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 drive axle unit.

SECTION 4 BRAKE SYSTEM

This section explains the brake mechanism, each component and operation.

SECTION 5 STEERING SYSTEM

This section explains the structure of the steering system.

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
   Item number (2. Structure and Function)
   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.
   10 - 4
   10 - 4 - 1
   10 - 4 - 2
   Added pages
   10 - 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.

Symbol	Item	Remarks
	Safety	Special safety precautions are necessary when performing the work.
		Extra special safety precautions are necessary when performing the work because it is under internal pressure.
※	Caution	Special technical precautions or other precautions for preserving standards are necessary when performing the work.

3. CONVERSION TABLE

Method of using the Conversion Table

The Conversion Table in this section is provided to enable simple conversion of figures. For details of the method of using the Conversion Table, see the example given below.

Example

1. **Method of using the Conversion Table to convert from millimeters to inches**

   Convert 55 mm into inches.

   (1) Locate the number 50in the vertical column at the left side, take this as ⓐ, then draw a horizontal line from ⓐ.

   (2) Locate the number 5in the row across the top, take this as ⓑ, then draw a perpendicular line down from ⓑ.

   (3) Take the point where the two lines cross as ⓒ. This point ⓒ gives the value when converting from millimeters to inches. Therefore, 55 mm = 2.165 inches.

2. Convert 550 mm into inches.

   (1) The number 550 does not appear in the table, so divide by 10 (move the decimal point one place to the left) to convert it to 55 mm.

   (2) Carry out the same procedure as above to convert 55 mm to 2.165 inches.

   (3) The original value (550 mm) was divided by 10, so multiply 2.165 inches by 10 (move the decimal point one place to the right) to return to the original value.
   This gives 550 mm = 21.65 inches.

Millimeters to inches

ⓑ

1 mm = 0.03937 in

	0	1	2	3	4	5	6	7	8	9
0		0.039	0.079	0.118	0.157	0.197	0.236	0.276	0.315	0.354
10	0.394	0.433	0.472	0.512	0.551	0.591	0.630	0.669	0.709	0.748
20	0.787	0.827	0.866	0.906	0.945	0.984	1.024	1.063	1.102	1.142
30	1.181	1.220	1.260	1.299	1.339	1.378	1.417	1.457	1.496	1.536
40	1.575	1.614	1.654	1.693	1.732	1.772	1.811	1.850	1.890	1.929
ⓐ 50	1.969	2.008	2.047	2.087	2.126	ⓒ 2.165	2.205	2.244	2.283	2.323
60	2.362	2.402	2.441	2.480	2.520	2.559	2.598	2.638	2.677	2.717
70	2.756	2.795	2.835	2.874	2.913	2.953	2.992	3.032	3.071	3.110
80	3.150	3.189	3.228	3.268	3.307	3.346	3.386	3.425	3.465	3.504
90	3.543	3.583	3.622	3.661	3.701	3.740	3.780	3.819	3.858	3.898

Millimeters to inches

1 mm = 0.03937in

	0	1	2	3	4	5	6	7	8	9
0		0.039	0.079	0.118	0.157	0.197	0.236	0.276	0.315	0.354
10	0.394	0.433	0.472	0.512	0.551	0.591	0.630	0.669	0.709	0.748
20	0.787	0.827	0.866	0.906	0.945	0.984	1.024	1.063	1.102	1.142
30	1.181	1.220	1.260	1.299	1.339	1.378	1.417	1.457	1.496	1.536
40	1.575	1.614	1.654	1.693	1.732	1.772	1.811	1.850	1.890	1.929
50	1.969	2.008	2.047	2.087	2.126	2.165	2.205	2.244	2.283	2.323
60	2.362	2.402	2.441	2.480	2.520	2.559	2.598	2.638	2.677	2.717
70	2.756	2.795	2.835	2.874	2.913	2.953	2.992	3.032	3.071	3.110
80	3.150	3.189	3.228	3.268	3.307	3.346	3.386	3.425	3.465	3.504
90	3.543	3.583	3.622	3.661	3.701	3.740	3.780	3.819	3.858	3.898

Kilogram to Pound

1 kg = 2.2046lb

	0	1	2	3	4	5	6	7	8	9
0		2.20	4.41	6.61	8.82	11.02	13.23	15.43	17.64	19.84
10	22.05	24.25	26.46	28.66	30.86	33.07	35.27	37.48	39.68	41.89
20	44.09	46.30	48.50	50.71	51.91	55.12	57.32	59.5.	61.73	63.93
30	66.14	68.34	70.55	72.75	74.96	77.16	79.37	81.57	83.78	85.98
40	88.18	90.39	92.59	94.80	97.00	99.21	101.41	103.62	105.82	108.03
50	110.23	112.44	114.64	116.85	119.05	121.25	123.46	125.66	127.87	130.07
60	132.28	134.48	136.69	138.89	141.10	143.30	145.51	147.71	149.91	152.12
70	154.32	156.53	158.73	160.94	163.14	165.35	167.55	169.76	171.96	174.17
80	176.37	178.57	180.78	182.98	185.19	187.39	189.60	191.80	194.01	196.21
90	198.42	200.62	202.83	205.03	207.24	209.44	211.64	213.85	216.05	218.26

Liter to U.S. Gallon

1 l = 0.2642 U.S.Gal

	0	1	2	3	4	5	6	7	8	9
0		0.264	0.528	0.793	1.057	1.321	1.585	1.849	2.113	2.378
10	2.642	2.906	3.170	3.434	3.698	3.963	4.227	4.491	4.755	5.019
20	5.283	5.548	5.812	6.6076	6.340	6.604	6.869	7.133	7.397	7.661
30	7.925	8.189	8.454	8.718	8.982	9.246	9.510	9.774	10.039	10.303
40	10.567	10.831	11.095	11.359	11.624	11.888	12.152	12.416	12.680	12.944
50	13.209	13.473	13.737	14.001	14.265	14.529	14.795	15.058	15.322	15.586
60	15.850	16.115	16.379	16.643	16.907	17.171	17.435	17.700	17.964	18.228
70	18.492	18.756	19.020	19.285	19.549	19.813	20.077	20.341	20.605	20.870
80	21.134	21.398	21.662	21.926	22.190	22.455	22.719	22.983	23.247	23.511
90	23.775	24.040	24.304	24.568	24.832	25.096	25.631	25.625	25.889	26.153

Liter to U.K. Gallon

1 l = 0.21997 U.K.Gal

	0	1	2	3	4	5	6	7	8	9
0		0.220	0.440	0.660	0.880	1.100	1.320	1.540	1.760	1.980
10	2.200	2.420	2.640	2.860	3.080	3.300	3.520	3.740	3.950	4.179
20	4.399	4.619	4.839	5.059	5.279	5.499	5.719	5.939	6.159	6.379
30	6.599	6.819	7.039	7.259	7.479	7.969	7.919	8.139	8.359	8.579
40	8.799	9.019	9.239	9.459	9.679	9.899	10.119	10.339	10.559	10.778
50	10.998	11.281	11.438	11.658	11.878	12.098	12.318	12.528	12.758	12.978
60	13.198	13.418	13.638	13.858	14.078	14.298	14.518	14.738	14.958	15.178
70	15.398	15.618	15.838	16.058	16.278	16.498	16.718	16.938	17.158	17.378
80	17.598	17.818	18.037	18.257	18.477	18.697	18.917	19.137	19.357	19.577
90	19.797	20.017	20.237	20.457	20.677	20.897	21.117	21.337	21.557	21.777

kgf · m to lbf · ft

1 kgf · m = 7.233 lbf · ft

	0	1	2	3	4	5	6	7	8	9
		7.2	14.5	21.7	28.9	36.2	43.4	50.6	57.9	65.1
10	72.3	79.6	86.8	94.0	101.3	108.5	115.7	123.0	130.2	137.4
20	144.7	151.9	159.1	166.4	173.6	180.8	188.1	195.3	202.5	209.8
30	217.0	224.2	231.5	238.7	245.9	253.2	260.4	267.6	274.9	282.1
40	289.3	396.6	303.8	311.0	318.3	325.5	332.7	340.0	347.2	354.4
50	361.7	368.9	376.1	383.4	390.6	397.8	405.1	412.3	419.5	426.8
60	434.0	441.2	448.5	455.7	462.9	470.2	477.4	484.6	491.8	499.1
70	506.3	513.5	520.8	528.0	535.2	542.5	549.7	556.9	564.2	571.4
80	578.6	585.9	593.1	600.3	607.6	614.8	622.0	629.3	636.5	643.7
90	651.0	658.2	665.4	672.7	679.9	687.1	694.4	701.6	708.8	716.1
100	723.3	730.5	737.8	745.0	752.2	759.5	766.7	773.9	781.2	788.4
110	795.6	802.9	810.1	817.3	824.6	831.8	839.0	846.3	853.5	860.7
120	868.0	875.2	882.4	889.7	896.9	904.1	911.4	918.6	925.8	933.1
130	940.3	947.5	954.8	962.0	969.2	976.5	983.7	990.9	998.2	10005.4
140	1012.6	1019.9	1027.1	1034.3	1041.5	1048.8	1056.0	1063.2	1070.5	1077.7
150	1084.9	1092.2	1099.4	1106.6	1113.9	1121.1	1128.3	1135.6	1142.8	1150.0
160	1157.3	1164.5	1171.7	1179.0	1186.2	1193.4	1200.7	1207.9	1215.1	1222.4
170	1129.6	1236.8	1244.1	1251.3	1258.5	1265.8	1273.0	1280.1	1287.5	1294.7
180	1301.9	1309.2	1316.4	1323.6	1330.9	1338.1	1345.3	1352.6	1359.8	1367.0
190	1374.3	1381.5	1388.7	1396.0	1403.2	1410.4	1417.7	1424.9	1432.1	1439.4

kgf/cm² to lbf/in²

1 kgf / cm² = 14.2233 lbf / in²

	0	1	2	3	4	5	6	7	8	9
		14.2	28.4	42.7	56.9	71.1	85.3	99.6	113.8	128.0
10	142.2	156.5	170.7	184.9	199.1	213.4	227.6	241.8	256.0	270.2
20	284.5	298.7	312.9	327.1	341.4	355.6	369.8	384.0	398.3	412.5
30	426.7	440.9	455.1	469.4	483.6	497.8	512.0	526.3	540.5	554.7
40	568.9	583.2	597.4	611.6	625.8	640.1	654.3	668.5	682.7	696.9
50	711.2	725.4	739.6	753.8	768.1	782.3	796.5	810.7	825.0	839.2
60	853.4	867.6	881.8	896.1	910.3	924.5	938.7	953.0	967.2	981.4
70	995.6	1010	1024	1038	1053	1067	1081	1095	1109	1124
80	1138	1152	1166	1181	1195	1209	1223	1237	1252	1266
90	1280	1294	1309	1323	1337	1351	1365	1380	1394	1408
100	1422	1437	1451	1465	1479	1493	1508	1522	1536	1550
110	1565	1579	1593	1607	1621	1636	1650	1664	1678	1693
120	1707	1721	1735	1749	1764	1778	1792	1806	1821	1835
130	1849	2863	1877	1892	1906	1920	1934	1949	1963	1977
140	1991	2005	2020	2034	2048	2062	2077	2091	2105	2119
150	2134	2148	2162	2176	2190	2205	2219	2233	2247	2262
160	2276	2290	2304	2318	2333	2347	2361	2375	2389	2404
170	2418	2432	2446	2460	2475	2489	2503	2518	2532	2546
180	2560	2574	2589	5603	2617	2631	2646	2660	2674	2688
200	2845	2859	2873	2887	2901	2916	2930	2944	2958	2973
210	2987	3001	3015	3030	3044	3058	3072	3086	3101	3115
220	3129	3143	3158	3172	3186	3200	3214	3229	3243	3257
230	3271	3286	3300	3314	3328	3343	3357	3371	3385	3399
240	3414	3428	3442	3456	3470	3485	3499	3513	3527	3542

TEMPERATURE

Fahrenheit-Centigrade Conversion.

A simple way to convert a fahrenheit temperature reading into a centigrade temperature reading or vice verse is to enter the accompanying table in the center or boldface column of figures.

These figures refer to the temperature in either Fahrenheit or Centigrade degrees.

If it is desired to convert from Fahrenheit to Centigrade degrees, consider the center column as a table of Fahrenheit temperatures and read the corresponding Centigrade temperature in the column at the left.

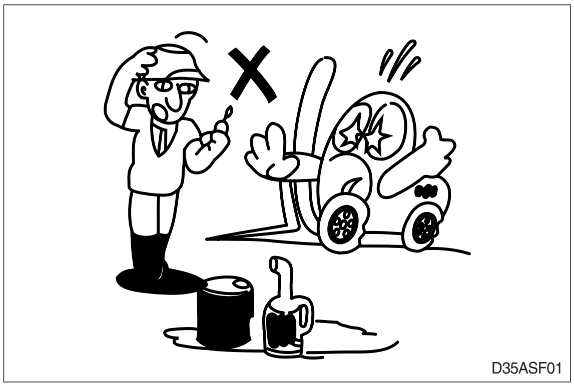
If it is desired to convert from Centigrade to Fahrenheit degrees, consider the center column as a table of Centigrade values, and read the corresponding Fahrenheit temperature on the right.

˚C		˚F	˚C		˚F	˚C		˚F	˚C		˚F
-40.4	-40	-40.0	-11.7	11	51.8	7.8	46	114.8	27.2	81	117.8
-37.2	-35	-31.0	-11.1	12	53.6	8.3	47	116.6	27.8	82	179.6
-34.4	-30	-22.0	-10.6	13	55.4	8.9	48	118.4	28.3	83	181.4
-31.7	-25	-13.0	-10.0	14	57.2	9.4	49	120.2	28.9	84	183.2
-28.9	-20	-4.0	-9.4	15	59.0	10.0	50	122.0	29.4	85	185.0
-28.3	-19	-2.2	-8.9	16	60.8	10.6	51	123.8	30.0	86	186.8
-27.8	-18	-0.4	-8.3	17	62.6	11.1	52	125.6	30.6	87	188.6
-27.2	-17	1.4	-7.8	18	64.4	11.7	53	127.4	31.1	88	190.4
-26.7	-16	3.2	-6.7	20	68.0	12.8	55	131.0	32.2	90	194.0
-26.1	-15	5.0	-6.7	20	68.0	12.8	55	131.0	32.2	90	194.0
-25.6	-14	6.8	-6.1	21	69.8	13.3	56	132.8	32.8	91	195.8
-25.0	-13	8.6	-5.6	22	71.6	13.9	57	134.6	33.3	92	197.6
-24.4	-12	10.4	-5.0	23	73.4	14.4	58	136.4	33.9	93	199.4
-23.9	-11	12.2	-4.4	24	75.2	15.0	59	138.2	34.4	94	201.2
-23.3	-10	14.0	-3.9	25	77.0	15.6	60	140.0	35.0	95	203.0
-22.8	-9	15.8	-3.3	26	78.8	16.1	61	141.8	35.6	96	204.8
-22.2	-8	17.6	-2.8	27	80.6	16.7	62	143.6	36.1	97	206.6
-21.7	-7	19.4	-2.2	28	82.4	17.2	63	145.4	36.7	98	208.4
-21.1	-6	21.2	-1.7	29	84.2	17.8	64	147.2	37.2	99	210.2
-20.6	-5	23.0	-1.1	35	95.0	21.1	70	158.0	51.7	125	257.0
-20.0	-4	24.8	-0.6	31	87.8	18.9	66	150.8	40.6	105	221.0
-19.4	-3	26.6	0	32	89.6	19.4	67	152.6	43.3	110	230.0
-18.9	-2	28.4	0.6	33	91.4	20.0	68	154.4	46.1	115	239.0
-18.3	-1	30.2	1.1	34	93.2	20.6	69	156.2	48.9	120	248.0
-17.8	0	32.0	1.7	35	95.0	21.1	70	158.0	51.7	125	257.0
-17.2	1	33.8	2.2	36	96.8	21.7	71	159.8	54.4	130	266.0
-16.7	2	35.6	2.8	37	98.6	22.2	72	161.6	57.2	135	275.0
-16.1	3	37.4	3.3	38	100.4	22.8	73	163.4	60.0	140	284.0
-15.6	4	39.2	3.9	39	102.2	23.3	74	165.2	62.7	145	293.0
-15.0	5	41.0	4.4	40	104.0	23.9	75	167.0	65.6	150	302.0
-14.4	6	42.8	5.0	41	105.8	24.4	76	168.8	68.3	155	311.0
-13.9	7	44.6	5.6	42	107.6	25.0	77	170.6	71.1	160	320.0
-13.3	8	46.4	6.1	43	109.4	25.6	78	172.4	73.9	165	329.0
-12.8	9	48.2	6.7	44	111.2	26.1	79	174.2	76.7	170	338.0
-12.2	10	50.0	7.2	45	113.0	26.7	80	176.0	79.4	172	347.0

SECTION 1 GENERAL

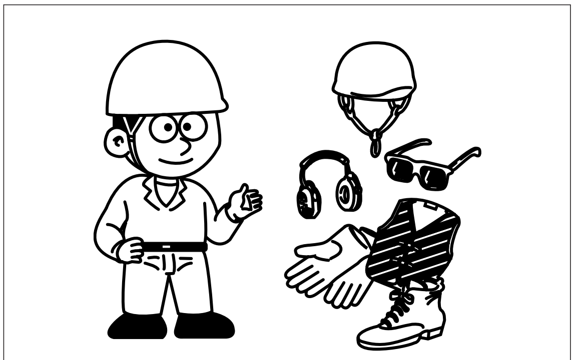
GROUP 1 SAFETY HINTS

Careless performing of the easy work may cause injuries.
Take care to always perform work safely, at least observing the following.



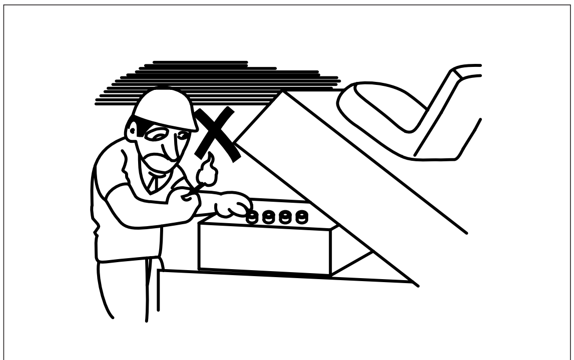
D35ASF01

- 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.



D35ASF02

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



D35ASF03

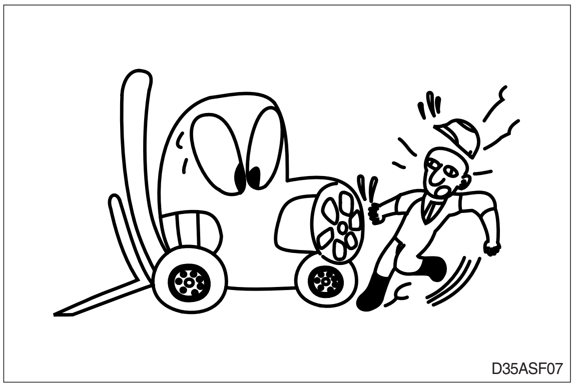
- Flames should never be used instead of lamps. Never use a naked flame to check leaks or the level of oil or electrolyte.

D35ASF06

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

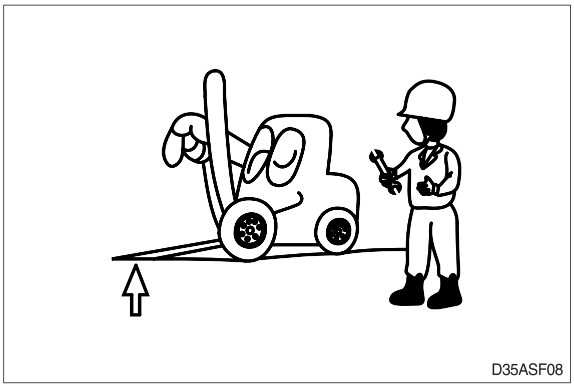
· Hand a caution sign in the operator's compartment (For example **Do not start** or **Maintenance in progress**).
This will prevent anyone from starting or moving the machine by mistake.

⚠ **It is extremely dangerous to try to check the fan belt tension while he engine is running.**

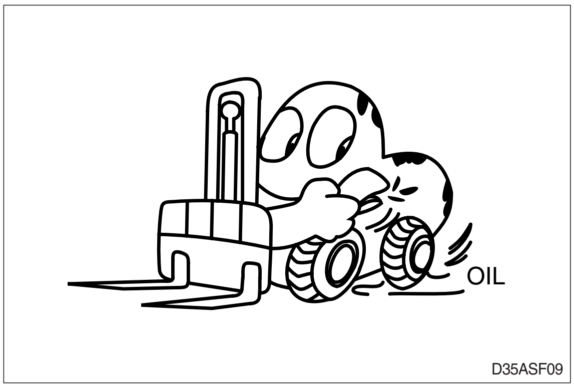

D35ASF07

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.

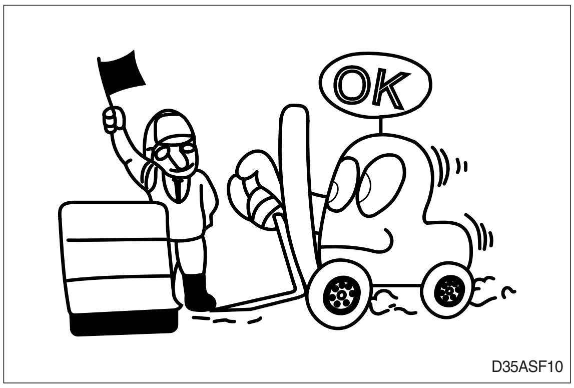

D35ASF08

· 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.



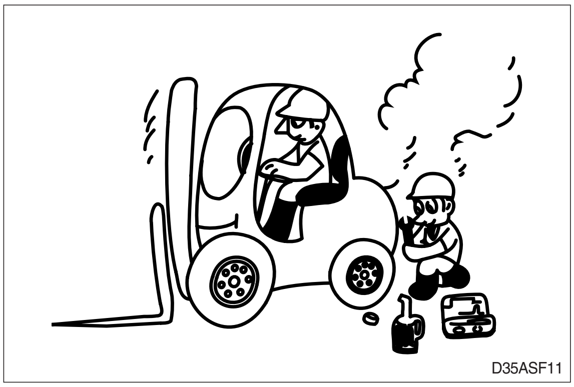
D35ASF09

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



D35ASF10

· Unless you have special instructions to the contrary, maintenance should always be carried out with the engine stopped. If maintenance is carried out with the engine 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.



· 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.

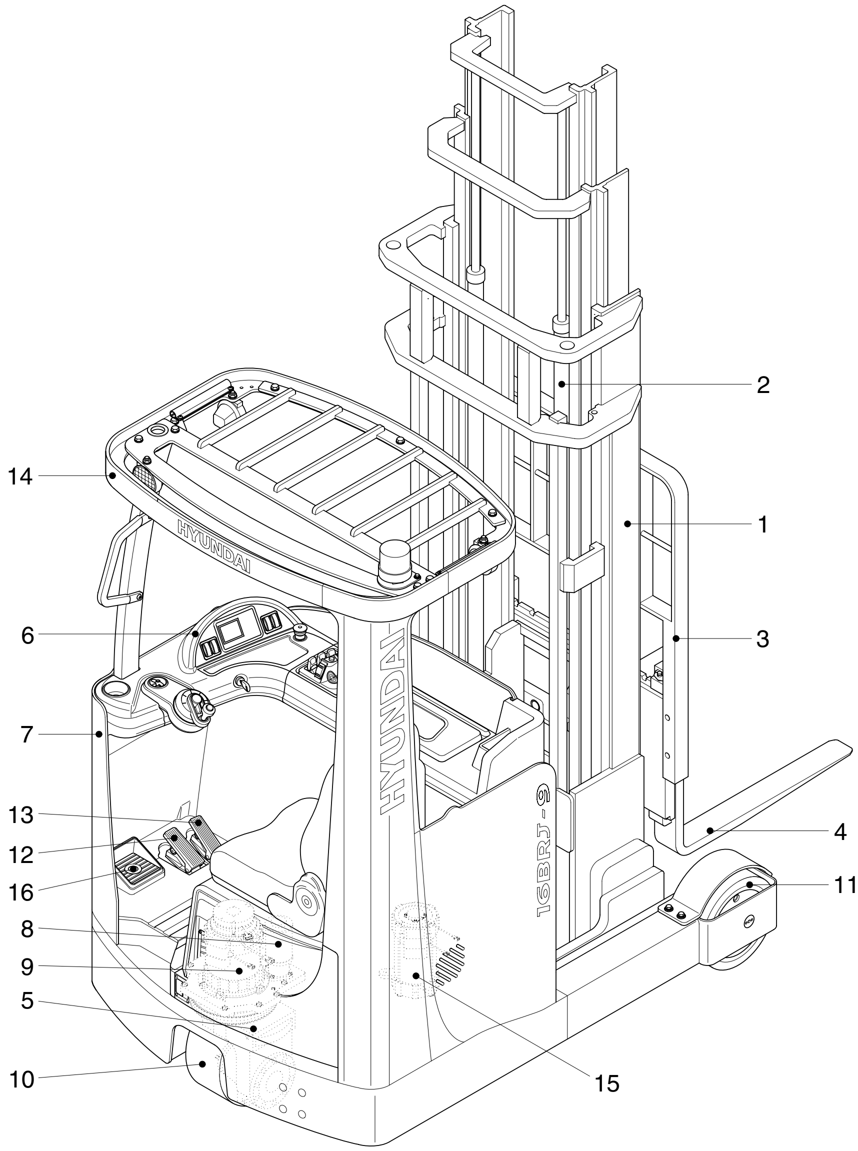
- Thoroughly clean the machine. In particular, be careful to clean the filler caps, grease fittings and the area around the dipsticks. Be careful not to let any dirt or dust into the system.
- Always use HYUNDAI Forklift genuine parts for replacement.
- Always use the grades of grease and oil recommended by HYUNDAI Forklift.
  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 40˚C.
- 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. Before removing the covers to inspect such cases, empty everything from your pockets. 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 to carry out it.

GROUP 2 SPECIFICATIONS

1. GENERAL LOCATIONS

Use the illustration below to locate components included in the PM procedures.

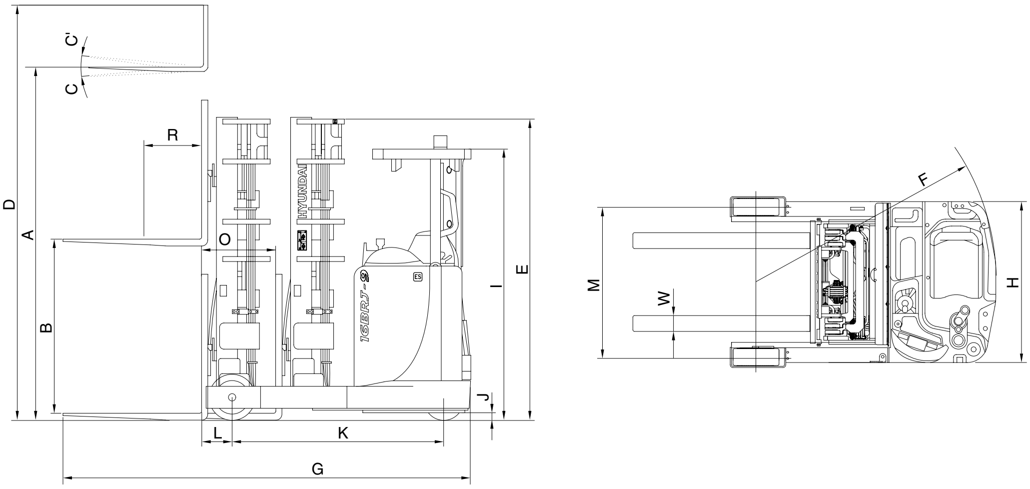


14BRJ9OM112

1	Mast	7	Frame	13	Accelerator pedal
2	Lift cylinder	8	EPS motor	14	Overhead guard
3	Carriage and backrest	9	Drive motor	15	Pump motor
4	Forks	10	Drive wheel	16	Deadman switch
5	Drive unit	11	Load wheel		
6	Dash board	12	Brake pedal		

2. SPECIFICATIONS

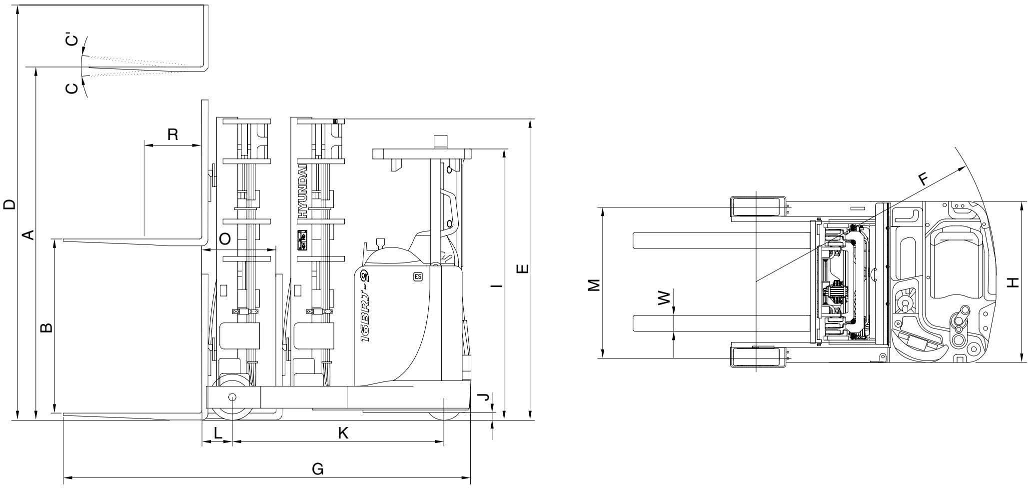
1) 14/16BRJ-9



14BRJ9SP01

Model			Unit	14BRJ-9	16BRJ-9
Capacity			kg (lb)	1400	1600
Load center		R	mm (in)	600	←
Weight (Unloaded, with battery)			kg (lb)	2910	3010
Fork	Lifting height	A	mm (ft-in)	5306	←
	Free lift	B	mm (in)	1761	←
	Lifting speed (Unload/Load)		mm/sec	580/370	←
	Lowering speed (Unload/Load)		mm/sec	450/500	←
	L×W×T	L,W,T	mm (in)	1200×100×40	1200×100×40
Mast	Tilt angle (forward/backward)	C/C'	degree	2/5	←
	Max height	D	mm (ft-in)	5812	←
	Min height	E	mm (ft-in)	2348	←
Body	Travel speed (Unload)		km/h	14	←
	Gradeability (Unload/Load)		%	18/13	18/12
	Min turning radius (Outside)	F	mm (ft-in)	1638	1685
ETC	Max hydraulic pressure		kgf/cm^2	190	←
	Hydraulic oil tank		l (usgal)	Refer to page 7-23	←
Overall length		G	mm (ft-in)	2570	←
Overall width		H	mm (ft-in)	1270	←
Overhead guard height		I	mm (ft-in)	2135	←
Ground clearance (Mast)		J	mm (in)	91	←
Wheel base		K	mm (ft-in)	1410	1460
Wheel tread rear (Load)		M/M'	mm (ft-in)	1149	←

2) 20/25BRJ-9



14BRJ9SP01

Model			Unit	20BRJ-9	25BRJ-9
Capacity			kg (lb)	2000	2500
Load center		R	mm (in)	600	←
Weight (Unloaded, with battery)			kg (lb)	3400	3700
Fork	Lifting height	A	mm (ft-in)	5305	←
	Free lift	B	mm (in)	1717	←
	Lifting speed (Unload/Load)		mm/sec	470/300	←
	Lowering speed (Unload/Load)		mm/sec	450/500	←
	L×W×T	L,W,T	mm (in)	1200×100×45	1200×122×45
Mast	Tilt angle (forward/backward)	C/C'	degree	2/5	←
	Max height	D	mm (ft-in)	5974	←
	Min height	E	mm (ft-in)	2386	←
Body	Travel speed (Unload)		km/h	14	←
	Gradeability (Unload/Load)		%	19/12	18/11
	Min turning radius (Outside)	F	mm (ft-in)	1742	1885
ETC	Max hydraulic pressure		kgf/cm^2	190	←
	Hydraulic oil tank		l (usgal)	Refer to page 7-23	←
Overall length		G	mm (ft-in)	2655	←
Overall width		H	mm (ft-in)	1270	←
Overhead guard height		I	mm (ft-in)	2135	←
Ground clearance (Mast)		J	mm (in)	109	←
Wheel base		K	mm (ft-in)	1520	1670
Wheel tread rear (Load)		M/M'	mm (ft-in)	1155	1184

3. SPECIFICATION FOR MAJOR COMPONENTS

1) 14/16BRJ-9

(1) Controller

Item	Unit	Drive & Pump motor controller	EPS motor controller	Fingertip controller
Model	-	AC-2	EPS-AC0	Mhyrio CB
Type	-	MOSFET	←	←
Dimension	mm	200×250×147.5	180×144×64.8	197×82×73
Current limit	A	450A	45A	-
Communication	-	CAN	←	←

(2) Motor

Item	Unit	Traction	Pump	EPS
Model	-	AMBL 4001P	ABDD 4003P	G104087A
Type	-	AC	AC	AC
Rated voltage	Vac	30	30	23
Output	kW	7.5	14.0	0.4
Insulation	-	Class F	Class F	Class H

(3) Battery

Item	Unit	14BRJ-9	16BRJ-9
Rated voltage	V	48	←
Dimension (W×L×H)	mm	1223×283 (*353)×787	←
Min. Battery weight	kg	710 (*890)	←
Max. Battery weight	kg	790 (*990)	←
Connector (CE spec)	-	SBE 320	

* : Option

(4) Charger

Item	Unit	14BRJ-9	16BRJ-9
Type	-	Constant current, constant voltage	
Battery capacity for charge	V-AH	48-280~335	←
AC input	V	Triple phase 410	
		Single phase 220	
		Triple phase 220/380	
		Triple phase 440	
DC output	V	62±1	←
Charge time	hr	8±2	←
Connector (CE spec)	-	(SBE320)	(SBE 320)

(5) Gear pump

Item	Unit	Specification
Type	–	Fixed displacement gear pump
Capacity	cc/rev	19.6
Maximum operating pressure	bar	210
Rated speed (max/min)	rpm	3000/500

(6) Main control valve

Item	Unit	Specification
Type	-	3 spool, 4 spool
Operating method	-	Proportional
Main relief valve pressure	bar	14BRJ : 160 16BRJ : 170

(7) Drive unit

Item	Unit	Specification
Gear ratio	-	14.5
Oil quantity	*l*	2.2

(8) Wheels

Item	Specification
Type (Load / Drive /Caster)	Polyurethane
Quantity (Load / Drive /Caster)	2 / 1
Load wheel	ø 285 × 100
Drive wheel	ø 305 × 140

(9) Brakes

Item	Specification
Brakes (Service & Parking)	Service : Load wheels, electromagnetic brake Parking : Drive wheel, electromagnetic brake

2) 20/25BRJ-9

(1) CONTROLLER

Item	Unit	Drive & Pump motor controller	EPS motor controller	Fingertip controller
Model	-	AC-2	EPS-AC0	Mhyrio CB
Type	-	MOSFET	←	←
Dimension	mm	200×250×147.5	180×144×64.8	197×82×73
Current limit	A	450A	45A	-
Communication	-	CAN	←	←

(2) MOTOR

Item	Unit	Traction	Pump	EPS
Model	-	AMBL 4001P	ABDD 4003P	G104087A
Type	-	AC	AC	AC
Rated voltage	Vac	30	30	23
Output	kW	7.5	14.0	0.4
Insulation	-	Class F	Class F	Class H

(3) BATTERY

Item	Unit	20BRJ-9	25BRJ-9
Rated voltage	V	48	←
Dimension (W×L×H)	mm	1223×353 (★425)×787	←
Min. Battery weight	kg	890 (★1065)	←
Max. Battery weight	kg	990 (★1180)	←
Connector (CE spec)	-	SBE 320	

★ : Option

(4) CHARGER

Item	Unit	20BRJ-9	25BRJ-9
Type	-	Constant current, constant voltage	
Battery capacity for charge	V-AH	48-450~520	←
AC input	V	Triple phase 410	
		Single phase 220	
		Triple phase 220/380	
		Triple phase 440	
DC output	V	62±1	←
Charge time	hr	8±2	←
Connector (CE spec)	-	(SBE320)	(SBE 320)

(5) GEAR PUMP

Item	Unit	Specification
Type	–	Fixed displacement gear pump
Capacity	cc/rev	19.6
Maximum operating pressure	bar	210
Rated speed (max/min)	rpm	3000/500

(6) MAIN CONTROL VALVE

Item	Unit	Specification
Type	-	3 spool, 4 spool
Operating method	-	Proportional
Main relief valve pressure	bar	20BRJ : 170 25BRJ : 190

(7) DRIVE UNIT

Item	Unit	Specification
Gear ratio	-	14.5
Oil quantity	l	2.2

(8) WHEELS

Item		Specification
Type (Load / Drive /Caster)		Polyurethane
Quantity (Load / Drive /Caster)		2 / 1
Load wheel	20BRJ-9	ø 355 × 106
	25BRJ-9	ø 355 × 135
Drive wheel		ø 345 × 140

(9) BRAKES

Item	Specification
Brakes (Service & Parking)	Service : Load wheels, electromagnetic brake Parking : Drive wheel, electromagnetic brake

4. TIGHTENING TORQUE FOR MAJOR COMPONENTS

1) 14/16BRJ-9

NO	Items		Size	kgf · m	lbf · ft
1	Electric system	Hyd pump motor mounting bolt	M 8×1.25	2.5±0.5	18±3.6
2		Traction motor mounting bolt	M12×1.75	14.7±2.2	106±15.9
3	Hydraulic system	Hydraulic pump mounting bolt	M10×1.5	5±1	36±7.2
4		MCV mounting bolt, nut	M 8×1.25	2.5±0.5	18.1±3.6
5		Hydraulic oil tank mounting bolt	M 8×1.25	2.5±0.5	18.1±3.6
6	Power train system	Drive unit mounting bolt	M12×1.75	14.7±2.2	106±15.9
7		Load wheels mounting bolt	M 8×1.25	2.5±0.2	18±1.4
8		Drive wheel mounting nut	M14×1.5	15.7±2.3	113.6±16.6
9	Other	Seat mounting nut	M 8×1.25	2.5±0.5	18.1±3.6
10		Head guard mounting bolt	M10×1.5 M14×2	6.9±1.4 19.6±2.9	50±10 141.8±21

2) 20/25BRJ-9

NO	Items		Size	kgf · m	lbf · ft
1	Electric system	Hyd pump motor mounting bolt	M 8×1.25	2.5±0.5	18±3.6
2		Traction motor mounting bolt	M12×1.75	14.7±2.2	106±15.9
3	Hydraulic system	Hydraulic pump mounting bolt	M10×1.5	5±1	36±7.2
4		MCV mounting bolt, nut	M 8×1.25	2.5±0.5	18.1±3.6
5		Hydraulic oil tank mounting bolt	M 8×1.25	2.5±0.5	18.1±3.6
6	Power train system	Drive unit mounting bolt	M12×1.75	14.7±2.2	106±15.9
7		Load wheels mounting bolt	M 8×1.25	2.5±0.2	18±1.4
8		Drive wheel mounting nut	M14×1.5	15.7±2.3	113.6±16.6
9	Other	Seat mounting nut	M 8×1.25	2.5±0.5	18.1±3.6
10		Head guard mounting bolt	M10×1.5 M14×2	6.9±1.4 19.6±2.9	50±10 141.8±21

5. TORQUE CHART

Use following table for unspecified torque.

1) BOLT AND NUT

(1) Coarse thread

Bolt size	8T		10T	
	kg · m	lb · ft	kg · m	lb · ft
M 6 × 1.0	0.85 ~ 1.25	6.15 ~ 9.04	1.14 ~ 1.74	8.2 ~ 12.6
M 8 × 1.25	2.0 ~ 3.0	14.5 ~ 21.7	2.73 ~ 4.12	19.5 ~ 29.8
M10 × 1.5	4.0 ~ 6.0	28.9 ~ 43.4	5.5 ~ 8.3	39.8 ~ 60
M12 × 1.75	7.4 ~ 11.2	53.5 ~ 79.5	9.8 ~ 15.8	71 ~ 114
M14 × 2.0	12.2 ~ 16.6	88.2 ~ 120	16.7 ~ 22.5	121 ~ 167
M16 × 2.0	18.6 ~ 25.2	135 ~ 182	25.2 ~ 34.2	182 ~ 247
M18 × 2.5	25.8 ~ 35.0	187 ~ 253	35.1 ~ 47.5	254 ~ 343
M20 × 2.5	36.2 ~ 49.0	262 ~ 354	49.2 ~ 66.6	356 ~ 482
M22 × 2.5	48.3 ~ 63.3	350 ~ 457	65.8 ~ 98.0	476 ~ 709
M24 × 3.0	62.5 ~ 84.5	452 ~ 611	85.0 ~ 115	615 ~ 832
M30 × 3.0	124 ~ 168	898 ~ 1214	169 ~ 229	1223 ~ 1655
M36 × 4.0	174 ~ 236	1261 ~ 1703	250 ~ 310	1808 ~ 2242

(2) Fine thread

Bolt size	8T		10T	
	kg · m	lb · ft	kg · m	lb · ft
M 8 × 1.0	2.17 ~ 3.37	15.7 ~ 24.3	3.04 ~ 4.44	22.0 ~ 32.0
M10 × 1.25	4.46 ~ 6.66	32.3 ~ 48.2	5.93 ~ 8.93	42.9 ~ 64.6
M12 × 1.25	7.78 ~ 11.58	76.3 ~ 83.7	10.6 ~ 16.0	76.6 ~ 115
M14 × 1.5	13.3 ~ 18.1	96.2 ~ 130	17.9 ~ 24.1	130 ~ 174
M16 × 1.5	19.9 ~ 26.9	144 ~ 194	26.6 ~ 36.0	193 ~ 260
M18 × 1.5	28.6 ~ 43.6	207 ~ 315	38.4 ~ 52.0	278 ~ 376
M20 × 1.5	40.0 ~ 54.0	289 ~ 390	53.4 ~ 72.2	386 ~ 522
M22 × 1.5	52.7 ~ 71.3	381 ~ 515	70.7 ~ 95.7	512 ~ 692
M24 × 2.0	67.9 ~ 91.9	491 ~ 664	90.9 ~ 123	658 ~ 890
M30 × 2.0	137 ~ 185	990 ~ 1338	182 ~ 248	1314 ~ 1795
M36 × 3.0	192 ~ 260	1389 ~ 1879	262 ~ 354	1893 ~ 2561

2) PIPE AND HOSE (FLARE type)

Thread size	Width across flat (mm)	kgf · m	lbf · ft
1/4"	19	4	28.9
3/8"	22	5	36.2
1/2"	27	9.5	68.7
3/4"	36	18	130
1"	41	21	152
1-1/4"	50	35	253

3) PIPE AND HOSE (ORFS type)

Thread size	Width across flat (mm)	kgf · m	lbf · ft
9/16-18	19	4	28.9
11/16-16	22	5	36.2
13/16-16	27	9.5	68.7
1-3/16-12	36	18	130
1-7/16-12	41	21	152
1-11/16-12	50	35	253

4) FITTING

Thread size	Width across flat (mm)	kgf · m	lbf · ft
1/4"	19	4	28.9
3/8"	22	5	36.2
1/2"	27	9.5	68.7
3/4"	36	18	130
1"	41	21	152
1-1/4"	50	35	253

6. RECOMMENDED LUBRICANTS

Service point	Kind of fluid	Capacity l (U.S. gal)		Ambient temperature °C (°F)
		14/16BRJ-9	20/25BRJ-9	-50 (-58), -30 (-22), -20 (-4), -10 (14), 0 (32), 10 (50), 20 (68), 30 (86), 40 (104)
Drive unit	Gear oil	2.2 (0.58)	3.3 (0.87)	SAE 80W-90
Hydraulic oil tank	Hydraulic oil	~TF 670 : 25 (6.6) TF 700~TF 800 : 28 (7.4) ~TF 850 : 32 (8.5)		ISO VG 15 ISO VG 22 ISO VG 46 ISO VG 68
Fitting (Grease nipple)	Grease	0.1 (0.03)	0.1 (0.03)	NLGI No.1 NLGI No.2

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.

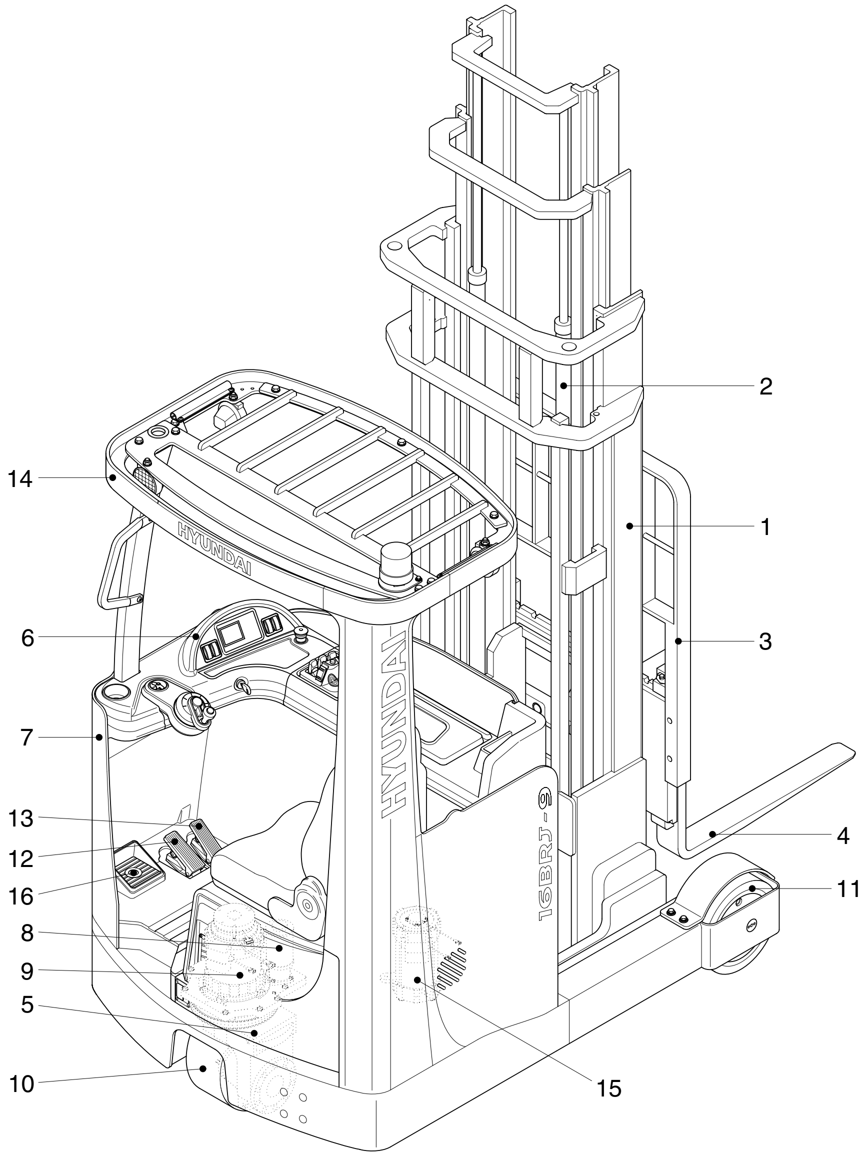
These parts may deteriorate in time and are susceptible to wear. It is difficult to estimate the degree of wear at time of periodic maintenance; therefore, even if no apparent wear is found, always replace with new parts within the prescribed period of replacement(Or earlier if trouble is found).
Note 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	Hydraulic oil	Every 1 year
2	Gear oil	Every 1 year
3	Power steering hose	Every 1 year
4	Rubber parts of the power steering inside	Every 2 year
5	Cups and dust seals etc. of cylinder	Every 2 year
6	Lift chain	Every 2 year
7	Hydraulic equiprnent hose	Every 2 year

SECTION 2 REMOVAL & INSTALLATION OF UNIT

GROUP 1 MAJOR COMPONENTS



14BRJ9OM112

1	Mast	7	Frame	13	Accelerator pedal
2	Lift cylinder	8	EPS motor	14	Overhead guard
3	Carriage and backrest	9	Drive motor	15	Pump motor
4	Forks	10	Drive wheel	16	Deadman switch
5	Drive unit	11	Load wheel		
6	Dash board	12	Brake pedal		

GROUP 2 REMOVAL AND INSTALLATION OF UNIT

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

1. MAST

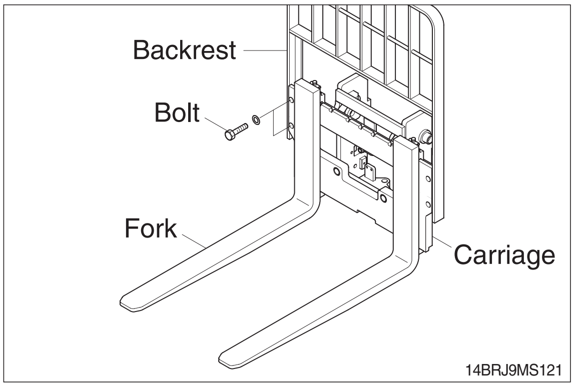
1) REMOVAL

Backrest & fork — Carriage — Piping — Mast

(1) Backrest

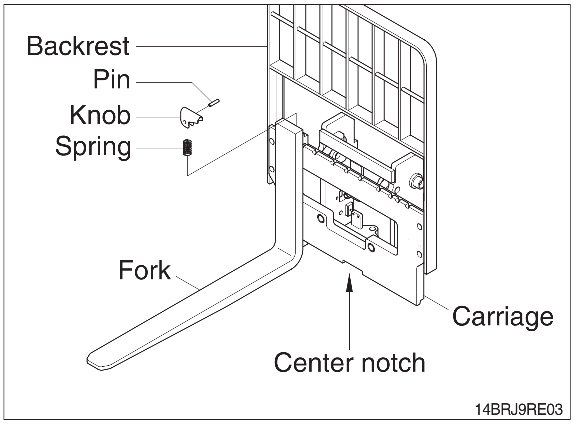
① Remove bolts securing backrest to fork carriage. Lift backrest straight up and remove it from carriage.

· Tightening torque : 7.8~11.6 kgf · m (56.4~83.9 lbf · ft)



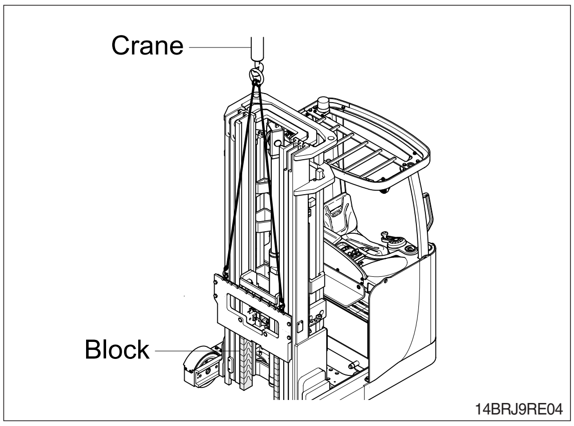
(2) Forks

① Disconnect cable for the fork camera if equipped.
② Remove shaft cover and bolt.
③ Remove fork set pin and then draw out the shaft.
④ Carefully remove forks one by one.

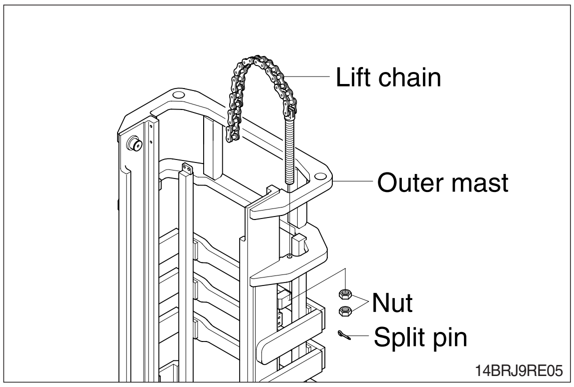


(3) Carriage

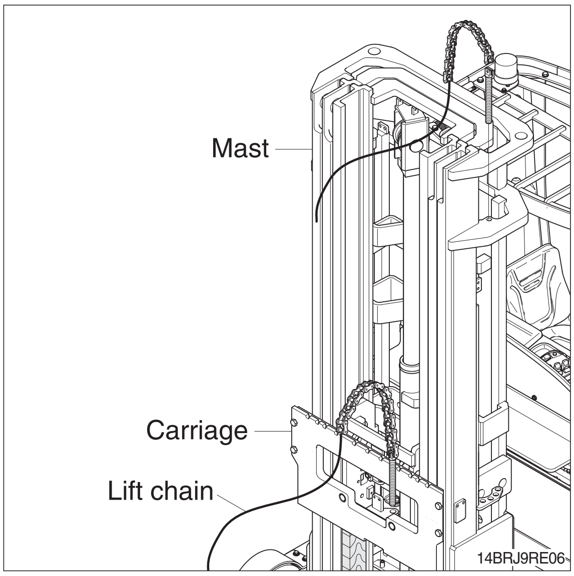
① Disconnect cable for the height indicator and the autotilt level if equipped.
② While supporting free lift chains, remove the split pins and nuts from anchor bolts of stationary upright.



② While supporting lift chains, remove the split pins and nuts from anchor bolts of stationary upright.



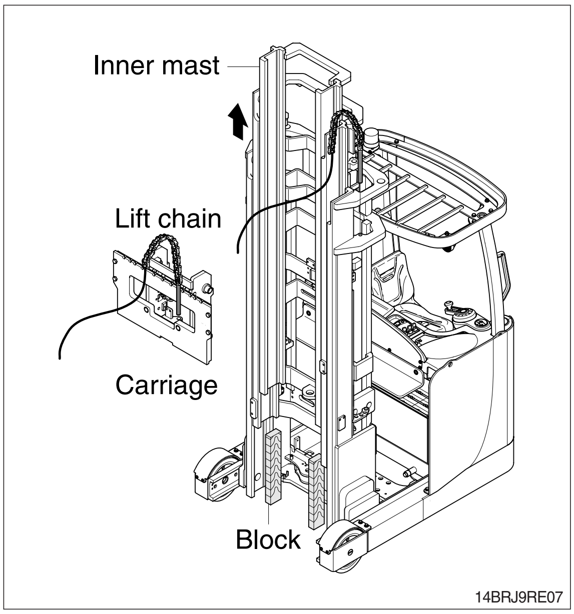
③ Pull the chains out of the sheaves and drape them over the front of the carriage.



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.**

⑤ Inspect all parts for wear or damage. Replace all worn or damaged parts.



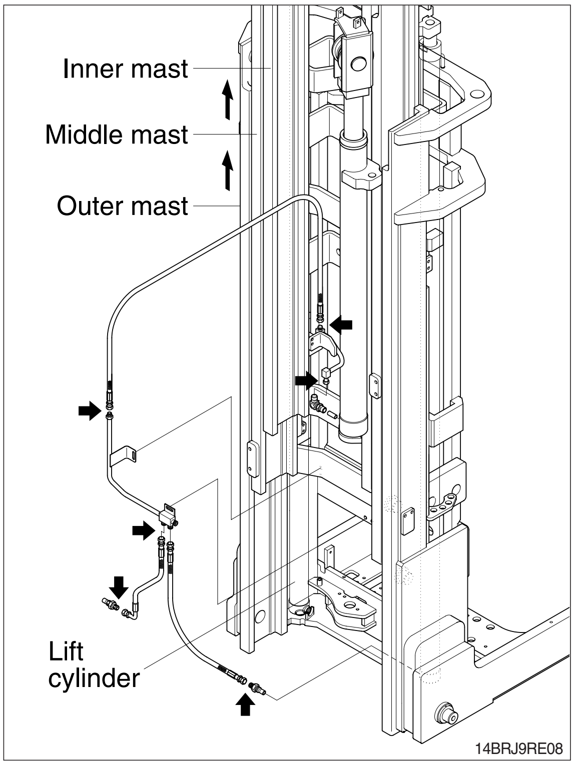
(4) PIPING

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

② Remove the return hoses from the connector.

③ Remove hose assembly, connector, down safety valve from the lift cylinder.

④ Disconnect hose assembly from the flow regulator.



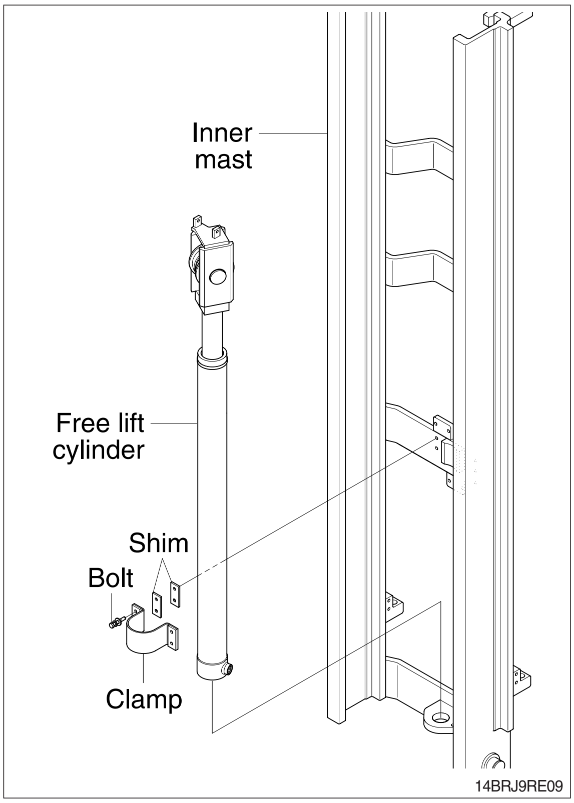
(5) FREE LIFT CYLINDER

① Bind the free lift cylinder with overhead hoist rope and pull up so that the rope has no slack or binding.

② Loosen the bolts and remove clamp, shims securing the free lift cylinder to inner mast.

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

③ Using an overhead hoist draw out free lift cylinder carefully and put down on the work floor.

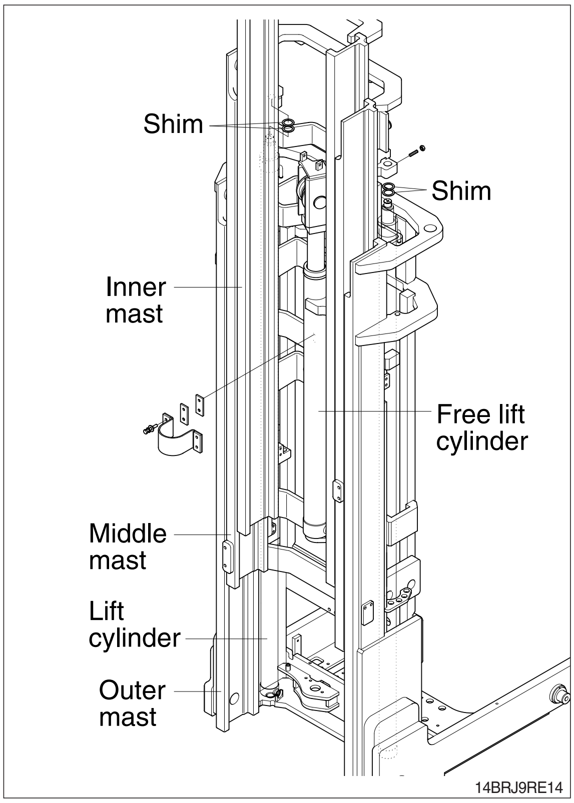


(6) LIFT CYLINDER

① Loosen hexagonal bolts and remove washers securing the lift cylinders to inner mast.
② Bind the lift cylinder with overhead hoist rope and pull up so that the rope has no slack or binding.

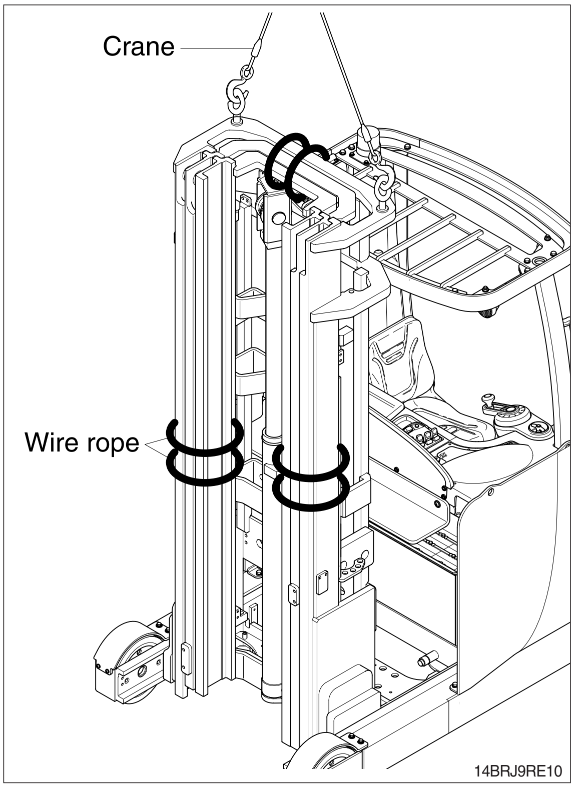
⚠ Make sure that the lift cylinder be tightened firmly for safety.

③ Loosen and remove hexagon nuts and cylinder band securing cylinder to outer mast.
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.



(7) MAST REMOVAL

① Pass wire rope around the inner, middle and outer masts to allow lifting them out with a hoist.
② Remove the stopper pin at the end of reach cylinder and then remove the stopper bolt at the end of guide rail.
③ Draw out the mast from the guide rail with lifting up.
④ Lower the mast and place it on stand.

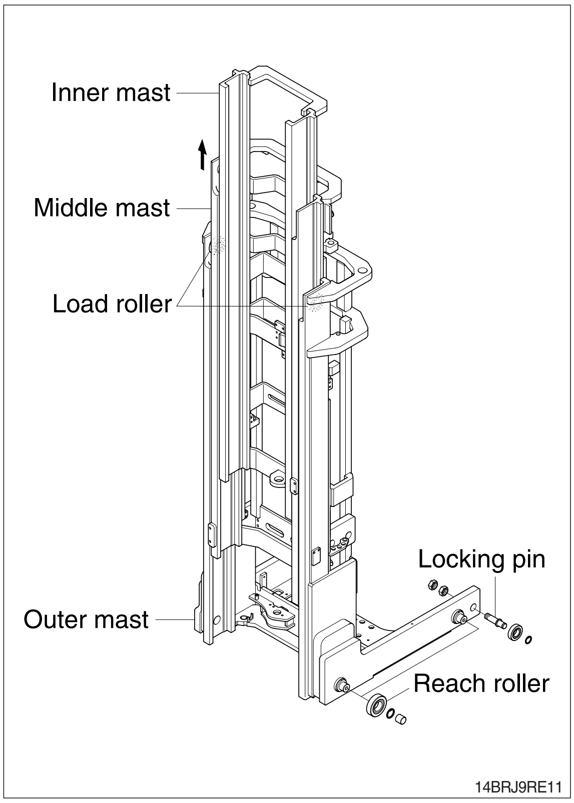


(8) MIDDLE AND INNER MAST

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

⚠ Be careful the mast not to swing or fall.

② Using an universal puller, remove the load rollers.



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) LIFT CYLINDER INSTALLATION AND ADJUSTMENT

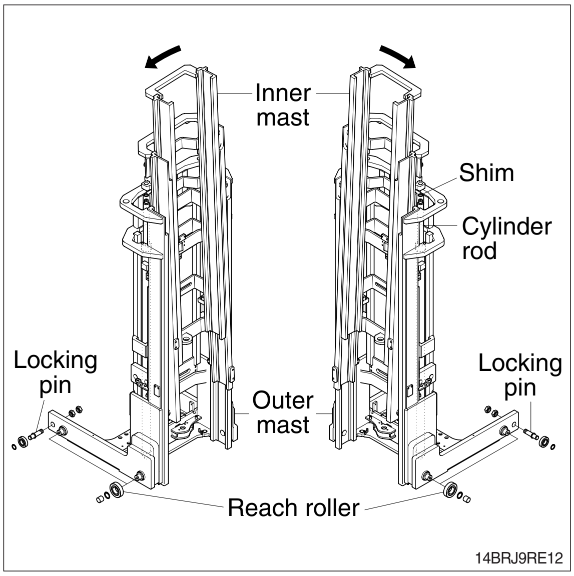
① Assemble the lift cylinder inside the outer mast, then tighten the stopper bolt. If the cylinder assembly has been replaced, adjust as follows so that the left and right cylinders are synchronized at the maximum lifting height.

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 (0.04 in)



(2) REACH ROLLER AND LOCKING PIN ADJUSTMENT

※ Refer to the page 8-8.

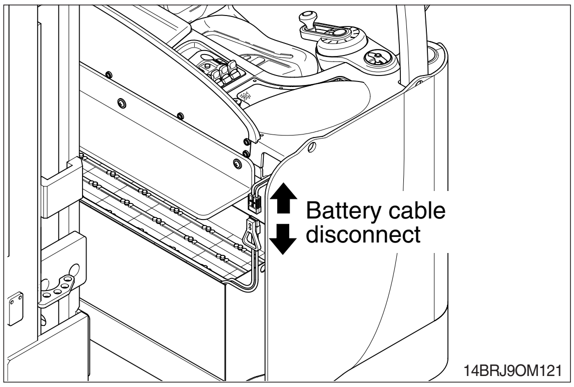
2. POWER TRAIN ASSEMBLY

1) REMOVAL

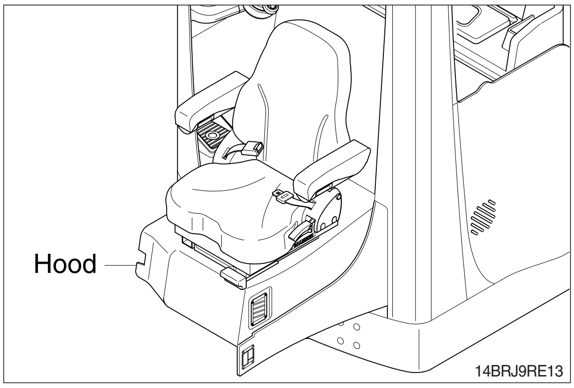
Battery disconnector — Seat & hood — Pump & pump motor — Drive unit assembly

BRJ7RE001

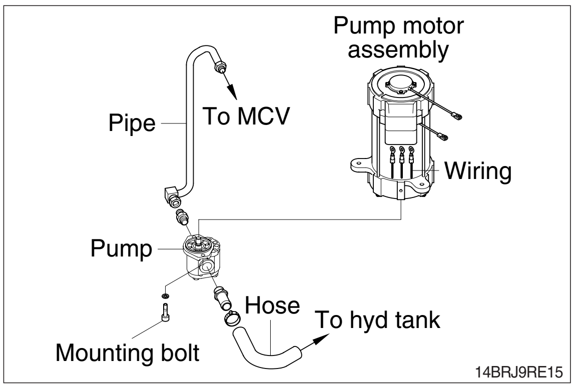
(1) Disconnect the battery cable.



(2) Remove seat and hood.

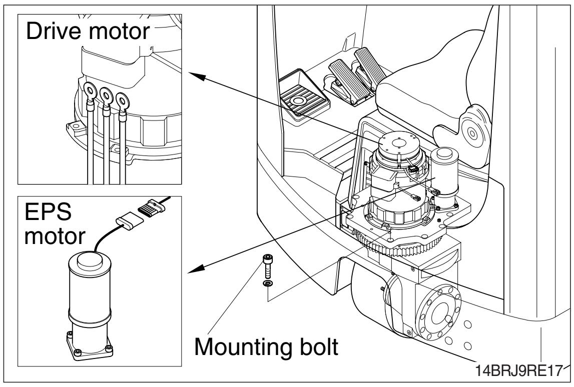


(3) Disconnect the hose, pipe and wiring from pump & motor assembly.
Loosen mounting nuts from frame and then take out the assembly.

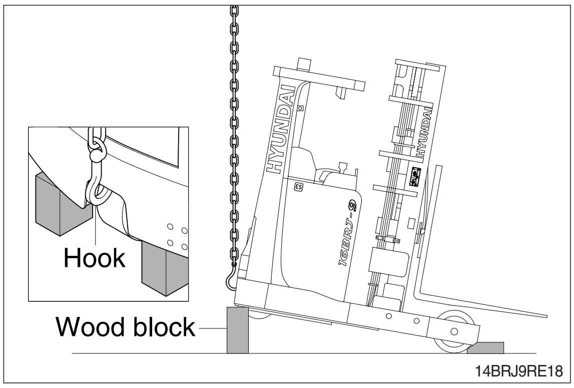


(4) Disconnect the wiring.
① Drive motor wiring
② EPS motor wiring.

