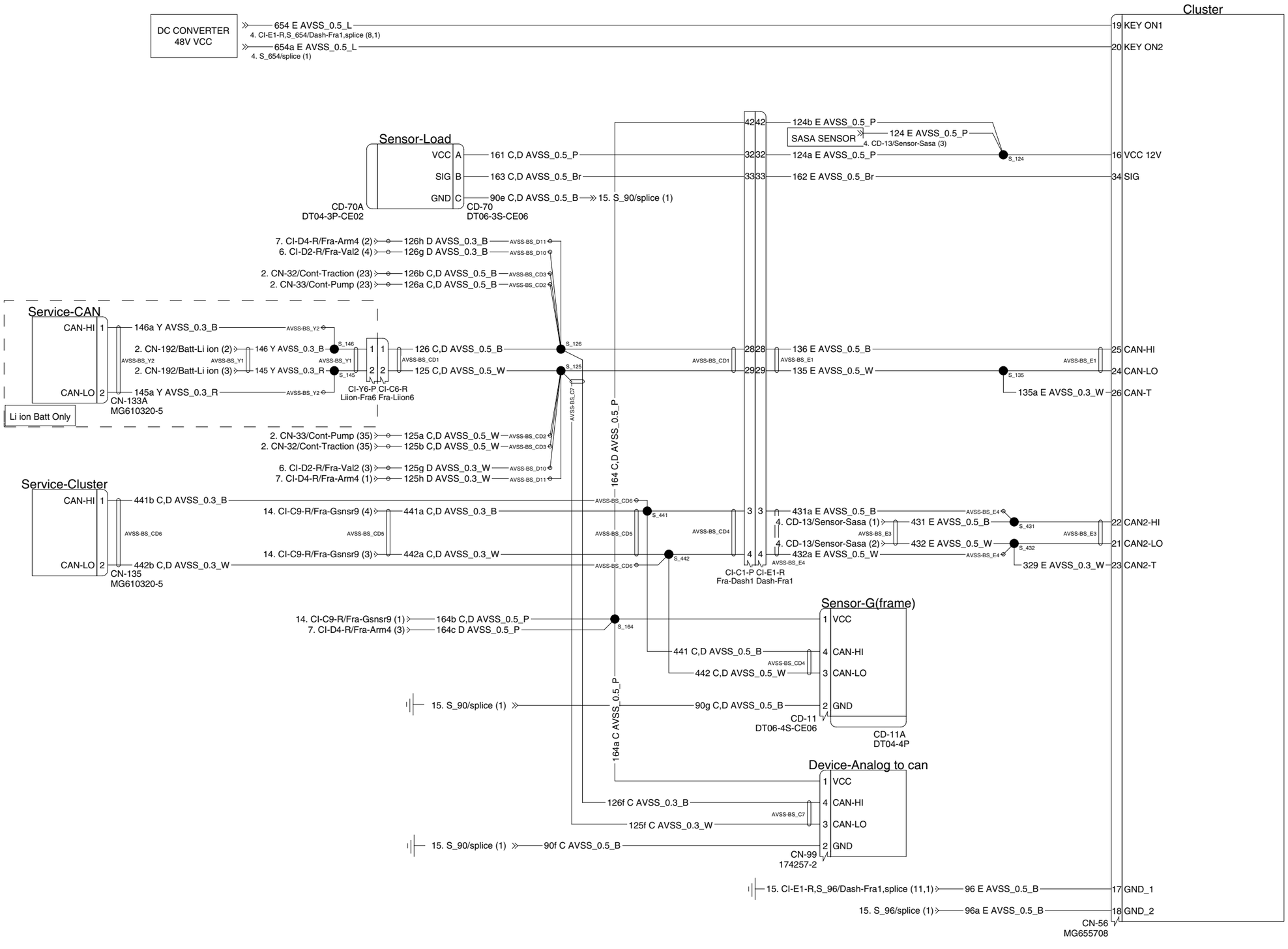
F/TIP-ARMREST (25B-X : #0251-, 30B-X : #0187-, 32B-X : #0043-, 35B-X : #0088-)



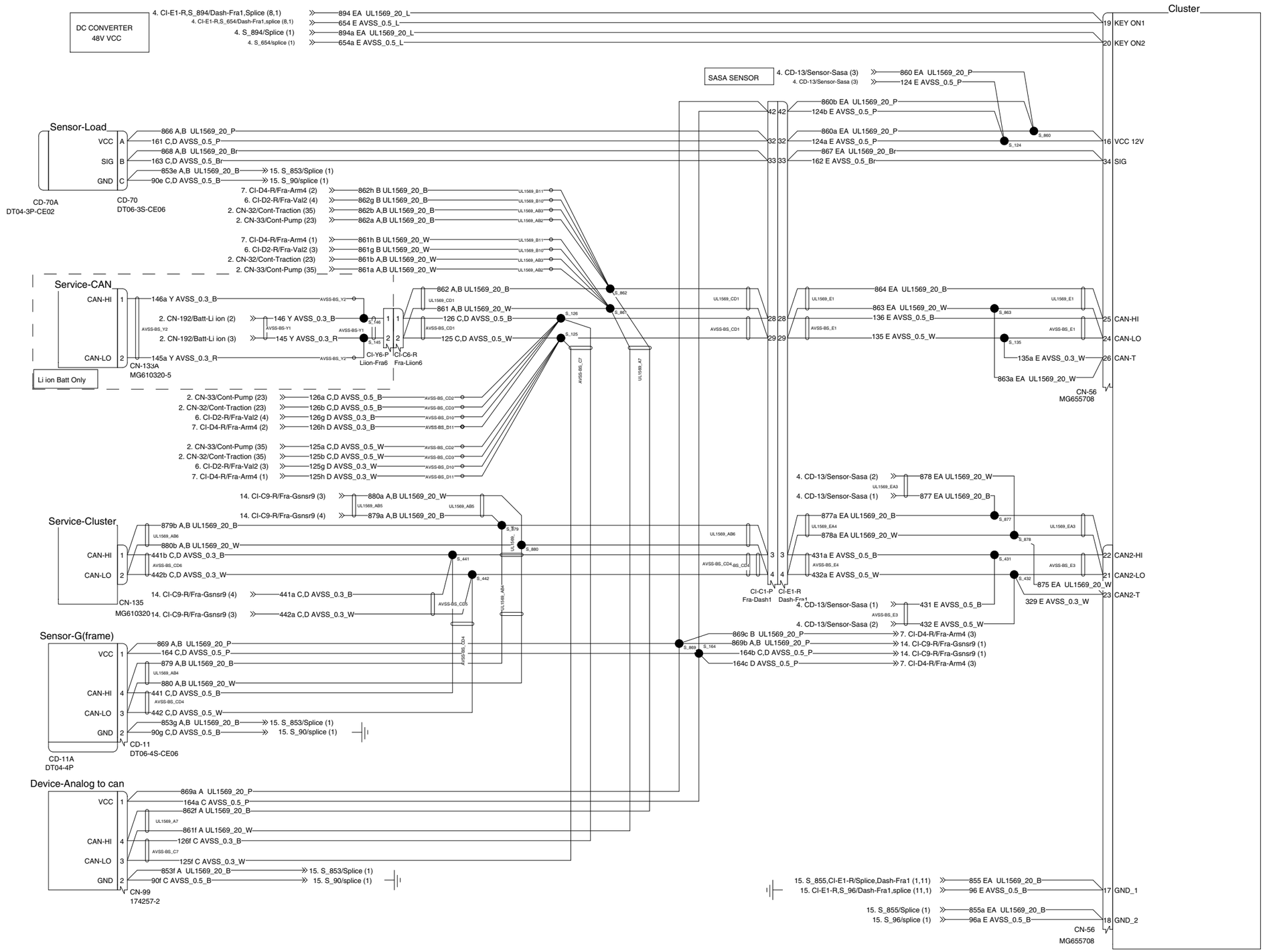
2YBD-00014-00-7

8) CLUSTER, SENSOR (25B-X : -#0250, 30B-X : -#0186, 32B-X : -#0042, 35B-X : -#0087)



2YBD-00013-00-8

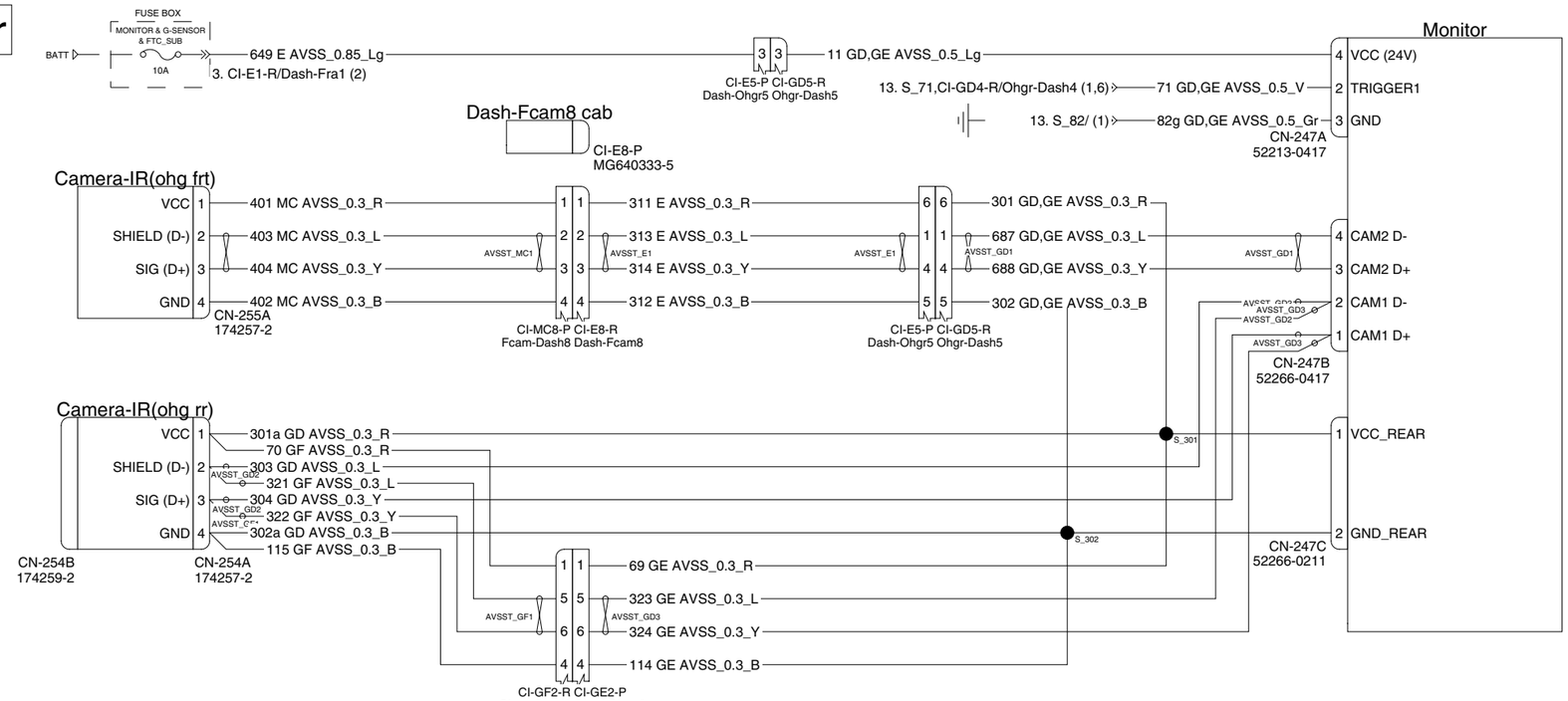
CLUSTER, SENSOR (25B-X : #0251-, 30B-X : #0187-, 32B-X : #0043-, 35B-X : #0088-)



2YBD-00014-00-8

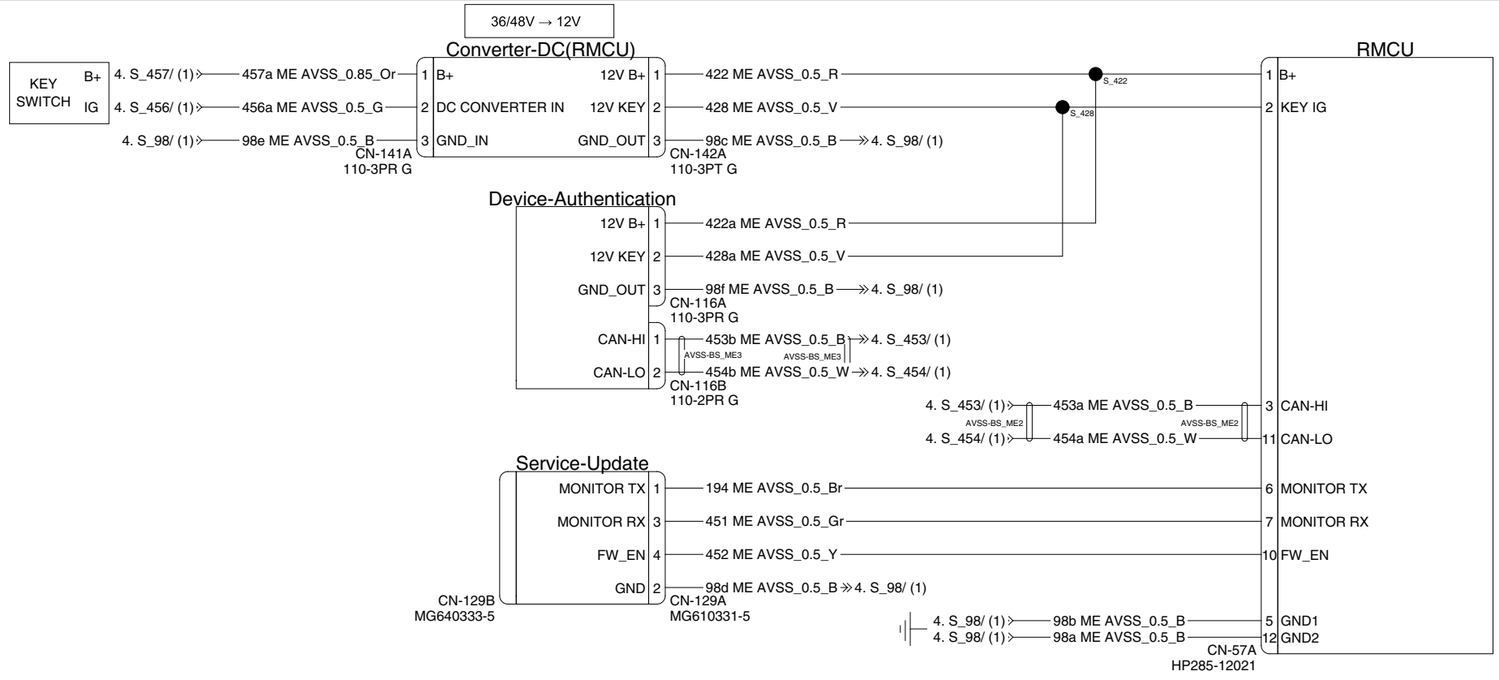
9) CAMERA, MONITOR, FMS (25B-X : -#0250, 30B-X : -#0186, 32B-X : -#0042, 35B-X : -#0087)

Camera,Monitor



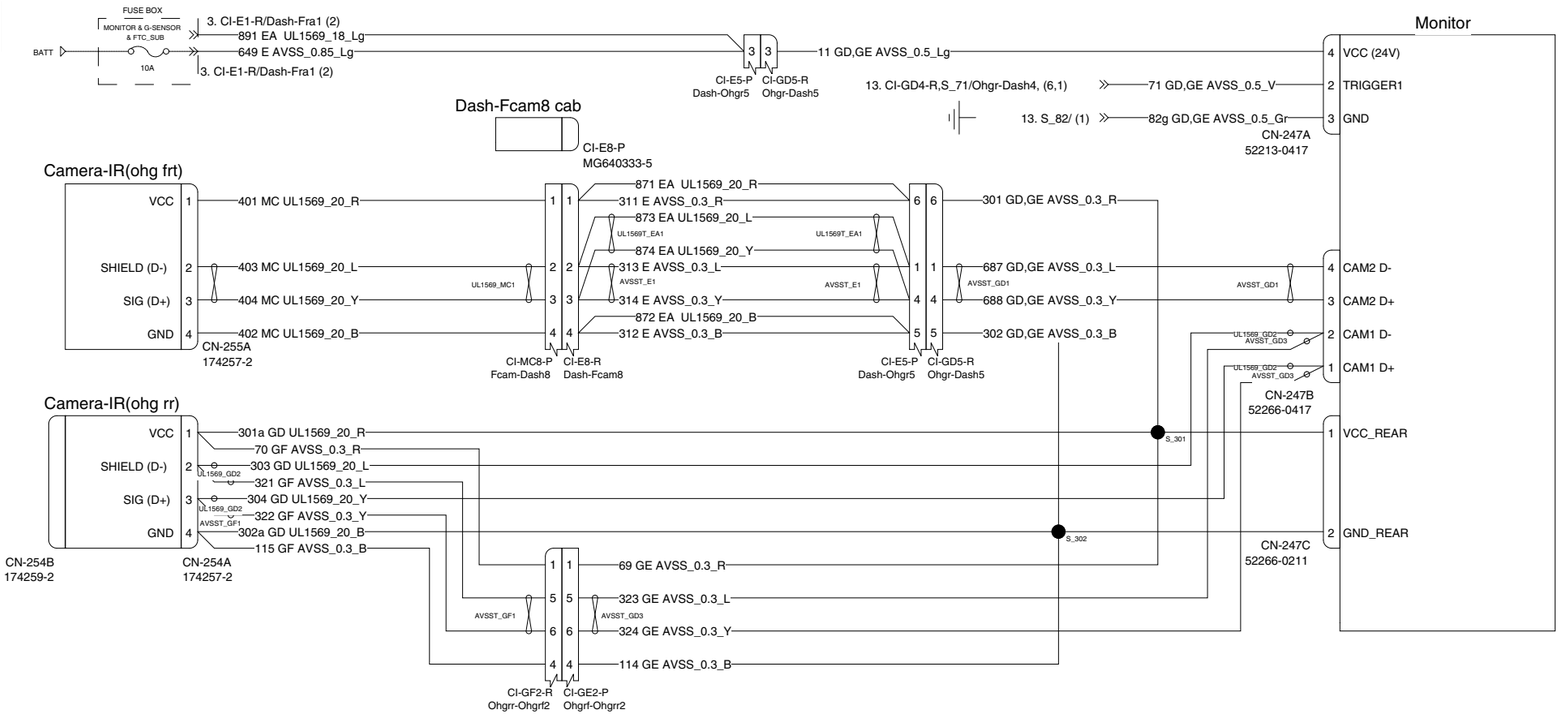
Ohgrr-Ohgrf2 Ohgrf-Ohgrr2

RMCU

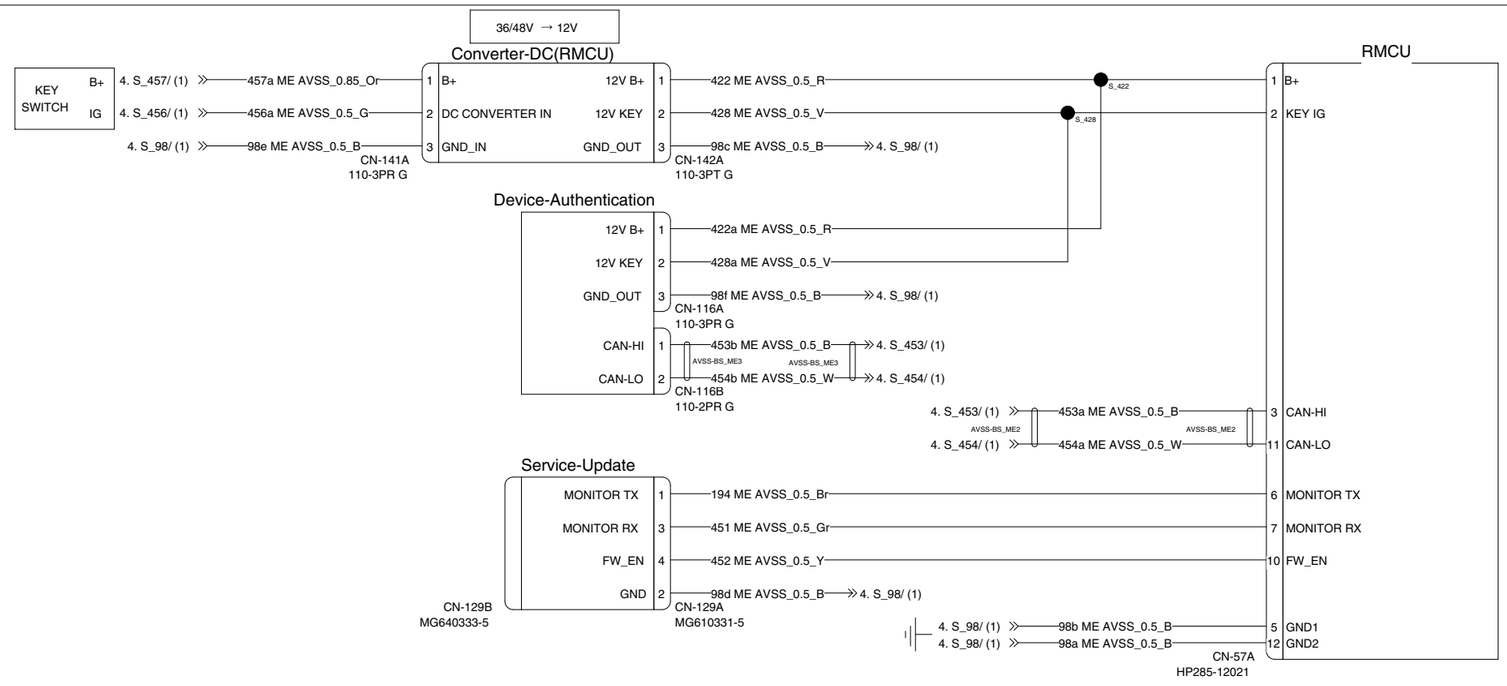


2YBD-00013-00-9

Camera,Monitor



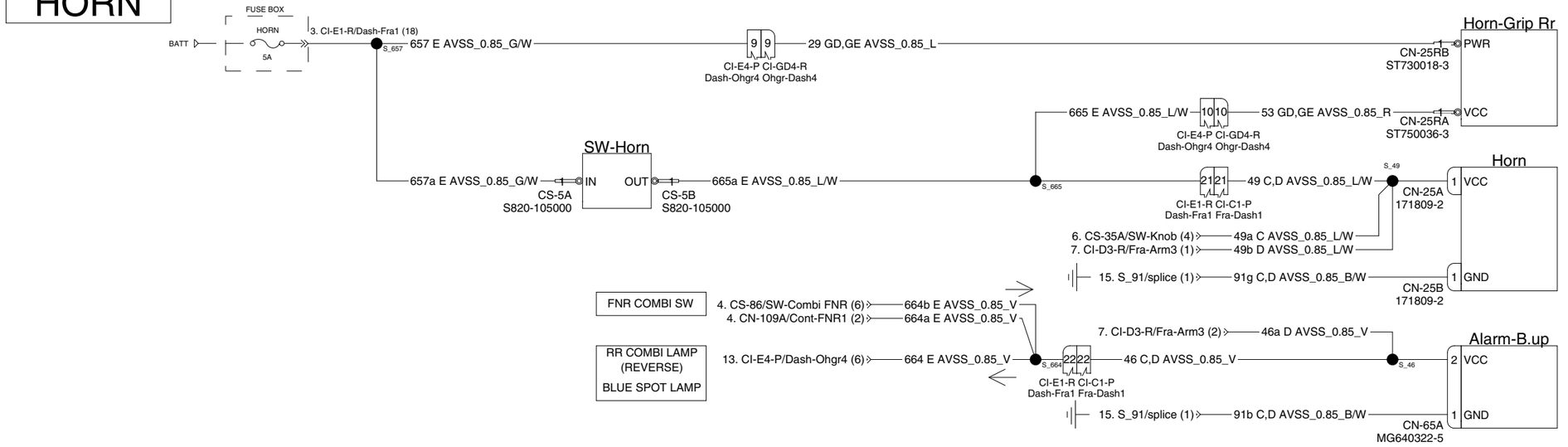
RMCU



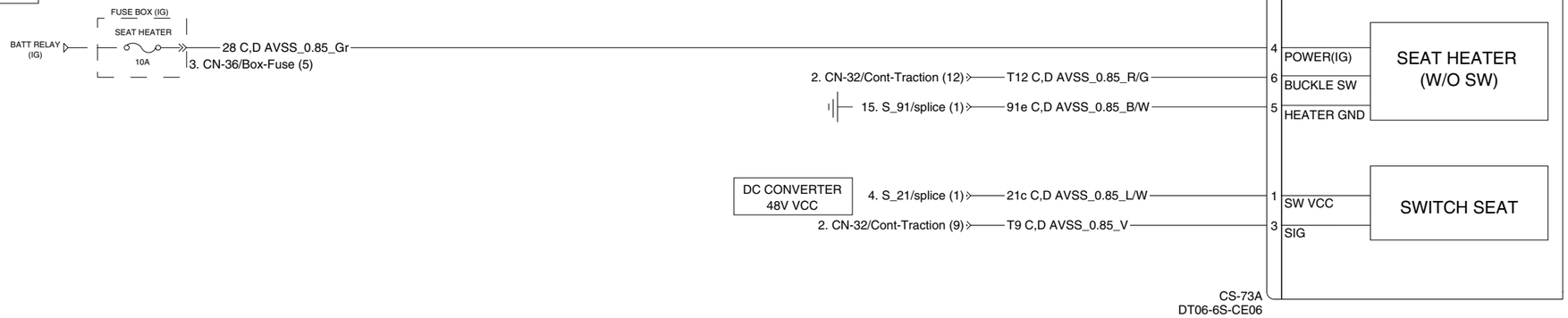
2YBD-00014-00-9

10) HORN, SEAT, SOCKET (25B-X : -#0250, 30B-X : -#0186, 32B-X : -#0042, 35B-X : -#0087)

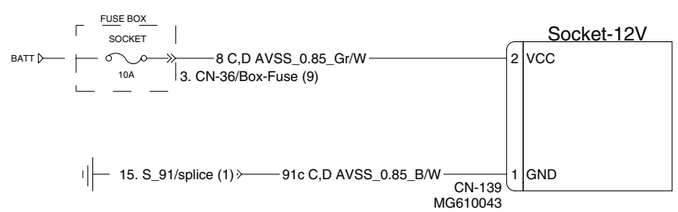
HORN



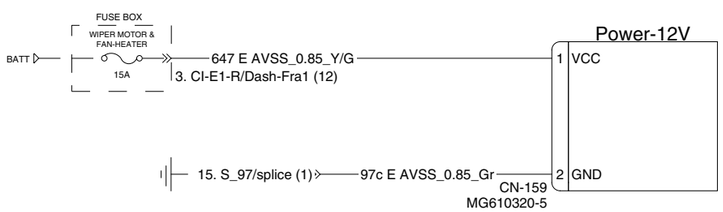
SEAT



12V SOCKET



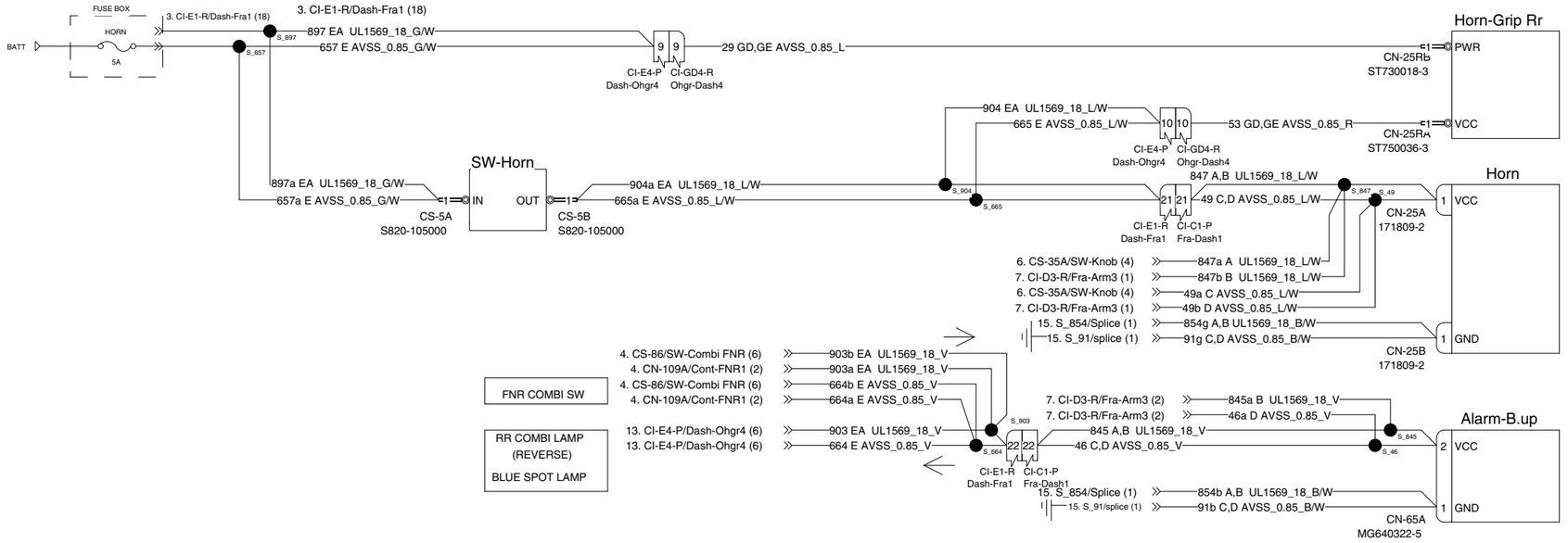
12V POWER (User)



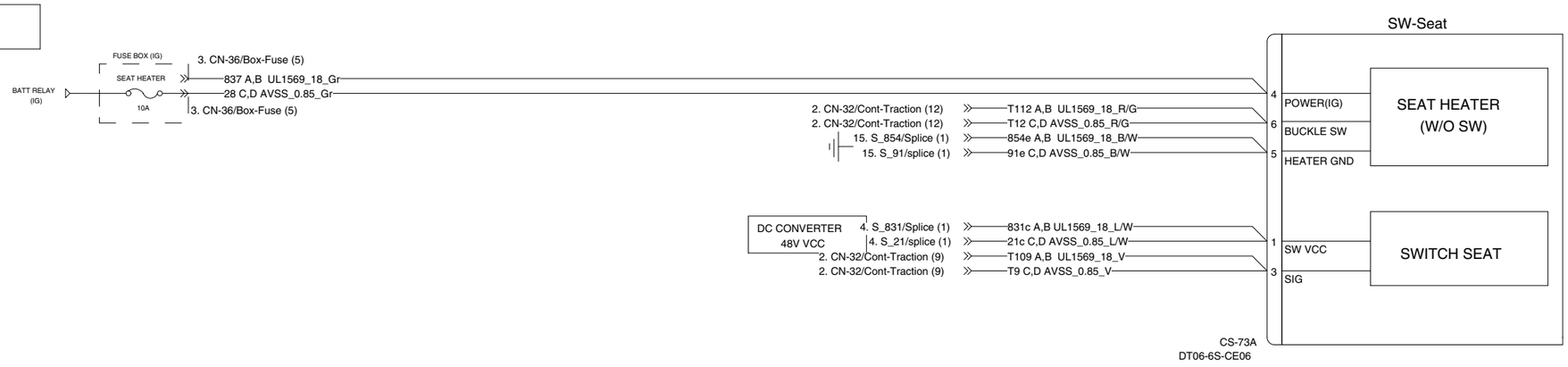
2YBD-00013-00-10

HORN, SEAT, SOCKET (25B-X : #0251-, 30B-X : #0187-, 32B-X : #0043-, 35B-X : #0088-)

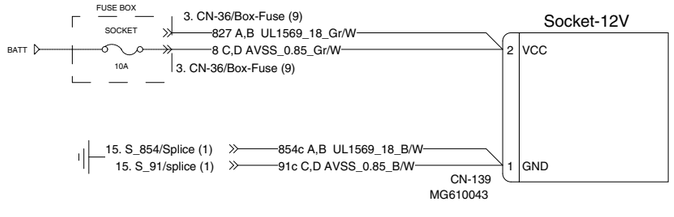
HORN



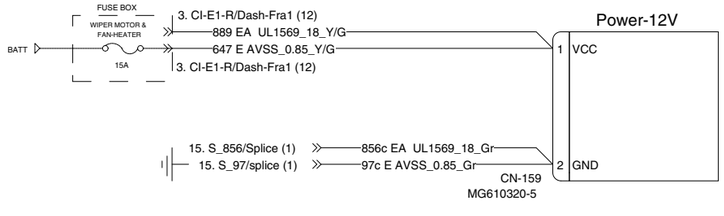
SEAT



12V SOCKET



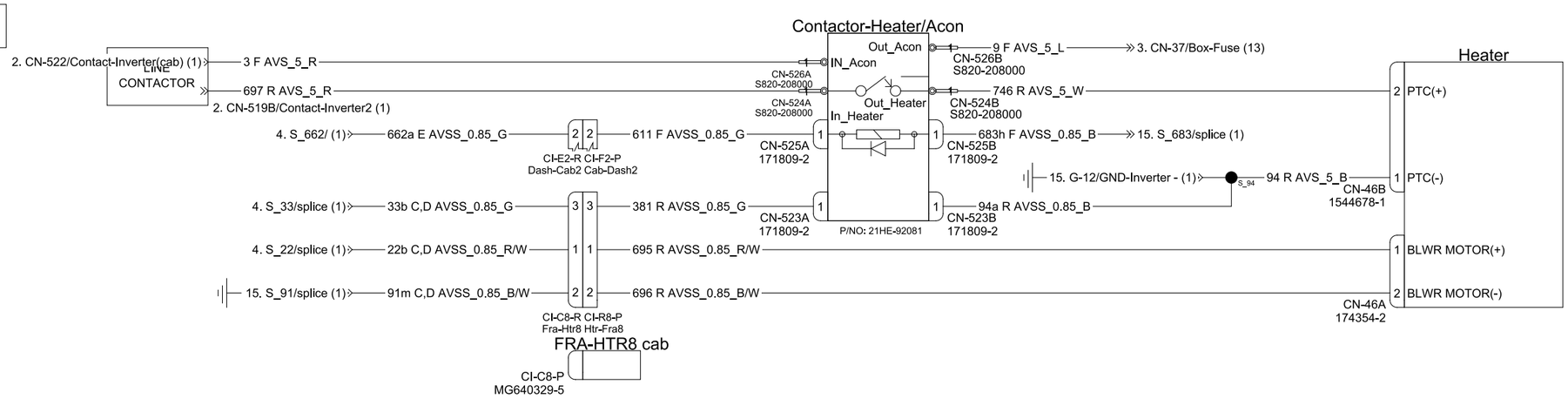
12V POWER (User)