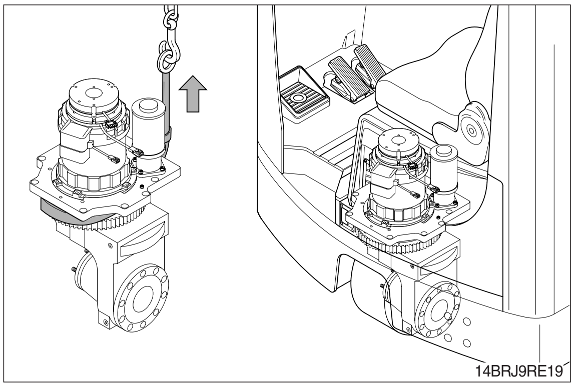
(5) Loosen mounting bolts from frame and then take out drive unit assembly.



(6) Lift up the frame and support both side of frame on wood block.



(7) Remove drive unit assembly from frame by lifting.

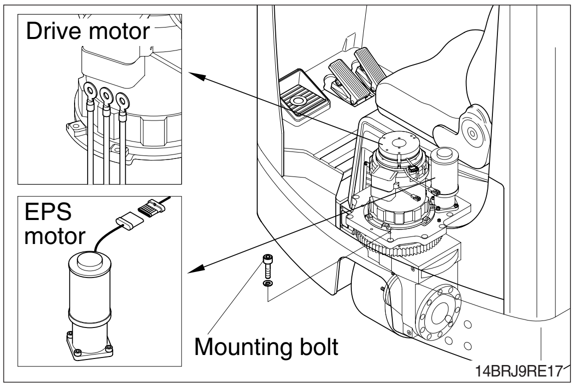


2) INSTALLATION

Installatron is in the reverse order to removal, but be careful of following points.

※ Apply loctite all of the bolt and nut before tightening.

(1) Drive unit mounting bolts : 6 EA
- Tightening torque : 12.5~16.9 kgf · m (90.4~122.2 lbf · ft)



(2) Drive unit bracket mounting bolt : 9 EA
- Tightening torque : 12.5~16.9 kgf · m (90.4~122.2 lbf · ft)

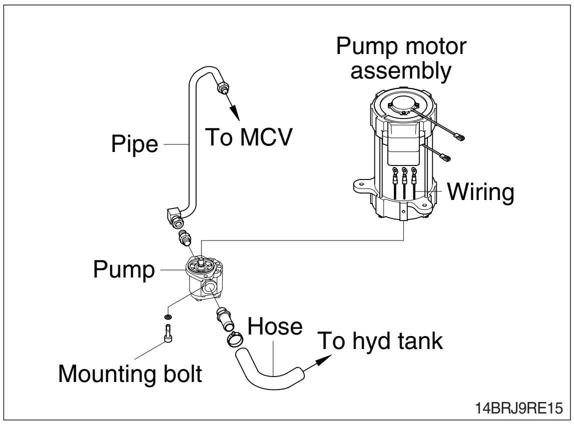
(3) Drive motor mounting bolts : 6 EA
- Tightening torque : 3.2~4.8 kgf · m (23.1~34.7 lbf · ft)

(4) EPS motor mounting bolts : 4 EA
- Tightening torque : 6.6~9.8 kgf · m (47.7~70.9 lbf · ft)

Position sensor : 1.3~1.7 kgf · m (9.4~12.3 lbf · ft)

(5) Pump motor mounting nuts : 3 EA
- S205-081006
- Tightening torque : 2.0~3.0 kgf · m (14.5~21.7 lbf · ft)

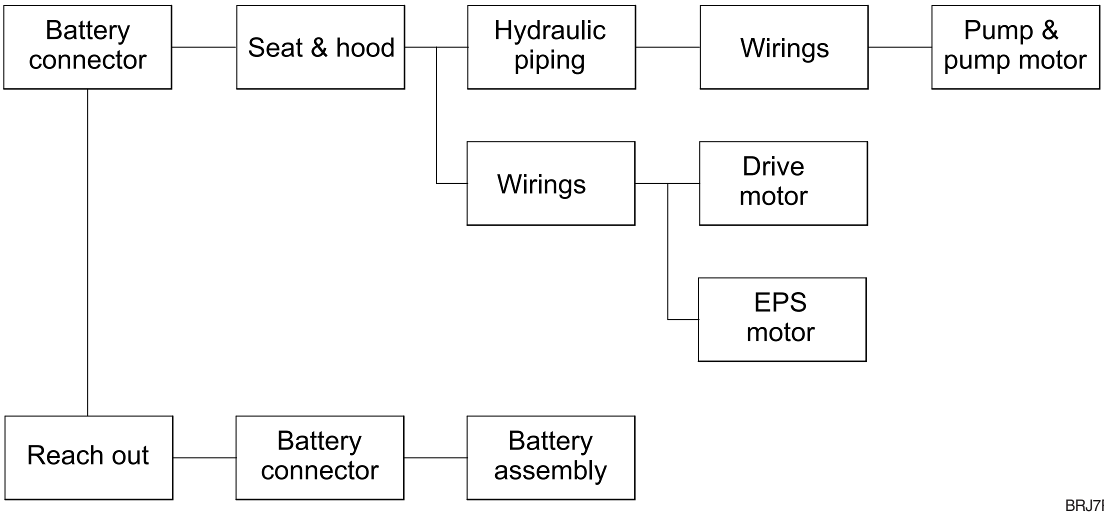
(6) Pump motor mounting bolt : 2 EA
- S109-100256
- Tightening torque : 6.6~10.0 kgf · m (47.7~72.3 lbf · ft)



3. ELECTRICAL COMPONENTS

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

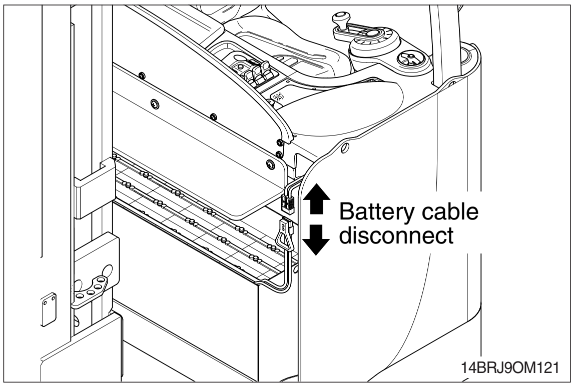
1) REMOVAL



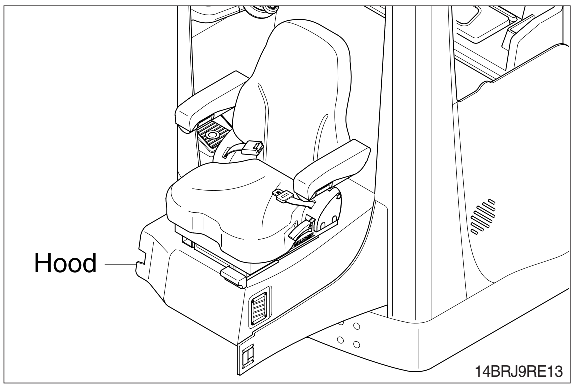
BRJ7RE002

(1) PUMP MOTOR

① Disconnect the battery cable.

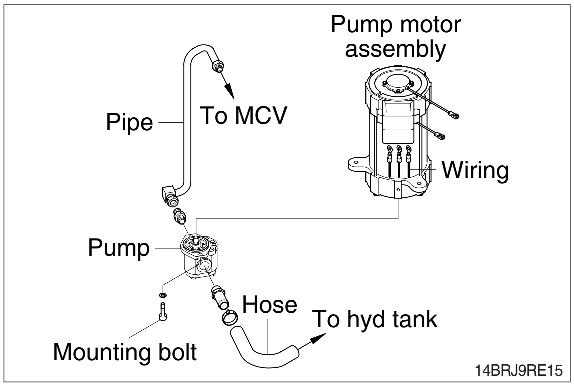


② Remove seat and hood.



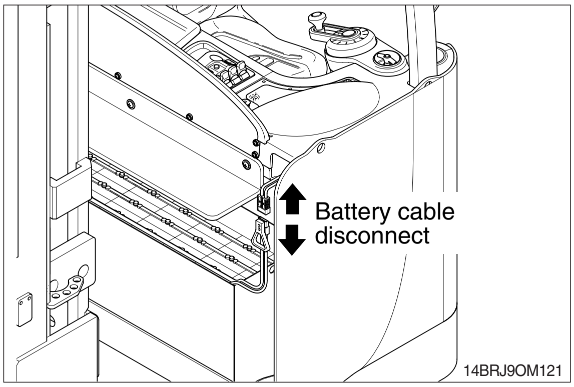
③ Disconnect the hose, pipe and wiring from pump & motor assembly.
Loosen mounting nuts from frame and then take out the assembly.

④ Remove 2 mounting bolts fastening the pump & motor and then disengage the pump from motor.

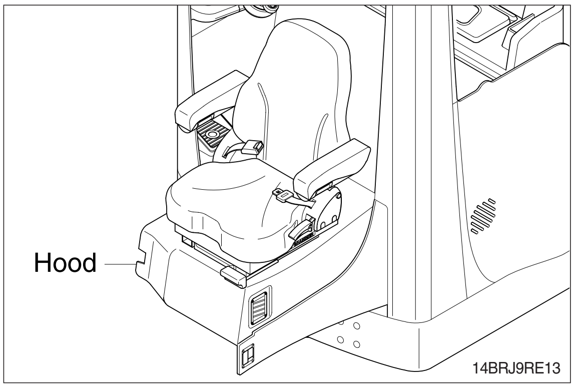


(2) DRIVE MOTOR

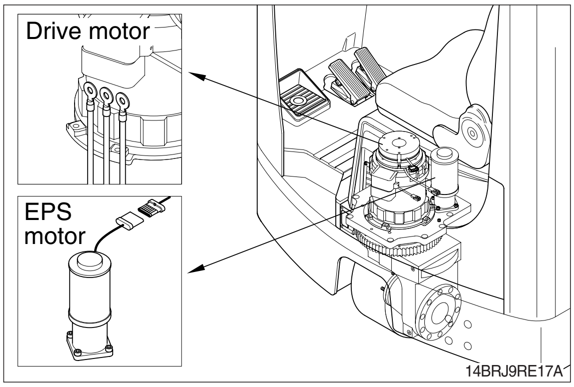
① Disconnect the battery cable.



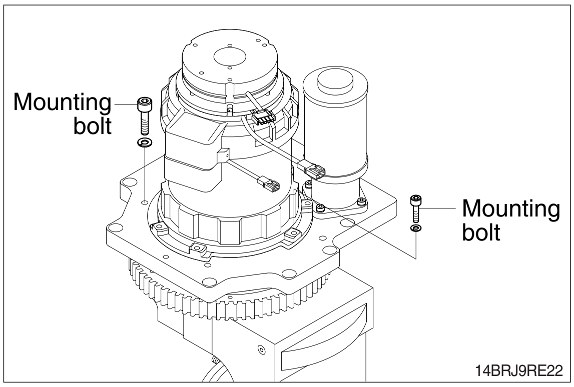
② Remove seat and hood.



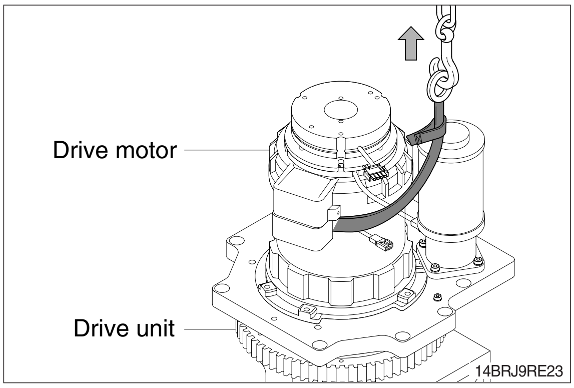
③ Disconnect wirings.
a. Drive motor wiring
b. EPS motor wiring



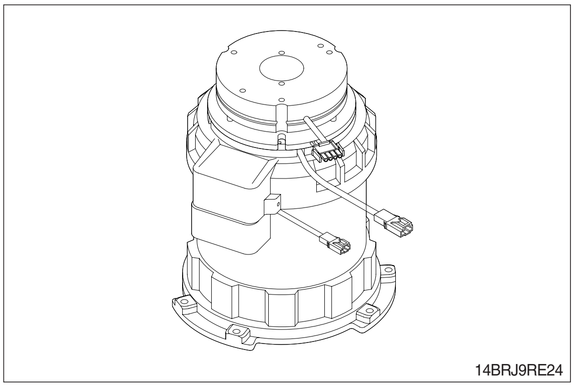
④ Remove bolts connecting the motor and drive unit.



⑤ Tie wire rope around the drive motor and lift up slowly.

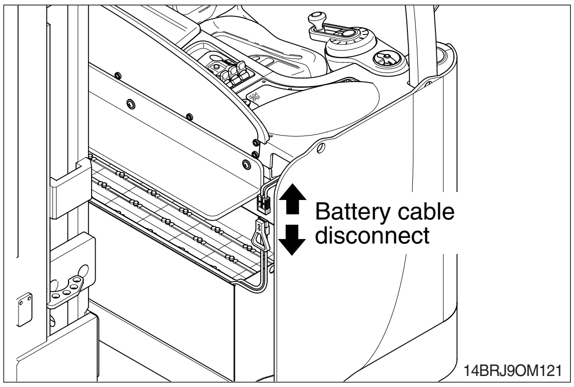


⑥ Put the motor on the clean work bench.

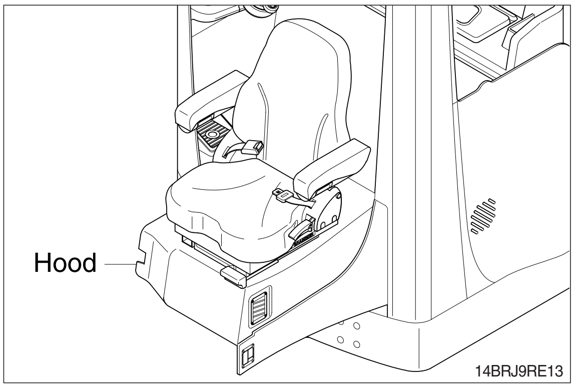


(3) EPS MOTOR

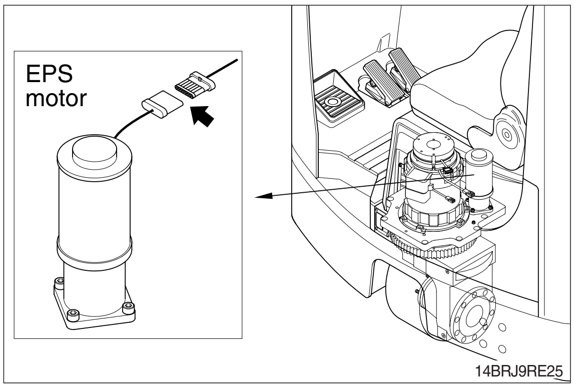
① Disconnect the battery cable.



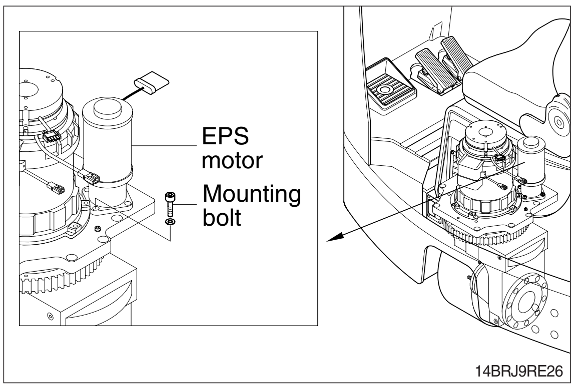
② Remove seat and hood.



③ Disconnect wirings.



④ Loosen bolts and remove EPS motor assembly.



(4) BATTERY REMOVAL

① Turn on the key.

② Foot on the battery unlock lever to unlock the battery trolley assembly..

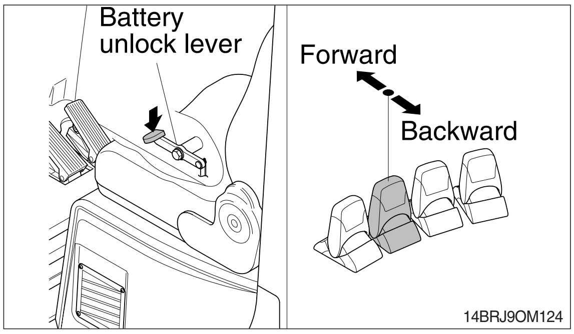
③ Pull the reach lever until it is relief.

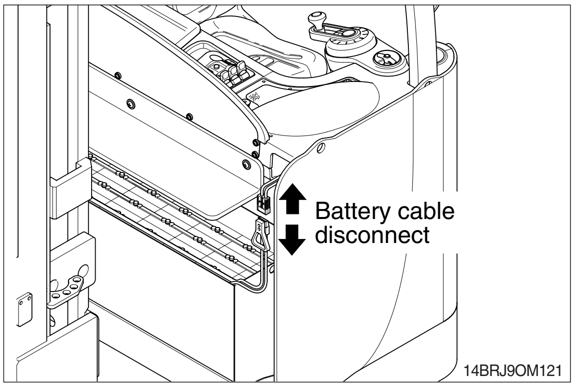
④ Push the reach lever until it is relief.

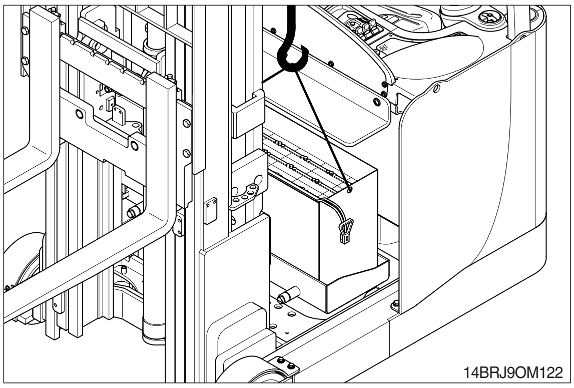
⑤ Turn off the key.

⑥ Disconnect the battery connector.

⑦ Using a battery hanger, carefully raise the battery assembly or using a battery carrier.







2) INSTALLATION

Installation is in the reverse order to removal, but be careful of following points.

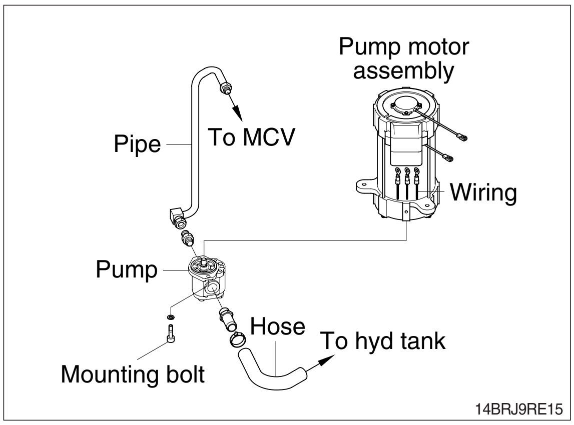
(1) PUMP MOTOR

① Pump motor mounting nut

· Tightening torque : 2.0~3.0 kgf · m (14.5~21.7 lbf · ft)

② Hydraulic pump mounting bolt

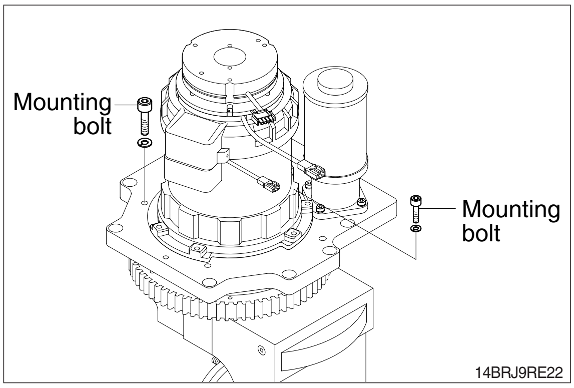
· Tightening torque : 6.6~10.0 kgf · m (47.7~72.3 lbf · ft)



(2) DRIVE MOTOR

① Connetion bolts between drive motor and drive unit.

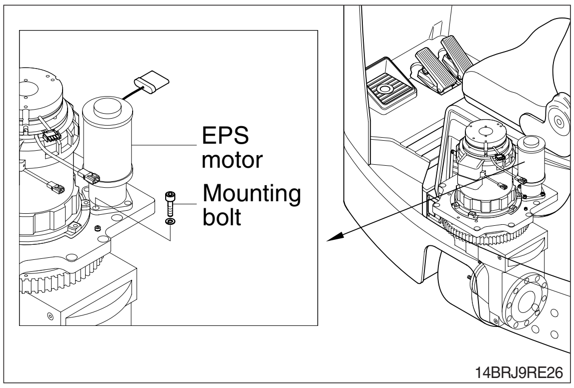
· Tightening torque : 3.2~4.8 kgf · m (23.1~34.7 lbf · ft)



(3) EPS MOTOR

① EPS motor mounting bolts.

· Tightening torque : 6.6~9.8 kgf · m (47.7~70.9 lbf · ft)



(4) BATTERY INSTALLATION

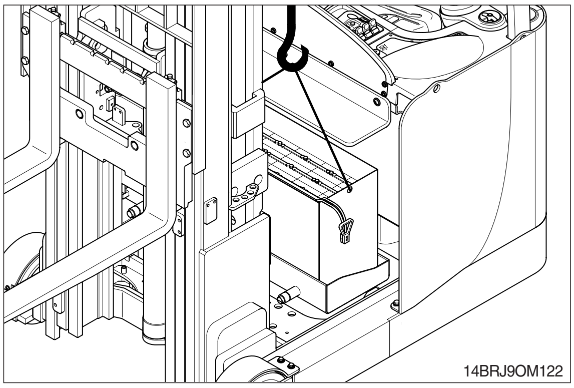
① Using a battery hanger, carefully put the battery assembly on the battery trolley between mast and frame.

② Connect the battery connector.

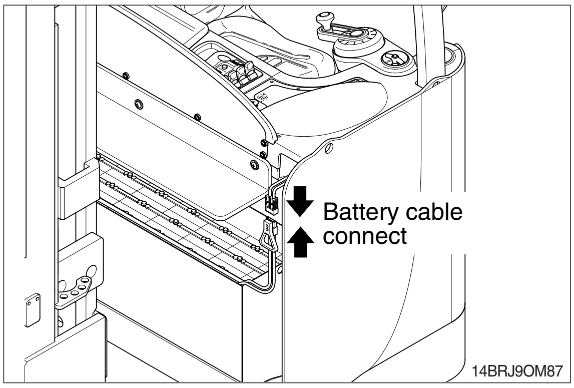
③ Turn on the key.

④ Pull the reach lever until it sounds locked. (Auto lock)

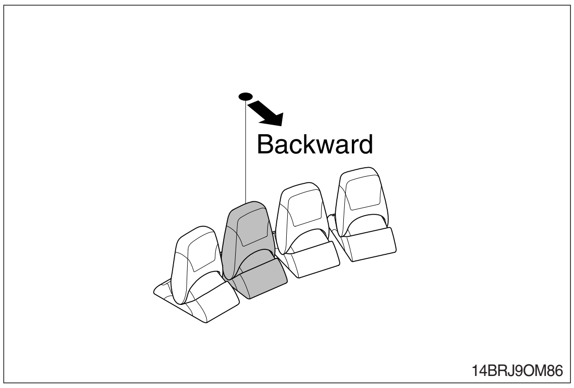
⑤ Complete installation.



14BRJ9OM122



14BRJ9OM87



14BRJ9OM86

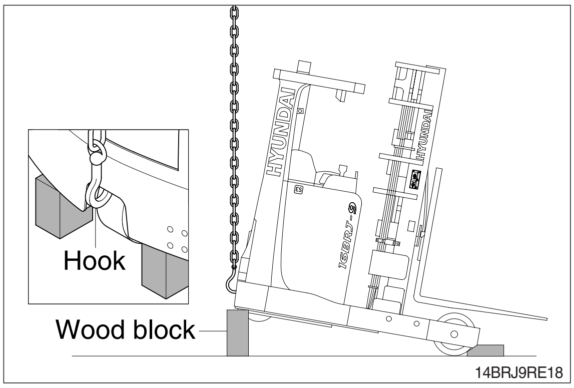
4. TIRE & WHEEL ASSEMBLY

1) REMOVAL

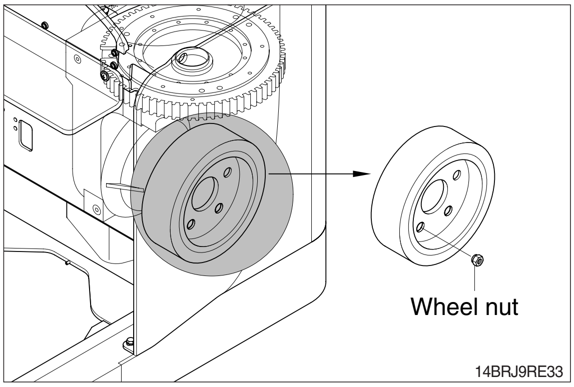
(1) DRIVE TIRE & WHEEL ASSEMBLY

① Lift up the frame

※ **Lift up until the tire clear off the ground.**

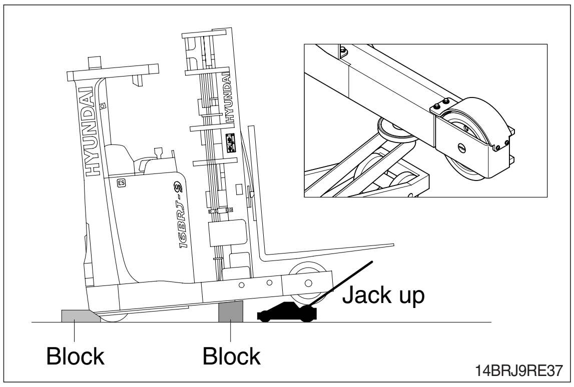


② Remove wheel nuts attaching the drive wheel and take off the drive wheel assembly.
- · Wheel nuts : 14/16BRJ : 5 EA
  20/25BRJ : 7 EA

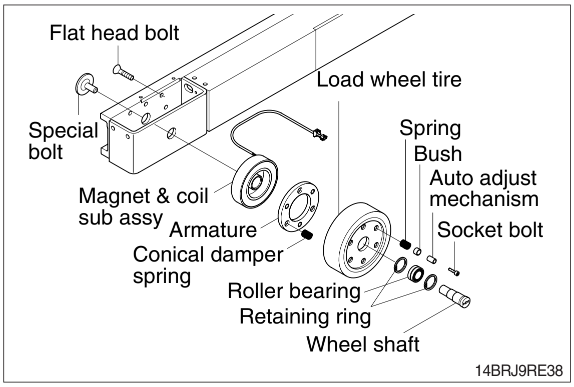


(2) LOAD WHEEL ASSEMBLY

① Lift up the reach legs and fix the machine with blocks.



② Disconnect brake cable
- Remove special bolt, flat head bolt and take out wheel shaft assy.
- Remove the load wheel tire assy.
- Remove socket bolt.

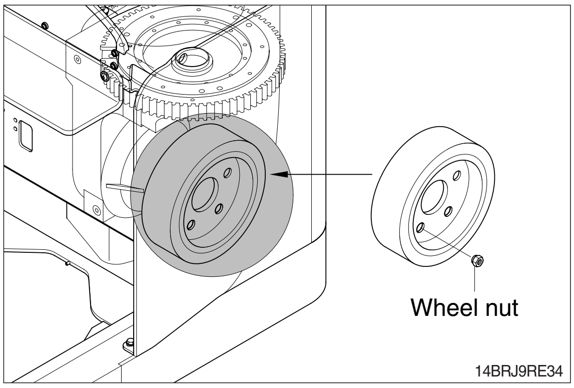


2) INSTALLATION

Installation is in the reverse order to removal, but be careful of the following points.

(1) Drive wheel nuts

· Tightening torque : 13.5~15.5 kgf · m (98~112 lbf · ft)

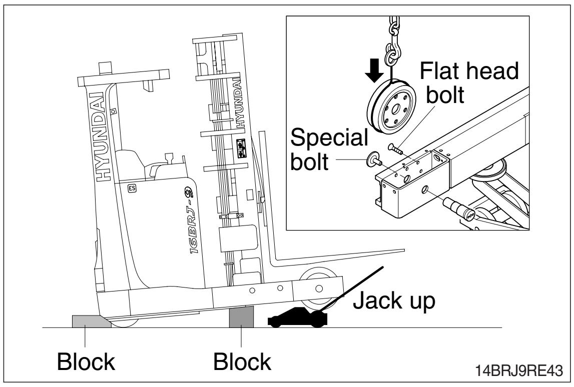


(2) Load wheel special bolts

· Tightening torque : 10~12 kgf · m (72.3~86.8 lbf · ft)

(3) Load wheel flat head socket bolts

· Tightening torque : 5~6 kgf · m (36.2~43.4 lbf · ft)



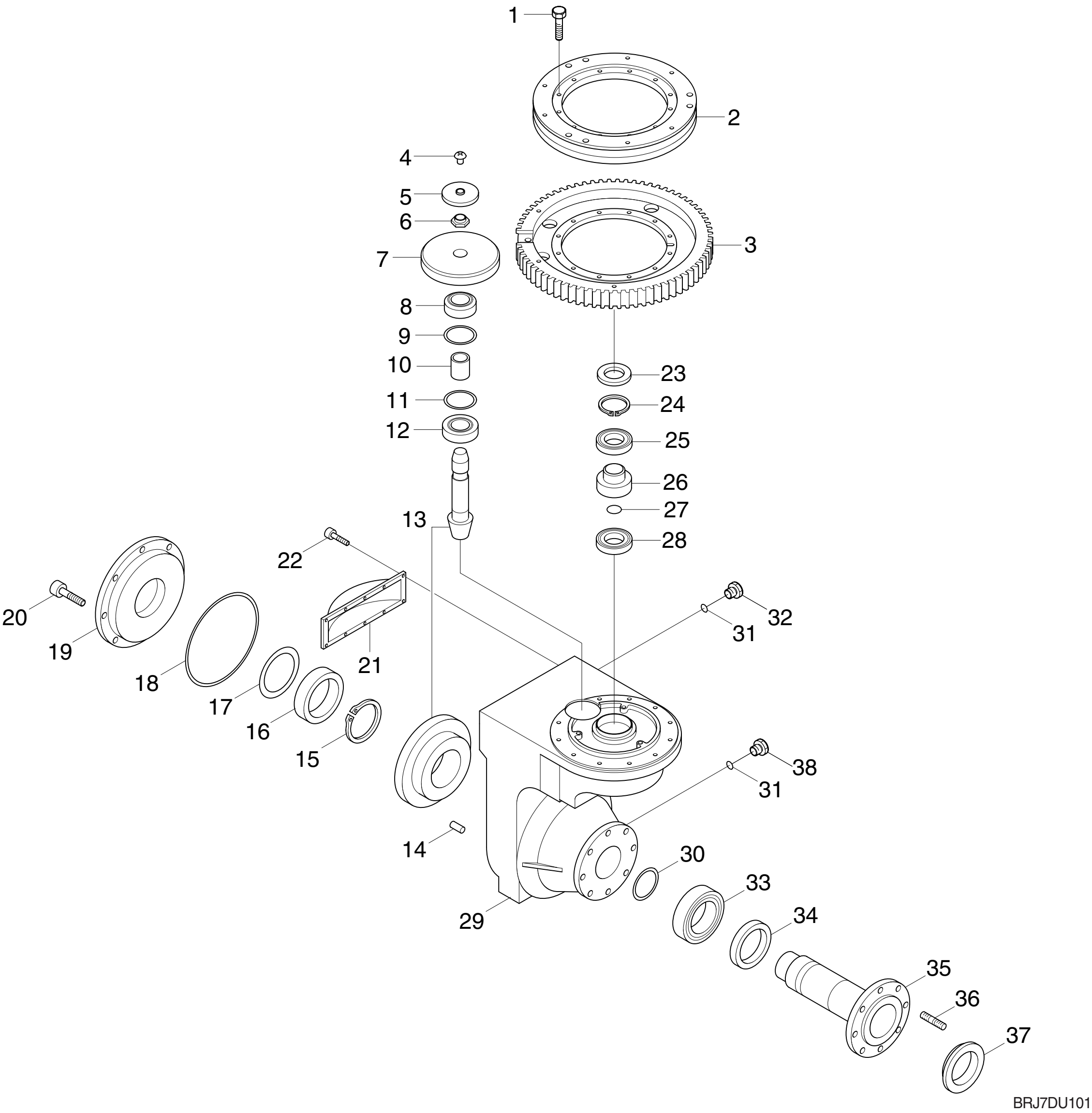
SECTION 3 POWER TRAIN SYSTEM

GROUP 1 STRUCTURE AND OPERATION

1. DRIVE UNIT

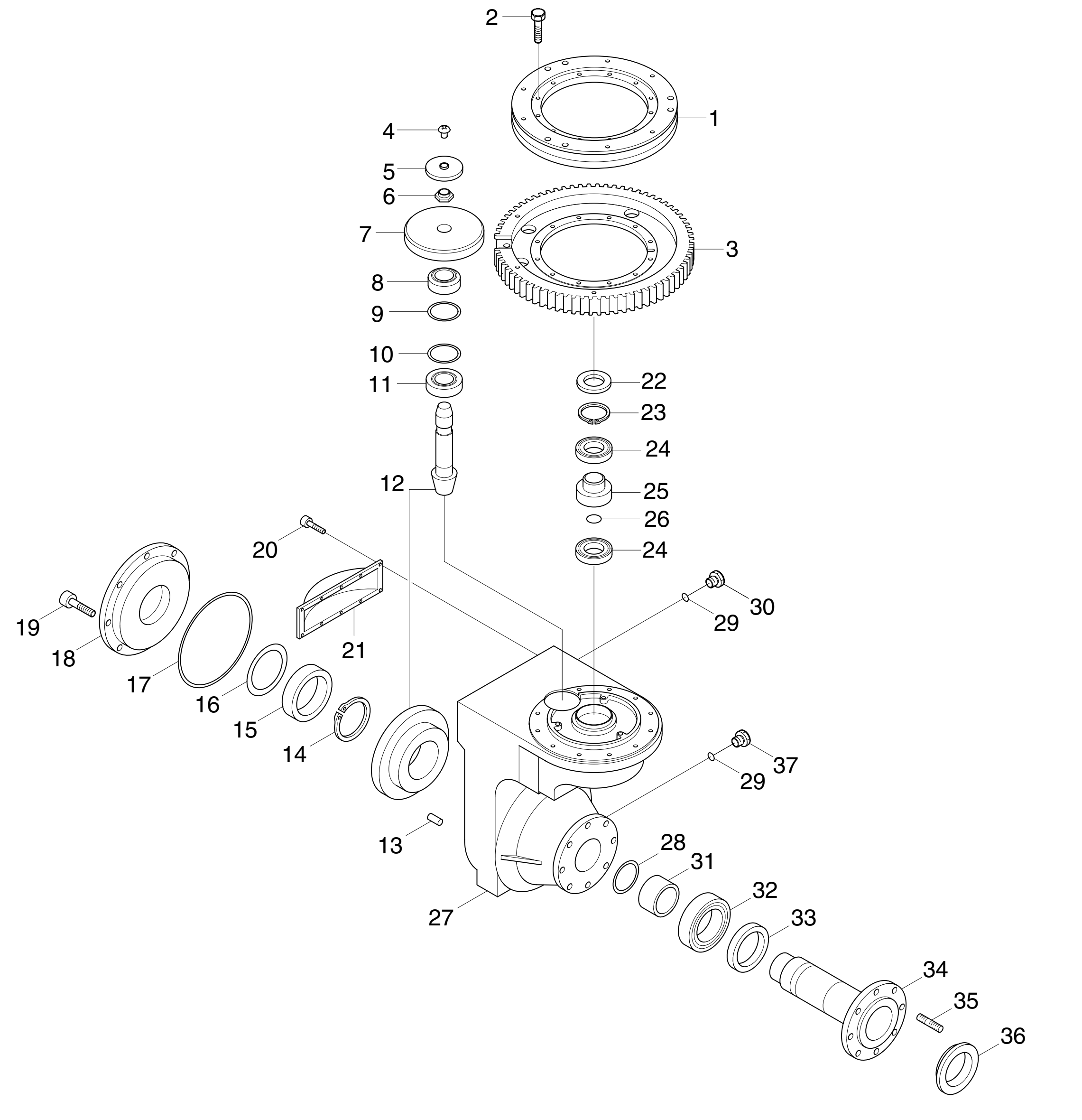
1) STRUCTURE

(1) 14/16BRJ-9



1	Hexagon screw	14	Slotted pin	27	Protection cap
2	Turntable bearing	15	Retaining ring	28	Bearing ball
3	Steering gear	16	Taper roller bearing	29	Housing
4	Breather valve	17	Shim	30	Shim
5	Protection cap	18	O-ring	31	Seal ring
6	Hexagon nut	19	Bearing cover	32	Plug
7	Spur gear	20	Cap screw	33	Taper roller bearing
8	Taper roller bearing	21	Cover	34	Taper roller bearing
9	Shim	22	Hex screw	35	Wheel shaft
10	Spacer	23	Shaft sealing ring	36	Wheel bolt
11	Shim	24	Retaining ring	37	Wheel shaft protection
12	Taper roller bearing	25	Bearing ball	38	Plug
13	Bevel gear set	26	Input pinion		

(2) 20/25BRJ-9



1	Turntable bearing	13	Slotted pin	25	Input pinion
2	Hexagon screw	14	Retaining ring	26	Protection cap
3	Steering gear	15	Taper roller bearing	27	Housing
4	Breather valve	16	Shim	28	Shim
5	Protection cap	17	O-ring	29	Seal ring
6	Hexagon nut	18	Housing cover	30	Plug
7	Spur gear	19	Cap screw	31	Bush
8	Taper roller bearing	20	Cap screw	32	Roller bearing
9	Shim	21	Cover	33	Shaft sealing ring
10	Shim	22	Shaft sealing ring	34	Gear shaft
11	Taper roller bearing	23	Retaining ring	35	Wheel bolt
12	Bevel gear set	24	Bearing ball	36	Wheel shaft protection
				37	Plug

2. SPECIFICATION

1) 14/16BRJ-9

Item		Unit	Specification
Gear ratio	Total	-	14.5
Oil quantity		l	2.2

2) 20/25BRJ-9

Item		Unit	Specification
Gear ratio	Total	-	20.2
Oil quantity		l	3.3

GROUP 2 TROUBLESHOOTING

Problem	Probable cause	Remedy
1. Noise		
1) Loud, beating noise	· Gearing of helical gear stage damaged, indentations.	- Check tooth flanks of the drive pinion and the helical gear for damage. In case of damage always replace both components.
	· Fault on grooved ball bearing Input.	- Remove and replace drive pinion bearing.
	· Contaminations.	- Remove and replace drive pinion bearing.
2) Loud, steady noise	· Motor/transmission connection not ok.	- Check motor installation.
	· Motor bearing defective.	- Check motor bearing.
3) Dull, grinding noise	· Wrong bearing preload or incorrect backlash.	- Check bearing preload and backlash and readjust it, if necessary.
2. Leakage		
1) Breather	· Excessive oil level.	- Check oil level.
2) Housing cover	· Screws not tightened with the specified tightening torque.	- Tighten screws with the specified tightening torque.
	· O-Ring sealing defective.	- Replace O-Ring.
3) Oil filler or oil drain plug	· Screws not tightened with the specified tightening torque.	- Tighten screws with the specified tightening torque.
	· Dirt between sealing ring and housing.	- Clean.
	· Sealing ring worn.	- Install new sealing ring.
4) Input shaft / wheel shaft	· Radial sealing ring damaged or worn.	- Install new radial sealing ring.
	· Damaged race on input- and/or wheel shaft.	- Replace input shaft and wheel shaft respectively.
5) Side cover	· Screws not tightened according to sequence of tightening and the tightening torque.	- Tighten screws according to correct sequence of tightening and with the tightening torque specified.
	· No uniform adhesive application of LOCTITE 5910.	- Apply LOCTITE 5910 evenly and continuously.
	· Joining time not observed.	- Observe LOCTITE specification and replace the sealing.
6) Sealing disc on drive pinion	· No uniform adhesive application of LOCTITE 5910.	- Apply LOCTITE 5910 evenly and continuously.
	· Joining time not observed.	- Observe LOCTITE specification and replace the sealing.
3. Other fault possibilities		
1) Only sluggish rotation of the pivoted bogie bearing is possible or bearing clearance is sensible	· Cover disc has loosened and dirt got into the bearing.	- Replace pivoted bogie bearing.
	· Cage segments are damaged.	- Replace pivoted bogie bearing.
	· Plastic deformation of the balls or the ball race.	- Replace pivoted bogie bearing.

Fault	Probable cause	Remedy
Oil leakage on oil filler or oil drain plug	· Dirt between sealing ring and housing. · Old sealing ring was used. · Bolts not tightened according to the specified tightening torque.	· Cleaning required. · Use new sealing ring · Tighten bolts with the specified tightening torque.
Oil leakage between housing and top section	· Seal faces not sealed or uneven. · Burrs on cylinder pin. · Bolts not tightened according to the specified tightening torque.	· Apply LOCTITE 574 onto seal faces. · Touch up seal faces with oil rubber. · Use a new cylinder pin. · Tighten bolts with the specified tightening torque.
Oil leakage on top section within helical gear stage / input	· Too much oil in transmission. · O-ring on cover defective. · Breather valve defective.	· Check oil level. · Install new O-ring. · Replace breather valve.
Beating noise at helical gear stage	· Teeth on input pinion and/or helical gear damaged by false installation.	· Check tooth flanks for damage and touch up damaged spots with oil rubber.
Ringing noise	· Helical gear stage running without oil.	· Check oil level. · Refill oil.
Grinding noise	· Bearing preload or backlash not correctly adjusted.	· Checking and new adjustment.
Bearing damage on input pinion	· No axial play.	· Install new bearing and adjust axial play.
Pivoting bearing is difficult to rotate or backlash recognizable	· Cover disc loosened and dirt enter-ed into the bearing. · Cage segments are damaged. · Plastic deformation of balls or ball race. · Bearing not relubricated. · Grease not distributed.	· Replace pivoting bearing. · Replace pivoting bearing. · Replace pivoting bearing. · Relubricate pivoting bearing. · Rotate pivoting bearing several times by hand.

GROUP 3 DISASSEMBLY AND ASSEMBLY

1. INSTRUCTION

1) Pay attention to cleanliness and expert like manner for all work to be carried out. Transmission removed from the vehicle has therefore to be cleaned prior to opening. Both utmost care and cleanliness are essential conditions for a correct disassembly and reassembly of the transmission as well as for the installation of each spare part. A fault during installation can result in an early wear and chips or other foreign particles in the transmission can cause fatal damages.
2) Prior to assembly all parts must be cleaned and inspected for wear and other defects.
3) If it is found that removed parts are damaged or worn, do not reinstall but replace them by new ones.
4) If not separately indicated, the housing and cover faces forming an oiltight connection are to be provided with the corresponding sealing compound during assembly.
5) Special devices and special tools are necessary besides the standard tools. Their use is unavoidable for a technically adequate dis- and reassembly. The application of devices, special tools and other fixtures are to be adapted to circumstances of the respective users.
6) Commercial tools and fixtures belonging to the basic equipment are assumed to be available.
7) If not otherwise indicated all pressing operations are made by means of the hand lever press.
8) All screws and threads in this transmission have metric dimensions. Only spanners and socket spanners with metric sizes are allowed to be used.
9) For reassembly all of the indicated setting values, test data and tightening torques must be observed.
10) Observe the described sequence of the working steps.
11) All pictures serve the illustration and are not obliging for this execution.

2. NECESSARY SPECIAL TOOLS FOR DISASSEMBLY AND REASSEMBLY

Reference number	Description	Is necessay for :
225296	Extracting fixture	Removal of drive pinion - 14/16/20/25BRJ-9
62519	Holding fixture	Loosening of taper press fit - 14/16BRJ-9
62513	Holding fixture	Loosening of taper press fit - 20/25BRJ-9
62507-1	Counter holder	Determination of shim thickness - 14/16/20/25BRJ-9
62523	Assembly fixture	Installation of drive pinion - 14/16/20/25BRJ-9
62478	Striking mandrel	Roller bearing drive pinion - 14/16/20/25BRJ-9
62507	Locating fixture	Transmission locating jack - 14/16/20/25BRJ-9
62508	Striking mandrel	Bearing outer ring pinion shaft bottom - 20/25BRJ-9
62529	Striking mandrel-Insert	Bearing outer ring pinion shaft bottom - 14/16BRJ-9
62625	Striking mandrel	Roller bearing housing - 14/16/20/25BRJ-9
63428	Press-in/out fixture	Wheel shaft and crown gear - 14/16/20/25BRJ-9
62521	Striking mandrel	Shaft seal drive pinion - 14/16/20/25BRJ-9
62522	Striking mandrel	Breather cover - 14/16/20/25BRJ-9
63290	Press-in sleeve	Grooved ball bearing drive pinion - 14/16/20/25BRJ-9
63293	Striking mandrel without handle	Thread protective shield - 14/16/20/25BRJ-9
63292	Striking mandrel without handle	Shaft seal wheel shaft - 20/25BRJ-9
63291	Striking mandrel without handle	Shaft seal wheel shaft - 14/16BRJ-9
62542	Striking mandrel without handle	Bearing outer ring crown gear - 14/16/20/25BRJ-9
63294	Striking mandrel without handle	Bearing inner ring wheel shaft - 14/16/20/25BRJ-9
62748	Striking mandrel	Bearing outer ring cover - 14/16BRJ-9
62749	Striking mandrel	Bearing outer ring cover - 20/25BRJ-9
63296	Handle	Striking mandrels
62819	Measuring stop	Torsional backlash - 14/16BRJ-9
62228	Gear lock	Helical gear lock - 14/16/20/25BRJ-9
62222	Pressure oil device	Loosen press fit
223705, 22	Pressure-in sleeve	Bearing inner ring pinion shaft - 14/16BRJ-9
223705, 009	Pressure-in sleeve	Bearing inner ring pinion shaft - 20/25BRJ-9
62747	Striking mandrel	Bearing outer ring pinion shaft top - 14/16BRJ-9
62746	Striking mandrel	Bearing outer ring pinion shaft top - 20/25BRJ-9
62846	Striking mandrel	Helical gear on pinion shaft - 14/16/20/25BRJ-9
62825	Measuring fixture	Housing dimension wheel shaft - 14/16BRJ-9
62828	Measuring fixture	Housing dimension wheel shaft - 20/25BRJ-9
62231	Measuring fixture	Housing dimension wheel shaft - 20/25BRJ-9
62827	Measuring fixture	Housing dimension crown shaft - 14/16BRJ-9
62829	Measuring fixture	Housing dimension crown shaft - 20/25BRJ-9
62232	Measuring fixture	Housing dimension crown shaft - 20/25BRJ-9
222863.2	Extracting fixture	Pulling-off taper roller bearing outer ring - 14/16/20/25BRJ-9
62532	Measuring fixture	Bearing friction torque wheel shaft - 14/16BRJ-9
62515	Extracting fixture	Bearing friction torque wheel shaft - 20/25BRJ-9

3. SAFETY INSTRUCTIONS

1) The use as directed requires the strict observance with the specification for installation, dis-and reassembly, initial operation and maintenance.

2) Every person concerned with installation, disassembly and reassembly, initial operation and maintenance of the transmission in the user plant must have read and understood the whole instruction and in particular the safety instructions.

3) Any working method which endangers the safety of the transmission is prohibited.

4) Modifications and changes without the proper permission are affecting the safety of the transmission and are not allowed.

5) Only original spare parts from Hyundai are allowed to be used. It is explicitly pointed out to the fact that spare parts and accessories, which were not supplied by Hyundai are not checked and approved by us either. We do not accept any liability or admit any original parts from Hyundai.

6) The described work is only allowed to be made by authorized, skilled and instructed staff.

7) The proper repair of this products requires adequately trained specialists. The repairer is responsible for the training.

8) Keep away aggressive cleaners from your skin, do not drink it or inhale its vapours. Always wear safety gloves and goggles. If by mistake cleaner was swallowed, call medical aid immediately. Strictly observe manufacturer instruction.

9) Do not drain cleaner or transmission oil into the sewerage system or into the soil.

10) Prior to start working on the installed or mounted transmission, the wheels must be blocked.

11) Prior to any work on the installed transmission (e.g. oil change) or its mounted-on parts the voltage source feeding the motor must always be disconnected resp. switched off.

12) The local regulations for safety and prevention of accidents must be observed.

4. COMPLETE DISASSEMBLY

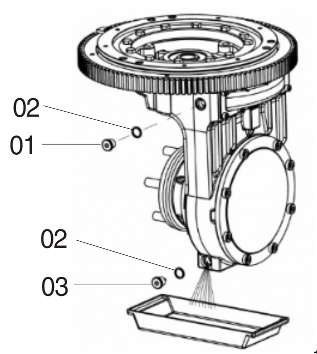
1) GENERAL INSTRUCTIONS DISASSEMBLY

(1) Prior to dismantling the transmission is to be cleaned carefully.
Parts which are only available as assemblies will not be dismantled further.
It is recommendable to install a locating fixture as shown in Figure 44. It serves to rotate the unit and offers easy working for disassembly and reassembly.
(S) Locating fixture 62507

BRJ7DU044

2) DRAIN OFF TRANSMISSION OIL

(1) Place a suitable big oil collecting vessel under the oil drain plug.
(2) Loosen the oil filler plug(item 01) with a 6mm allen wrench. Remove the oil filler plug and the sealing ring(item 02).
(3) Loosen the oil drain plug(item 03) with a 6mm allen wrench. Remove the oil drain plug and the sealing ring(item 02).
(4) Have the transmission oil drained into the vessel completely.
※ Do not drain transmission oil into the soil or the sewerage system. Pay attention to the type and quantity of debris.
▲ High oil temperatures are to be expected after continuous operation of the transmission. Wear temperature-resistant gloves.

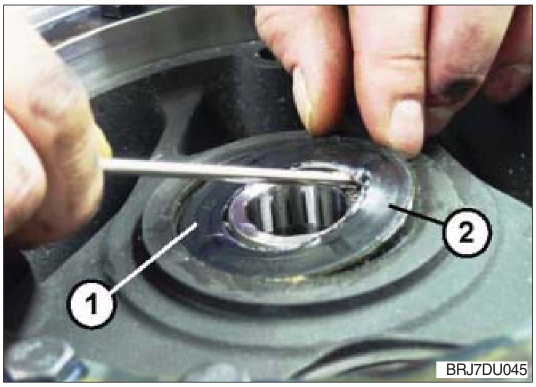


14BRJ7OM119

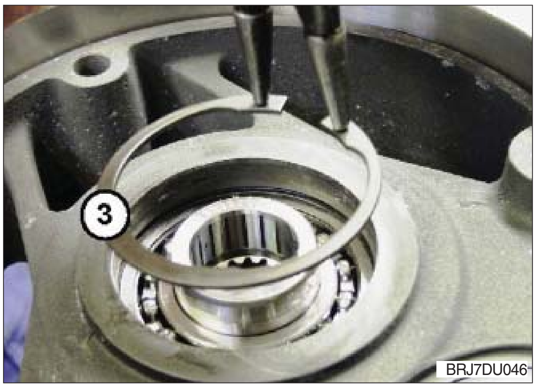
3) REMOVAL OF DRIVE PINION

(1) With a screwdriver press the radial sealing ring (item 2) upwards from the bore seat of the housing and remove it.

Dispose of the radial sealing ring according to chapter 6.

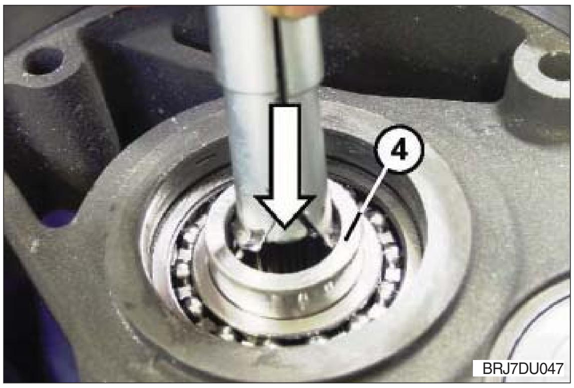


(2) Unsnap and remove the retaining ring (item 3) from the housing bore by means of flat-head pliers.



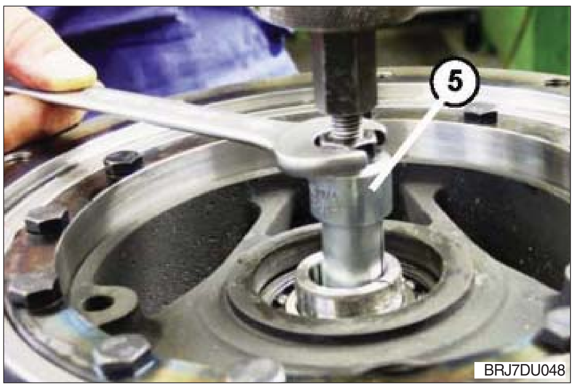
(3) Extracting fixture 225296 is necessary to remove the drive pinion (item 4) from the bore.

Insert the extracting fixture into the bore of the drive pinion.



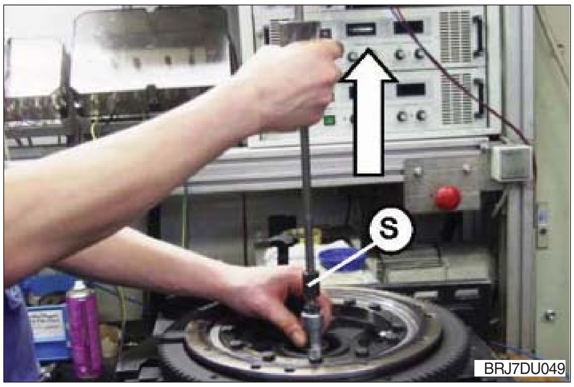
(4) Fasten the hexagon screw of the bearing puller hand-tight so that a sufficient preload of the clamping jaws is given.

By tightening the hexagon screw expand the clamping jaws of the bearing puller (item 5) in the bore of the drive pinion.

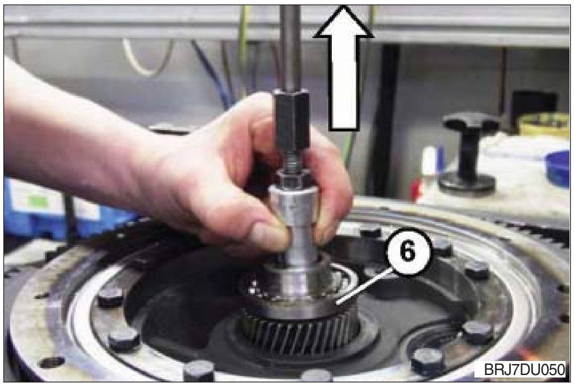


(5) Handle the extracting fixture "S" as shown on the right. Move the handle on the bar upwards strongly several times until the drive pinion is loosened from the bearing seat completely.

⚠ Do not damage the gearing of the drive pinion at the next work step! Damages might cause louder running noises and consequential damages!



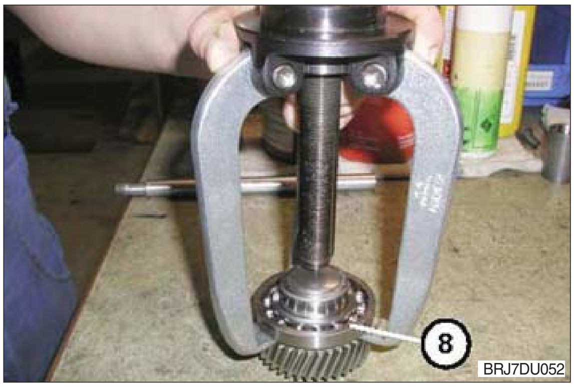
(6) By means of the extracting fixture pull the drive pinion (item 6) out of the housing bore and remove it.



(7) Loosen the hexagon bolt (item 7) and remove the extracting fixture from the drive pinion.

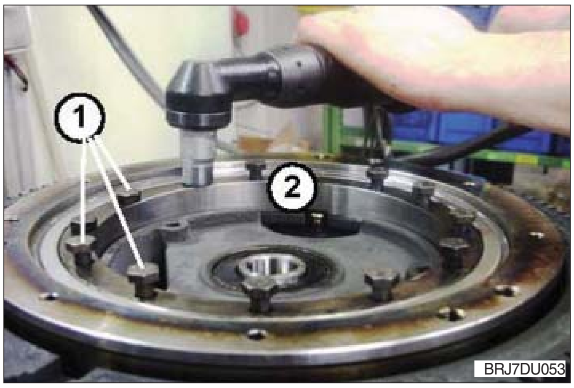
⚠ Do not damage the gearing of the drive pinion! Damages might cause louder running noises and consequential damages!

(8) Pull of the grooved ball bearing (item 8) by means of a puller or a parting tool over the bearing seat of the drive pinion and dispose it of according to chapter 6.

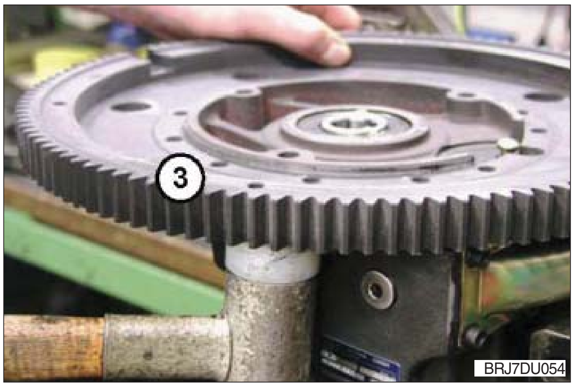


4) REMOVAL OF GEAR RING AND PIVOTED BOGIE BEARING

(1) Loosen the 12 hexagon screws (item 1) on the pivoted bogie bearing (item 2), remove and dispose them of acc. to chapter 6.



(2) With a dead-blow soft-face hammer slightly beat against the gear ring (item 3) from the bottom to loosen it from the connecting construction. Take off and remove the pivoted bogie bearing and the gear ring.



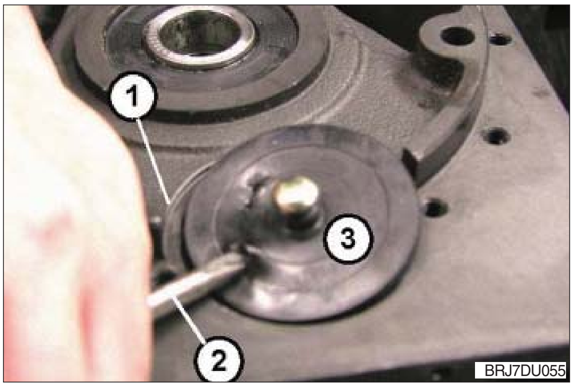
5) DISASSEMBLY OF TRANSMISSION HOUSING WITH TRANSMISSION COMPONENTS

(1) Removal of sealing cap

⚠ The surface (item 1) where the sealing cap is located must not be damaged. The sealing cap itself is destroyed and cannot be reused.

① Insert a screwdriver (item 2) into the sealing cap (item 3) beating cautiously and press it off or by using the lever effect upwards and scrap it.

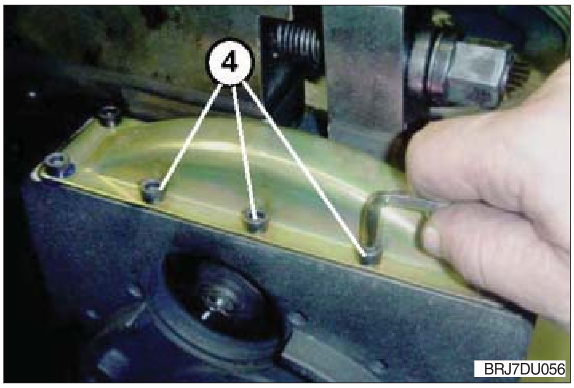
② The breather valve is not to be scrapped.



(2) Removal of side cover

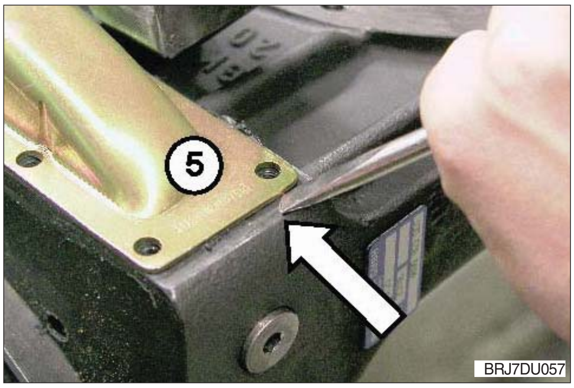
① Loosen and remove the 10 cap screws (item 4) on the side cover.

⚠ Do not damage the housing surface at the next working step! Burrs and other damages on the sealing surface which are caused during the removal have to be eliminated. Touch up damaged sealing surface on the housing with an oil stone!



② Separate the side cover (item 5) from the sealing compound with a suitable screwdriver. Place the tool between housing and cover and press it off slightly from the housing.

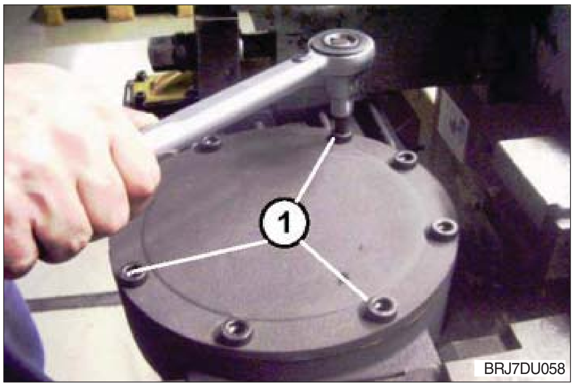
③ Loosen the side cover from the housing by tapping onto the outer contour and dispose it of acc. to chapter 6.



(3) Removal of wheel shaft and crown gear

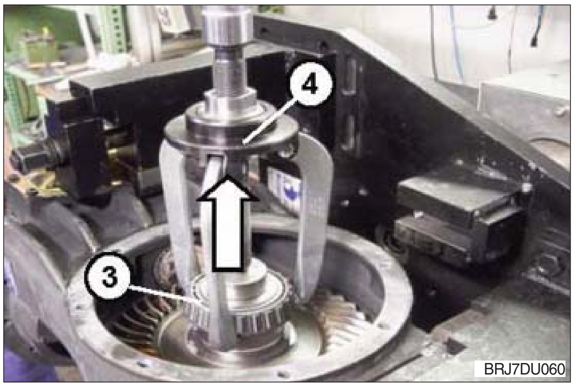
① Loosen and remove the 8 cap screws (item 1) in the housing cover.

⚠ Do not damage the housing and cover surface! Burrs and other damages on the sealing surface which are caused during the removal have to be eliminated. Touch up damaged sealing surface on the housing with an oil stone!

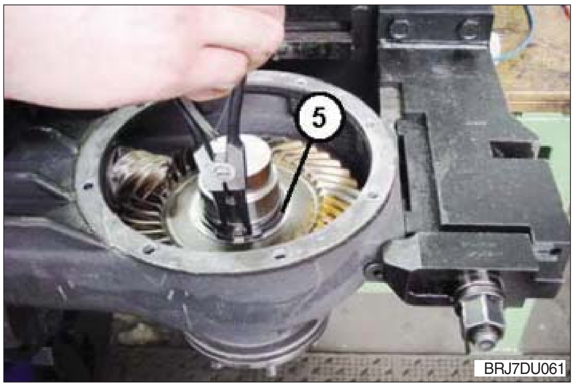


② Loosen the housing cover (item 2) by tapping against the outer edges and remove it. Use the two recesses in the housing.

③ With a three-armed puller (item 4) pull the taper roller bearing inner ring (item 3) over the bearing seat of the wheel shaft and remove it.



④ Unsnap and remove the retaining ring (item 5) by means of flat-head pliers.



(4) Loosening of taper press fit

※ For work at high oil pressures to loosen the taper press fit there is the danger of eye and skin injuries, if oil would come out under high pressure. Always wear goggles and safety gloves! Observe and follow the instructions of the pressure oil device manufacturer.

① A pressure oil device with a maximum pressure of up to 300 MPa is necessary for widening of the taper press fit. There are two possibilities to press out the shaft wheel from the crown gear which are described in the following:

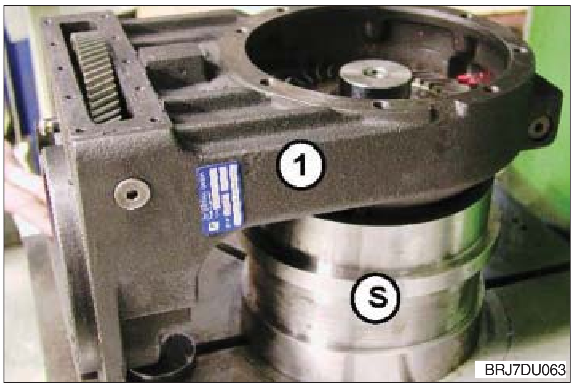
(S) Pressure oil device 62222

BRJ7DU062

② Pressing-off by means of press

Locate the housing (item 1) in the press-out fixture "S" on the press as shown in the picture.

(S) Press-out fixture 63428



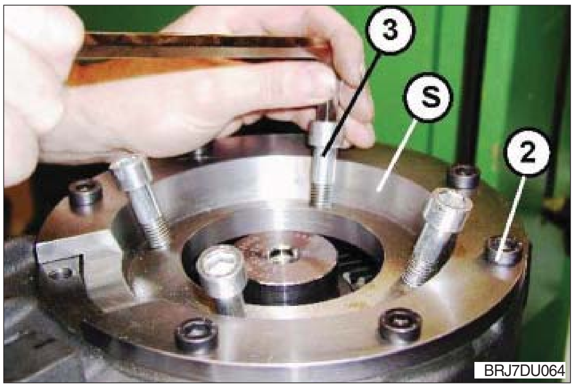
BRJ7DU063

③ The holding fixture "S" which is used as stop for the gliding off wheel shaft is to be connected to the cover surface with the appropriate cap screws (item 2).

Fasten the 4 supporting bolts (item 3) hand-tight until contact with the crown gear.

(S) Holding fixture 62519 : 14/16BRJ

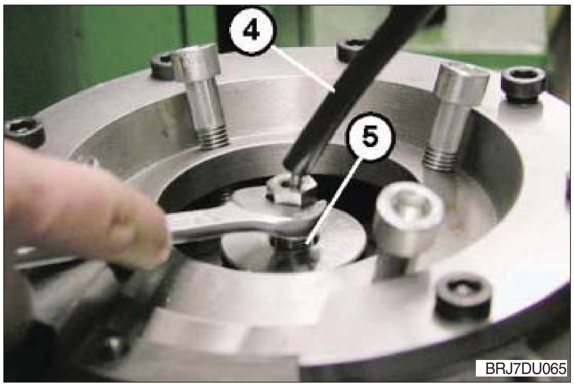
(S) Holding fixture 62513 : 20/25BRJ



BRJ7DU064

④ Connect the flexible high-pressure pipe (item 4) from the pressure oil device into the connecting bore provided in the wheel shaft (item 5).

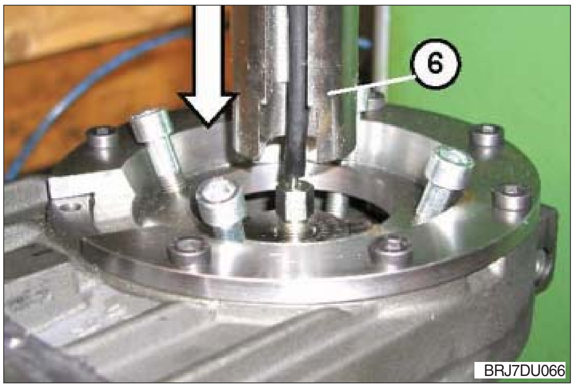
Fixedly tighten the connecting nipple with an openjaw spanner.



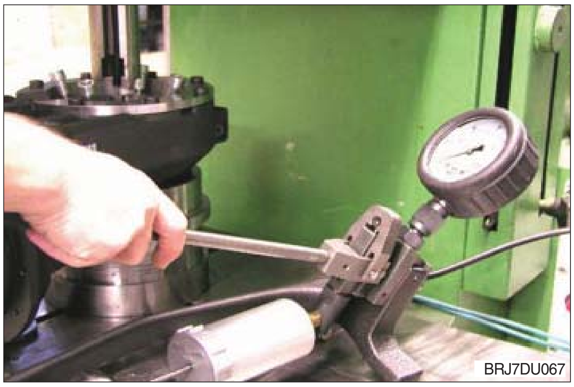
⚠ **Pay attention for pressing-off that there is sufficient clearance in pressing-off direction avoiding that the wheel shaft is bottoming. Do not jam the wheel shaft at the pressing-off procedure.**

⑤ Mount the stamp (item 6) from the holding fixture (see Figure 64) into the press.

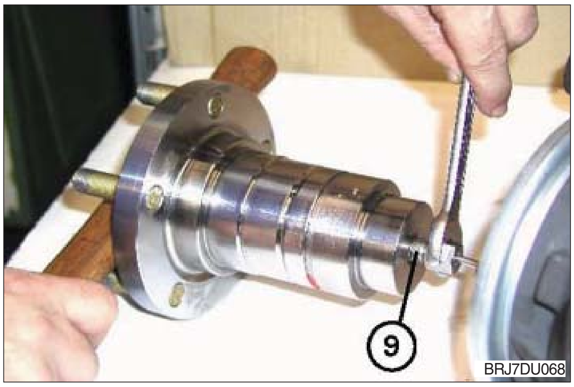
Adjust a pressing-off force from approx. 80 ... max.
120 KN on the press.



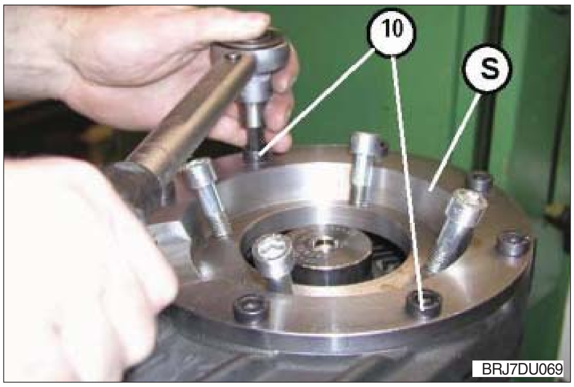
⑥ At the same time also use fixture 62222 to produce the necessary pressure until the wheel shaft is pressed out from the crown gear.



⑦ Remove and handle the wheel shaft in such a way that the flexible high-pressure pipe can be unscrewed from the connecting bore of the wheel shaft (item 9), removed and put aside.



⑧ Loosen the cap screws (item 10), take off and remove the holding fixture "S" from the housing.



⑨ Pressing-off by means of 2nd hand pump

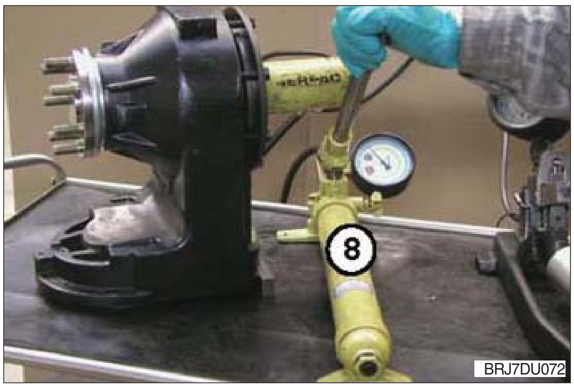
Alternatively the wheel shaft can be pressed off with a second press-out cylinder, e.g. in the mobile area. It is to be proceeded as follows:

Connect the dis- and assembly fixture with the press-out cylinder for the wheel shaft and bolt it with the transmission completely.

(S) Press-out cylinder 63428

⑩ Actuate the pressure oil device (item 7) until approx. 30MPa/4300psi is reached. Under this pressure the bevel gear is expanded sufficiently.
This pressure is to be kept constant by pumping subsequently until the wheel shaft has been loosened completely.

⑪ Actuate the second oil pressure device (item 8) until the pressure oil cylinder has loosened the wheel shaft from the bevel gear completely.



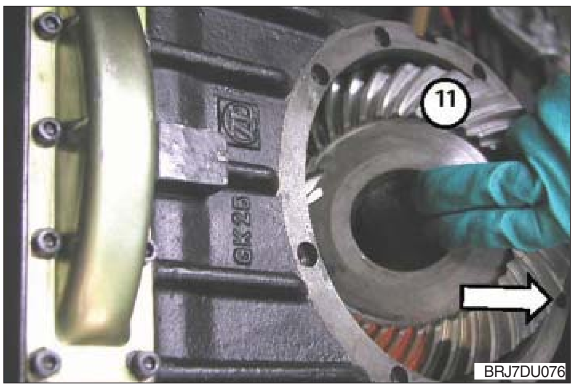
⑫ Take the wheel shaft out of the transmission.

⑬ Unscrew the hydraulic hose from cylinder 1 of the wheel shaft. Wipe off excessive oil.

⑭ Unscrew the dis- and assembly fixture from the transmission

⚠ When the gearing is damaged, running noises and consequential damages might occur, so that the bevel gear set has to be replaced.

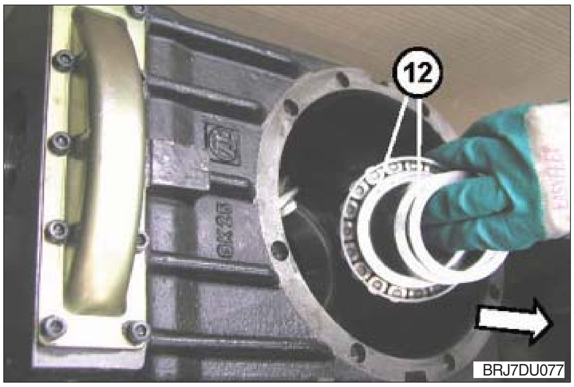
⑮ Take the crown gear (item 11) cautiously out of the housing as shown.



⑯ Then remove the following parts from the housing (item 12):

· 14/16BRJ-9 : Shims and taper roller bearing

· 20/25BRJ-9 : Shims, spacer ring and taper roller bearing



(5) Removal of bevel pinion shaft

① Put the gear lock "S" into the housing bearing bore of the drive pinion and block the helical gear with it.

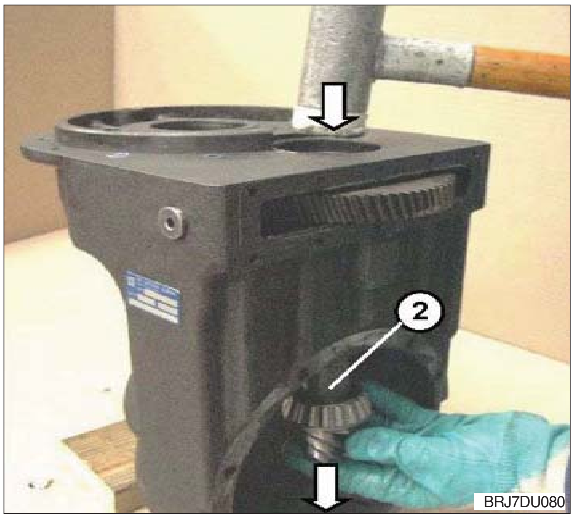
(S) Gear lock 62228

② Unlock the hexagon nut (item 1). Loosen, take off and remove the hexagon nut.

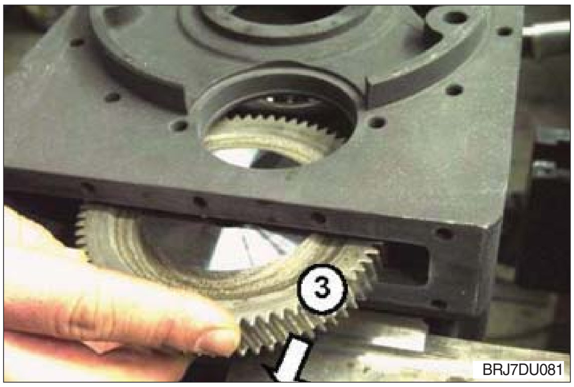
③ Take out and remove the gear lock.

⚠ **Pay attention not to damage the bevel pinion shaft when it is expelled in the following procedure.**

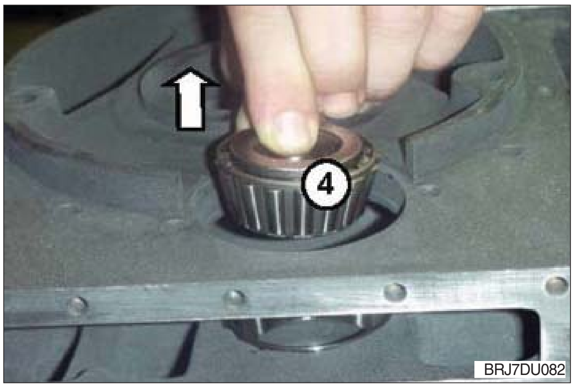
④ By means of a dead-blow soft face hammer expel the bevel pinion shaft (item 2) from the internal gearing and the bearings.



⑤ Pull out, remove and keep the helical gear (item 3) from the cover opening of the housing.



⑥ Take out and remove the taper roller bearing inner ring (item 4) upwards from the bearing bore:



⑦ · 14/16BRJ-9

Take off and remove the spacer bush (item 5) from the bevel pinion shaft.

· 20/25BRJ-9

Pull off and remove the taper roller bearing inner ring (item 6) from the bevel pinion shaft.

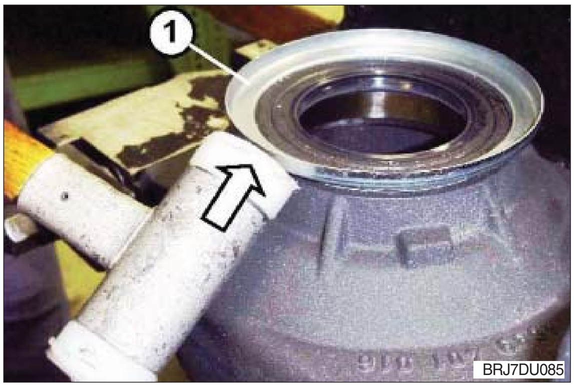
⚠ If disassembly of the bearing inner ring is not possible with a special tool or puller, the bearing cage must be destroyed and the inner ring must be removed by heating.

⚠ When the gearing of the bevel pinion shaft is damaged, running noises and consequential damages might occur, so that the bevel gear set has to be replaced.

(6) Removal of thread protective shield and radial sealing ring

① By means of a hammer remove the thread protective shield (item 1) from the glued joint on the housing.

⚠ Do not damage the housing and supporting face!



② With a screwdriver and a hammer expel and remove the radial sealing ring (item 2) cautiously from the housing seat.

⚠ Do not damage the surface where the radial sealing ring is seated! At this working step the
radial sealing ring is destroyed completely.

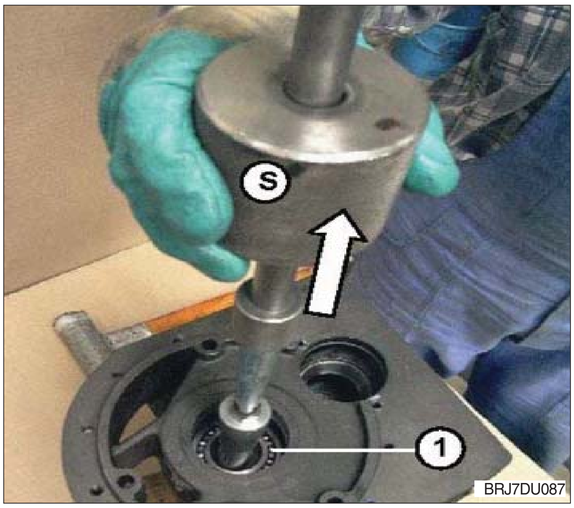
(7) Disassembly of bearings
Disassembly bearings drive pinion

① With an extracting fixture (S) pull out the grooved ball bearing (item 1) from the bore of the housing seat and dispose it of acc. to chapter 6.

② The service of the extracting fixture (S) is analogous like in the figures 47 to 51 shown.

(S) Extracting fixture 225296

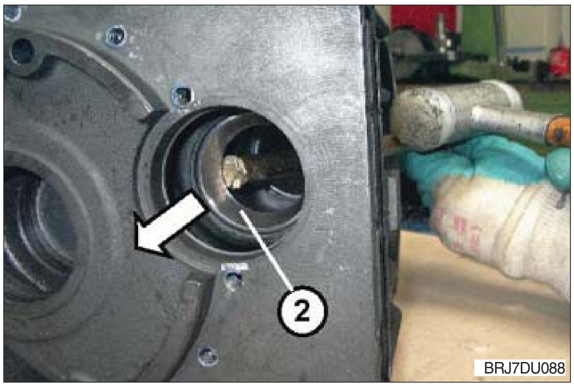
⚠ Upon removal of the bearing outer rings put them to the respective bearing inner ring.



Disassembly bearings bevel pinion shaft

① Expel the outer rings of the taper roller bearings (item 2) on both sides from the housing seat cautiously.

② Shims which were damaged have to be replaced by new shims of the same size.



Disassembly bearings wheel shaft

① Expel the outer ring of the taper roller bearing (item 3) by means of a copper mandrel and a hammer from the housing cautiously.

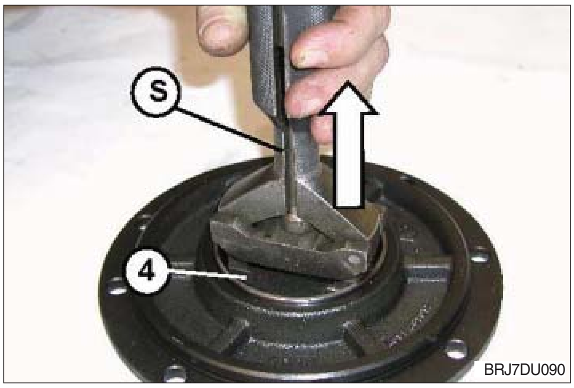
② Pull out and remove the outer ring of the 2nd taper bevel bearing (item 4) with the bearing extracting fixture "S" from the bore of the housing cover.

③ The service of the extracting fixture (S) is analogous like in the figures 49 to 50 shown.

④ Shims which were damaged have to be replaced by new shims of the same size.

(S) Extracting fixture 222863.2

Thus the disassembly is ended.



5. COMPLETE REASSEMBLY

1) GENERAL INSTRUCTIONS FOR REASSEMBLY

(1) Clean components by means of cleaning agent if necessary and remove the loctite residues.

(2) Check all components for wear, damage and cracks, if necessary components have to be replaced.

(3) All connection faces and plan face clean and steadly smoothing.

2) CONSUMABLES

Suitable cold cleaners, e.g. LOCTITE.
Only use suitable agents, which are non toxic, non-combustible and permissible on the market. Never use benzens, solvents or other combustible agents for cleaning purposes.

Description	To be used for
Loctite No. 243	Screw lock up to size M10 and bigger
Loctite No. 270	Screw lock for studs
Loctite No. 574	To glue the shaft seals into the housing & sealing of housing and cover
Loctite No. 5910	Surface sealing for side cover on the housing
Grease "Shell Alvania R3"	To grease or wet the sealing lip of the shaft seal
Siilicone grease 704 or transmission oil acc. to API GL-5 or MIL-L-2105C/D	To grease or wet the O-rings

3) USED DESCRIPTIONS AND SYMBOLS

You will find again all descriptions used in the following sections and their calculations.

Description	To be used for
Bearing width taper roller bearing	Dimension "B"
Housing dimension	Dimension "G"
Housing bearing bore 1	L1
Housing bearing bore 2	L2
Housing bearing bore 3	L3
Zero position at measuring fixture I (Part I) with dial guage	Dimension "1"
Difference dimension bevel pinion shaft calculation of L3	Dimension "2"
Zero position at measuring fixture II (Part I) with dial gauge	Dimension "3"
Difference dimension crown gear calculation of L3	Dimension "4"
Installation dimension bevel pinion shaft	Dimension "E"
Bearing difference dimension	Dimension "D"
Constant on 14/16BRJ & 20/25BRJ	K1
Constant on 20/25BRJ	K2
Free constant	a
Shim dimension	Dimension "P"
Bush width on 20/25BRJ	Dimension "H"
Shim thickness	Dimension "X"

4) USE OF REMOVED SHIMS AS BASIS FOR REASSEMBLY

The bevel gear set, consisting of bevel pinion shaft and crown gear, has fixed installation dimensions. However the transmission housing and the taper roller bearings have to be measured.

(1) If the removed shims are used as basis it is not necessary to measure the transmission housing.

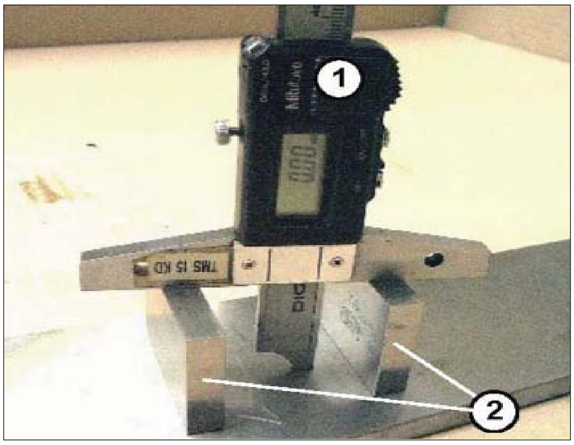
(2) If all of the removed components are to be reused, the original shim thickness has also to be used again.

(3) It the taper roller bearings with the bevel gear set replaced, only the taper roller bearings have to be measured.

5) DETERMINATION OF BEARING WIDTH DIFFERENCE OF A TAPER ROLLER BEARING

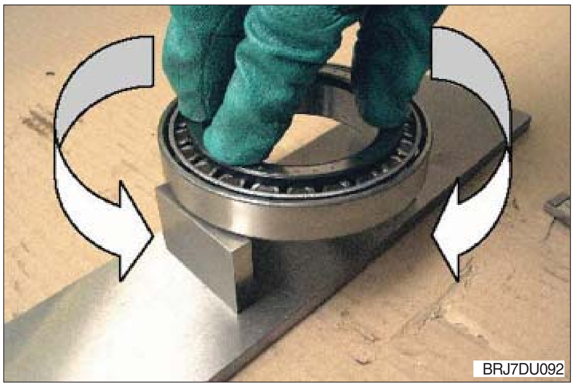
(1) Determination of bearing width general

① Zeroize depth gauge (item 1) by means of gauge blocks (item 2).

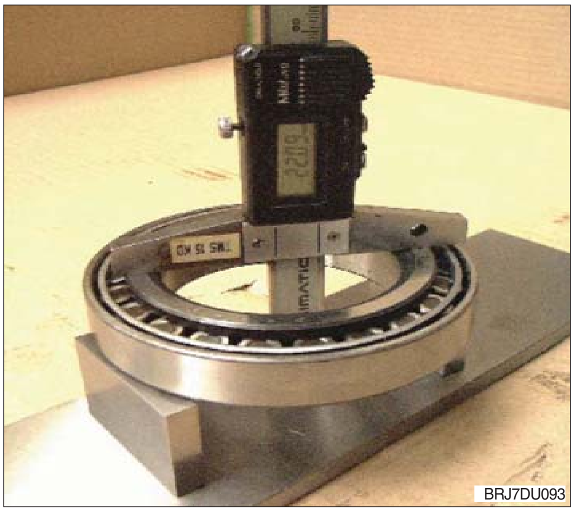


BRJ7DU091

② Put the new bearing on both gauge blocks and roll it as shown.


BRJ7DU092

③ Determine dimension "B".
Example : Dimension "B" = 22.09 mm


BRJ7DU093

(2) Determination of bearing difference for the installation of removal shims

① The difference dimension "D" of the new bearings to the bearings to be replaced is compensated with the shim dimension.

Example :

New bearing dimension	"B"	22.09 mm
Difference "D"		0.10 mm
Original bearing		- 21.99 mm

The height of the existing shim set must by reduced by 0.1 mm.

6) DETERMINATION OF BASIC INSTALLATION DIMENSIONS

(1) Determination of the necessary shim thickness for the exact installation dimension setting of the bevel pinion shaft

The correct position of the bevel pinion shaft is required for an optimum service life of the transmission.

Thickness of the shim (Item 1) and the correct setting of the bevel pinion shaft respectively will be determined acc. to the following method:

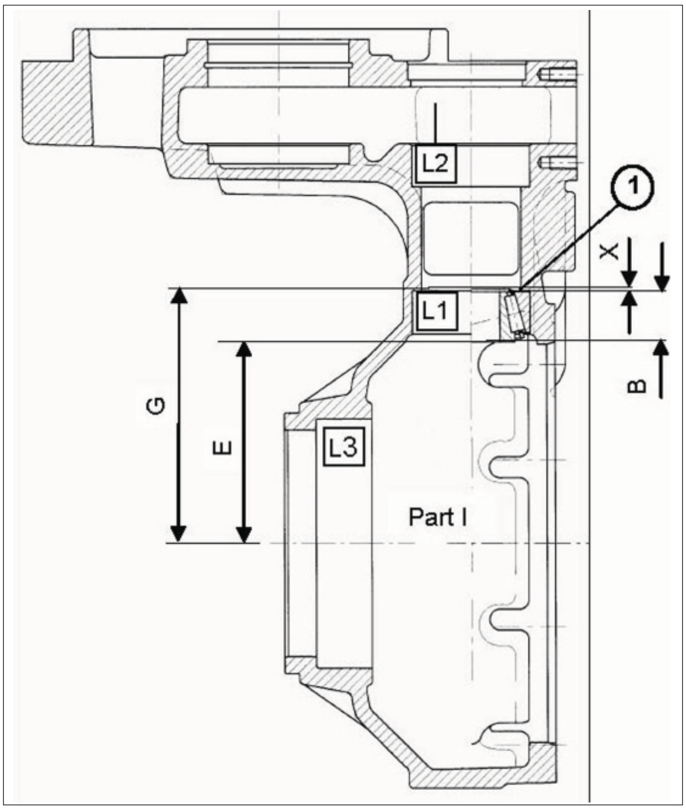
① Put measuring fixture I Part Ⅰ(see figure 95) into the housing bearing bore L1 until contact is obtained.

② Put measuring fixture I Part Ⅱ(see figure 96) into the housing bearing bore L2 until contact is obtained and fasten it hand-tight with measuring fixture I Part Ⅰ.

③ Put measuring fixture part Ⅰ to zero.

(S) Measuring fixture I 62231
: 14/16BRJ

(S) Measuring fixture I 62828
: 20/25BRJ



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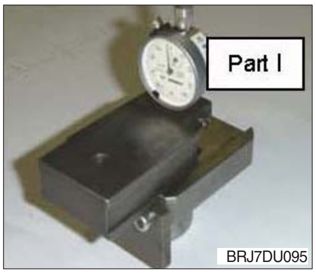


BRJ7DU095

BRJ7DU096

BRJ7DU097

At zero position of the dial gauge the following can be taken as basis:
14/16BRJ-9 Dimension "1" = 111.50 mm
20/25BRJ-9 Dimension "1" = 117.00 mm

Determine Dimension "2" in housing bearing bore L3 (see figure 94) and add it to the respective Dimension "1".

Example :

Dimension "1"	111.50 mm
Dimension "2"	0.05 mm
Housing dimension "G"	**111.55 mm**

By means of the equation
X = G - E - B

The required thickness of the shim (Item 1, Figure 94) can be calculated. “E“ means the installation dimension of the bevel pinion shaft

Dimension "E" :

14/16BRJ-9	89.00 mm
20/25BRJ-9	95.00 mm

Calculation example for 14/16BRJ-9 :

Dimension "G"	- 111.55 mm
Dimension "B"	- 22.09 mm
Dimension "E"	- 89.00 mm

X = G - E - B
X = 111.55 - 89.00 - 22.09 = **0.46 mm**

Add shims acc. to thickness X = **0.46 mm.**

Analogously to example 14/16BRJ-9 the necessary thickness of the shims can be determined for 20/25BRJ-9.

(2) Determination of necessary shim thickness for optimum setting of torsional backlash of the crown Gear

Correct setting of the crown gear is necessary to obtain an optimum torsional backlash of the bevel gearing.

Bearing width "B" for the taper roller bearing on the crown gear can be measured according to chapter 5) at page 3-25 "Determination of bearing width and difference of a taper roller bearing".

Thickness of the shim and the correct setting of the crown gear respectively will be determined acc. to the following method :

① Put the measuring fixture into the housing bearing bore L3 until contact is obtained (see Figure 100 or 101).
(S) Measuring fixture 62827 : 14/16BRJ
(S) Measuring fixture 62232 : 20/25BRJ

BRJ7DU098

② Put measuring fixture dial gauge to zero position.
At zero position of the dial gauge the following can be taken as basis :
14/16BRJ-9 Dimension "3" = 68.50 mm
20/25BRJ-9 Dimension "3" = 110.50 mm

Determine Dimension "4" in housing bearing bore L3 and add it to the respective Dimension "3".

BRJ7DU099

Example:

Dimension "3"	68.50 mm
Dimension "4"	0.03 mm
Housing dimension "G"	68.53 mm

By means of the equation

X = G – E – B – K1

the required thickness of the shim (Item 3) can be calculated, i.e. with

Dimension "E" 14/16BRJ-9 =
46.00 mm

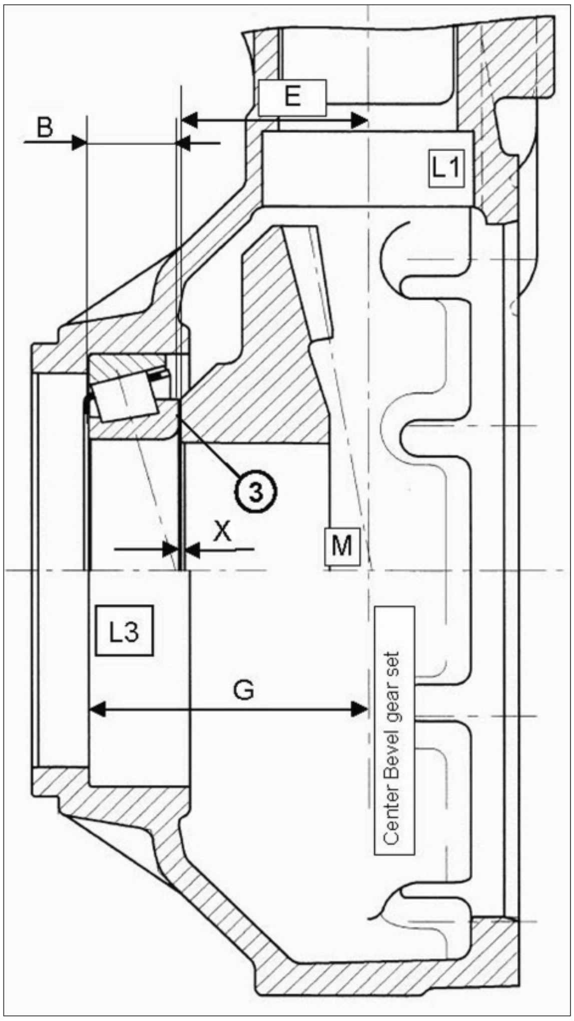
Example 14/16BRJ-9 :

Dimension "G"	68.53 mm
Dimension "B"	22.09 mm
Dimension "E"	46.00 mm
Dimension "K1"	0.11 mm

X = G – E – B – K1

X = 68.53 – 46.00 – 22.09 – 0.11 =
0.37 mm

Schematic sketch 14/16BRJ-9



BRJ7DU100

By means of the equation:

X = G – E – B – H – K2

the required thickness of the shim (Item 3) can be calculated, i.e. with

Dimension "E" 20/25BRJ-9 =
64.50 mm

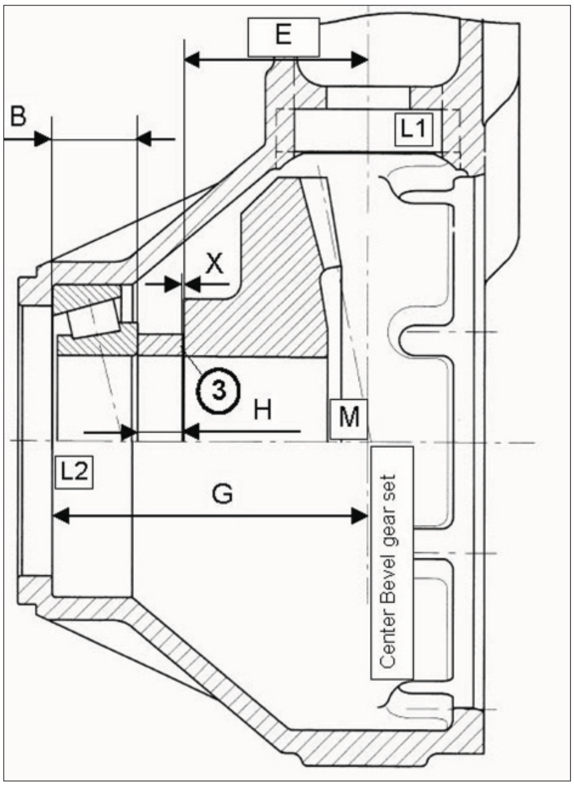
Example 20/25BRJ-9 :

Dimension "G"	110.51 mm
Dimension "B"	29.85 mm
Dimension "H"	15.69 mm
Dimension "E"	64.50 mm
Dimension "K2"	0.13 mm

X = G – E – B – H – K2

X = 110.51–64.50–29.85–15.69–0.13
= **0.34 mm**

Schematic sketch 20/25BRJ-9



BRJ7DU101

7) INSTALLATION OF BEARING FOR BEVEL PINION SHAFT AND EXACT SETTING OF THE BEARING PRELOAD

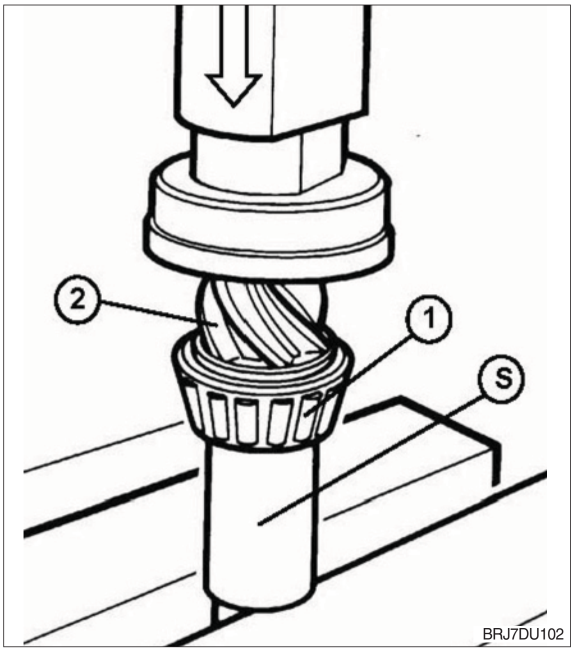
(1) Preassembly of bevel pinion shaft with bearing

① Use a hand-lever press for pressing the taper roller bearing inner ring (item 1) with the press-in sleeve "S" cautiously on the bevel pinion shaft (item 2) until contact is obtained.

⚠ **Pay attention to the gearing when the bearing of the bevel pinion shaft is installed. In case of damage, noise problems can be caused later.**

(S) Press-in sleeve 223705.22 : 14/16BRJ

(S) Press-in sleeve 223705.009 : 20/25BRJ

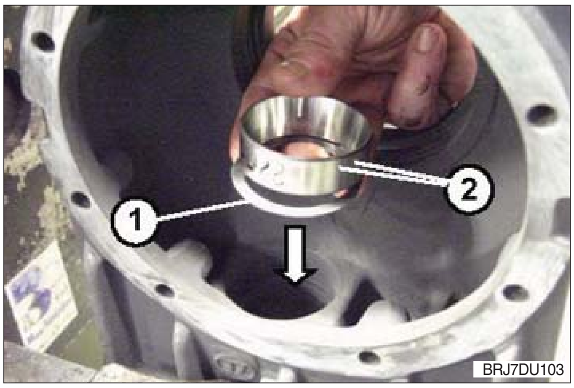


BRJ7DU102

(2) Installation of bearing outer ring into the housing

① Prepare the shim thickness determined according to chapter (1) at page 3-26 "Determination of the necessary shim thickness for the exact installation dimension setting of the bevel pinion shaft" by means of the differently thick shims.

② Put the shim(s) (item 1) and the bearing outer ring (item 2) into the bearing seat.



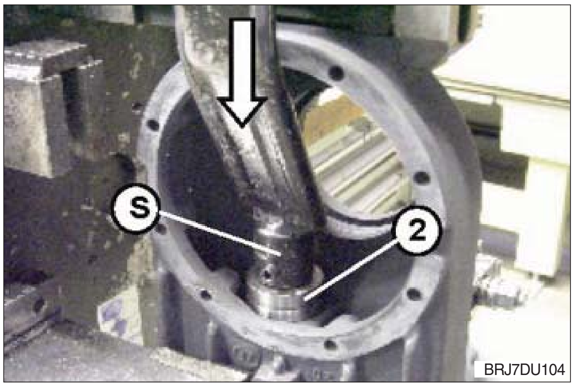
BRJ7DU103

③ By means of striking mandrel "S" install the shim (s) and the bearing outer ring into the bearing seat of the housing until contact is obtained.

⚠ **A repeated measurement of the bearing height is only allowed to result in a deviation of max. ±0.05 mm. Otherwise the process of the shim calculation has to be repeated.**

(S) Striking mandrel 62529 : 14/16BRJ-9

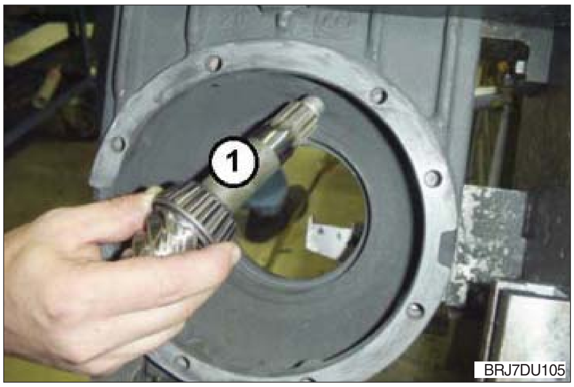
(S) Striking mandrel 62508 : 20/25BRJ-9



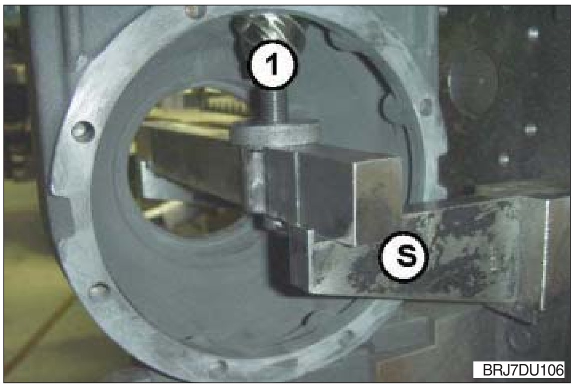
BRJ7DU104

(3) Calculation of distance dimension between collar bevel pinion shaft and housing

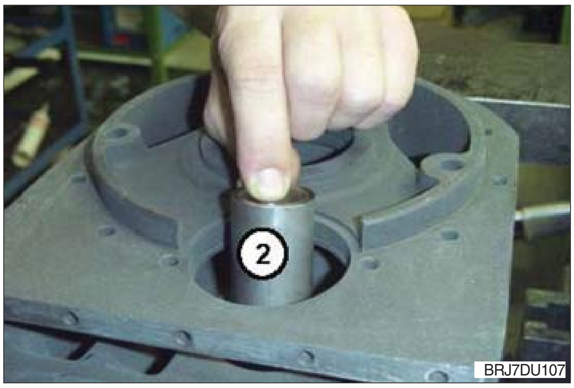
① Install the preassembled bevel pinion shaft (item 1)
from the bottom into the housing.



② By means of the counter holder "S" preload the bearing outer ring in the housing hand-tight.
(S) Counter holder 62507-1 :
14/16/20/25BRJ-9



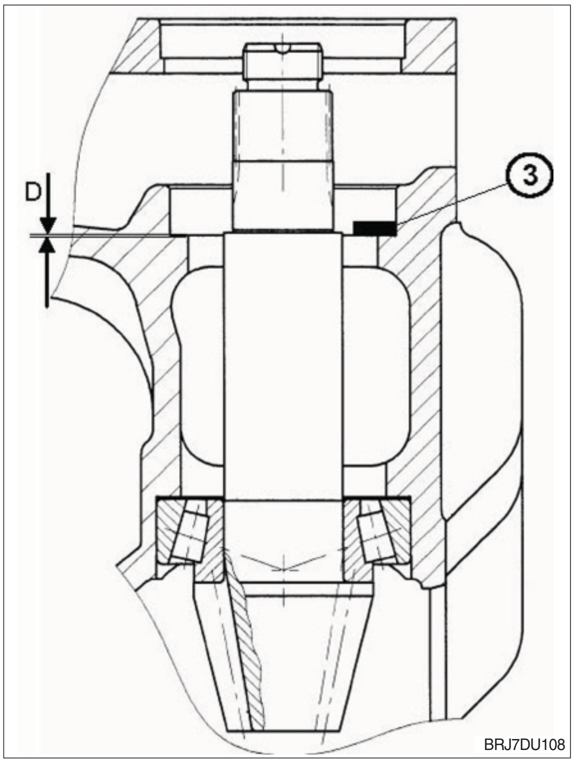
③ Only for 14/16BRJ-9 :
Put the spacer bush (item 2) onto the bevel pinion shaft.



14/16BRJ-9 :

Determine distance dimension "D" from the spacer bush (item 2) to contact of the bearing outer ring in the housing.

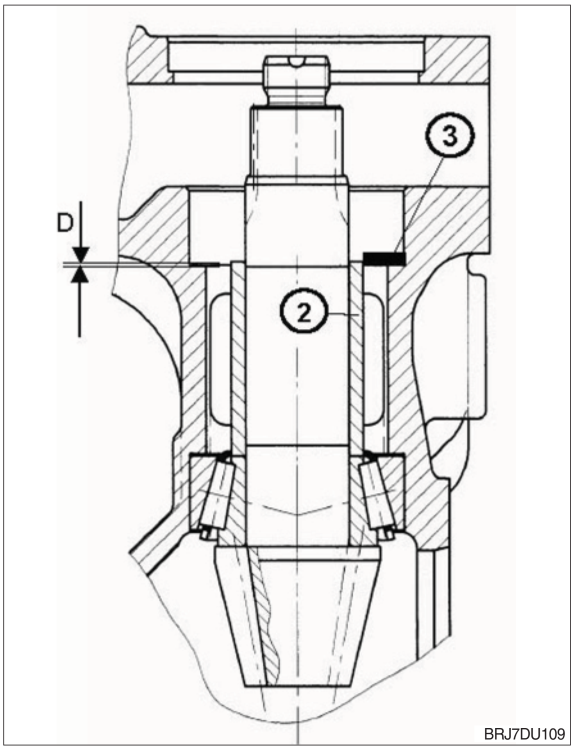
(item 3 is the required shim thickness)



20/25BRJ-9 :

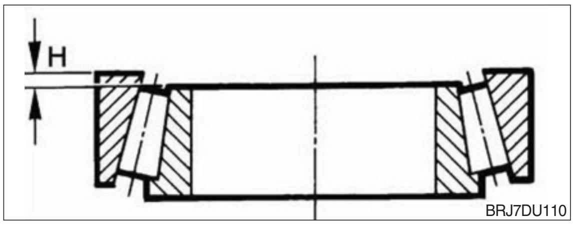
Determine distance dimension "D" by means of depth gauge from the collar of the bevel pinion shaft to contact of the bearing outer ring in the housing.

(item 3 is the required shim thickness)



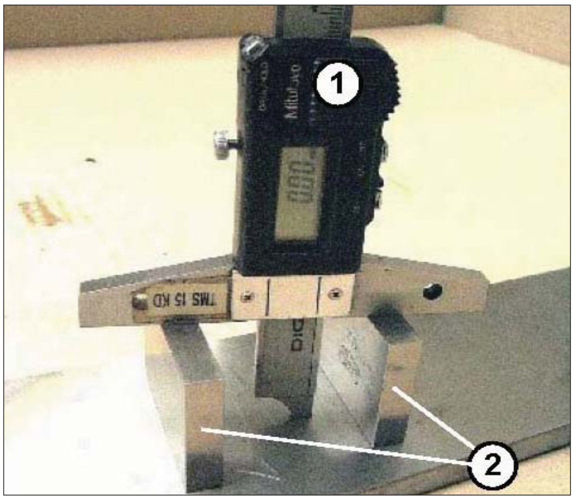
(4) Determination of bearing slack of the taper roller bearing

① Arrow gap = Bearing slack H



Measure the bearing slack "H" with a measuring fixture and gauge blocks/ measuring ledge in the following steps :

① Zeroizing of depth gauge (item 1) by means of gauge blocks (item 2).



BRJ7DU111

② Rolling-in of bearing.

③ Measuring of bearing slack H.

Example : Dimension "H" = 0.10 mm

(5) Calculation of shims required for upper bevel pinion shaft bearing

By means of the equation

X = D – H

the required thickness of the shim (Item 3 figure 108 or 109) can be calculated, i.e. with

Dimension "D"	on 14/16BRJ-9 : Distance from spacer bush
	on 20/25BRJ-9 : Distance from collar of bevel pinion shaft
Dimension "H"	Bearing slack of taper roller bearing
Dimension "a"	Constant = 0.04 mm

Example :

Distance dimension :	Dimension **D** measured on the housing	- 0.7 mm
Bearing slack :	Dimension **H** measured on the bearing	- 0.10 mm

X = D – H – a

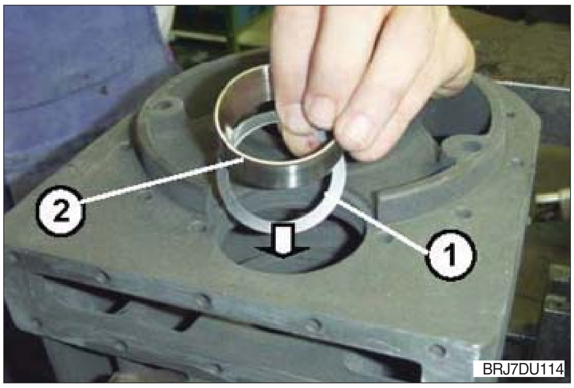
X = 0.7 – 0.10 – 0.04 = 0.56 mm

Add shims corresponding to thickness X = 0.56 mm.

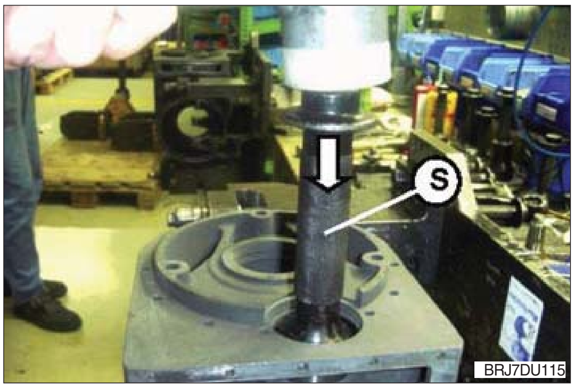
8) INSTALLATION OF UPPER TAPER ROLLER BEARING OF THE BEVEL PINION SHAFT

Prepare the shim thickness determined according to chapter (5) above "Calculation of shims required for upper bevel pinion shaft bearing" by means of the differently thick shims and continue the installation as follows:

① Put shim(s) (item 1) and bearing outer ring (item 2) into the bearing seat.



② By means of striking mandrel "S" install the shim(s) and the bearing outer ring into the bearing seat of the housing until contact is obtained.

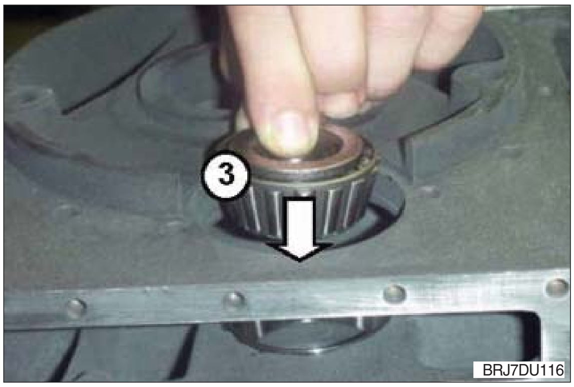


⚠ A repeated measurement of the bearing height is only allowed to result in a deviation of max. ±0.05 mm. Otherwise the process of the shim calculation has to be repeated.

(S) Striking mandrel 62747 : 14/16BRJ-9

(S) Striking mandrel 62746 : 20/25BRJ-9

③ Put the bearing inner ring (item 3) into the outer ring of the taper roller bearing.

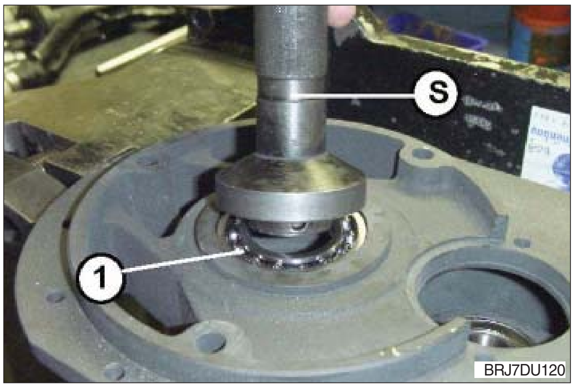


(1) Installation of grooved ball bearing for drive pinion

① Install the grooved ball bearing (item 1) with the striking mandrel "S" into the bearing seat of the housing until contact is obtained.

(S) Striking mandrel 62625

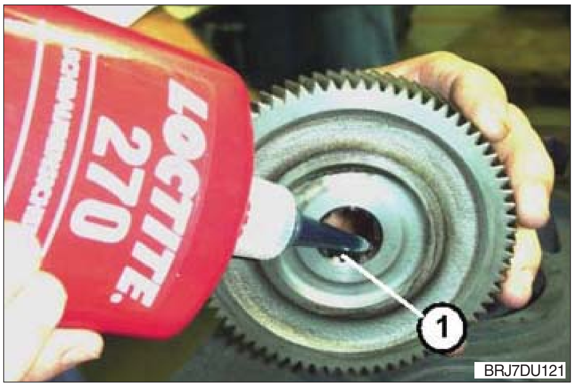
⚠ Prior to installation of the helical gear the lower grooved ball bearing has to be installed into the housing bearing bore.



(2) Installation of helical gear with bevel pinion shaft

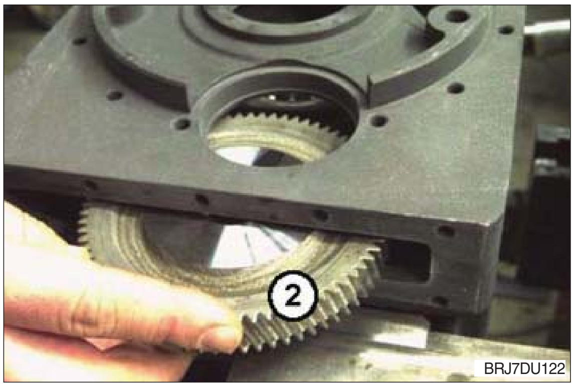
① Apply a thin and even layer of LOCTITE 270 onto the internal gearing of the helical gear (item 1).

⚠ Wear safety gloves for working with adhesives and observe the LOCTITE instructions.

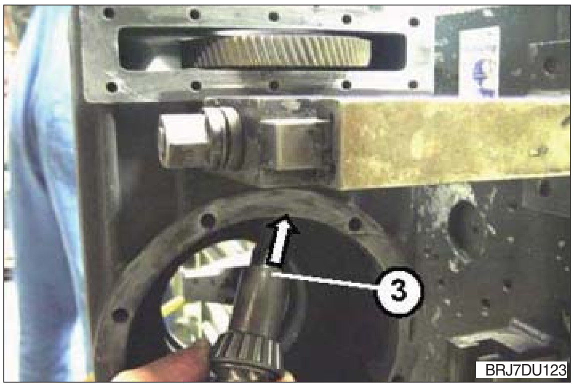


② Insert the helical gear (item 2) by the lateral opening of the housing, align it centrally and put it onto the taper roller bearing.

⚠ When inserting the helical gear pay attention that the helical gear is not damaged. In case of damage noise problems can occur later.

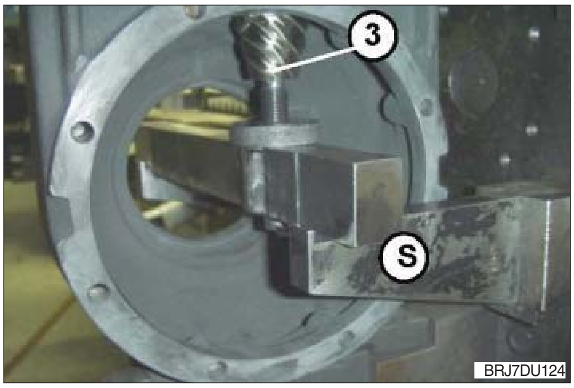


③ Install the bevel pinion shaft (item 3, on 14/16BRJ-9 with spacer bush) from the bottom into the housing and assemble is through the profiled seat of the helical gear bore.



④ Preload the bevel pinion shaft (item 3) with the counter holder "S" hand-tight against the bearing outer rings in the housing.

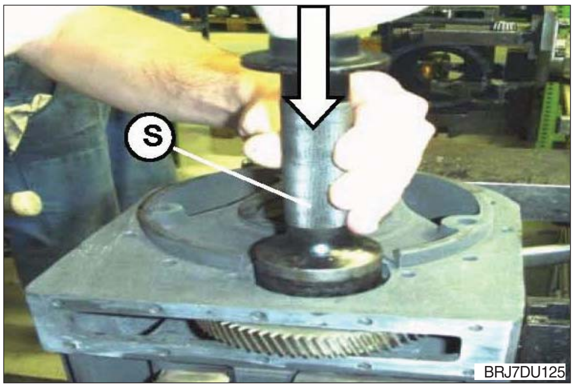
(S) Counter holder 62507-1



⑤ By means of striking mandrel "S" install the helical gear until contact is obtained. Hand-tighten the adjusting screw on the counter holder repeatedly, so that all components like taper roller bearing, spacer bush (on 14/16BRJ-9) and shims are located exactly.

⑥ When all components are located tightly the counter holder can be removed again.

(S) Striking mandrel 62846

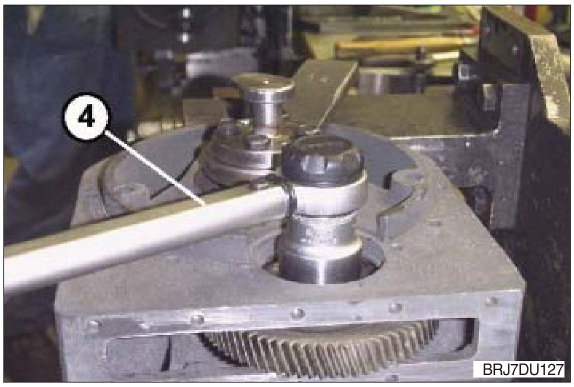


⑦ Insert gear lock "S" into the housing bearing bore of the drive pinion and block the helical gear.

(S) Gear lock 62228

⑧ Place the hexagon nut M16×1.5 (14/16 BRJ-9) and M20×1.5 (20/25BRJ-9) onto the bevel pinion shaft and tighten it with a torque spanner (item 4).

Tightening torque : 14/16BRJ-9 : 100 Nm
20/25BRJ-9 : 150 Nm

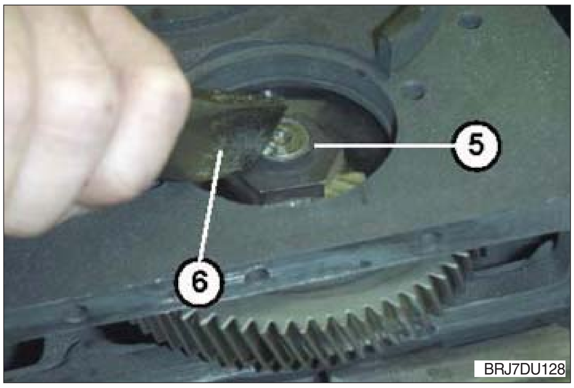


⚠ Do not yet peen the hexagon nut with the bevel pinion shaft! The hexagon nut must only be peened after setting and checking of the bearing preload! Use the hexagon nut only once.

⑨ Turn the bevel pinion shaft and the helical gear respectively by hand several times, that the taper rollers can align in the bearing rings.

⑩ Check the bearing preload by means of a drag torque spanner with dial gauge.
The bearing preload is adjusted correctly, when a bearing friction torque of
0.5 ... 1.0 Nm
is reached on the bevel pinion shaft.
If this value deviates the procedure must be repeated.

⑪ Drive the collar of the hexagon nut (item 5) by means of a chisel (item 6, edge of the chisel must be a radius of approx. 2.0 mm) into the recesses of the bevel pinion shaft. Lock the hexagon nut by peening!

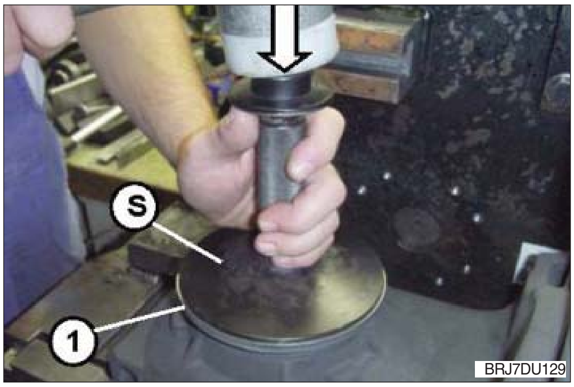


9) INSTALLATION OF CROWN GEAR AND WHEEL SHAFT INTO THE HOUSING

(1) Installation of thread protective shield and radial sealing ring

① Wet the thread protective shield (item1) on the bore
seat evenly with LOCTITE 270 and install it until contact by means of the striking mandrel "S".

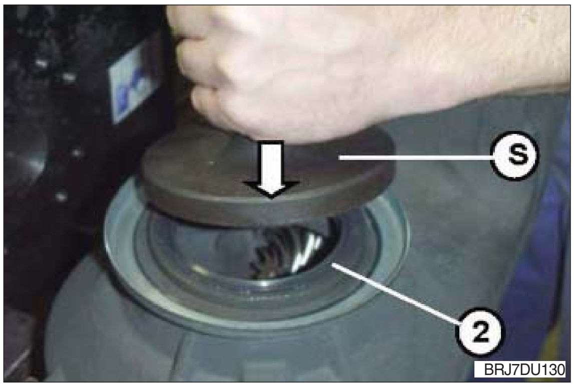
(S) Striking mandrel 63293



② Apply a thin and even layer of LOCTITE 574 onto the outer diameter of the radial sealing ring.

③ By means of the striking mandrel "S" drive the radial sealing ring (item 2) into the housing seat until contact is obtained at the mandrel.

(S) Striking mandrel 63291 : 14/16BRJ-9
(S) Striking mandrel 63292 : 20/25BRJ-9



⚠ **Pay attention that the radial sealing ring is not jammed during installation. Jamming will cause leakage.**

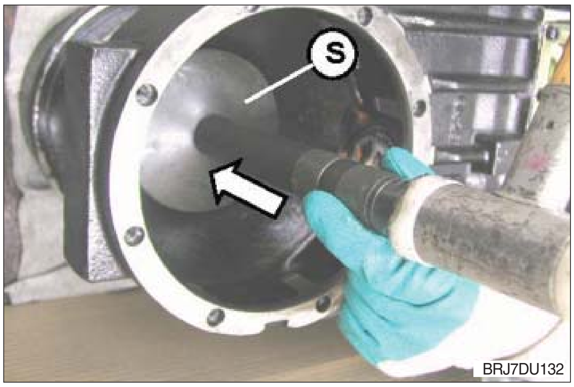
⚠ **Do not damage the sealing lip of the radial sealing ring.**

③ Wet the sealing lip of the radial sealing ring with grease (e.g. Shell Alvania R3) slightly.

(2) Installation of taper roller bearing into the housing

① By means of striking mandrel "S" drive the bearing outer ring into the bearing seat of the housing until contact is obtained.

(S) Striking mandrel 62542



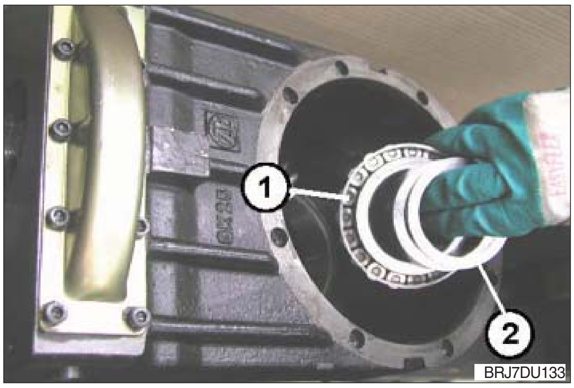
BRJ7DU132

② Insert the bearing inner ring (item 1) into the outer ring of the taper roller bearing.

③ For 20/25BRJ-9 : Insert the bush into the housing.

④ Prepare the shim thickness (thickness X) with the differently thick shims as determined in Chapter 7) (5) at page 3-34 "Calculation of shims required for upper bevel pinion shaft bearing".

⑤ Insert shim(s) (item 2).



BRJ7DU133

(3) Determination of control dimension for seat

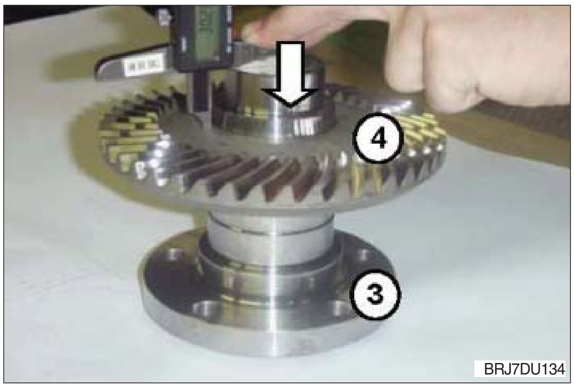
① Place the wheel shaft (item 3) onto a plane and solid support. Mount the crown gear (item 4) onto the taper seat of the wheel shaft by hand cautiously and press it on slightly.

Determine distance "A" from plane face P of the wheel shaft to face S of the crown gear as shown in Figure135.

Dimension "A" e.g. 30.85 mm

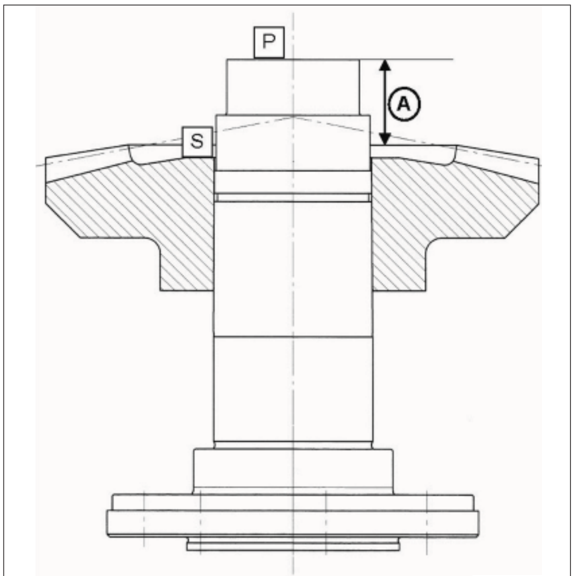
⚠ Carry out this measuring procedure to 1/100mm exactly.

⚠ Pay attention not to damage the gearing of the crown gear, when the crown gear is mounted onto the wheel shaft. In case of damage, noise problems can occur later.



BRJ7DU134

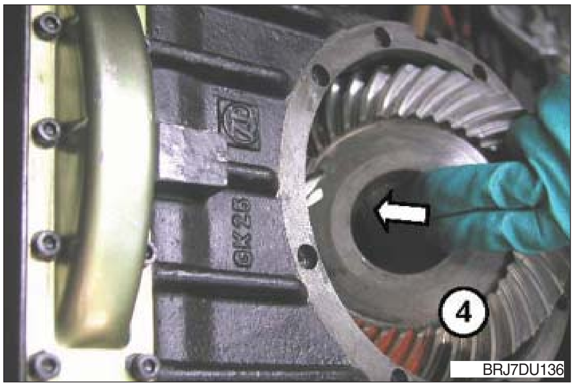
⚠ Pay attention not to damage the gearing, when the crown gear is assembled.



BRJ7DU135

① Assemble the crown gear (item 4) into the housing carefully and insert it into the gearing of the bevel pinion shaft at the same time. Pay attention that the crown gear is aligned centrally to the shim and the bush.

② Center the taper roller bearing inner ring, shims, crown gear and bush (only 20/25BRJ-9).



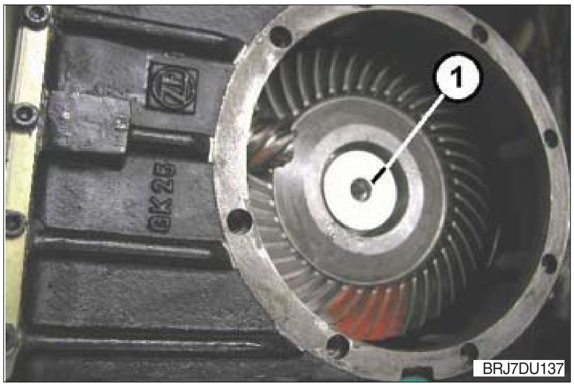
BRJ7DU136

(4) Pressing-on wheel shaft

⚠ Taper press fit must be grease- and oilfree. Pay attention to an impeccable surface of the press fit. In case of damage use a new wheel shaft.
All components must be aligned and centered for the press-on procedure.
For this installation procedure a press with a controllable press-on force is required.

Press-on force: 250 kN up to max. 300 kN.

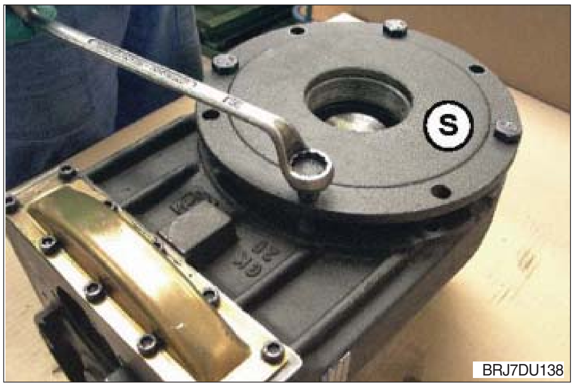
① Assemble the wheel shaft (item 1) cautiously and install it until contact is obtained.



BRJ7DU137

② Screw on the press-on fixture (S).

(S) Press-on fixture 63428



BRJ7DU138

③ Press the wheel shaft onto the crown gear.
During this procedure the shim(s), the taper roller bearing inner ring and the bush (only 20/25BRJ-9) are pressed on until contact is obtained.

⚠ For pressing on the wheel shaft, only apply the press-on force to the wheel shaft.

BRJ7DU139

(5) Determination of seat

⚠ **The seat must be 10 to 15 mm.**

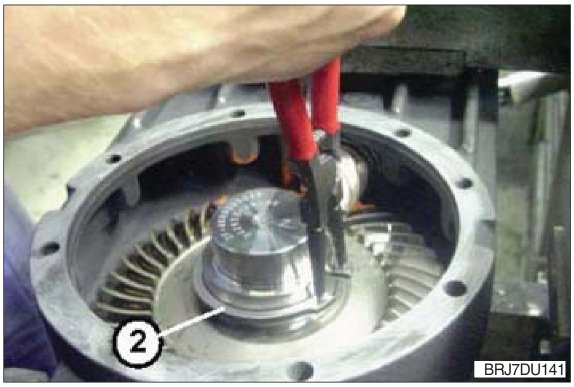
① Measure Dimension A from plane face/wheel shaft to face/crown gear once again (see chapter 9) (3) at page 3-39 "Determination of control dimension for seat").

Dimension "A" e.g. 44.34 mm

Example:
Dimension "A" after pressing-on 44.43 mm
Dimension "A" after pressing-on 30.85 mm
resulting difference = Seat 13.49 mm

⚠ **If the seat determined is not between 10 and 15 mm a new wheel shaft and a new crown gear have to be installed.**

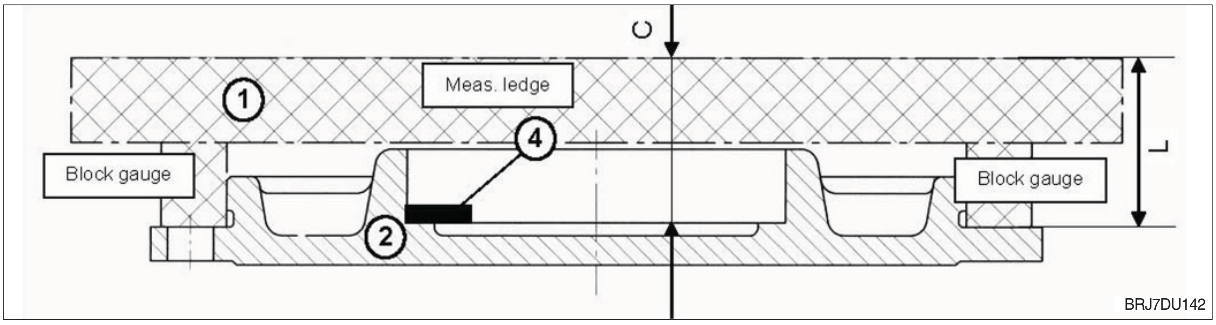
② Install the retaining ring (item 2).



10) INSTALLATION OF BEARING FOR WHEEL SHAFT

(1) Determination of required shim thickness for exact bearing preload of the wheel shaft

Thickness of the shim (item 4) to be added can be determined with the following method:



1　Measuring ledge
2　Housing cover

Dim. "L"　Distance from mounting face/housing cover equal to zero position on measuring instrument
Dim. "C"　Measure distance from contact shim/housing cover.
Dim. "L"　e.g. Zero position on measuring instrument = 0
Dim. "C"　e.g. 0.85 mm

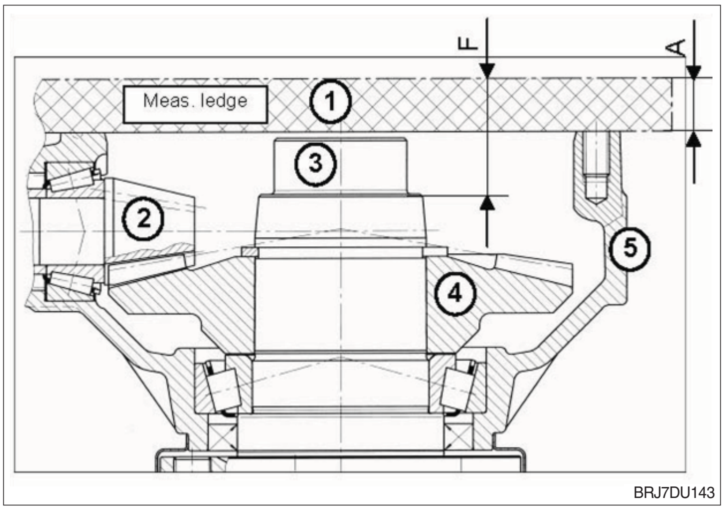
1　Measuring ledge
2　Bevel pinion shaft
3　Wheel shaft
4　Crown gear
5　Housing

Dim. "A"
Distance from mounting face / housing equal to zero position on measuring instrument

Dim. "F"
Measure distance from contact bearing inner ring / wheel shaft.

Dim. "A"
e.g. zero position on measuring instrument = 0

Dim. "F"
e.g. 23.01 mm



(2) Calculation of shim required

Thickness of shim can be calculated with the dimensions determined.

Example for 14/16BRJ-9 :

Cover dimension :	Dim. C measured on housing cover	0.85 mm
Housing dimension :	Dim. F measured on housing	23.01 mm
Bearing dimension :	Dim. B measured on bearing under preloading force	21.85 mm

$$X1 = F - (C + B)$$
$$X1 = 23.01 - (0.85 + 21.85) = 0.31 \text{ mm}$$

Constant : $a = 0.20$ at $X1 \geq 0.31$
$a = 0.25$ at $X1 \leq 0.30$

$$X = X1 + a$$
$$X = 0.31 + 0.20 \text{ mm} = 0.51$$

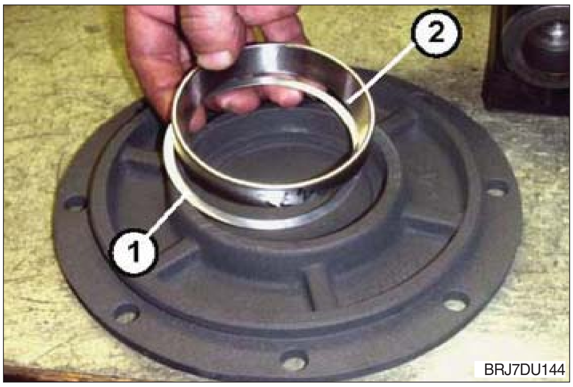
Add shims according to thickness X.