2YBD-00014-00-10

11) HEATER, AIR-CONDITIONER (25B-X : -#0250, 30B-X : -#0186, 32B-X : -#0042, 35B-X : -#0087)

HEATER

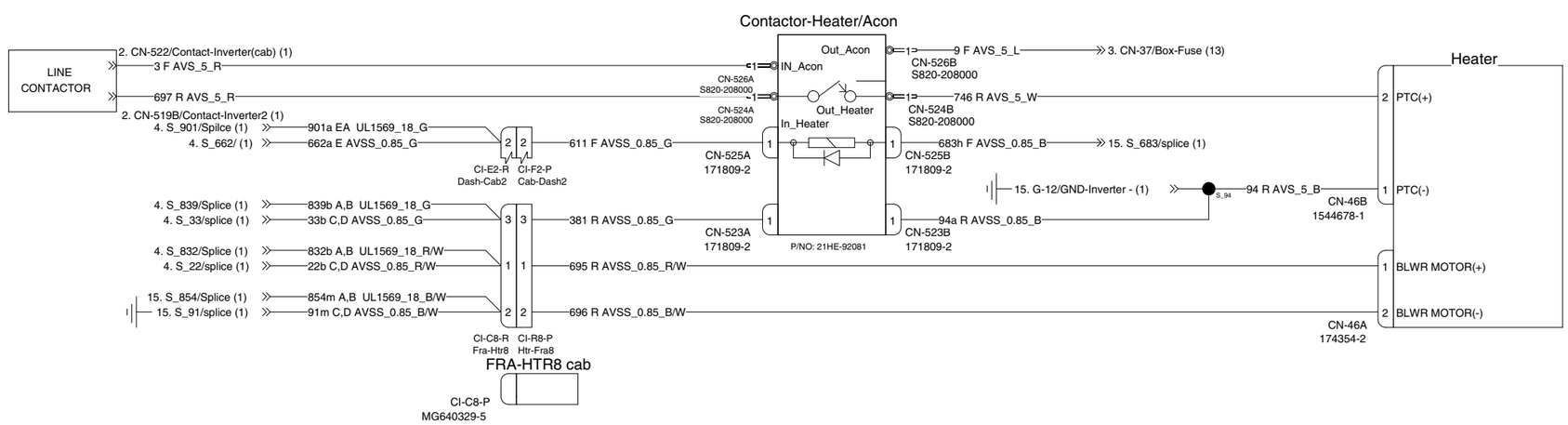


AIR-CON

2YBD-00013-00-11

HEATER, AIR-CONDITIONER (25B-X : #0251-, 30B-X : #0187-, 32B-X : #0043-, 35B-X : #0088-)

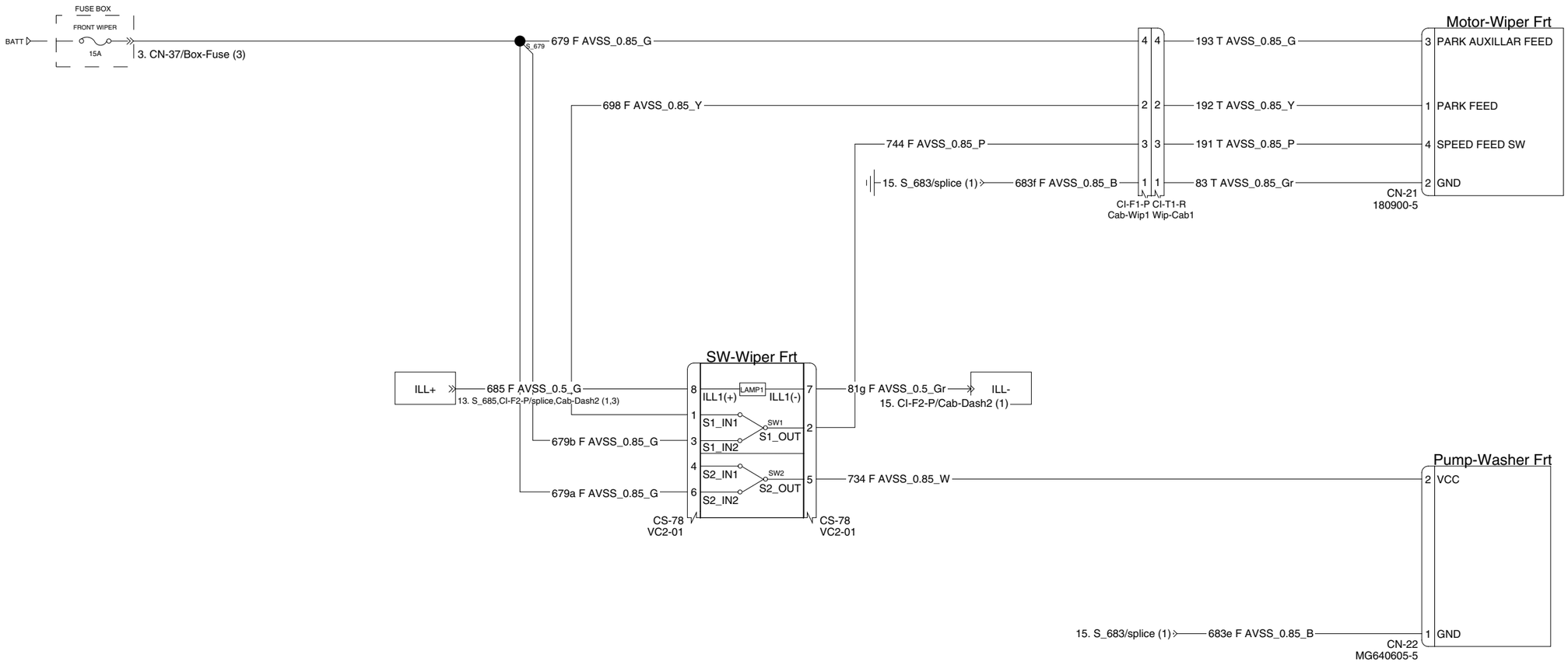
HEATER



AIR-CON

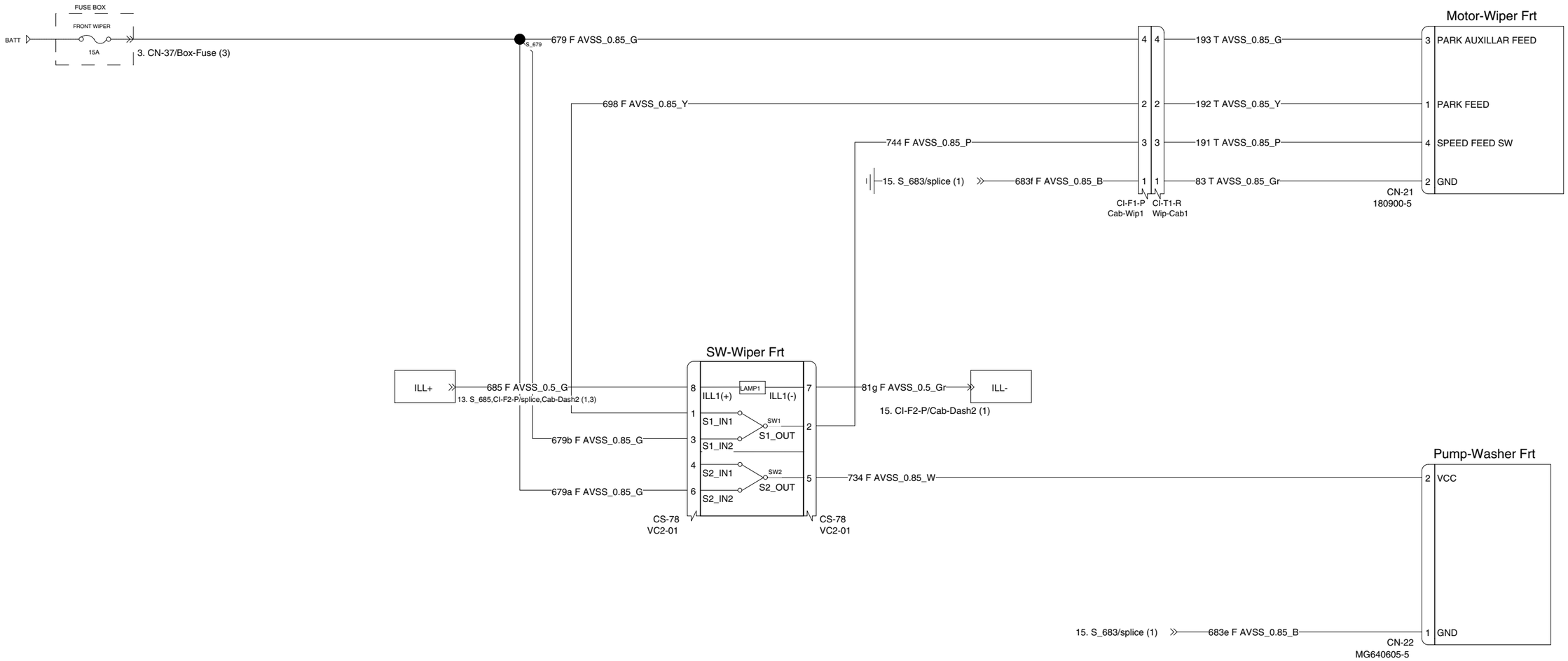
2YBD-00014-00-11

12) WIPER, WASHER (25B-X : -#0250, 30B-X : -#0186, 32B-X : -#0042, 35B-X : -#0087)



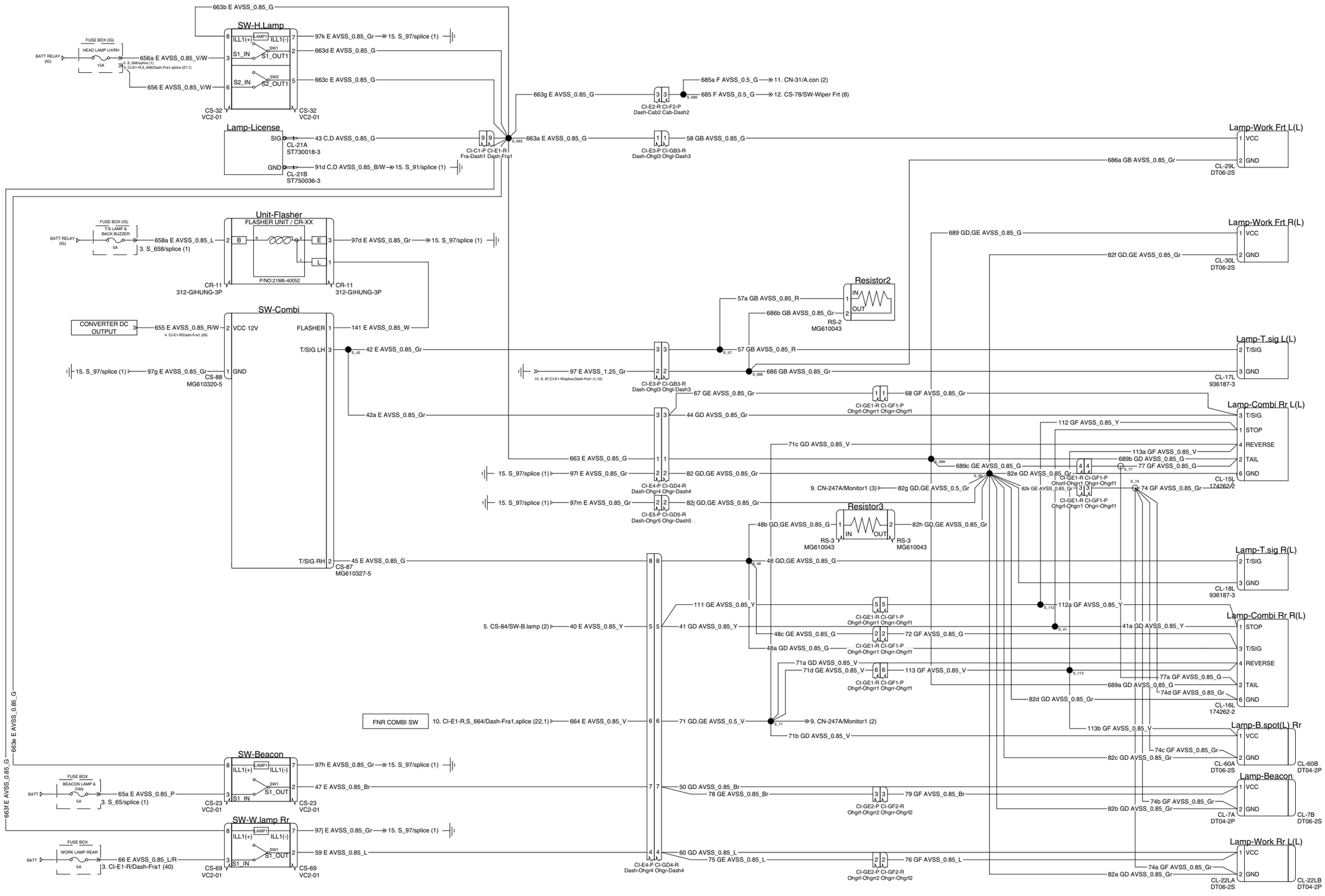
2YBD-00013-00-12

WIPER, WASHER (25B-X : #0251-, 30B-X : #0187-, 32B-X : #0043-, 35B-X : #0088-)

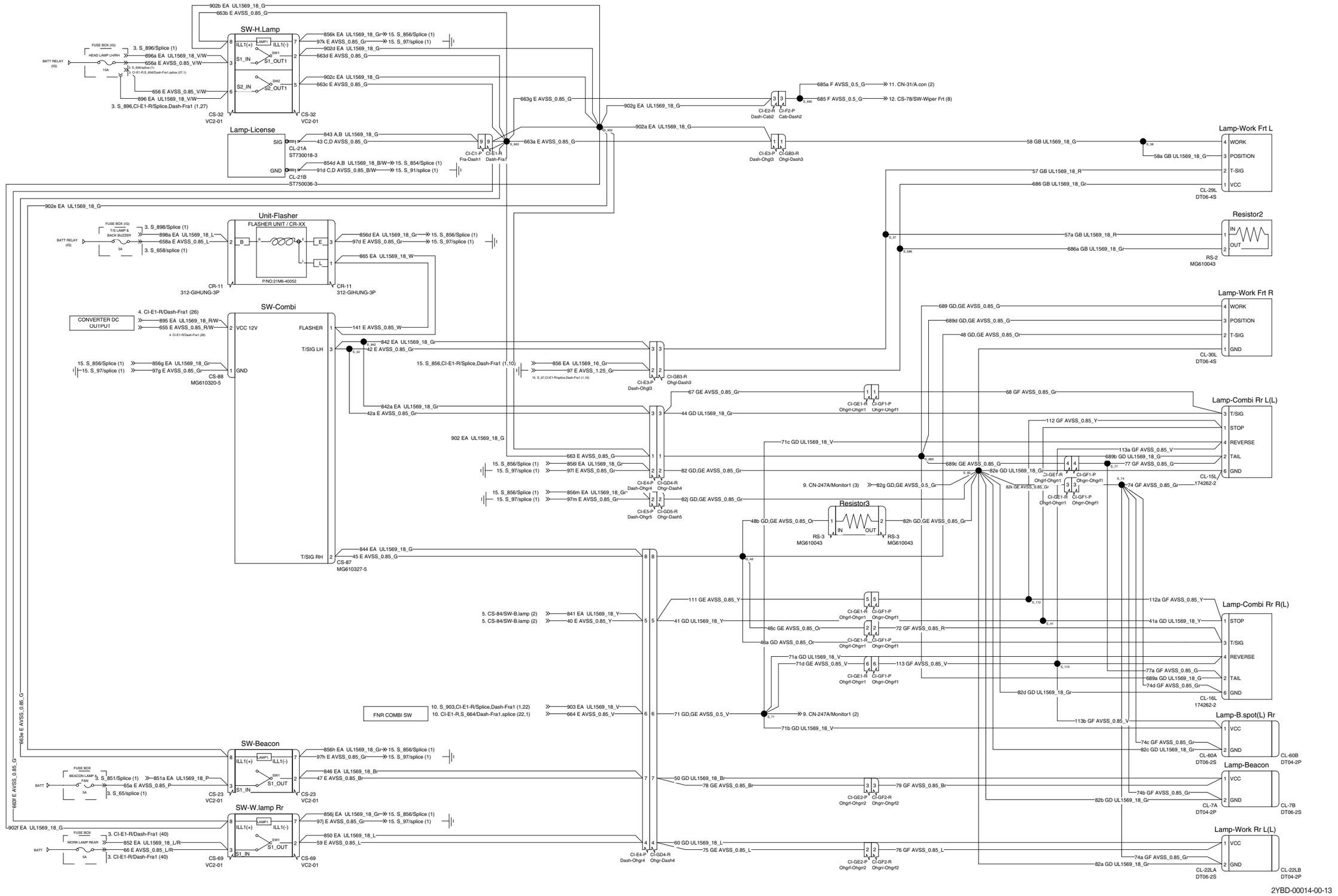


2YBD-00014-00-12

13) LAMP (25B-X : -#0250, 30B-X : -#0186, 32B-X : -#0042, 35B-X : -#0087)



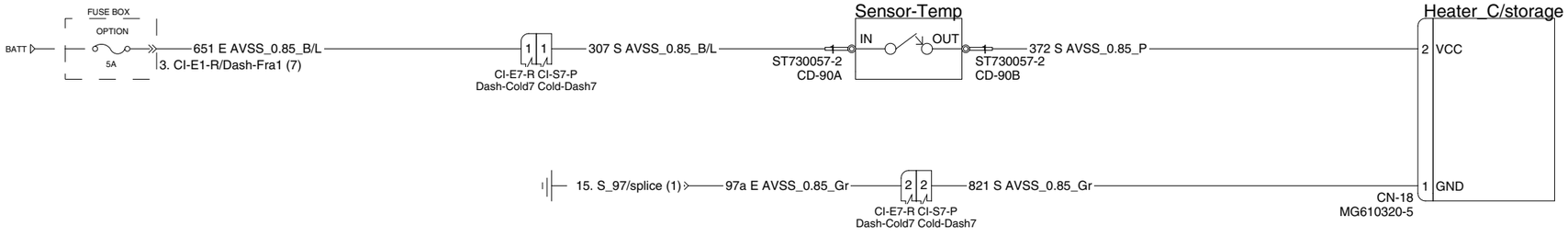
LAMP (25B-X : #0251-, 30B-X : #0187-, 32B-X : #0043-, 35B-X : #0088-)



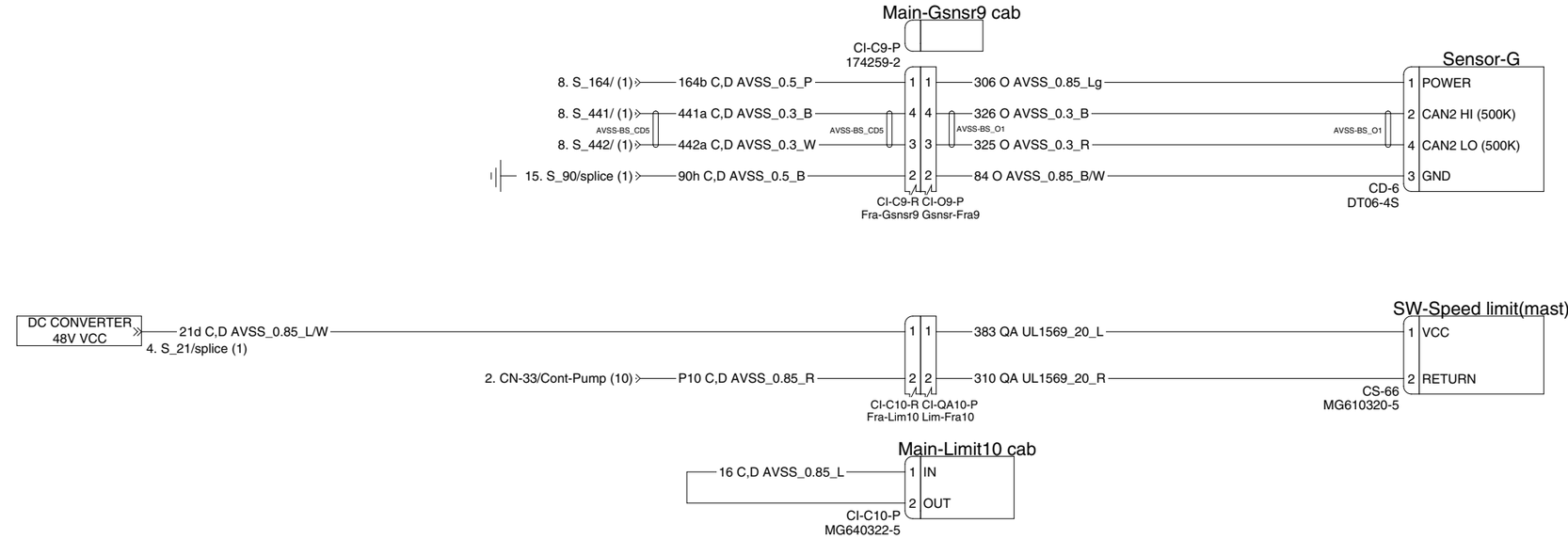
2YBD-00014-00-13

14) COLD CLIMATE AREA, FORK AND MAST (25B-X : -#0250, 30B-X : -#0186, 32B-X : -#0042, 35B-X : -#0087)

COLD STORAGE

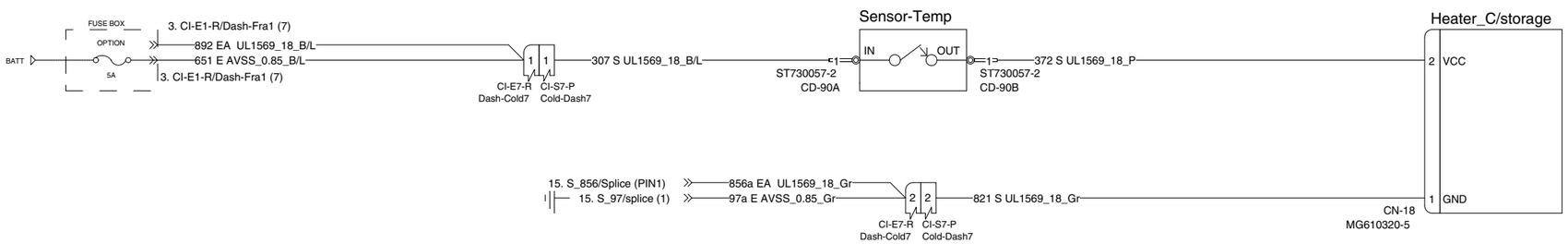


FORK & MAST

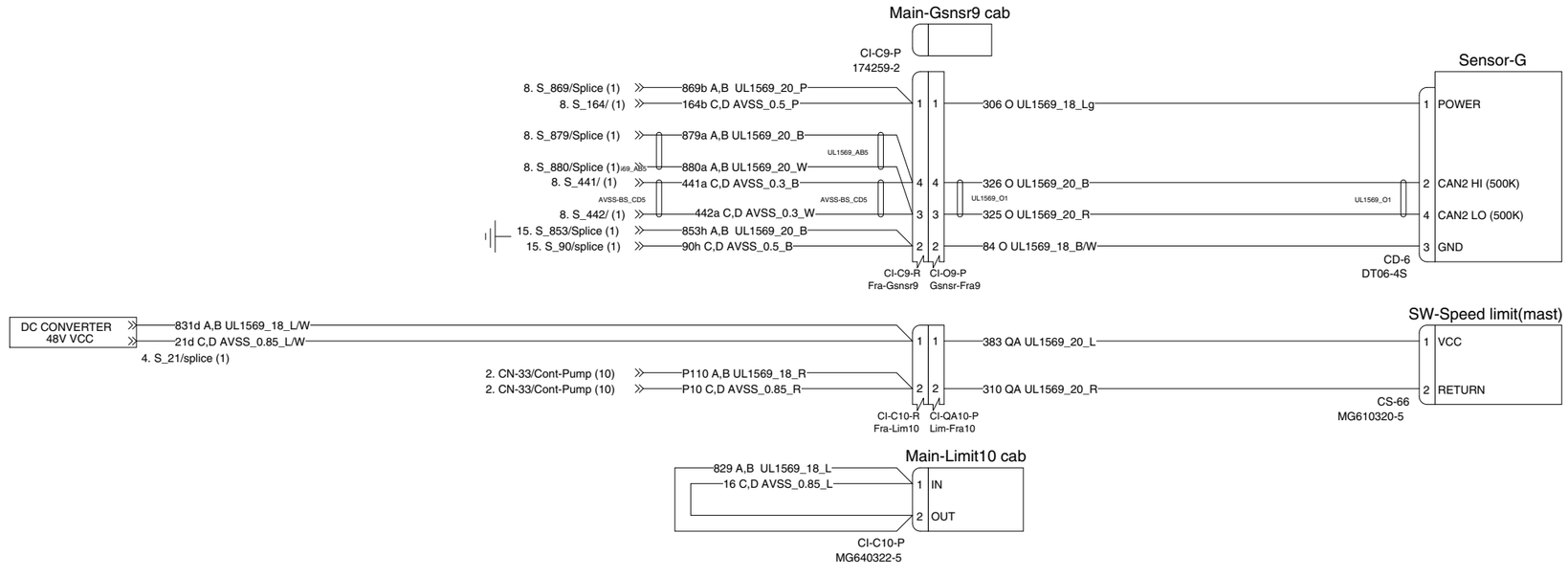


2YBD-00013-00-14

COLD STORAGE

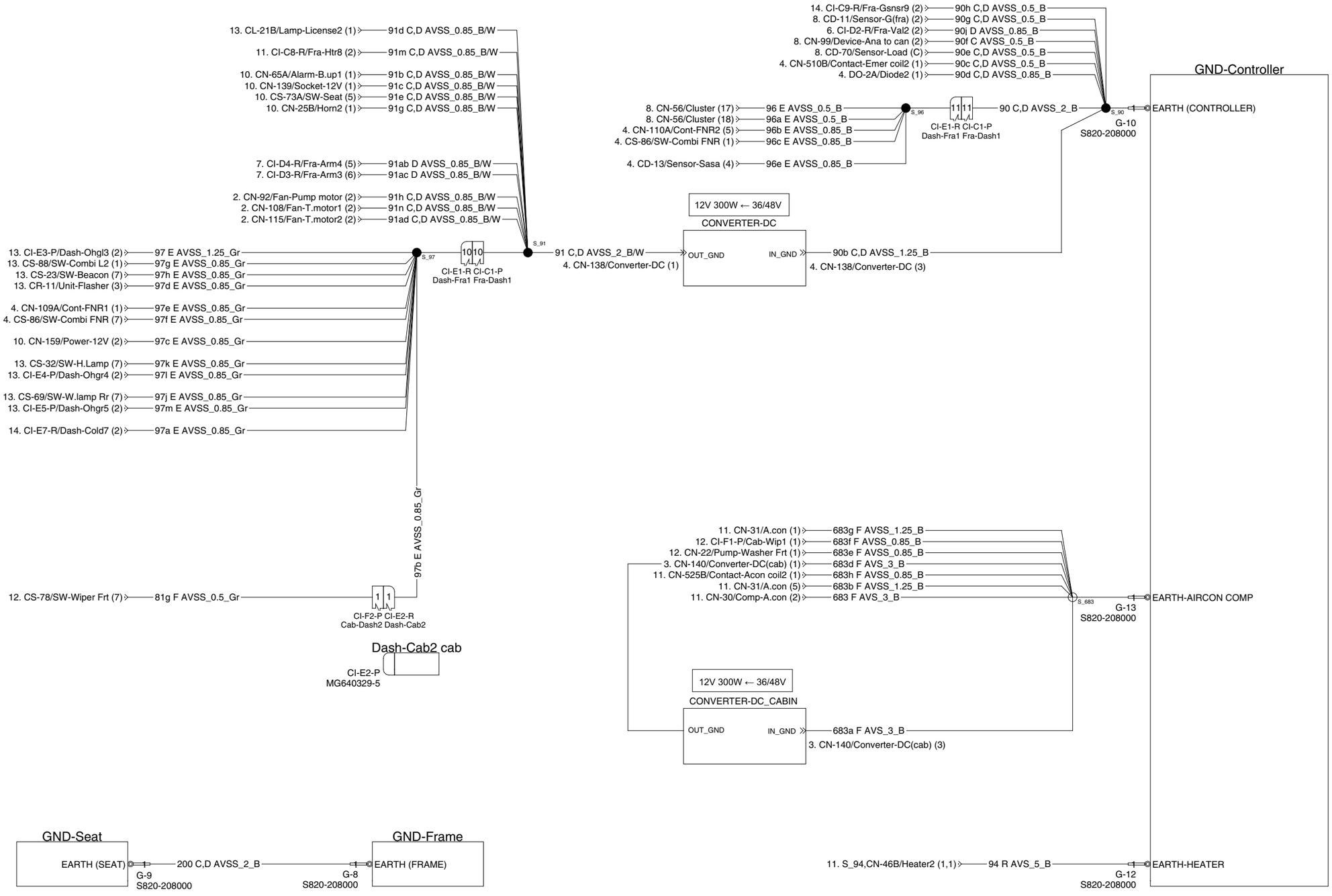


FORK & MAST



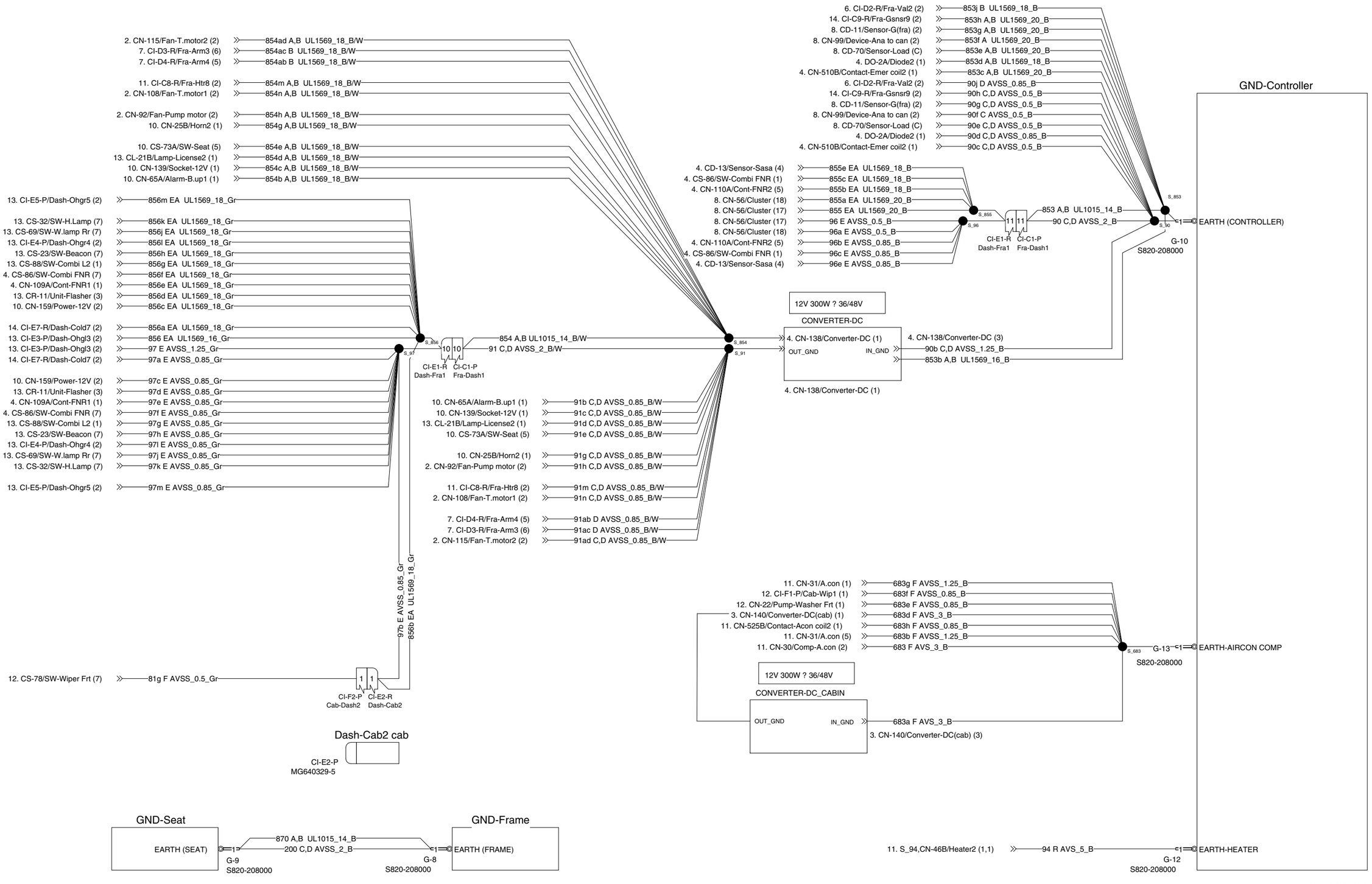
2YBD-00014-00-14

15) GROUND (25B-X : -#0250, 30B-X : -#0186, 32B-X : -#0042, 35B-X : -#0087)



2YBD-00013-00-15

GROUND (25B-X : #0251-, 30B-X : #0187-, 32B-X : #0043-, 35B-X : #0088-)



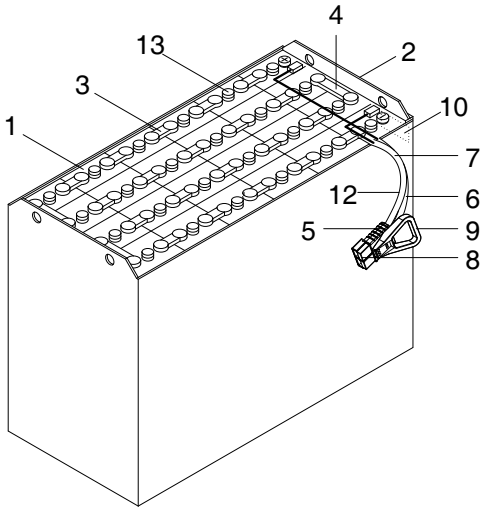
GROUP 3 ELECTRIC FUNCTIONAL PARTS

1. FUNCTIONS OF POWER FORKLIFT TRUCK AND PARTS

The major functions of forklift truck are classified into two categories: Driving and loading/unloading.
These functions operated by AC motor, which uses battery as power source, and requires battery charger, accordingly.
It is required to select driving direction by making use of electric components such as drive control system and direction switching lever (front/rear section switch), and to adjust speed drive motor to operate forklift truck.
Protection circuits are embedded in control system for protecting truck and components from failure.
Monitoring system embedded in monitor panel monitors and shows conditions of truck and working to let operator take adequate acti9ons, if required. Monitoring system is mounted with sensors such as current sensor, hydraulic pressure sensor and temperature sensor.
Forklift truck of Hyundai has operator-friendly features for adjusting conditions of truck dependent upon working environments at driver's seat by making use of the advanced drive control system. Self-diagnosis function displays current conditions of working truck, and provides environment for operation of truck in more efficient manner.