Analogously to example 14/16BRJ-9 the thickness required of the shim is determined for 20/25BRJ-9.

(3) Installation of bearing into housing cover and wheel shaft

① Prepare the shim thickness determined under chapter (2) above "Calculation of shim required" by means of the differently thick shims.

② Put shim(s) (item 1) and bearing outer ring (item 2) into the bearing seat.

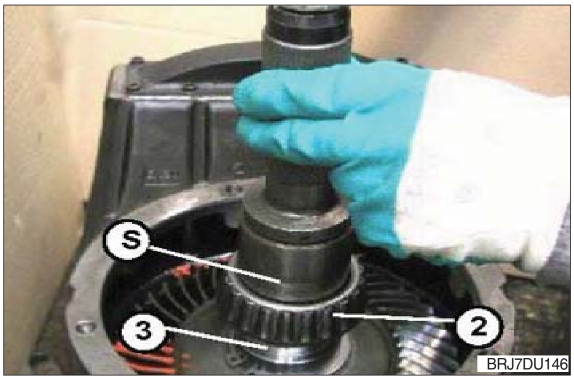


③ By means of striking mandrel "S" drive shim(s) and bearing outer ring (item 1) into the bearing seat of the housing cover until contact is obtained.

(S) Striking mandrel 62748 : 14/16BRJ-9
(S) Striking mandrel 62749 : 20/25BRJ-9

④ Place counter holder "N" into the assembly fixture and preload it hand-tight against the wheel shaft (cf. figure 124).
(N) Counter holder 62507-1

⑤ Mount the taper roller bearing inner ring (item 2) by
means of striking mandrel "S" onto the bearing seat of the wheel shaft (item 3) until contact is obtained.
(S) Striking mandrel 63294



(4) Installation of housing cover

⚠ Use a new O-Ring for the installation. Wet the O-Ring with transmission oil or grease slightly. Clean plane face of the housing cover carefully and do not damage it.

① Put the O-Ring (item 4) into the groove of the housing cover.

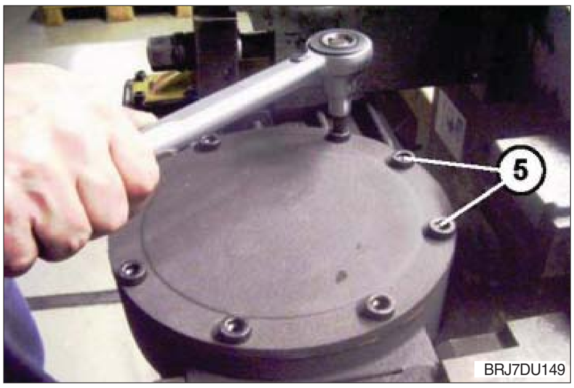
② Plane face for housing cover on the housing is to be cleaned carefully and must be grease-free.

③ Apply a thin and even layer of LOCTITE 574 onto the plane face.

④ Place the housing cover cautiously and install it slightly tapping with a dead-blow soft face hammer until contact is obtained.

By means of cap screws M10×25 (item 5) bolt the cover to the housing. Tighten the cap screws crosswise evenly!

Tightening torque of the cap screws : 46 Nm.

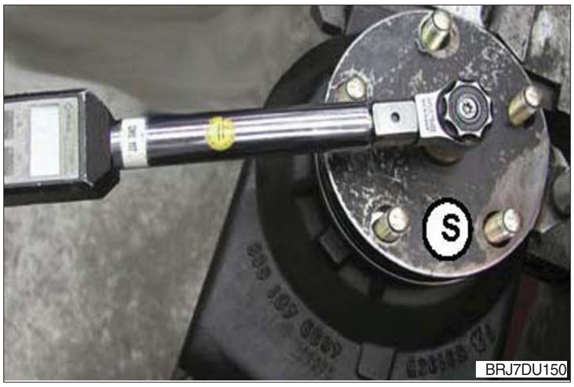


(5) Checking of bearing friction torque on wheel shaft

Rolling

For measuring of the bearing friction torque place tool "S" on the wheel shaft congruent with the wheel bolts and by means of the torque spanner turn the wheel shaft several times.

(S) : Measuring fixture 62532 : 14/16BRJ-9
(S) : Measuring fixture 62515 : 20/25BRJ-9



BRJ7DU150

Bearing preload is adjusted correctly when a bearing friction torque of
7.0 ~ 14 Nm for 14/16BRJ-9
8.0 ~ 22 Nm for 20/25BRJ-9

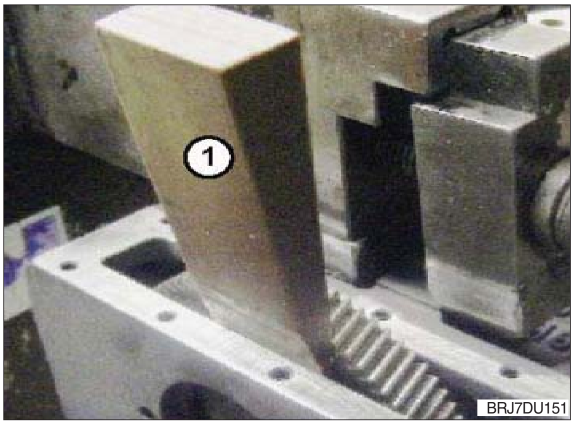
is obtained at the wheel shaft.

If this value is not reached the working steps from Chapter 10) (2) have to be repeated. The cover has to be removed again.
If the measured value is greater than the above mentioned value, the shim thickness of value "X" in "Chapter 10) (2) calculation of shim required" has to be reduced.

If the measured value is smaller than the above mentioned, the shim thickness of value "X" in "Chapter 10) (2) at page 3-44 calculation of shim required" has to be increased.

(6) Measuring of torsional backlash on wheel shaft

① For measuring of the torsional backlash lock the bevel pinion shaft against distortion, e.g. with a wooden wedge (item 1).



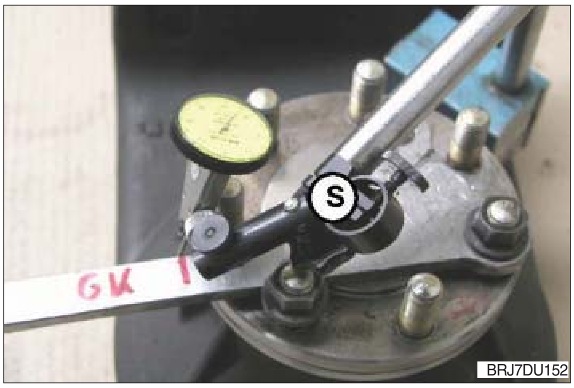
BRJ7DU151

② Measure the torsional backlash with measuring stop "S".

(S) Measuring stop 62819

Admissible torsional backlash:
14/16BRJ-9 : 0.10 ~ 0.15 mm
20/25BRJ-9 : 0.13 ~ 0.18 mm

The torsional backlash can be adjusted by adding or removing of the shim(s) (see Chapter 6) (2) at page 3-28 "determination of the necessary shim thickness for optimum setting of the torsional backlash of crown gear"). The wheel shaft has to be removed again.



BRJ7DU152

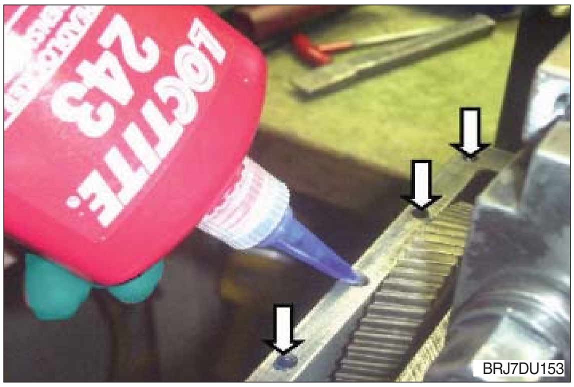
(7) Installation of side cover

Prior to the installation of the side cover clean the sealing surface on the housing and remove the oil residues. The sealing surface must not be damaged.

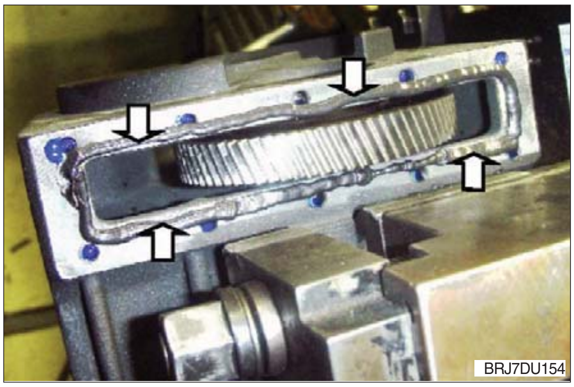
⚠ Wear safety gloves for working with adhesives and observe the LOCTITE instructions.

⚠ The following step must be carried out within 10 minutes since the LOCTITE hardens.

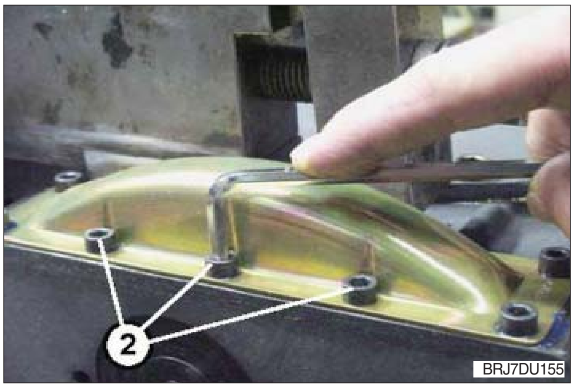
① For sealing of the through holes as well as of the area around the screw the following sealing application is required:
LOCTITE 243 : Product application into the threaded blind holes M6 as sealing function by excess product.



② Sealing of the cover:
LOCTITE 5910: Product application as uniform adhesive application onto the sealing surface at the housing as sealing function.



③ Put on the side cover (sheet cover) and fasten it hand-tight with 10 cap screws M6 × 10 (item 2) onto the housing.

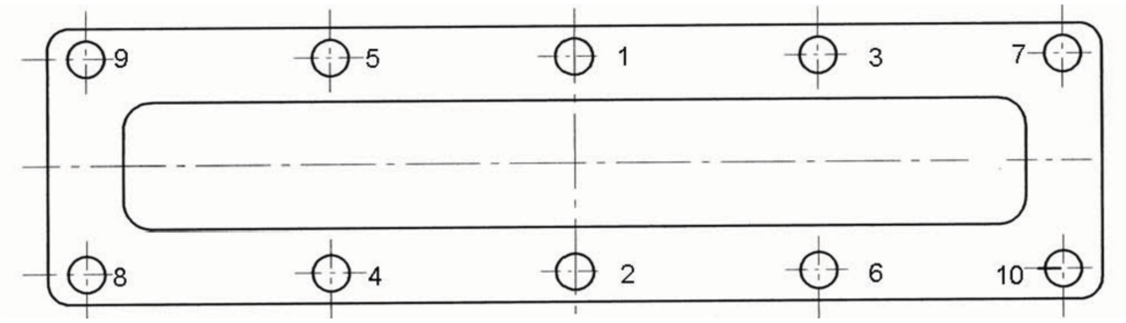


⚠ **Do not yet tighten the cap screws with the corresponding tightening torque.**

Tighten the 10 cap screws evenly only in the tightening sequence shown in Figure 156.
Sequence of tightening :

Number 1 beginning ...... Number 10 end

Tightening torque of the cap screws : 9.5 Nm



BRJ7DU156

11) PREASSEMBLY AND INSTALLATION OF DRIVE PINION

(1) Installation of ball bearing

① For mounting of the bearing onto the drive pinion use assembly fixture "S", as shown.

(S) Assembly fixture 62523

② Put the drive pinion (item 1) onto the guide mandrel (item 2) of the assembly fixture and install it until contact is obtained.

③ Put on the ball bearing (item 4) and the pressing sleeve (item 3). By means of a hand lever press, press on the ball bearing with the pressing sleeve onto the drive pinion (item 1) until contact is obtained.

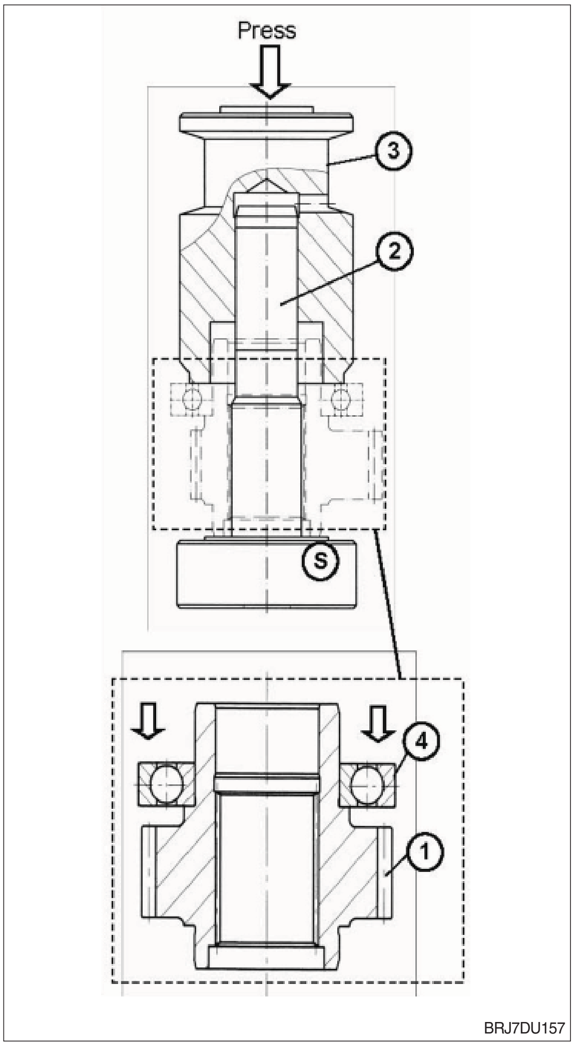
(item 3) Pressing sleeve 63290

④ If there is no hand press available, the bearing can be installed as follows:

⚠ **Danger of burnings! Wear safety gloves.**

⑤ Heat the ball bearing to max. 90° C and install it onto the drive pinion until contact is obtained.

⑥ After cooling down install the bearing subsequently.



BRJ7DU157

(2) Mounting of sealing cap

For sealing of the bore in the drive pinion a sealing cap (item 5) must be mounted. This requires the following sealing application:

① LOCTITE 5910 : Product application as adhesive application onto the supporting face and around the bore in the drive pinion as sealing function by excessive product.

② Insert the sealing cap.

③ Press in the sealing cap with a press until contact is obtained.

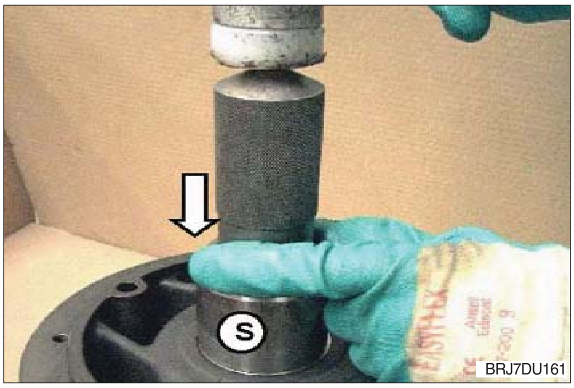
(3) Installation of drive pinion

⚠ Pay attention when inserting the drive pinion not to damage the gearing of drive pinion and helical gear. Damages might cause louder running noises and consequential damages.

① Install the preassembled drive pinion (item 1) into the housing bearing bore cautiously. For joining turn the wheel shaft of the transmission cautiously until the drive pinion engages into the gearing of the helical gear.

② By means of the striking mandrel "S" install the drive pinion into the bearing seat until contact is obtained.

(S) Striking mandrel 62478



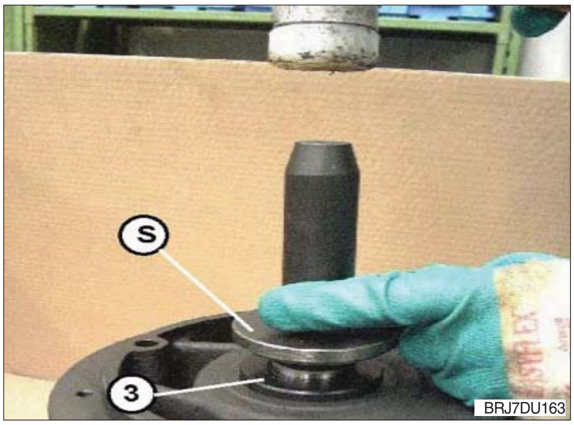
③ Snap the retaining ring (item 2) by means of flat-head pliers into the groove of the housing bore and install it until contact is obtained.

④ Wet the sealing lip of the radial sealing ring with grease (e.g. Shell Alvania R3) slightly.

⑤ Apply a thin and even layer of LOCTITE 574 onto the outer diameter of the radial sealing ring.

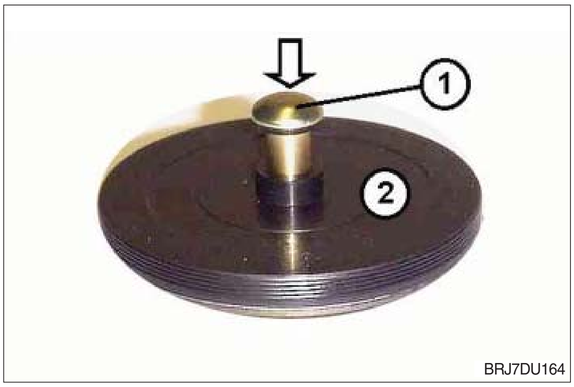
⑥ By means of striking mandrel "S" drive the radial sealing ring with the closed surface upwards into the housing seat until contact at the mandrel is obtained.

(S) Striking mandrel 62521



(4) Installation of sealing cap

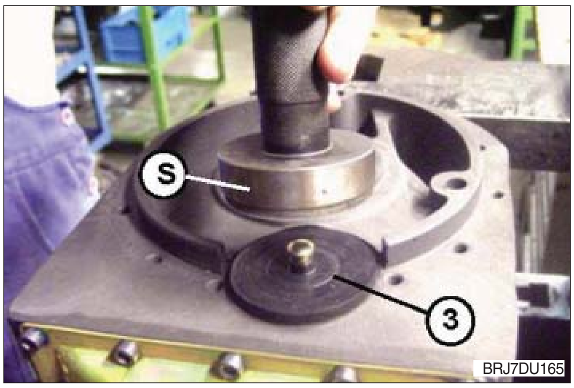
① Press the breather valve (item 1) slightly by hand into the central bore of the sealing cap (item 2) (Reference depth approx. 5 mm).



③ Insert the sealing cap with breather valve (item 3) into the boring seat of the housing bore in the bevel pinion shaft.

④ By means of the striking mandrel "S" install the sealing cap subsequently until contact is obtained.

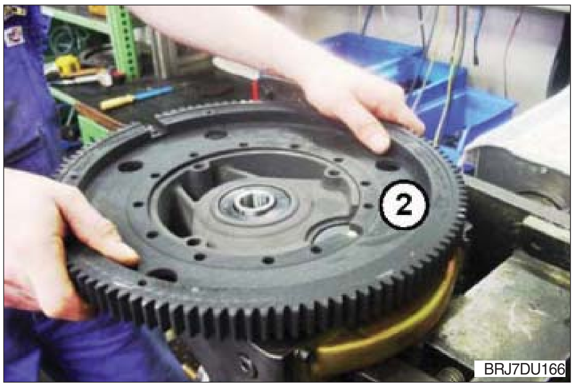
(S) Striking mandrel 62522



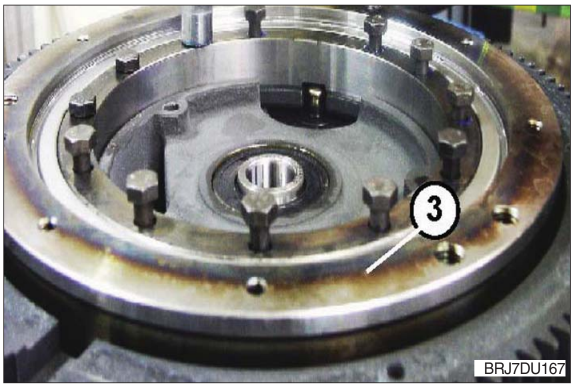
(5) Attachment of pivoted connection geared steering

① Place the gear ring (item 2) and turn it so that the bolt holes match the threaded holes of the connecting construction.

② Install the gear ring with a dead-blow soft face hammer until contact is obtained.



③ Put on the pivoted bogie bearing (item 3) with the peripheral recess upwards and turn it that the bolt holes in the pivoted bogie bearing match with the gear ring and housing hole pattern.



④ Wet screws M80×40-10.9 with LOCTITE 243.

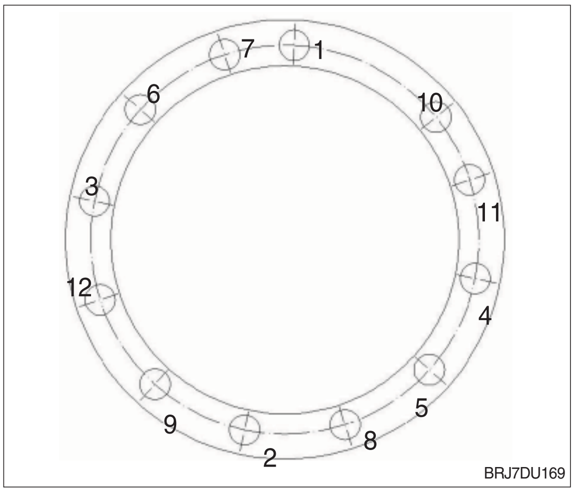
⑤ By means of the screws fasten the pivoted bogie bearing and the gear ring onto the connecting constructions.

⑥ Tighten the screws evenly in the tightening sequence shown in figure 169.

Sequence of tightening:
Number 1 beginning   Number 12 end

Tightening torque of cap screws: 34 Nm

⚠ **Pay attention for installing of the drive pinion that the gearing of drive pinion and helical gear are not damaged. Damages might cause louder running noises and consequential damages.**



Thus the reassembly is ended.

12) GENERAL INSTRUCTIONS AFTER REASSEMBLY

(1) For reinstallation of the transmission into the vehicle observe the installation instructions at page 2-9.

(2) Fill in oil according to the operating instructions.

(3) Transmission and vehicle respectively may be used or operated at the earliest 24 hours after the reassembly again.

6. DISPOSAL

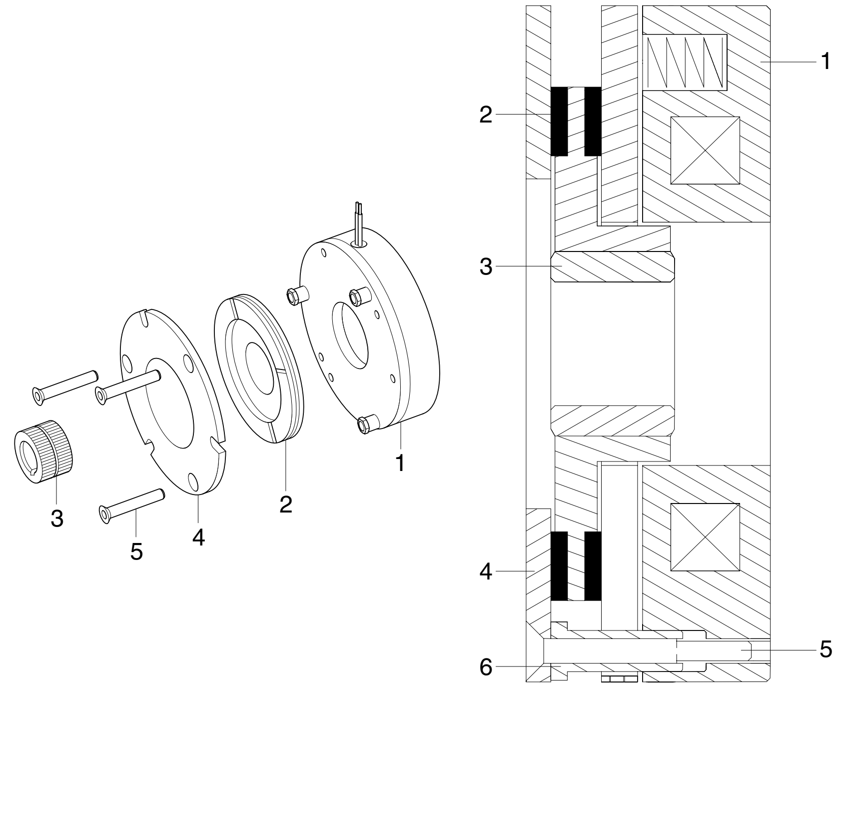
Disposal of the replaced components, materials and substances adequately, environmentally friendly and in accordance with the legal regulations for disposal for the respective material :

Component	Consisting of	Disposal acc. to the regulations :
Transmission oil		Waste oil
Side cover	Sheet	Scrap metal
Radial sealing ring	Sheet	
Shims	Sheet	
Wheel bolts	Steel	
Grooved ball bearing	Steel	
Screw	Steel	
O-ring	PE	PE plastic meterials
Shaft seal	PE	
Sealing cap	PE	

SECTION 4 BRAKE SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. STRUCTURE



1	Inductor	4	Flange
2	Friction disc	5	Assembly screws
3	Hub	6	Adjusting screws

2. SPECIFICATION

Item	Specification
Nominal torque (std versions)	120 Nm
Nominal airgap	0.3 mm
Maximum ratation speed	5000 rpm

3. PRECAUTIONS AND RESTRICTIONS ON USE

1) Restrictions on use

(1) The equipment is designed for dry running. Friction faces must be kept completely clean of any oil, grease or abrasive dust.
(2) Exceeding the maximum rotation speeds stated in the catalogue invalidates the warranty.
(3) The equipment can be fitted either horizontally or vertically.
(4) This equipment is designed for an ambient temperature of 40° maximum (155°C insulation class).

2) Precautions and safety measures

⚠ During maintenance, ensure that the Mechanism to be braked by the equipment is at rest and that there is no risk of accidental start-up. All interventions have to be made by qualified personnel owning this manual.

⚠ Any modification made to the brake without the express authorisation of a representative of Warner Electric, in the same way than any use out of the contractual specifications accepted by Warner Electric Europe, will result in the warranty being invalidated and Warner Electric will no longer be liable in any way with regard to conformity.

4. INSTALLATION

1) Transport / storage

These units are delivered in packaging that guarantees a 6 months storage period whether transported by land, by air, or by sea to any destination excepting tropical countries.
(For tropical destinations please consult Warner Electric technical services).

2) Handling

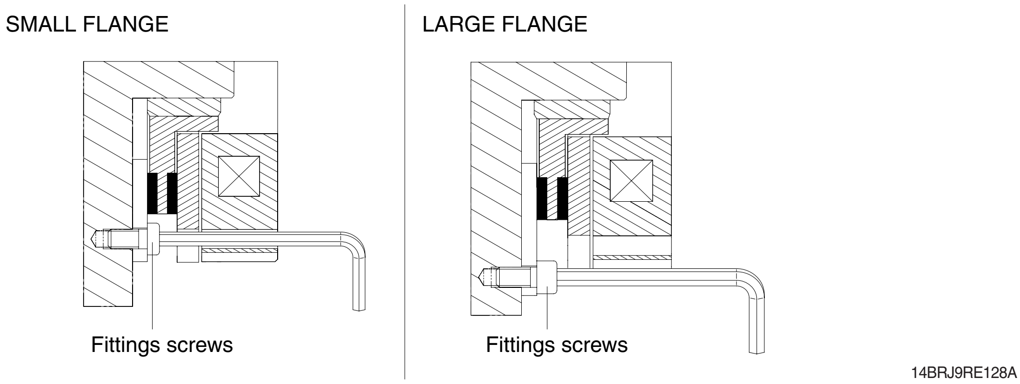
(1) Avoid any impacts on the equipment so as not to alter their performance.
(2) Never carry the equipment by the electrical supply cable.

3) Installing

※ This brakes are delivered completely assembled, the airgap is adjusted in our workshop.

- Put the key into the shaft then slide the hub (3) onto the shaft and secure it axially by suitable means
- Slide the brake onto the hub (3), taking care not to damage the splines of the disc (2). Make sure that the disk locates properly on the splines of the hub
- Secure the brake in position using suitable screws, (see below figure and specification). Secure the fitting screws using a Loctite 270 type thermoplastic liquid
- Switch the equipment on and confirm that the friction disc rotates freely
- Make several motor manoeuvres stationary and check the value of the airgap

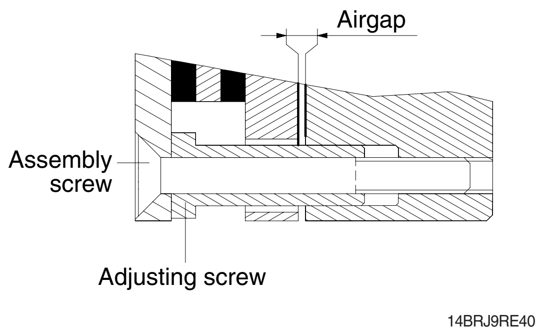
※ Do not grease the guiding splines (friction disc / hub). It will change the brake's performances.
※ Respect obligatory the direction of the hub when mounting (see the brake drawing).



5. MAINTENANCE

1) Adjusting the airgap

To adjust the airgap (right figure), undo the fitting screws then take off the brake. Undo the assembly screws (5) and adjust the screws (6) in order to get the necessary value (see specification). Check the value of the airgap at several points. Make several motor manoeuvres, then check the value of the airgap again. Assembly screws must be tightened with a torque of 22 Nm.



2) Spare parts

After several adjustments, it is necessary to replace the friction disc.

To replace the friction disc (2), undo the fitting screws then take off the brake.

Undo the assembly screws (5) then take out the friction disc (2).

Put the new friction disc into position and secure assembly screws (5) with Loctite 221 or similar. Then adjust the airgap (see above 1)).

6. ELECTRICAL CONNECTION

This brakes have to be supplied with direct current. The polarity does not affect operation, except special versions.

1) Important recommendations

⚠ **All works on the electrical connections have to be made with power off.**

※ Ensure compliance with the nominal supply voltage (inadequate supply causes a reduction in the starting distance).

※ The connecting wires should be of sufficient diameter to prevent voltage drops between the source and equipment supplied.

I(A) / L (m)	0 ~ 10 m	10 ~ 20 m
0~3 (A)	1.5 mm^2	1.5 mm^2
3~6 (A)	1.5 mm^2	2.5 mm^2

※ Tolerance for the supply voltage to the brake terminals +5% / -10% (NF C 79-300).

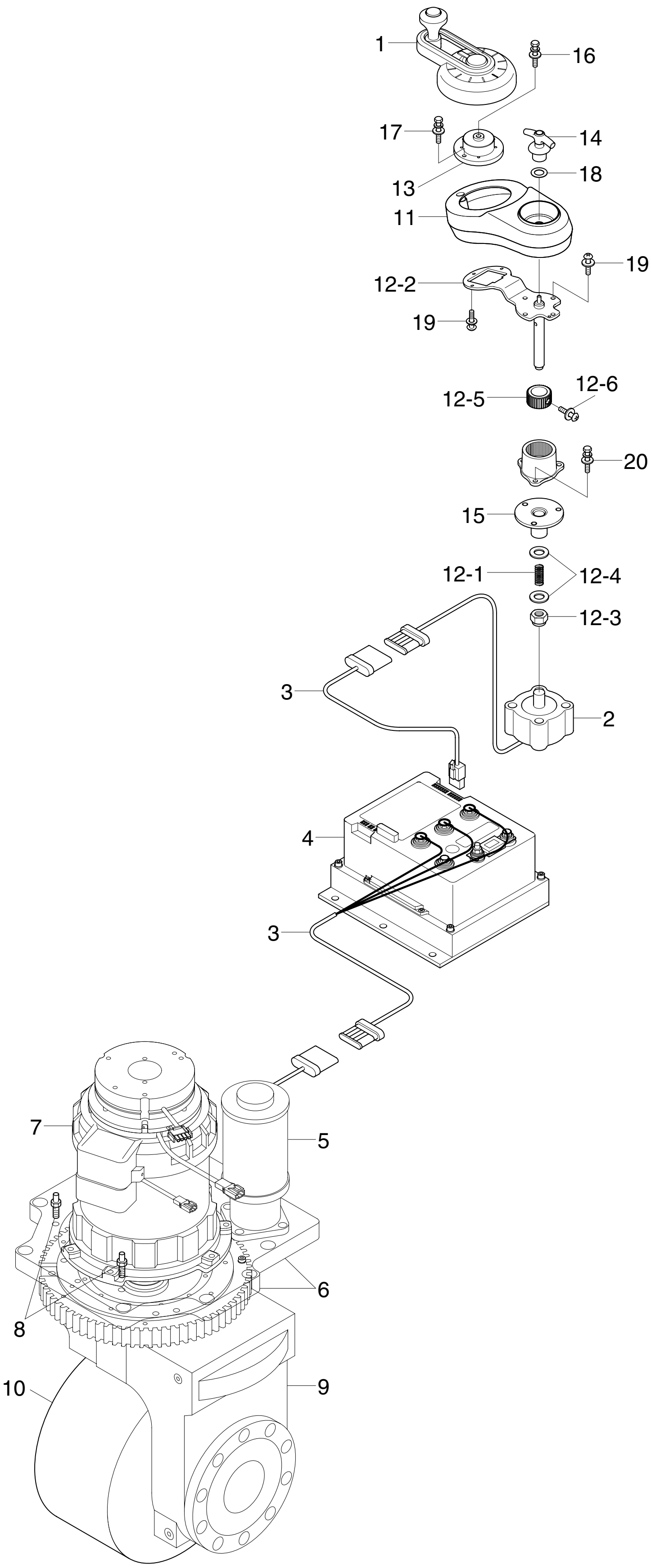
7. TROUBLESHOOTING AND FAULT ELIMINATION

Fault	Cause	Remedy
Brake does not release	· Power supply is too low · Power supply is interrupted · Airgap too large · Worn disc · Coil is damaged · Airgap too small	· Adjust power supply · Reconnect power supply · Re-adjust the airgap · Change disc and readjust the airgap (PK 60) · Replace the brake · Re-adjust the airgap
Brake does not brake	· Voltage present at switch off position · Grease on friction faces	· Check the customer's power supply · Change the disc and re-adjust the airgap
Nuisance braking	· Power supply is too low	· Adjust power supply

SECTION 5 STEERING SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

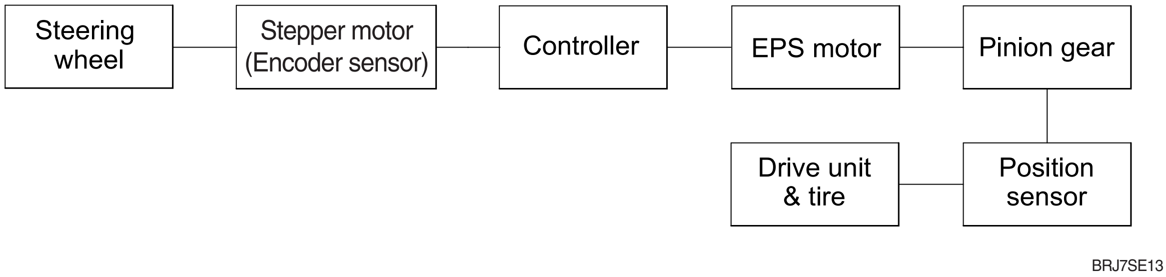
1. STRUCTURE



1	Steering wheel
2	Stepping motor
3	Main harness
4	Controller sub assy
5	EPS motor
6	Pinion & steering gear
7	Traction motor
8	Position sensor assy
9	Drive unit
10	Drive tire
11	Steering panel assy
12	Steering rotate assy
12-1	Return spring
12-2	Shaft
12-3	Self locking nut
12-4	Plain washer
12-5	Inner rotate shaft
12-6	Flat head screw
13	Boss sub assy
14	Rotate handle
15	Shaft support
16	Bolt
17	Bolt
18	Washer
19	Bolt
20	Bolt

14BRJ9SE02

2. FUNCTION



1) Steering wheel

(1) It decides the direction of rotation of the truck.
(2) It transmits the handling of operator.

2) Stepper motor

(1) It is sensing the operation of steering wheel.
(2) It is transmits the output signal to controller.

3) Controller

(1) It decides the torque and the direction of rotation of motor.
(2) It supplied power to motor.

4) EPS motor

(1) It transmits torque to pinion gear.

5) Pinion gear

(1) It increases torque to drive unit steering gear.

6) Position sensor

(1) It is sensing angle of steering.
(2) It transmits resistance to controller.

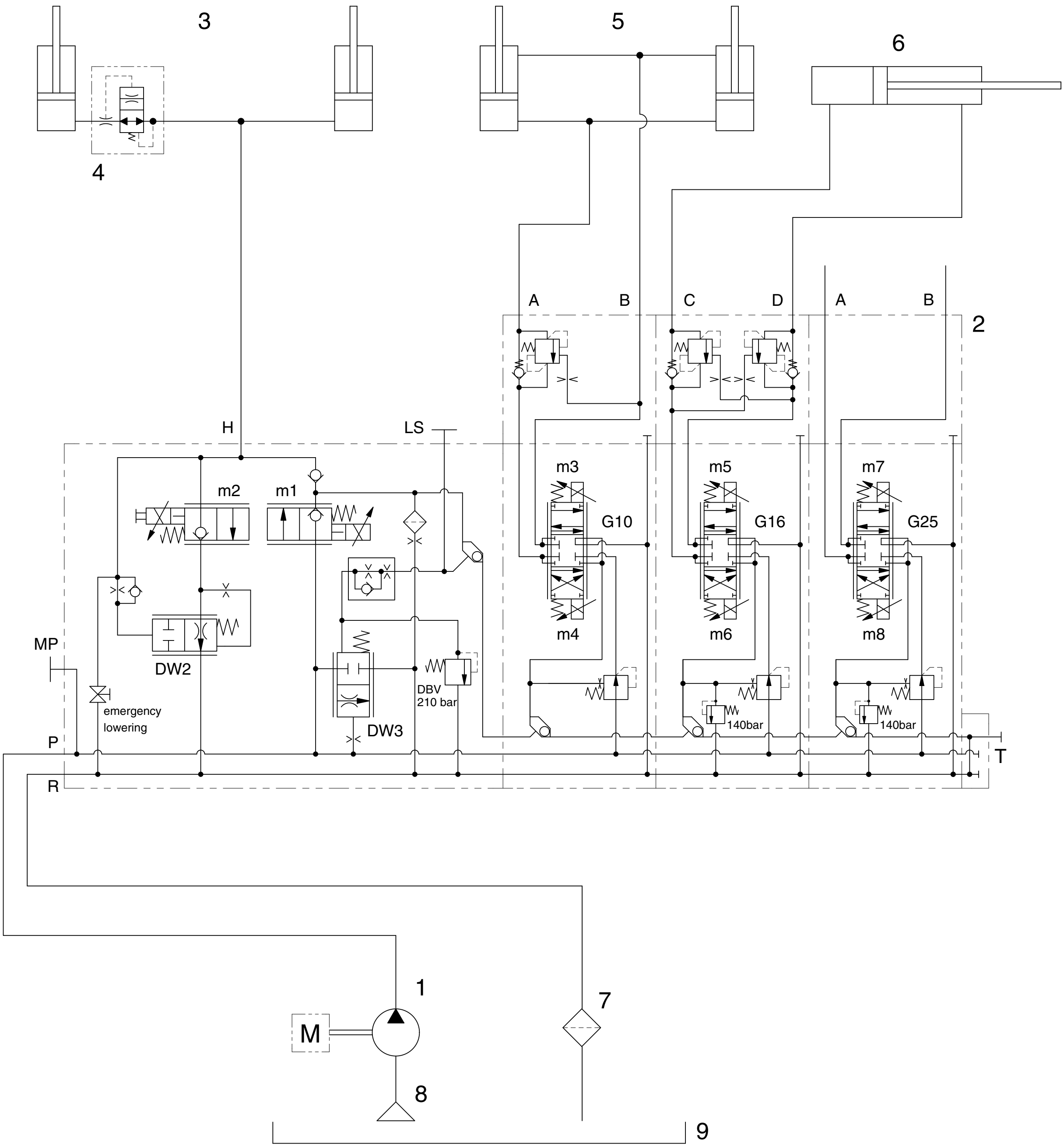
7) Tire

(1) It is rotated by the transmitted torque.

SECTION 6 HYDRAULIC SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. HYDRAULIC CIRCUIT

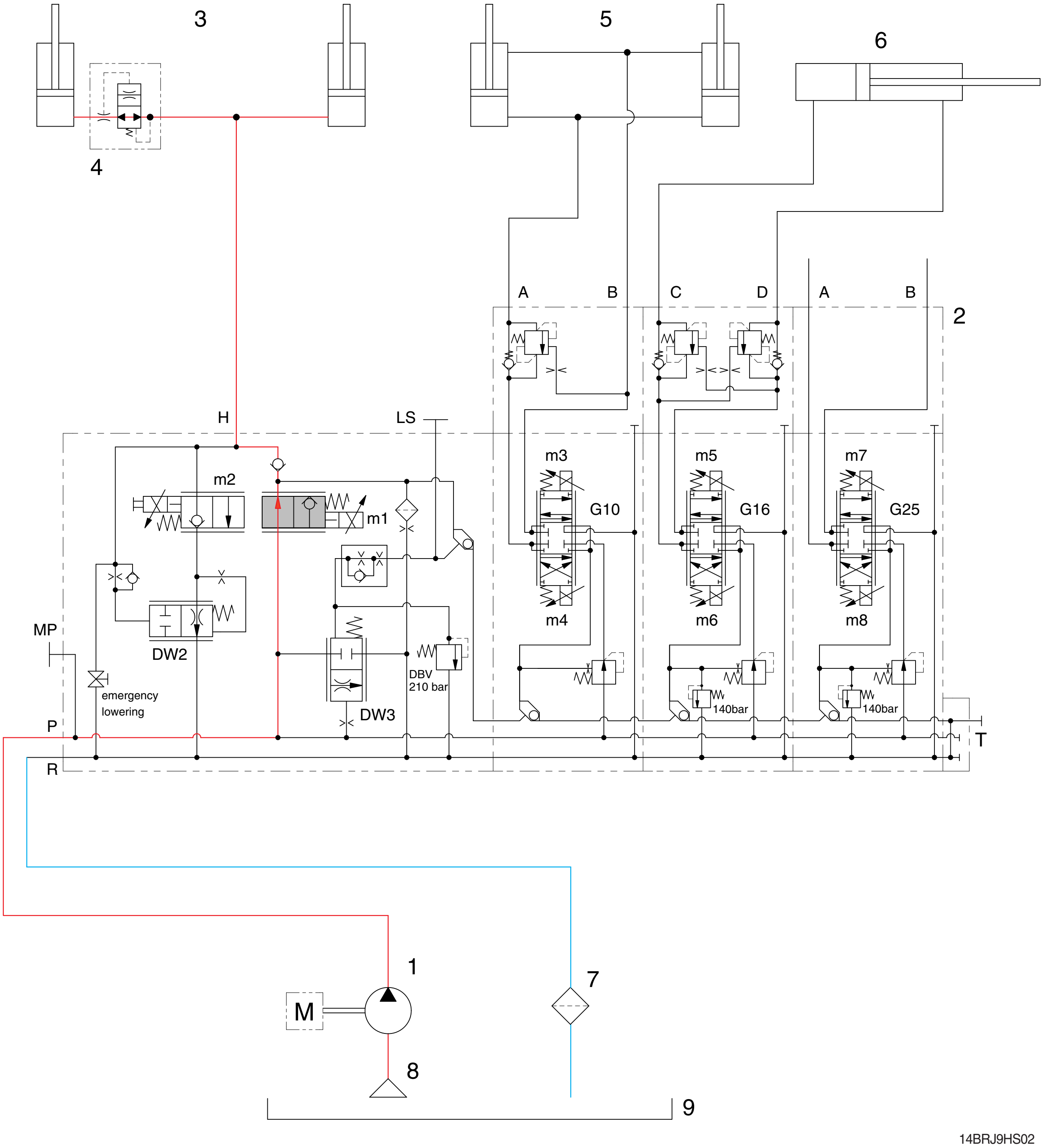


14BRJ9HS01

1	Hydraulic pump	6	Reach cylinder
2	Main control valve	7	Return filter
3	Lift cylinder	8	Suction strainer
4	Down safety valve	9	Hydraulic tank
5	Tilt cylinder		

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

1) WHEN THE LIFT CONTROL LEVER IS IN THE LIFT POSITION



When the lift control lever is pulled back, the m1 valve on the lift block is moves to open position.

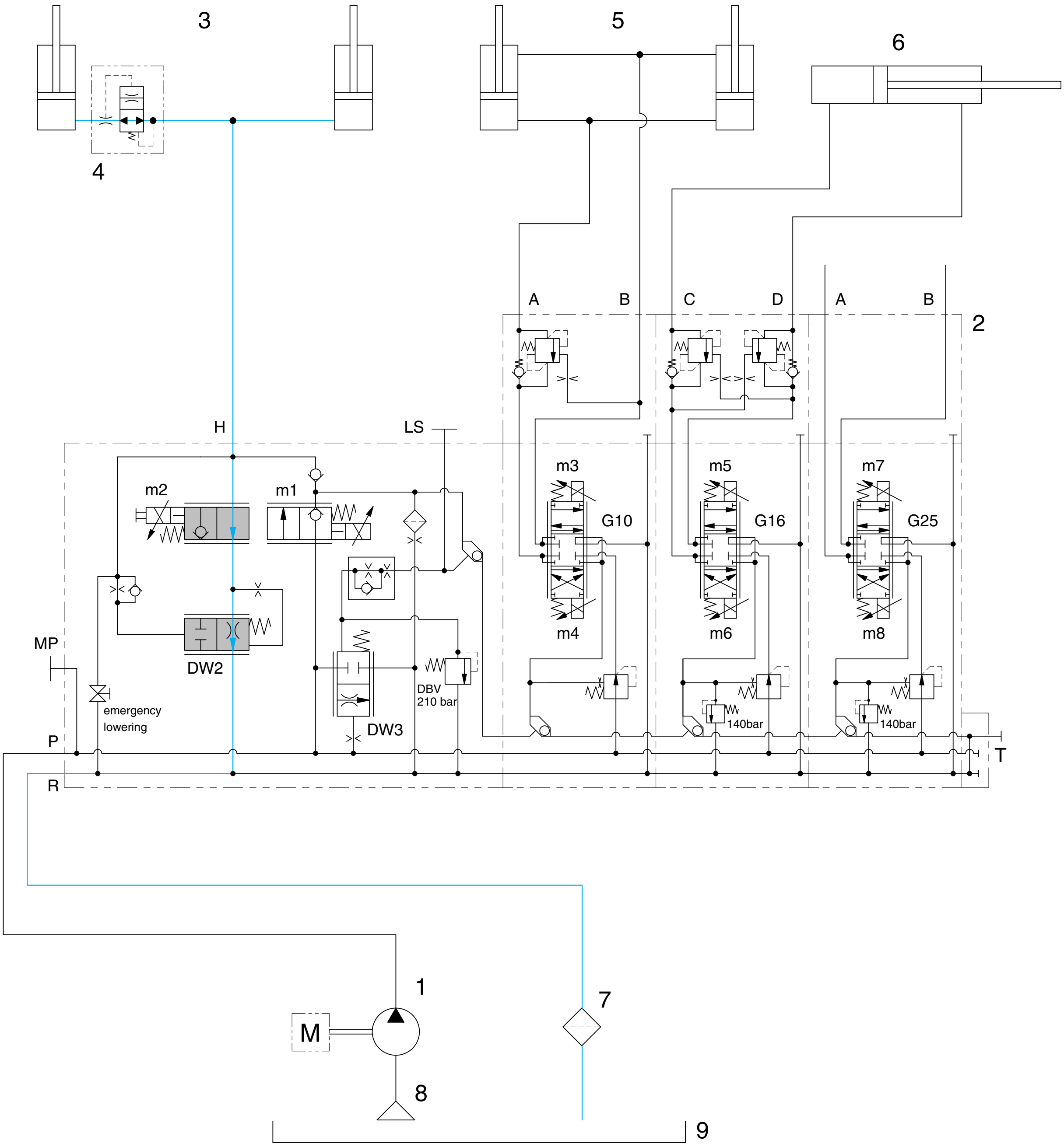
The oil from hydraulic gear pump (1) flows into main control valve (2) and then goes to the large chamber of lift cylinder (3).

The air of the small chamber of lift cylinder (3) is compressed at the same time.

When this happens, the forks go up.

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

2) WHEN THE LIFT CONTROL LEVER IS IN THE LOWER POSITION

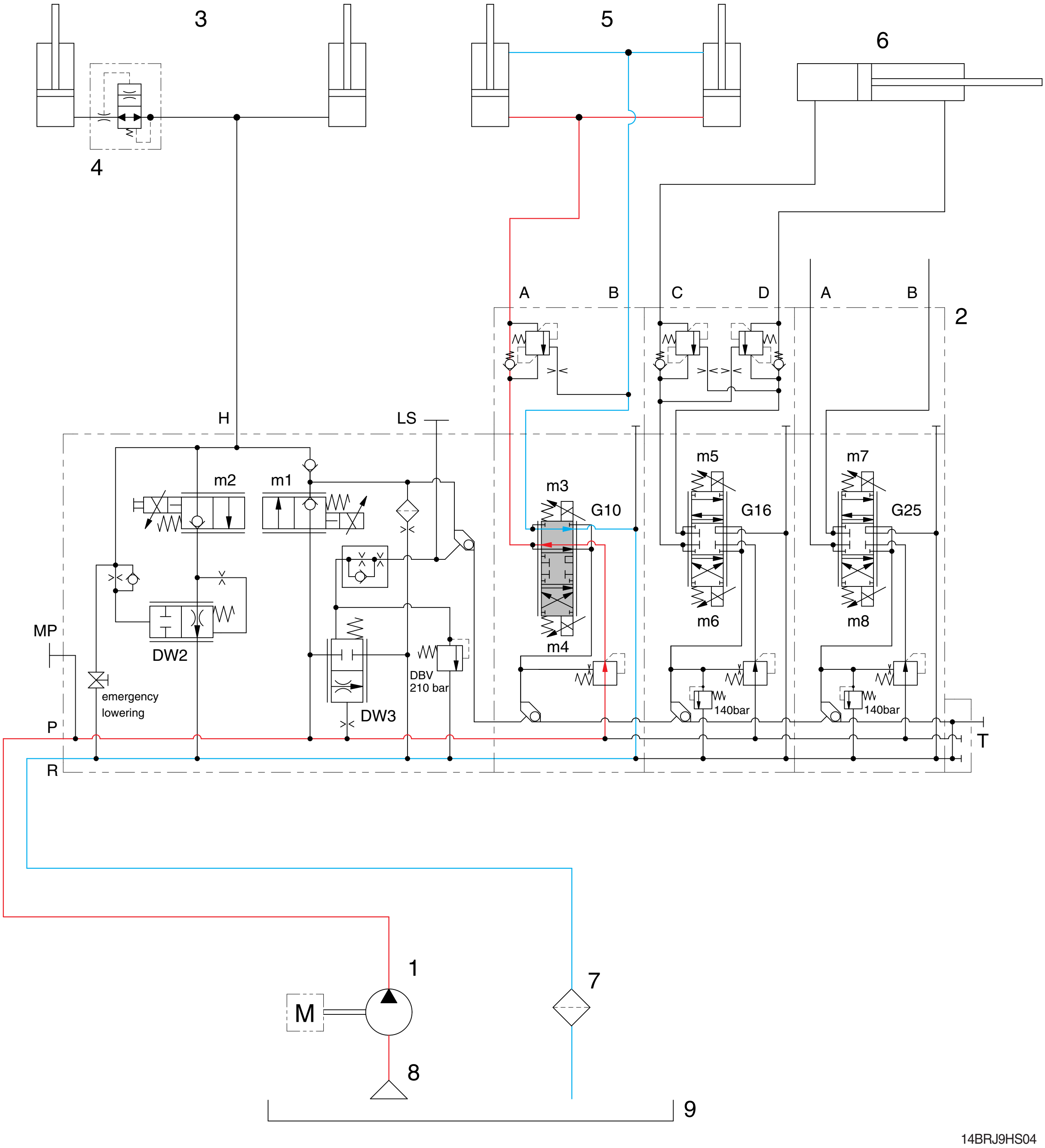


14BRJ9HS03

When the lift control is pushed forward, the m2 valve on the lift block is moved to open position. The work port (H) and the large chamber are connected to the return passage, so the lift will be lowered due to its own weight.

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

3) WHEN THE TILT CONTROL LEVER IS IN THE BACKWARD POSITION



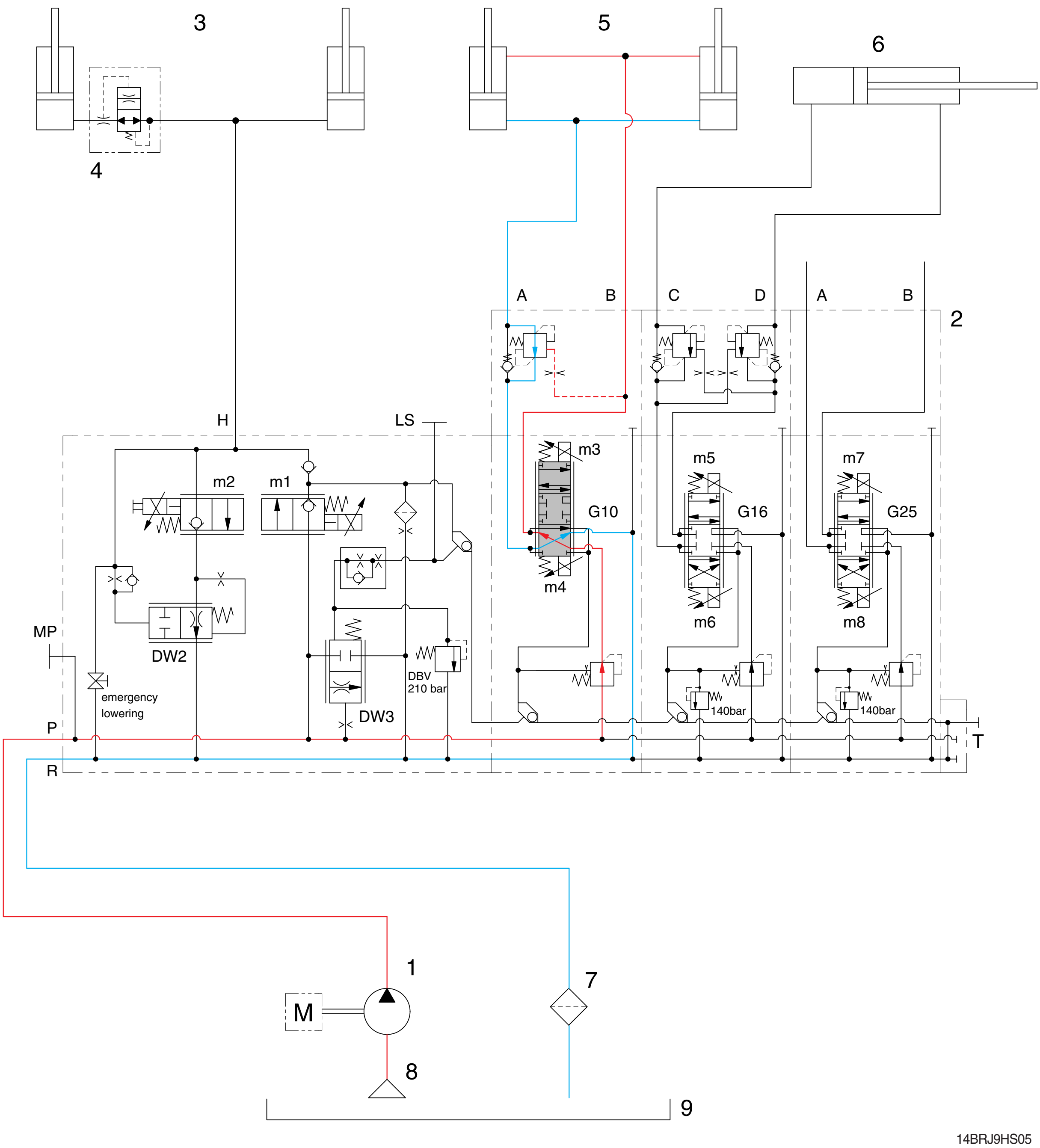
When the tilt control lever is pulled backward, the spool on the second block is moved to tilt backward position.

The oil from hydraulic gear pump (1) flows into main control valve (2) and then goes to the large chamber of tilt cylinder (5).

The oil at the small chamber of tilt cylinder (5) returns to hydraulic tank (9) at the same time.

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

4) WHEN THE TILT CONTROL LEVER IS IN THE FORWARD POSITION



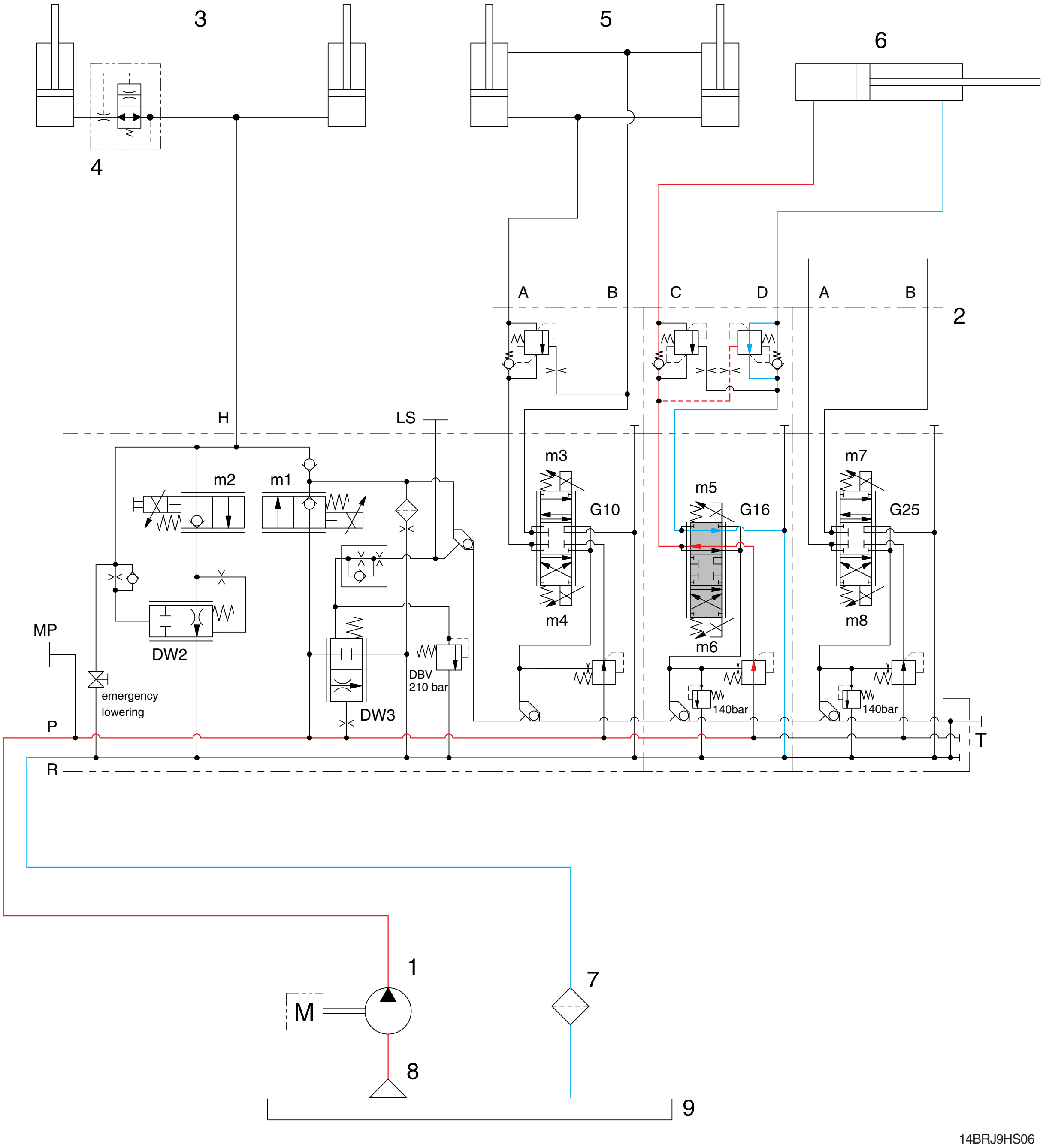
When the tilt control lever is pushed forward, the spool on the second block is moved to tilt forward position.

The oil from hydraulic gear pump (1) flows into main control valve (2) and then goes to the small chamber of tilt cylinder (5).

The oil at the large chamber of tilt cylinder (5) returns to hydraulic tank (9) at the same time.

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

5) WHEN THE REACH CONTROL LEVER IS IN THE FORWARD (REACH OUT) POSITION



When the reach control lever is pushed forward, the spool on the third block is moved to reach out position.

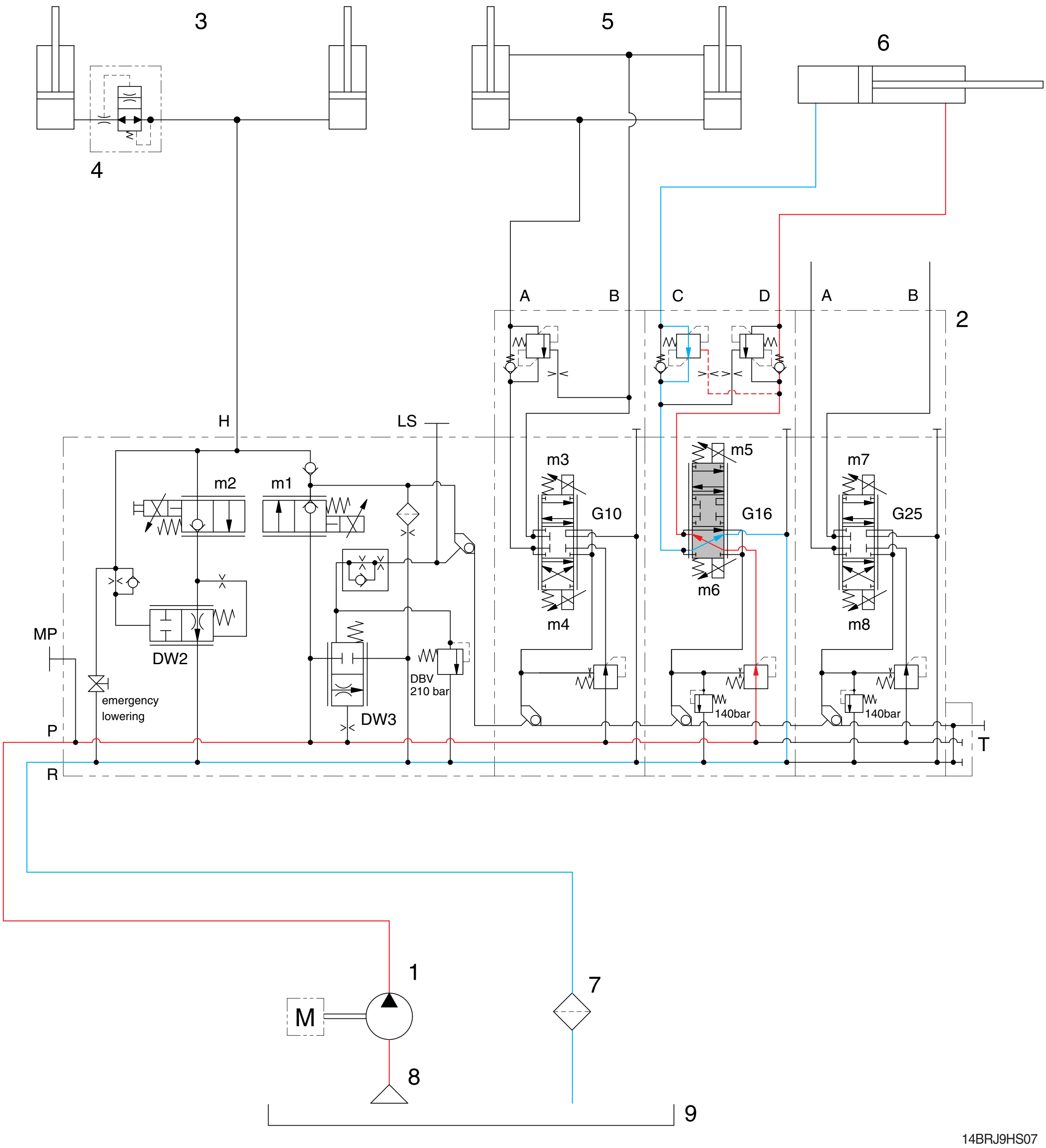
The oil from hydraulic gear pump (1) flows into main control valve (2) and then goes to the large chamber of reach cylinder (6).

The oil at the small chamber of reach cylinder (6) returns to hydraulic tank (9) at the same time.

When this happens, the mast reaches out.

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

6) WHEN THE REACH CONTROL LEVER IS IN THE BACKWARD POSITION

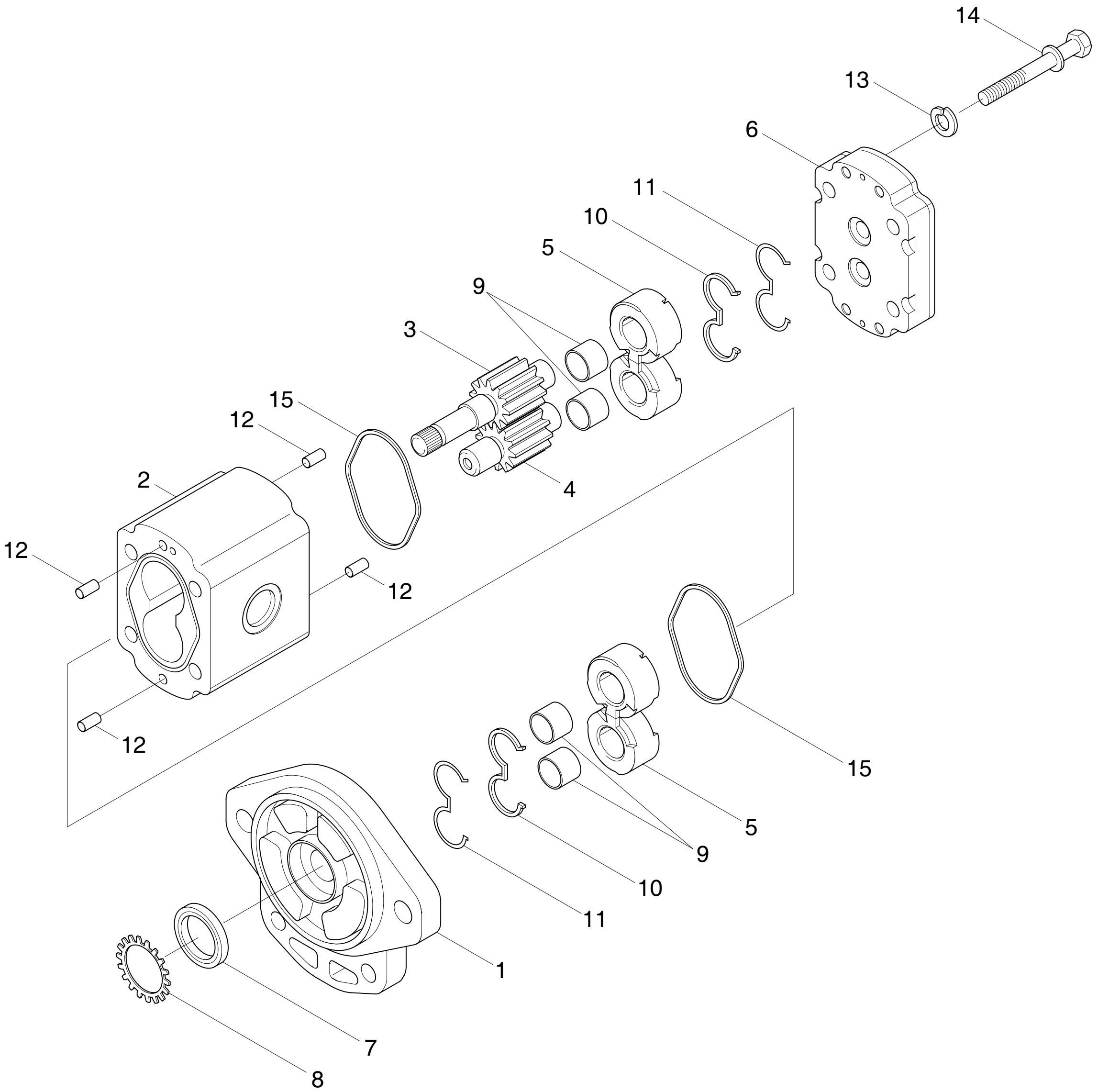


When the reach control lever is pulled backward, the spool on the third block is moved to reach in position.
The oil from hydraulic gear pump (1) flows into main control valve (2) and then goes to the small chamber of reach cylinder (6).
The oil at the large chamber of reach cylinder (6) returns to hydraulic tank (9) at the same time.
When this happens, the mast reaches in.