2. BATTERY

1) STRUCTURE

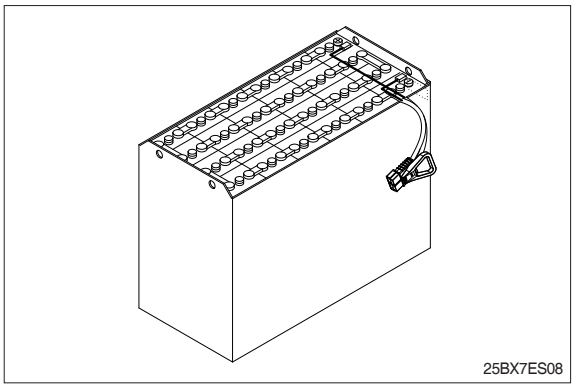


25BX7ES07

1	Cell	5	Terminal connector	9	Steering wheel
2	Battery box	6	(+) Cable	10	lead acid level sensor
3	Connector	7	(-) Cable	12	Sleeve
4	Connector	8	Plug	13	Cap

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 SERVICING

Item	Unit	25B-X	30/32/35B-X
Type	-	Plumbic acid	←
Rated voltage	V	48	←
Capacity	AH/hr	600/5	700/5
Electrolyte	-	Wet	←
Dimensions (W×L×H)	mm	984×466×744	984×536×744
Connector (CE standard)	-	SB 350 or SR 350	
Weight	kg	1000	1150

Specific gravity of fully charged battery	1.280 (25˚C)
Specific gravity of fully discharged battery	1.120 (25˚C)
Voltage at end of discharging	48V
Electrolyte	Refined thin sulfuric acid
Makeup solution	Purified water (distilled water)
Insulation resistance	1 MΩ

4) SAFETY PRECAUTIONS

(1) When skin making contact with sulfuric acid

When skin, eyeball or clothes contacts with sulfuric acid, immediately flush with flowing water. If ingested, drink large volume of water or milk, and immediately see physician. Always wear safety goggles, face mask and rubber gloves when handling acid materials.

(2) Prevention of heat source, and ventilation

Battery produces explosive hydrogen. There should be heat source in the vicinity of battery. Open battery cover to ventilate before battery charging. Charging battery in confined space, explosion may take place.

(3) Never put metal articles on the top of battery.

Metal article on battery may cause short circuit, especially during charging. Flame is equally dangerous open fires.

(4) Handling of charger

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

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 1.5V.

(2) Avoid over-charging

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

(3) Avoid excessive elevation of temperature

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

6) CHECKING

(1) Unpacking

Batteries are delivered to customers in dry-charged condition. At unpacking, check whether the batteries and accessories have been damaged. If there are observed defects, you should notify the condition to our branch office or agent. Never remove the sealing plug until the battery is put into service.

(2) Performance and maintenance of batteries

① Initial charging

Battery gradually decreases its capacity during storage. In order to provide sufficient discharge capacity in the first discharge, the good initial charge is required. The conditions of initial charging are seen as below (at room temperature).

a. **By modified constant voltage charger**

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

b. **By constant voltage constant current charger (standard)**

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

② Discharge and capacity

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

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

③ Specific gravity of electrolyte

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

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

Where, S25 : Specific gravity at 25˚C

St : Actually measured specific gravity at t˚C

t : Electrolyte temperature (˚C)

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

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

④ Normal charging

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

a. Charging by modified constant voltage automatic charger

There is almost automatic charger today which completes the charging just only connecting the plug between battery and charger without outer operating timer. But if your charger has it, after setting the timer for 3-4 hours and turn on the charger and the charger is left as it is, then the charge will be made automatically. In principle, regardless of the amount of previous discharge, it is not required to alter the setting of timer time. The recommendable current value of this type

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

Charging by constant current constant voltage automatic charger

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

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

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

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.

⑤ Equalizing charging

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

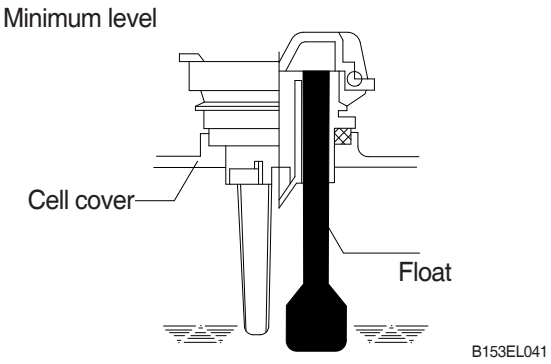
⑥ Replenishment of distilled water

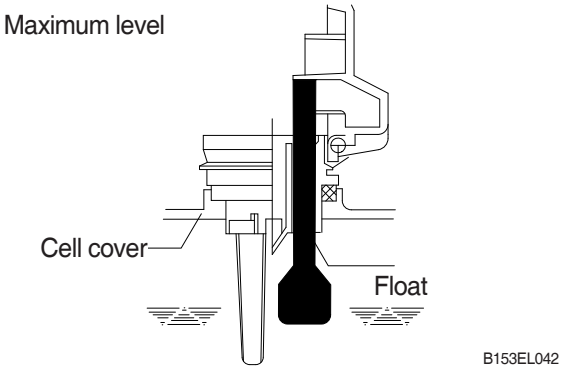
Only the water content of electrolyte is decreased due to electrolysis of distilled water during charge and natural evaporation. If a battery used with the electrolyte decreased excessively, plates will deteriorate resulting in markedly shortening of battery life. Be sure to check the electrolyte level once every week. If the electrolyte level is lowered, replenish distilled water up to the specified level. In this case, never attempt to replenish sulfuric acid or tap water. Use only distilled water for battery replenishment. If the amount of water required for weekly addition to a unit cell for 100 AH of battery capacity is in excess of 45 cc, it is assumed that the cell is receiving overcharge. Accordingly, be sure to reduce slightly the daily charge amount. Under the normal conditions, the addition of water per week is 45 cc or less. Incidentally, distilled water replenishment should be made before charging to the content of minimum level. (For the purpose of uniform stirring of electrolyte by charging).

If the electrolyte level is improper after completion of charging, you may topping up the electrolyte level to the maximum level.

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

Confirm the electrolyte level by looking at the float in the ONE TOUCH CAP. If too low as shown in figure, replenish distilled water. Replenishment shall be performed after opening the cover of the plug using syringe and jug. When refilling is completed, close each cover completely until "click" sound is heard.





⑦ **Cleaning**

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

⑧ **Notice on charging**

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

⑨ **Repair of failure cell**

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

⚠ **You must make sure to clear of explosive hydrogen gas in the cells before repairs. Be careful not to drill to far into the cell and damage the unit. During drilling operation make sure lead curls produced do not contact opposite cell poles and cause a spark.**

d. Upon completion of drilling, the intercell connectors can be lifted off.
e. Lifted off the failure cell from circuit after removing of intercell connector.
f. Installing new cell and connector.
g. With surfaces properly cleaned and neutralized, position the connectors.
h. Place damp rags around each lead head. Hold tip of the welder in center of post move welder completely around top of post and out to the area where the post meets the connector. Move welder back to center of post and add molten lead until area is filled to top of connector. Again, move welder completely around area, with tip on molten lead. If you have jig for welding connector, have easier and better welding work.
i. When replacing electrolyte in a repaired cell, use sulphuric acid of the same specific gravity that is found in the balance of the battery.
j. Finally, rejoin connector covers and one-touch caps to the cells.

⑩ Summary of daily maintenance

a. Avoid overcharge. After discharge, charge the batteries immediately. The standard frequency of equalizing charge is more than once every month.
b. Be sure to check the electrolyte level once every week. If the electrolyte level is lowered, replenish distilled water up to the specified level.
c. The top surface of battery cells should be kept clean and dry.
d. Be sure to keep open the cover of battery housing tray during charge.
e. Never draw near open fires such as lighted cigarettes or burning matches during charge.

(3) Others

① Storage of batteries

When batteries are stored, keep them away from room heaters or other heat generating sources.

Clean, cool and dry place where no direct sunlight is suited for battery storage. Before putting into storage, it is important to charge the batteries and keep the electrolyte level at the specified level.

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

② Maintenance record

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

③ Electrolyte temperature (˚C)

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

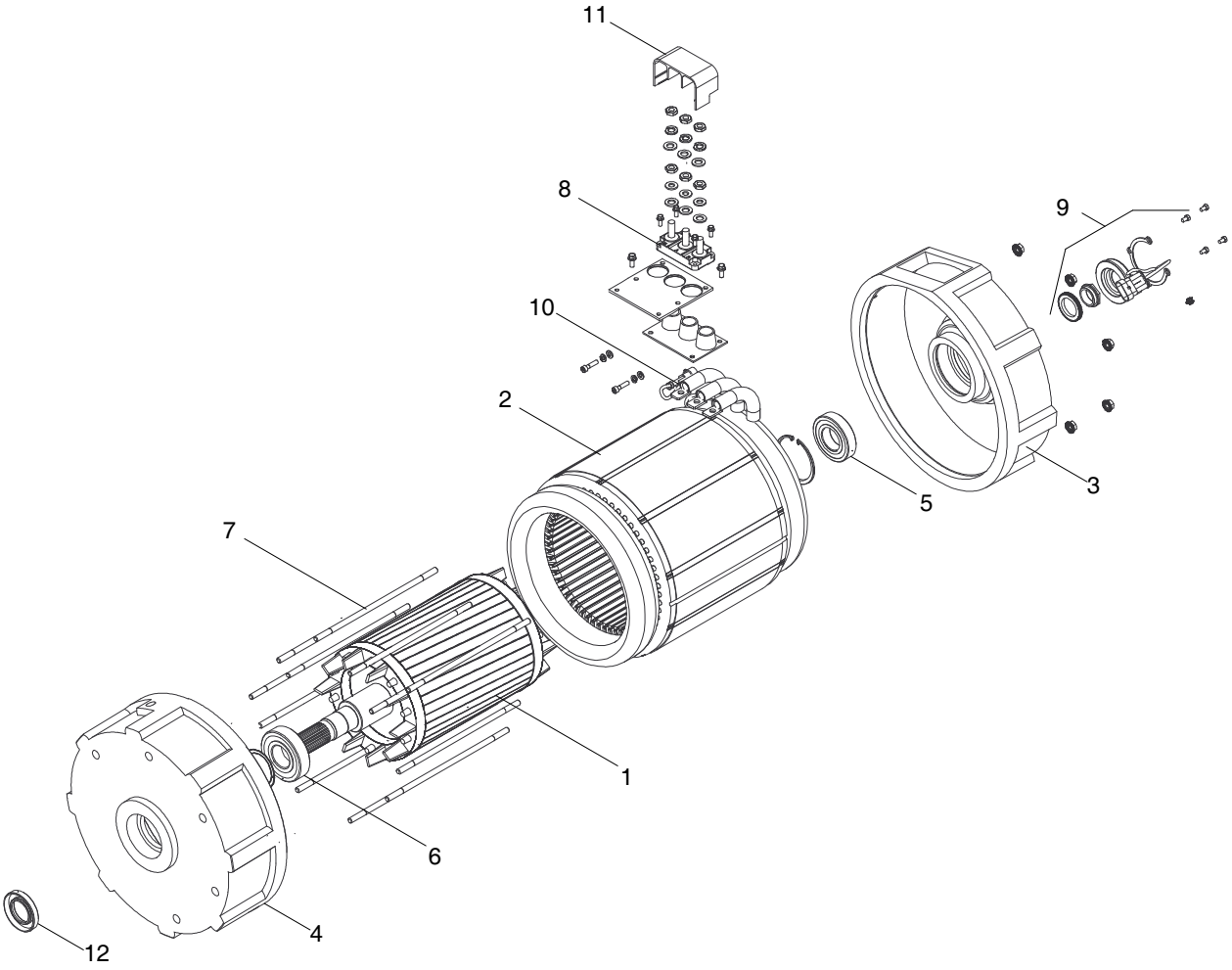
Contrarily if the temperature is high, especially if used at above 55˚C, the battery life will be considerably shortened. Care must be taken so that the temperature during charge will be maintained at 55˚C or lower. Even under unavoidable circumstances it should not exceed 55˚C.

7) FAILURE DIAGNOSIS AND TROUBLESHOOTING

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

3. DRIVE MOTOR

1) STRUCTURE



25BX7ES02

1	Rotor	5	Bearing	9	Speed sensor kit
2	Stator	6	Bearing	10	Temperature sensor
3	End cap	7	Stud bolt	11	Protection block
4	End cap	8	Terminal block	12	Oil seal

2) SPECIFICATIONS

Item	Unit	Specifications
Type	-	ASRH4001
Rated voltage	Vac	30
Rated output	kW	14
Insulation	-	Grade F

3) CHECKING

(1) Rotor

Always clean the rotor with compressed air. If dust is not removed, wipe the rotor with soft cloth or cotton dampened with gasoline.

· Diameter : Ø 178.9±0.05

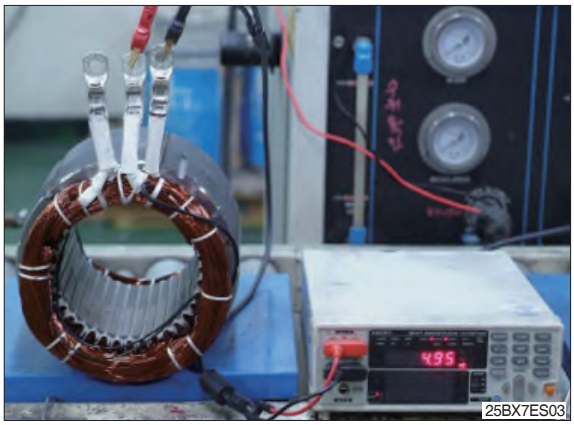
· Tools : Vernier calipers and standard tools

(2) Stator

Always clean the rotor with compressed air. If dust is not removed, wipe the stator with soft cloth or cotton dampened with gasoline while exercising care for protecting coil insulator from damage.

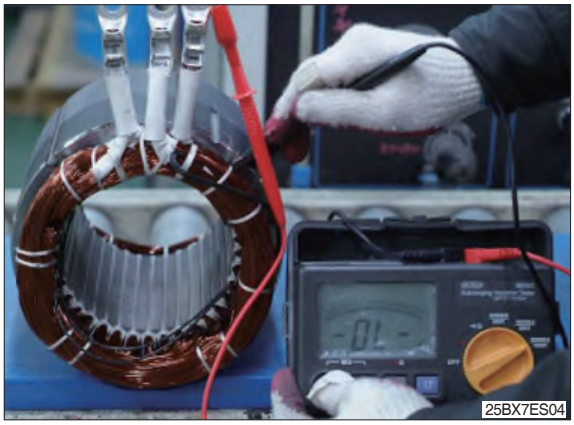
① Repeat inspection of power source line 2 of the stator with meter-ohm gauge. (U-V, V-W, W-U)

· Proper resistance : 3.2 mΩ



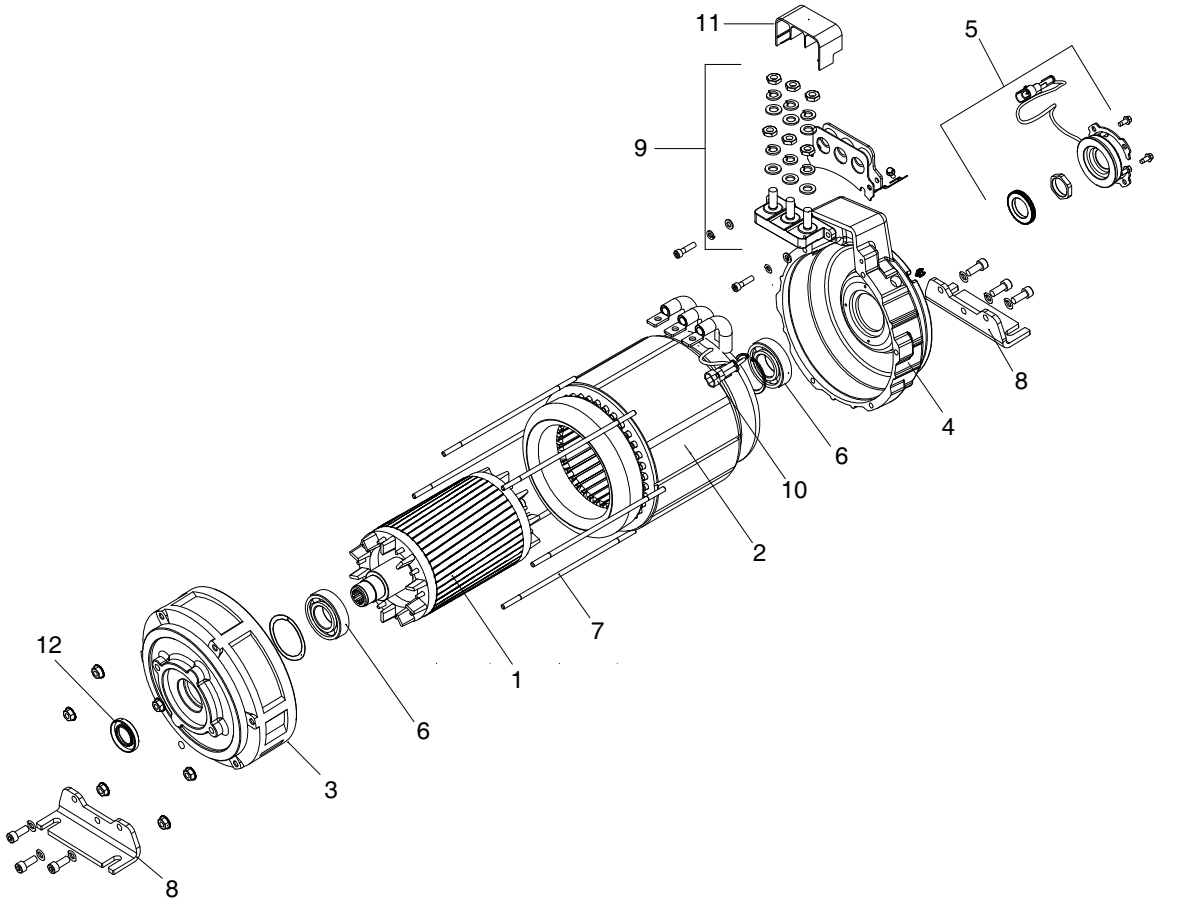
② Measuring insulator

Make use of insulator gauge (1000V, min. 10 mΩ) to perform measurement as shown on the photo. Replace insulator with new part, if damaged.



4. PUMP MOTOR

1) STRUCTURE



25BX7ES05

1	Rotor	5	Speed sensor kit	9	Terminal block
2	Stator	6	Bearing	10	Temperature sensor
3	End cap	7	Stud bolt	11	Protection block
4	End cap	8	Bracket	12	Oil seal

2) SPECIFICATIONS

Item	Unit	Specifications
Type	-	AMSR4001
Rated voltage	Vac	30
Rated output	kW	15
Insulation	-	Grade F

3) INTERNAL INVOLUTE SPLINE DATA

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

4) CHECKING

(1) Rotor

Always clean the rotor with compressed air. If dust is not removed, wipe the rotor with soft cloth or cotton dampened with gasoline.

· Diameter : Ø 123.1±0.05

· Tools : Vernier calipers and standard tools

(2) Stator

Always clean the rotor with compressed air. If dust is not removed, wipe the stator with soft cloth or cotton dampened with gasoline while exercising care for protecting coil insulator from damage.

① Repeat inspection of power source line 2 of the stator with meter-ohm gauge. (U-V, V-W, W-U)

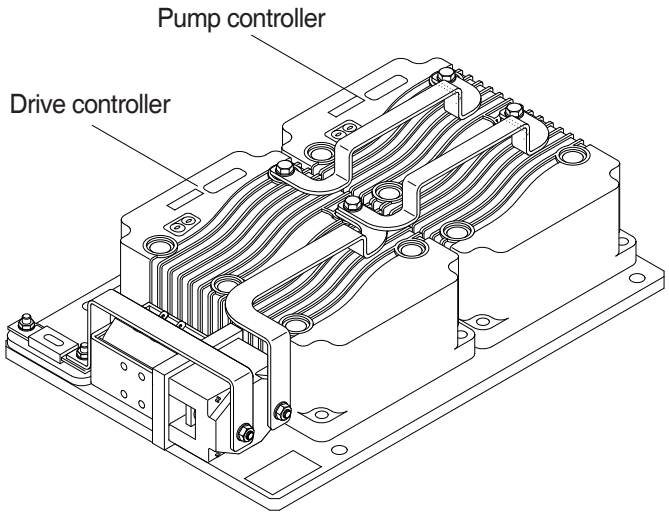
· Proper resistance: 3.8 mΩ

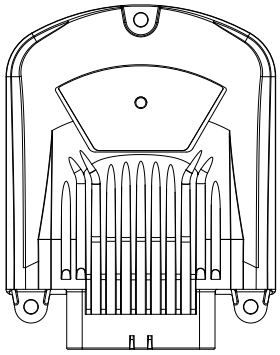
② Measuring insulator

Refer to Page 7-28 Measuring Stator of Drive Motor.

6. CONTROLLER SYSTEM

1) STRUCTURE





Fingertip controller

25BX7ES06

Model	Application	Type	Power	Current limit
1236SE-5621	Traction	MOSFET	36-48V, 600A	600A/2 min
1236SE-5621	Pump	MOSFET	36-48V, 600A	600A/2 min
1353-6101	Fingertip	Valve controller	36-48V, 70A	-

2) OPERATIONAL FEATURES (TRACTION AND PUMP CONTROLLER)

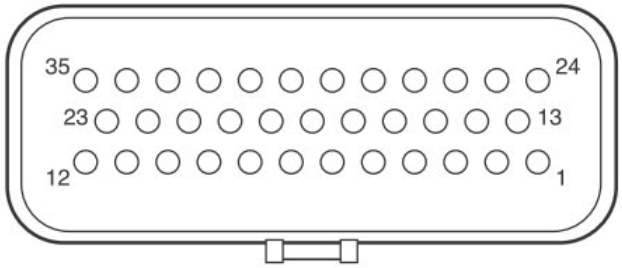
(1) Features

- The controller controls closed circuit speed and torque for induction (ACIM) and surface permanent magnet (SPM) motor.
- Field-oriented motor control algorithm of high efficiency capable of exerting max. motor torque in any working environments
- Hi-end pulse-width modification technology ensuring efficient consumption of battery voltage, low motor harmonics, low torque ripple, and min. conversion loss
- Very large-scope torques and speeds including full playing function
- Smooth low-speed control including zero speed
- ACIM motor mitigating field, an d SPM motor capable of controlling speeds including non-load basic speed
  Control algorithm is applied to motor temperature variation for keeping optimal capabilities in conditions of wide range and high diversity.
- Power limit map reduces heat generated from motor, and is capable of satisfying capability requirements for keeping capability constant under various battery charging conditions.
- The functions of overheat prevention, warning and auto stop protect motor and controller.
- Power base of metal insulation substrate of excellent heat transfer enhances reliability.
- Embedded auto characterization routine for optimizing trucks for motor capabilities and efficiency
- Powerful operating system is capable of performing control of truck and motor, and parallel processing of user-defined programmable logic (VCL).
- Wide-range input/out are applied whenever required for controlling distributed systems to the largest extent.
- Embedded dual drive software easily sets and controls of common dual drive trucks without VCL.
- Battery charging indicator, hour meter and service timer
- CANopen compatible with CAN bus (CAN bus protocol configured through VCL)
- Increased CAN master capabilities (VCL execution speed and code space)
- Field programming mode allowing flash download of main operation codes.
- Programming facilitated by portable Curtis 1311 programmer, and 1314 PC programming.
- Stubbornly sealed housing and connector satisfy IP65 environmental sealing standards in severe environments.
- Compliant with 2006/42/EC and EN13849

3) DESCRIPTION OF THE CONNECTORS

(1) Traction and pump controller

Every low-power connection is connected through single 35-in AMPSEAL connector.
Plug housing for coupling is AMP P/N 776164-1, and contact pin is AMP P/N 770520-3.
Connector accommodates 0.5-1.25 ㎜ (20-16 AWG) wire having thin wall insulator of 1.7-2.7 mm diameter. The wire is sealed in unused connector of silo-diagram together with seal plug 77068-1.



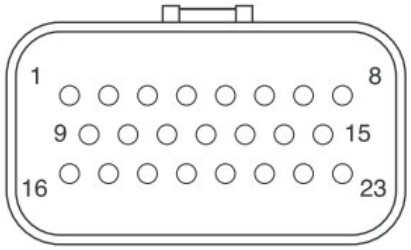
25BX7ES11

PIN	NAME	DESCRIPTION
1	KSI	Input of key switch signal, supplying controller logic and coil driver power
2	Prop. Driver	Proportional driver. Coil driver having current control function commonly used on hydraulic proportional valve
3	Driver 4	Common driver No. 4: Usable as digital input also; low-frequency PWM function
4	Driver 3	Common driver No. 3: Usable as digital input also; low-frequency PWM function; typically used for pump connector
5	Driver 2	Common driver No. 2: Usable as digital input also; low-frequency PWM function; slightly higher rated current, typically used for electromagnetic brake
6	Driver 1	Common driver No. 1: Usable as digital input also; low-frequency PWM function; typically used for main connector
7	I/O Ground	Input & output ground criteria
8	Switch 2 Analog 2	Usable as common switch input No. 2 or common analog input No. 2
9	Switch 3	Common switch input No. 3
10	Switch 4	Common switch input No. 4
11	Switch 5	Common switch input No. 5
12	Switch 6	Common switch input No. 6
13	Coil Return	Coil return pin of every connector coil
14	Switch 16	Common switch input No. 16
15	Throttle Pot High	Pot high power connection of 3-wire throttle pot 1
16	Throttle Pot Wiper	Pot wire connection of throttle pot 1
17	Pot2 Wiper	Port wire connection of throttle pot 2

PIN	NAME	DESCRIPTION
18	Pot Low	Common pot low-connections of throttle and brake pots
19	Digital Out 6	Usable for On/Off function or output driver, and digital input
20	Digital Out 7	Usable for On/Off function or output driver, and digital input
21	CAN Term H	High-power connection of CAN terminal jumper
22	Switch 7	Common switch input No. 7
23	CAN H	CAN Bus High
24	Switch 1	Usable as common switch input No. 1 or common analog input No. 1
25	+12V Out	Non-regulatory low-power +12V output
28	Serial TX	Serial transmission line for display or flash update
29	Serial RX	Serial receiving line for flash update
30	Analog Output	Low-power, low-frequency 0V - 10V analog output
31	Position Feedback A	Quadrature encoder input phase A (ACIM motor), Sin/Cos sensor input sine (SPM motor)
32	Position Feedback B	Quadrature encoder input B (ACIM motor), Sin/Cos sensor input sine (SPM motor)
33	Switch 8	Common switch input No. 8
34	CAN Term L	Low-power connection of CAN terminal jumper
35	CAN L	CAN Bus Low

(2) Fingertip controller

Every low-power connection is connected through single 23-in AMPSEAL connector.
Plug housing for coupling is AMP P/N 770680-1, and contact pin is AMP P/N 770520-3.
Connector accommodates 1.7-2.7 mm (20-16 AWG) wire having thin wall insulator of 1.7-2.7 mm diameter.
Pins of 1353 are not sealed until connector is fully latched and locked. Cable harness connector include silicone rubber, an essential part for module sealing.



25BX7ES11

PIN	NAME	DESCRIPTION
1	B+	Positive electrode of battery
2	B-	Negative electrode of battery
3	+5 V	Non-regulatory low-power +5 V output
4	I/O GND	Input & output ground criteria
5	Analog Input 4 / Encoder 2B	Voltage or resistance input 4, quadrature encoder input phase 2B
6	Analog Input 4 / Encoder 2B	Voltage or resistance input 3, quadrature encoder input phase 2A
7	CAN H	CAN Bus High communication line
8	CAN L	CAN Bus Low communication line
9	B-	Marginal battery negative electrode (for high-current drive)
10	+12 V	Non-regulatory low-power +12 V output
11	Analog Input 5 / Serial TX	Voltage or resistance input 5, serial transmission
12	Analog Input 6 / Serial RX	Voltage or resistance input 6, serial receiving
13	Analog Input 2 / Serial 1B	Voltage or resistance input 2, quadrature encoder input phase 1B
14	Analog Input 1 / Serial 1A	Voltage or resistance input 1, quadrature encoder input phase 1A
15	Input/Output 9	Active high input 9, high-power PWM active low output 9
16	Input/Output 8	Active high input 8, high-power PWM active low output 8
17	Input/Output 7	Active high input 7, high-power PWM active low output 7
18	Input/Output 6	Active high input 6, high-power PWM active low output 6
19	Input/Output 5	Active high input 5, high-power PWM active low output 5

PIN	NAME	DESCRIPTION
20	Input/Output 4	Active high input 4, high-power PWM active low output 4
21	Input/Output 3	Active high input 3, high-power PWM active low output 3
22	Input/Output 2	Active high input 2, high-power PWM active low output 2
23	Input/Output 1	Active high input 1, high-power PWM active low output 1

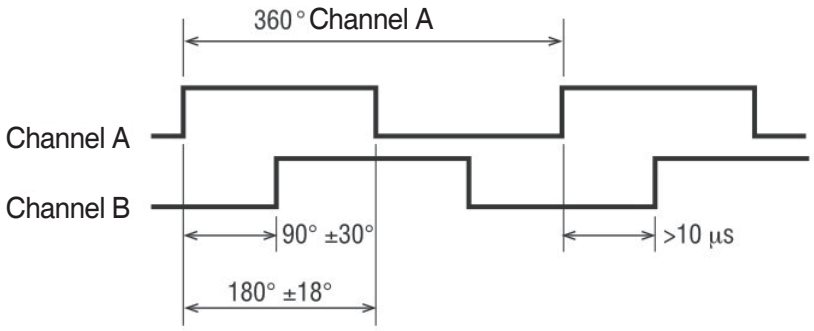
(3) Encoder connection (drive and pump)

Two control lines are configured inside for reading quadrature type position encoder.

Power supply of encoder is commonly 5V (Pin 26) or 12V (Pin 25), and power can be supplied by 5V - B+ by external source only when logic critical value is satisfied.

PIN	NAME	DESCRIPTION
25	+ 12 V	Power supplying to positive electrode of encoder
7	GND	Power supplying to negative electrode of encoder
31	ENC A	Encoder A phase
32	ENC B	Encoder B phase

These signal tolerances should be within operating conditions of application including scope of voltage, temperature, speed and torque.



25BX7ES12

4) PROGRAMING AND ADJUSTMENT

It is allowed to adjustment parameters through portable 1313 programmer or cluster.

※ **Refer to Display Section for adjustment of variables on cluster. (Page 7-64)**

Adjusting with portable programmer (opt)

Adjustment and change of variables for inverter configuration are made through portable 1313 programmer.