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

2. HYDRAULIC GEAR PUMP

1) STRUCTURE



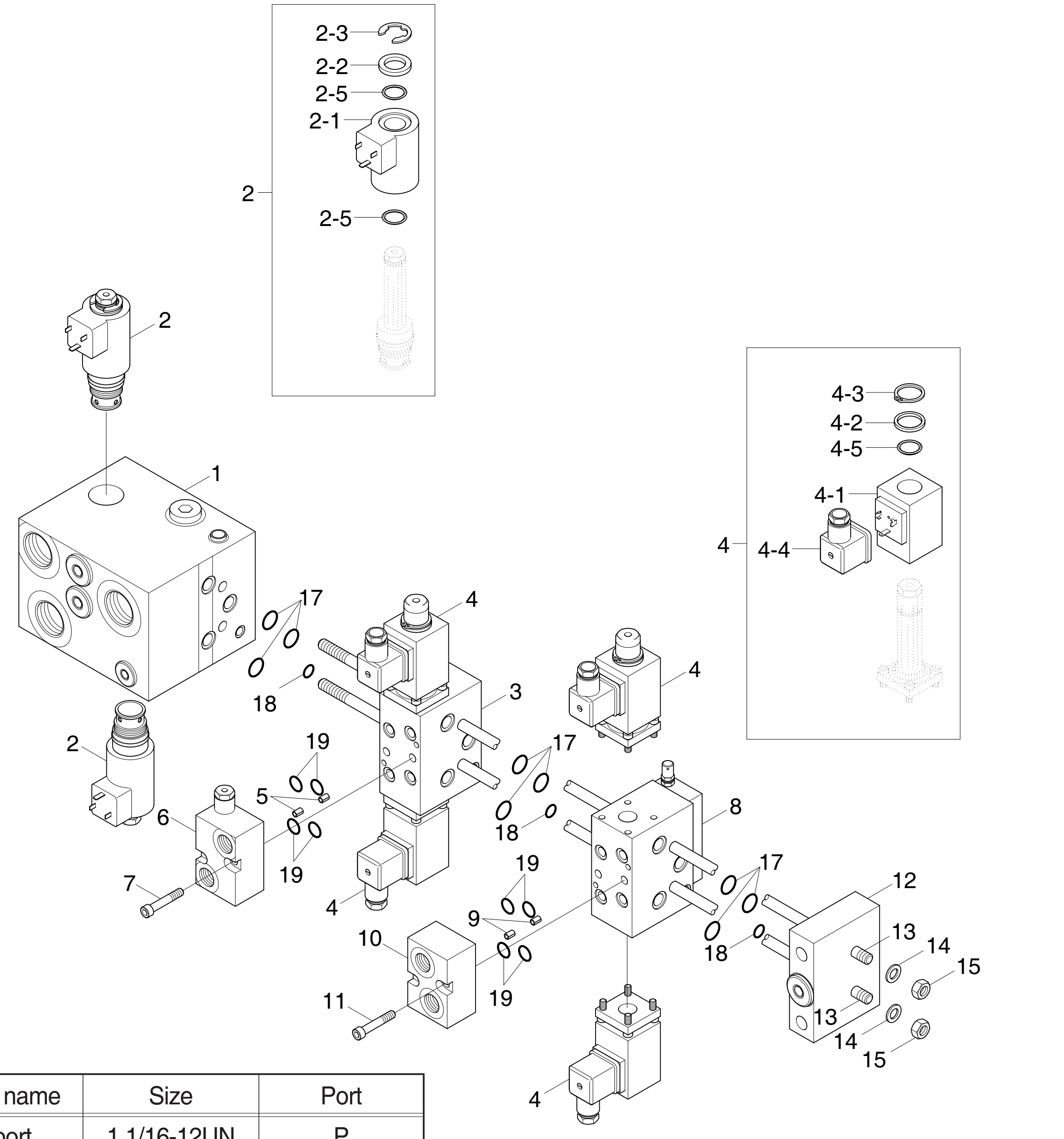
1	Housing	6	Rear cover	11	E-backup ring
2	Body	7	oil seal	12	Pin
3	Drive gear	8	Snap ring	13	Washer
4	Idle gear	9	DU bush	14	Hex bolt
5	Side plate	10	E-seal	15	O-ring

2) OPERATION

This pump comprises of an rear cover, a body, bushings and a housing bolted together with bolts. The gear journals are supported in side plate within pressure balanced bushings to give high volumetric and mechanical efficiencies.

3. MAIN CONTROL VALVE

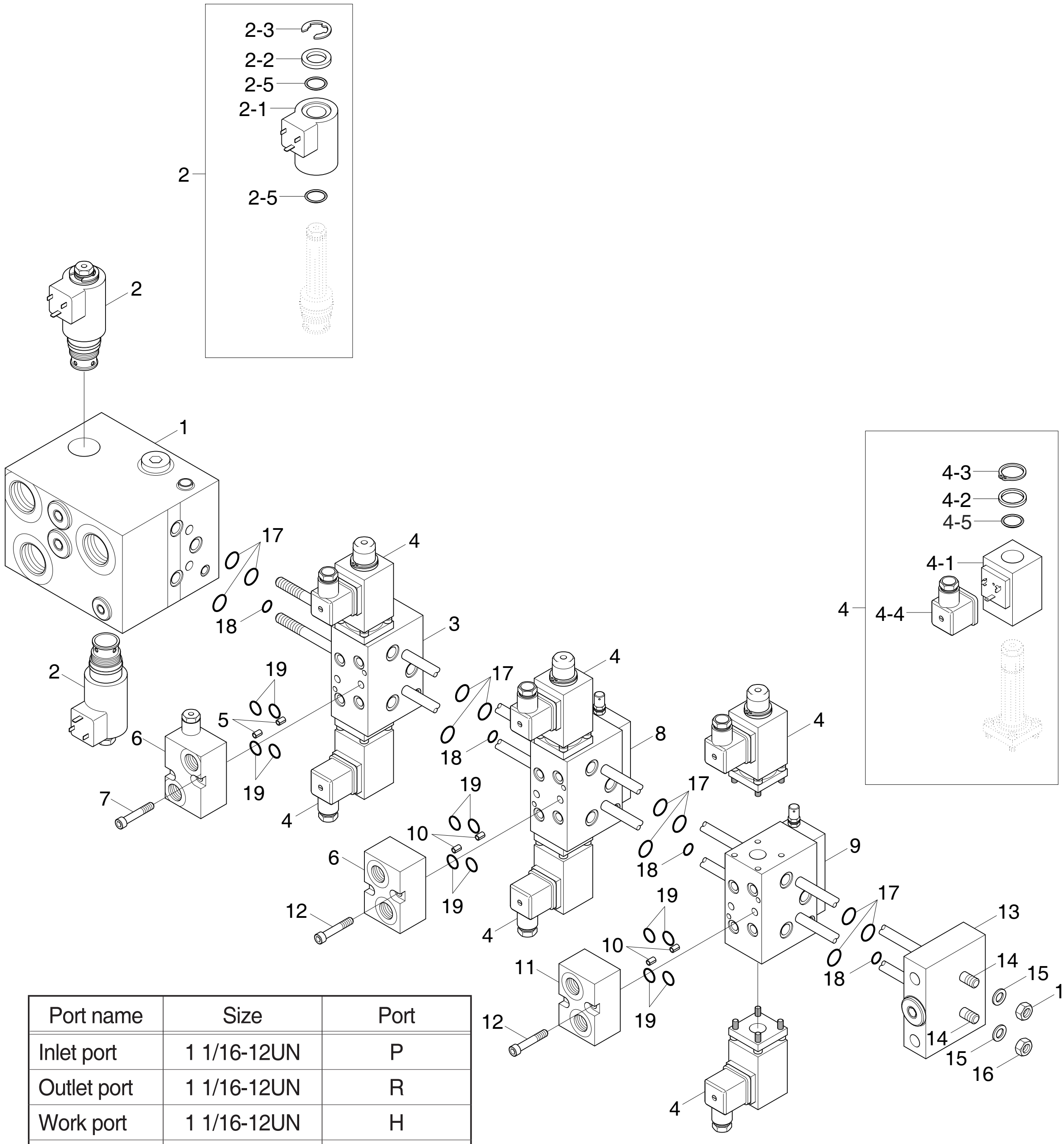
1) STRUCTURE (3 Spool)



Port name	Size	Port
Inlet port	1 1/16-12UN	P
Outlet port	1 1/16-12UN	R
Work port	1 1/16-12UN	H
Work port	9/16-18 UNF	A, B

1	Main block	4-1	Coil	10	Adapter
2	Solenoid valve	4-2	Disc	11	Head screw
2-1	EVI coil	4-3	Circlip	12	End block
2-2	Washer	4-4	Black plug	13	Tension rod
2-3	Lock washer	4-5	O-ring	14	Shape washer
2-4	Black plug	5	Roll pin	15	Hexagon nut
2-5	O-ring	6	Adapter	17	O-ring
3	Tilt block	7	Head screw	18	O-ring
4	Solenoid valve	8	Reach block	19	O-ring

2) STRUCTURE(4 Spool, Option)



Port name	Size	Port
Inlet port	1 1/16-12UN	P
Outlet port	1 1/16-12UN	R
Work port	1 1/16-12UN	H
Work port	9/16-18 UNF	A, B

1	Main block	4-2	Disc	11	Adapter
2	Solenoid valve	4-3	Circlip	12	Head screw
2-1	EVI coil	4-4	Black plug	13	End block
2-2	Washer	4-5	O-ring	14	Tension rod
2-3	Lock washer	5	Roll pin	15	Shape washer
2-4	Black plug	6	Adapter	16	Hexagon nut
2-5	O-ring	7	Head screw	17	O-ring
3	Tilt block	8	Reach block	18	O-ring
4	Solenoid valve	9	Auxiliary block	19	O-ring
4-1	Coil	10	Roll pin	20	Adapter

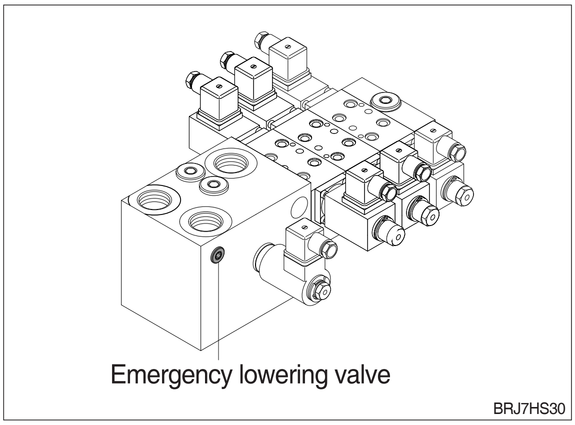
3) EMERGENCY LOWERING

In case of the mast cannot be lowered due to a problem in the controller, active the emergency lowering valve on the valve block with hexagonal wrench.

(1) Turn off the electric emergency switch.

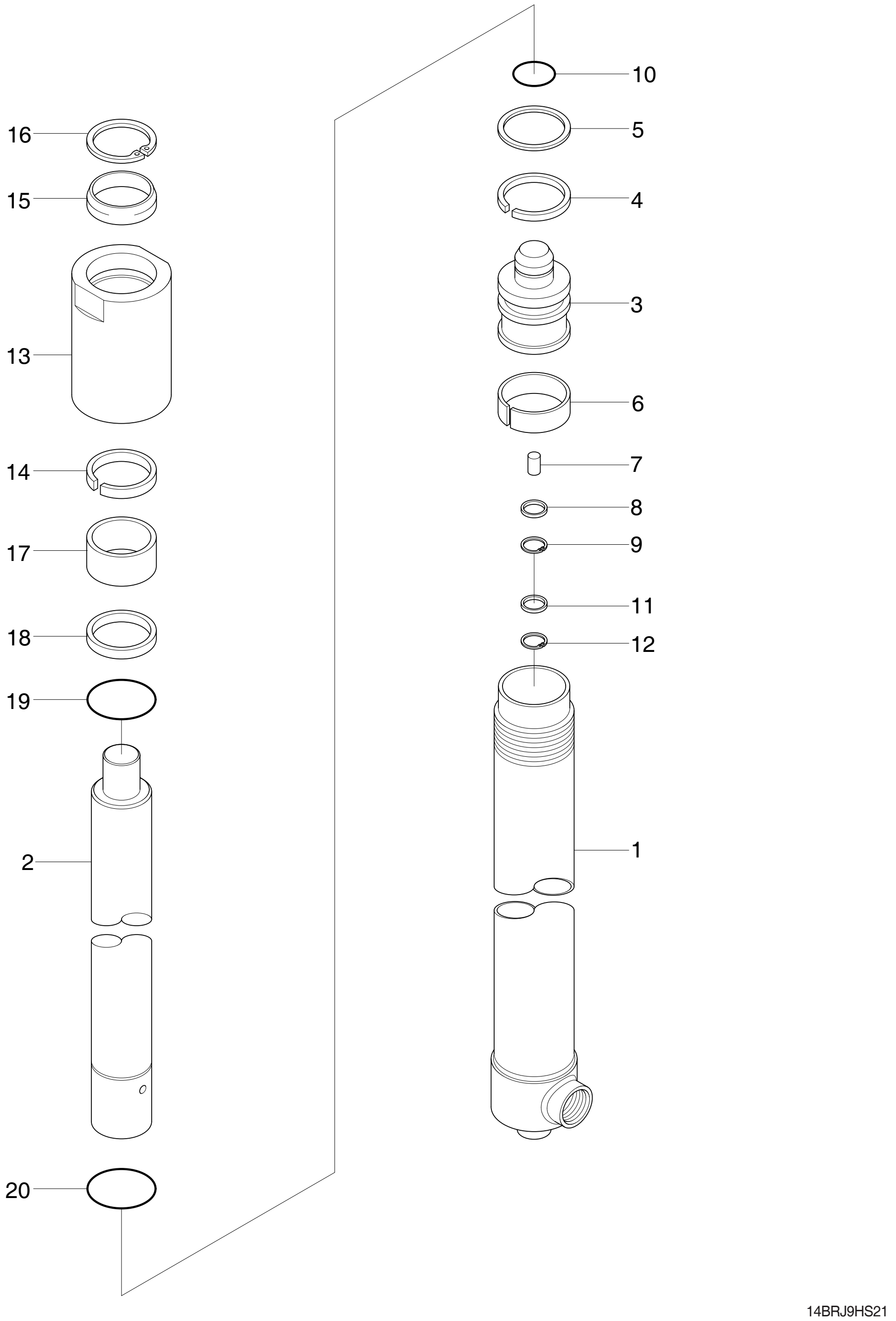
(2) Open the lowering valve using the 5mm hexagonal wrench. Slowly lower the mast and the load carriage.

(3) After lowering, close the emergency lowering valve.



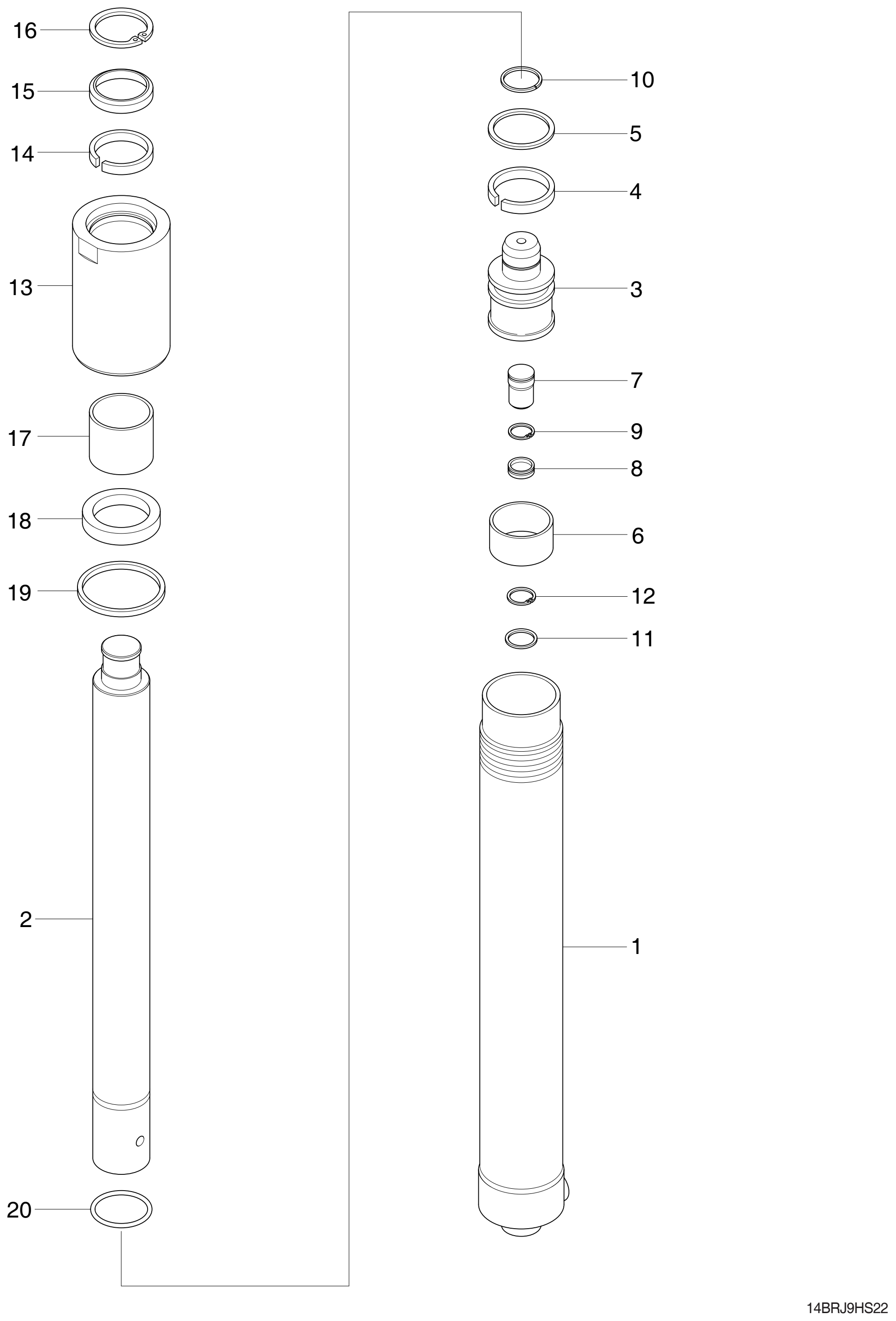
4. LIFT CYLINDER

1) 14/16BRJ-9



1	Tube assy	7	Stop ring	13	Rod bush
2	Rod	8	Cushion seal	14	Rod cover
3	Piston	9	Retaining ring	15	U-packing
4	U-packing	10	Spacer	16	Dust wiper
5	Back up ring	11	O-ring	17	O-ring
6	Wear ring	12	Stopper		

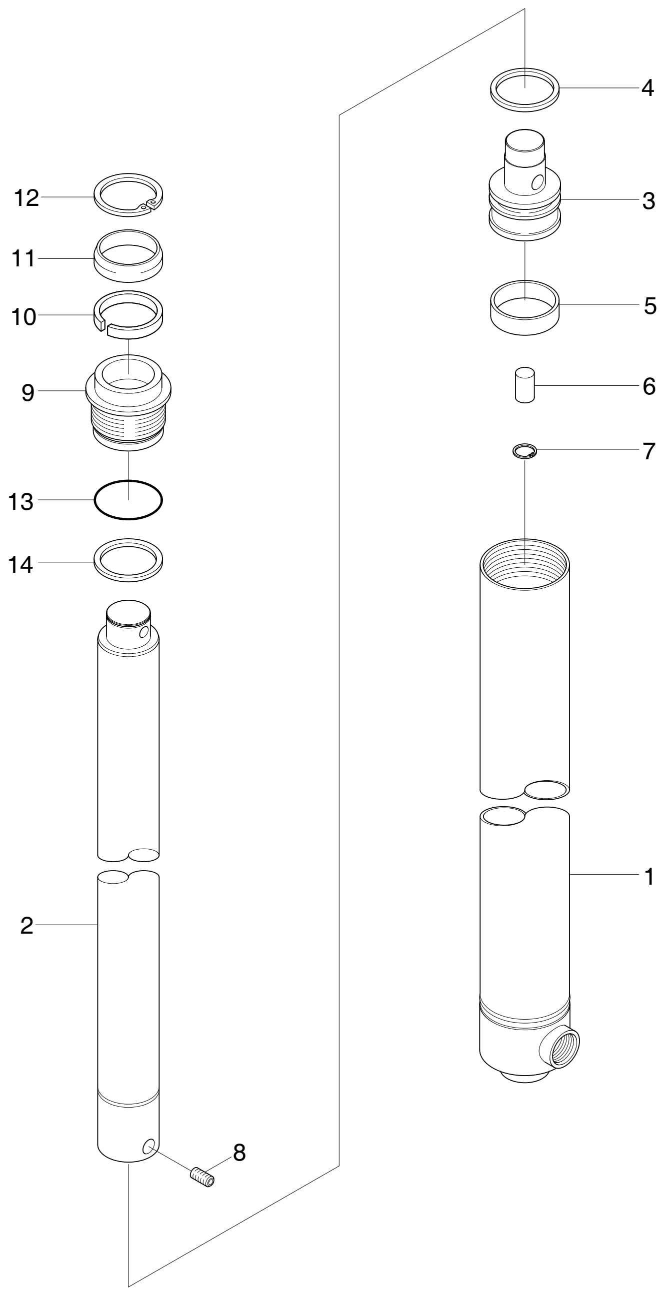
2) 20/25BRJ-9



1	Tube assy	8	Cushion seal	15	U-packing
2	Rod	9	Retaining ring	16	Dust wiper
3	Piston	10	Spacer	17	O-ring
4	U-packing	11	O-ring		
5	Back up ring	12	Stopper		
6	Wear ring	13	Rod bush		
7	Stop ring	14	Rod cover		

5. FREE LIFT CYLINDER

1) 14/16/20/25BRJ-9

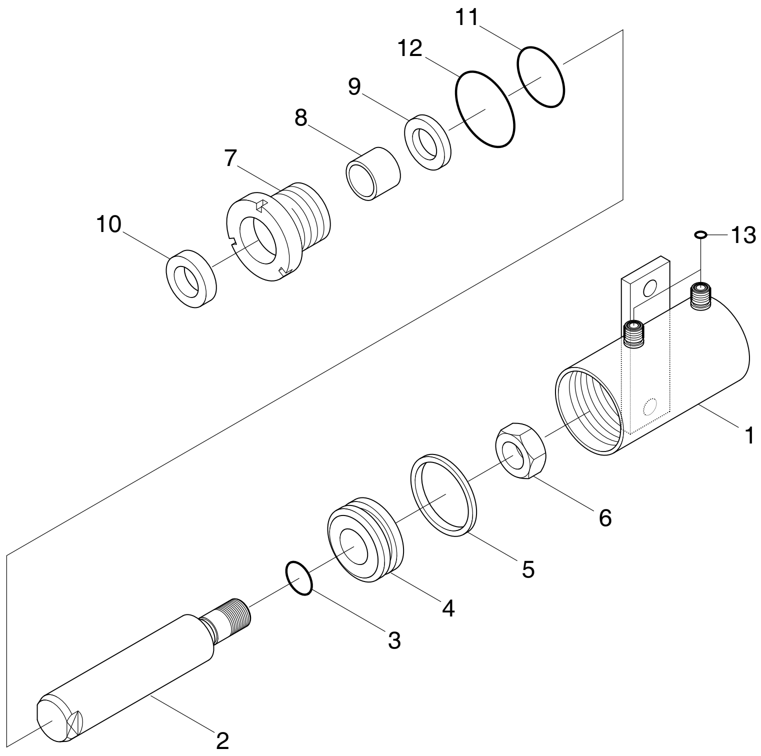


14BRJ9HS23

1	Tube assy	6	Check valve	11	Dust wiper
2	Rod	7	Retaining ring	12	Retaining ring
3	Piston	8	Set screw	13	O-ring
4	Piston seal	9	Rod cover	14	Back up ring
5	Set screw	10	U-packing		

6. TILT CYLINDER

1) 14/16/20/25BRJ-9

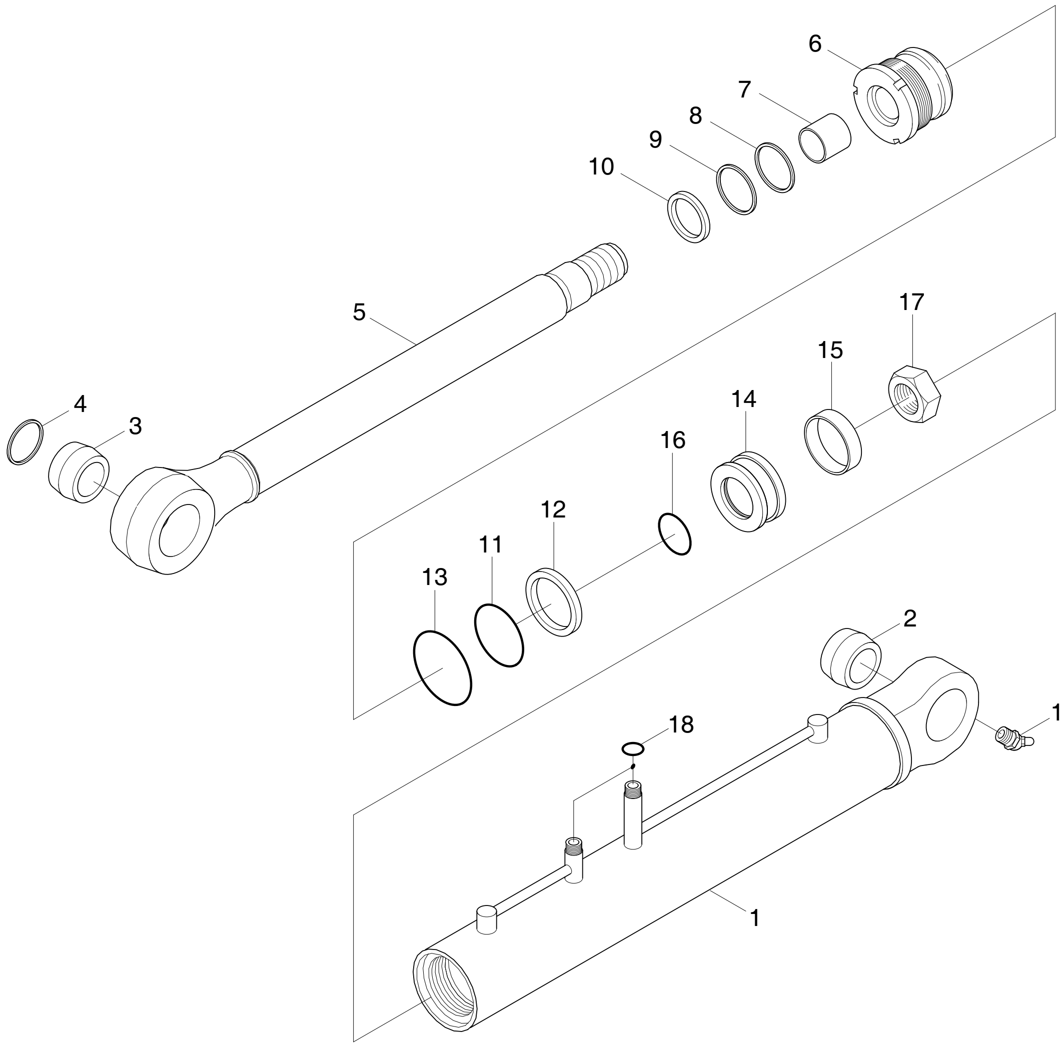


BRJ7HS25

1	Tube assy	6	Nylon nut	11	O-ring
2	Rod	7	Gland	12	O-ring
3	O-ring	8	DU bushing	13	O-ring
4	Piston	9	Rod seal		
5	Piston seal	10	Dust wiper		

7. REACH CYLINDER

1) 14/16/20/25BRJ-9



14BRJ9HS27

1	Tube assy	8	Buffer seal	15	Piston seal
2	Pin bush	9	U-packing	16	O-ring
2	Spherical bearing	10	Back up ring	17	Hex nut
4	Retaining ring	11	O-ring	18	O-ring
5	Rod assy	12	Back up ring	19	Grease nipple
6	Rod cover	13	O-ring		
7	Rod bush	14	Piston		

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

1) CHECK ITEM

(1) Check visually for deformation, cracks or damage of rod.

(2) Load maximum load, set mast vertical and raise 1m from ground. Wait for 10 minutes and measure hydraulic drift (amount forks move down and amount mast tilts forward).

·Hydraulic drift

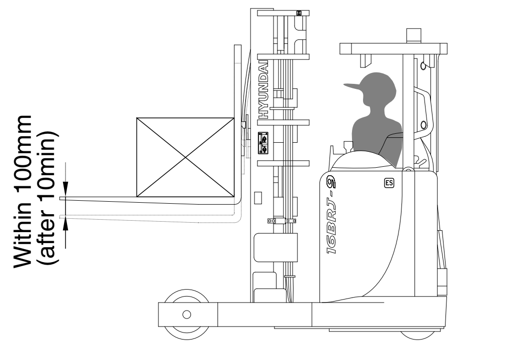
- Down (Downward movement of forks)
  : Within 100 mm (3.9 in)
- Forward (Extension of tilt cylinder)
  : Within 5°

If the hydraulic drift is more than the specified value, replace the control valve or cylinder packing.

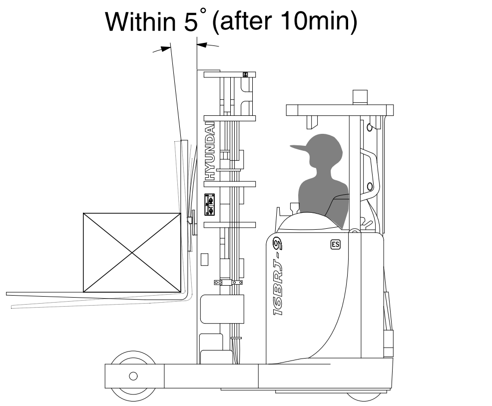
(3) Check that clearance between tilt cylinder bushing and mounting pin is within standard range.

mm (in)

Standard	Under 0.6 (0.02)



14BRJ9HS16

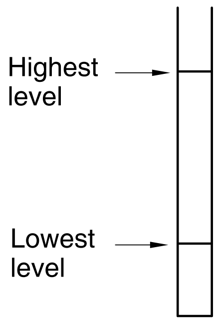


14BRJ9HS17

2) HYDRAULIC OIL

(1) Using dipstick, measure oil level, fill up oil if necessary.

(2) When changing hydraulic oil, clean suction strainer (screwed into outlet port pipe) and return filter(screwed into inlet pipe). Return filter uses paper element, so replace periodically (2000 hours).



B15AOM116

3) CONTROL VALVE

(1) Raise forks to maximum height and measure oil pressure.

Check that oil pressure is 210 kgf/cm^2.
(2990 psi)

2. TROUBLESHOOTING

1) SYSTEM

Problem	Cause	Remedy
Large fork lowering speed	·Seal inside control valve defective. ·Oil leaks from joint or hose. ·Seal inside cylinder defective.	·Replace spool or valve body. ·Replace. ·Replace packing.
Large spontaneous tilt of mast	·Tilting backward : Check valve defective. ·Tilting forward : tilt lock valve defective. ·Oil leaks from joint or hose. ·Seal inside cylinder defective.	·Clean or replace. ·Clean or replace. ·Replace. ·Replace seal.
Slow fork lifting or slow mast tilting	·Lack of hydraulic oil. ·Hydraulic oil mixed with air. ·Oil leaks from joint or hose. ·Excessive restriction of oil flow on pump suction side. ·Relief valve fails to keep specified pressure. ·Poor sealing inside cylinder. ·High hydraulic oil viscosity. ·Mast fails to move smoothly. ·Oil leaks from lift control valve spool. ·Oil leaks from tilt control valve spool.	·Add oil. ·Bleed air. ·Replace. ·Clean filter. ·Adjust relief valve. ·Replace packing. ·Change to ISO VG 46. ·Adjust roll to rail clearance. ·Replace spool or valve body. ·Replace spool or valve body.
Hydraulic system makes abnormal sounds	·Excessive restriction of oil flow pump suction side. ·Gear or bearing in hydraulic pump defective.	·Clean filter. ·Replace gear or bearing.
Control valve lever is locked	·Foreign matter jammed between spool and valve body. ·Valve body defective.	·Clean. ·Tighten body mounting bolts uniformly.
High oil temperature	·Lack of hydraulic oil. ·High oil viscosity. ·Oil filter clogged.	·Add oil. ·Change to SAE80W-90LSD, class API GL-5 gear oil. ·Clean filter.

2) HYDRAULIC GEAR PUMP

Problem	Cause	Remedy
Pump does not develop full pressure	·System relief valve set too low or leaking. ·Oil viscosity too low. ·Pump is worn out.	·Check system relief valve for proper setting. ·Change to proper viscosity oil. ·Repair or replace pump.
Pump will not pump oil	·Reservoir low or empty. ·Suction strainer clogged.	·Fill reservoir to proper level. ·Clean suction strainer.
Noisy pump caused by cavitation	·Oil too thick. ·Oil filter plugged. ·Suction line plugged or too small.	·Change to proper viscosity. ·Clean filters. ·Clean line and check for proper size.
Oil heating	·Oil supply low. ·Contaminated oil. ·Setting of relief valve too high or too low. ·Oil viscosity too low.	·Fill reservoir to proper level. ·Drain reservoir and refill with clean oil. ·Set to correct pressure. ·Drain reservoir and fill with proper viscosity.
Foaming oil	·Low oil level. ·Air leaking into suction line. ·Wrong kind of oil.	·Fill reservoir to proper level. ·Tighten fittings, check condition of line. ·Drain reservoir, fill with non-foaming oil.
Shaft seal leakage	·Worn shaft seal. ·Worn shaft in seal area.	·Replace shaft seal. ·Replace drive shaft and seal.

3) MAIN RELIEF VALVE

Problem	Cause	Remedy
Can't get pressure	·Poppet D, E or K stuck open or contamination under seat.	·Check for foreign matter between poppets D, E or K and their mating parts. Parts must slide freely.
Erratic pressure	·Pilot poppet seat damaged. ·Poppet C sticking in D.	·Replace the relief valve. ·Clean and remove surface marks for free movement.
Pressure setting not correct	·Normal wear. Lock nut & adjust screw loose.	·See ★Test of main control valve.
Leaks	·Damaged seats. ·Worn O-rings. ·Parts sticking due to contamination.	·Replace the relief valve. ·Install seal and spring kit. ·Disassemble and clean.

★ A good pressure gauge must be installed in the line which is in communication with the main relief.
A load must be applied in a manner to reach the set pressure of the main relief unit.
Then, follow these steps:

· Loosen lock nut.
· Set adjusting nut to desired pressure setting.
· If desired pressure setting cannot be achieved, tighten or loosen the adjusting screw as required.
· Tighten lock nut.
· Retest in similar manner as above.

4) LIFT CYLINDER

Problem	Cause	Remedy
Oil leaks out from rod cover through rod	·Foreign matters on packing. ·Unallowable score on rod. ·Unusual distortion of dust seal. ·Chrome plating is striped.	·Replace packing. ·Smooth rod surface with an oil stone. ·Replace dust seal. ·Replace rod.
Oil leaks out from cylinder rod cover thread	·O-ring damaged.	·Replace O-ring.
Rod spontaneously retract	·Scores on inner surface of tube. ·Unallowable score on the inner suface of tube. ·Foreign matters in piston seal.	·Smooth rod surface with an oil stone. ·Replace cylinder tube. ·Replace piston seal.
Wear (clearance between cylinder tube and wear ring)	·Excessive clearance between cylinder tube and wear ring.	·Replace wear ring.
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.

GROUP 3 DISASSEMBLY AND ASSEMBLY

1. HYDRAULIC GEAR PUMP

※ Tools required

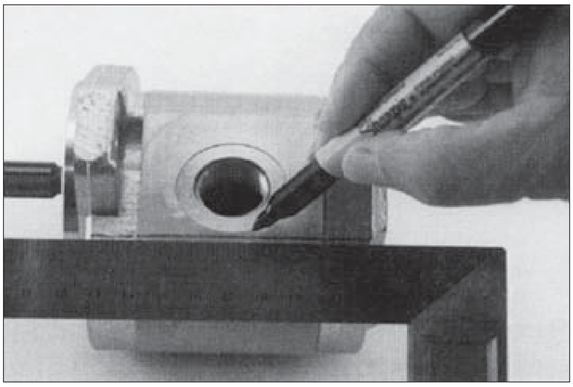
·Metric socket set
·Internal snap ring pliers
·Shaft seal sleeve
·Torque wrench

(1) It is very important to work in a clean work area when repairing hydraulic products. Plug ports and wash exterior of pump with a proper cleaning solvent before continuing.

(2) Remove port plugs and drain oil from pump.

(3) Use a permanent marker pen to mark a line across the mounting flange, gear housing and end cover. This will assure proper reassembly and rotation of pump.

(4) Remove key from drive shaft if applicable.

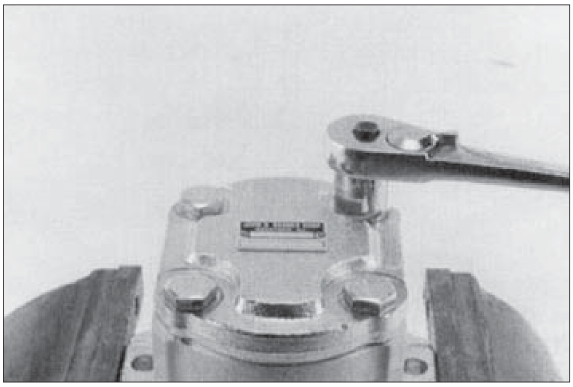


PUMP 01

(5) Clamp mounting flange in a protected jaw vise with pump shaft facing down.

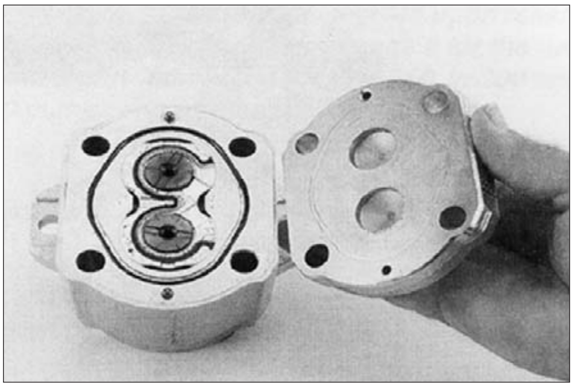
(6) Loosen the four metric hexagon head bolts.

(7) Remove pump from vise and place on clean work bench, remove the four hexagon head bolts and spacers applicable.



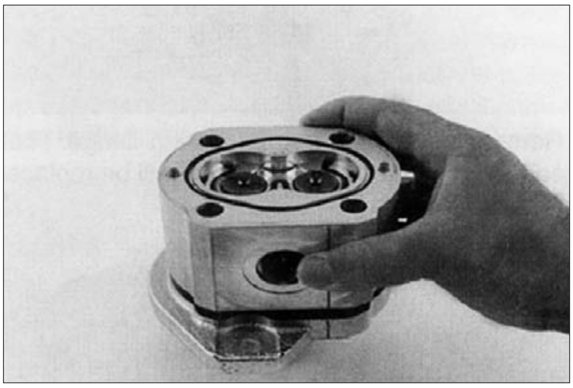
PUMP 02

(8) Lift and remove end cover.



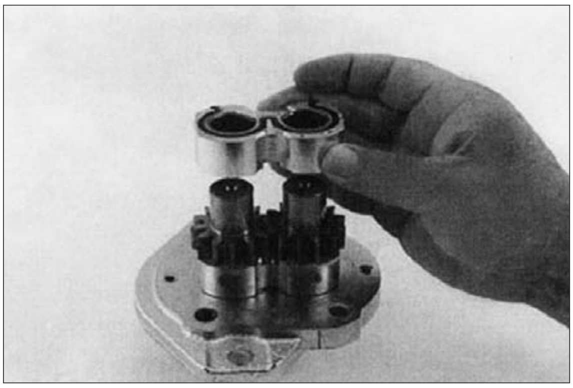
PUMP 03

(9) Carefully remove gear housing and place on work bench. Make sure the rear bearing block remains on the drive and idler shafts.



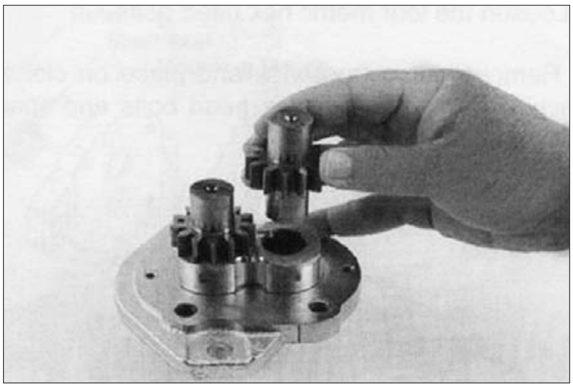
PUMP 04

(10) Remove rear bearing block from drive and idler shafts.



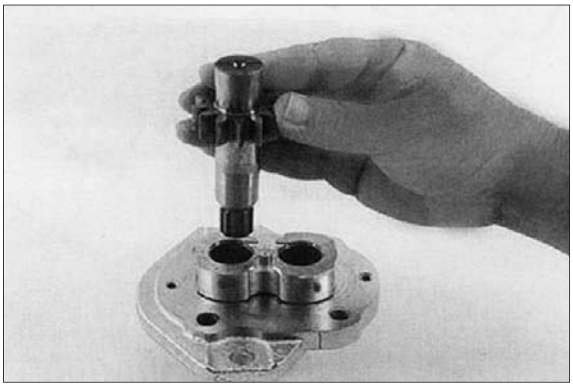
PUMP 05

(11) Remove idler shaft from bearing block.



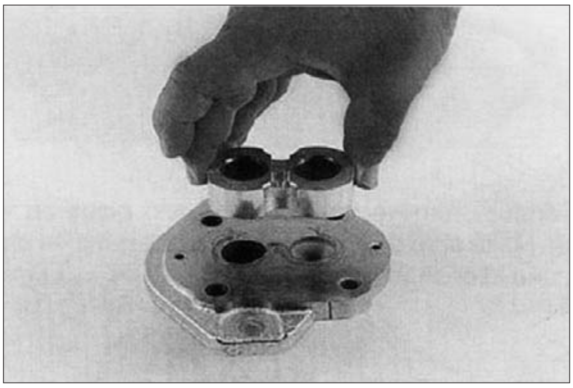
PUMP 06

(12) Remove drive shaft from mounting flange. There is no need to protect the shaft seal as it will be replaced as a new item.



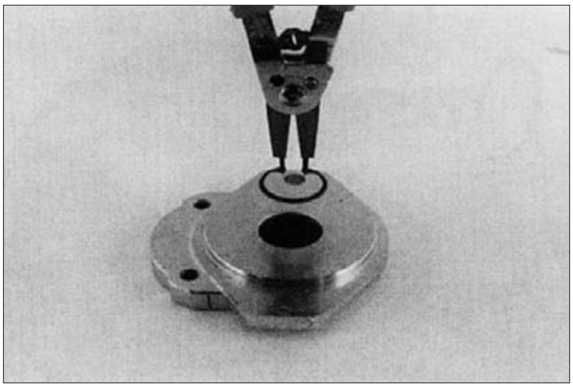
PUMP 07

(13) Remove the front bearing block.



PUMP 08

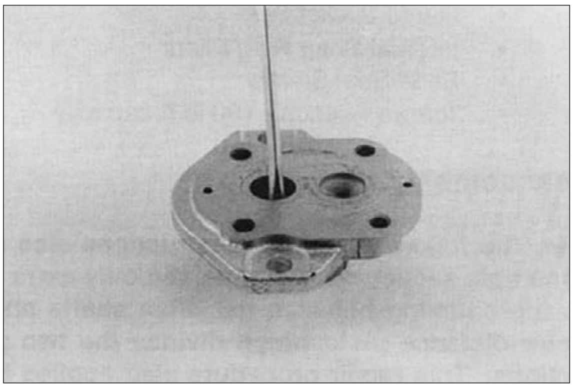
(14) Turn mounting flange over, with shaft seal up, and remove the retaining ring with proper snap ring pliers.



PUMP 09

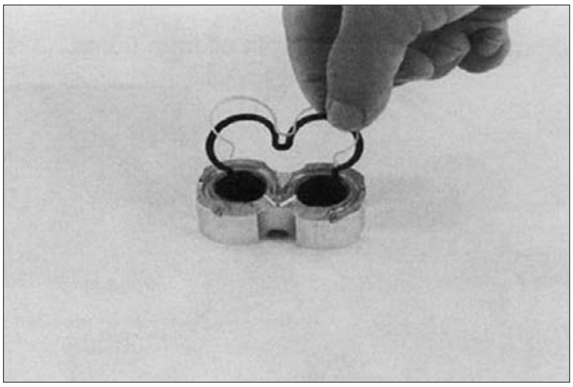
(15) Remove the oil seal from mounting flange, be careful not to mar or scratch the seal bore.

(16) Remove the dowel pins from the gear housing. Do not lose pins.



PUMP 10

(17) Remove seals from both bearing blocks and discard.



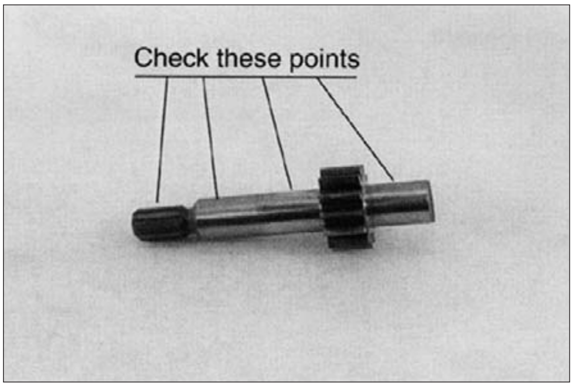
PUMP 11

2) INSPECT PARTS FOR WEAR

(1) Clean and dry all parts thoroughly prior to inspection. It is not necessary to inspect the seals as they will be replaced as new items.

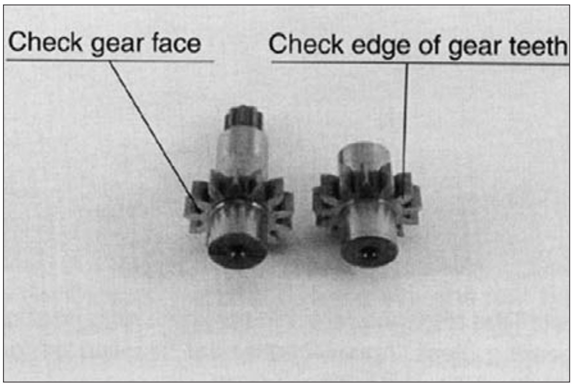
(2) Check drive shaft spline for twisted or broken teeth, check keyed drive shaft for broken or chipped keyway. No marks or grooves on shaft in seal area, some discoloration of shaft is allowable.

(3) Inspect both the drive gear shaft and idler gear shafts at the bearing points and seal area for rough surfaces and excessive wear.



PUMP 12

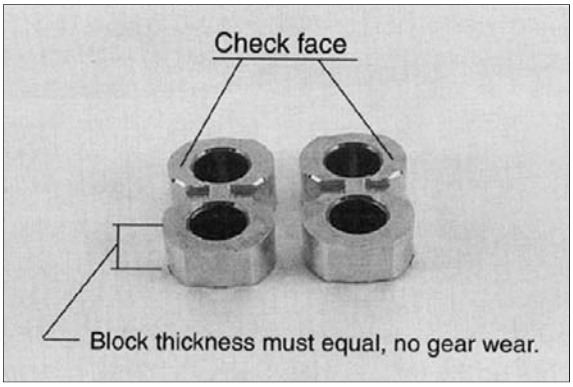
(4) Inspect gear face for scoring or excessive wear. If the face edge of gear teeth are sharp, they will mill into the bearing blocks. If wear has occurred, the parts are unusable.



PUMP 13

(5) Inspect bearing blocks for excessive wear or scoring on the surfaces which are in contact with the gears. Also inspect the bearings for excessive wear or scoring.

(6) Inspect the area inside the gear housing. It is normal for the surface inside the gear housing to show a clean "wipe" on the inside surface on the intake side. There should not be excessive wear or deep scratches and gouges.



PUMP 14

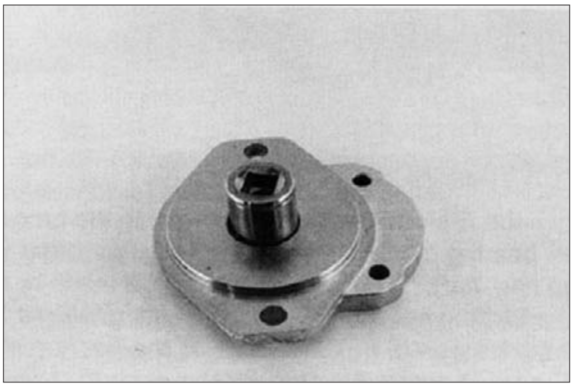
※ General information
It is important that the relationship of the mounting flange, bearing blocks and gear housing is correct. Failure to properly assemble this pump will result with little or no flow at rated pressure.

※ This pump is not bi-rotational.

3) ASSEMBLY

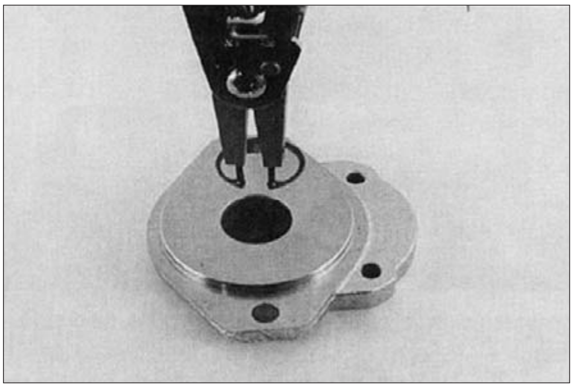
※ **New seals should be installed upon reassembly of pump.**

(1) Install new shaft seal in mounting flange with part number side facing outboard. Press the seal into the seal bore until the seal reaches the bottom of the bore. Uniform pressure must be used to prevent misalignment or damage to the seal.



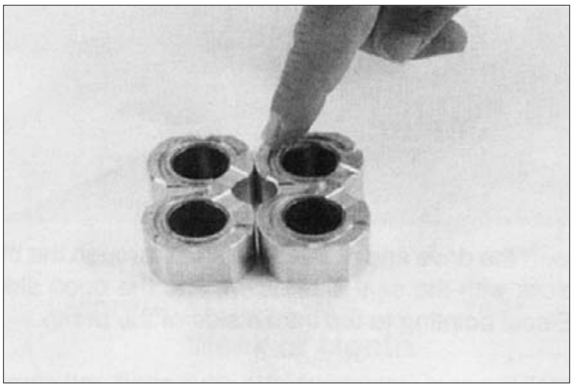
PUMP 15

(2) Install retaining ring in groove in seal bore of mounting flange.



PUMP 16

(3) Place front and back bearing blocks on a clean surface with the E-seal grooves facing up. Apply a light coating of petroleum jelly in the grooves. Also coat the E-seal and backup with the petroleum jelly, this will help keep the seals in place during assembly.

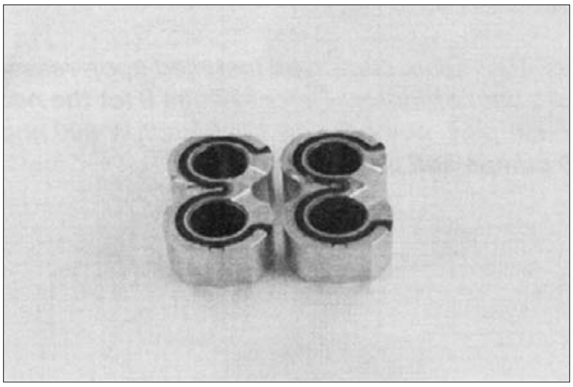


PUMP 17

(4) Place the E-seals, flat side outward, into the grooves in both bearing blocks. Follow by carefully placing the backup ring, flat side outward, in the groove made by the E-seal and the groove in the bearing block.

(5) Place mounting flange, with shaft seal side down, on a clean flat surface.

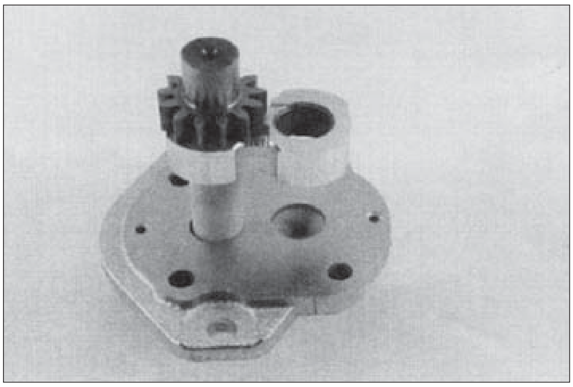
(6) Apply a light coating of petroleum jelly to the exposed face of the front bearing block.



PUMP 18

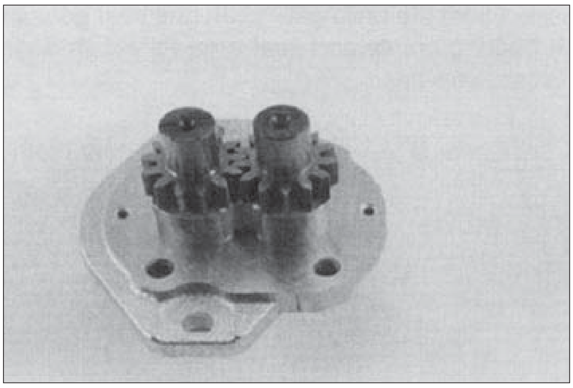
(7) Insert the drive end of the drive shaft through the bearing block with the seal side down, and the open side of the E-seal pointing to the intake side of the pump.

(8) Install the seal sleeve over the drive shaft and carefully slide the drive shaft through the shaft seal. Remove the seal sleeve from shaft.



PUMP 19

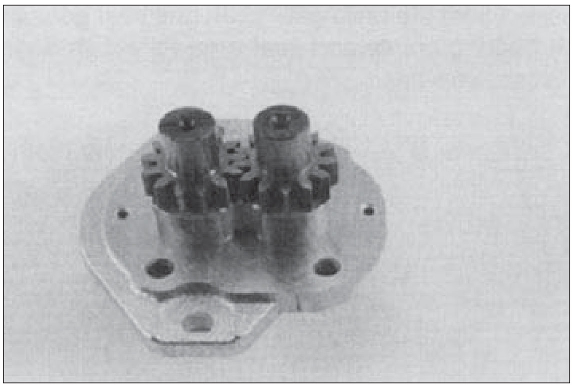
(9) Install the idler gear shaft in the remaining position in the bearing block. Apply a light coat of clean oil to the face of the drive and idler gears.



PUMP 20

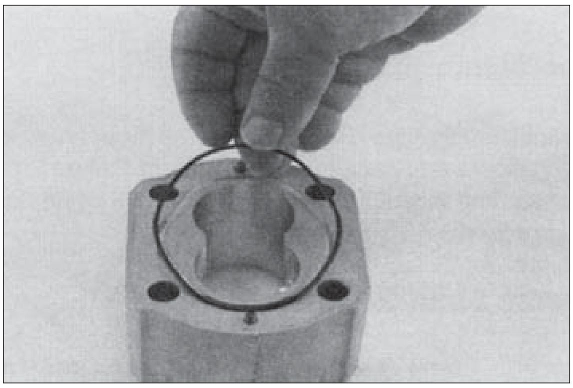
(10) Pick up the rear bearing block, with seal side up and with open end of the E-seal facing the intake side of the pump, place over the drive and idler gear shafts.

(11) Install two dowel pins in the holes in the mounting flange or two long dowel pins through gear housing if pump is a multiple section pump.



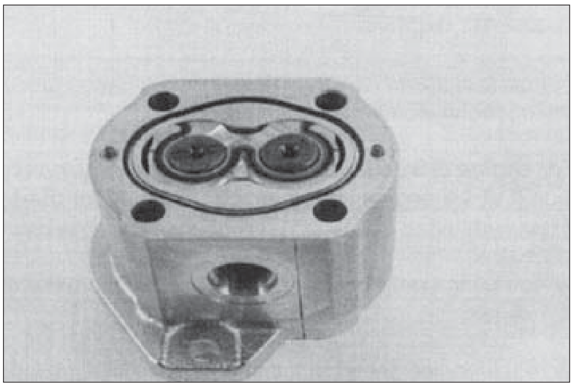
PUMP 21

(12) To install the O-rings in the gear housing, apply a light coating of petroleum jelly in the grooves on both sides of the gear housing.
Also coat the new O-ring and install them in the grooves.



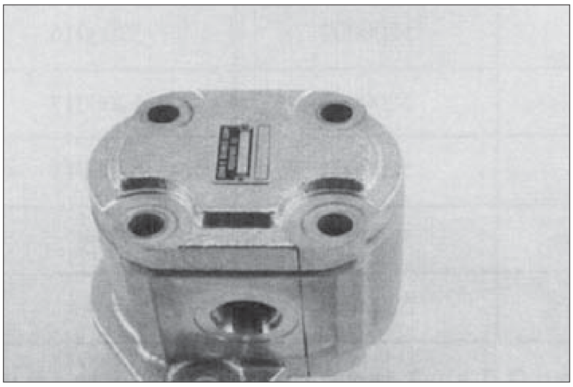
PUMP 22

(13) Gently slide the gear housing over the rear bearing block assembly, slide housing down until the housing engages the dowel pins. Press firmly in place with hands, do not force or use any tool.
Check to make sure the intake port in the housing in on the same side as the open end of the E-seal and that the marked lines on the mounting flange and gear housing are in alignment.

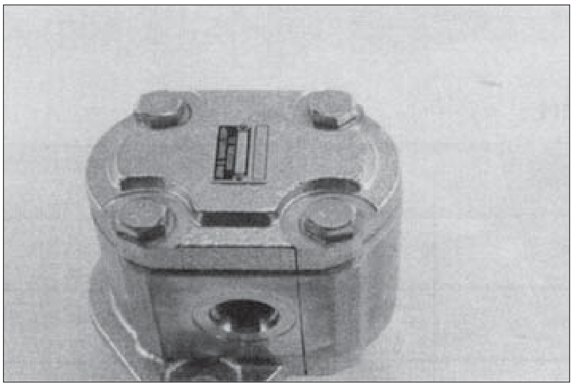

PUMP 23

(14) The surface of the rear bearing block should be slightly below the face of the gear housing. If the bearing block sits higher then the rear face of the gear housing then the E-seal or O-ring have shifted out of the groove. If this is the case, remove the gear housing and check for proper seal installation.

(15) Install the two remaining dowel pins in the rear of the gear housing and place the end cover over the back of the pump.


PUMP 24

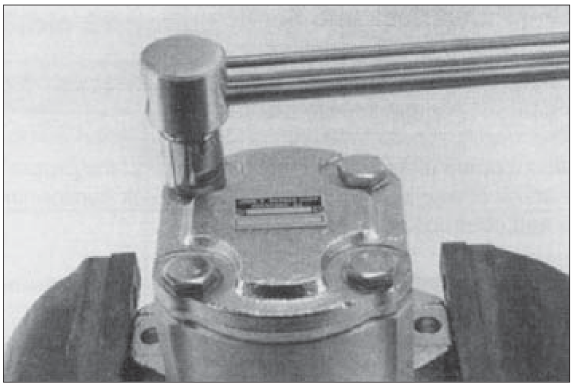
(16) Install the four spacers and hexagon head bolts through the bolt holes in the end cover, hand tighten.


PUMP 25

(17) Place mounting flange of the pump back in the protected jawed vise and alternately torque the bolts.
 ·Tighten torque : 6~7 kgf·m
 (43.4~50.6 lbf·ft)

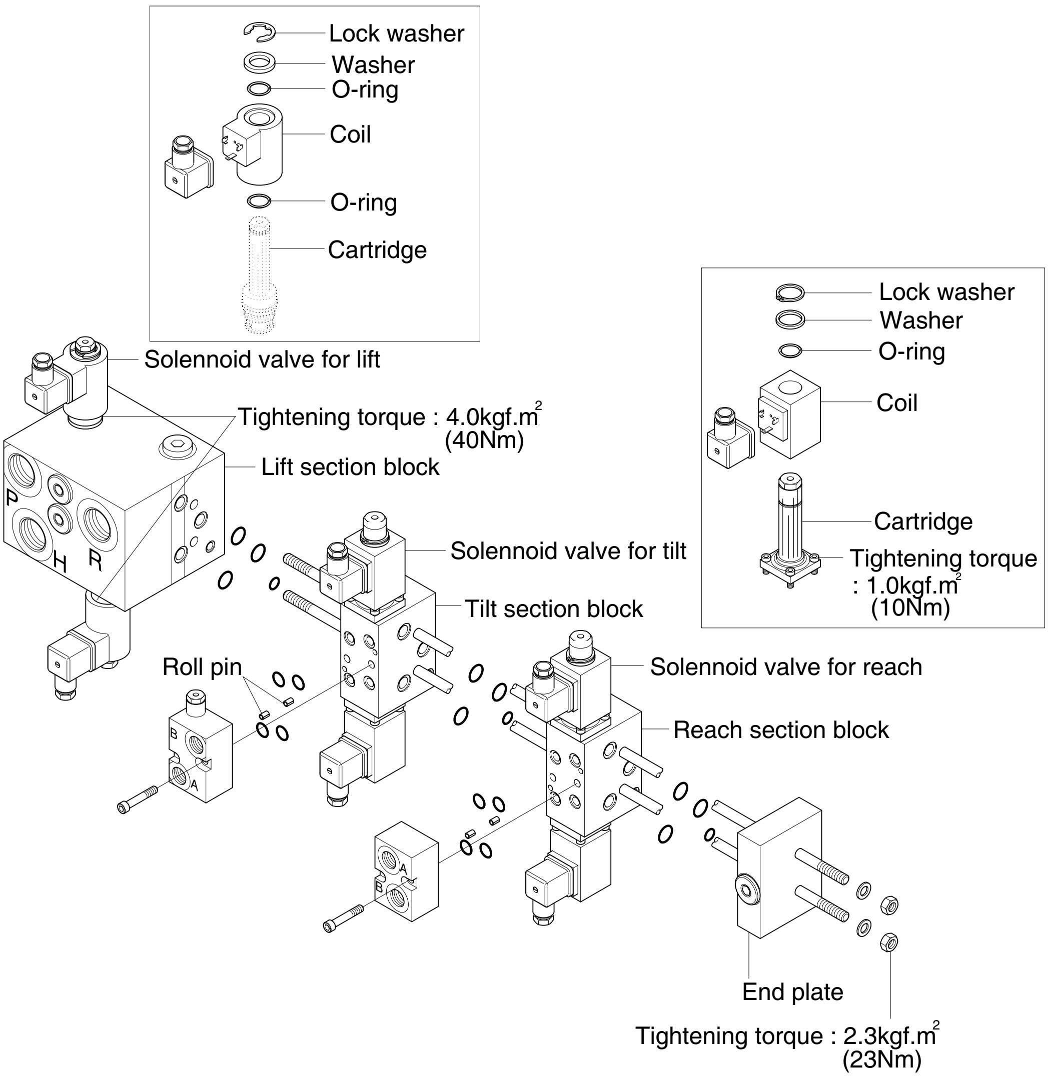
(18) Remove pump from vise.

(19) Place a small amount of clean oil in the inlet of the pump and rotate the drive shaft away from the inlet one revolution. If the drive shaft binds, disassemble the pump and check for assembly problems, then reassemble the pump.



PUMP 26

2. MAIN CONTROL VALVE
(14BRJ-9: ~#0058, 16BRJ-9 : ~#0241, 20BRJ-9 : ~#0112, 25BRJ-9 : ~#0036)



BRJ7HS13

1) ASSEMBLY INSTRUCTION

(1) General

① Ensure that the assembly area will be clean and free of contamination.
Use a flat (within 0.5 ㎜) work surface when bolting the valve sections together.
Use calibrated torque wrenches and instrumentation.

(2) Block subassembly

① Attach all the O-ring to the appropriate grooves between the spool section.
② Stack the valve section as above picture on a flat surface.
③ Insert all the tie rod through the drilled holes in each of the housings.
④ Press the sections together being careful not to damage sealing surface or seals.
⑤ Install nuts to tie rod and progressively torque in a circular pattern until reaching a torque of 2.3 kgf·cm² (23 Nm) on all the rods.

(3) Lift block solenoid assembly

① The solenoid is installed upper side and below side cavities in lift block.
Torque to 4.1 kgf·cm² (40 Nm)

② Install the O-ring, coil, O-ring and washer to the assemblied cartridge.

③ Insert the lock washer to the groove of the cartridge.

(4) Tilt & Auxiliary section assembly

① The solenoid is installed upper side and below side in tilt & auxiliary block with bolts.
Torque to 1 kgf·m (10 Nm)

② Install the coil, O-ring and washer to the assemblied cartridge.

③ Insert the snap ring to the groove of the cartridge.

④ Insert the roll pin to the pin hole on the front side of each block.

⑤ Place the O-rings in the O-ring grooves.

⑥ Install the ancillary blocks to the each body with bolts.

2) DISASSEMBLY INSTRUCTION

(1) General

① Disassemble the valve sections on the flat working surface.

② Ensure that the disassembly area will be clean and free of contamination.

③ Keep the disassembly area neat to avoid loss or damage of parts.

(2) Perform the assembly in reverse order

① Remove the solenoid valves and ancillary blocks from the main blocks.

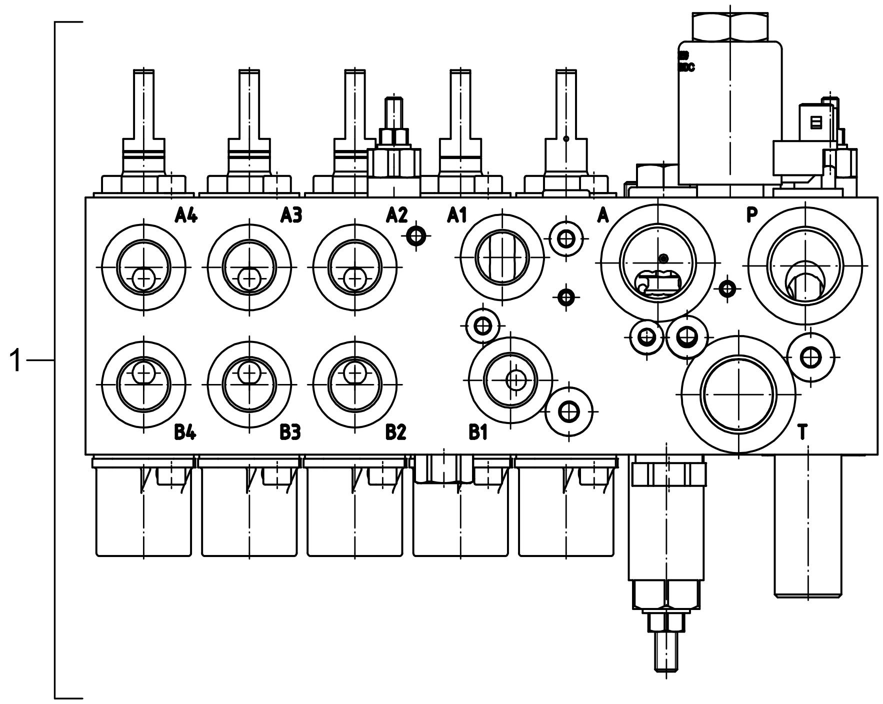
② Loosen the tie-rods from the valve section.

③ Remove the seals between valve section.