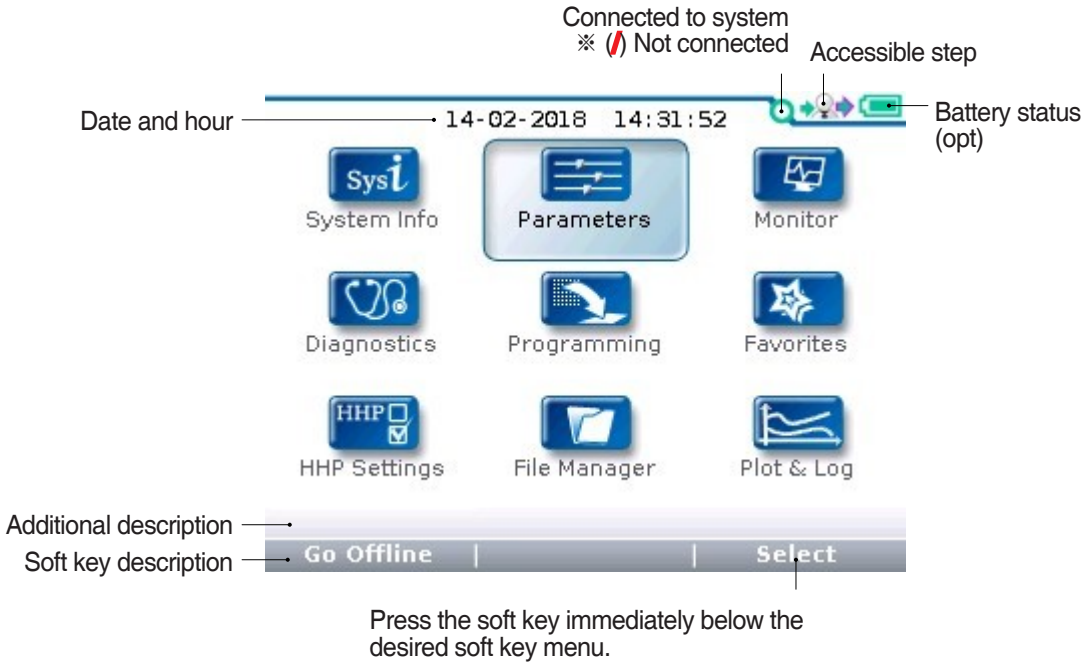
Connect to the main harness of the lift truck.

※ **Turn Start key to OFF position, and then make connection and release.**

25BX7ES14

(1) Connected

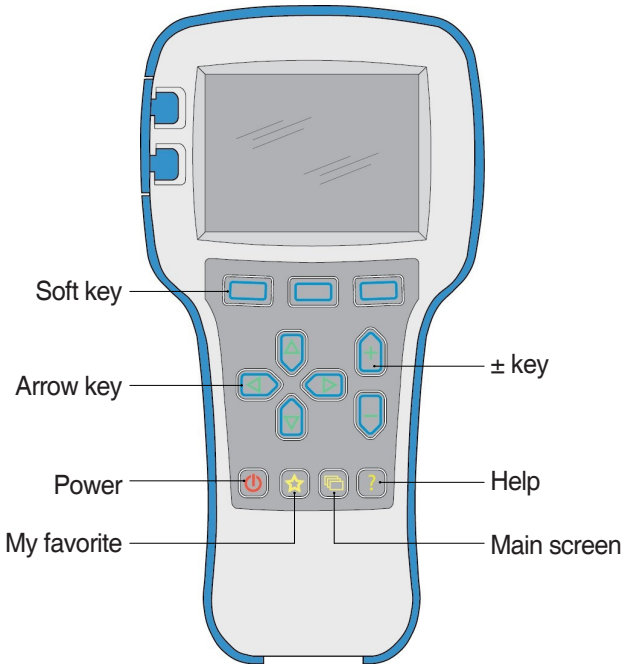
Once connection is made, the screen is displayed as shown below.



25BX7ES15

Pressing Select soft key on the screen prompts the variable screen. Pressing Offline soft key switches 1313 HHP to offline mode. 1313 HHP can be connected to the controller. 1313 HHP is cable of performing functions not required of connection.

(2) Key description



25BX7ES16

(3) How to adjust variables

On Variable screen of the main screen, press +/- keys to adjust parameters. If the menu contains 8 items or more, a scroll bar appears on the right corner of the screen. (See Page 7-40.)

(4) Monitor

This menu displays real-time values. Refer to the user's manual of the controller for description of the values. This menu is useful for setup, testing, diagnosis and troubleshooting. (See Page 7-45.)

(5) Diagnosis

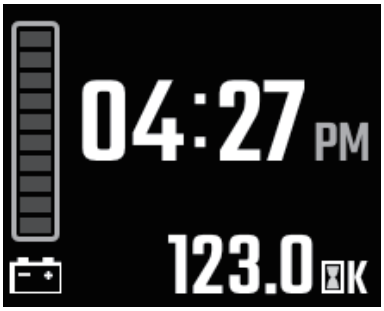
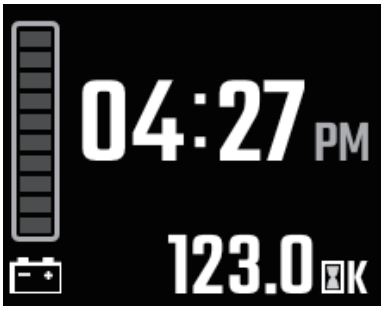
This menu displays current errors and defects records. (See Page 7-49.)

5) SAFETY INSTRUCTIONS

- Make sure that battery is disconnected before use.
- Driving wheel should be prompted or deactivated during driving to prevent unexpected operation or moving in wrong direction during initial startup of the truck. Open the value during hydraulic operation to prevent excessive rise of pressure if the relief valve pressure malfunctions.
- Prerequisite actions should be taken for safety for ensuring prevention of damage to workers or equipments.
- 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 10-100 Ω to make short circuit between power terminals of positive and negative electrodes of the inverter battery.

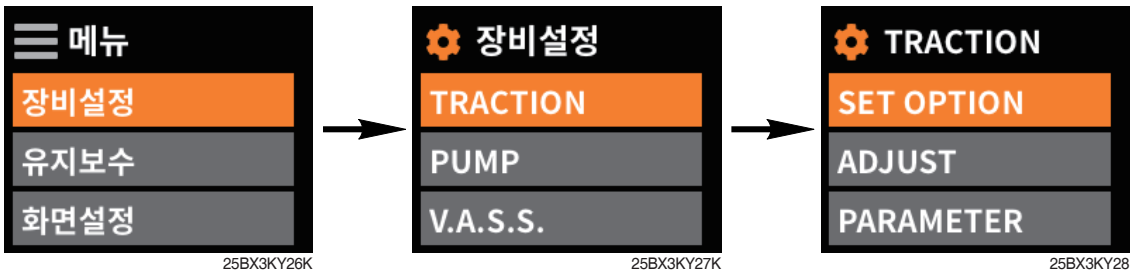
7. CLUSTER

1) SERVICE MENU

Step	Display	DESCRIPTION
1	 25BX7ES17	1. When starting the truck, a screen is prompted as shown on the left. 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. Use "LEFT/RIGHT" buttons and "ENTER"button to enter password.
3	 25BX7ES17	1. Once password is entered, the first screen is displayed as shown on the left. 2. Press "HOME" button.
4	 25BX7ES19K	1. Service Menus are displayed as shown on the left. 2. Press "LEFT/RIGHT" button to select desired menu, and press "ENTER" button to access the menu. 3. Press "ESC" to move to the previous menu.

(2) System setup

It is allowed to change setting and variables of drive and pump.



25BX3KY26K 25BX3KY27K 25BX3KY28

25BX3KY29

① Drive inverter

Set options	Description
Battery Charge Check Enable	- ON : Activating battery charging door sensor function - OFF : Deactivating battery charging door sensor function
Lithium Battery Enable	This setting is used for checking AC conditions between the drive system and the lithium ion battery management system. - ON : Lithium ion battery and BMS in use - OFF : Lithium ion battery and BMS not in use
Safety Belt Sequence Option	- None : Sitting on driver seat for drive and lifting - Option #1 : Sitting on driver seat, and wearing safety belt for drive and lifting; sequence independent - Option #2 : Sitting on driver seat, and wearing safety belt for drive and lifting; sequence dependent
BDI Lockout Enable	- ON : Activating BDI locking device - OFF : Deactivating BDI locking device (default) ※ BDI lockout: Controller limiting lifting function if battery changing balance is less then set level
Motor Fan Working Type	The cooling fan installed adjacent to the motor plays the following functions: - None : Fan inactive - Option #1 : Fan operating always - Option #2 : Operating upon abnormal temperatu7re of drive and pump motor - Option #3 : Activating when motor operates
Position Hold Enable	- ON : Activating slop stop function - OFF : Deactivating slop stop function
Traction Cutback En-able	Drive speed is limited if the mast ascends higher than specified height. - ON : Activating drive speed limiting - OFF : Deactivating drive speed limiting

Variable	Description
BDI LockOut Level	(Used when BDI Lockout Enable setting is ON) ※ BDI lockout level: Controller limiting lifting function if battery changing balance is less then set level
Seat Switch Delay	Defining variable of time delay after turning driver seat switch
Traction Cutback Speed	Setting limited drive speed when mast ascends higher than specified height
Mast Cutback Speed	Setting max. drive speed dependent upon max. height of mast
BMS Warning Speed	Defining max. drive speed upon BMS warning 1
BMS Warning Current	Defining max. current upon BMS warning 0
Brake Rate Foot Pedal	Setting deceleration speed (second) from high to low speed by applying full throttle in the operating direction or opposite direction of brake
Brake Rate Else	Setting deceleration speed (second) from high to low speed by applying partial throttle in the non-operating direction or opposite direction of brake
T mode Speed	(Turtle mode) Setting max. rpm of drive motor; partially applied throttle proportional with speed Example: 40% throttle is identical with 40% of max. set speed.
T mode Drive Current	(Turtle mode) Setting max. RMS current supplied to motor during drive in proportional with full current of controller ※ Reducing this value drops max. torque of drive motor.
R mode Fwd Max Speed	(Rabbit mode, Forwarding) Setting max. rpm of drive motor; partially applied throttle proportional with speed Example: 40% throttle is identical with 40% of max. set speed.
R mode Rev Max Speed	(Rabbit mode, Reversing) Setting max. rpm of drive motor; partially applied throttle proportional with speed Example: 40% throttle is identical with 40% of max. set speed.
R mode Drive Current	(Rabbit mode) Setting max. RMS current supplied to motor during drive in proportional with full current of controller ※ Reducing this value drops max. torque of drive motor.
H mode Fwd Max Speed	(H mode, Forwarding) Setting max. rpm of drive motor; partially applied throttle proportional with speed Example: 40% throttle is identical with 40% of max. set speed.
H mode Rev Max Speed	(H mode, Reversing) Setting max. rpm of drive motor; partially applied throttle proportional with speed Example: 40% throttle is identical with 40% of max. set speed.
H mode Drive Current	(H mode) Setting max. RMS current supplied to motor during drive in proportional with full current of controller ※ Reducing this value drops max. torque of drive motor.
N mode Fwd Max Speed	(N mode, Forwarding) Setting max. rpm of drive motor; partially applied throttle proportional with speed Example: 40% throttle is identical with 40% of max. set speed.

Variable	Description
N mode Rev Max Speed	(N mode, Reversing) Setting max. rpm of drive motor; partially applied throttle proportional with speed Example: 40% throttle is identical with 40% of max. set speed.
N mode Drive Current	(N mode) Setting max. RMS current supplied to motor during drive in proportional with full current of controller ※ Reducing this value drops max. torque of drive motor.
E mode Fwd Max Speed	(E mode, Forwarding) Setting max. rpm of drive motor; partially applied throttle proportional with speed Example: 40% throttle is identical with 40% of max. set speed.
E mode Rev Max Speed	(E mode, Reversing) Setting max. rpm of drive motor; partially applied throttle proportional with speed Example: 40% throttle is identical with 40% of max. set speed.
E mode Drive Current	(E mode) Setting max. RMS current supplied to motor during drive in proportional with full current of controller ※ Reducing this value drops max. torque of drive motor.
T mode Full Accel Rate HS	(Turtle mode) Setting accelerated speed (second) in high speed when applying full acceleration pedal ※ Larger setting stands for slower response.
T mode Full Accel Rate LS	(Turtle mode) Setting accelerated speed (second) in low speed when applying full acceleration pedal ※ Larger setting stands for slower response.
R mode Full Accel Rate HS	(Rabbit mode) Setting accelerated speed (second) in high speed when applying full acceleration pedal ※ Larger setting stands for slower response.
R mode Full Accel Rate LS	(Rabbit mode) Setting accelerated speed (second) in low speed when applying full acceleration pedal ※ Larger setting stands for slower response.
H mode Full Accel Rate HS	(H mode) Setting accelerated speed (second) in high speed when applying full acceleration pedal ※ Larger setting stands for slower response.
H mode Full Accel Rate LS	(H mode) Setting accelerated speed (second) in low speed when applying full acceleration pedal ※ Larger setting stands for slower response.
N mode Full Accel Rate HS	(N mode) Setting accelerated speed (second) in high speed when applying full acceleration pedal ※ Larger setting stands for slower response.
N mode Full Accel Rate LS	(N mode) Setting accelerated speed (second) in low speed when applying full acceleration pedal ※ Larger setting stands for slower response.
E mode Full Accel Rate HS	(E mode) Setting accelerated speed (second) in high speed when applying full acceleration pedal ※ Larger setting stands for slower response.

Variable	Description
E mode Full Accel Rate LS	(E mode) Setting accelerated speed (second) in low speed when applying full acceleration pedal ※ Larger setting stands for slower response.
Low Accel Rate	Setting accelerated speed (second) in low speed when applying full acceleration pedal ※ The setting is adjusted typically for giving effects on mobility at low speed.
Neutral Decel Rate HS	Setting decelerated speed (second) in neutral position during high speed drive
Neutral Decel Rate LS	Setting decelerated speed (second) in neutral position during low speed drive
Position Hold Timeout Time	Setting max. time for stopping lift truck before starting drive after stop. Setting the variable to zero deactivates the function. Setting time for function activating.
Forward Map	Adjusting response of lift truck for throttle input. Setting throttle map to 50% provides linear output response to throttle position. Value below 50% reduces controller output at low throttle setting providing increased mobility at low speed drive. Value above 50% provides faster and more response to lift truck under low throttle setting.
Reverse Map	Description is same as Forward Map, and applied to reversing.
Speed to RPM	Coefficient of rpm conversion for drive speed. Km/h : RPM (G/d)×5305, G = gear ratio, d = tire diameter (mm) MPH : RPM (G/D)×336.1, G = gear ratio, d = tire diameter (inch)

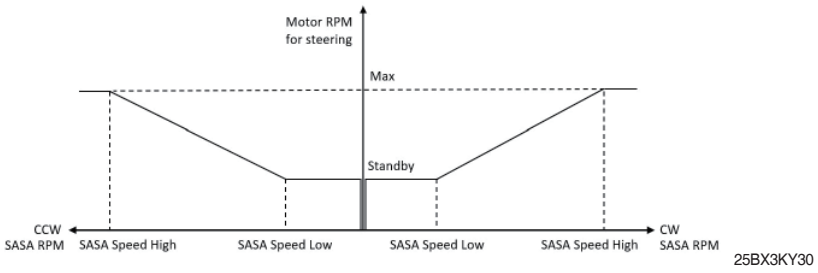
Adjustment	Description
Traction Motor Fan Starting Temp	(Motor Fan Working Type: For Option #2 , in use) Setting temperature of drive motor with working fan.
Pump Motor Fan Starting Temp	(Motor Fan Working Type: For Option #2 , in use) Setting temperature of pump motor with working fan.
OCV 10 Percent Voltage	1. Upon starting 1) The controller obtains battery voltage from key input. 2) BDI changes BDI conditions through "OCV 10 Percent Voltage" and “OCV Percent Voltage." If BDI is existing BDI ± "BDI RESET 1,” not change is made.
OCV 100 Percent Voltage	
BDI Reset 1	
BDI Reset 2	2. Neutral (Motor inactive)
Standby Time	1) The controller obtains battery voltage from B+ input when motor is not operating during "Standby Time." 2) BDI changes BDI conditions through "OCV 10 Percent Voltage" and “OCV Percent Voltage." If BDI is existing BDI ± "BDI RESET 2,” not change is made.

Adjustment	Description
Reset Volts Per Cell Full Volts Per Cell Empty Volts Per Cell Discharge Time BDI Reset Percent	3. Discharging (during motor operation) - Full Volts Per Cell: Full voltage level is set to B+ standing for 100% charging. If voltage drops below this level, charged voltage starts losing. ※ Full voltage level = Total volts/cell × cells in battery pack (24 cells) - Empty Volts Per Cell: Empty voltage level is set to capacitor voltage standing for 0 % charging. ※ Empty voltage level = Empty volts/cell × cells in battery pack (24 cells) - Discharge Time: Sets the least time for reducing from 100% to 0% during BDI algorithm. BDI algorithm integrates time when filtered capacity voltage is below charged voltage level. If accumulated time exceeds “Discharging time/100,” percentile of BDI is reduced to 1% point, and new conditions of charged voltage level are calculated. ※ State of Charge Level = [(Full Voltage Level - Empty Voltage Level) × BDI percent/100] + Empty Voltage Level - Reset Volts Per Cell: Not in use - BDI Reset Percent: Not in use

② Pump inverter

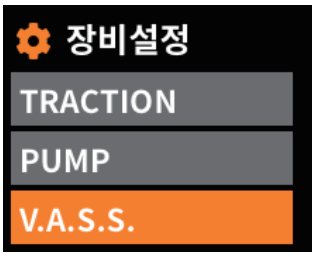
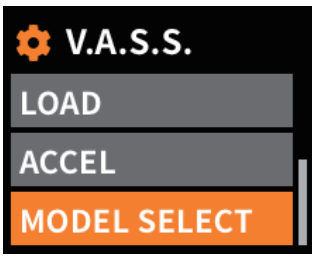
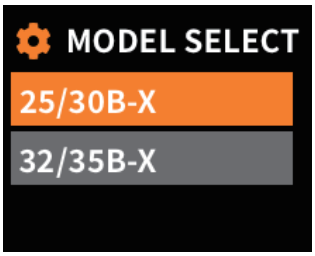
Set options	Description
Fingertip Enable	- ON : Fingertip, an electric hydraulic system, is mounted. Activating current of CAN 1353-6101 (fingertip controller) and 1236SE-5621 (pump controller) - OFF : Mechanical hydraulic system mounted
SASA Sensor Enable	- ON : Activating current of CAN SASA sensor and 1236SE-5621 (pump controller) - OFF : Deactivating current of CAN SASA sensor and 1236SE-5621 (pump controller)
Load Sensor Enable	- OFF : Deactivating load sensor function - ON : Activating load sensor function
Lift Cutback Enable	Pump speed adjustment function activated upon the function setting when mast is higher than specified height - ON : Adjustment activated upon pump speed setting (Pump Cutback Speed) - OFF : Adjustment deactivated upon pump speed setting (Pump Cutback Speed)

Variable	Description
Max Total Speed	Defines motor speed limit. Motor speed includes all of lift, tilting and steering. Speed is limited to setting even if requested value is greater than the setting.
BMS Warning Current	Defining max. current upon BMS warning 0
Lift Speed BMS Warning Mode	Defining max. current upon BMS warning 1
Steer Delay	Defines delay time for keeping motor rpm after completing steering.
Steer Speed Standby	Defines motor speed when steering is requested, if "SASA Sensor Enable" is set to OFF.

Variable	Description
Steer Speed Max	Steering rpm is as shown on the graph below, when "SASA Sensor Enable" is set to ON.
SASA Speed Low	
SASA Speed High	 25BX3KY30
Lift Speed High Mode	(H mode) Defines max. speed of pump motor during lifting function.
Lift Speed Normal Mode	(N mode) Defines max. speed of pump motor during lifting function.
Lift Speed Low Mode	(E mode) Defines max. speed of pump motor during lifting function.
Lift Cutback Speed	Sets pump speed while lift cutback switch operates.
Tilt UP Speed	Defines max. speed of pump motor during rear tilting.
Tilt Down Speed	Defines max. speed of pump motor during forward tilting.
AUX1 Speed	Defines max. speed of pump motor during aux function 1.
AUX2 Speed	Defines max. speed of pump motor during aux function 2.
Decel Rate Lift	Sets deceleration (second) while lift throttle moves to neural position.
Decel Rate Else	Sets deceleration (second) while throttle other than lift is in neutral position.
Accel Rate When Speed Below 500	Sets acceleration (second) when motor speed is below 500 rpm. □ Larger setting stands for slower response.
Full Accel Rate HS	Sets accelerated speed (second) in high speed drive when applying full acceleration pedal.
Full Accel Rate LS	Sets accelerated speed (second) in low speed when applying full acceleration pedal.
Low Accel Rate	Setting accelerated speed (second) in low speed when applying full acceleration pedal

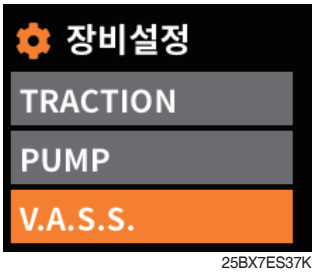
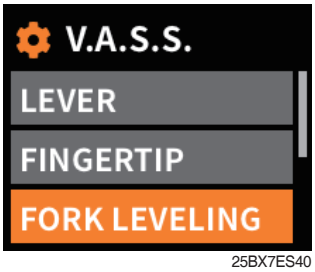
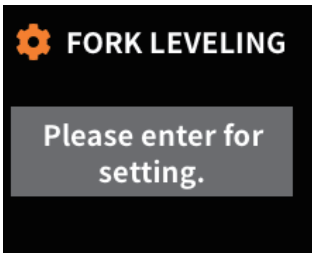
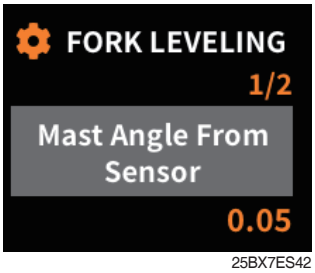
③ Model setting

※ Since there is no MODEL SELECT function supported by 25/30/32/35B-X, it is allowed to changing whole parameters on the display. Therefore, MODEL SELECT value is not stored separately.

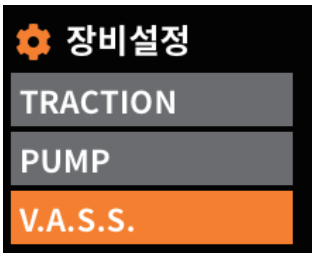
Step	Cluster	Description
1	 25BX3KY26K	Select SYSTEM SETTING menu by pressing “LEFT/ RIGHT” button on TRUCK menu screen, and then press "ENTER" button.
2	 25BX7ES37K	Select VASS menu by pressing “LEFT/RIGHT” button on the system setting menu screen, and press “ENTER” button.
3	 25BX7ES38	Select MODEL SELECT menu by pressing “LEFT/RIGHT” button on VASS screen, and then press "ENTER" button.
4	 25BX7ES39	Select applicable model, and then press “ENTER” button to save it.

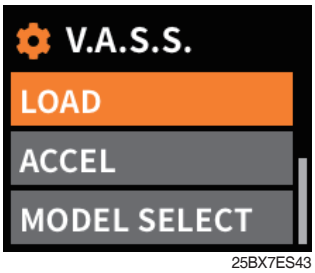
④ AUTO TILT LEVELING SETTING (opt)

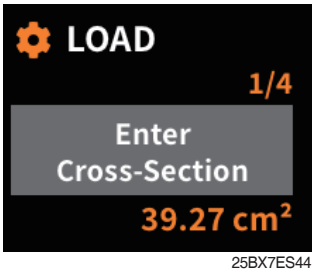
※ The function aligns the mast and the fork horizontal, and should be set as follows before truck shipping, and when replacing controller and tilting sensor:

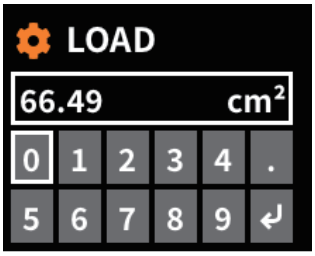
Step	Cluster	Description
1	 25BX7ES37K	1) Select SYSTEM SETTING menu by pressing “LEFT/ RIGHT” button on TRUCK menu screen, and then press "ENTER" button. 2) Select VASS menu by pressing “LEFT/RIGHT” button on the system setting menu screen, and press “ENTER” button.
2	 25BX7ES40	Select FORK LEVELING menu by pressing “LEFT/RIGHT” button on VASS screen, and then press "ENTER" button.
3	 25BX7ES41	3) A screen for setting is displayed as shown on the left. 2) Adjust TILT LEVER to keep the forks horizontal, and then press "ENTER" button.
4	 25BX7ES42	1) Once setting is complete, you can check values of Mast Angle From Sensor and Frame Angle From Sensor as shown on the left. 2) The values are mast/truck angle values received from sensors. Operate TILT LEVER the make sure that Mast Angle From Sensor normally moves.

⑤ **Weight meter setting** (opt)

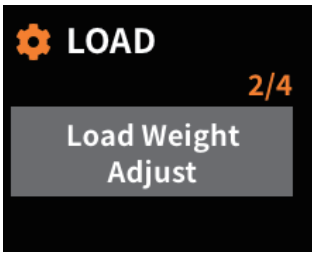
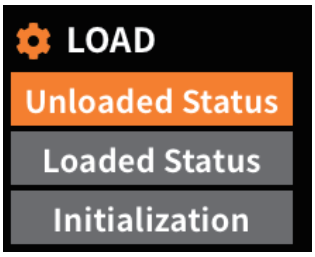
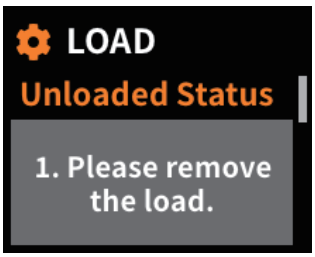
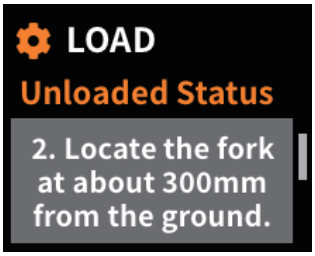
<table>
<tr><th>Step</th><th>Cluster</th><th>Description</th></tr>
<tr><td>1</td><td> 

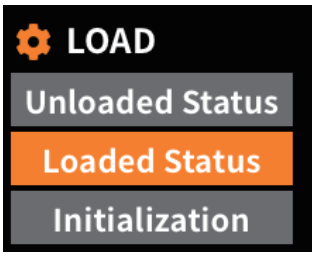
25BX7ES37K</td><td>1) Select SYSTEM SETTING menu by pressing “LEFT/ RIGHT” button on TRUCK menu screen, and then press "ENTER" button.
2) Select VASS menu by pressing “LEFT/RIGHT” button on the system setting menu screen, and press “ENTER” button.</td></tr>
<tr><td>2</td><td> 

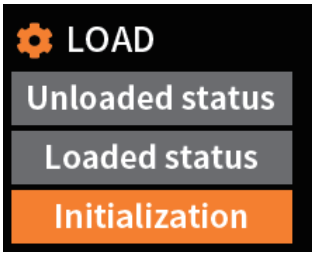
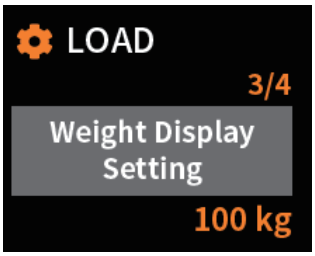
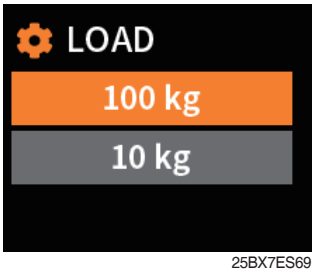
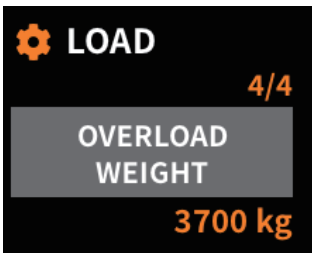
25BX7ES43</td><td>Select LOAD menu by pressing “LEFT/RIGHT” button on VASS screen, and then press "ENTER" button.</td></tr>
<tr><td>3</td><td> 

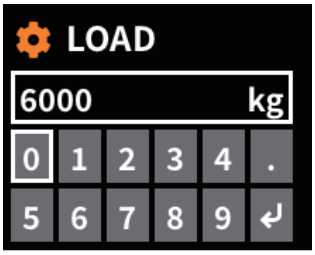
25BX7ES44</td><td>Select Cylinder Enter Cross-Section menu by pressing “LEFT/RIGHT” button on LOAD menu screen, and then press "ENTER" button.</td></tr>
<tr><td rowspan="2">5</td><td> 

25BX7ES45</td><td>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.</td></tr>
<tr><td colspan="2">※ Cylinder cross section
<table>
<tr><th>Model</th><th>Option</th><th>Lift cylinder
Cross section (cm2)</th><th>Pre-lift cylinder
Cross section (cm2)</th></tr>
<tr><td rowspan="7">25/30B-X</td><td>V</td><td>39.27</td><td>-</td></tr>
<tr><td>VF</td><td>25.13</td><td>56.75</td></tr>
<tr><td>TF</td><td>39.27</td><td>44.18</td></tr>
<tr><td>TS</td><td>39.27</td><td>47.52</td></tr>
<tr><td>QF</td><td>56.55</td><td>44.18</td></tr>
<tr><td>VS</td><td>25.13</td><td>56.55</td></tr>
<tr><td rowspan="7">32/35B-X</td><td>V</td><td>47.52</td><td>-</td></tr>
<tr><td>VF</td><td>25.13</td><td>56.75</td></tr>
<tr><td>TF</td><td>47.52</td><td>56.75</td></tr>
<tr><td>TS</td><td>47.52</td><td>56.55</td></tr>
<tr><td>QF</td><td>56.55</td><td>44.18</td></tr>
<tr><td>VS</td><td>25.13</td><td>56.55</td></tr>
</table></td></tr>
</table>

Step	Cluster	Description
6	 25BX7ES46	Make sure that setting has been complete as shown on the left.
7	 25BX7ES47	Select Load Weight Adjust menu by pressing “LEFT/ RIGHT” button on LOAD menu screen, and then press "ENTER" button.
8	 25BX7ES48	Select Unloaded Status menu by pressing “LEFT/RIGHT” button on LOAD menu screen, and then press "ENTER" button.
9	 25BX7ES49	A screen for setting is displayed as shown on the top left.
	 25BX7ES50	Pressing "RIGHT" button switches the screen as shown on bottom left.
	 25BX7ES51	Do not lift load, lift the forks 300 mm from the ground, and then press "ENTER" three seconds later.

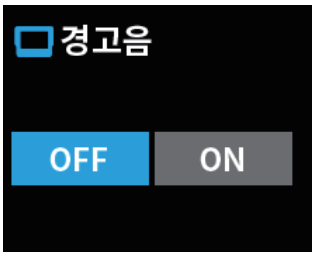
Step	Cluster	Description
10	 25BX7ES52	Make sure that setting has been complete as shown on the left.
11	 25BX7ES53	Select Load Weight Adjust menu by pressing “LEFT/ RIGHT” button on LOAD menu screen, and then press "ENTER" button.
12	 25BX7ES54	1) A screen for entering load weight is displayed as shown on the left. 2) Enter load weight to be used for setting, and select "ENTER" button image.
13	 25BX7ES55	1) A screen for setting is displayed as shown on the left. Pick load, lift the forks 300 mm from the ground, and then press "ENTER" three seconds later.
14	 25BX7ES56	Make sure that setting has been complete as shown on the left.

Step	Cluster	Description
15	 25BX7ES65  25BX7ES66  25BX7ES67	It is allowed to initialize Unloaded Status and Loaded Status by pressing "LEFT/RIGHT" button on LOAD menu screen, and then pressing "ENTER" button. ※ The screen is used if setting is erroneous due to sensor failure.
16	 25BX7ES68  25BX7ES69	1) It is possible to change unit of weight in the third menu, the load weight indication setting. (1) 100 kg: Value on second digit discarded (2) 10 kg : Value on first digit discarded 2) Press "ENTER" button to check weight indication functions of respective settings, change the value to default 100 kg.
17	 25BX7ES57	Select OVERLOAD menu by pressing “LEFT/RIGHT” button on LOAD menu screen, and then press "ENTER" button.

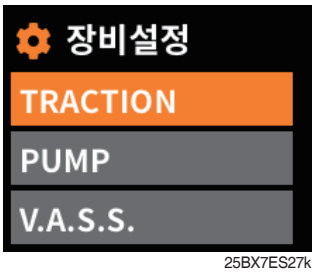
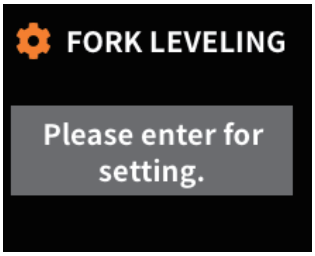
<table>
<tr><th>Step</th><th>Cluster</th><th>Description</th></tr>
<tr><td rowspan="2">18</td><td> 

25BX7ES58</td><td>1) A screen for entering load weight is displayed as shown on the left.
2) Enter value by referring to OVERLOAD WEIGHT, and then select “ENTER” button image.</td></tr>
<tr><td colspan="2">※ OVERLOAD WEIGHT
<table>
<tr><th rowspan="2">Mast</th><th colspan="2">25B-X</th><th colspan="2">30B-X</th><th colspan="2">32B-X</th><th colspan="2">35B-X</th></tr>
<tr><th>Rated</th><th>OVERLOAD WEIGHT</th><th>Rated</th><th>OVERLOAD WEIGHT</th><th>Rated</th><th>OVERLOAD WEIGHT</th><th>Rated</th><th>OVERLOAD WEIGHT</th></tr>
<tr><td>V300</td><td>2500</td><td>2625</td><td>3000</td><td>3150</td><td>3200</td><td>3360</td><td>3500</td><td>3675</td></tr>
<tr><td>V330</td><td>2500</td><td>2625</td><td>3000</td><td>3150</td><td>3200</td><td>3360</td><td>3500</td><td>3675</td></tr>
<tr><td>V350</td><td>2500</td><td>2625</td><td>3000</td><td>3150</td><td>3200</td><td>3360</td><td>3500</td><td>3675</td></tr>
<tr><td>V370</td><td>2500</td><td>2625</td><td>3000</td><td>3150</td><td>3200</td><td>3360</td><td>3500</td><td>3675</td></tr>
<tr><td>V400</td><td>2500</td><td>2625</td><td>3000</td><td>3150</td><td>3180</td><td>3340</td><td>3500</td><td>3675</td></tr>
<tr><td>V430</td><td>2430</td><td>2555</td><td>2920</td><td>3070</td><td>3110</td><td>3270</td><td>3390</td><td>3560</td></tr>
<tr><td>V450</td><td>2390</td><td>2510</td><td>2870</td><td>3015</td><td>3060</td><td>3215</td><td>3340</td><td>3510</td></tr>
<tr><td>V470</td><td>2350</td><td>2470</td><td>2830</td><td>2975</td><td>3010</td><td>3165</td><td>3290</td><td>3455</td></tr>
<tr><td>V500</td><td>2300</td><td>2415</td><td>2770</td><td>2910</td><td>2950</td><td>3100</td><td>3210</td><td>3375</td></tr>
<tr><td>VF/VS295</td><td>2500</td><td>2625</td><td>3000</td><td>3150</td><td>3200</td><td>3360</td><td>3500</td><td>3675</td></tr>
<tr><td>VF/VS325</td><td>2500</td><td>2625</td><td>3000</td><td>3150</td><td>3200</td><td>3360</td><td>3500</td><td>3675</td></tr>
<tr><td>VF/VS345</td><td>2500</td><td>2625</td><td>3000</td><td>3150</td><td>3200</td><td>3360</td><td>3500</td><td>3675</td></tr>
<tr><td>TF/TS370</td><td>2500</td><td>2625</td><td>3000</td><td>3150</td><td>3200</td><td>3360</td><td>3500</td><td>3675</td></tr>
<tr><td>TF/TS400</td><td>2500</td><td>2625</td><td>3000</td><td>3150</td><td>3120</td><td>3280</td><td>3410</td><td>3585</td></tr>
<tr><td>TF/TS430</td><td>2410</td><td>2535</td><td>2880</td><td>3025</td><td>3050</td><td>3205</td><td>3330</td><td>3500</td></tr>
<tr><td>TF/TS450</td><td>2370</td><td>2490</td><td>2830</td><td>2975</td><td>3000</td><td>3150</td><td>3280</td><td>3445</td></tr>
<tr><td>TF/TS470</td><td>2330</td><td>2450</td><td>2790</td><td>2930</td><td>2950</td><td>3100</td><td>3230</td><td>3395</td></tr>
<tr><td>TF/TS500</td><td>1880</td><td>1975</td><td>2250</td><td>2365</td><td>2500</td><td>2625</td><td>2650</td><td>2785</td></tr>
<tr><td>TF/TS550</td><td>1550</td><td>1630</td><td>1750</td><td>1840</td><td>2200</td><td>2310</td><td>2380</td><td>2500</td></tr>
<tr><td>TF/TS600</td><td>1400</td><td>1470</td><td>1450</td><td>1525</td><td>1500</td><td>1575</td><td>1700</td><td>1785</td></tr>
<tr><td>TF/TS650</td><td>1350</td><td>1420</td><td>1400</td><td>1470</td><td>1450</td><td>1525</td><td>1590</td><td>1670</td></tr>
<tr><td>TF/TS700</td><td>1150</td><td>1210</td><td>1200</td><td>1260</td><td>1250</td><td>1315</td><td>1350</td><td>1420</td></tr>
<tr><td>QF610</td><td>1650</td><td>1735</td><td>1700</td><td>1785</td><td>1800</td><td>1890</td><td>1920</td><td>2020</td></tr>
<tr><td>QF660</td><td>1450</td><td>1525</td><td>1500</td><td>1575</td><td>1600</td><td>1680</td><td>1720</td><td>1810</td></tr>
<tr><td>QF700</td><td>1100</td><td>1155</td><td>1200</td><td>1260</td><td>1300</td><td>1365</td><td>1410</td><td>1485</td></tr>
<tr><td>QF745</td><td>850</td><td>895</td><td>900</td><td>945</td><td>1000</td><td>1050</td><td>1100</td><td>1155</td></tr>
</table></td></tr>
<tr><td>19</td><td> 

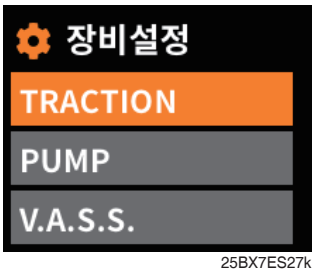
25BX7ES46</td><td>Make sure that setting has been complete as shown on the left.</td></tr>
</table>

Step	Cluster	Description
20	 25BX7ES59K	1) Press "LEFT/RIGHT" button on SCREEN SET menu to select Buzzer menu. 2) Press "ENTER" button to access Language Setting.
21	 25BX7ES60K	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.

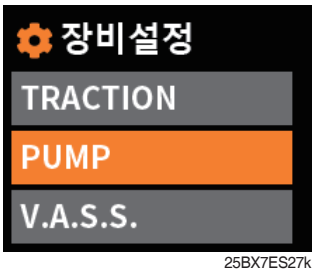
⑥ Setting seat and seat belt interlock

Step	Cluster	Description
1	 25BX7ES26K	Select SYSTEM SETTING menu by pressing “LEFT/ RIGHT” button on TRUCK menu screen, and then press "ENTER" button.
2	 25BX7ES27k	1) A screen for selecting controller in TRUCT SETTING menu is displayed as shown on the left. 2) Use "LEFT/RIGHT" button to make selection for each model, and then press "ENTER" button. · 25/30/32/35B-X → TRACTION - SET OPTION
3	 25BX7ES41	1) Press "LEFT/RIGHT" button to find Safety Belt Sequence Option parameter. 2) When Safety Belt Sequence Option is found, default NONE is displayed as shown on the left. 3) There three Safety Belt Sequence Options: (1) NONE: Truck operating when turning Seat switch to ON position ※ FG17/36/38/40/43, BI00 (2) OPTION #1: Truck operating when turning Seat & Belt Switch to ON position ※ FG37/39. BI00 (3) OPTION #2: Turing Seat Switch to ON position Truck operating when turning Belt Switch to ON position ※ FG37/39, BI01 ※ Option 2 should satisfy operation sequences of Seat and Belt Switches. 4) When you desire to change the setting, press "ENTER” button, and make use of "LEFT/RIGHT" button to select desired option, and then press “ENTER" button. 5) Turn Truck Key to OFF and then ON position once.

⑦ Lithium Ion Battery Setting (opt)

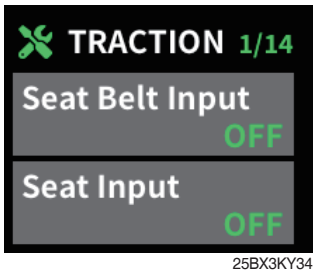
Step	Cluster	Description
1	 25BX7ES26K	Select SYSTEM SETTING menu by pressing “LEFT/ RIGHT” button on TRUCK menu screen, and then press "ENTER" button.
2	 25BX7ES27k	1) A screen for selecting controller in TRUCT SETTING menu is displayed as shown on the left. 2) Use "LEFT/RIGHT" button to make selection for each model, and then press "ENTER" button. · 25/30/32/35B-X → TRACTION - SET OPTION
3	 25BX7ES61	1) Press "LEFT/RIGHT" button to search Lithium Battery Enable parameter. 2) When Lithium Battery Enable parameter is searched, default OFF is displayed as shown on the left. 3) 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.
4	 25BX7ES62	1) Lithium Battery Enable parameter is changed to ON as shown on the left. 2) Turn Truck Key to OFF and then ON position once.

⑧ **Fingertip Lever Setting** (opt)

Step	Cluster	Description
1	 25BX7ES26K	Select SYSTEM SETTING menu by pressing “LEFT/ RIGHT” button on TRUCK menu screen, and then press "ENTER" button.
2	 25BX7ES27k	1) A screen for selecting controller in TRUCT SETTING menu is displayed as shown on the left. 2) Use "LEFT/RIGHT" button to make selection for each model, and then press "ENTER" button. ·25/30/32/35B-X PUMP - SET OPTION
3	 25BX7ES61	1) Access the menu, and search Fingertip Enable parameter. 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.
4	 25BX7ES62	1) Fingertip Enable parameter is changed to ON as shown on the left. 2) Turn Truck Key to OFF and then ON position once.

(3) Monitoring

You can check the conditions of the drive, the pump, and the fingertip controllers.



① Drive inverter

Monitoring	Description
Seat Belt Input	Seat Belt Switch entered (Pin 12, Switch 6)
Seat Input	Seat Switch entered (Pin 9, Switch 3)
Brake Switch Input	Brake Switch entered (Pin 10, Switch 4)
Forward Switch Input	Forward Switch entered (Pin 22, Switch 7)
Reverse Switch Input	Reverse Switch entered (Pin 33, Switch 8)
Throttle Command	Percentage of request for throttle of acceleration pedal
Throttle Pot_Accel. Pedal 1	Input voltage of acceleration pedal (analog signal increasing) (Pin 16)
Pot2 Raw_Accel. Pedal 2	Input voltage of acceleration pedal (analog signal decreasing) (Pin 17)
SW1_Brake oil SW	Brake Oil Switch entered (Pin 24, Switch 1)
SW4_Pedal brake SW	Brake Pressure Switch entered (Pin 10, Switch 4)
SW5_Parking brake SW	Parking Brake Switch entered (Pin 11, Switch 5)
Dig7 Input_B.C.Door SW	Battery Charging Door Switch entered (Pin 20, Digital Out 7)
SW16_SBR SW	SBR Switch entered (Pin 14, Switch 16)
Driver 1 PWM_M.C.	Voltage applied to main connector coil (Pin 6, Driver 1 PWM) The value is identical with mandatory circulation value applied on PWM, and indicated in percentage.
Driver 2 PWM T.Fan.R.	Voltage applied to main driver motor fan relay (Pin 5, Driver 2 PWM) The value is identical with mandatory circulation value applied on PWM, and indicated in percentage.
5 Volts	Voltage at +5V output (Pin 26)

Monitoring	Description
12 Volts	Voltage at +12 V output (Pin 25)
Ext Supply Current	Current of combination of external +12V and +5V supplies (Pins 25 & 26)
BDI	Battery charging status
Capacitor Voltage	Voltage of capacitor bank in the controller at B+ terminal
Keyswitch Voltage	Voltage at KSI (Pin 1)
Motor RPM	Motor rpm
Motor Temperature	Temperature of drive motor
MotorSpeed A	Motor rpm of encoder Phase A speed
MotorSpeed B	Motor rpm of encoder Phase B speed
Current (RMS)	RMS current of controller considering all of three phases
Frequency	Frequency of controller
Controller Temp.	Temperature inside controller
Controller SW ver	Controller software version

② Pump inverter

Monitoring	Description
Pressure Sensor	Input of load sensor potentiometer (analog signal) (Cluster Pin 34)
Weight	Measured weight of load
Mast Angle From Sensor	Angle calculated from CAN data of gravity sensor mounted on mast
Mast Angle	Calculated angels of "Mast Angle From Sensor" and "Mast Angle Offset"
Mast Angle Offset	When setting to 0˚, stored mast angle sensor offset
Frame Angle From Sensor	Angle calculated from CAN data of gravity sensor mounted on frame
Frame Angle	Calculated angels of "Frame From Sensor" and "Mast Angle Offset"
Frame Angle Offset	When setting to 0˚, stored frame angle sensor offset
Steer Angle	Steering wheel angle from SASA sensor
Steer Speed	Speed upon steering wheel angle from SASA sensor
Manual_Lift Pot	Lift lever throttle pot from CAN data of MCV sensor box
Manual_Tilit Pot	Tilting lever throttle pot from CAN data of MCV sensor box
Manual_Aux1 Pot	Aux. 1 lever throttle pot from CAN data of MCV sensor box
Manual_Aux2 Pot	Aux. 2 lever throttle pot from CAN data of MCV sensor box
F.tip_Lift Lower Pot	Lift lever throttle pot from CAN data of fingertip controller
F.tip_Tilit Pot	Tilting lever throttle pot from CAN data of fingertip controller
F.tip_Aux1 Pot	Aux. 1 lever throttle pot from CAN data of fingertip controller
F.tip_Aux2 Pot	Aux. 2 lever throttle pot from CAN data of fingertip controller
SW4_Lift CB SW	Input of Lift Cutback Switch (Pin 10, Switch 4)

Monitoring	Description
SW16_Tilt Leveling SW	Input of Auto Tilt Leveling Switch (Pin 14, Switch 16)
Driver 1 PWM P.Fan. R.	Voltage applied pump motor fan relay (Pin 6, Driver 1 PWM) The value is identical with mandatory circulation value applied on PWM, and indicated in percentage.
Driver 2 PWM_OPSS	Voltage applied to drive motor fan relay (Pin 5, Driver 2 PWM) The value is identical with mandatory circulation value applied on PWM, and indicated in percentage.
5 Volts	Voltage at +5V output (Pin 26)
12 Volts	Voltage at +12 V output (Pin 25)
Ext Supply Current	Current of combination of external +12V and +5V supplies (Pins 25 & 26)
Capacitor Voltage	Voltage of capacitor bank in the controller at B+ terminal
Keyswitch Voltage	Voltage at KSI (Pin 1)
Motor RPM	Motor rpm
Motor Temperature	Temperature of pump motor
MotorSpeed A	Motor rpm of encoder Phase A speed
MotorSpeed B	Motor rpm of encoder Phase B speed
Current (RMS)	RMS current of controller considering all of three phases
Frequency	Frequency of controller
Controller Temp.	Temperature inside controller
Controller SW ver	Controller software version

③ Fingertip inverter

Monitoring	Description
Battery Voltage	Voltage at KSI (Pin 1)
Driver 1 Current_Lift Up	Driver 1 current output (Pin 23)
Driver 1 PWM_Lift Up	Driver 1 PWM output The value is identical with mandatory circulation value applied on PWM, and indicated in percentage.
Driver 2 Current_Lift Lowering	Driver 2 current output (Pin 22)
Driver 2 PWM_Lift Lowering	Driver 2 PWM output The value is identical with mandatory circulation value applied on PWM, and indicated in percentage.
Driver 3 Current_Tilt In	Driver 3 current output (Pin 21)
Driver 3 PWM_Tilt In	Driver 3 PWM output The value is identical with mandatory circulation value applied on PWM, and indicated in percentage.
Driver 4 Current_Tilt Out	Driver 4 current output (Pin 20)
Driver 4 PWM_Tilt Out	Driver 4 PWM output The value is identical with mandatory circulation value applied on PWM, and indicated in percentage.

Monitoring	Description
Driver 5 Current_Aux1 In	Driver 5 current output (Pin 19)
Driver 5 PWM_Aux1 In	Driver 5 PWM output The value is identical with mandatory circulation value applied on PWM, and indicated in percentage.
Driver 6 Current_Aux1 Out	Driver 6 current output (Pin 18)
Driver 6 PWM_Aux1 Out	Driver 6 PWM output The value is identical with mandatory circulation value applied on PWM, and indicated in percentage.
Driver 7 Current_Aux2 In	Driver 7 current output (Pin 17)
Driver 7 PWM_Aux2 In	Driver 7 PWM output The value is identical with mandatory circulation value applied on PWM, and indicated in percentage.
Driver 8 Current_Aux2 Out	Driver 8 current output (Pin 16)
Driver 8 PWM_Aux2 Out	Driver 8 PWM output The value is identical with mandatory circulation value applied on PWM, and indicated in percentage.
Driver 9 Current	Driver 9 current output (Pin 15)
Driver 9 PWM	Driver 9 PWM output The value is identical with mandatory circulation value applied on PWM, and indicated in percentage.
Controller SW ver	Controller software version

2) ALARMS AND ALARM HISTORY

(1) How to check alarm

The alarm screen is prompted when alarm takes place. You can switch between the main screen and the alarm screen by pressing ( ) and ( ) for one second or longer.

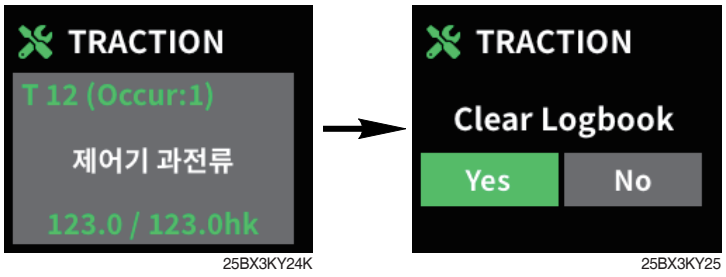
(2) In-depth description of alarm screen

25BX7ES20K

①Green capital letters indicate controller (T: Drive, P: Pump) that triggers alarm.
②Two numbers indicate alarm code.
③Alarm name is displayed.

(3) Alarm history

You can check and delete alarm history as follows:



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

(4) Alarm code

① **Drive and pump controller** (manual)

Code	Alarm	Traveling	Pump	Causes	Symptom and troubleshooting
18	Overcurrent on controller	O	O	1. External short-circuit of phases of U, V or W motor connection 2. Erroneous setting of motor variables 3. Controller defect 4. Noise from speed encoder	Symptom: Phase current exceeding measurement current limit Troubleshooting: Restarting
19	Current sensor failed	O	O	1. Leak of Phase U, V or W to lift truck frame (short-circuit of motor stator) 2. Controller defect	Symptom: Invalid offset reading on controller current sensor Troubleshooting: Restarting
20	Pre-charging failed	O	O	1. Checking Monitoring "Capacitor Voltage" menu 2. External load on capacitor bank (B+ connection terminal) interrupting capacity bank charging	Symptom: Pre-charging failed on capacitor bank Troubleshooting: Restarting, sitting on driver seal, and wearing safety belt

Code	Alarm	Traveling	Pump	Causes	Symptom and troubleshooting
21	Excessively low temperature on controller	O	O	1. Checking “Temperature” menu on Monitoring 2. Operating controller under severe environment	Symptom: Heatsink temperature lower than -40˚C Troubleshooting: Keeping heatsink temperature higher than -40˚C, restarting, sitting on driver seat, and wearing safety belt
22	Excessively high temperature on controller	O	O	1. Checking “Temperature” menu on Monitoring 2. Operating controller under severe environment 3. Excessive load 4. Improper mounting of controller	Symptom: Heatsink temperature exceeding +95˚C Troubleshooting: Keeping heatsink temperature lower than +95˚C, restarting, sitting on driver seat, and wearing safety belt
23	Serious B+ low voltage	O	O	1. Erroneous setting of battery variables 2. Discharging to battery of non-controller system 3. High battery resistance 4. Battery disconnected during drive 5. Checking Monitoring "Capacitor Voltage" menu 6. B+ fuse broken, or main contact not closed	Symptom: FET bridge enabled, and voltage of capacitor bank lower than serious low voltage limit Troubleshooting: Increasing capacity voltage higher than low voltage limit
	Serious KSI low voltage	O	O	1. Checking "Keyswitch Voltage" menu on Monitoring 2. Discharging to battery and KSI circuit of non-controller system 3. KSI disconnected during drive 4. KSI fuse broken	Symptom: Lower voltage lower than voltage drop for 2 seconds Troubleshooting: Increasing low voltage of KSI higher than voltage drop
	※ Serious low voltage: Drive current reduced to 0% for 64 msec, or reaching voltage drop, whichever reached first				
24	Serious B+ excessive voltage	O	O	1. Checking Monitoring "Capacitor Voltage" menu 2. Erroneous setting of battery variables 3. Excessively high battery resistance on specified regenerative current 4. Battery disconnected during regenerative braking	Symptom: FET bridge enabled, and voltage of capacitor bank higher than serious high voltage limit Troubleshooting: Restarting after reducing capacitor voltage lower than over-voltage limit
	Serious KSI over-voltage	O	O	1. Erroneous connection of battery voltage to KSI (Pin 1) 2. Checking "Keyswitch Voltage" menu on Monitoring ※ If KSI is greater than serious over-voltage limit, prevent closing of main connector.	Symptom: KSI voltage higher than severe over-voltage limit Symptom: Reducing KSI voltage lower than severe over-voltage limit
※ Cutis 13213 portable programmer is used to identify cause of code 17 or 18; B+ or KSI.					

Code	Alarm	Traveling	Pump	Causes	Symptom and troubleshooting
34	Controller overheated	O	O	1. Checking “Temperature” menu on Monitoring 2. Controller capability limited at certain temperature 3. Operating controller under severe environment 4. Excessive load 5. Improper mounting of controller	Symptom: Heatsink temperature exceeding +85℃ Troubleshooting: Keeping heatsink temperature lower than +85℃
35	B+ low voltage	O	O	1. Normal operation. Abnormal condition requiring recharging of battery 2. Controller capability limited at certain voltage 3. Erroneous adjustment of battery variables 4. Discharging to battery of non-controller system 5. Excessively high battery resistance 6. Battery disconnected during drive 7. Checking "Capacitor Voltage" menu on Monitoring 8. B+ fuse broken, or main contact not closed	Symptom: FET bridge enabled, and voltage of capacitor bank lower than low voltage limit Troubleshooting: Increasing capacity voltage higher than low voltage limit
36	B+ over-voltage	O	O	1. Normal operation. Failure due to increase of battery voltage by braking current during regenerative braking 2. Controller capability limited at certain voltage 3. Erroneous adjustment of battery variables 4. Excessively high battery resistance on specified regenerative current 5. Battery disconnected during regenerative braking 6. Checking "Capacitor Voltage" menu on Monitoring	Symptom: FET bridge enabled, and voltage of capacitor bank higher than high voltage limit Troubleshooting: Reducing capacitor voltage lower than over-voltage limit

※ Over-voltage: Max. voltage or user’s over-voltage x lowest rated voltage

※ Serious high voltage: Over-voltage + 10 V

※ Low voltage: Min. voltage or user’s low voltage x highest rated voltage

※ Serious low voltage: Drive current reduced to 0% for 64 msec, or reaching voltage drop, whichever reached first

Rated voltage	Min. voltage	Max. voltage	Voltage drop
24 V	14 V	30 V	12 V
24 - 36 V	16.8 V	45 V	15 V
36 - 48 V	25.2 V	60 V	20 V
48 - 80 V	33.6 V	105 V	20 V
72 - 96 V	50.4 V	120 V	30 V

Code	Alarm	Traveling	Pump	Causes	Symptom and troubleshooting
37	+5V power supply failed	O	O	1. External load impedance on +5V supply (Pin 26) excessively low 2. Checking "5 Volts" and "Ext Supply Current" on Monitoring	Symptom: +5V supply (Pin 26) beyond +5V±10% range Troubleshooting: Keeping voltage within the range
38	Digital output 6 open-circuit/short-circuit	O	O	· Excessively low external impedance on digital output 6 driver (Pin 19)	Symptom: Current of digital output 6 (Pin 19) exceeding 1A Troubleshooting: Resolving cause of over-current
39	Digital output 7 open-circuit/short-circuit	O	O	· Excessively low external impedance on digital output 7 driver (Pin 20)	Symptom: Current of digital output 7 (Pin 20) exceeding 1A Troubleshooting: Resolving cause of over-current
40	Motor overheated	O	O	1. Motor temperature higher than overheating temperature setting, and current reduced 2. Erroneous setting of motor temperature variable setting 3. Checking "Temperature" and "Inputs: Analog2" on Monitoring 4. If motor thermistor is not used, functions of temperature calibration and temperature reduction are deactivated.	Symptom: Motor temperature higher than overheating temperature setting Troubleshooting: Keeping motor temperature within the range
41	Motor temperature sensor failed	O	O	1. Improper connection of motor thermistor 2. If motor thermistor is not used, motor temperature function is deactivated. 3. Checking "Temperature" and "Inputs: Analog2" on Monitoring	Symptom: Motor thermistor input (Pin 8) on voltage rail (0 or 10V) Troubleshooting: Keeping motor thermistor input voltage within the range

Code	Alarm	Traveling	Pump	Causes	Symptom and troubleshooting
49	Coil 1 driver open-/ short-circuit	O	O	1. Open- or short-circuit of driver load 2. Connector pin contaminated 3. Creep or wiring defect	Symptom: Open- or short-circuit of driver 1 (Pin 6). This failure can be set only when mains enabled = OFF. Troubleshooting: Correcting open- or short-circuit, and then cycling driver
	Main contactor coil open-/short-circuit			1. Open- or short-circuit of driver load 2. Connector pin contaminated 3. Creep or wiring defect	Symptom: Open- or short-circuit of main contactor driver 1 (Pin 6). This failure can be set only when mains enabled = ON. Troubleshooting: Correcting open- or short-circuit, and then cycling driver
50	Coil 2 driver open-/ short-circuit	O	O	1. Open- or short-circuit of driver load 2. Connector pin contaminated 3. Creep or wiring defect	Symptom: Open- or short-circuit of driver 2 (Pin 5). This failure can be set only when EM brake type = 0. Troubleshooting: Correcting open- or short-circuit, and then cycling driver
	EM brake open-/ short-circuit			1. Open- or short-circuit of driver load 2. Connector pin contaminated 3. Creep or wiring defect	Symptom: Open- or short-circuit of electromagnetic brake driver 1 (Pin 5). This failure can be set only when EM brake type > 0. Troubleshooting: Correcting open- or short-circuit, and then cycling driver
51	Coil 3 driver open-/ short-circuit	O	O	1. Open- or short-circuit of driver load 2. Connector pin contaminated 3. Creep or wiring defect	Symptom: Open- or short-circuit of driver 3 (Pin 4) Troubleshooting: Correcting open- or short-circuit, and then cycling driver
52	Coil 3 driver open-/ short-circuit	O	O	1. Open- or short-circuit of driver load 2. Connector pin contaminated 3. Creep or wiring defect	Symptom: Open- or short-circuit of driver 4 (Pin 3) Troubleshooting: Correcting open- or short-circuit, and then cycling driver
53	Open-/short-circuit of electromagnetic proportional driver	O	O	1. Open- or short-circuit of driver load 2. Connector pin contaminated 3. Creep or wiring defect	Symptom: Open- or short-circuit of proportional driver (Pin 2) Troubleshooting: Correcting open- or short-circuit, and then cycling driver

Code	Alarm	Traveling	Pump	Causes	Symptom and troubleshooting
54	Encoder failed Sine/cosine sensor failed	O	O	1. Motor encoder failed 2. Creep or wiring defect 3. Checking "Motor RPM" menu on Monitoring	Symptom: Motor encoder phase failure detected. This failure can be set only when feedback option = 1 (encoder). Troubleshooting: Encoder failure is resolved upon restarting, or LOS Upon Encoder Fault = ON and safety belt is worn. Encoder LOS failure (Code 93) is set, and motor control is limited.
				1. Sin/Cos sensor failed 2. Creep or wiring defect 3. Checking "Motor RPM" menu on Monitoring	Symptom: Difference larger than Sin/Cos failure critical value % from value estimated between two phases takes place five times or more in one second. This failure can be set only when feedback option = 2 (Sin/Cos). Troubleshooting: Input in LOS mode upon restarting or activation.
	※ 25/30/32/35B-X is Feedback Options = 1 (Encoder).				
55	Motor phase open-circuit	O	O	1. Motor phase open-circuit 2. Creep or wiring defect	Symptom: Motor phase U, V or W open-circuit detected Troubleshooting: Restarting
56	Main contactor closed	O	O	1. Closed main contractor tip caught 2. Motor phase U or V disconnected or open-circuit 3. Alternative voltage path (external pre-charging resistor) supplies current to capacitor bank (B+ connection terminal).	Symptom: Capacitor bank voltage (B+ connection terminal) momentarily loaded immediately before main contactor closes, and no voltage discharged Troubleshooting: Restarting
57	Main contactor opened	O	O	1. Main contactor not closed 2. Main contactor tip oxidized, burned or poor of contact. External load on capacitor bank (B+ connection terminal) interrupting capacity bank charging 3. B+ fuse broken	Symptom: Capacity bank voltage (B+ connection terminal) not charged to B+ with command for closing main contactor notified Troubleshooting: Restarting

Code	Alarm	Traveling	Pump	Causes	Symptom and troubleshooting
65	High voltage on acceleration signal 1/Pin 16	O	O	1. Checking “Inputs: Throttle Port" menu on Monitoring 2. Excessively high voltage of throttle pot wiper	Symptom: Voltage of throttle pot wiper (Pin 16) higher than high failure critical value Troubleshooting: Reducing throttle pot wiper voltage lower than failure critical value
66	Low voltage on acceleration signal 1/Pin 16	O	O	1. Checking “Inputs: Throttle Port" menu on Monitoring 2. Excessively low voltage of throttle pot wiper	Symptom: Voltage of throttle pot wiper (Pin 16) lower than low failure critical value Troubleshooting: Increasing throttle pot wiper voltage higher than failure critical value
67	High voltage on acceleration signal 2/Pin 17	O	O	1. Checking “Inputs: Port2 Row" on Monitoring 2. Excessively high voltage of Pot 2 Wiper	Symptom: Voltage of pot 2 wiper (Pin 17) higher than high failure critical value Troubleshooting: Reducing pot 2 wiper voltage lower than failure critical value
68	Low voltage on acceleration signal 2/Pin 17	O	O	1. Checking “Inputs: Port2 Row" on Monitoring 2. Excessively low voltage of Pot 2 Wiper	Symptom: Voltage of pot 2 wiper (Pin 17) lower than low failure critical value Troubleshooting: Increasing pot 2 wiper voltage higher than failure critical value
69	Over-current of potentiometer ground/Pin 18	O	O	1. Checking “Outputs: Port Row" menu on Monitoring 2. Excessively low resistance on combination pot connected to Port Row	Symptom: Current of Port Row (Pin 18) exceeding 10 mA Troubleshooting: Deleting Port Row over-current conditions, and restarting
	※ Pin 18 not in use for 25/30/32/35B-X. Pin 18 is for resistance accelerator type.				
70	EEPROM failed	O	O	1. EEPROM writing failed Beginning with writing on 2. EEPROM started through variable adjustment through VCL, CAN bus, or programmer, or new software update of controller	Symptom: Controller operating system attempted writing on EEPROM only to fail Troubleshooting: Setting default variables matched with downloaded correct software (OS), and restarting

Code	Alarm	Traveling	Pump	Causes	Symptom and troubleshooting
71	Error in operation sequences	O	O	1. Input of KSI, interlock, direction and throttle applied in wrong sequences 2. Switch defects on wiring, crimp or KSI, interlock, direction or throttle 3. Checking "Inputs" menu on Monitoring	Symptom: Wrong sequences of input of KSI, interlock, direction and throttle, or HPD (High Pedal Disable) Troubleshooting: Reapplying input in correct sequences
	Emer Rev HPD			· Emergency reverse operation was complete; however, throttle forwarding and reversing input and interlock did not returned to neutral position.	Symptom: All of inputs did not returned to the neutral position upon completion of emergency reversing to cause failure. This failure is set only when EMR_Interlock = ON. Troubleshooting: In case of EMR_Interlock = ON, delete inputs of interlock, throttle and direction. In case of EMR_Interlock = ON, delete inputs of throttle and direction.
	※ 25/30/32/35B-X is EMR_Interlock = OFF.				
73	Error in parameter changing	O	O	· Lift truck will not operate until restarting in case of failure in safety resulted from change of specific variable setting. For example, when user changes throttle type, this failure is indicated. Lift truck will operate only upon restarting.	Symptom: Restarting after adjusting variables Troubleshooting: Restarting
81	Poor hydraulic controller communication	O		1. Defects on crimp or wiring between drive controller and 2. pump controller 3. Connector pin contaminated Failure of pump controller	Symptom: CAN current failed between drive and pump controllers upon restarting Alarm is triggered on drive controller while failure is indicated during pump CAN checking upon restarting. Troubleshooting: Restarting
	Poor fingertip controller communication		O	· Input of restarting, interlock, direction and throttle applied in wrong sequences Example: Starting with lift lever kept pulled	Symptom: Wrong sequences of input of KSI, interlock, direction and throttle, or HPD (High Pedal Disable) Troubleshooting: Reapplying input in correct sequences

Code	Alarm	Traveling	Pump	Causes	Symptom and troubleshooting
82	Hydraulic controller communication time exceeded	O		1. Defects on crimp or wiring between drive controller and 2. pump controller 3. Connector pin contaminated Failure of pump controller	Symptom: Gap between receiving CAN PDO of pump controller exceeded PDO receiving limit time Troubleshooting: Restarting or receiving message from CAN NMT
	Fingertip controller communication time exceeded		O	1. Defects on crimp or wiring between pump an d fingertip 2. controllers 3. Connector pin contaminated Failure of pump controller	Symptom: Gap between receiving CAN PDO of fingertip controller exceeded PDO receiving limit time Troubleshooting: Restarting or receiving message from CAN NMT
83	Accelerator signals 1 and 2 not matched to each other	O		1. Accelerator pedal failed 2. Creep or wiring defect 3. Checking “Inputs: Throttle Port" menu on Monitoring 4. Checking “Inputs: Port2 Row" on Monitoring	Symptom: Sum of input voltages of throttle pot and Pot 2 row not same as supply sensor voltage Troubleshooting: Restarting
	Error in operation sequences		O	· Input of restarting, interlock, direction and throttle applied in wrong sequences Example: Pulling lift lever not turning seat turned to ON position	Symptom: Wrong sequences of input of KSI, interlock, direction and throttle, or HPD (High Pedal Disable) Troubleshooting: Reapplying input in correct sequences
84	BMS communication time exceeded	O		· Defective crimp or wiring between drive controller and BMS (Battery Management System)	Symptom: Gap between receiving CAN PDO message exceeded PDO receiving limit time Troubleshooting: Restarting or receiving message from CAN NMT
	SASA communication time exceeded		O	· Defective crimp or wiring between pump controller and SASA steering sensor	Symptom: Gap between receiving CAN PDO of SASA steering sensor exceeded PDO receiving limit time Troubleshooting: Restarting or receiving message from CAN NMT
85	Insufficient brake oil	O		· Insufficient brake oil Brake oil sensor failed Creep or wiring defect Checking “Inputs: Checking Switch 1 (Traction controller)” menu	Symptom: Drive controller switch 1 (Pin 24) turned to ON position Troubleshooting: Checking brake oil tank and sensor

Code	Alarm	Traveling	Pump	Causes	Symptom and troubleshooting
86	SBR switch opened	O		1. SBR (Side Battery Removal) switch opened 2. SBR switch failed 3. Creep or wiring defect 4. Checking “Inputs: Checking Switch 16 (Traction controller)” menu	Symptom: Drive controller switch 16 (Pin 14) turned to Off position Troubleshooting: Checking SBR switch
87	BMS Not Ready	O		· Battery monitoring system not ready for BMS	Symptom: Battery monitoring system not ready for BMS. Receiving message through CAN Troubleshooting: BMS checking
88	BMS Warning 0	O		· Battery monitoring system in Alarm 0	Symptom: Battery monitoring system in Alarm 0. Receiving message through CAN Troubleshooting: BMS checking
89	Display model error	O		Not in use	Not in use
97	Display not matched	O		Not in use	Not in use
98	BMS Warning 1	O		· Battery monitoring system in Alarm 1	Symptom: Battery monitoring system in Alarm 1. Receiving message through CAN Troubleshooting: BMS checking
99	BMS Fault	O		· Battery monitoring system failed	Symptom: Battery monitoring system failed. Receiving message through CAN Troubleshooting: BMS checking
100	Battery charging door opened	O		1. Battery charging door switch opened 2. SBR switch failed 3. Creep or wiring defect 4. Checking “Inputs: Checking DigOut7 Input (Traction contrroller)" menu	Symptom: DigOut7 Input = OFF on drive controller Troubleshooting: Checking SBR switch
104	VCK run time error	O	O	1. Run time VCL error on VCL code 2. Checking "VCL Error Module" and "VCL Error" on Monitoring 3. This error is comparable with definition of VCL module ID and error code contained in specific OS system information file.	Symptom: Run time VCL code error Troubleshooting: Editing VCL application software to correct the error conditions. Flashing with default variable matched with newly edited software; restarting.