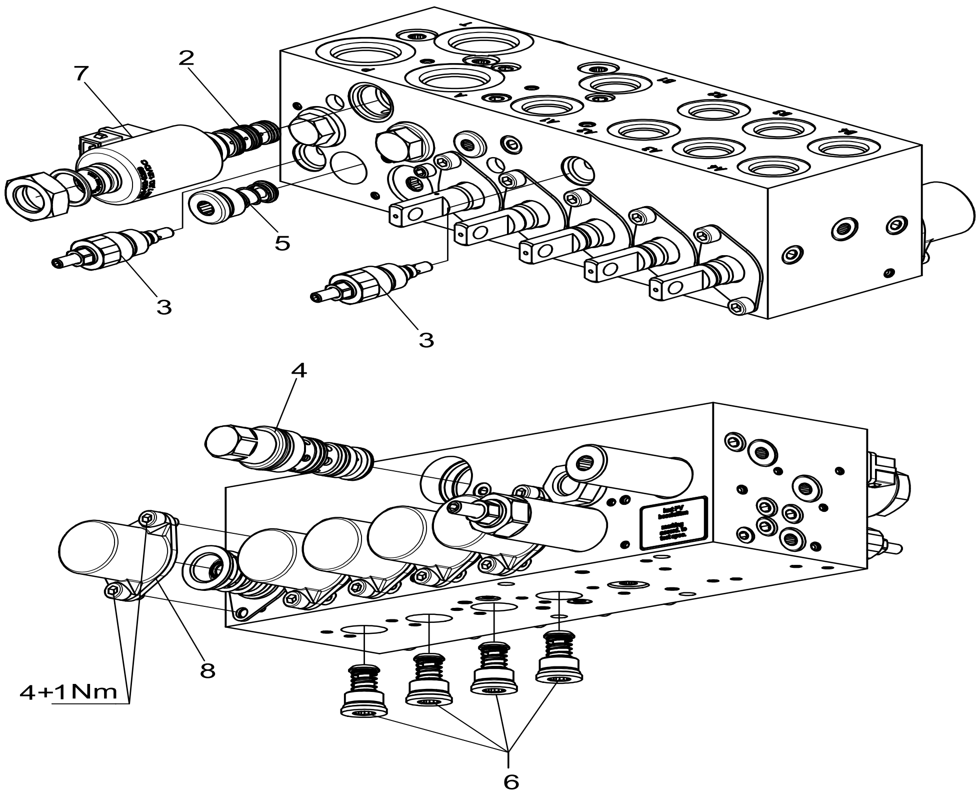
④ Valve components are precision items, and care must be taken when handling them to avoid damage or the introduction of contamination that could adversely affect performance.

2-1. MAIN CONTROL VALVE
(14BRJ-9: #0059~, 16BRJ-9 : #0242~, 20BRJ-9 : #0113~, 25BRJ-9 : #0037~)

1) STRUCTURE (5 SPOOL, with OPSS, BUCHHOLZ)

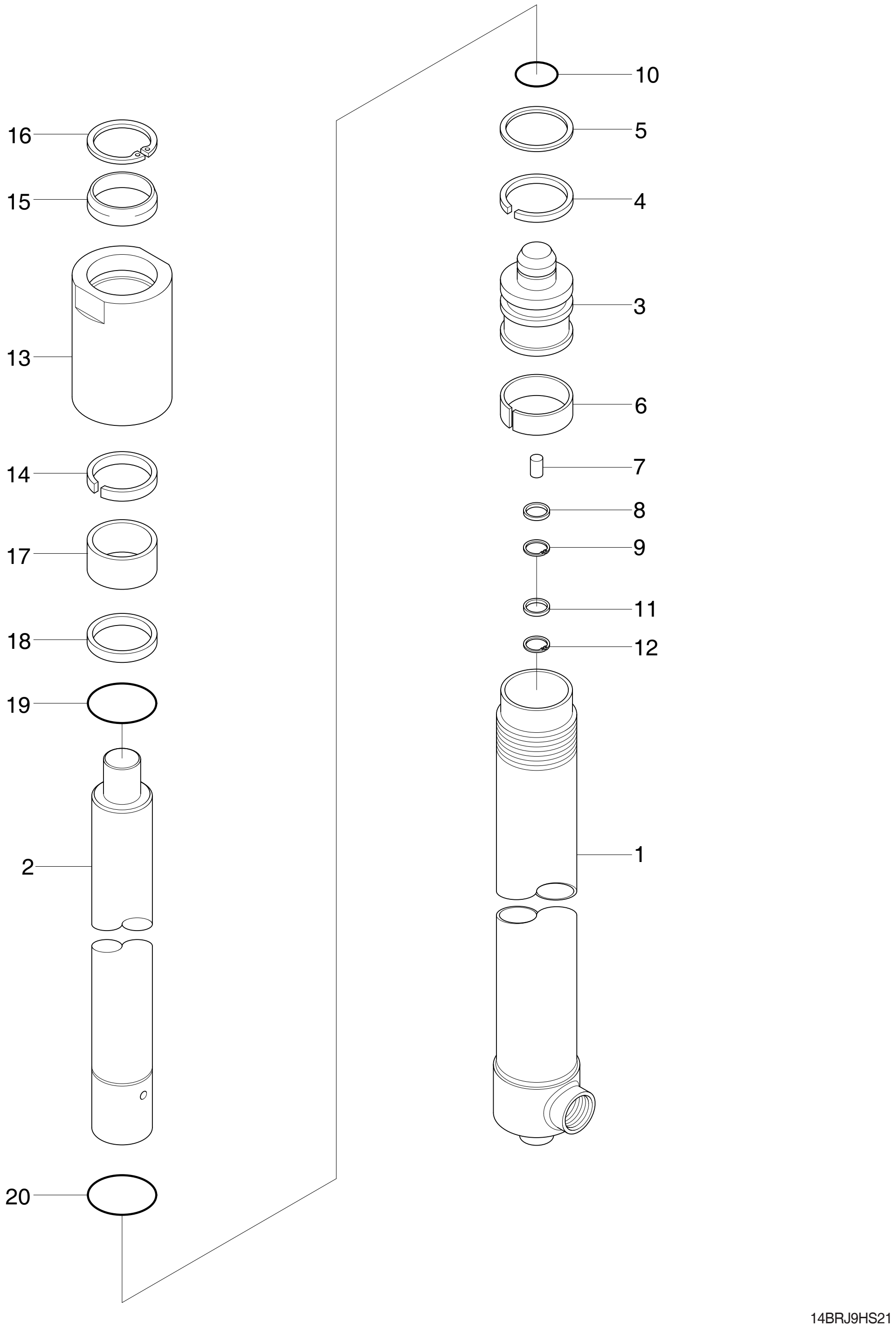


1	Control V/V	4	Overcenter V/V	7	Solenoid coil 12V
2	Directional V/V	5	Check V/V NG12	8	Spring cap with screws
3	Pressure relief V/V NG4	6	Check V/V NG10.5		



3. LIFT CYLINDER

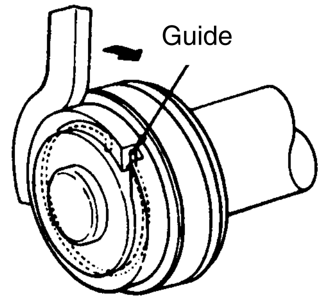
1) STRUCTURE



1	Tube assy	7	Stop ring	13	Rod bush
2	Rod	8	Cushion seal	14	Rod cover
3	Piston	9	Retaining ring	15	U-packing
4	U-packing	10	Spacer	16	Dust wiper
5	Back up ring	11	O-ring	17	O-ring
6	Wear ring	12	Stopper		

2) DISASSEMBLY

(1) Hold the cylinder tube in a vice, loosen the cylinder head and remove it.
Remove the spacer from the cylinder tube and knock out the bushing. Hook a wrench in the hole in the retainer at the piston end and turn. Lever up the edge of the guide, then turn the guide in again and the guide can be removed.



L15C3HS25

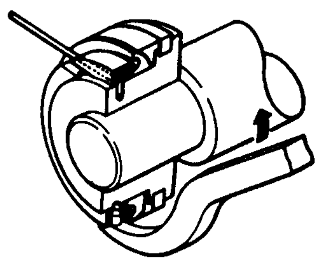
3) CHECK AND INSPECTION

mm (in)

Check item	Standard size	Repair limit	Remedy
Clearance between cylinder rod & bushing	0.072~0.288 (0.003~0.011)	0.5 (0.020)	Replace bushing
Clearance between piston ring & tube	0.05~0.030 (0.002~0.012)	0.5 (0.020)	Replace piston ring

4) ASSEMBLY

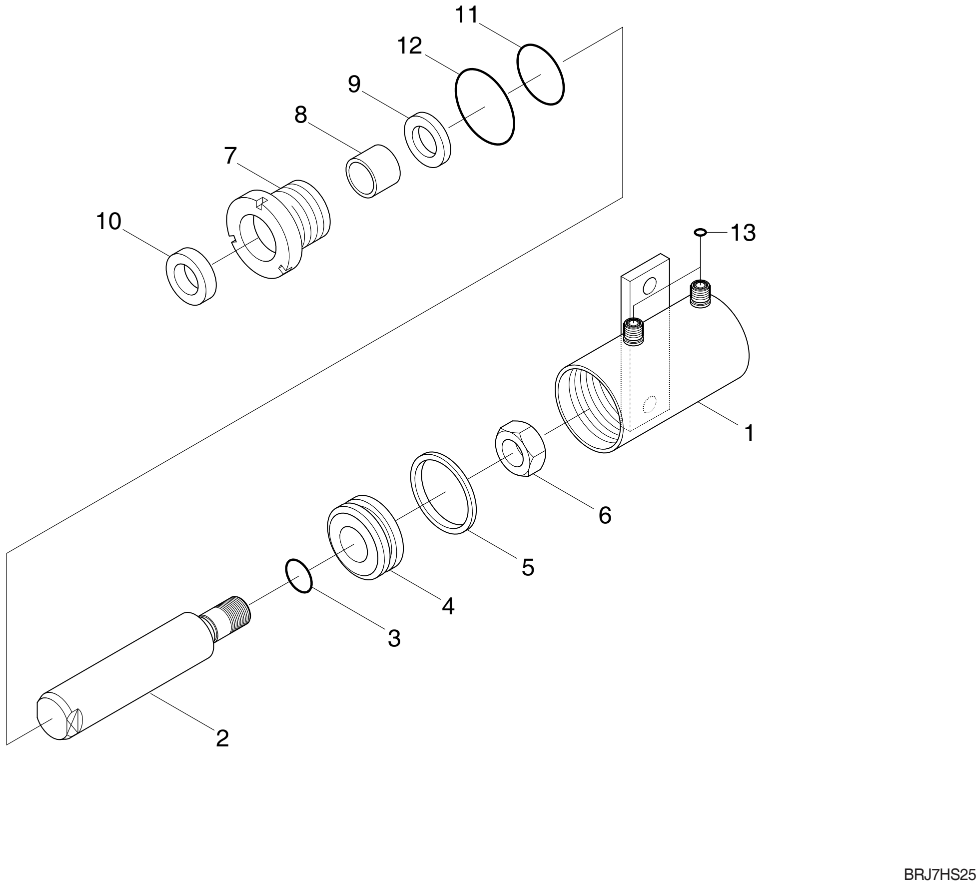
(1) Soak the piston ring in hydraulic oil at a temperature of 40 to 50˚C, expand the inside diameter and assemble on the piston. Install a piston seal.
Bend the edge of the guide and rotate it to install the guide completely.



L15C3HS26

4. TILT CYLINDER

1) STRUCTURE



1	Tube assy	6	Nylon nut	11	O-ring
2	Rod	7	Gland	12	O-ring
3	O-ring	8	DU bushing	13	O-ring
4	Piston	9	Rod seal		
5	Piston seal	10	Dust wiper		

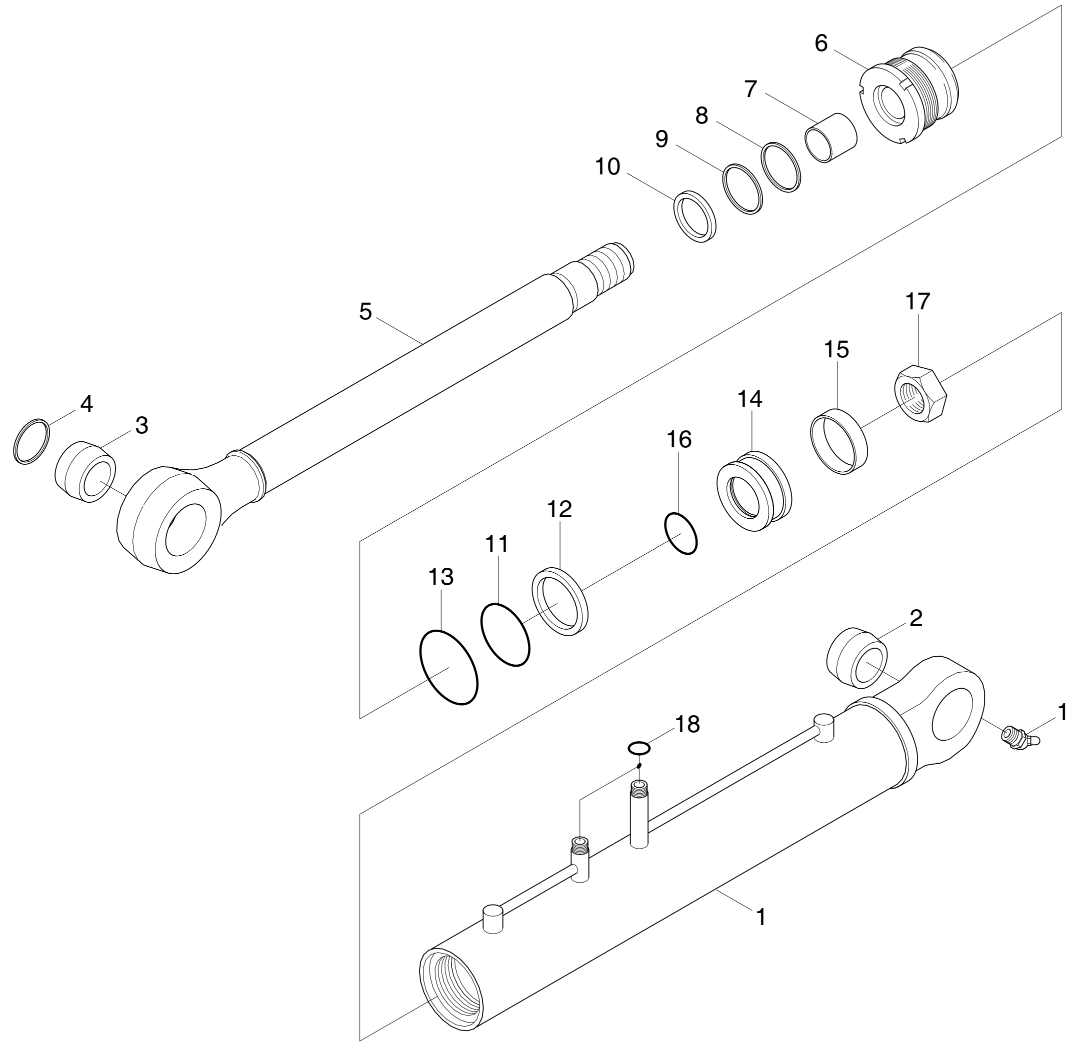
2) CHECK AND INSPECTION

mm (in)

Check item	Standard size	Repair limit	Remedy
Clearance between cylinder rod & bushing	0.072~0.288 (0.003~0.011)	0.5 (0.020)	Replace bushing
Clearance between rod head bushing & pin	0.10~0.35 (0.004~0.014)	0.6 (0.024)	Replace bushing

5. REACH CYLINDER

1) STRUCTURE



14BRJ9HS27

1	Tube assy	8	Buffer seal	15	Piston seal
2	Pin bush	9	U-packing	16	O-ring
2	Spherical bearing	10	Back up ring	17	Hex nut
4	Retaining ring	11	O-ring	18	O-ring
5	Rod assy	12	Back up ring	19	Grease nipple
6	Rod cover	13	O-ring		
7	Rod bush	14	Piston		

2) CHECK AND INSPECTION

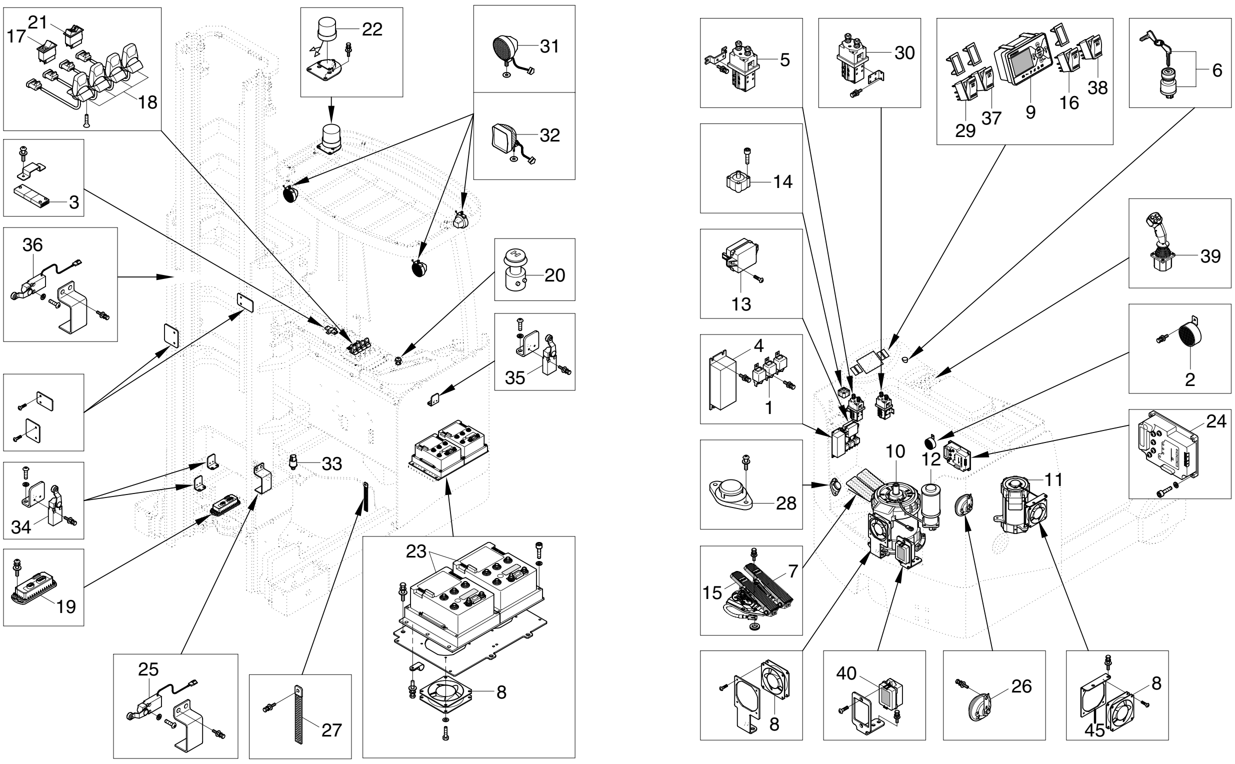
mm (in)

Check item	Standard size	Repair limit	Remedy
Clearance between cylinder rod & bushing	0.072~0.288 (0.003~0.011)	0.5 (0.020)	Replace bushing
Clearance between rod head bushing & pin	0.10~0.35 (0.004~0.014)	0.6 (0.024)	Replace bushing

SECTION 7 ELECTRICAL SYSTEM

SECTION 7 ELECTRICAL SYSTEM

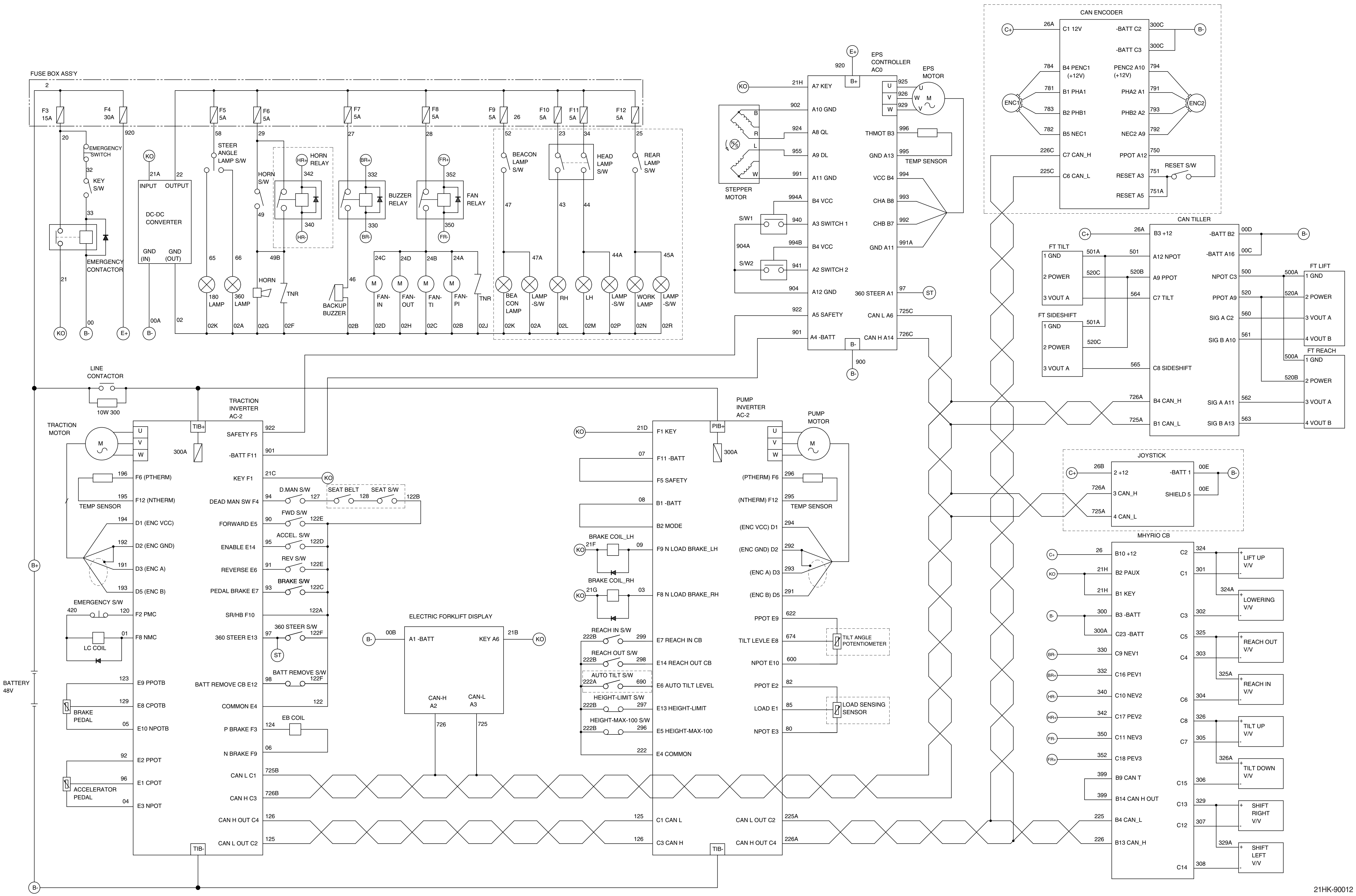
GROUP 1 COMPONENT LOCATION



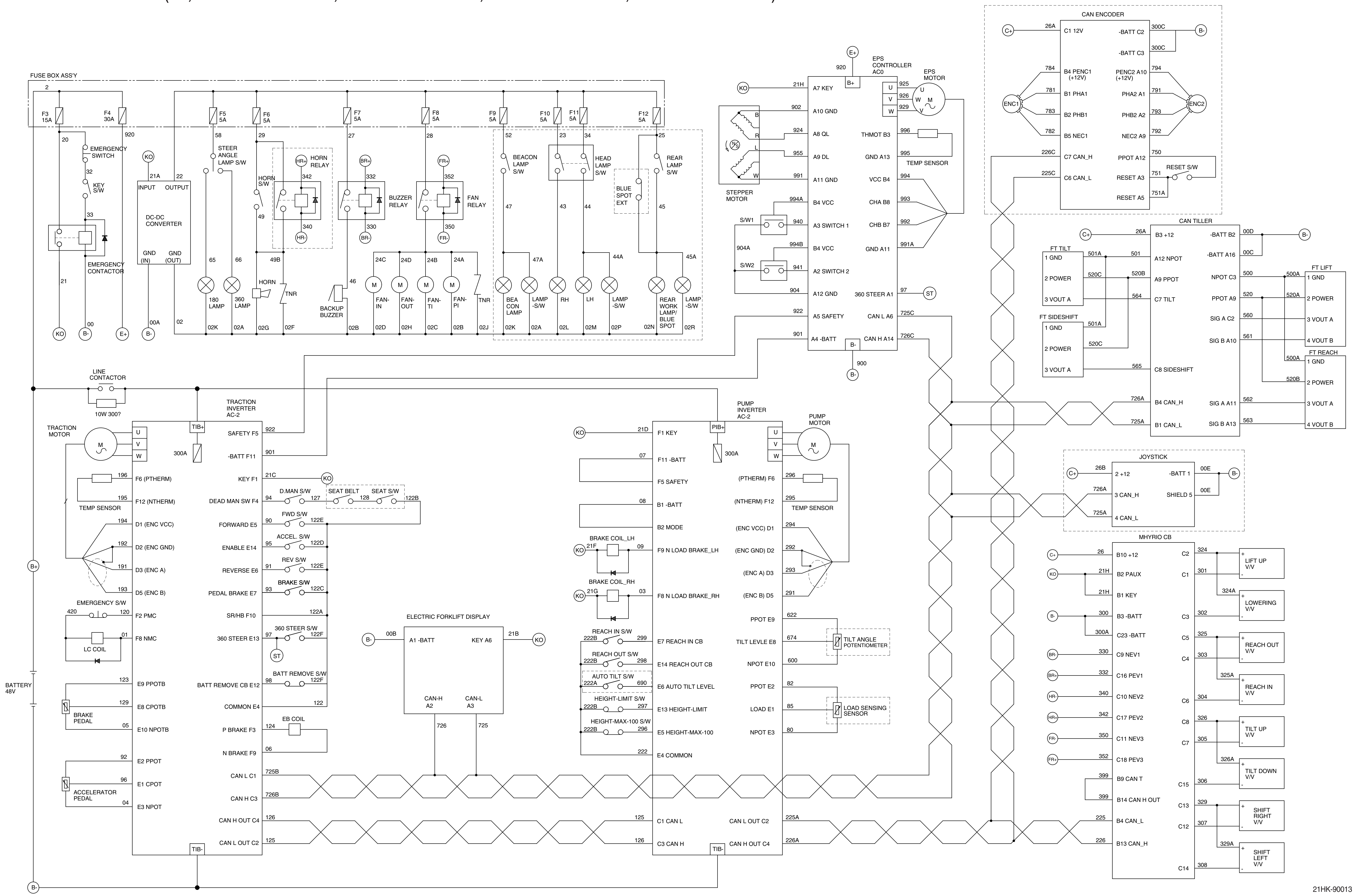
14BRJ9EL01

1 Relay
2 Back buzzer
3 Can tiller card
4 DC converter
5 Contactor
6 Key switch assy
7 Accelerator assy
8 Fan
9 Display
10 Traction motor
11 Pump motor
12 EPS motor
13 Fuse box assy
14 Stepping & gear motor
15 Brake pedal assy
16 Beacon switch
17 Horn switch
18 Fingertip lever
19 Fingertip controller
20 Emergency switch
21 Direction switch
22 Beacon lamp
23 Inverter
24 EPS control
25 Limit switch assy
26 High horn
27 Static strap
28 Seat switch
29 Head lamp switch
30 Contactor
31 Work lamp
32 LED work lamp
33 Pressure sensor
34 Reachin/reachout switch
35 Battery remove assy
36 Lift end switch
37 Rear work lamp switch
38 Steer angle switch
39 Joystick
40 Fuse box assy
45 Fan bracket
46 Limit switch guide bracket

· ELECTRICAL CIRCUIT (1/3, 14BRJ-9 : #0001-0006, 16BRJ-9 : #0001-0054, 20BRJ-9 : #0001-0048, 25BRJ-9 : #0001-0009)

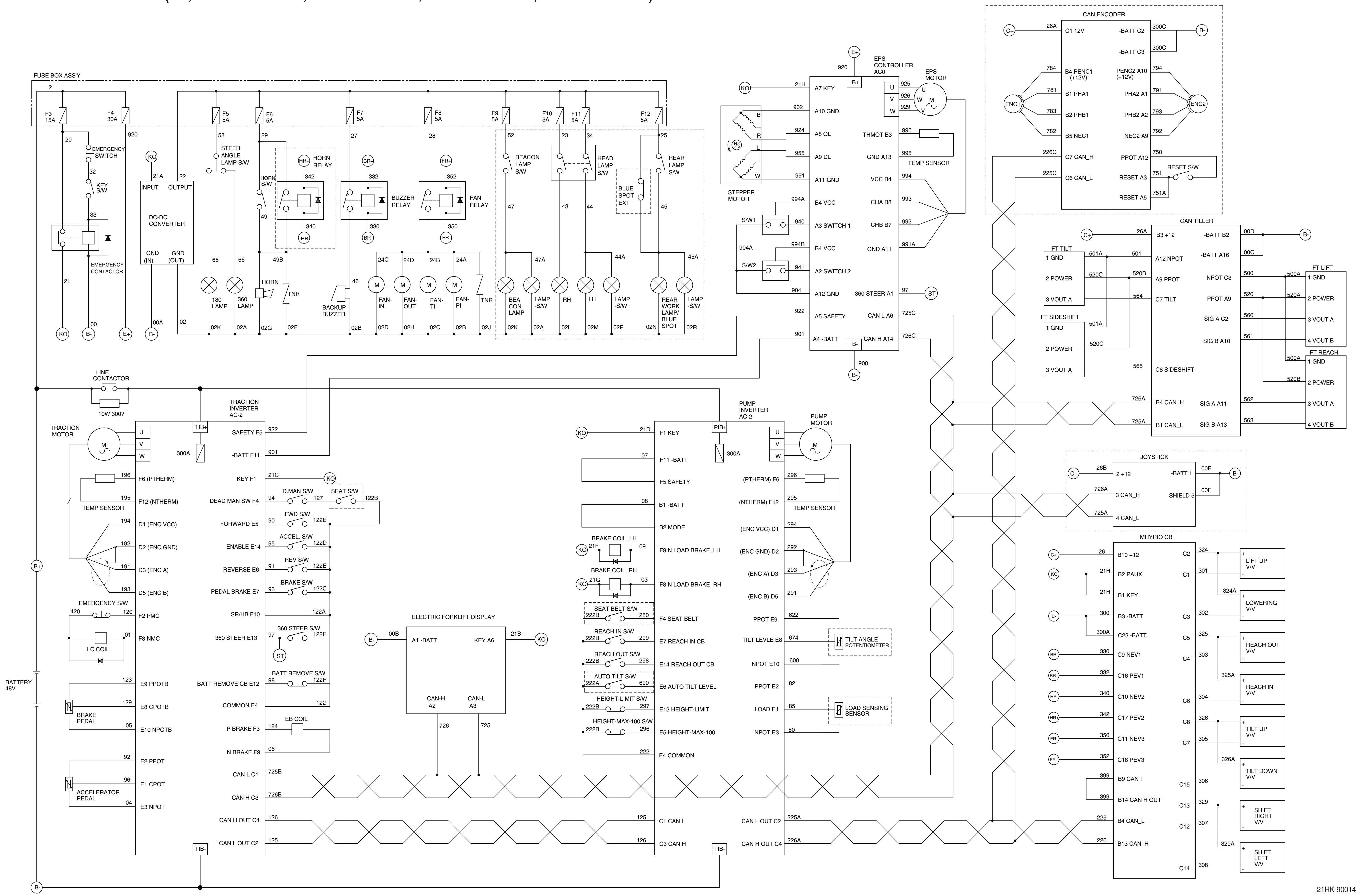


· ELECTRICAL CIRCUIT (2/3, 14BRJ-9 : #0007-0012, 16BRJ-9 : #0055-0108, 20BRJ-9 : #0049-0064, 25BRJ-9 : #0010-0015)

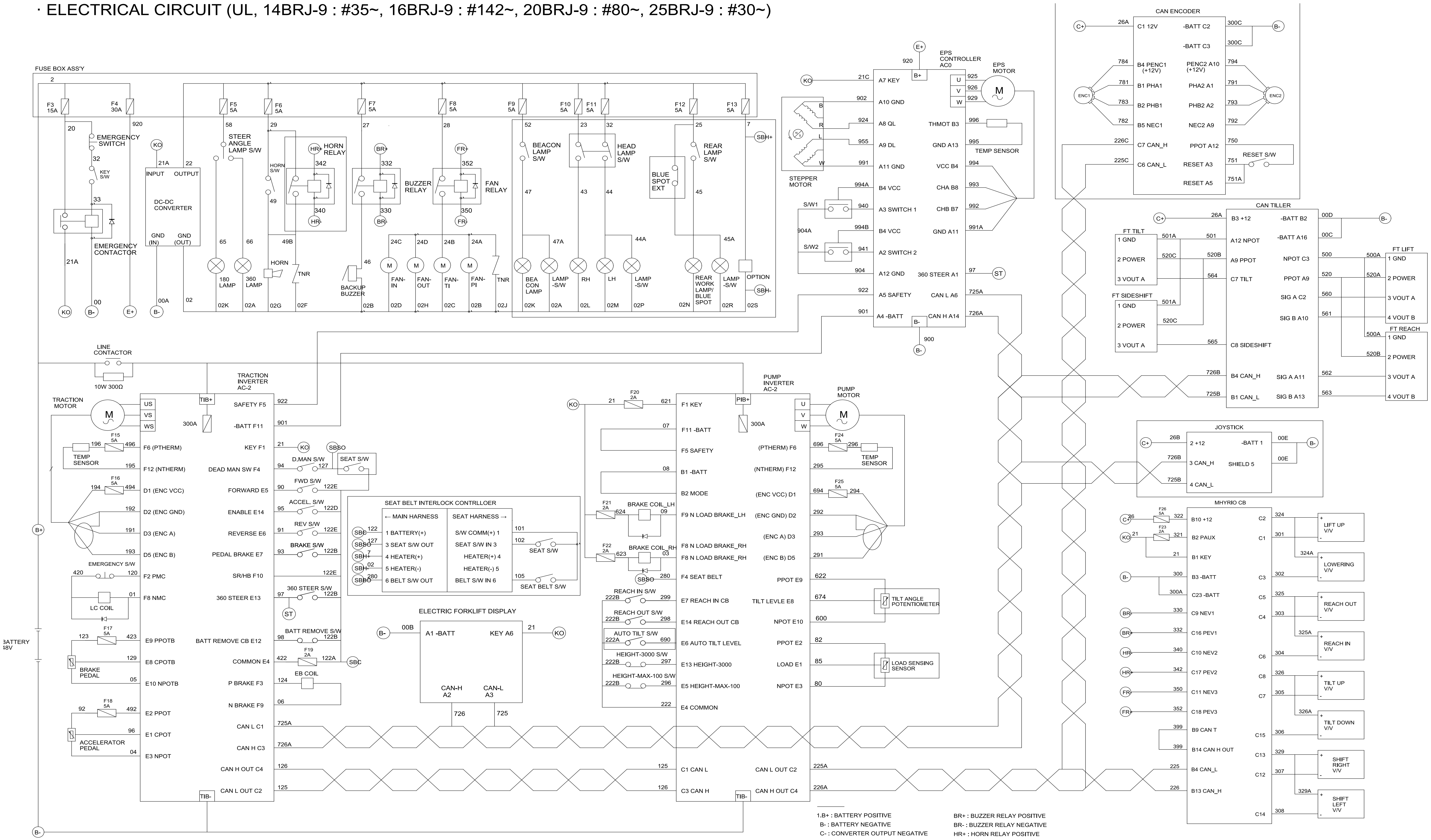


21HK-90013

· ELECTRICAL CIRCUIT (3/3, 14BRJ-9 : #0013-, 16BRJ-9 : #0109-, 20BRJ-9 : #0065-, 25BRJ-9 : #0016-)



· ELECTRICAL CIRCUIT (UL, 14BRJ-9 : #35~, 16BRJ-9 : #142~, 20BRJ-9 : #80~, 25BRJ-9 : #30~)



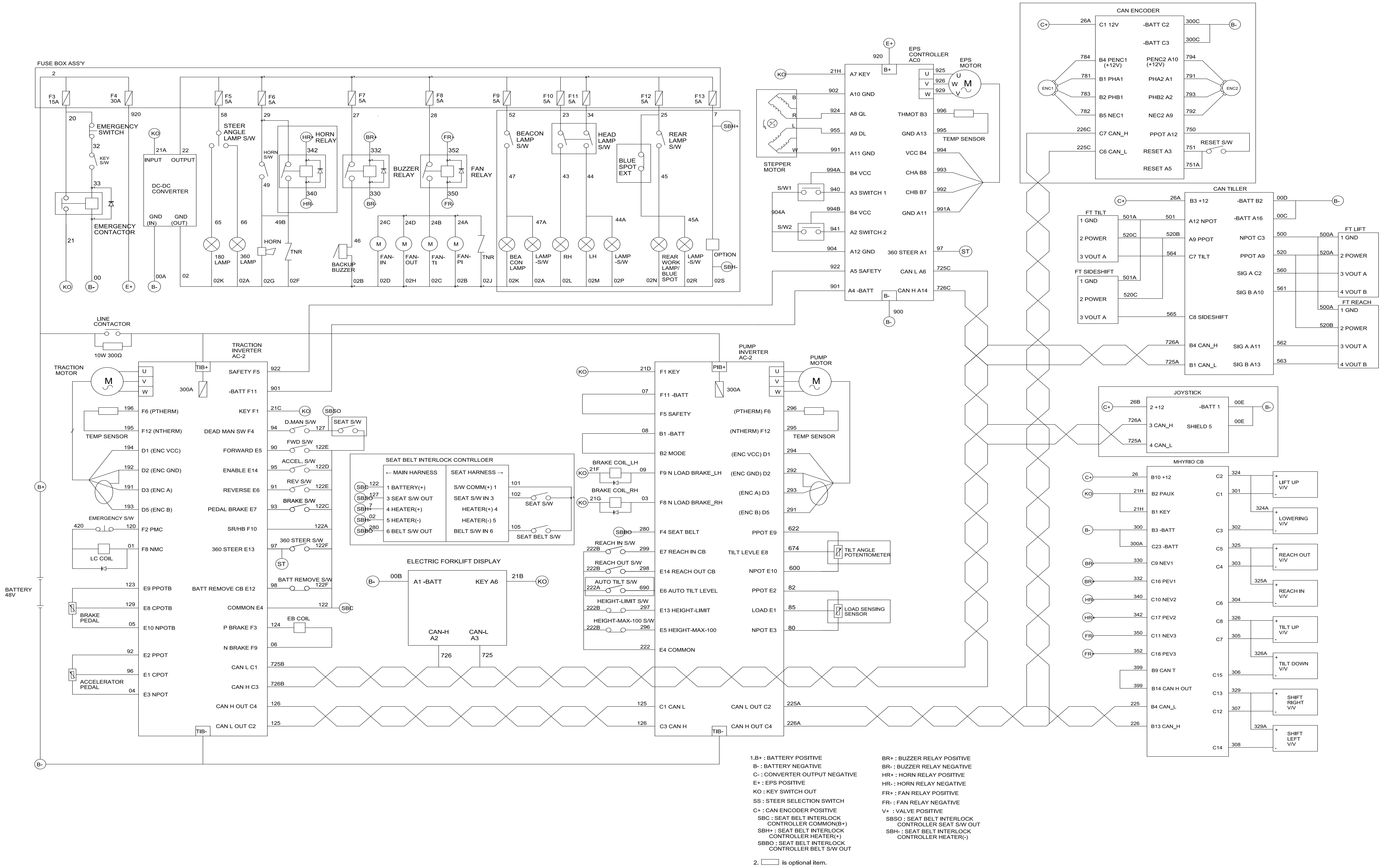
1. B+ : BATTERY POSITIVE
B- : BATTERY NEGATIVE
C- : CONVERTER OUTPUT NEGATIVE
E+ : EPS POSITIVE
KO : KEY SWITCH OUT
SS : STEER SELECTION SWITCH
C+ : CAN ENCODER POSITIVE
SBC : SEAT BELT INTERLOCK CONTROLLER COMMON(B+)
SBH+ : SEAT BELT INTERLOCK CONTROLLER HEATER(+)
SBBO : SEAT BELT INTERLOCK CONTROLLER BELT S/W OUT
BR+ : BUZZER RELAY POSITIVE
BR- : BUZZER RELAY NEGATIVE
HR+ : HORN RELAY POSITIVE
HR- : HORN RELAY NEGATIVE
FR+ : FAN RELAY POSITIVE
FR- : FAN RELAY NEGATIVE
V+ : VALVE POSITIVE
SBSO : SEAT BELT INTERLOCK CONTROLLER SEAT S/W OUT
SBH- : SEAT BELT INTERLOCK CONTROLLER HEATER(-)

2. ▭ is optional item.

3. F3~F14 ARE CONTAINED IN FUSE BOX UL#1.

4. F15~F26 ARE CONTAINED IN FUSE BOX UL#2.

· ELECTRICAL CIRCUIT (NON-UL, 14BRJ-9 : #35~, 16BRJ-9 : #142~, 20BRJ-9 : #80~, 25BRJ-9 : #30~)



GROUP 3 ELECTRIC COMPONENTS

1. FUNCTIONS OF BATTERY FORKLIFT TRUCK AND ELECTRIC COMPONENTS.

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

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

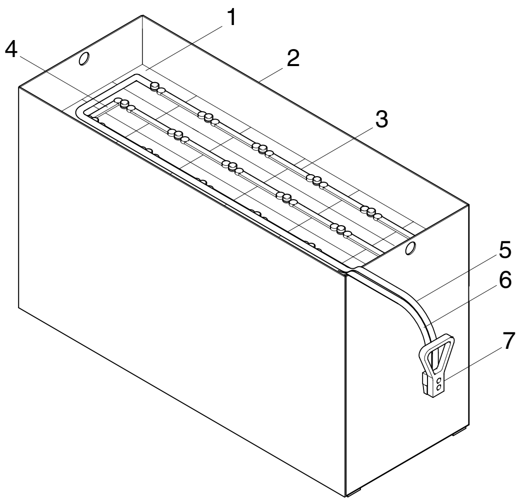
To drive the fork lift truck, a DRIVING CONTROL SYSTEM and some electric components such as direction change lever (forward/reverse section switch) and accelerator are required to select the driving direction and to control the speed of driving motor.

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

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

2. BATTERY

1) STRUCTURE

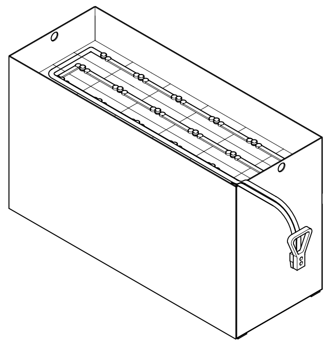


BRJ7EL03

1	Cells	7	Plug
2	Steel box	8	Spacer
3	Cell connector	9	Handle (Red)
4	Row connector	10	Screw
5	Positive leading cable	11	Spring washer
6	Negative leading cable		

2) GENERAL

As in the battery forklift, the battery is an energy source, the handling of the battery is very important. The life and performance of the battery greatly depend on the ordinary handling and maintenance. Therefore, be sure to check and maintain the battery so that it may be kept best.



BRJ7EL04

3) SPECIFICATION AND SERVICE DATA

Item	Unit	14/16BRJ-9	20/25BRJ-9
Type	-	Lead Acid	
Rated voltage	V	48	
Capacity	AH/hr	420 (★560)	560 (★700)
Electrolyte	-	WET	
Dimension (W×D×H)	mm	1223×283 (★353)×787	1223×353 (★425)×787
Connector (CE spec)	-	SBE320	
Weight	kg	750 (★940)	940 (★1120)

★ : Option

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

4) SAFETY PRECAUTIONS

(1) When a sulfuric acid contact with skin

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

(2) Strict prohibition of fire and ventilation

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

(3) Never place metallic articles on the batteries

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

(4) Handling of charger

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

5) OPERATION PRECAUTIONS

(1) Avoid over-discharge

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

(2) Avoid over-charge

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

(3) Avoid excessive elevation of temperature

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

6) INSTRUCTION

(1) Unpacking

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

(2) Performance and maintenance of batteries

① Initial charge

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

a. By modified constant voltage charger

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

b. By constant voltage constant current charger

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

c. By constant current charger

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

· When a constant value is indicated for more than 1 hour after the battery voltage has reached the maximum value.

· When more than 1 hour of charge is continued after the electrolyte specific gravity has risen fully and becomes constant.

② Discharge and capacity

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

That is, the capacity is indicated by AH (ampere hour) being calculated as the product of ampere (A) and time (H). However, even in the same type of batteries, the capacity varies with the discharge conditions (discharge current, battery temperature and specific gravity of electrolyte)

Even if the batteries discharged its full capacity, if immediately charged to full, there will be no harmful effects remained. Ideal charging amount (AH) is 110-125% of the amount of previous discharge.

③ Specific gravity of electrolyte

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

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

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

S_t : Actually measured specific gravity at t °C

t : Electrolyte temperature (°C)

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

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

④ **Normal charge**

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

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

There is almost automatic charger today which completes the charging just only connecting the plug between battery and charger without outer operating timer. But if your charger has it, after setting the timer for 3-4 hours and turn on the charger and the charger is left as it is, then the charge will be made automatically. In principle, regardless of the amount of previous discharge, it is not required to alter the setting of timer time. The recommendable current value of this type of charger is "5 hour rate current $\times$1.0~1.5" at the start of charging, and at the final stage it is "5 hour rate current $\times$0.15~0.25". Normally the charge is terminated within 8~12 hours automatically.

b. **Charging by constant current constant voltage automatic charger**

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

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

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

⑤ **Equalizing charge**

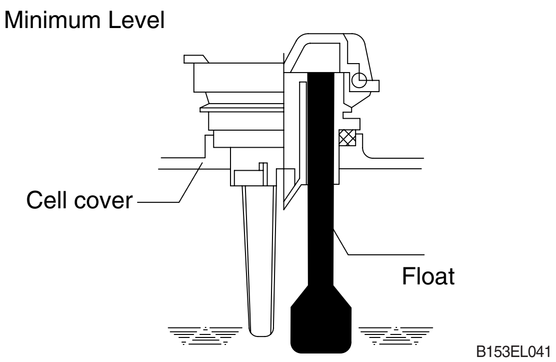
When large number of cells are used in a set of battery, the voltage and specific gravity of respective cells tend to become unequal, resulting in necessity of charging all the cells at an appropriate time in order to equalize them. This is called equalizing charge. Normally the equalizing charge should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

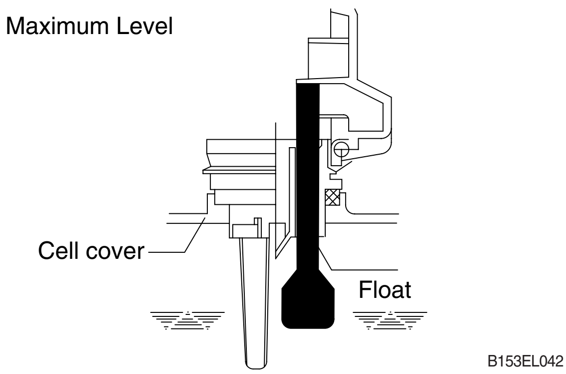
⑥ **Water replenishment**

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

(for the purpose of uniform stirring of electrolyte by charging). If the electrolyte level is improper after completion of charging, you may topping up the electrolyte level to the maximum level .

a. Determination of replenishment time and methods (cell with ONE TOUCH CAP)
Confirm the electrolyte level by looking at the float in the ONE TOUCH CAP. If too low as shown in figure, replenish water. Replenishment shall be performed after opening the cover of the plug using syringe and jug. When refilling is completed, close each cover completely until “click” sound is heard.





⑦ Cleaning
If electrolyte spills or the cells are polluted with dust or stains, it will cause generation of leak current. Wipe off dust and stains with moist cloth and clean in such a manner that the cells are kept in dry condition. In the case of plastic containers or covers, never use such organic solvents as paint thinner and gasoline. If used, the plastic containers or covers may suffer cracking. If you are forced to use them, be sure to use white kerosene.

⑧ Notice on charging
The charging area must be well ventilated to facilitate exhaust of gas generated from the battery during charging. Charge the battery in an area free from iron working, welding, etc. Further the battery generates hydrogen, oxygen, acid mist and on rare occasions, hydrogen sulfide during charging depending on the case. Special care may be required in the case of equipment and objects near the battery that may contaminated or damaged. Do not pull out the charging plug during charging, as it will cause sparks. Since hydrogen gas generated during charging may remain in the area surrounding the battery after charging, never bring fire or flame close to this area. In case of counter-balance type vehicles, open the battery cover before charging.

⑨ Repair of failure cell

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

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

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

⑩ Summary of daily maintenance

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

(3) Others

① Storage of batteries

When batteries are stored, keep them distant from room heaters or other heat generating sources. Clean, cool and dry place where no direct sunlight is directed is suited for battery storage. Before putting into storage, it is important to charge the batteries and keep the electrolyte level at the specified level. When the temperature in storage location is higher than 20°C, check the specific gravity once a month, and when lower than 20°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 water replenishment requirements can be clarified at a glance. Measurements of specific gravity and temperatures once every two to four months after equalizing charge and maintenance thereof will serve for battery health diagnosis.

③ Electrolyte temperature

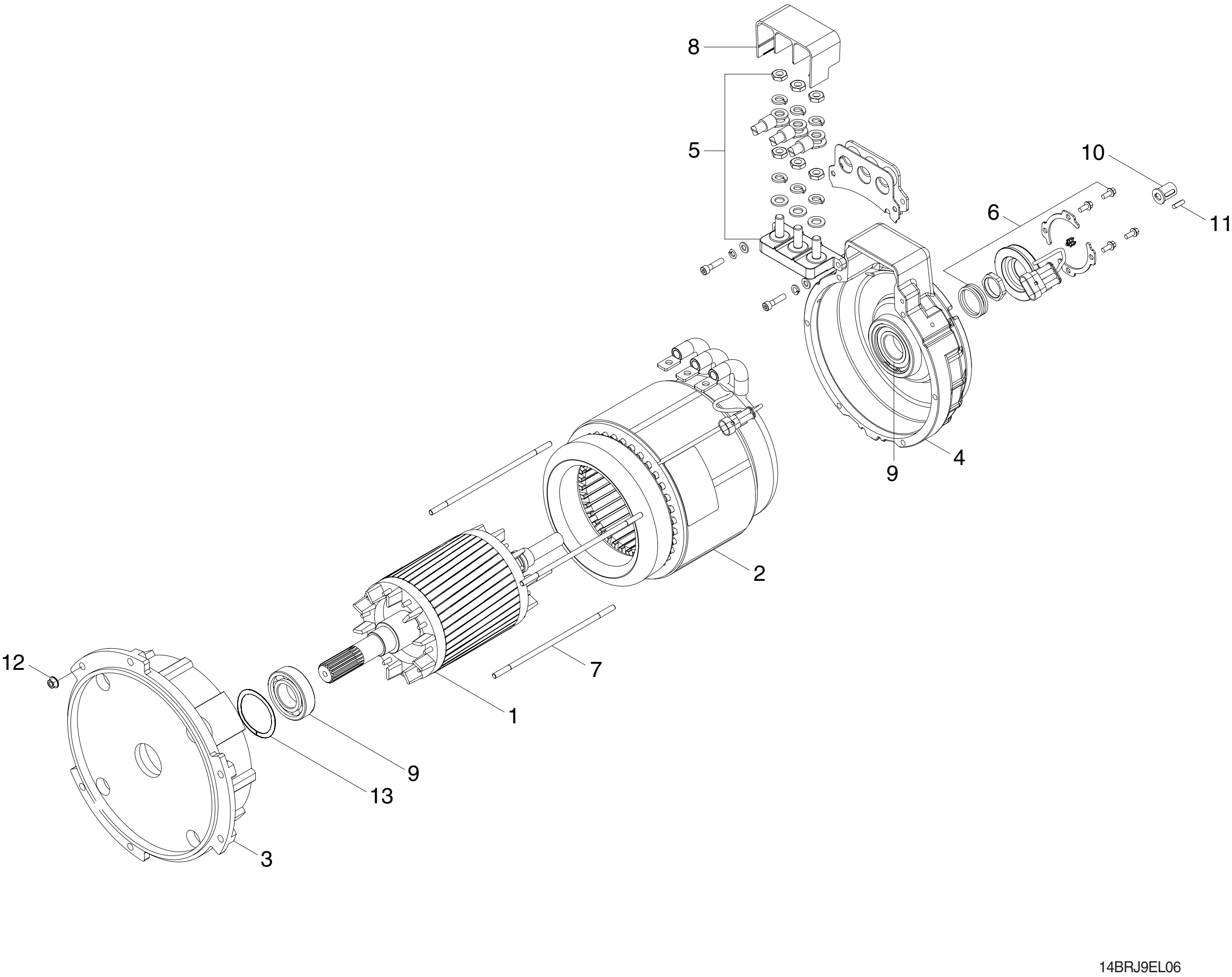
The operating temperature range of batteries is -10~45°C (temperature of electrolyte). If the batteries are exposed to cold atmosphere in discharged condition, the electrolyte may freeze, and in extreme cases, the capacity will be decreased, but, if not frozen, no adverse effects will be exerted over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

7) TROUBLESHOOTING

Nature of trouble	Symptoms	Causes	Corrective Action
Deformation	· Deformation of container. Lid or one touch cap	· Excessive temperature rising or external impact	· Replace
Breakage	· Electrolyte leakage according to breakage of container, lid or one touch cap · Termination of connector or pole post etc.	· External impact, improper handling, excessive vibration · Excessive temperature rising or vibration/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



1	Rotor assy	6	Speed Sensor Kit	11	Sunk key
2	Stator assy	7	Stud bolt	12	Flange nut
3	Endbell De	8	Terminal protector	13	Wave washer
4	Endbell	9	Bearing		
5	Terminal A block	10	Shaft holder		

2) SPECIFICATION

Item	Unit	Specification
Type	-	AMBL4001P
Rated voltage	Vac	30
Rated output	kW	7.5
Insulation	-	Class F

3) MAINTENANCE INSTRUCTION

(1) Inspection

① Rotor assembly inspection

Rotor should always be cleaned with compressed air.

If the dirt will not come off lightly wipe off with piece of cotton or soft cloth wetted with gasoline.

Rotor out diameter : ø 123.1 ± 0.05

Tool : Vernier calipers and standard tool

18BR9EL41

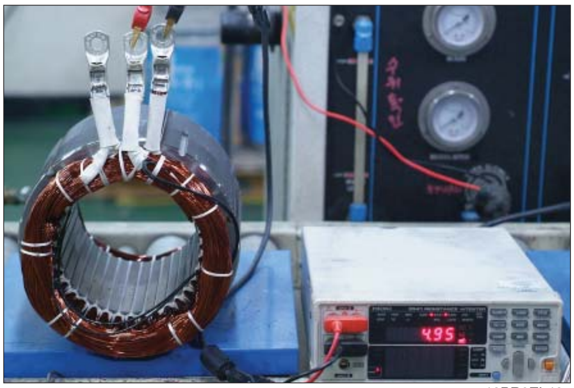
② Stator assembly inspection

Stator should always be cleaned with compressed air.

If the dirt will not come off lightly wipe off with piece of cotton or soft cloth wetted with gasoline, using care not to damage the coil insulation.

Use mmΩ tester and check for two power line of stator repeatedly (U-V, V-W, W-U).

At that time resistance is around 6.3 mmΩ.

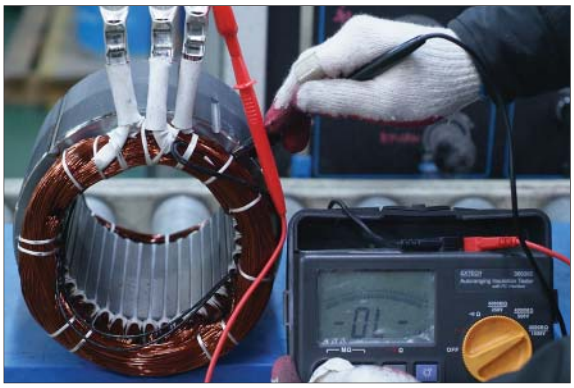


18BR9EL42

Insulation test

Use insulation tester (1000 Vac, Min. 10 MΩ) and measure as a picture.

If the insulation is defective, replace with new parts.



18BR9EL43

(2) Disassembly for AC motor

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

18BR9EL44

18BR9EL45

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

18BR9EL46

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

18BR9EL47

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

18BR9EL48

⑤ Remove endbell de and wave washer.

18BR9EL49

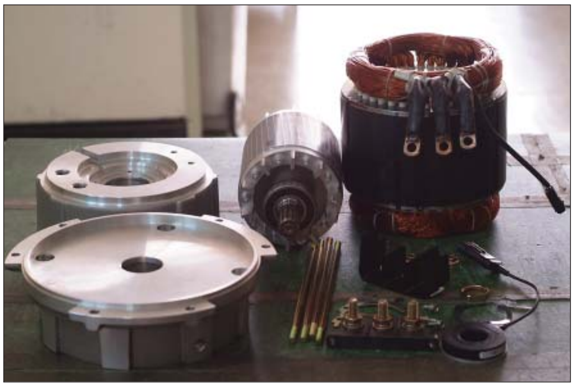
⑥ Remove stator assembly by hand or suitable tool.

18BR9EL50

⑦ Remove endbell from rotor assembly by hand-puller as a right picture.

18BR9EL51

⑧ The motor are composed of 5-parts (rotor assembly, stator assembly, enbell de, endbell, etc).

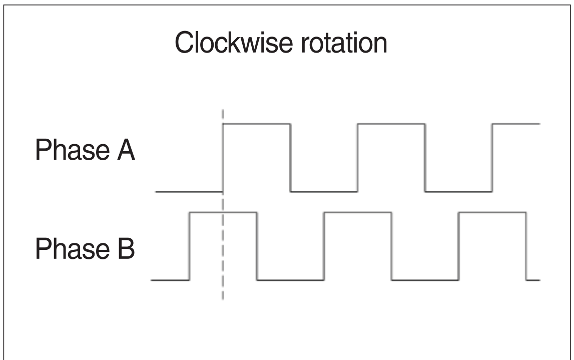


18BR9EL52

(3) Assembly and installation

Perform assembly in the reverse order of disassembling.

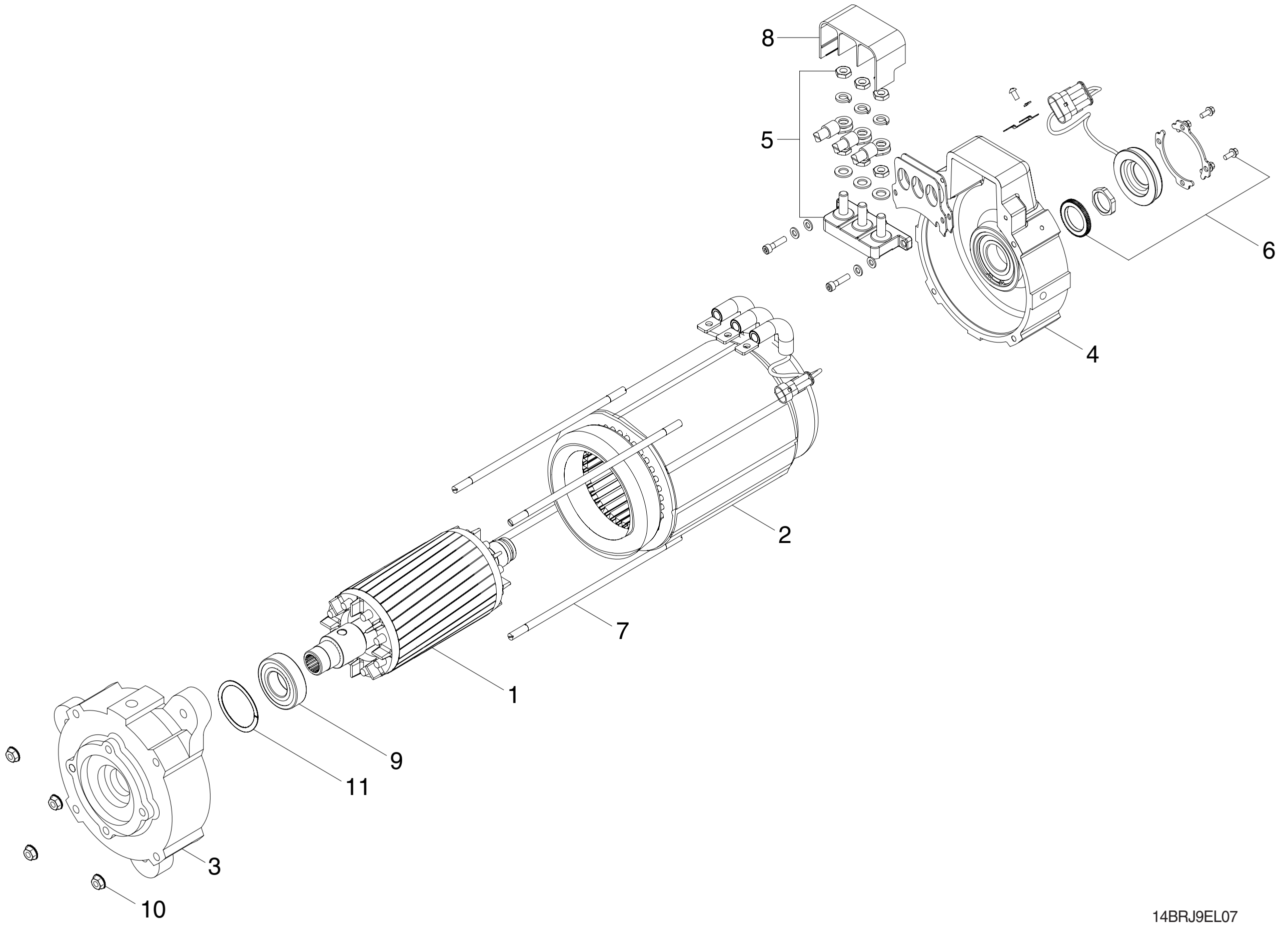
After assembling, check for speed sensor. Normal signal is as right.



18BR9EL53

4. PUMP MOTOR

1) STRUCTURE



1	Rotor assy	5	Terminal A block	9	Bearing
2	Stator assy	6	Speed Sensor Kit	10	Flange nut
3	Endbell De	7	Stud bolt	11	Wave washer
4	Endbell	8	Terminal protector		

2) SPECIFICATION

Item	Unit	Specification
Type	-	ABDD 4003P
Rated voltage	Vac	30
Rated output	kW	14.0
Insulation	-	Class F

3) INTERNAL INVOLUTE SPLINE DATA

Item	Unit	Specification
Flat root side fit	-	Class 7
No of teeth	EA	9
Spline pitch	mm	16/32
Pressure angle	Degree	30
Major diameter	mm	16.535
Form diameter	mm	15.977
Minor diameter	mm	12.9286
Pin diameter	mm	2.743
Measurement over 2 pins	mm	10.251-0.1

4) INSPECTION

(1) Rotor assembly inspection

① Rotor should always be cleaned with compressed air.
If the dirt will not come off lightly wipe off with piece of cotton or soft cloth wetted with gasoline.
Rotor out diameter : ø 104.1 ± 0.05
Tool : Vernier calipers and standard tool

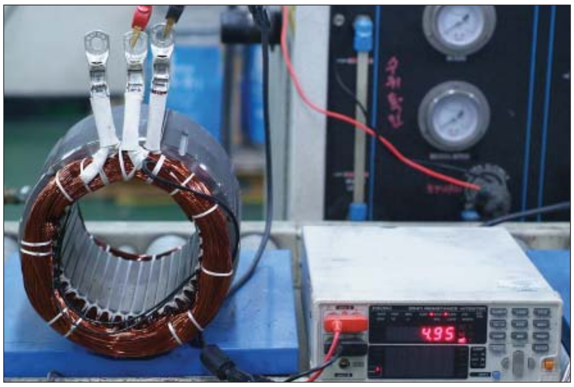
18BR9EL54

② **Stator assembly inspection**

Stator should always be cleaned with compressed air.

If the dirt will not come off lightly wipe off with piece of cotton or soft cloth wetted with gasoline, using care not to damage the coil insulation.

Use mmΩ tester and check for two power line of stator repeatedly (U-V, V-W, W-U). At that time resistance is around 3.5 mmΩ.

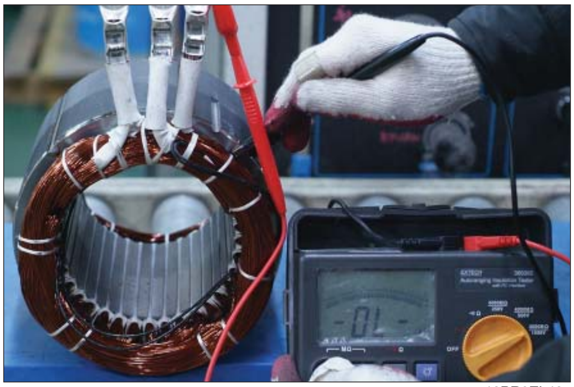


18BR9EL42

Insulation test

Use insulation tester (1000 Vac, Min. 10 MΩ) and measure as a picture.

If the insulation is defective, replace with new parts.

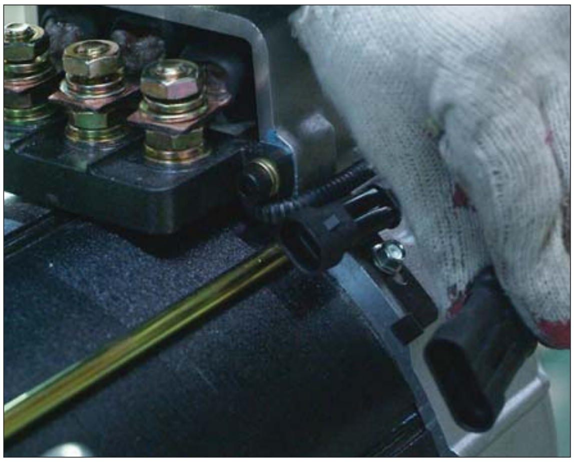


18BR9EL43

5) Disassembly for AC motor

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

18BR9EL44



18BR9EL45

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

18BR9EL46

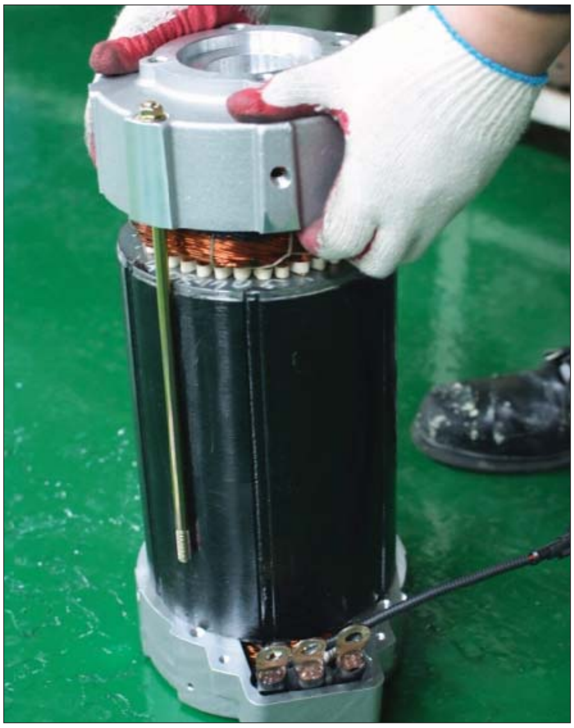
③ Remove 4 screw fixing speed sensor on the endbell side and then disassemble speed sensor, fixed nut and toothed wheel of the motor.

18BR9EL55

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

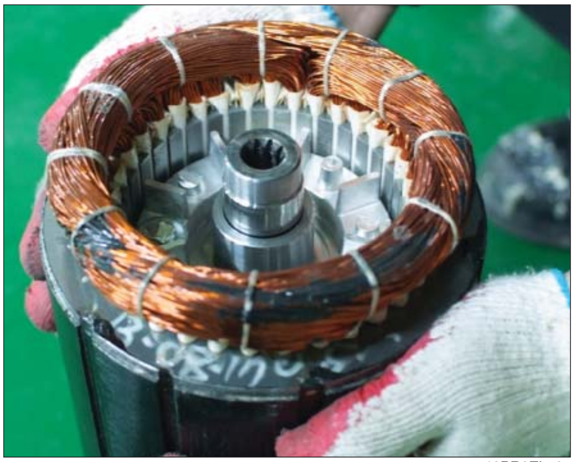
18BR9EL56

⑤ Remove endbell de and wave washer.



18BR9EL57

⑥ Remove stator assembly by hand or suitable tool.



18BR9EL58

⑦ Remove endbell from rotor assembly by hand-puller as a right picture.

18BR9EL51

⑧ The motor are composed of 5-parts (rotor assembly, stator assembly, enbell de, endbell, etc).

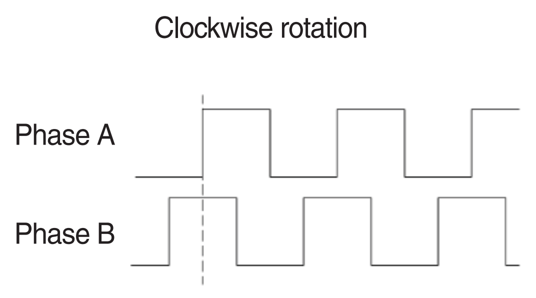
18BR9EL59

6) Assembly and installation

Perform assembly in the reverse order of disassembling.

After assembling, check for speed sensor.

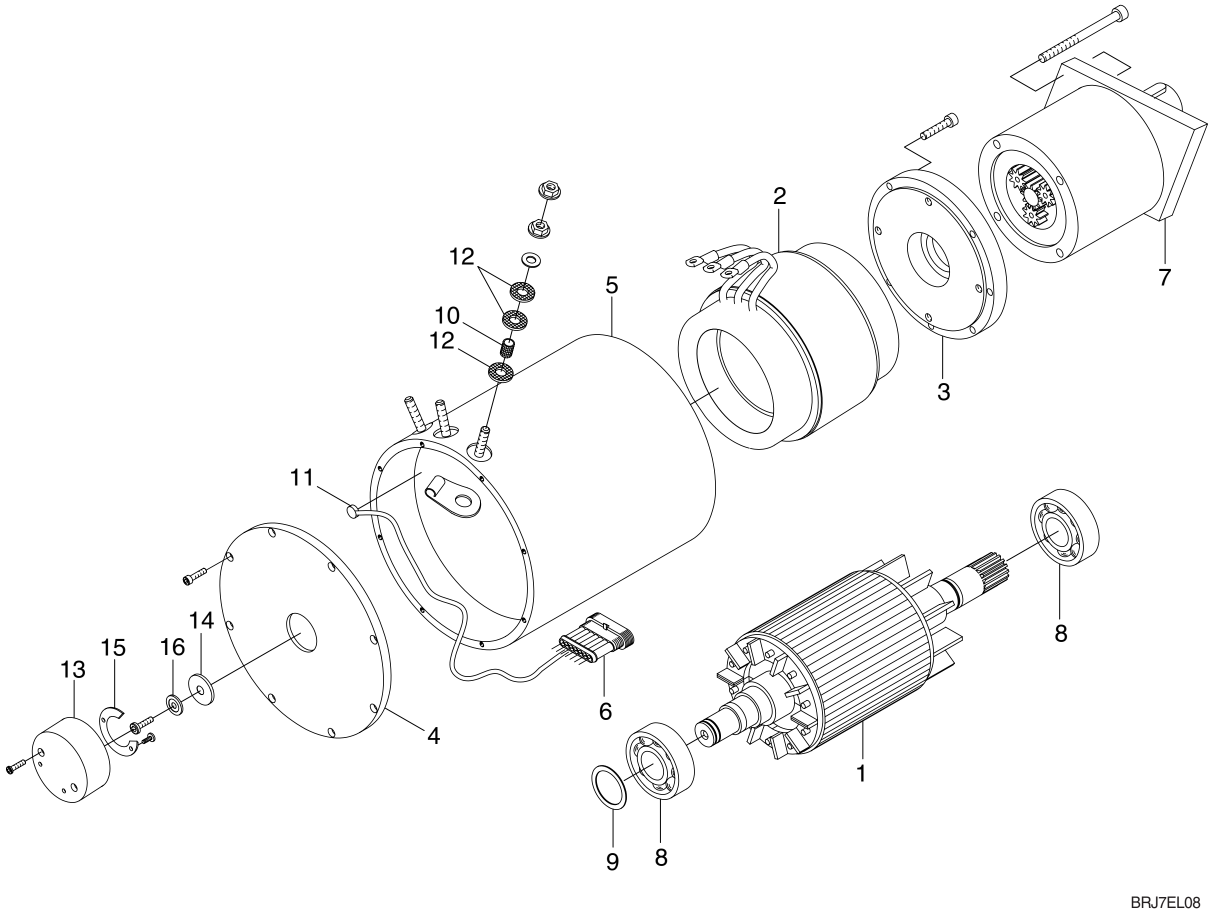
Normal signal is as right.



18BR9EL53

5. EPS MOTOR

1) STRUCTURE



1	Rotor	9	Screw	17	Screw
2	Stator	10	Screw	18	Washer
3	Flange	11	Thickness ring	19	Bakelite washer
4	Flange	12	Flange nut	20	Sensor support
5	Casing	13	Bakelite pipe	21	Magnet
6	Super seal	14	Thermal	22	Screw
7	Gear	15	Screw	23	Sensor card
8	Bearing	16	Grower	24	Magnet support

2) SPECIFICATION

Item	Unit	Specification
Type	-	G104087A
Rated voltage	Vac	23
Rated output	kW	400
Insulation	-	Class H

3) MAINTENANCE INSTRUCTION

※ Before starting the maintenance please disconnect the power supply.

(1) Ball bearing

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

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

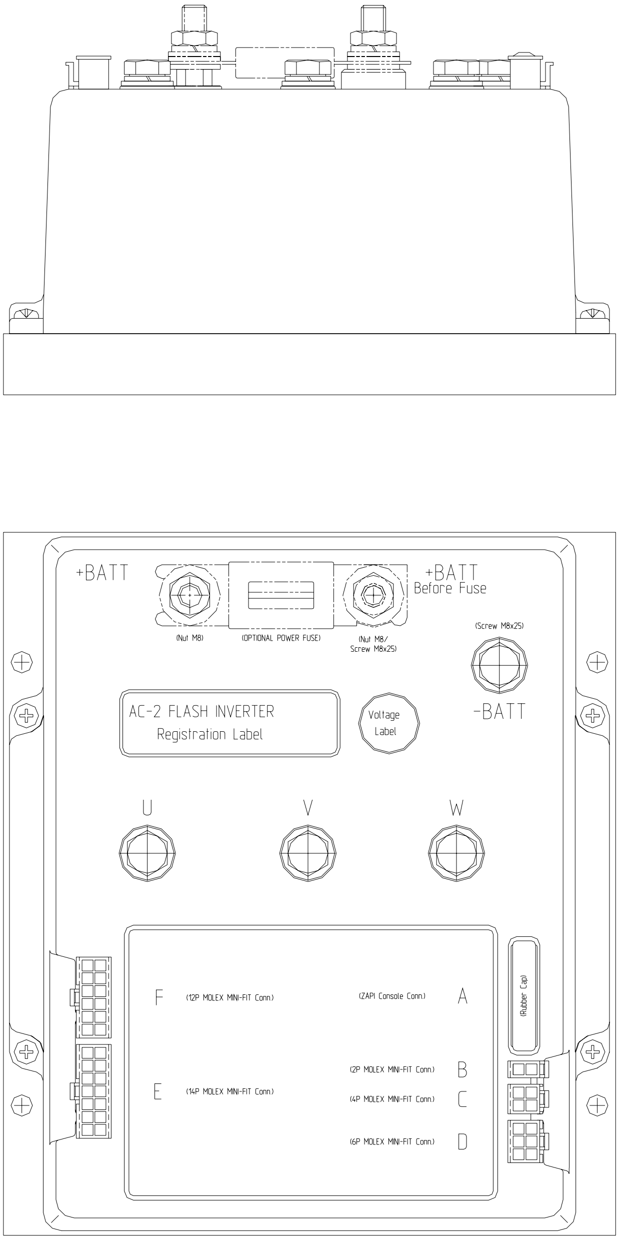
After approximately 10,000 operating hours the bearings have to be replaced.

(2) Disassembly and assembly

The motor is assembled and disassembled according to the relevant sectional drawing and part list. (See page 7-17)

6. CONTROLLER SYSTEM

1) STRUCTURE



BRJ7EL11

(1) Specifications

Model	Model	Application	Type	Power	Current limit
14/16/20/25BRJ-9	AC2	Traction	AC	36-48V, 450A	450A/3min
	AC2	Pump	AC	36-48V, 450A	450A/3min

2) OPERATIONAL FEATURES

(1) Features

① Speed control.

② Optimum behavior an a slope due to the speed feedback:

- The motors speed follows the accelerator, starting a regenerative braking if the speed overtakes the speed set-point.
- The system can perform an electrical stop on a ramp (the machine is electrically hold on a slope) for a programmable time.

③ Electronic differential feature with torque balance between external and internal wheel.

④ Regenerative release braking based upon deceleration ramps.

⑤ Regenerative braking when the accelerator pedal is partially released (deceleration).

⑥ Direction inversion with regenerative braking based upon deceleration ramp.

⑦ Regenerative braking and direction inversion without contactors: only the main contactor is present.

⑧ Optimum sensitivity at low speeds.

⑨ Voltage boost at the start and with overload to obtain more torque (with current control).

⑩ Hydraulic steering function:

- The traction inverter sends a "hydraulic steering function" request to the pump inverter on the can-bus line.

⑪ Backing forward and reverse options are available, with the tune and the speed of the function programmable with Zapi console or buttons on a display.

⑫ High efficiency of motor and battery due to high frequency commutations.

⑬ Modification of parameters through the programming console or buttons on a display.

⑭ Internal hour-meter with values that can be displayed on the console.

⑮ Memory of the last five alarms with relative hour-meter and temperature displayed on the console.

⑯ Diagnostic function with Zapi console for checking main parameters.

⑰ Built in BDI feature.

⑱ Flash memory, software downloadable via serial link and via CANBUS.

(2) Diagnosis

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

① Diagnosis on key switch closing that checks: watchdog circuit, current sensor, capacitor charging, phase's voltages, contactor drivers, can-bus interface, if the switch sequence for operation is correct and if the output of accelerator unit is correct, correct synchronization of the two μCS, integrity of safety related inputs hardware.

② Standby diagnosis in standby that checks: Watchdog circuit, phase's voltages, contactor driver, current sensor, can-bus interface.

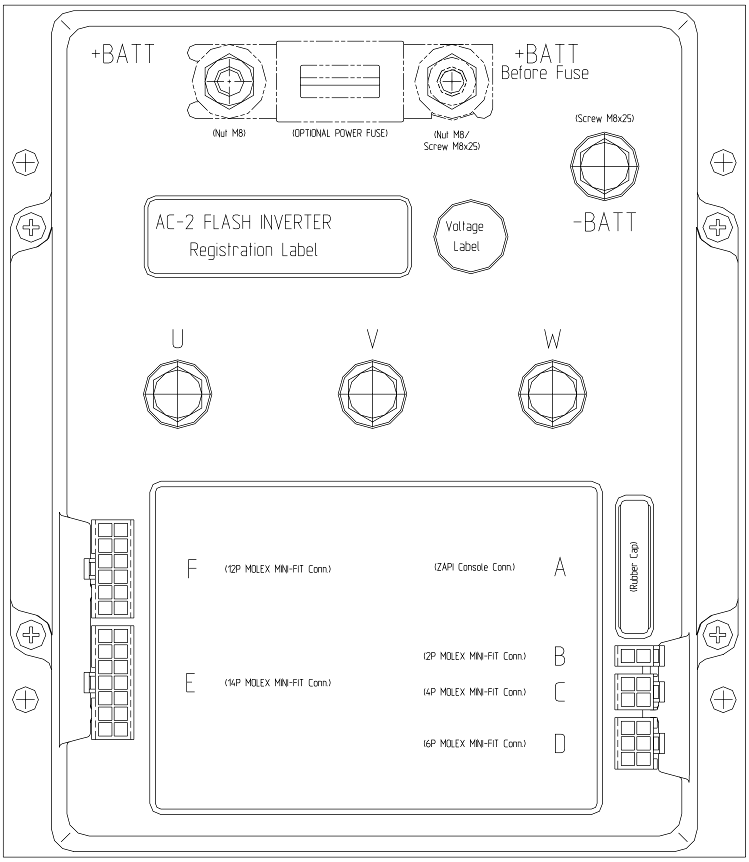
③ Diagnosis during operation that checks: Watchdog circuits, contactor driver, current sensors, can-bus interface.

④ Continuous diagnosis that checks: Temperature of the inverter, motor temperature.

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

3) DESCRIPTION OF THE CONNECTORS

(1) Traction controller



BRJ7EL12

No. of pin	Function	Description
A1	PCLRXD	Positive serial reception.
A2	NCLRXD	Negative serial reception.
A3	PCLTXD	Positive serial transmission.
A4	NCLTXD	Negative serial transmission.
A5	GND	Negative console power supply.
A6	+12	Positive console power supply.
A7	FLASH	It must be connected to A8 for the flash memory programming.
A8	FLASH	It must be connected to A7 for the flash memory programming.
C1	CAN_L	Low level CAN-BUS voltage I/O.
C2	CAN_L_OUT	Low level CAN-BUS voltage I/O.
C3	CAN_H	High level CAN-BUS voltage I/O.
C4	CAN_H_OUT	High level CAN-BUS voltage I/O.
D1÷D6		Incremental ENCODER connector.
E1	CPOT	Accelerator potentiometer wiper.
E2	PPOT	Positive of accelerator (+12V DC)
E3	NPOT	Negative of accelerator unit, tested for wire disconnection diagnosis.
E4	COMMON	Common of pedal/FWD/REV/ENABLE/PB microswitches.

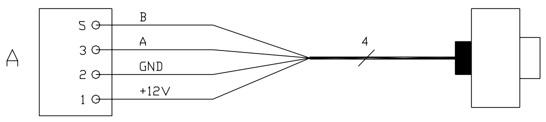
No. of pin	Function	Description
E5	FORW	Forward direction request input. It must be connected to the forward direction microswitch, active high.
E6	REVERSE	Reverse direction request input. It must be connected to the reverse direction microswitch, active high.
E7	PB	Brake request input. It must be connected to the brake pedal switch, active high.
E8	CPO TB	Brake potentiometer wiper.
E9	PPOTB	Positive of brake pedal (+12V DC)
E10	NPO TB	-BATT.
E12	BATT REMOVE CB	Battery removal status sensor input. It must be connected to the battery remove switch. Active low.
E13	360˚ STEER	Steering angle type selection input. It must be connected to the switch angle. Active high means 360˚ steer angle is selected. Active low means 180˚ steer angle is selected.
E14	ENABLE	Accelerator enable function input. It must be connected to the accelerator enable switch. Active high.
F1	KEY	Connected to the power supply through a microswitch (CH) with a 10A fuse in series.
F2	PMC	Positive of main contactor coil.
F3	PBRAKE	Positive of the electro mechanical brake coil.
F4	PEDAL S/W	PEDAL S/W ; It must be connected to the PEDAL microswitch ; It is active high.
F5	SAFETY	If not connected to -Batt the MC coil power output will be disabled.
F5	SAFETY	Input for motor temperature sensor.
F8	NMC	Negative of main contactor coil.
F9	NBRAKE	Output for driving a brake or an hydraulic steering contactor coil ; It drives the load to -Batt maximum current : 3A.
F10	SR/HB	Speed reduction (hand brake) input. Active low (switch opened). See also option chapter (not applicable).
F11	GND	-Batt.
F12	NTHERM	-Batt.

Encoder installation

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

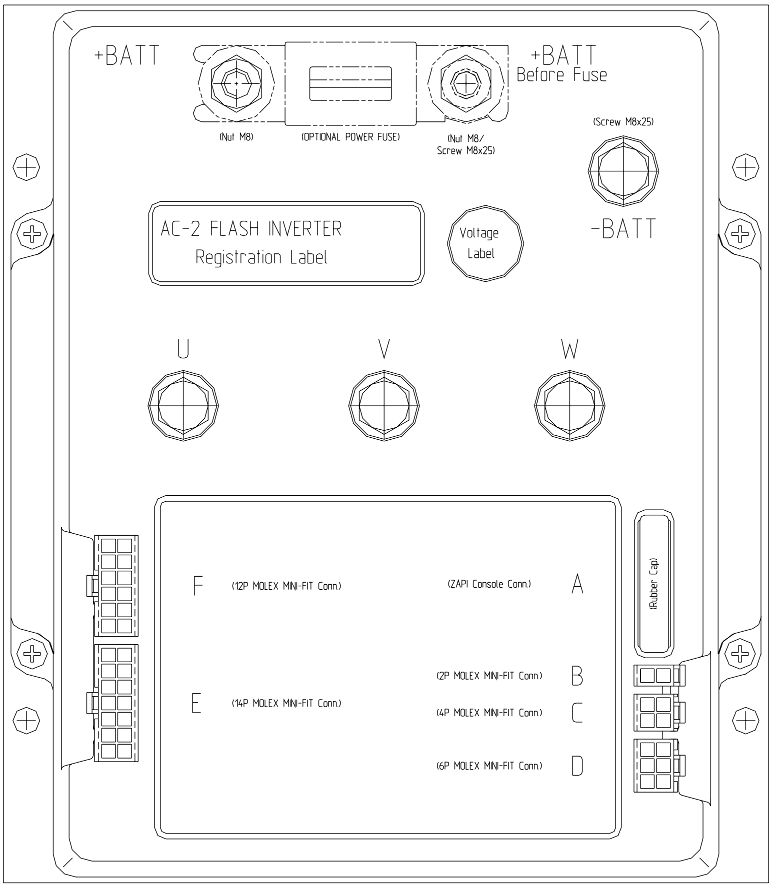
D1 : +12V - Positive of encoder power supply.
D2 : GND - Negative of encoder power supply.
D3 : A - Phase A of encoder.
D4 : B - Phase B of encoder.

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



BRJ7EL26

(2) Pump controller



BRJ7EL12

No. of pin	Function	Description
A1	PCLRXD	Positive serial reception.
A2	NCLRXD	Negative serial reception.
A3	PCLTXD	Positive serial transmission.
A4	NCLTXD	Negative serial transmission.
A5	GND	Negative console power supply.
A6	+12	Positive console power supply.
A7	FLASH	It must be connected to A8 for the flash memory programming.
A8	FLASH	It must be connected to A7 for the flash memory programming.
B1	-BATT	-Batt.
B2	MODE	This input allows the customer to select the software for traction or lifting application. Configuration : Mode : Open (not connected) : Traction inverter Mode : Close (connected with B1) : Pump inverter
C1	CAN_L	Low level CAN-BUS voltage I/O.
C2	CAN_L_OUT	Low level CAN-BUS voltage I/O.
C3	CAN_H	High level CAN-BUS voltage I/O.
C4	CAN_H_OUT	High level CAN-BUS voltage I/O.

No. of pin	Function	Description
D1÷D6		Incremental ENCODER connector.
E1	CPOT LOAD	Load sensor analog input
E2	PPOT LOAD	Positive of load sensor (+12VDC)
E3	NPOT LOAD	Negative of load sensor (ground).
E4	CM	Positive of height limit microswitch
E5	HEIGHT LIFT END	Lift end switch input. Active low.
E6	AUTO TILT LEVEL	Auto tilt leveling switch input. Active high.
E7	REACH IN CTB	Reach in cutback switch input. Active high.
E8	CPOT TILT LEVEL	Tilt up analog input
E9	PPOT TILT LEVEL	Positive of tilt angle sensor (+12VDC)
E10	NPOT TILT LEVEL	Negative of tilt angle sensor (ground).
E13	HEIGHT LIMIT	Height limit switch input. Active low.
E14	REACH OUT CB	Reach out cutback switch input. Active low.
F1	KEY	Connected to the power supply through a microswitch (CH) with a 10A fuse in series.
F2	P LOAD BRAKE_RH	Positive of right load brake output.
F3	P LOAD BRAKE_LH	Positive of left load brake output.
F5	SAFETY	If not connected to -Batt. the MC coil power output will be disabled. It can also be used as a general purpose input.
F6	PTHERM	Input for motor temperature sensor.
F8	N LOAD BRAKE_RH	Negative of right-load brake output.
F9	N LOAD BRAKE_LH	Negative of left-load brake output.
F11	BATT.	-Batt.
F12	NTHERM	-Batt.

4) FUNCTION CONFIGURATION

■ TRACTION CONTROLLER

Using the CONFIG MENU of the programming console, the user can configure the following functions (see "OPERATIONAL FEATURE" chapter for an explanation of "hydraulic steering function") :

(1) Submenu "SET OPTIONS"

① Hour counter

This option specifies the hour counter mode. It can be set one of two :

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

② Battery check

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

③ Cutback mode

- PRESENT : Input F10 is managed as a cutback speed input.
- ABSENT : Input F10 is managed as a handbrake input.

④ Traction cutout

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

⑤ Lift cutout

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

⑥ Stop on ramp

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

⑦ Pedal brake

- ANALOG : The mechanical brake pedal has a switch and a potentiometer installed. When the accelerator is released and the pedal brake is pushed the inverter performs an electrical braking whose intensity is proportional to the brake pedal potentiometer. The minimum intensity is established by the "Release braking" parameter, when the brake pedal is slightly pressed (brake switch close but brake potentiometer at the minimum). The maximum intensity is established by the "Pedal braking" parameter when the brake pedal is fully pressed (brake potentiometer at the maximum). In the middle positions, the electrical braking intensity is a linear function between minimum and maximum intensity.
- DIGITAL : The truck does not have a potentiometer installed on the mechanical brake pedal, but only a microswitch; when the accelerator pedal is released and the brake pedal is pushed (brake switch closed), the inverter performs an electrical braking following "Pedal braking" parameter.

⑧ Set temperature

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

⑨ EPS

- ON : If this option is set to ON, electric power steering function is used.
- OFF : If this option is set to OFF, electric power steering function isn't used.

⑩ Display

This option set the communication check between traction and display.

- ON : Communication check is enable. If the traction can not detect the display communication signal, CAN BUS KO DISP is occured and travel speed cutback to turtle speed.
- OFF : Communication check is disable.

⑪ S.R.O.

If this option is set to on the static return to off is requested for starting the truck.

The required sequence is :

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

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

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

⑫ Pedal type

- OPTION #1 : The pedal position is sent to the display for graphic indication.
- OPTION #2 : The speed set-point is sent to the display for graphic indication.

⑬ Pedal brake stop

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

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

⑭ Model selection

There are 2 options, 14/16BRJ-9 , 20/25BRJ-9.

(Model setting is only avalible at the traction inverter side.)

⑮ Traction cutback

If the mast is lifted the height over free lift, traction speed reduction is working depends on the setting status of this function.

- ON : If set to on this function, traction speed control (TRAC. CTB. SPEED) is performed.
- OFF : If set to off this function, traction speed control (TRAC. CTB. SPEED) isn't performed.

⑯ Joystick mode

- ON : If set to on this function, joystick operation is activated.
- OFF : If set to off this function, joystick operation is disabled.

(2) Submenu "ADJUSTMENTS"

① Set battery type

It selects the nominal battery voltage.

② Adjust battery

Fine adjustment of the battery voltage measured by the controller.

③ **Throttle 0 zone**

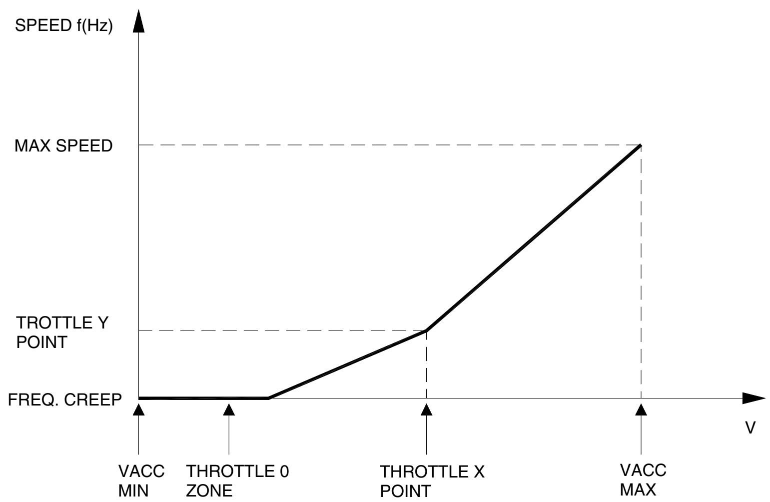
It establishes a deadband in the accelerator input curve.

④ **Throttle X point**

This parameter, together with the THROTTLE Y POINT, changes the characteristic of the accelerator input curve : when the accelerator is de-pressed to X point per cent, the corresponding truck speed is Y point per cent of the Maximum truck speed. The relationship between the accelerator position and the truck speed is linear between the THROTTLE 0 ZONE and the X point and also between the X point and the maximum accelerator position but with two different slopes.

⑤ **Throttle Y point**

This parameter, together with the THROTTLE X POINT, changes the characteristic of the accelerator input curve : when the accelerator is de-pressed to X point per cent, the corresponding truck speed is Y point per cent of the Maximum truck speed. The relationship between the accelerator position and the truck speed is linear between the THROTTLE 0 ZONE and the X point and also between the X point and the maximum accelerator position but with two different slope.



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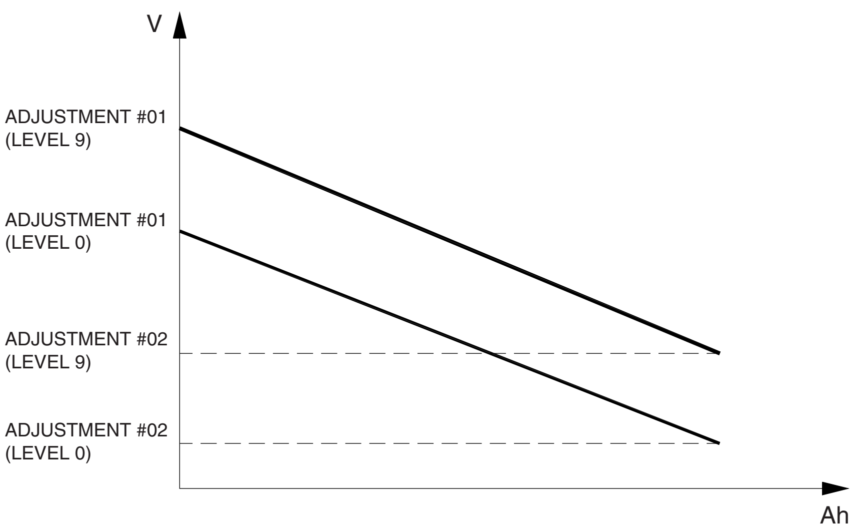
⑥ **Adjustment #2 bdi**

It adjusts the lower level of the battery discharge table.

⑦ **Adjustment #1 bdi**

It adjusts the upper level of the battery discharge table.



BRJ7EL13

⑧ **Bdi adj start up**
Adjust the upper level of the battery charge table
When the key on, this setting table is applied.

⑨ **Adjustment #03 :**
Set an increment of battery charge above actual value. If battery voltage exceed this total value the software recognize charging, and battery charge percentage increase to correct value also if battery isn't fully charged.

⑩ **PWM on main contactor**
- OFF : The inverter applies the battery voltage to the coil on F8 output.
- ON : The PWM reduces the voltage to the set value.

⑪ **PWM on aux output**
- OFF : The inverter applies the battery voltage to the coil on F9 output.
- ON : The PWM reduces the voltage to the set value.

⑫ **MC/AUX PWM** : It sets the PWM level in % on the outputs F8 and F9. Here is used to drive a main contactor.

⑬ **Speed factor**
It adjust the speed coefficient to have the correct speed indication on the display. This coefficient has to be regulated depending on truck mechanic characteristics. It results from the following formula :
Speed factor = 88*rr*p/ ø
Where : rr = total gearbox ratio
ø = traction wheel diameter(㎝)
P = number of pair poles of the motor

⑭ **Adjustment #04** : This parameter determines the motor temperature level at which the "MOTOR TEMPERATURE" alarm is signalled. This parameter must be adjusted only if the "SET TEMPERATURE" (menu "SET OPTION") parameter is programmed "ANALOG"

(3) Submenu "PARAMETER CHANGE"

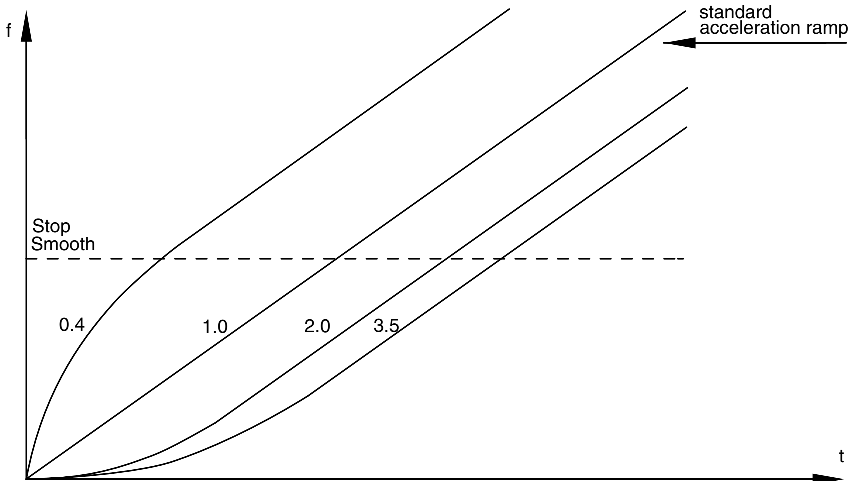
① **Acceleration delay** : It determines the acceleration ramp.
② **Acceleration cutback** : It controls the acceleration ramps when TRACTION CUTBACK is on.
③ **Release braking** : It controls the deceleration ramp when the travel request is released.
④ **Inverse braking** : It controls the deceleration ramp when the direction switch is inverted during travel.
⑤ **Pedal braking** : It determines the deceleration ramp when the travel request is released and the brake pedal switch is closed.
⑥ **Speed limit braking** : Deceleration ramp when the pedal position is changed but not completely released.
⑦ **Brake cutback** : It determines the deceleration ramp when the speed reduction input becomes active and the motor slow down.
⑧ **Max speed forward** : It determines the maximum speed in forward direction.
⑨ **Max speed backward** : It determines the maximum speed in backward direction.
⑩ **Turtle speed** : It determines the maximum speed at turtle mode.
⑪ **Batt remove speed** : It determines the maximum speed when battery remove switch is open.
⑫ **Cutback speed 1** : Typically from 10% to 100%. It determines the percentage of the max speed applied when the cutback switch is active. When set to 100% the speed reduction is ineffective.
⑬ **Frequency creep** : Minimum speed when the forward or reverse switch is closed, but the accelerator is on a minimum position.

⑭ **Maximum current** : This parameter changes the maximum current of the inverter.

⑮ **Acc. smooth** : It gives a different from to the acceleration curve in the frequency range 0 Hz to "Stop smooth" value (seel the figure below).

⑯ **INV. smooth** : It gives a different from to the acceleration curve after a direction inversion in the frequency range 0 Hz to "Stop smooth" value (see the figure below).

⑰ **Stop smooth** : It sets the level of frequency where the smooth effect on the acceleration ramp ends.



BRJ7EL14A

⑱ **Seat delay time** : It sets the delay time after the seat switch is off.

⑲ **Sequence delay** : It sets the delay from the accelerator enable to direction signal input.

⑳ **Chat time** : In seconds. When truck is key on, if the operator doesn't use the truck for the time (CHAT TIME), main contactor is open to save energy.

㉑ **Curve cutback** : Speed reduction when the truck is doing a curve. The parameter sets the speed setpoint when the truck driving wheels are running in opposite direction or when the maximum steering angle is reached.

㉒ **Dead angle** : It determines the tire angle range be able to get full speed.

㉓ **Traction cutback speed** : It sets the traction speed when traction cutback is on.

■ PUMP CONTROLLER

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

(1) Submenu "SET OPTIONS"

① **Hour counter**

This option specifies the hour counter mode. It can be set one of two:
- RUNNING : The counter registers travel time only.
- KEY ON : The counter registers when the "key" switch is closed.

② **Set motor sens**
- DIGITAL : A digital (ON/OFF) motor thermal sensor is connected to A25 input.
- ANALOG : An analog motor thermal sensor is connected A25 (the curve can be customized on a customer request).
- NONE : No motor thermal sensor switch is connected.

③ **Electrical distribution**
- ON : In case of BRJ truck that has electro solenoid valves, It is set to On.
- OFF : In case of BRJ truck that has manual valves, It is set to Off.

④ **Model selection**
There are 2 options, 14/16BRJ-9 , 20/25BRJ-9.
(Model setting is only avalible at the traction inverter side.)

⑤ **Digital lift**
- OFF : The lift sensor includes a lift switch and an analogue lift sensor. Lift speed can be controlled proportionally with lever position.
- ON : The lift sensor includes a lift switch only. Lift speed cannot be controlled proportionally.

⑥ **Lifting cutback**
If the mast is lifted the height over free lift, lift speed reduction is working depends on the setting status of this function.
- ON : If set to on this function, lift speed control is performed.
- OFF : If set to off this function, lift speed control isn't performed.

⑦ **Side shift function**
- OFF : The truck doesn't have the side shift function (default)
- ON : The truck has the side shift function (option)

⑧ **Lever full**
- OFF : Multi hydrulic function is not available at special condition for the safety.
  (Lift + reach out , lift + tilt down)
- ON : Multi hydrulic function is available.

⑨ **Height indicat.**
- OFF : Height indicator function is not activated.
- ON : Height indicator function is activated.

⑩ **Reach speed red**
If the mast is lifted the height over free lift, reach speed reduction is working depends on the setting status of this function.
- ON : If set to on this function, reach speed control is performed.
- OFF : If set to off this function, reach speed control isn't performed.

⑪ **Load sensor**
- None : Load sensing function is
- Option #1 : Load sensing function is activated. (sensing process is same as CB truck.)
- Option #2 : Load sensing function is activated. (only after lift & lowering function, sensing process is going on.)

⑫ **Fork leveling**
- OFF : Auto fork leveling function is not activated.
- ON : Auto fork leveling function is activated.

⑬ **Buzzer direction**
- Option #1 : When the truck is moving to fork direction, buzzer is working.
- Option #2 : When the truck is moving to anti-fork direction, buzzer is working.
- Option #3 : When the truck is moving to any direction, buzzer is working.

⑭ **Fan control**
Cooling fans installed on nearby motors and controllers will work as follows;
- None : fans don't work.
- Option #1 : fans work always.
- Option #2 : fans work in case a temperature of controller or motor exceeds a temperature set in FAN CTL. TEMP menu
- Option #3 : fans work when motors work.

⑮ **Overload type**

This option specifies how overload alarm works in overloaded situation.

- NONE : There would'n be any kind of alarms or limitations. If re-configuration of V.A.S.S LOAD is required, please set this parameter as NONE, then proceedure-configuration.
- Option #1 : If the weight of load filed on forks exceeds the overload weight set in overload parameter, OVERLOAD alarm will be displayed and followed by traction & pump limitation except lift down & steering function.
- Option #2 : If the weight of load filed on forks exceeds the overload weight set in overload parameter, OVERLOAD alarm will be displayed.

(2) Submenu "ADJUSTMENTS"

① **Set battery type** : Selects the nominal battery voltage.

② **Adjust battery** : Fine adjustment of the battery voltage measured by the controller.

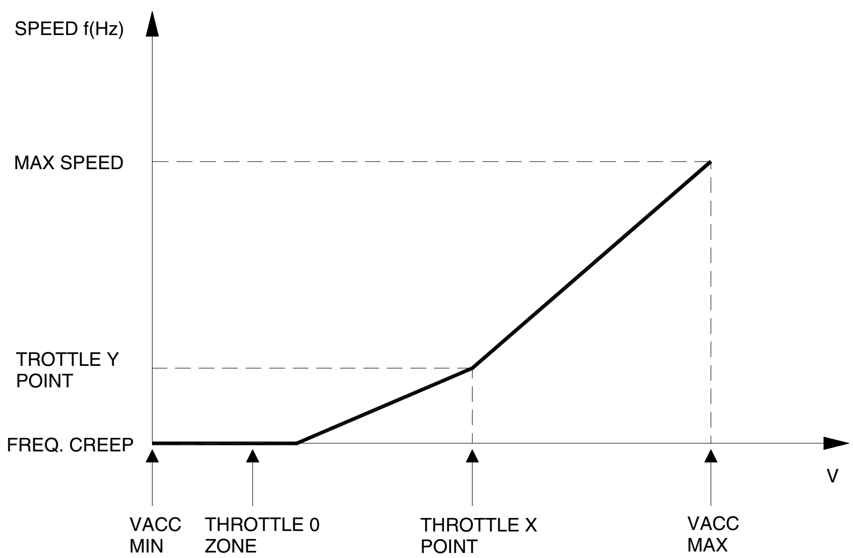
③ **Throttle 0 zone** : Establishes a deadband in the accelerator input curve.

④ **Throttle X point**

This parameter, together with the THROTTLE Y POINT, changes the characteristic of the accelerator input curve : when the accelerator is de-pressed to X point per cent, the corresponding truck speed is Y point per cent of the Maximum truck speed. The relationship between the accelerator position and the truck speed is linear between the THROTTLE 0 ZONE and the X point and also between the X point and the maximum accelerator position but with two different slopes.

⑤ **Throttle Y point**

This parameter, together with the THROTTLE X POINT, changes the characteristic of the accelerator input curve : when the accelerator is de-pressed to X point per cent, the corresponding truck speed is Y point per cent of the Maximum truck speed. The relationship between the accelerator position and the truck speed is linear between the THROTTLE 0 ZONE and the X point and also between the X point and the maximum accelerator position but with two different slope.



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⑥ **Adjustment #04 :** This parameter determines the motor temperature level at which the "MOTOR TEMPERATURE" alarm is signalled. This parameter must be adjusted only if the "SET TEMPERATURE" (menu "SET OPTION") parameter is programmed "ANALOG"

⑦ **PWM on main contactor**

-OFF: The inverter applies the battery voltage to the coil on F8 output.

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

⑧ **PWM on aux output**

-OFF: The inverter applies the battery voltage to the coil on F9 output.

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

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

⑩ **Fan ctl. temp :** if FAN CONTROL menu is set as option #2, This menu is used to set a temperature limitation which allows fans to work when a temperature of controller or motor exceeds the limitation.

⑪ **Fork min speed :** (This parameter used for auto fork leveling function is on)
It sets the motor speed reduction pecentage of the set tilt speed, when fork leveling function is doing.

⑫ **Fork valve min :** (This parameter used for auto fork leveling function is on)
It sets the pecentage of tilt valve current , when fork leveling function is doing.

⑬ **Fork appr rng :** (This parameter used for auto fork leveling function is on)
It sets the pecentage of approach range from the center value, when fork leveling function is doing.

⑭ **Fork center dead :** (This parameter used for auto fork leveling function is on)
It sets the pecentage of center dead zone from the center value, when fork leveling function is doing.

⑮ **Reference weight :** (This parameter used for load sensor function)
This parameter is used to show and configurate the reference load weight.

⑯ **Overload weight :** (This parameter used for load sensor function)
This parameter is used to show and configurate the trigger condition for OVERLOAD alarm. If the loaded weight exceeds the weight indicated in this paramter, OVERLOAD alarm and function limitation will occur accroding to OVERLOAD TYPE paramter.

⑰ **Maximmum weight :** (This parameter used for load sensor function)
This parameter is used to show and configurate the maximum load weight.

⑱ **Minimum weight :** (This parameter used for load sensor function)
This parameter is used to show and configurate the minimum load weight.

⑲ **Load speed upd. :** (This parameter used for load sensor function)
To increase accuracy, Load Sensor only works when the traction motor speed is lower than as set in this parameter.

⑳ **Offset height :** (This parameter used for height indicator function)
It sets the free lift height.

㉑ **Max height 100 mm :** (This parameter used for height indicator function)
It sets the maximun lift height over 100 mm digit. (ef. set value 10 means 1000 mm)
If fork is approached the set height, lifting function is not working.

㉒ **Max height 1 mm :** (This parameter used for height indicator function)
It sets the maximun lift height from 1 mm to 99 mm digit. (ef. set value 10 means 10 mm)
If fork is approached the set height, lifting function is not working.

(3) Submenu "PARAMETER CHANGE"

① **Acceleration delay :** It determines the acceleration ramp.
② **Deceleration delay :** It determines the acceleration ramp.
③ **Max speed up :** It determines the maximum lifting speed with a potentiometer control.
④ **Min speed up :** It determines the minimum lifting speed with a potentiometer control when the lifting enable switch is closed.
⑤ **Cutback speed :** Speed reduction when the cutback switch is active.
⑥ **Reach in speed :** It determines the reach in speed.
⑦ **Reach out speed :** It determines the reach out speed.
⑧ **Min reach speed :** It determines the minimum reach speed with a potentiometer control when the reach switch is closed.
⑨ **Shift speed :** It determines the sideshift speed.
⑩ **Min shift speed :** It determines the minimum sideshift speed with a potentiometer control when the sideshift switch is closed.
⑪ **Tilt speed :** It determines the tilt speed.
⑫ **Fork max speed :** (This parameter used for auto fork leveling function is on)
It sets the maximum motor speed for the tilt function, when fork leveling function is doing.
⑬ **Creep fork lev :** (This parameter used for auto fork leveling function is on)
It sets the minimum motor speed for the tilt function, when fork leveling function is doing.
⑭ **Fork dw. val max :** (This parameter used for auto fork leveling function is on)
It sets the pecentage of tilt valve current , when fork leveling function is doing from up position to down position.
⑮ **Lift speed red :** It sets the motor speed for the lifting function when lift end switch is off.
⑯ **Min tilt speed :** It determines the minimum tilt speed with a potentiometer control when the tilt switch is closed.
⑰ **Aux speed :** It determines the aux speed.
⑱ **Maximum current :** This parameter changes the maximum current of the inverter.
⑲ **Reach in ctb2 :** It sets the percentage of reach in valve current.
(This set value is applied only when reach in operation is doing in the reach in cutback stroke.)
⑳ **Reach out ctb2 :** It sets the percentage of reach out valve current.
(This set value is applied only when reach out operation is doing in the reach out cutback stroke.)
㉑ **Rein ctb cls del :** It sets the close delay of reach in valve after reach in cutback switch is on.
(This delay is applied only when reach in cutback switch status is from open to close on the reach in operation. If delay time is over, reach in valve is closed automatically.)
㉒ **Reout ct cls del :** It sets the close delay of reach out valve after reach out cutback switch is on.
(This delay is applied only when reach out cutback switch status is from open to close on the reach out operation. If delay time is over, reach out valve is closed automatically.)
㉓ **Reach in sp red :** It sets the motor speed for the reach in function when reach speed red is on.
㉔ **Reach out sp red :** It sets the motor speed for the reach out function when reach speed red is on.
㉕ **Lifting speed 2 :** It sets the motor speed for the lifting function when lifting cutback is on.

5) PROGRAMMING & ADJUSTMENTS

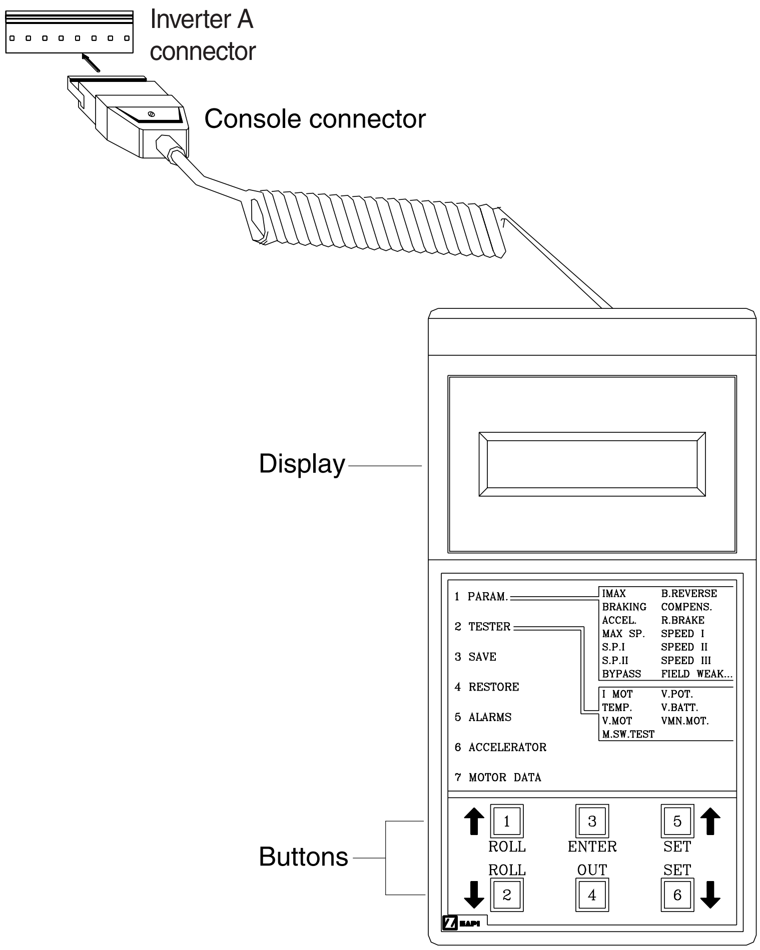
There are two ways to adjust parameter via a console or buttons on a display.

※ Adjustments via buttons on a display, please refer to the display section. (page 7-51)

ADJUSTMENTS VIA CONSOLE (Option)

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

(1) Descriptions of console



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※ Digital consoles used to communicate with AC inverter controllers must be fitted with EPROM CK ULTRA, minimum "Release number 3.02".

(2) Description of standard console menu

① Traction controller

HEADING

MAIN MENU

PARAMETER CHANGE

ACCELER. DELAY	LEVEL
ACC. CUTBACK	LEVEL
RELEASE BRAKING	LEVEL
INVERS. BRAKING	LEVEL
PEDAL BRAKING	LEVEL
SPEED LIMIT BRK.	LEVEL
BRAKE CUTBACK	LEVEL
MAX SPEED FORW	HZ
MAX SPEED BACK	HZ
TURTLE SPEED	HZ
BATT REMOV SPEED	HZ
CUTBACK SPEED 1	%
FREQUENCY CREEP	HZ
MAXIMUM CURRENT	LEVEL
ACC. SMOOTH	
INV. SMOOTH	
STOP SMOOTH	HZ
SEAT DELAY TIME	SEC
SEQUENCE DE.TIME	SEC
CHAT TIME	MIN
CURVE CUTBACK	%
DEAD ANGLE	LEVEL
TRAC.CTB.SPEED	HZ

TEATER

MOTOR VOLTAGE	%
FREQUENCY	HZ
ENCODER	HZ
SLIP VALUE	HZ
CURRENT RMS	A
TEMPERATURE	°C
MOTOR TEMPERAT.	°C
JOY GRIP AXIS	
STEER ANGLE	°
ACCELERATOR	V
FORWARD SWITCH	ON-OFF
BACKWARD SWITCH	ON-OFF
ENABLE SWITCH	ON-OFF
SEAT SWITCH	ON-OFF
CUTBACK SWITCH	ON-OFF
BRAKE SWITCH	ON-OFF
BATTERY CUTBACK	ON-OFF
BRAKEPEDAL POT.	V
HANDBRAKE	ON-OFF
VOLTAGE BOOSTER	%
BATTERY VOLTAGE	V
BATTERY CHARGE	%

SAVE PARAMETER

RESTORE PARAMETER

ALARMS — CODE. h, N°, °C

PROGRAM VACC — VACC SETTING MIN/MAX

SET MODEL — CONNECTED TO 2

SET OPTIONS

HOUR COUNTER	RUNNING/KEYON
BATTERY CHECK	ON/OFF
CUTBACK MODE	ON/OFF
TRACTUON CUTOUT	ON/OFF
LIFT CUTOUT	ON/OFF
STOP ON RAMP	ON/OFF
PEDAL BRAKE	DIGITAL/ANALOG
SET TEMPERATURE	NONE/DIGITAL/ANALOG
EPS	ON/OFF
DISPLAY	ON/OFF
S.R.O	ON/OFF
PEDAL TYPE	OPTION#1/#2
PEDAL BRK STOP	ON/OFF
MODEL SELECTION	16/25
TRACTION CUTBACK	ON/OFF
TYPE DIRECTION	OPTION#1/#2
PHASE DIRECTION	OPTION#1/#2
JOYSTICK MODE	ON/OFF

ADJUSTMENTS

SET POT BRK MIN	V
SET POT BRK MAX	V
SET BATTERY TYPE	24/36/48/72/80/96
ADJUST BATTERY	V
THROTTLE 0 ZONE	%
THROTTLE X POINT	%
THROTTLE Y POINT	%
ADJUSTMENT#2 BDI	LEVEL
ADJUSTMENT#1 BDI	LEVEL
BDI ADJ START UP	LEVEL
ADJUSTMENT #03	%
PWM ON MAIN CONT	ON/OFF
PWM ON AUX OUT.	ON/OFF
MC/AUX PWM	%
ADJUSTMENT #04	°C
SPEED FACTOR	0 - 255

② Pump controller

- HEADING
  - MAIN MENU
    - PARAMETER CHANGE
    - TEATER
    - SAVE PARAMETER
    - RESTORE PARAMETER
    - ALARMS
    - PROGRAM VACC
  - SET MODEL
  - SET OPTIONS
  - ADJUSTMENTS

PARAMETER CHANGE

ACCELER. DELAY	LEVEL
DECELER. DELAY	LEVEL
MAX SPEED UP	HZ
MIN SPEED UP	HZ
CUTBACK SPEED	HZ
REACH IN SPEED	HZ
REACH OUT SPEED	HZ
MIN REACH SPEED	HZ
SHIFT SPEED	HZ
MIN SHIFT SPEED	HZ
TILT SPEED	HZ
FORK MAX SPEED	HZ
CREEP FORK LEV	%
FORK DW. VAL MAX	%
LIFT SPEED RED	HZ
MIN TILT SPEED	HZ
AUX SPEED	HZ
MAXIMUM CURRENT	LEVEL
REACH IN CTB	%
REACH OUT CTB	%
REACH IN CTB 2	%
REACH OUT CTB 2	%
REIN CTB CLS DEL	SEC
REOUT CT CLS DEL	SEC
REACH IN SP RED	HZ
REACH OUT SP RED	HZ
LIFTING SPEED 2	HZ

TEATER

MOTOR VOLTAGE	%
FREQUENCY	HZ
ENCODER	HZ
SLIP VALUE	HZ
CURRENT RMS	A
TEMPERATURE	°C
MOTOR TEMPERAT.	°C
LIFTING SWITCH	ON/OFF
DESCENT SWITCH	ON/OFF
FORK LEV. REQ.	ON/OFF
CUTBACK SWITCH 1	ON/OFF
CUTBACK SWITCH 2	ON/OFF
TILT UP SWITCH	ON/OFF
TILT DOWN SWITCH	ON/OFF
SHIFT LFT.SWITCH	ON/OFF
SHIFT RGT.SWITCH	ON/OFF
REACH IN SWITCH	ON/OFF
REACH OUT SWITCH	ON/OFF
REACH IN SW CTB	ON/OFF
REACH OUT SW CTB	ON/OFF
JOY LEVEL BUTTON	ON/OFF
JOY TILT BUTTON	ON/OFF
JOY LIFT BUTTON	ON/OFF
JOY HORN BUTTON	ON/OFF
LIFT/LOWER REQ.	V
TILT REQUEST	V
SHIFT REQUEST	V
AUX REQUEST	V
REACH REQUEST	V
VOLT MAX LOAD	V
VOLT OVR LOAD	V
LOAD WEIGHT	KG
ENCODER 1 MM	MM
ENCODER 2 MM	MM
MES HEIGHT MM	MM
SET POINT HEIGHT	MM
JOY X AXIS REQ	
JOY Y AXIS REQ	
CUTBACK SWITCH	ON/OFF
VOLTAGE BOOSTER	%
FORK POSITION	V

SAVE PARAMETER

RESTORE PARAMETER

ALARMS: CODE. h, N°, °C

PROGRAM VACC: VACC SETTING MIN/MAX

SET MODEL: CONNECTED TO 5

SET OPTIONS

HOUR COUNTER	RUNNING/KEYON
SET MOTOR SENS	NONE/DIGITAL/ANALOG
ELECTRICAL DIST.	ON/OFF
MODEL SELECTION	16/25
DIGITAL LIFT	ON/OFF
LIFTING CUTBACK	ON/OFF
REACH SPEED RED	ON/OFF
SIDE SHIFT FUNCT	ON/OFF
LEVER FULL	ON/OFF
HEIGHT INDICAT.	ON/OFF
LOAD SENSOR	NONE/OPTION#1/#2
FORK LEVELING	ON/OFF
BUZZER DIRECTION	OPTION#1/#2/#3
FAN CONTROL	ON/OFF
OVERLOAD TYPE	NONE/OPTION#1/#2

ADJUSTMENTS

SET BATTERY TYPE	24/36/48/72/80/96
ADJUST BATTERY	V
THROTTLE 0 ZONE	%
THROTTLE X POINT	%
THROTTLE Y POINT	%
ADJUSTMENT #04	°C
PWM ON MAIN CONT	ON/OFF
PWM ON AUX OUT.	ON/OFF
MC/AUX PWM	%
FAN CTL. TEMP	°C
MIN LIFT	V
MAX LIFT	V
MIN LOWER	V
MAX LOWER	V
MIN REACH OUT	V
MAX REACH OUT	V
MIN REACH IN	V
MAX REACH IN	V
MIN SHIFT LFT.	V
MAX SHIFT LFT.	V
MIN SHIFT RGT.	V
MAX SHIFT RGT.	V
MIN TILT DOWN	V
MAX TILT DOWN	V
MIN TILT UP	V
MAX TILT UP	V
FORK LEVEL MIN	V
FORK LEVEL MAX	V
FORK LVL CENTER	V
FORK MIN SPEED	%
FORK VALVE MIN	%
FORK APPR RNG	%
FORK CENTER DEAD	%
ADJ. MIN LOAD	V
ADJ. REF LOAD	V
REFERENCE WEIGHT	KG
OVERLOAD WEIGHT	KG
MAXIMMUM WEIGHT	KG
MINIMUM WEIGHT	KG
LOAD SPEED UPD.	HZ
OFFSET HEIGHT	MM
MAX HEIGHT 100MM	
MAX HEIGHT 1MM	
ENC.SENS.100 MM	
ENC.SENS. 01 MM	
MIN SPEED LIFT	%
MIN SPEED LOW	%
LIFT STOP WINDOW	
LOW. STOP WINDOW	
SPEED REDUCTION	

(3) Description of ALARMS menu

The microprocessor in the controller records the last five alarms that have occurred. Items remembered relative to each alarm are: the code of the alarm, the number of times the particular Alarm occurred, the hour meter count, and the inverter temperature.
This function permits a deeper diagnosis of problems as the recent history can now be accessed.
Flow chart showing how to use the ALARMS function via the digital console.

① Opening Zapi display.

② Press ENTER to go into the general menu.

③ The display will show:

④ Press ROLL UP or ROLL DOWN button until PARAMETER CHANGE. appear on the display.

⑤ The display shows:

⑥ Press ENTER to go into the ALARMS function.

⑦ The display will show the most recent alarm.

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

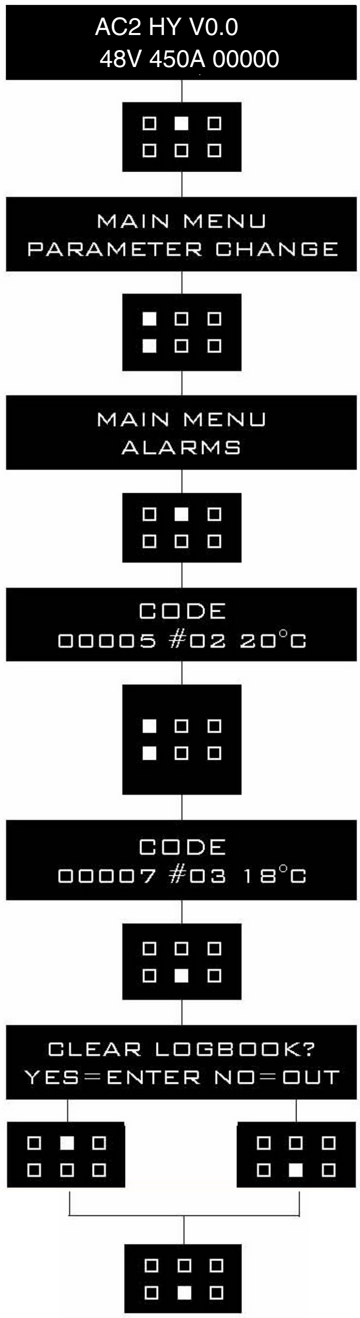
⑨ If an alarm has not occurred, the display will show: ALARM NULL.

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

⑪ The display will ask "CLEAR LOGBOOK?".

⑫ Press ENTER for yes, or OUT for NO.

⑬ Press OUT to return to the opening Zapi display.



BRJ7EL23

(4) Description of console PROGRAM VACC function

This function looks for and remembers the minimum and maximum potentiometer wiper voltage over the full mechanical range of the pedal. It enables compensation for non symmetry of the mechanical system between directions.
The operation is performed by operating the pedal after entering the PROGRAM VACC function.
Flow chart showing how to use the PROGRAM VACC function of the digital console:

① Opening Zapi display.

② Press ENTER to go into the general menu.

③ The display will show:

④ Press ROLL UP or ROLL DOWN button until PROGRAM VACC. appear on the display.

⑤ The display shows:

⑥ Press ENTER to go into the PROGRAM VACC routine.

⑦ The display will show the minimum and maximum values of potentiometer wiper output. Both directions can be shown.

⑧ Press ENTER to clear these values. Display will show 0.0.

⑨ Select forward direction, close any interlock switches that may be in the system.

⑩ Slowly depress the accelerator pedal (or tiller butterfly) to its maximum value. The new minimum and maximum voltages will be displayed on the console plus an arrow indicating the direction.

⑪ Select the reverse direction and repeat Item10.

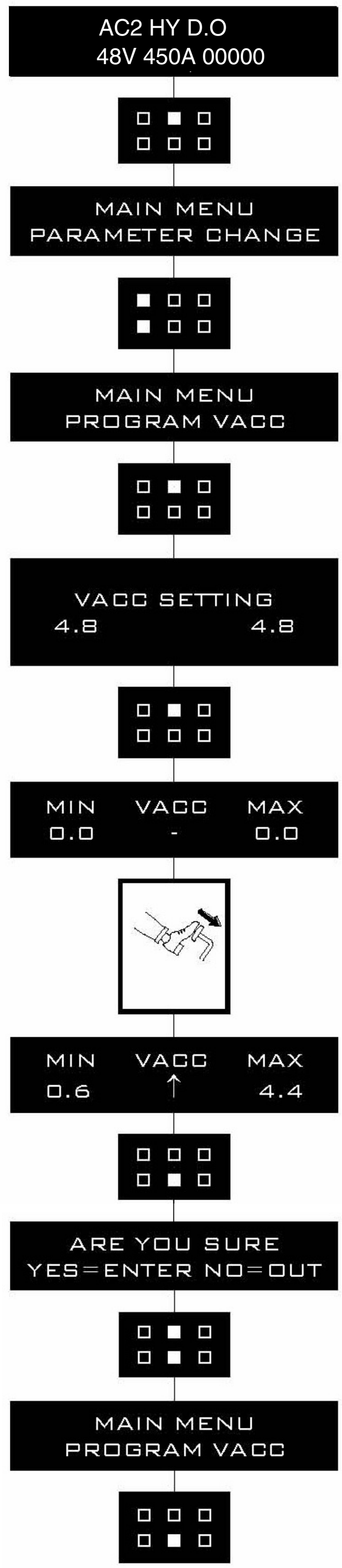
⑫ When finished, press OUT.

⑬ The display will ask : "ARE YOU SURE?".

⑭ Press ENTER for yes, or OUT for NO.

⑮ When finished, the console shows:

⑯ Press OUT again to return to the opening Zapi menu.



BRJ7EL24

6) TESTER MENU (IN DISPLAY, MONITORING MENU)

(1) Traction controller

The most important input or output signals can be measured in real time using the TESTER function of the console. The console acts as a multimeter able to read voltage, current and temperature. In the following chapter a list of relative measurements for different configurations.

① Motor voltage

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

② Frequency

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

③ Encoder

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

④ Slip value

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

⑤ Current rms

Root Mean Square value of the motor current.

⑥ Temperature

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

⑦ Motor temperature

This is the temperature of the motor; if the option is programmed "None" it shows 0°C.

⑧ Joy grip axis

This is the amount of joystick right rocker operation. (it selects the forward/backward direction)

⑨ Steer angle

This is the degree of steer tire angle.

⑩ Accelerator

The voltage of the accelerator potentiometer's wiper (CPOT). The voltage level is shown on the left hand side of the console display and the value in percentage is shown on the right hand side.

⑪ Forward switch

The level of the forward direction digital entry FW.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑫ Backward switch

The level of the reverse direction digital entry BW.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch

⑬ Enable switch

The level of the accel enable switch.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch

⑭ Seat switch

The level of the seat microswitch digital entry.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑮ Cutback switch

The level of the speed reduction microswitch.

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

⑯ Brake switch

The level of the pedal brake microswitch.

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

⑰ Battery cutback

The level of the battery remove switch.

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

⑱ Brake pedal pot.

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

⑲ Hand brake

The level of the handbrake microswitch.

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

⑳ Voltage booster

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

㉑ Battery voltage

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

㉒ Battery charge

The percentage charge level of the battery.

(2) Pump controller

The most important input or output signals can be measured in real time using the TESTER function of the console. The Console acts as a multimeter able to read voltage, current and temperature. In the following chapter a list of relative measurements for different configurations.

① Motor voltage

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

② Frequency

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

③ Encoder

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

④ Slip value

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

⑤ Current RMS

Root mean square value of the motor current.

⑥ Temperature

The temperature measured on the aluminum heat sink holding the MOSFETdevices.

⑦ Motor temperature

This is the temperature of the motor; if the option is programmed "None" it shows 0°C.

⑧ Lifting switch

Status of the lifting switch.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑨ Descent switch

Status of the lowering switch.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑩ Fork lev. Req.

Status of the auto tilt leveling enable switch.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑪ Cutback switch 1

The level of the speed reduction1 microswitch.

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

⑫ Cutback switch 2

The level of the speed reduction2 microswitch.

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

⑬ Tilt up switch

Status of the tilt up switch.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑭ Tilt down switch

Status of the tilt down switch.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑮ Shift left switch

Status of the shift left speed switch.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑯ Shift right switch

Status of the shift right speed switch.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑰ Reach in switch

Status of the reach in switch.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑱ Reach out switch

Status of the reach out switch.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑲ **Reach in sw ctb**
Status of the reach in cutback switch.
- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑳ **Reach out sw ctb**
Status of the reach out cutback switch.
- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

㉑ **Joy level button**
Status of the tilt leveling enable switch on joystick.
- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

㉒ **Joy tilt button**
Status of the tilt enable switch on joystick.
- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

㉓ **Joy horn button**
Status of the horn switch on joystick.
- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

㉔ **Lift/lower request**
Level of the lift and lower analogue signal. The voltage is shown on the left hand side of the display and the value in percentage on the right hand side.

㉕ **Tilt request**
Level of the tilt analogue signal. The voltage is shown on the left hand side of the display and the value in percentage on the right hand side.

㉖ **Shift request**
Level of the shift analogue signal. The voltage is shown on the left hand side of the display and the value in percentage on the right hand side.

㉗ **Aux request**
Level of the auxiliary analogue signal. The voltage is shown on the left hand side of the display and the value in percentage on the right hand side.

㉘ **Reach request**
Level of the reach analogue signal. The voltage is shown on the left hand side of the display and the value in percentage on the right hand side.

㉙ **Volt max load**
This shows the set max load voltate.

㉚ **Volt ovr load**
This shows the set overload voltage.

㉛ **Load weight**
This shows the measured load weight voltage.

㉜ **Encoder 1 mm**
This shows the encoder1 value for the height indicator.

㉝ **Encoder 2 mm**
This shows the encoder2 value for the height indicator.

㉞ **Mes height mm**
This shows the mesured height calculated by controller.

㉟ **Set point height**

This shows the preset height selected by operator.

㊱ **Joy X axis req**

This is the amount of joystick x axis operation.

㊲ **Joy Y axis req**

This is the amount of joystick y axis operation.

㊳ **Cutback switch**

The level of the speed reduction microswitch.

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

㊴ **Voltage booster**

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

㊵ **Fork position**

This is the voltage signal of the tilt angle.

7) GENERAL SUGGESTION FOR SAFETY

For a proper installation take care of the following recommendations:

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

⚠ Do not connect the inverter to a battery with a nominal value different from the value indicated on the controller plate. If the battery value is greater, the MOS may fail; if it is lower, the control unit does not "power up"

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

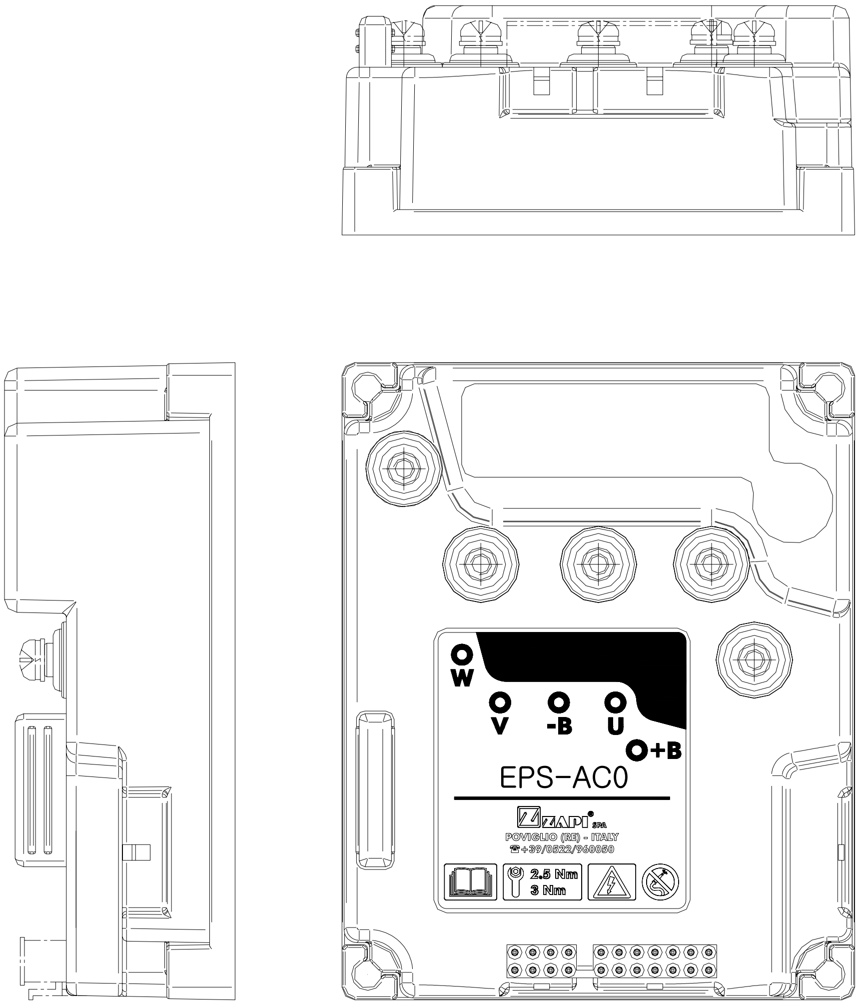
⚠ Do not connect the controller to a battery with a nominal voltage different than the value indicated on the controller label. A higher battery voltage may cause power section failure. A lower voltage may prevent the logic operating.

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

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

7. EPS CONTROLLER

1) STRUCTURE



BRJ7EL51

(1) Specifications

Model	Model	Application	Type	Power	Current limit
14/16/20/25BRJ-9	AC0	EPS	AC	36-48V, 45A	45A/2min

2) OPERATIONAL FEATURES

(1) Features

A list of eps-ac0 operational features follows below:

① Static sensitivity boost in open loop (steering sensitivity increases for a slow moving steering wheel).

② Static numbness in closed loop (steering sensitivity decreases for handle steer close to the straight-ahead direction).

③ Dynamic numbness in open loop (steering sensitivity reduces when the truck speed increases).

④ Dynamic numbness on request in closed loop (steering sensitivity reduces when the truck speed increases).

⑤ Truck speed reduces when the steering angle increases.

⑥ Alignment at the rest position in open loop application (to avoid the drift of the steered wheel when travelling with released steering wheel).

⑦ Embedded PID algorithm for automatic functions (AUTC).

⑧ Special debugging & troubleshooting system makes easier the fault catching.

⑨ Possibility to run in a stand-alone (not CAN Bus supported) configuration.

⑩ Motor control may be performed with encoder.

⑪ Redundant processing (two microprocessors aboard) fulfils the category #3 requirement including the set-point comes via CAN Bus from a remote unit.

⑫ Redundant set point and feedback sensors fulfil the category #3 requirement.