Code	Alarm	Traveling	Pump	Causes	Symptom and troubleshooting
105	5/12V supply power defective	O	O	1. External load supplying 5V or 12V causing induction of excessively large or small current 2. Error in adjusting of failure checking menu variables of "Ext Supply Max" and "Ext Supply Min" 3. Checking "Ext Supply Current" menu on Monitoring	Symptom: External supply current [combination current used for 5V supply (Pin 26) and 12V (Pin 25)] exceeding top current critical value or less than bottom current critical value. Two critical values are defined as max. external supply variable and min. external supply variable respectively. Troubleshooting: Keeping external supply current within the range
	□ Max. external supply value is 200 mA, and min. external supply value 0 mA on 25/30/32/35B-X.				
113	Operating system failed	O	O	· Defect inside the controller	Symptom: Defect inside the controller detected Troubleshooting: Restarting
114	CAN communication time exceeded	O	O	· Gap between receiving CAN PDO message exceeded PDO receiving limit time	Symptom: Gap between receiving CAN PDO message exceeded PDO receiving limit time Troubleshooting: Restarting or receiving message from CAN NMT
115	Motor locked	O	O	1. Motor locked 2. Motor encoder failed 3. Creep or wiring defect 4. Trouble of power supply of motor encoder. 5. Checking "Motor RPM" menu on Monitoring	Symptom: Motor encoder movement not detected Troubleshooting: Restarting; or if variable LOS Upon Encoder Fault = ON, and interlock cycled, motor locking is deleted, and Encoder LOS failure (Code 93) is set, and motor control is limited.
116	Dual drive failed	O	O	· Dual drive failed: See the dual drive manual.	25/30/32/35B-X is single drive.
117	Serious dual drive failure	O	O	· Dual drive failed: See the dual drive manual.	25/30/32/35B-X is single drive.
119	Supervisor failed	O	O	1. Supervisor sending discrepancy between 2. duplicated readings Internal damage of supervisor 3. microprocessor Switch input should be kept within top and bottom critical limits for 100 msec or longer (Check switch for moisture if error persists).	Symptom: Duplicated readings not matched to each other; supervisor damaged; erroneous switch input Troubleshooting: Checking all of switch inputs for noise or voltage conversion; checking connection; restarting

Code	Alarm	Traveling	Pump	Causes	Symptom and troubleshooting
120	Supervisor incompatible	O	O	· Major OS not compatible with Supervisor OS	Symptom: Incompatible software Troubleshooting: Loading proper OS or Supervisor code updating; restarting
130	Internal measurement error	O	O	· Defect inside the controller	Symptom: Defect inside the controller detected Troubleshooting: Restarting
131	Internal power supply error	O	O	· Internal controller defect at supply voltage of driver circuit	Symptom: Defect inside the controller detected Troubleshooting: Restarting
135	Motor characterization error	O	O	1. Motor characterization error during characterization process 2. Checking "Motor Characterization Error for cause" menu on Monitoring 0 = Sequence error due to terminating motor characterization before testing 1 = Encoder signal displayed, but not determined of size; manual setting of encoder step size 2= Motor temperature sensor failed 3= Motor temperature overheat reduction failure 4 = Controller high-temperature reduction failure 5 = Controller low-temperature reduction failure 6 = Low voltage reduction failure 7 = Serious over-voltage failure 8 = No encoder signal displayed, or no one or both channels 9 = Motor variation deviated from characterization scope	Symptom: More characterization failed by variable "Motor_Characteriztion_Test_Enable" OFF before testing. Controller resetting required. Troubleshooting: Defect correction; restarting or VCL resetting
136	Encoder pulse error	O	O	· Variables in individual encoder steps not matched with actual motor encoder	Symptom: Setting error of variable detected in each encoder step Troubleshooting: Adjusting variables of each encoder step to match with actual encoder; restarting
137	Motor type error	O	O	· Variable of Motor_Type beyond scope	Symptom: Motor_Type variable setting error Troubleshooting: Motor_Type variable resetting and restarting

Code	Alarm	Traveling	Pump	Causes	Symptom and troubleshooting
145	VCL/OS not matched	O	O	· VCL software inside software not matched with OS software	Symptom: Incompatible between VCL and OS software; Failure identified when detecting incompatibility with software upon restarting Troubleshooting: Downloading correct VCL and OS software to controller
146	EM brake failed	O	O	1. Lift truck movement sensed after receiving request for EM 2. brake setting EM brake not stopping motor rotation	Symptom: Movement of lift truck sensed after receiving request for full application of EM brake Troubleshooting: Throttle activating (EM brake type 2). Interlock activating (EM brake type 1)
	□ 25/30/32/35B-X not mounted with EM brake				
147	Accessing LOS mode	O	O	1. LOS (Limited Operating Strategy) control mode activated to cause encoder failure (Code 36), or detected lockout failure (Code 73) 2. Motor encoder failed 3. Creep or wiring defect 4. Lift truck stopped	Symptom: Encoder failed (Code 36) or detected lockout failure (Code 73) activated; When LOS Upon Encoder Fault = ON and interlock cycle is performed, encoder LOS (Code 93) control mode activated to limit motor control Troubleshooting: Restarting; or if LOS mode is activated by detected lockout failure, check if encoder recognizes RPM = 0 and throttle demand = 0 for proper operation, and delete them.
148	Emer Rev time exceeded		O	1. Emergency reversing activated, and stopped upon termination of EMR-set time 2. Input of emergency reversing being caught on ON	Symptom: Emergency reversing activated, and continued until termination of EMR-set time Troubleshooting: Turning emergency reversing input OFF
	□ 25/30/32/35B-X is EMR_Interlock = OFF.				
152	Model number error		O	1. Model_Number variable error Incompatibility between software and hardware 2. Controller defect.	Symptom: Model_Number variable error; checking Model_Number, and failure upon restarting Troubleshooting: Downloading software adequate for controller model

Code	Alarm	Traveling	Pump	Causes	Symptom and troubleshooting
153	Parameter discrepancy		O	1. Dual operation allowed on a single controller 2. Wrong position feedback type selected for motor technology 3. Dual operation allowed on talk mode	Symptom: When dual drive software is available, it is required to set the controller to Speed Mode Express or Speed Mode. Otherwise, failure will be set. Motor Technology = 0 should be Feedback Type = 1, and Motor Technology = 1 be Feedback Type = 2. Otherwise, failure will be set. Troubleshooting: Adjusting correct variable, and restarting

② **Drive and pump controller** (fingertip)

Code	Alarm	Traveling	Pump	Description	Results	Troubleshooting
23	Internal error	O	O	Encryption failed	1353 at stop	Request for repair, and ATS testing
24	EEPROM error	O	O	Improper use of EEPROM, or checksum not matched	All outputs stopped	Failure location recorded
25	5V power supply error	O	O	Very low external load impedance at +5V supply	No effects	Keeping voltage within the range
32	12V power supply error	O	O	Very low external load impedance at +12 V supply	No effects	Keeping voltage within the range
33	5/12V power over-voltage	O	O	External load exceeding 200 mA at +5V or +12V supply	No effects	Keeping external supply current within the range
34	Flash error	O	O	Flash improperly written	1353 at stop	Failure location recorded
35	Analog input error	O	O	Analog input exceeding 15.5V (input voltage) or 7.5 kΩ (input resistance)	No effects	Keeping analog signal within the range
36	Encoder error	O	O	Encoder cable open-circuit	Encoder counting stopped	Restarting
51	Over-voltage error	O	O	Max. battery voltage = (Rated voltage x 1.25) + 5V	All outputs stopped	Keeping battery within normal range in one second

Code	Alarm	Traveling	Pump	Description	Results	Troubleshooting
52	Low voltage error	O	O	When nominal voltage ≥ 24V, min. battery voltage = (nominal voltage x 0.7) - 5V. When nominal voltage = 12V, min. battery voltage = (nominal voltage x 0.7) - 0.6V	All outputs stopped	Keeping battery within normal range in one second
53	Overheated	O	O	Temperature allowed for heatsink exceeded	All outputs stopped	Keeping temperature within normal range (< 95°C)
54	Low temperature	O	O	Lower than temperature allowed for heatsink	All outputs stopped	Keeping temperature within normal range (≥ 50°C)
55	Over-current	O	O	Total current exceeding 18A	All outputs stopped	Keeping temperature within normal range (< 95°C)
73	Driver 1 error	O	O	Driver under over-current condition (>3.5 amps)	Stopping output from defective driver	Sending request for 0% PDO to defective driver
80	Driver 2 error	O	O			
81	Driver 3 error	O	O			
82	Driver 4 error	O	O			
83	Driver 5 error	O	O			
84	Driver 6 error	O	O			
85	Driver 7 error	O	O			
86	Driver 8 error	O	O			
87	Driver 9 error	O	O			
101	Coil 1 error	O	O	Low driver pin output with driver kept OFF Pin opened	Output function disabled for defective driver	Driver pin reconnecting
102	Coil 2 error	O	O			
103	Coil 3 error	O	O			
104	Coil 4 error	O	O			
105	Coil 5 error	O	O			
112	Coil 6 error	O	O			
113	Coil 7 error	O	O			
114	Coil 8 error	O	O			
115	Coil 9 error	O	O			
129	Communication time exceeded	O	O	Communication not received in PDO limit time from master	All of drivers disabled, and command removed	Receiving new PDO in limit time
130	Communication error detected	O	O	Too many CAN bus errors detected	1353 at stop	Receiving NMT, or bus receiving and transmission restoration

8. BATTERY CHARGER

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

1) BASIC INFORMATION

(1) What is charger

Charger is a device which makes a battery accept DC electricity under optimal condition as it transforms AC provided from external source of electricity. The charger is a constant-current and constant-voltage way, SCR type charger that it has advantages as follows:

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

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

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

④ It prevents from under charging and overcharging.

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

(2) Notice on caring chargers

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

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

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

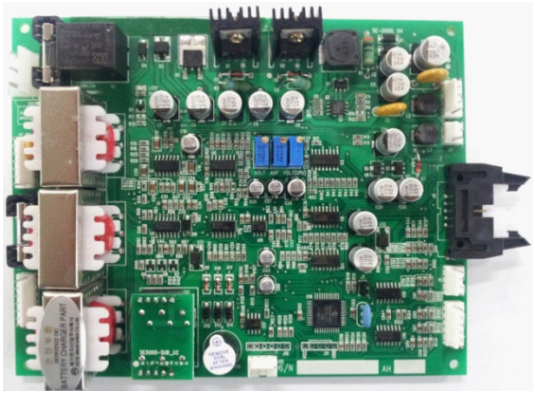
④ Check the electrolyte of the battery every week and provide distilled water immediately if it is required (Electrolyte has to be provided between 10-12 mm level on the positive plate inside storage battery).

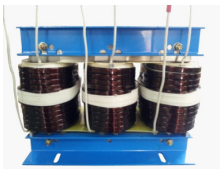
⑤ If battery liquid temperature becomes over 55°C, charging should be stopped.
If it is continued,
- The appearance is transformed
- and metal area can be attacked as electrolyte overflows.

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

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

(3) Names of each part (independent items)

① 

② 

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22B9BAT30

1	Main PCB	5	Monitor PCB	9	Resistor (RD)
2	Main transformer (Class H)	6	Overload	10	Resistor (DR)
3	Cooling fan	7	MG switch		
4	SCR module	8	Assistance transformer		

2) CHARGER INSTALLATION METHOD

(1) Location for charger installation

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

(2) Check points before installing charger

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

(3) Table for capacity of charger input cable

48V battery	Cable capacity	Input Voltage	Remarks
600-800 AH	4P - 6 mm^2	Criteria: 3Ø380 V 3Ø440 V	For 3Ø220V, one step higher capacity cable should be used (2.5 mm^2 → 4mm^2).
850-1000 AH	4P - 10 mm^2		

3) HOW TO USE A CHARGER

(1) General charging method (Floating charging)

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

② Connect battery connecter and charger connecter.

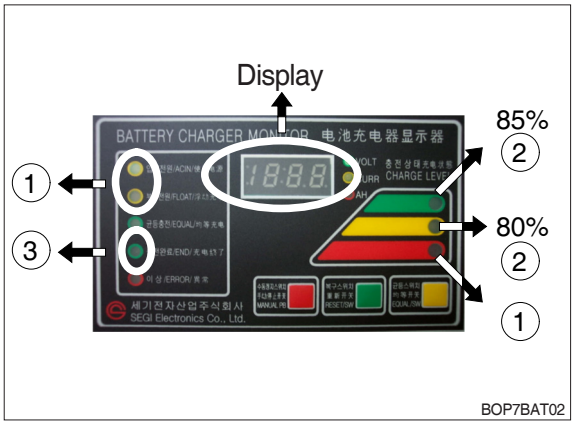
· **According to charging condition**

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

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

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

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



(2) Equalizing charging

① Equalized charging is

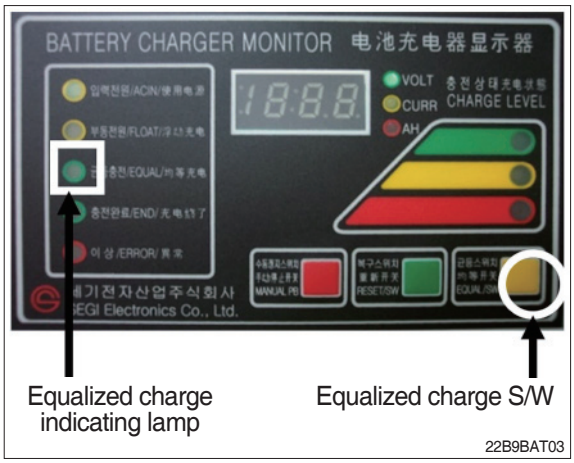
Equalized charging is to correct the battery when it does not normally perform its functions as the voltage differences are too big between cells of a battery.

When equalized charging is required?

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

② Tips for equalized charging
If once push the equalized charging button on the monitor in the beginning of charging, the equalized charging lamp becomes on and starts charging.

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

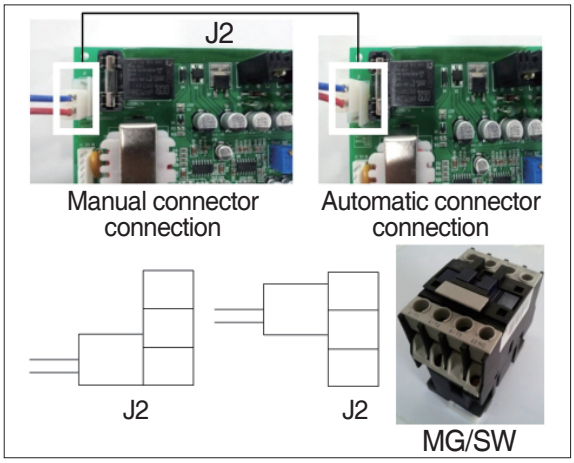


22B9BAT03

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

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

⊙ MG/SW operation
(Refer to the charger component manual.)



22B9BAT04

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

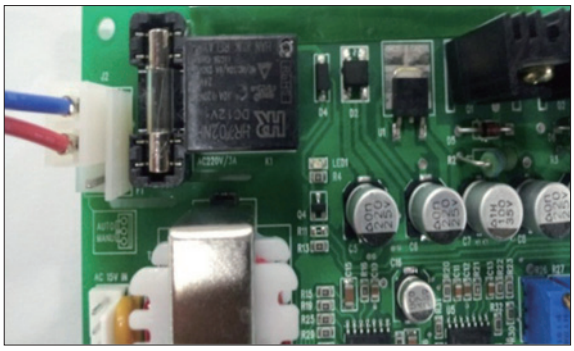
① Plug it into a manual connector and input after 5 sec., a floating charge, charging status red LED lights up.
② After 15 sec., charging status yellow LED lights up.
③ After a green LED lights up, if measured voltage comes out as lulua63V - lula64V by measuring output voltage of battery connector side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

BOP7BAT10

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

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

※ **Error code displayed on the front cover as following table.**



22B9BAT11

Sequences	Code	Description of error
1	E.F	EPROM fail
2	O.V	Over-voltage
3	O.C	Over-current
4	F.B	Battery error (After starting charging, the voltage doesn't go over 52V for 2 hours.) Check the battery.
5	O.T	Transformer over heat (Stop charging when it is over 160˚C). - If input voltage is high, output current is over normal value and there is heat in the trans because of SCR control part fault. - Check the output current and PCB control board.
6	O.H	Heatsink over heat (Stop charging when it is over 100℃). - Check the cooling fan, SCR connection cable contact point and control part.
7	A.O	Power supply error (input power 220/380V wrong wiring).
8	A.F	Power supply error (absent phase) - Check if input cable is open.
9	A.C	AC fail (black out) - Check if input voltage is right.
10	L.C	Low current (If this sign is on for setting value (60 sec), charging is over).
11	F	Manual stop.

4) CHECK POINTS BEFORE APPLYING A/S

(1) AC input power source switch is ON.

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

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

(4) Check the front cover indicator.

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

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

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

④ O.C: Check the electric current, as charging current of the battery isoverstandardss condition.

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

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

5) ERROR DETECTION

(1) Error list

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

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

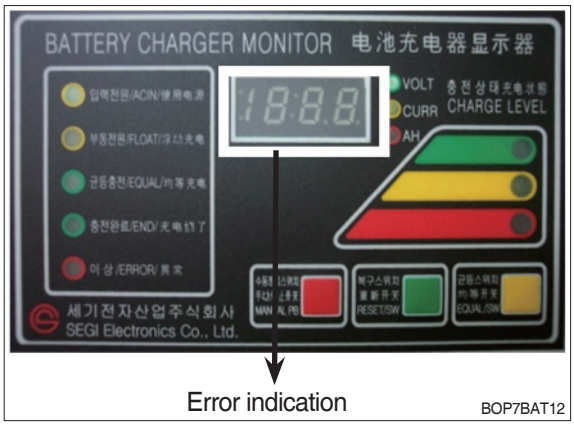
③ Charger TRIP is occurred after abnormality lamp is on. In case error code is "O.V"

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

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

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

⑦ SCR module checking method

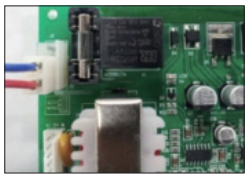


(2) Failure Diagnosis and Troubleshooting

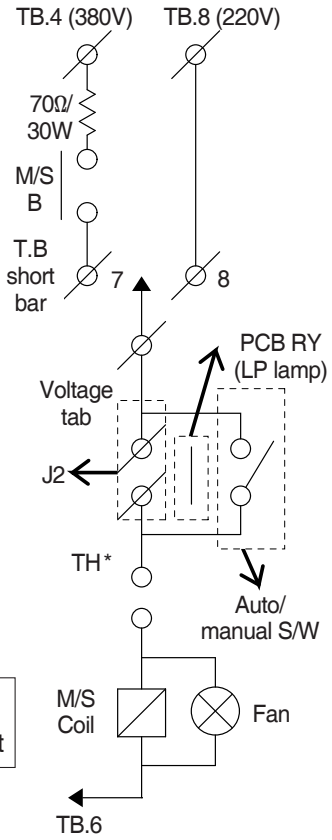
① Only floating charge lamp is on after indicating A.O., It's not charged.

· 220/380V Model : Measure the voltage between input voltage change over tabs 2-4 2-6 4-6.
· 220,380,410,440V Model : Measure the voltage in front of AC INPUT MS S/W.

MS electric plug



Manual/auto tap (J2)



M/S electric circuit diagram

Rated voltage checking

YES

Insert automatic/ manual connector (J2) at the upper part of PCB to manual, after separating battery connector.

AC INPUT MS switch ON

YES

PCB (LP lamp) ON

YES

NO

PCB replacing

NO

CN4 contact fault
PCB RY contact fault

NO

Put a black lead of multi-tester to input voltage switch No. 6 and measure voltage between tab No.8, PCB CN4, TH contact points with a red lead.

Voltage 220V

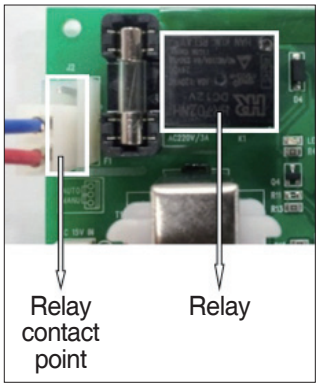
NO

TH contact fault
CN4 contact fault
PCB relay contact fault
TH manual Restoration release

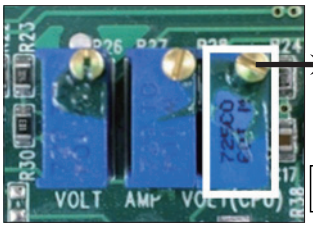
YES

MS COIL fault

Input power supply is not supplied.
· Check external lead cable.
· Check the connection of external input connecter.
· Check external NFB TRIP



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



Output current

De-creasing

In-creasing

MS ON Transformer noise is severe at MS ON status

NO

Measure output current using DC current measure

Current value: 10-16A /100AH

NO

Exceeding standard current

Adjust output current AMP, VR Re-adjust to VR

YES

· TH setting fault
· TH setting value re-adjusting

TH. TRIP

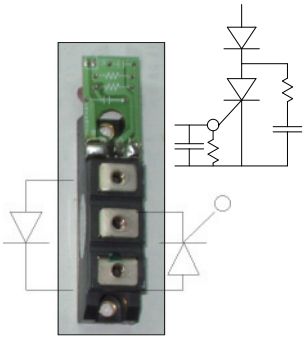
YES

TH replacing

NO

Complete

* Refer to SCR Module checking method



YES

Rated current setting

YES

NO

Complete

PCB replacing

Separate the battery connector and tune the charger off

SCR module checking

NO

SCR module replacing

YES

Main transformer voltage measuring

NO

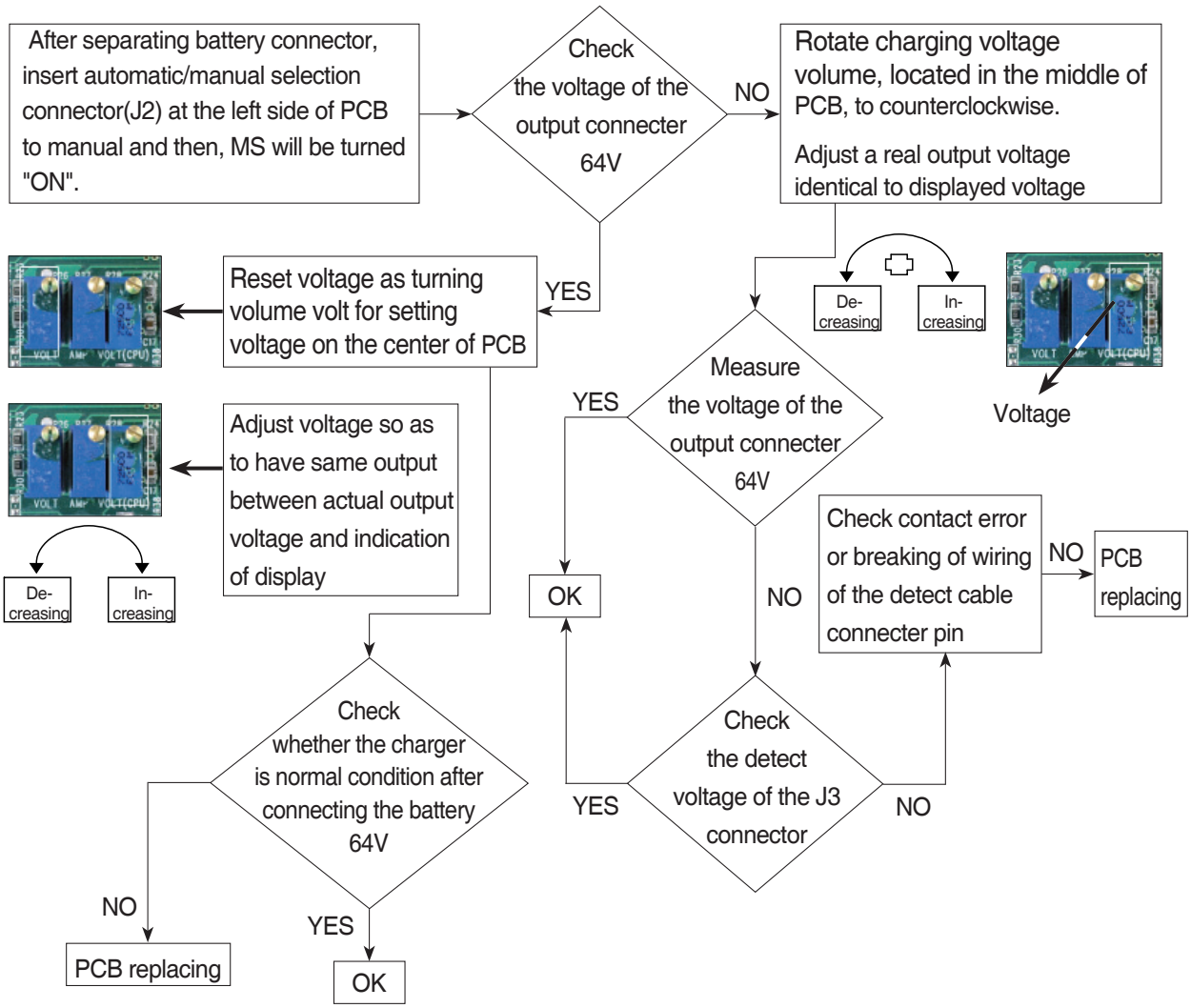
PCB replacing

YES

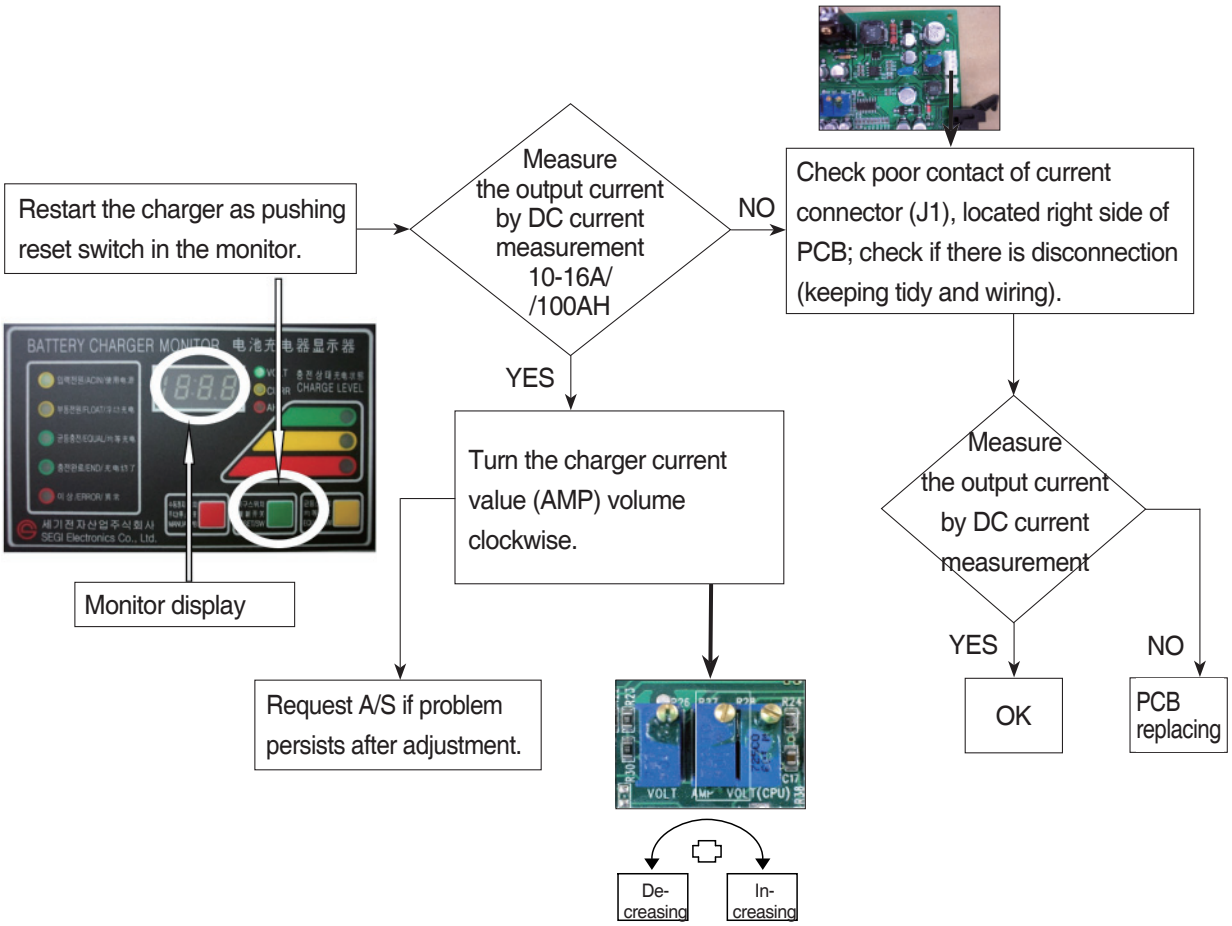
Check the normal operating condition of the charger

③ Charger TRIP is occurred after abnormality lamp is on.

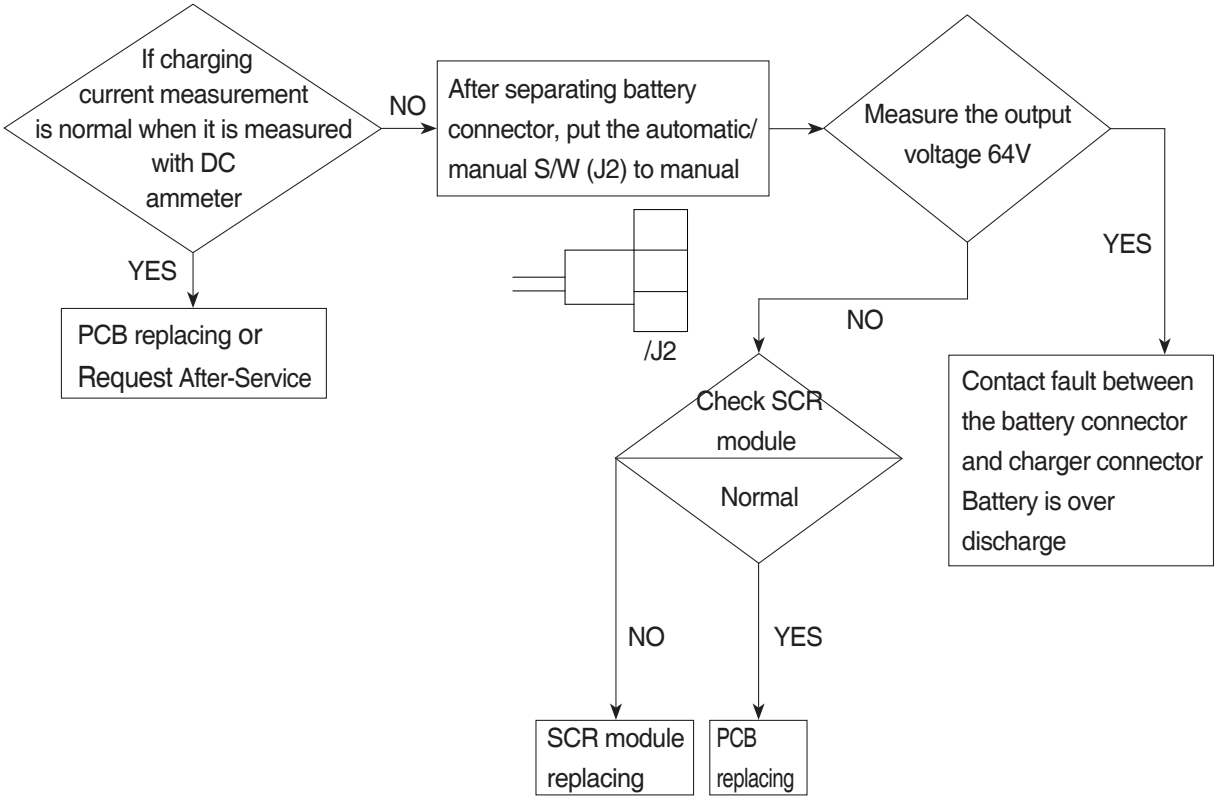
In case error code is O.V → Over-voltage output / Set at 66V (In case of BATT 48V)
34V (In case of BATT 24V)
108V (In case of BATT 80V)



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

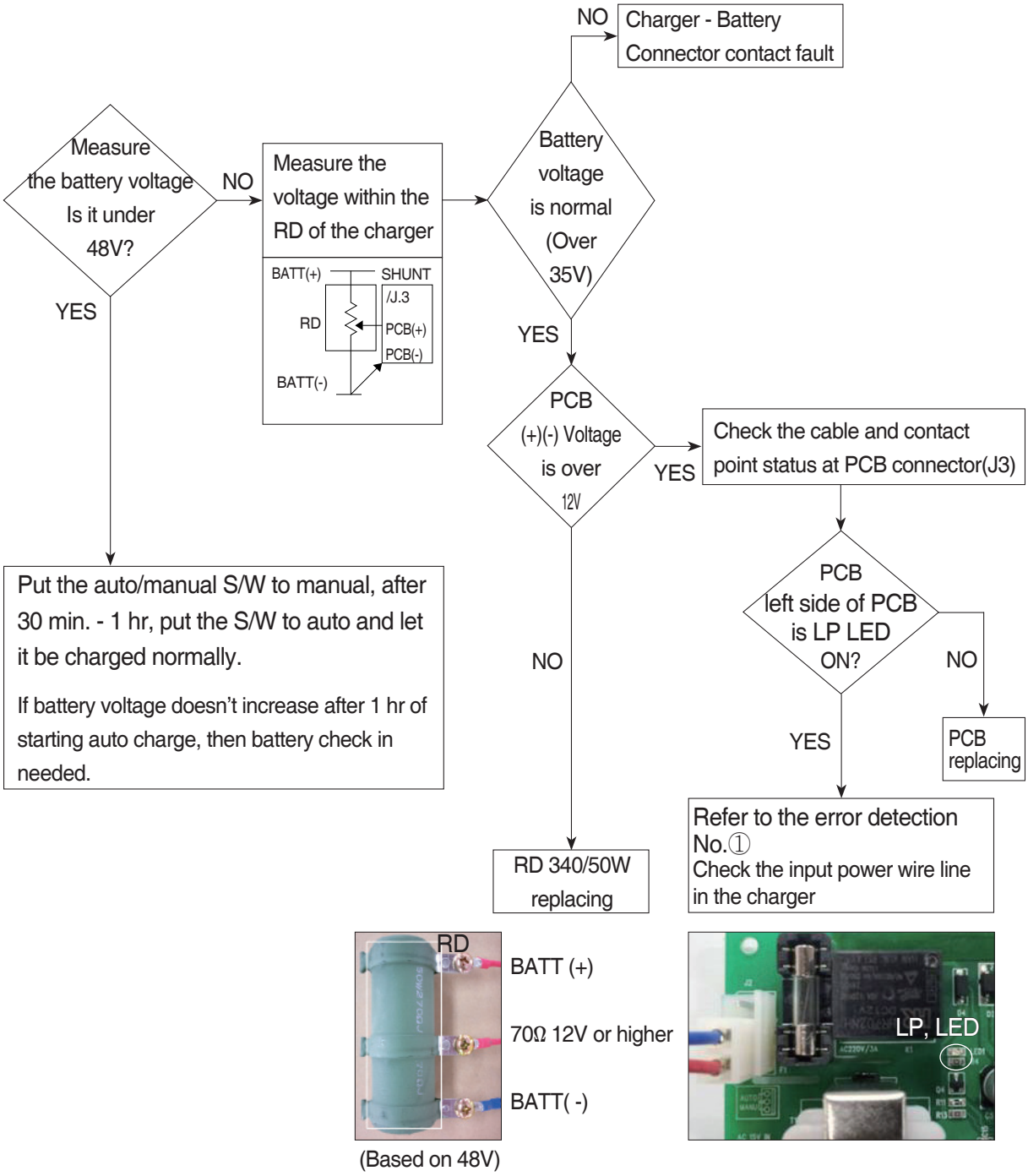


⑤ Charger TRIP is occurred after it started charging and charging completion lamp is on.
(In case input voltage is normal - Refer to the error detection No. 1)
Restore the charger as pushing reset switch.



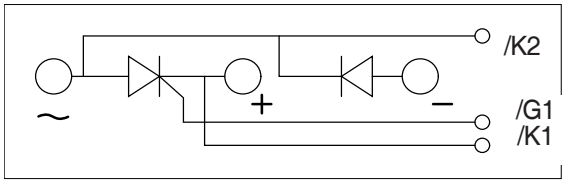
⑥ Charger has no response even the battery connector is connected.

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

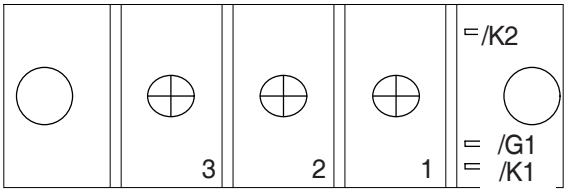


7) HOW TO CHECK THE SCR MODULE

Circuit

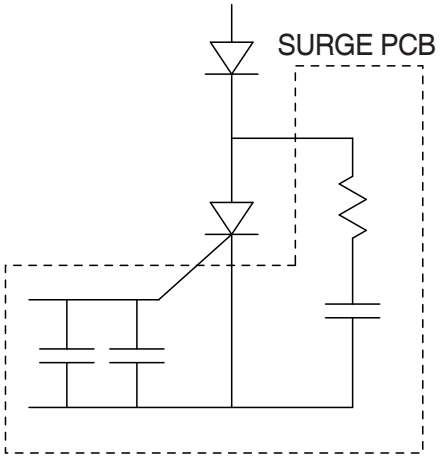


Real diagram

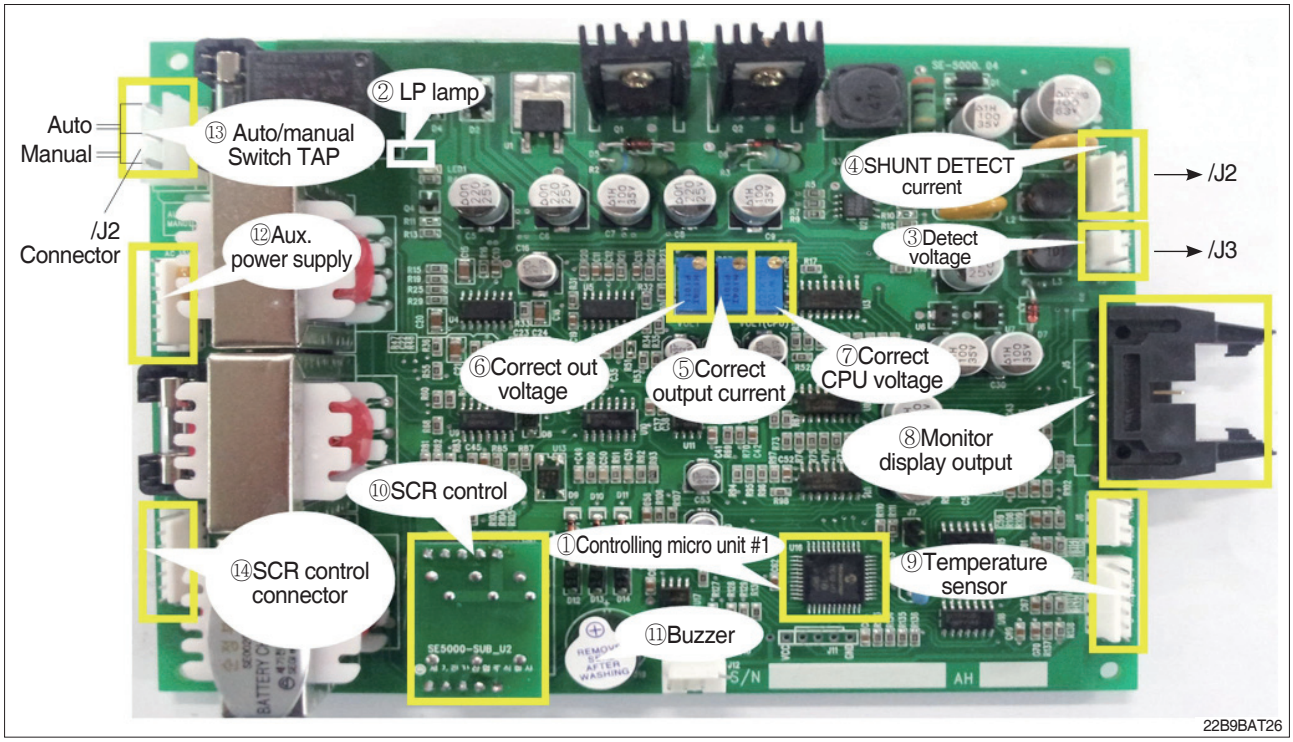


* Before checking SCR, be sure to disconnect bus bar and wire on the terminal.

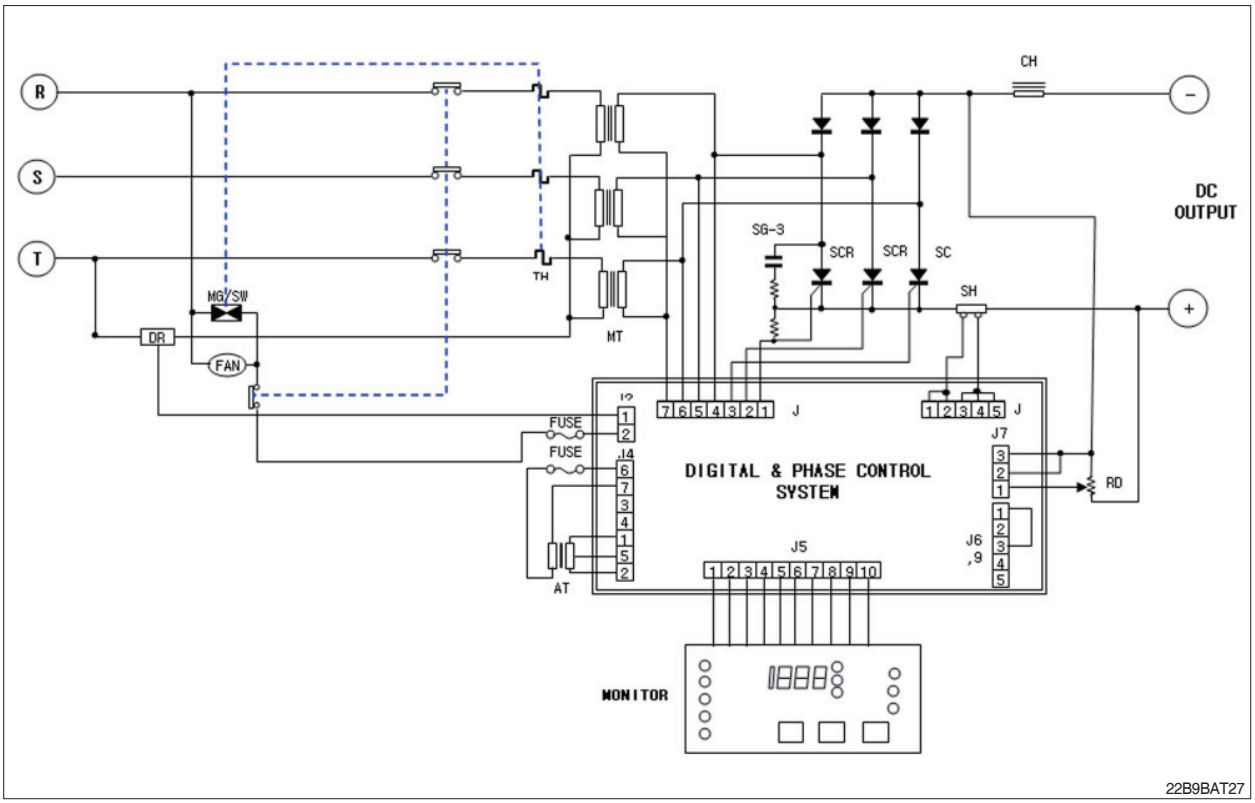
No.	Measuring point (Real diagram)	Measured value (Measurement of digital tester)
1	No.1 - No.3	Forward: Under 100 k ohm Reverse: Infinite (∞)
2	No.2 - No.3	Forward: Infinite (∞) Reverse: Infinite (∞)
3	G1 - K1	Forward: Under 100 ohm Reverse: Under 100 ohm But It depends on the module. If it is not 0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



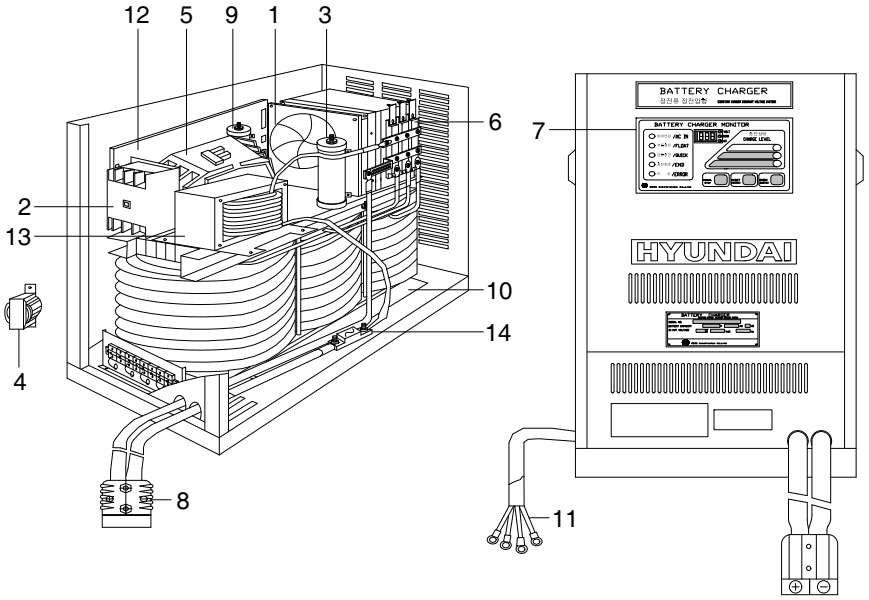
8) PCB MAJOR PARTS (NAME AND LOCATION)



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


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

CHARGER INTERIOR PARTS



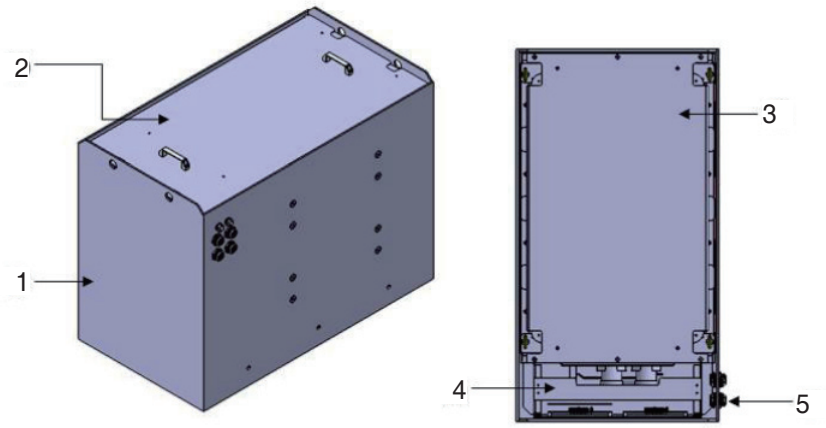
22B9BAT28

1	AC fan	6	SCR module	11	AC input cable
2	Overload	7	Monitor board assembly	12	Main board
3	Resistor - 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 (OPT)

1) STRUCTURE

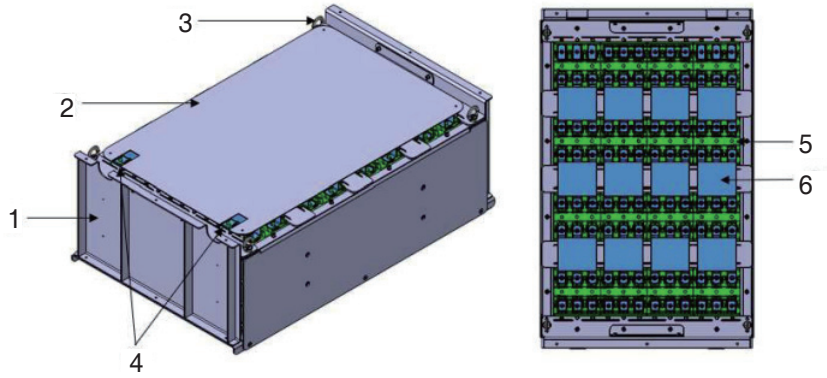
(1) Battery pack



25BXPM14

1	Housing	3	Module	5	Cable
2	Top case	4	BPU		

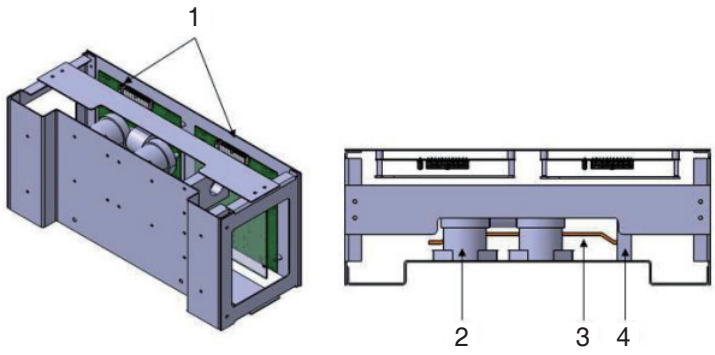
(2) Battery module



25BXPM15

1	Module frame	3	Eye-cut	5	Cell
2	PC cover	4	+: Anode terminal, -: Cathode terminal	6	Module bus bar

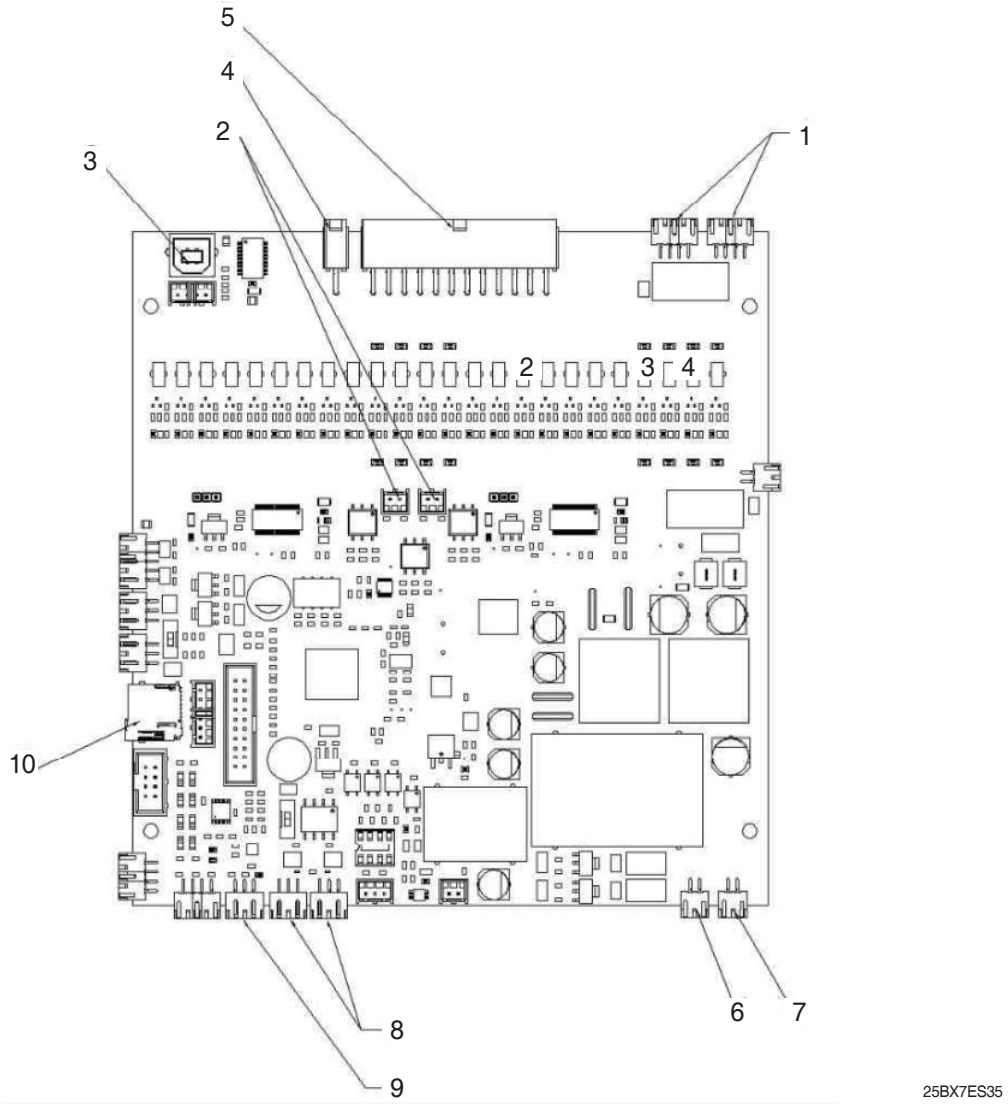
(3) BMS and BPU



25BXPM16

1	BMS	3	Grounding bus bar	4	Current sensor
2	Relay				

(4) Names and functions of BMS parts



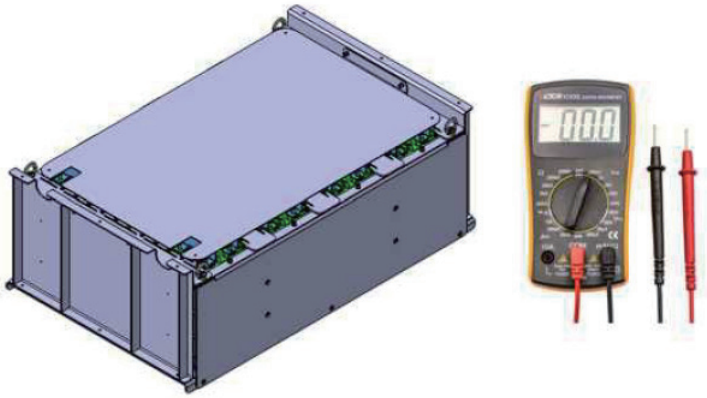
1	Switch	5	Cell cable	9	Current sensor port
2	Temperature sensor	6	CHA relay port	10	SD card slot
3	USB port	7	DIS relay port		
4	Ground cable	8	CAN port		

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 discharge 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 discharge protection function in case of over-charging, over-current, or overheating.

2) SPECIFICATION TABLE

Item	Unit	25B-X	30/32/35B-X
Rated voltage	V	51.2	←
Capacity	AH	500	600
Dimensions (W×L×H)	mm	984×466×750	984×536×750
Weight	kg	1000	1150
Connector	-	DIN 320	←

3) CHECKING BEFORE REPLACING



25BX7ES36

(1) Module voltage measuring

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 voltage deviation between modules within max. and min. 0.02V
- Measurement points: Positive and negative electrode terminals

(2) Insulation resistance measuring

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

- Criteria for judgment of normal conditions: 500V applied/100 MΩ or higher
- Measurement points: Positive electrode terminal - module case, or negative electrode terminal - module 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 top cover of the battery pack.
② Remove BPU CASE FWD from BPU assembly.
③ Make use of a screw driver to remove M8 bolt over the fuse. (Care should be exercised for preventing short-circuit resulted from movement of the main cable.)
④ Replace the fuse.
⑤ Assemble the parts in reverse order of disassembling.

2) Relay replacement

① Remove the top cover of the battery pack.
② Remove BPU CASE FWD from BPU assembly.
③ 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.)
④ Make use of a screw driver to remove M4 bolt for fastening the relay.
⑤ Replace the relay.
Assemble the parts in reverse order of disassembling.

3) BMS replacement

① Remove the top cover of the battery pack.
② Remove BPU CASE FWD from BPU assembly.
③ Remove the cell cable from the top of BMS. (Connector specifications: MOLEX 5557-24P, -2P)
④ Remove cables from BMS.
⑤ Remove M3 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.)
⑥ Replace BMS.
⑦ Assemble BMS in reverse order of disassembling

(4) Replacing cable gland

① Remove the top cover of the battery pack.
② Remove M8 bolts on the ring terminal from cables wired in the cable gland to replace with a screw driver.
③ Remove cables from the cable gland.
④ Remove mounted cable gland.
⑤ Replace the cable gland.
⑥ Assemble the parts in reverse order of disassembling.

(5) Battery module replacement

① Remove the top cover of the battery pack.
② Hook cables in the eye nuts of the battery module, and lift the module out of the battery pack. (Pay attention to cables when removing the battery modules by hosting.)
③ Remove BMS INSTL from the battery module.
④ Remove M8 bolts from the module, and then replace the module.
⑤ Replace the module.
⑥ Assemble the parts in reverse order of disassembling.

(6) Handle

① Remove the top cover of the battery pack.
② Remove M8 bolt from the top cover of the battery pack with a spanner.
③ Replace the handle.
④ Assemble the parts in reverse order of disassembling.

(7) 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.

① Remove M8 bolts from (+) and (-) terminals of the battery module, and also remove connected main cable.

① 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 This battery charger contains electrical components which can generate electric arcs and sparks, so if used in enclosed areas it must be positioned in a site suitable to its function; anyhow the standard battery charger must 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 must 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). For sufficient selectivity, the protection must 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. Ensure to also correctly connect the earth conductor.

It is good practice during installation (or successively if the battery charger is moved), 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

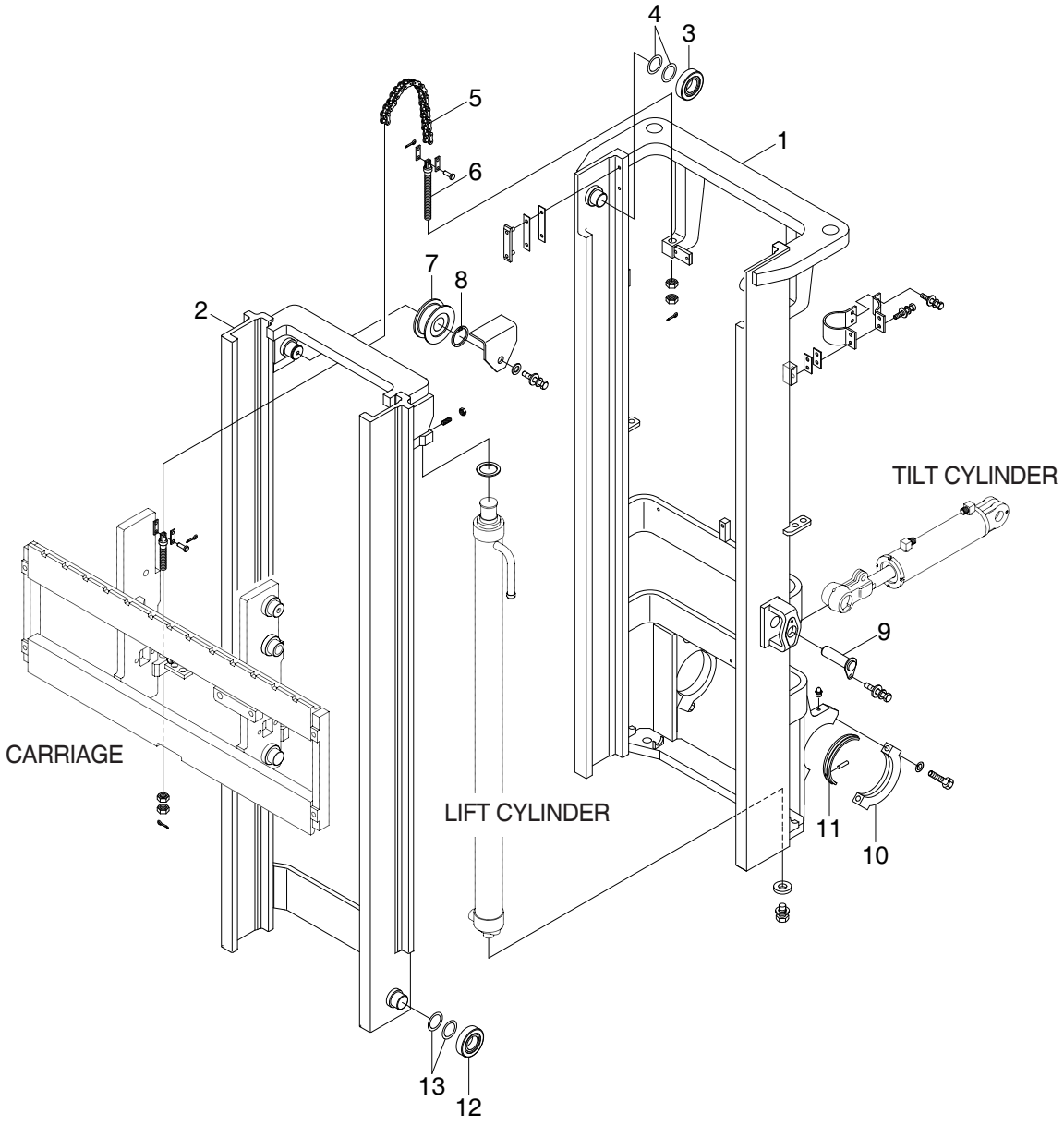
It is recommended to use relevant bi-polar connectors in compliance with Standards. Also check the current connection of the cables in the connector contacts. This operation has to be performed by skilled personnel only.

※ 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.

SECTION 8 MAST

GROUP 1 STRUCTURE

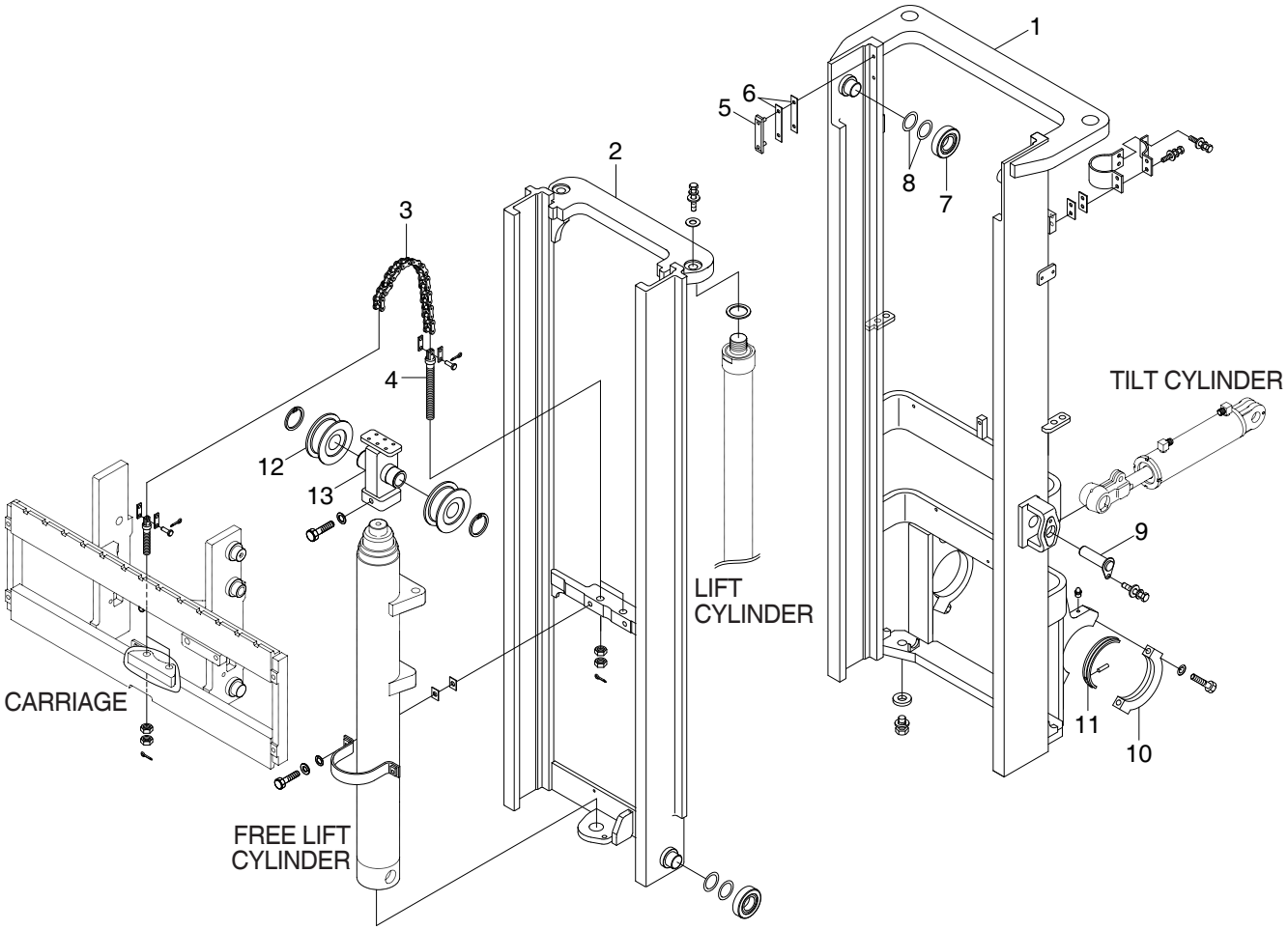
1. 2 STAGE MAST (V MAST)



22D9MS01

1	Outer mast	6	Anchor bolt	11	Bushing
2	Inner mast	7	Sheave bearing	12	Roller
3	Roller	8	Retaining ring	13	Shim (0.5, 1.0t)
4	Shim (0.5 1.0t)	9	Tilt cylinder pin		
5	Chain	10	Trunnion cap		

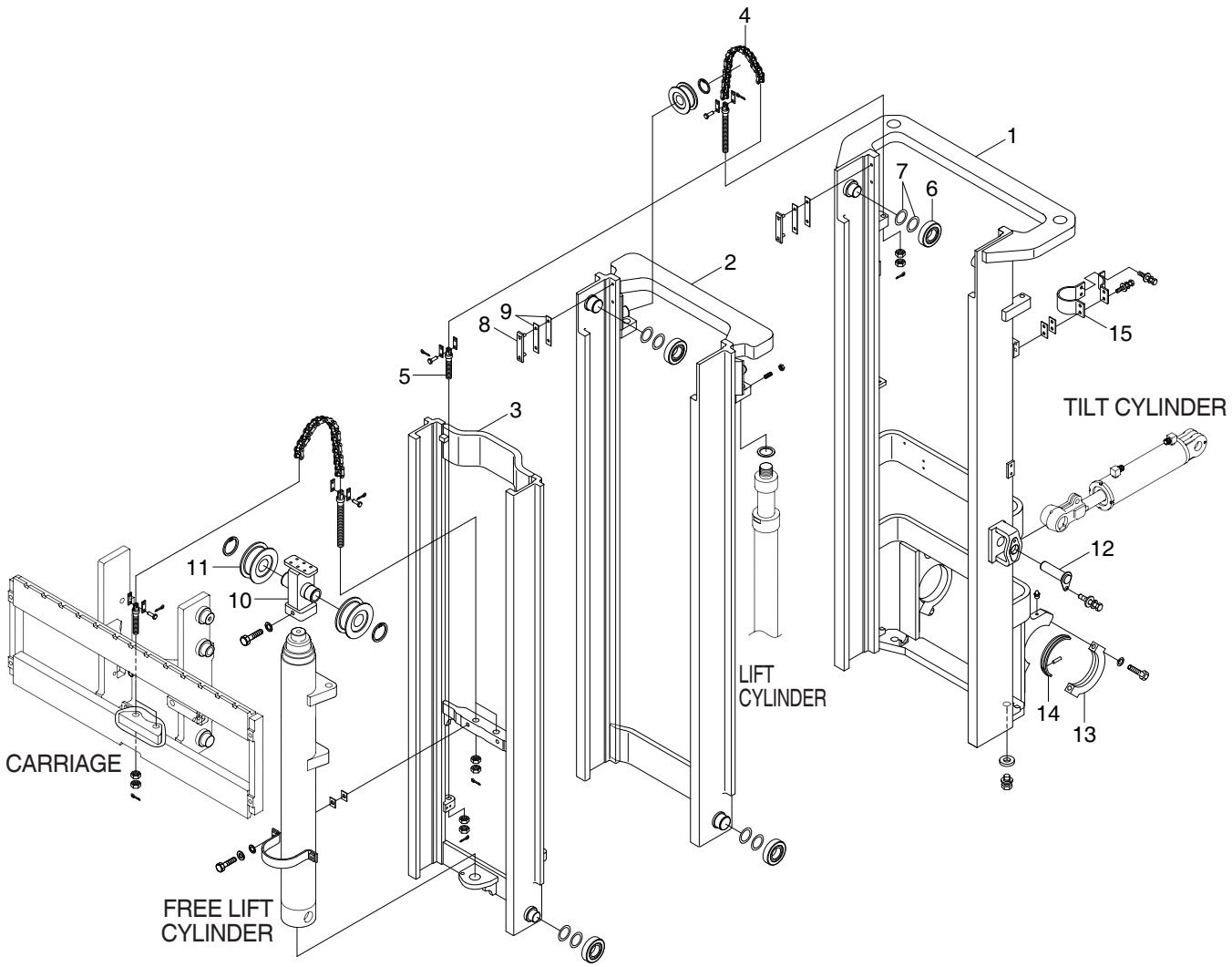
2. 2 STAGE MAST (VF MAST)



22D9MS02

1	Outer mast	6	Shim (0.5, 1.0t)	11	Bushing
2	Inner mast	7	Roller	12	Sheave bearing
3	Chain	8	Shim (0.5, 1.0t)	13	Shim (0.5, 1.0t)
4	Anchor bolt	9	Tilt cylinder pin		
5	Backup liner	10	Trunnion cap		

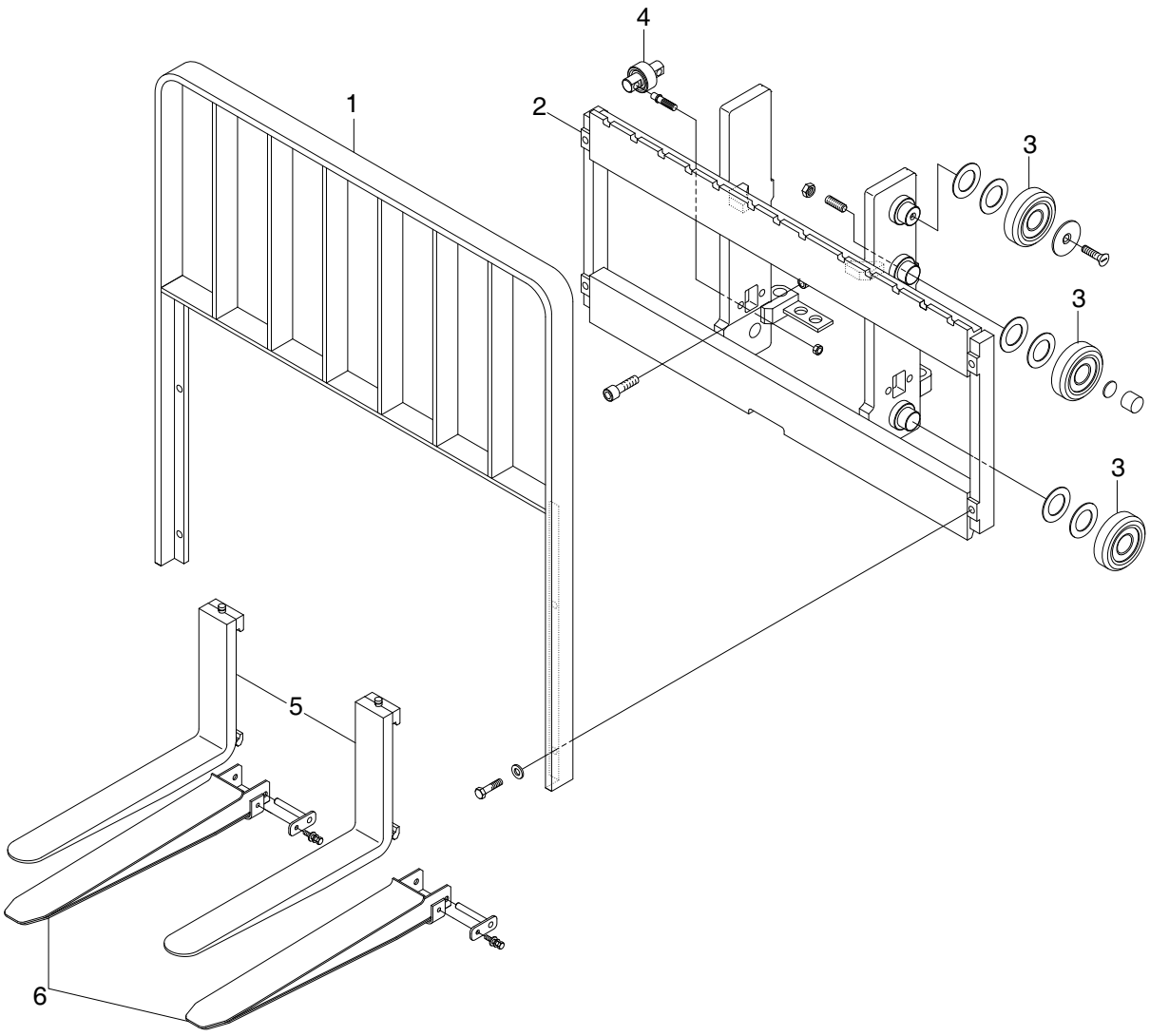
3. 3 STAGE MAST (TF MAST)



22D9MS21

1	Outer mast	6	Roller	11	Chain wheel bearing
2	Middle mast	7	Shim (0.5, 1.0t)	12	Tilt cylinder pin
3	Inner mast	8	Backup liner	13	Trunnion cap
4	Chain	9	Shim (0.5, 1.0t)	14	Bushing
5	Anchor bolt	10	Bearing bracket	15	Clamp

4. CARRIAGE, BACKREST AND FORK



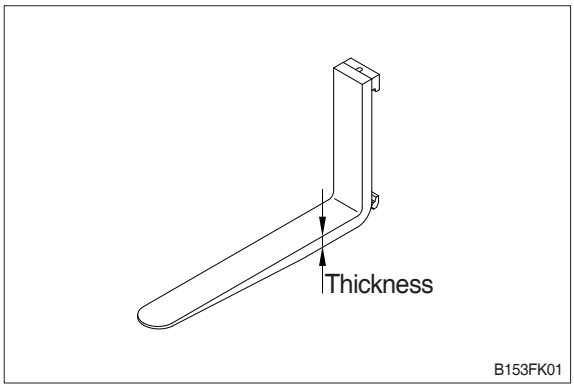
22BH9MS03

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

1. OPERATIONAL CHECKS

1) FORKS

(1) Measure thickness of root of forks and check that it is more than specified value.
· Length : 1050 mm

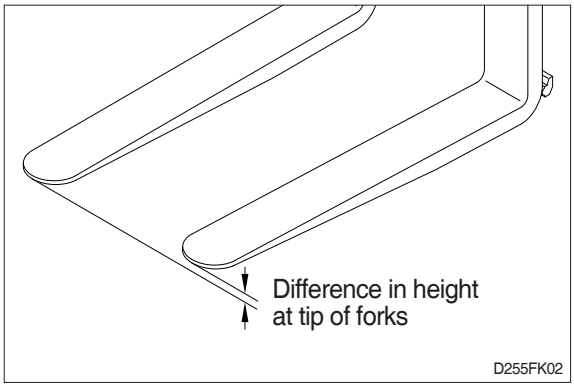


mm

STD Fork assy	Model	Standard	Limit
64HN-21040	25B-X	45	40
64HN-31040	30/32/35B-X	45	40

(2) Set forks in middle and measure out of parallel and difference in height at the top of forks.

Model	Fork length (mm)	Height difference (mm)
Overall	Equal or below 1500	3
	Above 1500	4



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

2) MAST

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

2. TROUBLESHOOTING

1) MAST

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

2) FORKS

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

1. MAST LOAD ROLLER (V, VF MAST)

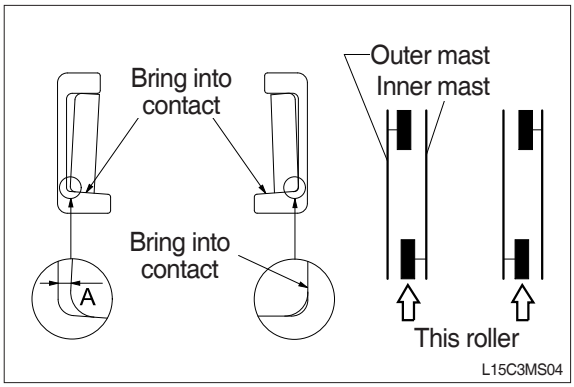
1) INNER/OUTER MAST ROLLER CLEARANCE ADJUSTMENT

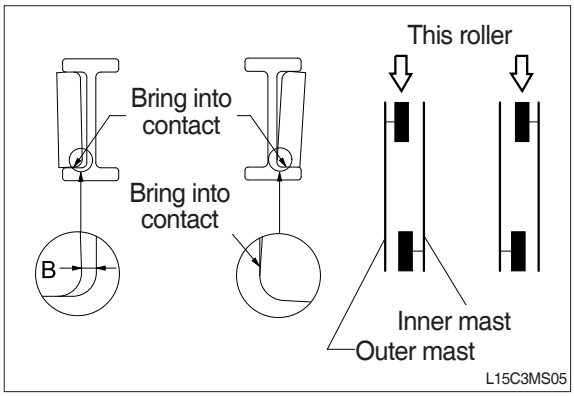
(1) Measure the clearance with the mast overlap at near 480 mm.

(2) Shift the inner mast to one side to bring the roller into contact with the outer mast, and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the inner/outer mast roller shim
- Standard clearance A, B = 0~0.6 mm
- Shim thickness 0.5, 1.0 mm

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

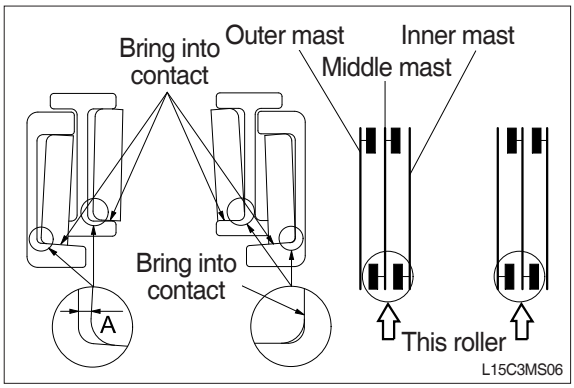
(4) After the adjustment, check that the inner mast moves smoothly in the outer mast.





2. MAST LOAD ROLLER (TF MAST)

1) INNER AND MIDDLE MAST ROLLER CLEARANCE ADJUSTMENT



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

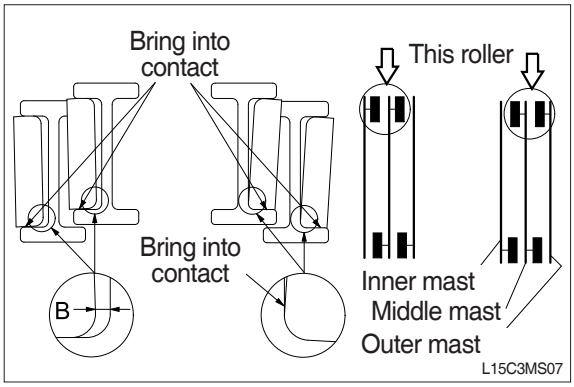
(2) Shift the inner mast to one side to bring the roller into contact with the outer mast and the middle mast, and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the inner and middle mast roller shim, respectively

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

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

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

2) OUTER AND MIDDLE MAST ROLLER CELARANCE ADJUSTMENT



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

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

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

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

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

3) CARRIAGE LOAD ROLLER

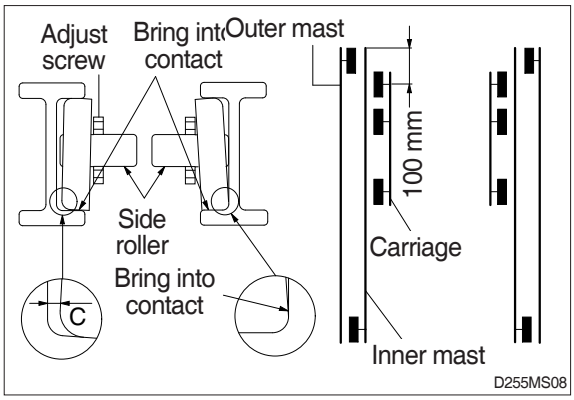
(1) Measure the clearance when the center of the carriage upper roller is 100 mm from the top of the inner mast.

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

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

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

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



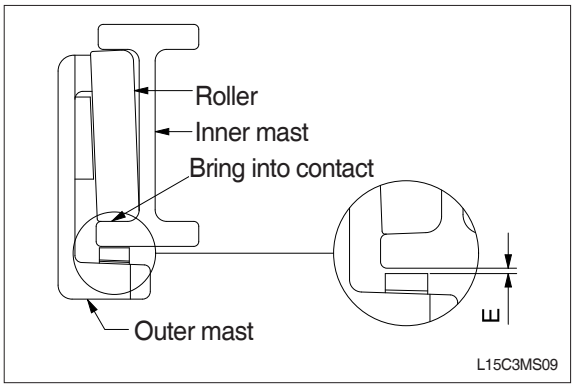
4) MAST BACKUP LINER

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

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

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

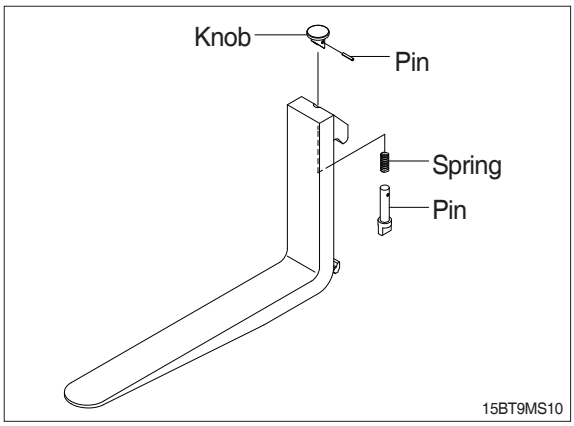
(3) After the adjustment, the mast should move smoothly.



GROUP 4 REMOVAL AND INSTALLATION

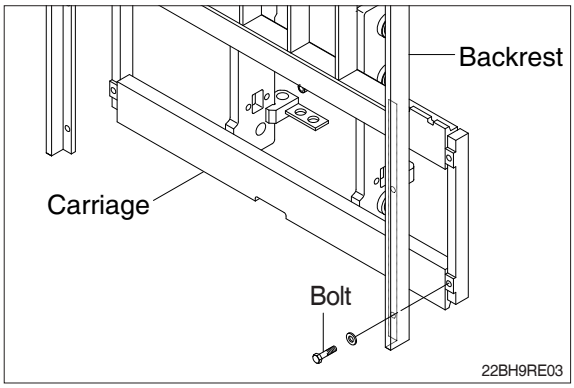
1. FORKS

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



2. BACKREST

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



3. CARRIAGE ASSEMBLY

1) CARRIAGE

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

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

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

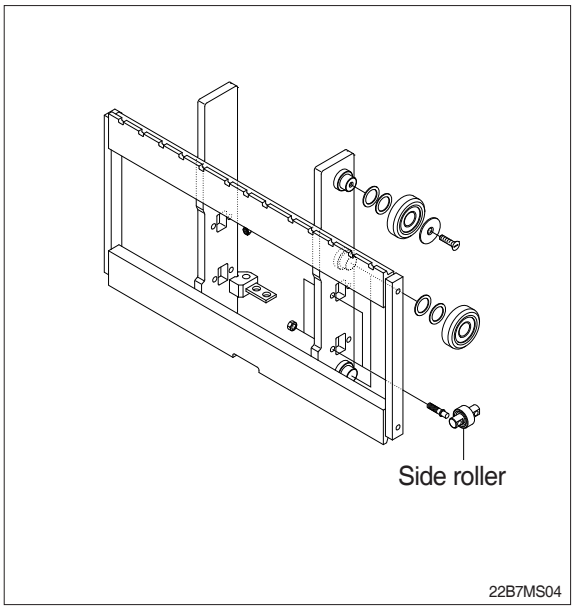
⚠ **Replace the split pin of chain anchor with new one**

2) SIDE ROLLER

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

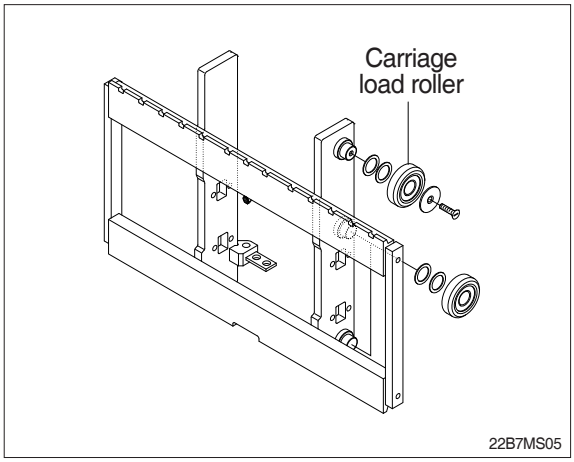
※ **Adjustment**

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



3) CARRIAGE LOAD ROLLER

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



4. MAST LOAD ROLLER AND BACKUP LINER

1) 2 STAGE MAST (V MAST)

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

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

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

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

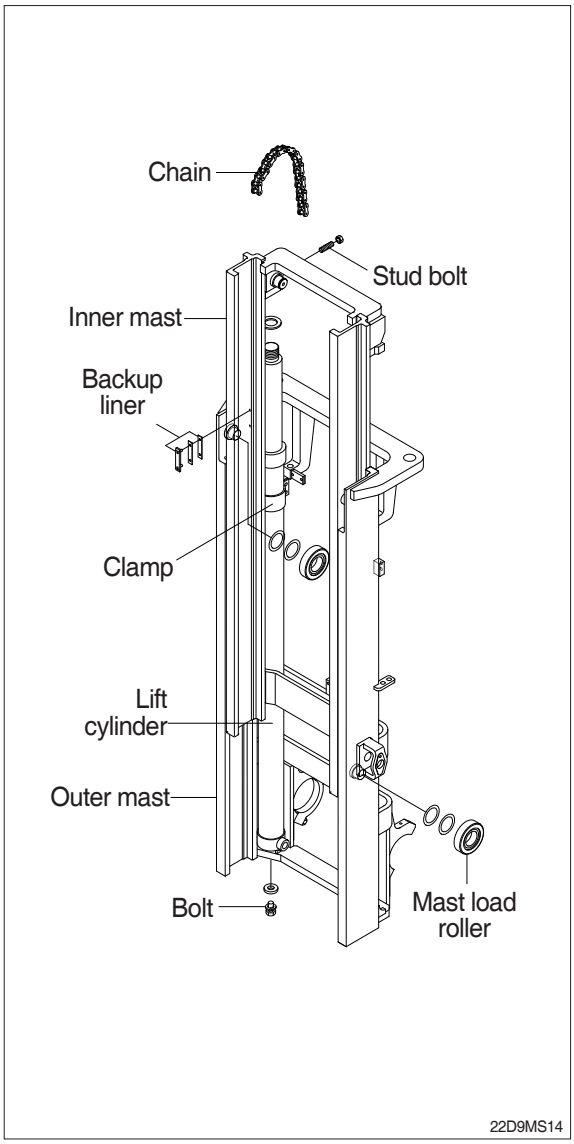
(5) After lowering the lift cylinder rods, and disconnecting lift cylinder hose, tilt the lift cylinders LHand RH and then tie them with ropes to the outer mast.

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

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

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

(9) Reverse the above procedure to reinstall. Refer to MAST LOAD ROLLER ADJUSTMENT paragraph.



2) 2 STAGE MAST (VF MAST)

(1) Remove free lift chain connecting carriage and free lift cylinder.

(2) Remove the carriage assembly and move it to one side.

(3) Loosen and remove hexagon bolts and washers securing lift cylinders to inner mast.

(4) Loosen and remove hexagon bolts and washers securing lift cylinders to inner mast.

(5) Attach chains to the inner mast section at top crossmember. Using an overhead hoist, slowly raise the inner mast high enough to clear lift cylinder

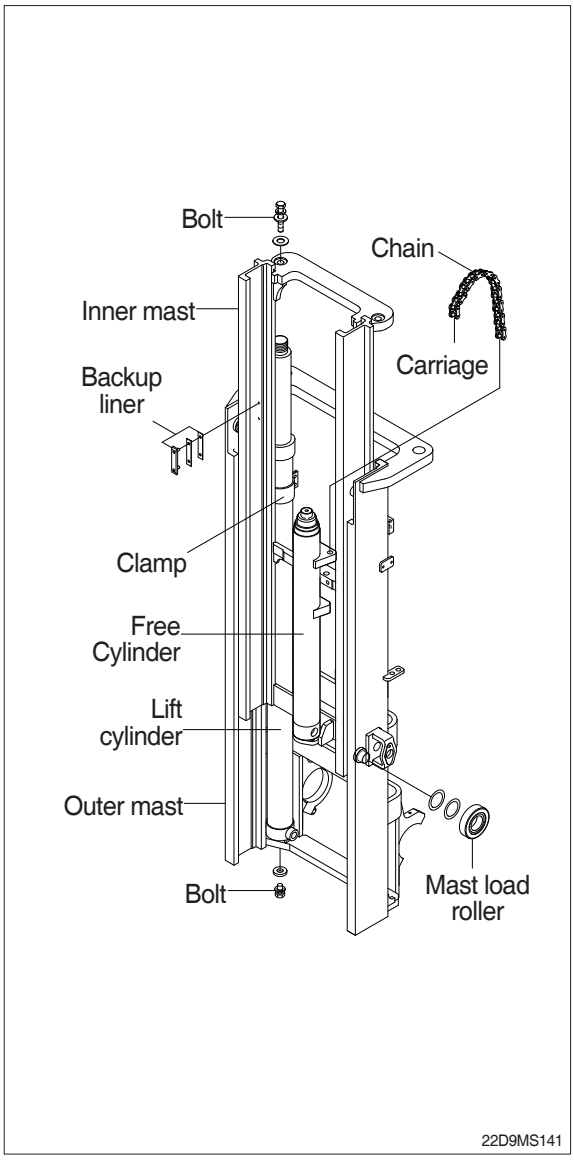
(6) After lowering the lift cylinder rods, and disconnecting lift cylinder hose, tilt the lift cylinders LH and RH and tie them with ropes to the outer mast.

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

(8) Using a pryer, remove load rollers from load roller bracket.

(9) Remove back up liners and shims.
Thoroughly clean, inspect and replace all worn or damaged parts.

(10) Reverse the above procedure to reinstall.
Refer to MAST LOAD ROLLER ADJUSTMENT paragraph.



2) 3 STAGE MAST (TF MAST)

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

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

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

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

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

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

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

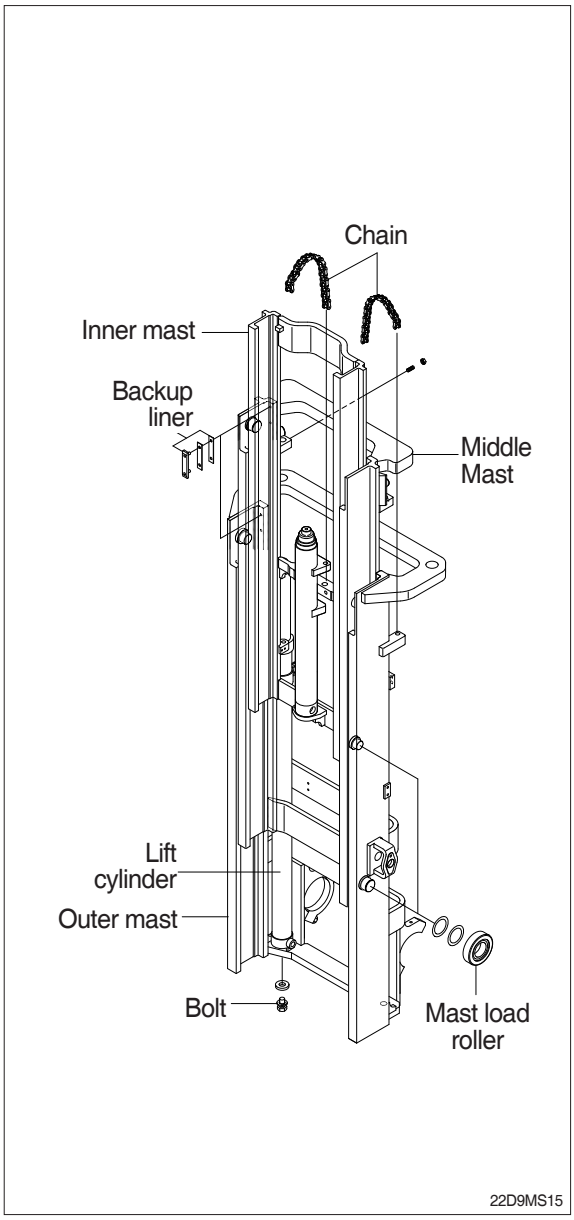
(8) Using a player, remove load rollers from load bracket. Remove back up liners and shims.

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

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

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

(12) Reverse the above procedure to reinstall. Refer to MAST LOAD ROLLER ADJUSTMENT paragraph.



5. ELEVATING MAST

1) INNER MAST (V, VF MAST)

(1) After completing all necessary steps for load rollers and back up liner removal use an overhead hoist to remove chain around upper crossmember of the inner mast section.
(2) Lift inner mast straight up and out of outer mast section.
(3) Replace and reverse above procedure to install. Make all necessary measurements and adjustments.

2) Inner and middle mast (TF mast)

(1) Follow all necessary steps for load rollers and back up liner removal. Remove rear chains and sheave support if not already done.
(2) Remove lift cylinder hose. Place hose into a suitable fan or container and close the hose cap.
(3) While supporting lift cylinder, remove bolts and washers securing cylinder to mast crossmember.
(4) Place a sling around lift cylinder and attach to an overhead hoist Slowly raise and move cylinder to one side.
(5) Attach chains or sling to the inner mast section at top crossmember. Using an overhead hoist slowly raise the mast straight up and out of middle mast section.
(6) Attach chains or sling to the middle mast section at top crossmember. Using an overhead hoist slowly raise the mast straight up and out of outer mast section.
(7) Replace mast and reverse above procedure to install Make all necessary measurements and adjustments.

6. CHAIN

1) CHAIN SHEAVE (V, VF MAST)

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

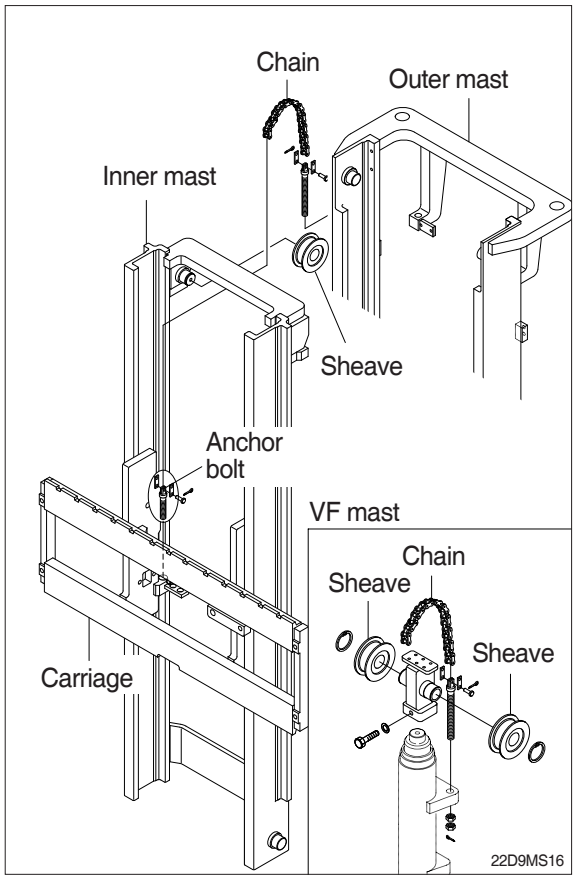
(2) Remove the split pin securing the chain anchor pins and discard.
While supporting the chains, remove the chain anchor pins and drape the chains over the carriage.

(3) Remove retaining ring securing sheaves to sheave support. Remove sheaves and bearings.

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

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

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



2) REAR CHAIN SHEAVE (TF MAST)

(1) Raise and securely block carriage and inner mast section

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

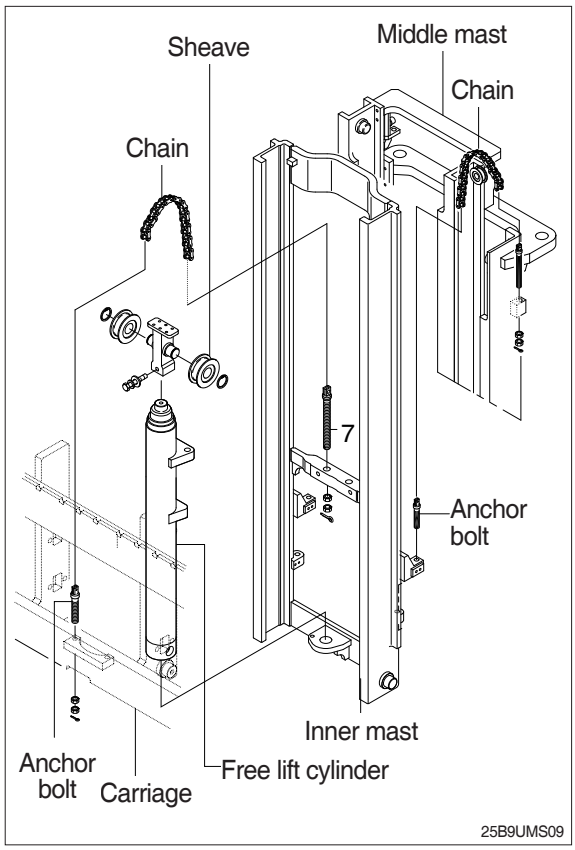
(3) Remove chains.

(4) Remove retaining ring securing chain sheaves to sheave support. Remove sheaves and bearings.

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

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

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



3) CHAIN WHEEL BEARING SUPPORT (TF MAST)

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

4) Rear chain (TF mast)

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

5) Carriage chain

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

6) Load chain inspection and maintenance

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

(1) Wear

As the chain flexes on and off the chain wheel bearings, the joints very gradually wear. The stretch a chain develops in service is due to material being worn off at the pin outer diameter and pitch hole inner diameter on the inside plate.
Chain wear can be measured using a wear scale or steel tape. When chains have elongated 2%, they should be discarded. When checking chain wear, be sure to measure a segment of chain that operates over a sheave. Do not repair chains by cutting our the worn section and splicing in a new piece. If part of the chain is worn, replace whole chain.

(2) Rust and corrosion

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

(3) Cracked plate

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

(4) Tight joints

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

Tight joints in lift chains can be caused by :

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

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

(5) Protruding or turned pins

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

(6) Chain side wear

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

(7) Chain anchors and chain wheel bearing

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

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

(8) Chain wear scale

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

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

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

7) Load chain lubrication and adjustment

(1) Lubrication

The most important consideration in field maintenance of lift chains is lubrication.

Hard working,heavily loaded chains cannot be expected to give satisfactory wear life without scheduled periodic re-lubrication.

Like all bearing surfaces, the precision manufactured, hardened steel, joint-wearing surfaces require a film of oil between mating parts to prevent rapid wear.

Oil must penetrate the chain joint to prevent wear. Applying oil to external surfaces will prevent rust, but oil must flow into the live bearing surfaces for maximum wear life.

Frequency of re-lube will vary with operating conditions and environment, the best estimate of lube period is 200 hours.

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

⚠ Wear eye protection

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

(2) Replacement

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

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

(3) Adjustment

Chain adjustments are important for the following reasons :

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

(4) Adjustment procedure

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