(2) Diagnosis

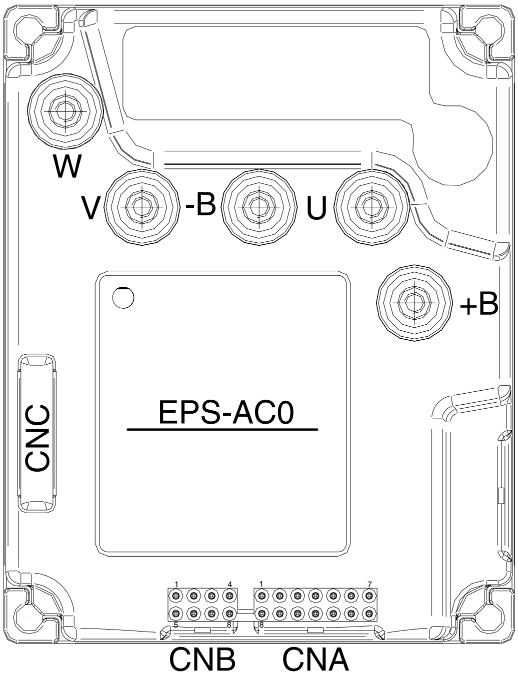
According to EN1175, most of the diagnoses deenergize steer and traction in less then 100 msec.

Few secondary alarm conditions require longer time for detection. They too deenergize steer and traction.

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

3) DESCRIPTION OF CONNECTORS

(1) EPS controller



BRJ7EL52

No. of pin	Function	Description
A2	SW 2	2nd toggle switch (90 degrees).
A3	SW 1	1st toggle switch (0 degrees).
A4	-BATT.	Safety switch lower voltage point.
A5	SAFETY	Safety switch higher voltage point.
A6	CAN L	Can bus low.
A7	KEY	Key in.
A8	QL	Stepper motor Q line.
A9	DL	Stepper motor D line.
A10	GND	GND. encoder D line negative supply
A11	GND	GND. encoder Q line negative supply and EPS motor encoder negative
A12	GND	GND. SW 1 & SW 2 negative.
A13	GND	GND. motor themal sensor negative.
A14	CANH	Can bus high.
B3	THMOT	Motor themal sensor (KTY84-130) input.
B4	VDC	Encoder positive supply.
B7	CHB	Encoder channel B.
B8	CHA	Encoder channel A.

No. of pin	Function	Description
C1	PCLRXD	Positive serial reception.
C2	NCLRXD	Negative serial reception.
C3	PCLTXD	Positive serial transmission.
C4	NCLTXD	Negative serial transmission.
C5	GND	Negative console power supply.
C6	+12	Positive console power supply.
C7	FLASH	It must be connected to A8 for the flash memory programming.
C8	FLASH	It must be connected to A7 for the flash memory programming.

4) FUNCTION CONFIGURATION

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

(1) Submenu "SET OPTIONS"

① MICRO CHECK

This option is useful to support debug and troubleshooting. It makes possible to inhibit the supervisor (slave uC) operations and allows the system to run with just the main uC. When entering this operating mode the safety contacts stay open. Therefore, traction shall be disabled.

It can be set one of two:

PRESENT: Default setting: enable the operations of the supervisor (slave uC).

ABSENT: Disable the operations of the supervisor (slave uC). The safety contacts stay opened.

② AUTOCENTERING

This option makes the automatic centering (AUTC) operation available. When it is set on, an automatic alignment of the steered wheel on the straight ahead toggle switch is always performed at key-on. When it is set off, the AUTC at key-on is still performed for any configuration but for the open loop (stepper motor at the steering wheel) without angle limitation. In this latest case, the centering must be manually executed. Besides, this option enables the AUTC on demand.

A centering request is required in this case to get the AUTC on-demand really performed.

③ RECOVERY AT REST

(Stepper motor version only).This option enables the function "alignment at the rest position"

It consists of the following steps:

- When releasing the stepper motor, the SW records the steered wheel angle.
- Then it is expected the steered wheel angle does not change meanwhile travelling with a released stepper motor.
- If the steered wheel angle changes more than 8 degrees, the system automatically turns back to the recorded position If the driver moves the stepper motor meanwhile an alignment at the rest position is in progress, the alignment will be aborted.

④ DIAG MOTOR TEMP

This option enables the diagnosis of the motor temperature. When it is set on and the motor temperature overtakes 150° , a MOTOR TEMPERAT alarm occurs.

The KTY84-130 motor thermal sensor must be connected between CNB#3 and a minus battery (CNA#13).

⑤ TRUCK TYPE

This option sets the truck type.

- Option #1 : 14/16/20/25BRJ-7
- Option #2 : 10/13BOP-7
- Option #3 : 15/18/20/23BRP-7
- Option #4 : 14/16/20/25BRJ-9

(2) Submenu "ADJUSTMENTS"

① SET BATTERY TYPE

Set this adjustment to the nominal battery voltage. Pay attention, never set SET BATTERY TYPE higher than 36 V for a 24/36 V controller. Never set SET BATTERY TYPE lower than 36V for a 36/48V controller.

② SET SAT. FREQ.

Set this adjustment to the corner frequency of the motor. SET SAT FREQ is to be meant as the maximum frequency at which the motor supplies the maximum torque (it is the superior limit of the constant torque characteristic). Frequency higher than SET SAT FREQUENCY gets the motor weakened.

③ AUTOTEACHING

This option (on/off) is used to launch the autoteaching procedure. Take care there is not mechanical angle limitation before to turn it on. Then recycle the key and the steering motor starts an automatic sequence to collect the ENC COUNT AT 360 and ENC COUNT AT 180. If the collected couple is consistent (ENC COUNT AT 180 stays inside the window from 3/8 to 6/8 of ENC COUNT AT 360) they are automatically saved on the settings SET ENC AT 360 and SET ENC AT 180. If the autoteaching procedure successful ends, the display switches from the DATA ACQUISITION alarm to the collected values (in the range 0 to 5Vdc. Left side shows the ENC COUNT AT 360 value; the right side shows the ENC COUNT AT 180 value). If the ouple of values is not consistent they were not saved and the display switches cyclically from the collected data to the DATA ACQUISITION inscription.

(3) Submenu "PARAMETER CHANGE"

① SPEED LIMIT

Level 0 to 9. It determines the scaling factor between the speed of the steering wheel and the speed of the steering motor but only when the steering wheel is fast turning. By increasing the SPEED LIMIT value, the steering motor speed increases too. In practice, it sets the maximum motor speed when the steering wheel is fast turning.

② AUX FUNCTION #3

Level 0 to 9. This setting performs the Dynamic Numbness compensation: it consists of a reduction in the steer sensitivity when the truck is driving at high speed. To get this goal, it is necessary to attenuate the scaling factor between the speed of the steering wheel and the speed of the steering motor. AUX FUNCTI ON #3 does that but only when the steering wheel is fast turning. This attenuation must be proportional to the drive speed. At full drive speed the attenuation of the scaling factor is maximum.

AUX FUNCTION #3 to Level 0 means no attenuation of the scaling factor with the truck speed.

AUX FUNCTION #3 to Level 9 means maximum attenuation of the scaling factor with the truck speed.

Obviously, to perform the Dynamic Numbness compensation, it is necessary to know the drive speed and so the eps-ac0 must be CAN Bus connected.

③ SENSITIVITY

Level 0 to 9. It determines the scaling factor between the speed of the steering wheel and the speed of the steering motor but only when the steering wheel is slow turning. By increasing the SENSITIVITY value, the steering motor speed increases too. In practice, it changes the sensitivity of the steering wheel when it is slow turning.

④ AUX FUNCTION #2

Level 0 to 9. This setting performs the dynamic numbness compensation: it consists of a reduction in the steer sensitivity when the truck is driving at high speed. To get this goal, it is necessary to attenuate the scaling factor between the speed of the steering wheel and the speed of the steering motor. AUX FUNCTI ON #2 does that but only when the steering wheel is slow turning. This attenuation must be proportional to the drive speed. At full drive speed the attenuation of the scaling factor is maximum.

AUX FUNCTION #2 to Level 0 means no attenuation of the scaling factor with the truck speed.

AUX FUNCTION #2 to Level 9 means maximum attenuation of the scaling factor with the truck speed.

Obviously, to perform the dynamic numbness compensation, it is necessary to know the drive speed and so the eps-ac0 must be CAN Bus connected.

⑤ ANTIROLLBACK

This parameter adjusts the stand still torque after the steer handle is released and the travel demand deactivated.

It is in percentage of the maximum current. Injecting a continuous current in the motor generates the stand still torque. It is useful (together with the CREEP SPEED parameter) to neutralize the recall torque generated by the elastic tyre on the steered wheel.

5) PROGRAMMING & ADJUSTMENTS

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

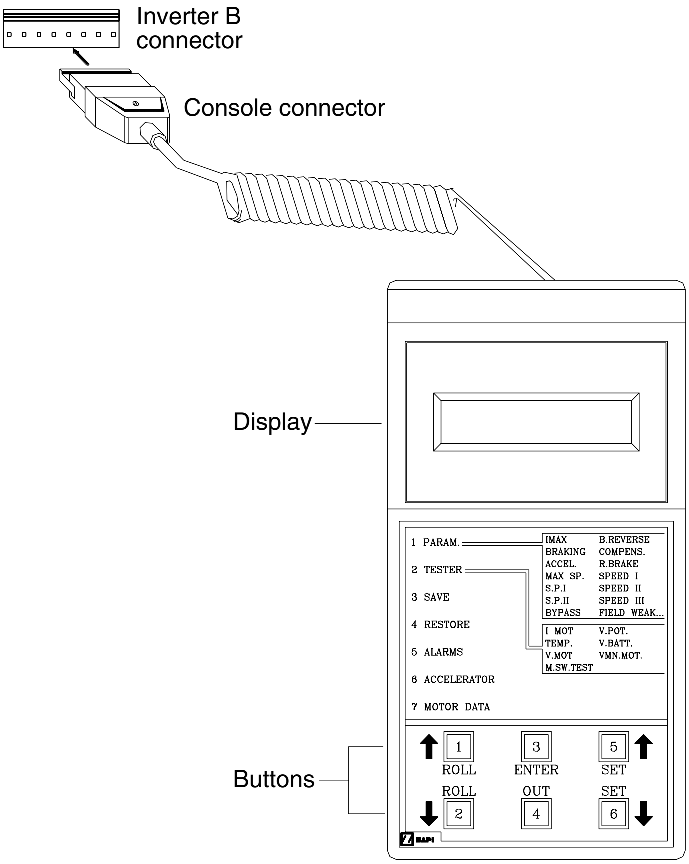
※ **Adjustments via buttons on a display, please refer to the display section.**

ADJUSTMENTS VIA CONSOLE (Option)

Adjustment of Parameters and changes to the inverter's configuration are made using the Digital Console.

The Console is connected to the CNC connector of the inverter.

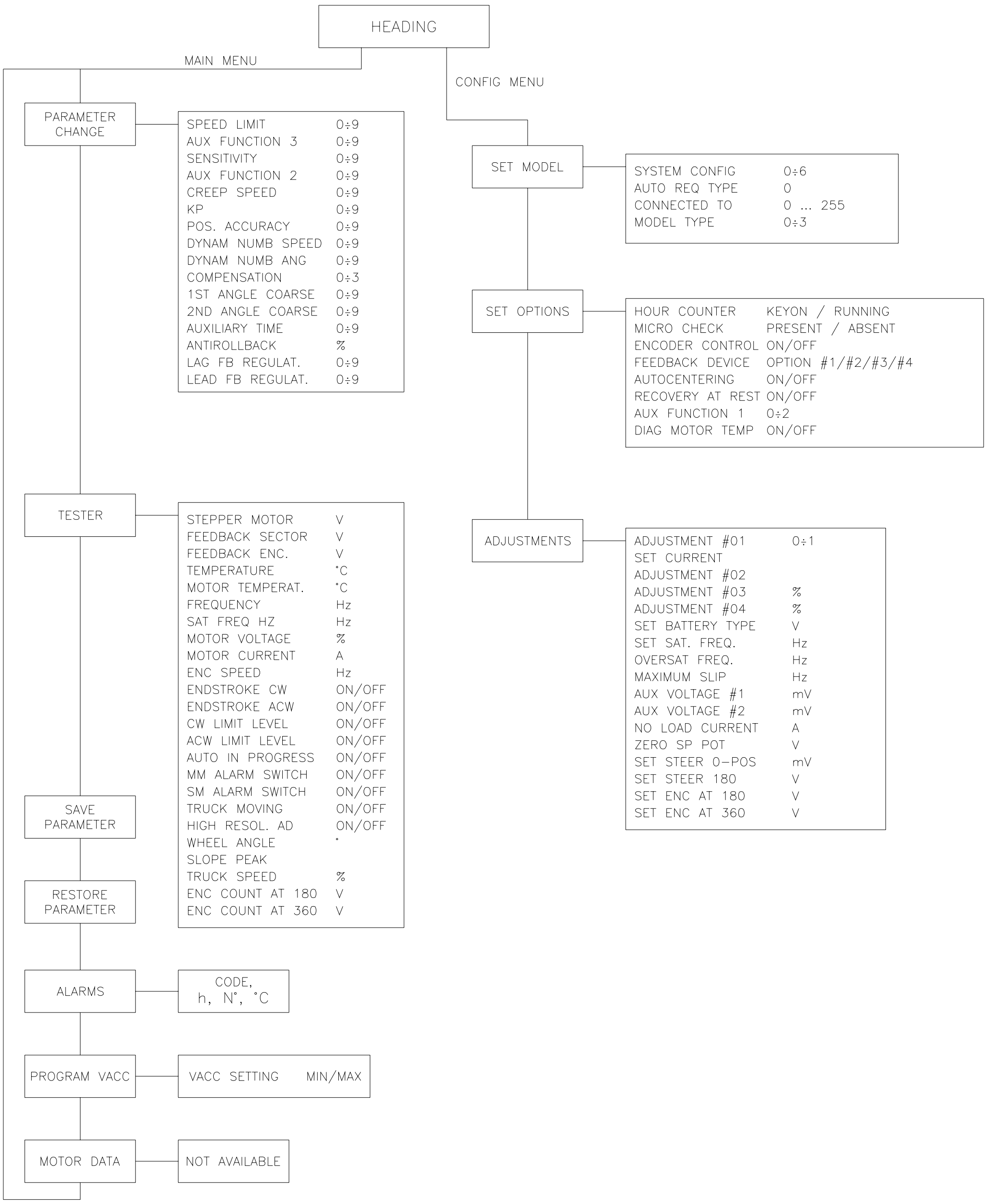
(1) Description of console



20B7EL15

※ Digital consoles used to communicate with AC inverter controllers must be fitted with EPROM CK ULTRA, minimum "Release Number 3.02".

(2) Description of standard console menu



BRJ7EL53

6) TESTER MENU (IN DISPLAY, MONITORING MENU)

The most important input or output signals can be measured in real time using the TESTER function of the console. The Console acts as a multimeter able to read voltage, current and temperature. In the following chapter a list of relative measurements for different configurations.

(1) Stepper motor

Voltage value with 2 decimal digit. Measurement of the stepper motor speed with sign in the range 0 to 5 Vdc.

(2) Feedback sector

Voltage value with 2 decimal digit. Measurement (scaled in the range 0 to 5 Vdc) of the actual state of the toggle switches. The steered wheel revolution is divided into 4 quadrants (sectors) corresponding to two toggle switches configurations:

The steered wheel is in the 1ST sector (FEEDBACK SECTOR to 3.13V) when the configuration of the toggle switches is the one expected for a steered wheel angle in the range 0 to 90 degrees.

The steered wheel is in the 2ST sector (FEEDBACK SECTOR to 4.39V) when the configuration of the toggle switches is the one expected for a steered wheel angle in the range 90 to 180 degrees.

The steered wheel is in the 3RD sector (FEEDBACK SECTOR to 0.62V) when the configuration of the toggle switches is the one expected for a steered wheel angle in the range -180 to -90 degrees.

The steered wheel is in the 4TH sector (FEEDBACK SECTOR to 1.88V) when the configuration of the toggle switches is the one expected for a steered wheel angle in the range -90 to 0 degrees.

(3) Feedback ENC

Voltage value with 2 decimal digit. Measurement (scaled in the range 0 to 5 Vdc) of the position of the feedback encoder connected to CNB#7 and CNB#8.

(4) Temperature

Degrees. Temperature of the controller base plate.

(5) Motor temperature

Degrees. Temperature of the motor windings measured with the thermal sensor inside the motor and connected to CNB#3.

(6) Frequency

Hertz value with 2 decimal digit. This is the frequency applied to the steering motor.

(7) SAT. FREQ HZ

Hertz value with 2 decimal digit. This is a real time magnetic flux measurement: Vbattery/ SAT. FREQ HZ provides real time the linked flux in the motor. The flux in the motor is modulated from 75% to 100% of the maximum flux.

The maximum flux is Vbattery/SET SAT FREQ.

The minimum flux is Vbattery/(1.33*SET SAT FREQ). When the motor is loaded, SAT. FREQ HZ is equal to SET SAT FREQ; when the motor is lightened the flux reduces and SAT. FREQ HZ increases up to 1.33*SET SAT FREQ.

(8) Motor voltage

It is a percentage. 100% means the sine waves in the motor have the maximum PWM amplitude.

(9) Motor current

Ampere value. Root Mean Square value of the line current in the motor.

(10) ENC speed

Hertz value with 2 decimal digit. This is the speed of the motor measured with the encoder on the motor shaft.

(11) Endstroke CW

Provides real time the active state (ON) or not of the CW toggle switch (connected to CNA#3). It is On when CNA#3 is low.

(12)Endstroke ACW

Provides real time the active state (ON) or not of the CCW toggle switch (connected to CNA#2). It is On when CNA#2 is low.

(13)CW limit level

When the maximum angle limitation via feedback sensors is enabled (option LIMIT DEVICE to ON) and the FEEDBACK ENC overtakes the superior limit for the steered wheel angle limitation, the steered wheel angle will be limited and CW LIMIT LEVEL turns ON (active).

(14)ACW limit level

When the maximum angle limitation via feedback sensors is enabled (option LIMIT DEVICE to ON) and the FEEDBACK ENC is lower than the inferior limit for the steered wheel angle limitation, the steered wheel angle will be limited and ACW LIMIT LEVEL turns ON (active).

(15)Auto in progress

Provides real time the information the eps-ac0 follows the manual command (AUTO IN PROGRESS is OFF) or is executing an automatic centering (AUTO IN PROGRESS is ON).

(16)MM alarm switch

It is On when the safety contact belonging to the main uC is closed.

(17)SM alarm switch

It is On when the safety contact belonging to the slave uC (supervisor) is closed.

(18)Truck moving

It provides the state of the travel demand for driving the truck. This information is obtained either with the travel demands directly connected to CNA#1 or via CAN Bus (depending by the state of the CAN BUS setting).

(19)High resol AD

It turns ON when the set point potentiometer is processed with a high resolution AD (it occurs when the set pot potentiometer is close to the straight ahead position and SET HI RESOL AD is Level 1).

(20)Wheel angle

It provides the current angle of the drive wheel by the degree.

(21)Slope peak

This reading is just for debugging the maximum slope of the potentiometers connected to the eps-ac0. Especially for not redundant sensor equipments (just a single command potentiometer or just a single feedback potentiometer without encoder) a concern regarding the safety raises: if a single potentiometer fails a sudden movement of the steered wheel may occur with danger. To avoid this problem it is necessary to detect any failure in a single potentiometer. This is hard to do because the failure mode can be quite different. Anyway, the best countermeasure we can take is to seek for the wiper voltage changes faster than its physical limit. In fact, for the limited speed of the steering motor(or of the steering wheel), the slope in the wiper voltage must be limited under a certain threshold. When this slope threshold is overtook, the potentiometer may be assumed broken. So, it is useful to measure the maximum slope occurring in your application when right working, in order a right slope threshold can be chosen to avoid an alarm occurs when the potentiometer is not failed.

The SLOPE PEAK reading in the tester menu is a real time measurement of the slope peak of the potentiometers. In particular:

When the special adjustments DEBUG OUTPUT is other than Level 12 or 13, SLOPE PEAK supplies the slope peak of the CPOC1 set point potentiometer (CNA#9).

When the special adjustments DEBUG OUTPUT is Level 13, SLOPE PEAK supplies the slope peak of the CPOT feedback potentiometer (CNB#6).

When the special adjustments DEBUG OUTPUT is Level 12, SLOPE PEAK supplies the slope peak of the CPOC2 set point potentiometer (CNA#8).

The SLOPE PEAK measurement is the difference between two AD conversions of the selected potentiometer picked up with 16 msec long interval. The SLOPE PEAK reading can be converted in a Voltage change (V in volts) of the wiper voltage in an interval 16 msec long, with the formula:

V = SLOPE PEAK*5/1024 = Voltage change in Volts in 16 msec

(e.g. When SLOPE PEAK is 61 it means the selected potentiometer, in the worst case, changes 61*5/1024 =0.3 V in 16 msec.).

Obviously the SLOPE PEAK reading must be compared with the threshold for the STEER SENSOR KO alarmThe STEER SENSOR KO alarm may be adjusted.

(22)TRUCK SPEED

Percentage value. It represents the truck speed represented in percentage of the full drive speed. It is used for the dynamic numbness (i.e. the steering sensitivity reduces when the truck speed increases).

(23)ENC COUNT AT 360

Voltage value with two digits in the range 0 to +/-5Vdc value. This reading supplies the encoder counting corresponding to a complete steered wheel revolution in the range 0 to +/- 5.00Vdc. At rest it assumes a 5Vdc value, after a first valid falling edge on the straight ahead sensor it switches from 5Vdc to 0Vdc.

After a second valid falling edge on the straight ahead sensor it switches to an intermediate value (between 0Vdc and +/-5Vdc) corresponding to the encoder counting for a full steered wheel revolution.

See also 10.5 and 10.6. This reading may be manually saved on the adjustments SET ENC AT 360.

(24)ENC COUNT AT 180

Voltage value with two digits in the range 0 to +/-5Vdc value. This reading supplies the encoder counting corresponding to a quasi-half steered wheel revolution (measured between the first and the seconds end of the iron plate in figure 4-4- and 4-5) in the range 0 to +/- 5.00Vdc. At rest it assumes a 5Vdc value, after a first valid falling edge on the straight ahead sensor it switches from 5Vdc to 0Vdc. After a second valid falling edge on the straight ahead sensor it switches to an intermediate value (between 0Vdc and +/-5Vdc) corresponding to the encoder counting for a side to side iron plate rotation. See also 10.5 and 10.6. This reading may be manually saved on the adjustments SET ENC AT 180.

ENC COUNT AT 180 is expected being about a half of the ENC COUNT AT 360.

8. FINGERTIP CONTROLLER

1) INTRODUCTION OF FINGER TIP

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

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

2) GENERAL CHARACTERISTIC

(1) Functional characteristics

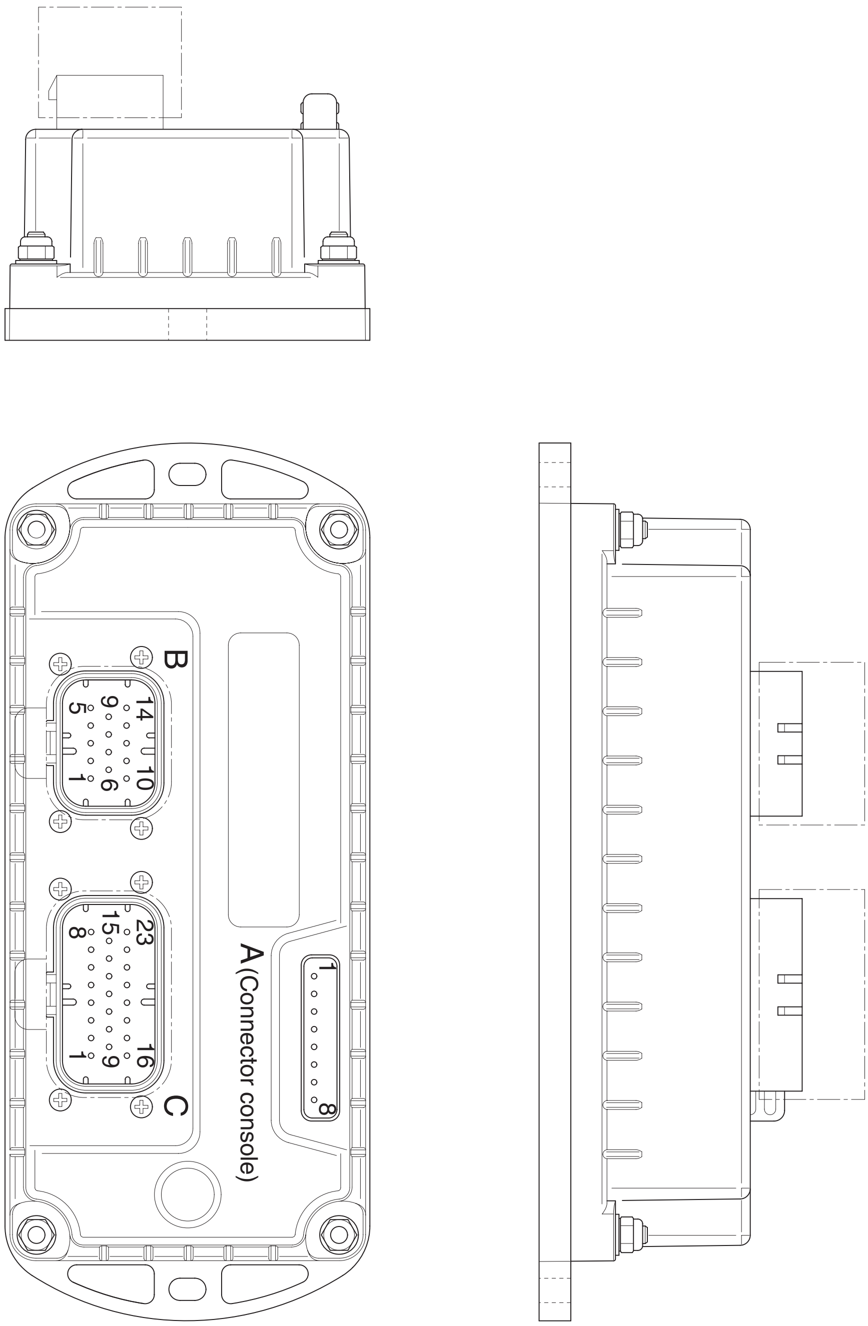
Voltage [V] ········ 24/36/48/80V
Output for ON-OFF valves [n˚] ········ 3
Output for proportional valves [n˚] ········ 9
Digital inputs [n˚] ········ 3
Analog inputs [n˚] ········ 1
RS-232 [n˚] ········ 1
CAN [n˚] ········ 1
Protection ········ IP65

(2) Input

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

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

3) STRUCTURE



BRJ7EL61

4) Description of connectors

No. of pin	Function	Description
A1	PCLRXD	Serial communication interface
A2	NCLRXD	Serial communication interface
A3	PCLTXD	Serial communication interface
A4	NCLTXD	Serial communication interface
A5	GND	Negative supply.
A6	+12	+12V supply.
A7	-	
A8	-	
B1	+KEY	Mhyrio CB positive power supply
B2	PAUX	Input of valves positive power supply
B3	-BATT	Mhyrio CB negative supply
B4	CAN_L	CAN low signal in
B9	CAN_T	CAN termination : connect to CANH_OUT to insert a 120 ohm termination resistance
B10	PPO_S	Positive supply of analog devices (+12 V) (Joystick, cantiller, can encoder)
B13	CAN_H	Can high signal in
B14	CANH_OUT	Can high signal out
C1	NEVP1	Negative of the proportional electro valve lift up.
C2	PEVP1/2	Positive of the proportional electro valves lift up & lowering.
C3	NEVP2	Negative of the proportional electro valve lowering.
C4	NEVP3	Negative of the proportional electro valve reach out.
C5	PEVP3/4	Positive of the proportional electro valves reach in & reach out.
C6	NEVP4	Negative of the proportional electro valve reach in.
C7	NEVP5	Negative of the proportional electro valve tilt up.
C8	PEVP5/6	Positive of the proportional electro valves tilt up & tilt down.
C9	NEV1	Buzzer relay negative.
C10	NEV2	Horn relay negative.
C11	NEV3	Fan relay negative.
C12	NEVP7	Negative of the proportional electro valve side shift right.
C13	PEVP7/8	Positive of the proportional electro valves side shift right & left.
C14	NEVP8	Negative of the proportional electro valve side shift left.
C15	NEVP6	Negative of the proportional electro valve tilt down.
C16	PEV1	Buzzer relay positive.
C17	PEV2	Horn relay positive.
C18	PEV3	Fan relay positive.
C23	-BATT	Mhyrio CB negative supply

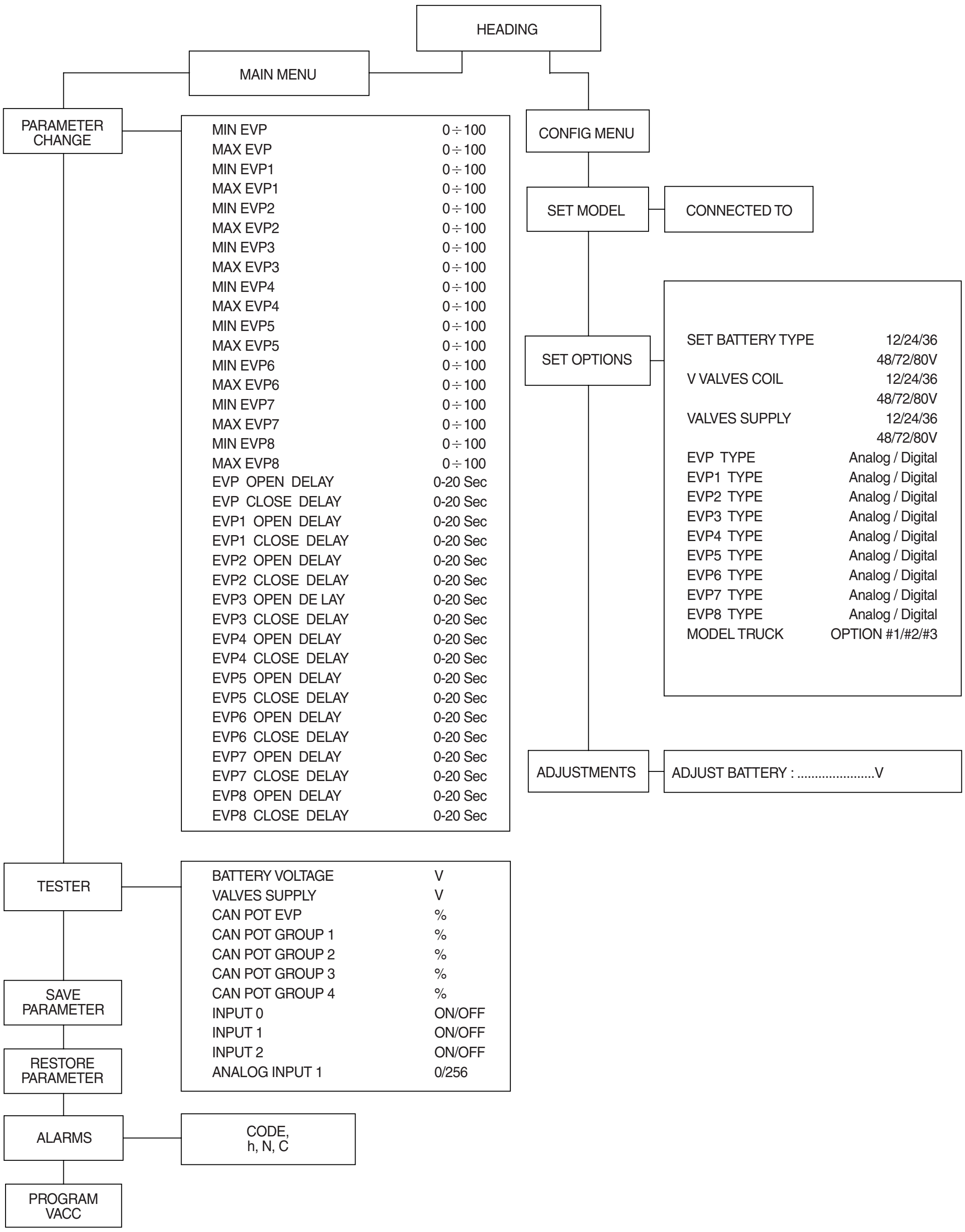
5) ADJUSTMENTS & FUNCTION

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

(1) Adjustments via console or buttons on a display

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

(2) Description of standard console menu



BRJ7EL62A

6) DESCRIPTION OF PARAMETERS THAT MAY BE PROGRAMMED (PARAMETER CHANGE)

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

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

The following parameters can be modified:

(1) Submenu "PARAMETER CHANGE"

① Min EVP

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

② Max EVP

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

③ Min EVP1

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

④ Max EVP1

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

⑤ Min EVP2

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

⑥ Max EVP2

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

⑦ Min EVP3

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

⑧ Max EVP3

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

⑨ Min EVP4

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

⑩ Max EVP4

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

⑪ Min EVP5

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

⑫ Max EVP5

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

⑬ Min EVP6

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

⑭ Max EVP6

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

⑮ Min EVP7

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

⑯ Max EVP7

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

⑰ Min EVP8

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

⑱ Max EVP8

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

⑲ EVP Open delay

Single proportional valve current ramping up time: this parameter sets the single valve current ramp, to change coil current from minimum EVP to maximum EVP.

⑳ EVP Close delay

Single proportional valve current ramping down time: this parameter sets the single valve closing ramp, to change coil current from maximum EVP to minimum EVP.

㉑ EVP1 Open delay

EVP1 proportional valve current ramping up time: this parameter sets the EVP1 valve current ramp, to change the coil current from minimum EVP1 to maximum EVP1.

㉒ EVP1 Close delay

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

㉓ EVP2 Open delay

EVP2 proportional valve current ramping up time: this parameter sets the EVP2 valve current ramp, to change the coil current from minimum EVP2 to maximum EVP2.

㉔ EVP2 Close delay

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

㉕ EVP3 Open delay

EVP3 proportional valve current ramping up time: this parameter sets the EVP3 valve current ramp, to change the coil current from minimum EVP3 to maximum EVP3.

㉖ EVP3 Close delay

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

㉗ EVP4 Open delay

EVP4 proportional valve current ramping up time: this parameter sets the EVP4 valve current ramp, to change the coil current from minimum EVP4 to maximum EVP4.

㉘ EVP4 Close delay
EVP4 proportional valve current ramping down time: this parameter sets the EVP4 valve closing ramp, to change the coil current from maximum EVP4 to minimum EVP4.

㉙ EVP5 Open delay
EVP5 proportional valve current ramping up time: this parameter sets the EVP5 valve current ramp, to change the coil current from minimum EVP5 to maximum EVP5.

㉚ EVP5 Close delay
EVP5 proportional valve current ramping down time: this parameter sets the EVP5 valve closing ramp, to change the coil current from maximum EVP5 to minimum EVP5.

㉛ EVP6 Open delay
EVP6 proportional valve current ramping up time: this parameter sets the EVP6 valve current ramp, to change the coil current from minimum EVP6 to maximum EVP6.

㉜ EVP6 Close delay
EVP6 proportional valve current ramping down time: this parameter sets the EVP6 valve closing ramp, to change the coil current from maximum EVP6 to minimum EVP6.

㉝ EVP7 Open delay
EVP7 proportional valve current ramping up time: this parameter sets the EVP7 valve current ramp, to change the coil current from minimum EVP7 to maximum EVP7.

㉞ EVP7 Close delay
EVP7 proportional valve current ramping down time: this parameter sets the EVP7 valve closing ramp, to change the coil current from maximum EVP7 to minimum EVP7.

㉟ EVP8 Open delay
EVP8 proportional valve current ramping up time: this parameter sets the EVP8 valve current ramp, to change the coil current from minimum EVP8 to maximum EVP8.

㊱ EVP8 Close delay
EVP8 proportional valve current ramping down time: this parameter sets the EVP8 valve closing ramp, to change the coil current from maximum EVP8 to minimum EVP8.

(2) Submenu "SET OPTIONS"

① Set Battery Type
This parameter sets the battery nominal voltage, that is the key input voltage (Mhyrio supply).

② V Valves Coil
This parameter sets the ON/OFF valves coil nominal voltage.

③ Valves Supply
This parameter sets the voltage of the valve's coil positive supply.

④ Model Truck
This parameter changes entire parameter's value to each model's default value as below after recycle of key.

- Option #1 : C/B trucks
- Option #2 : BRJ-7
- Option #3 : BRP-9
- Option #4 : BRJ-9

7) TESTER MENU (IN DISPLAY, MONITORING MENU)

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

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

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

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

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

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

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

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

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

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

⑩ Input 2
Level of digital input 2 :
- ON / +VB : input active, switch closed
- OFF / COND : input not active, switch open.

⑪ Analog input 1
Voltage of the analog input.

8) GENERAL SUGGESTION FOR SAFETY

For a proper installation take care of the following recommendations:

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

⚠ Do not connect the inverter to a battery with a nominal value different from the value indicated on the controller plate. If the battery value is greater, the MOS may fail; if it is lower, the control unit does not "power up"

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

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

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

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

※ **The method of discharging internal capacitor**

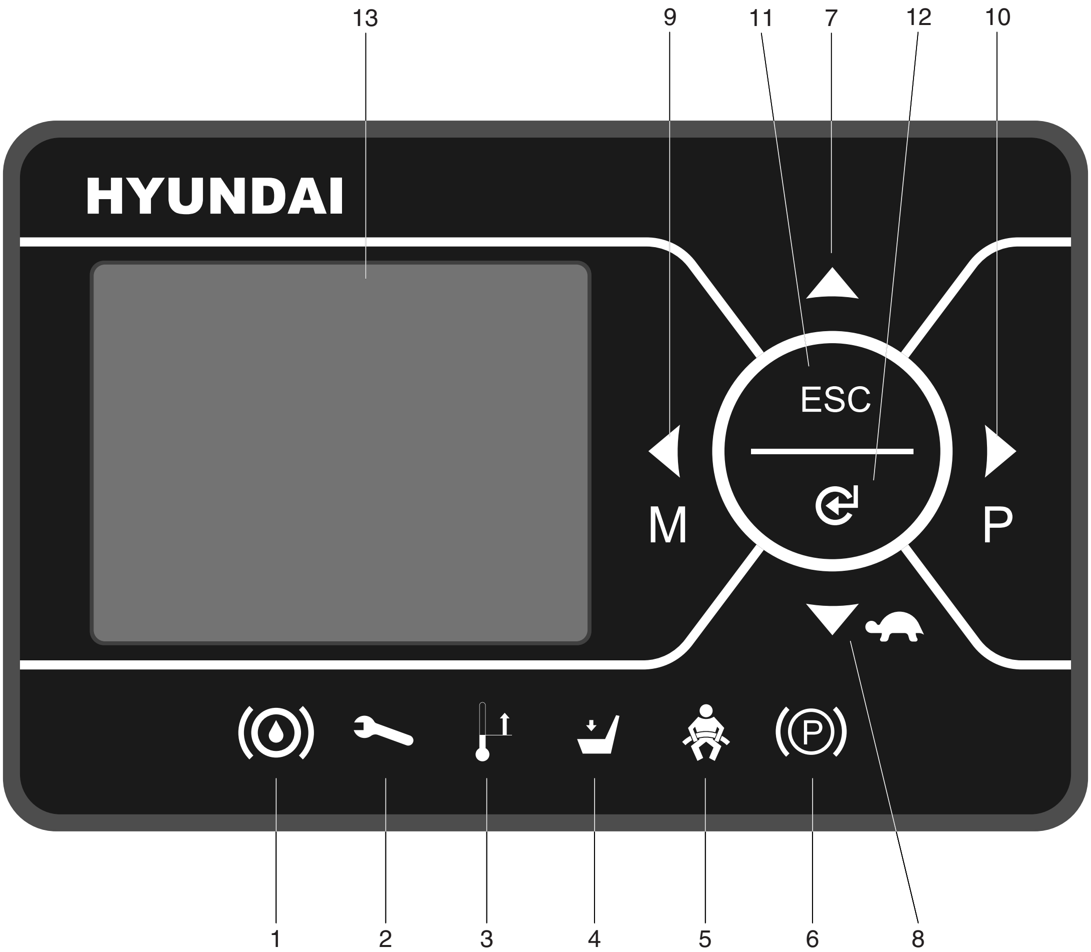
Bofore checking controllers, motors, cables and etc., discharge the internal capacitor in controllers by following below steps ;

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

9. DISPLAY

1) STRUCTURE

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

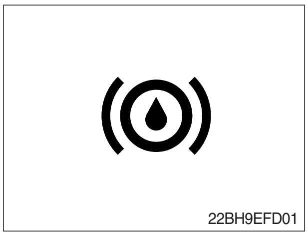


22BH9OM65

1	Oil level warning lamp	8	Down/turtle button
2	Wrench warning lamp	9	Left/menu button
3	Thermometer warning lamp	10	Right/performance button
4	Seat warning lamp	11	ESC button
5	Seat belt warning lamp	12	Enter button
6	Parking brake warning lamp	13	LCD function
7	Up button		

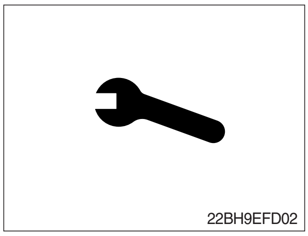
2) WARNING LAMP

(1) Brake oil level warning lamp



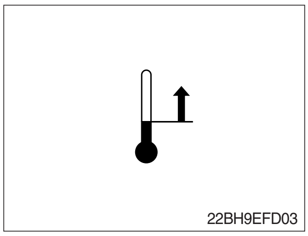
This LED lights when measured level of brake oil stored in reservoir tank is below the minimum acceptable mark.
This lamp doesn't work in BRJ-9 model, which doesn't have any hydraulic brake.

(2) Wrench warning lamp



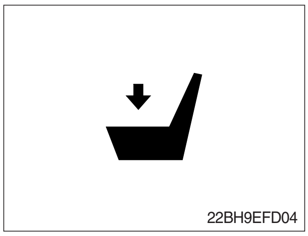
This LED lights when an electric device (controller, motor, cable, etc.) is in abnormal condition.

(3) Thermometer warning lamp



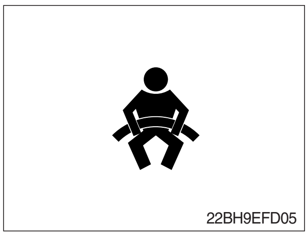
This LED lights when the controller or motor temperature is high.

(4) Seat warning lamp



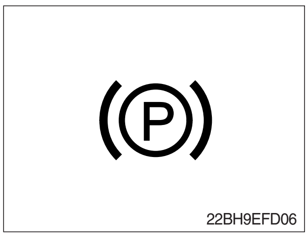
This LED lights when the operator is not on the seat.

(5) Seat belt warning lamp



(1) This LED blinks in following 2 cases.
  ① When operator starts the truck, LED blinks for 5 seconds, which means initial diagnosis is on going, and buttons on display will work properely just after the diagnosis is completed.
  ② LED blinks when the seat belt is not correctly fastened.

(6) Parking brake warning lamp

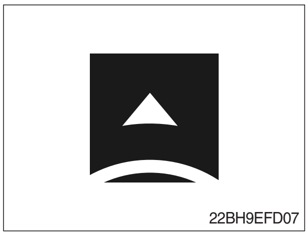


(1) This LED lights when the parking brake is activated.
This lamp doesn't work in BRJ-9 model do to a lack of parking brake.

3) BUTTON

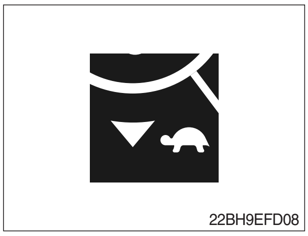
These buttons are used to select or change the menu and input value of the LCD function and display menu.

(1) Up button



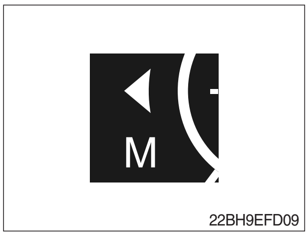
Press to select upward move.

(2) DOWN/TURTLE button



Press to select downward move.
TURTLE MODE ON/OFF

(3) LEFT/MENU button

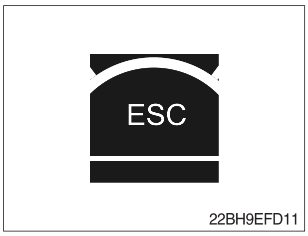


Press to select leftward move.
Go into the menu.

(4) RIGHT/PERFORMANCE button

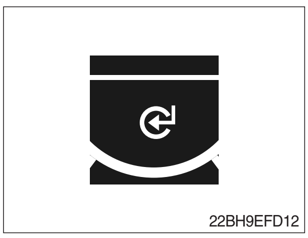
Press to select rightward move.
POWER MODE H/N/E

(5) Cancel (ESC) button



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

(6) ENTER button



Press to select Enter.

4) LCD FUNCTION

22BH9EFD13

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

(1) Current time

The number shows the current time according to the setting, which can be changed by display setting at page 7-78.

(2) Turtle mode

The turtle symbol is normally off. When this symbol appears, the turtle mode is activated regardless of the power mode of the truck to reduce the maximum speed to the set-point. This mode can be activated by pressing the  button.

(3) Truck speed pointer

The speed of the truck is indicated with a pointer.

(4) Speed level

It indicates the speed level by 2 km.

(5) Truck speed

The truck speed is shown in number. The unit can be km/h or mph according to the display setting (see 7-78 page).

(6) Hour meter

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

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

(7) Wheel position and running direction

The arrow point is up when the truck is forward running and points down when the truck is reverse running. The arrow points the direction of the steering angle.

(8) Power mode

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

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

(9) BDI (battery's state of charge)

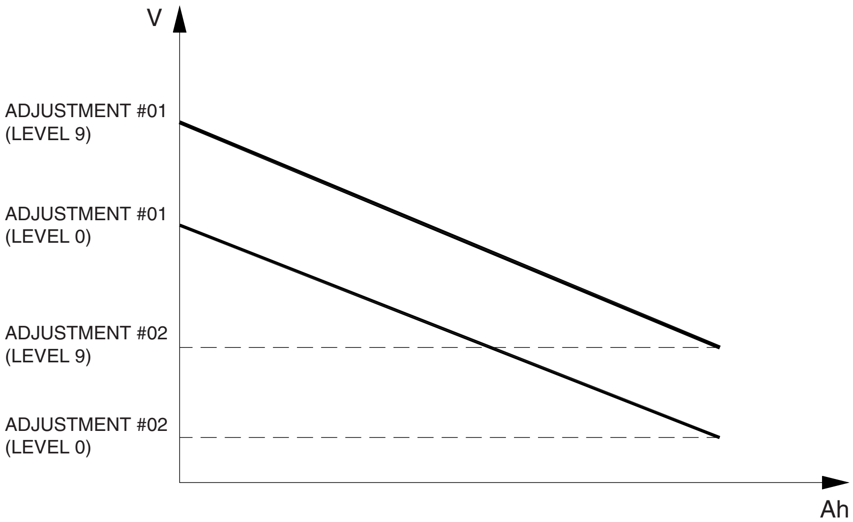
The battery's state of charge is shown by ten bars. Each bar represents the 10% of the battery charge. As the battery becomes discharged, the bars turn off progressively, one after another, in proportion to the value of the residual battery charge. When the residual battery charge is 20% or under, the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

※ How to adjust BDI

Service engineer can adjust BDI level simply by adjusting "adjustment #1, #2 BDI" parameter in truck menu - settings →traction → adjustments.

① Adjustment #1 BDI
It adjusts the upper level of the battery discharge table.

② Adjustment #2 BDI
It adjusts the lower level of the battery discharge table.



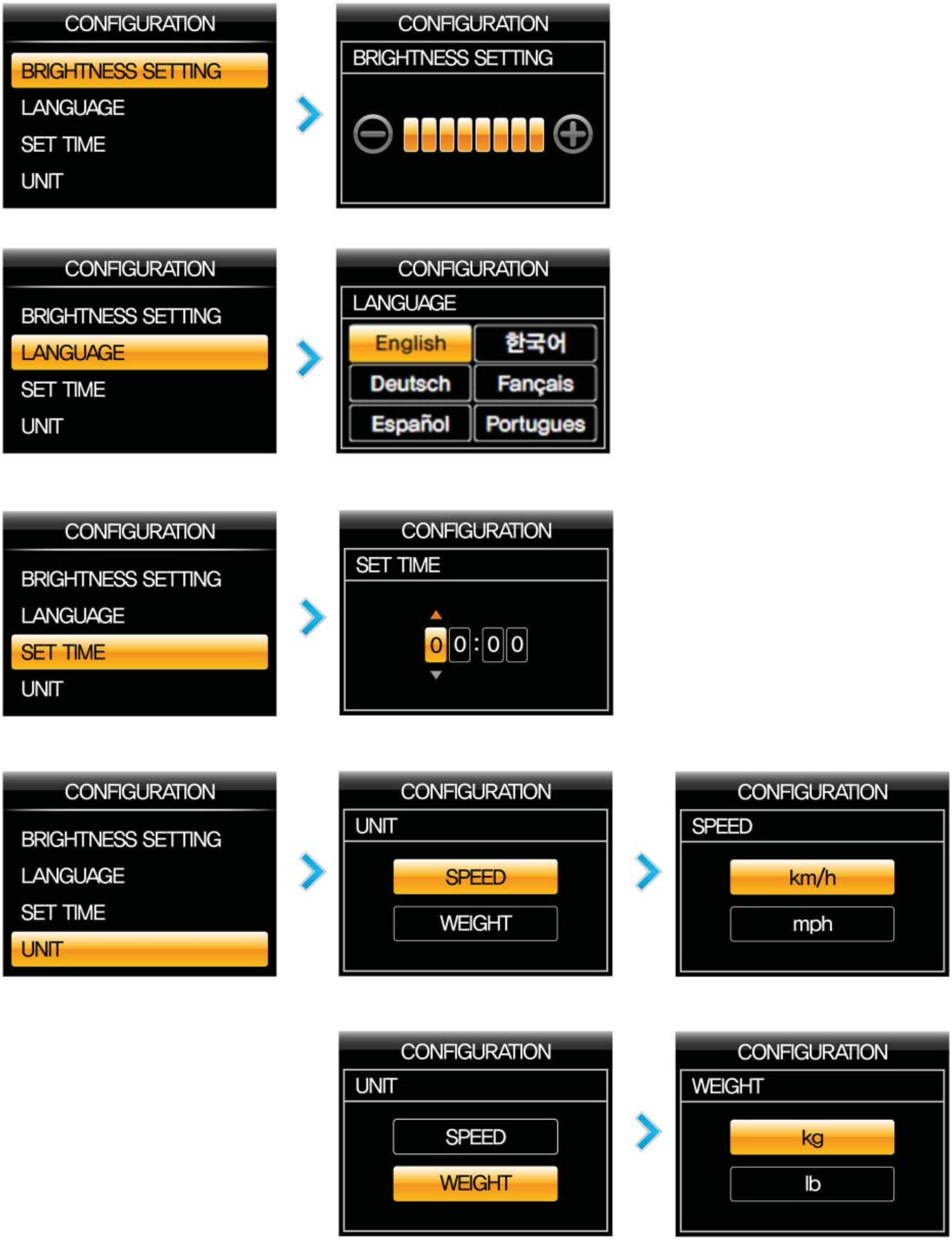
BRJ7EL13

(10) Load weight (option)

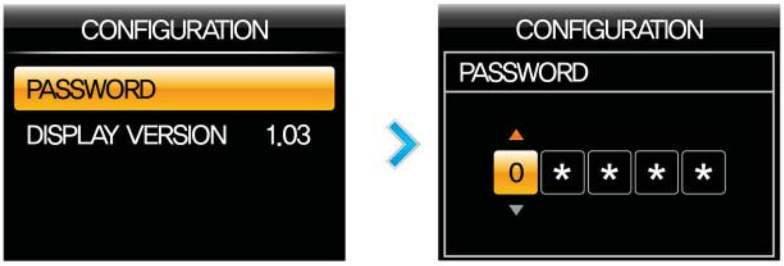
The indicator shows the weight the machine carrying at load.

- Indicator range : 0~6375 ㎏

5) HOW TO SET THE DISPLAY MENU



22BH9EFD14


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

22BH9EFD15

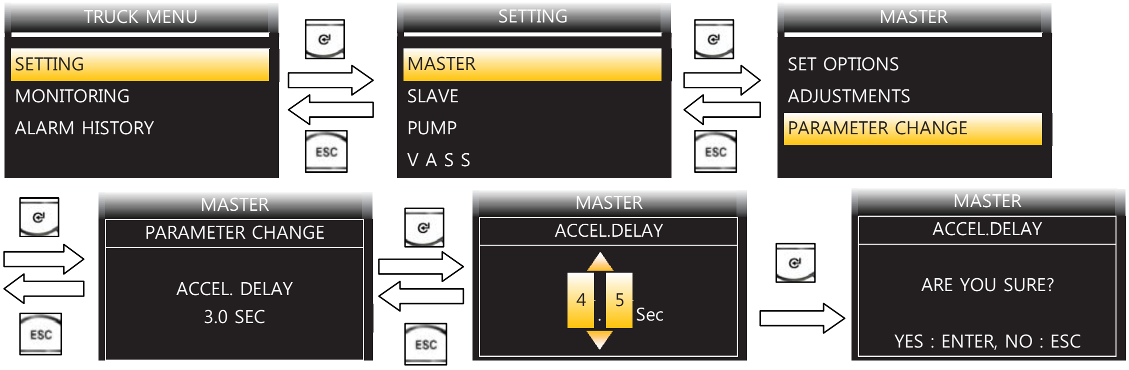
6) DESCRIPTION OF THE TRUCK MENU

(1) Access to truck menu

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

(2) How to change detail menus

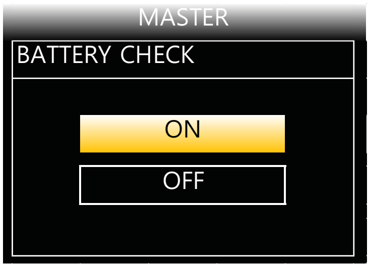
The detail items of menu can be changed as follows ;



22B9EL24

Selection can be made in 4 methods as follows ;

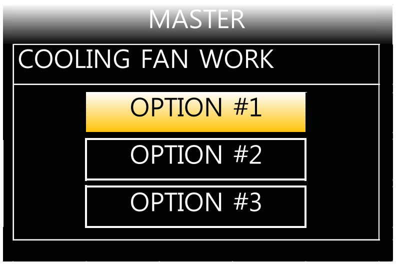
- ON/OFF Selection



22B9EL25

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

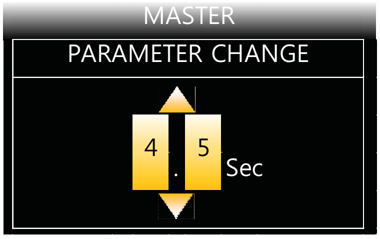
- Type Selection



22B9EL30

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

- Level Selection



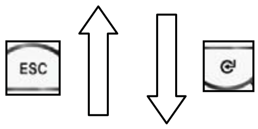
22B9EL30

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

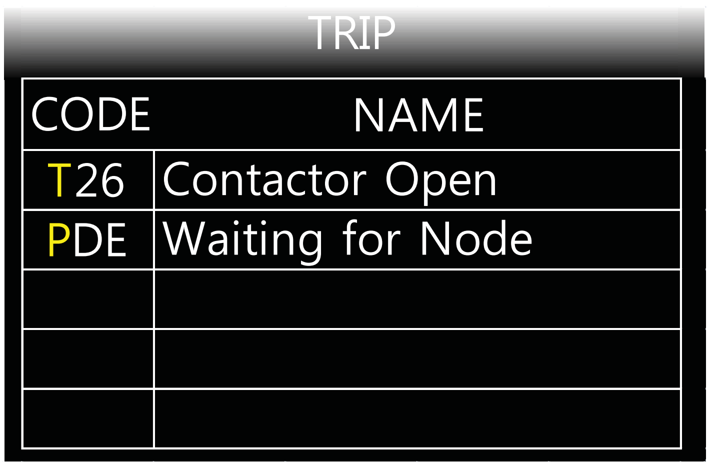
7) ALARM & ALARM HISTORY

(1) How to check alarms

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

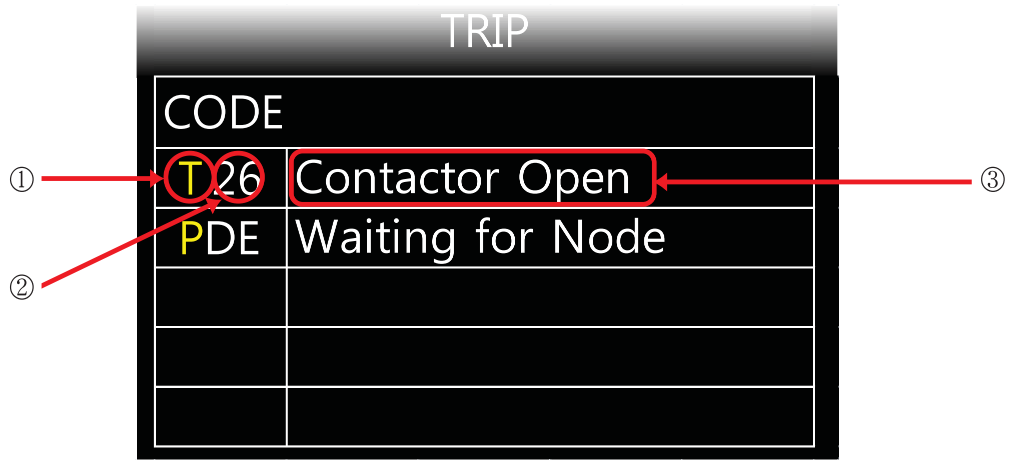


(Press more than 1 sec)



18BR9EL35

(2) Detail description of ALARM SCREEN



18BR9EL36

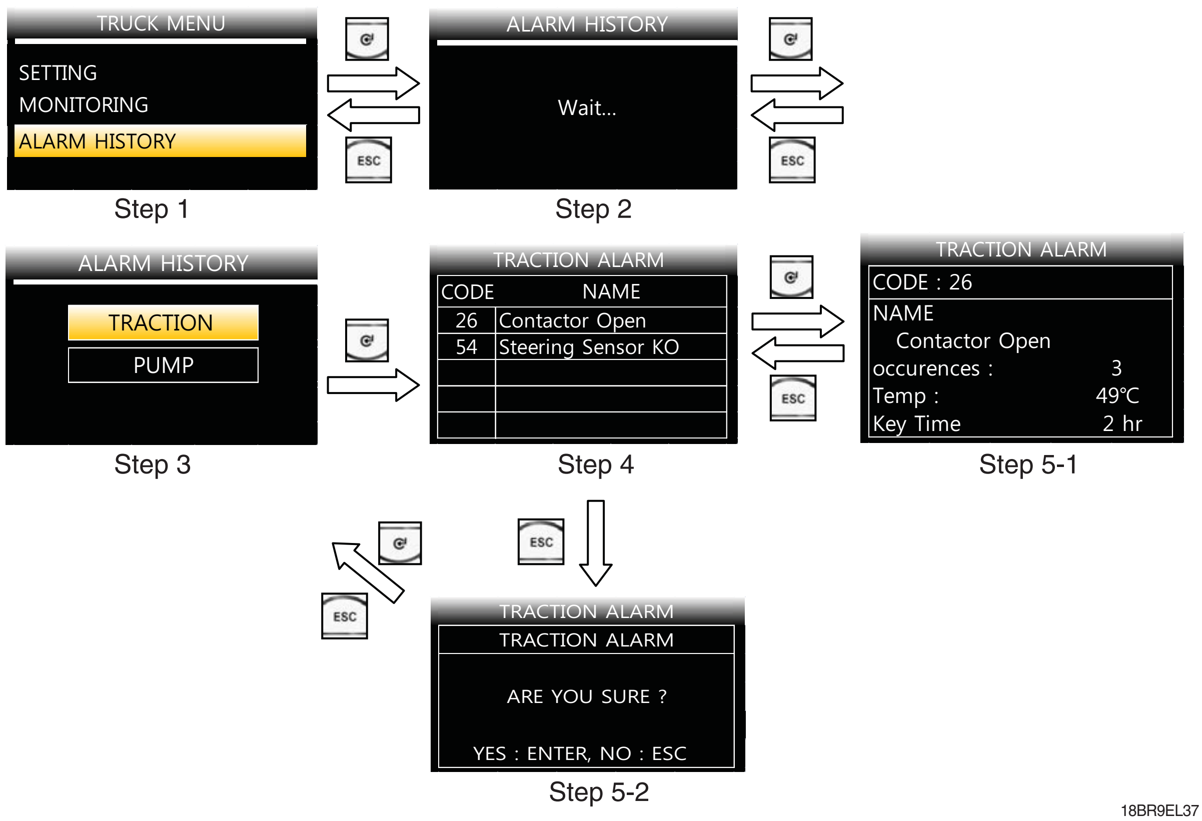
① First yellow capital letter shows in which controller the alarm happens as below;
T : Traction
P : Pump

② Following two letters or digits show alarm code. Please refer to 12) DIAGNOSTIC FAULT CODES (Page 7-93).

③ This shows a name of ALARM. Please refer to 12) DIAGNOSTIC FAULT CODES (page 7-93).

(3) Alatm history

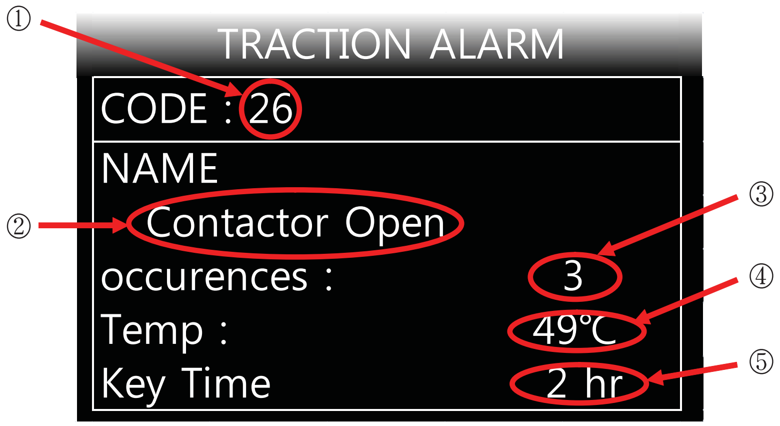
Alarm History can be looked up as follows ;



18BR9EL37

① Step 1 : Service man can check the alarm history on ALARM HISTORY menu
② Step 2 : When service man enter the ALARM HISTORY menu, display read entire alarm records of all controller. So it takes 9~15 seconds to read.
③ Step 3 : When display finish to read alarm records, service man can choose each controller to read the alarm history.
④ Step 4 : When service man enters each controller's alarm history, service man can check simply up to 5 alarms and choose a specific alarm to read detail alarm information.
⑤ Step 5-1 : When service man press button at Step 4, operator can see a detail alarm information of chosen alarm. Please refer to 6-7)-(4) DETAIL ALARM INFORMATION.
⑥ Step 5-2 : When service man press button at Step 4, service man can see a alarm clear menu. If service man press button, Recorded alarms of selected controller will be erased. (to verify cleaned alarm records, service man should be back to Step 1 & 2 to refresh.) If operator press button, just escape to step 3 without clearing

(4) Detail alarm information



22B9EL38

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

8) VASS SETUP USING DISPLAY MENU

This function searches and memorizes the minimum and maximum potentiometer wiper voltage of the accelerator pedal, brake pedal, fingertip lever, load sensor and tilt sensor which use potentiometer sensors. The belows show how to use the VASS function of DISPLAY.
(All figures in belows are just example.)

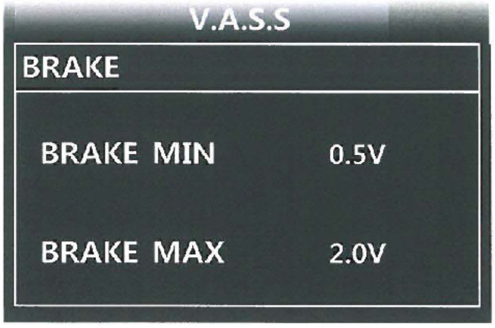
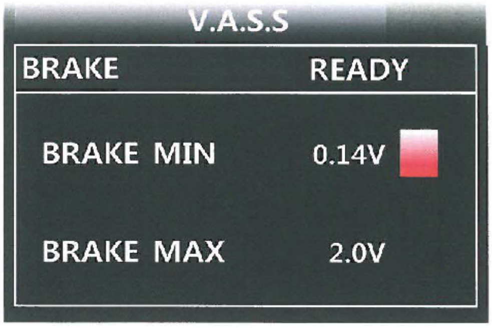
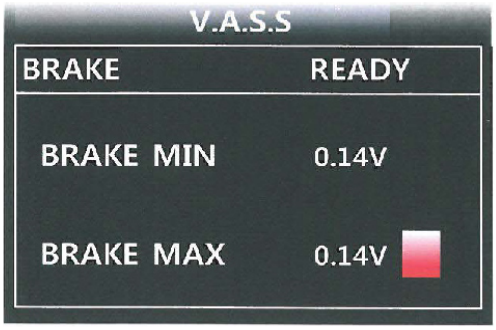
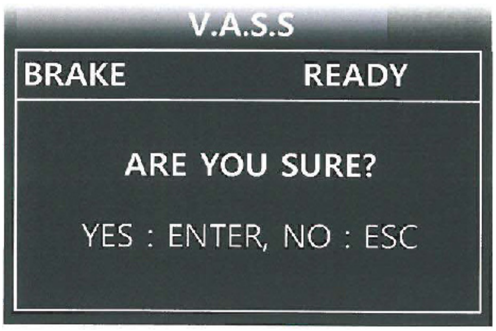
※ While even a motor is running, VASS can not be configurated properly, so please be sure that all motors are not running before entering configuration process & saving.

(1) ACCEL VASS setting method

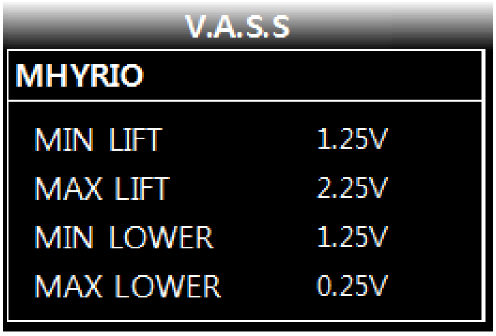
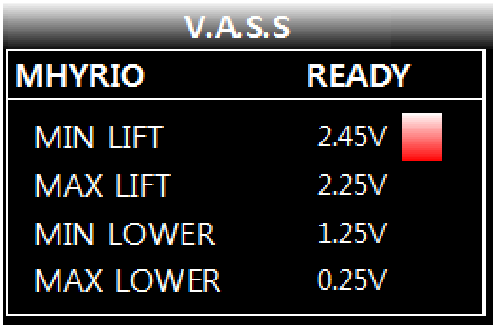
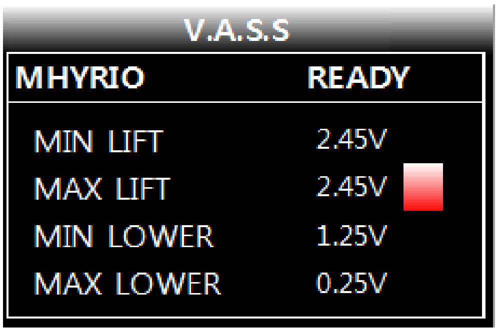
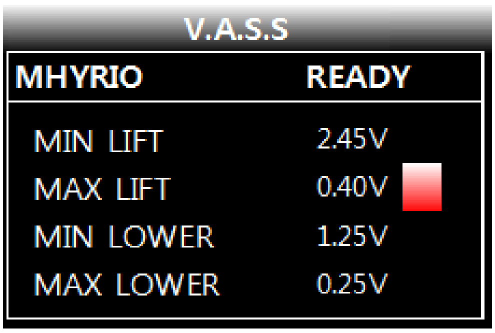
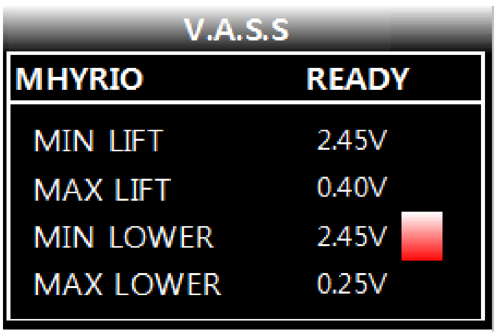
Step	Display	Description
1	V.A.S.S ACCEL MIN FORWARD 0.76V MAX FORWARD 1.76V MIN REVERSE 0.76V MAX REVERSE 1.76V	1. Access the ACCEL setting screen via "TRUCK MENU → SETTINGS → V.A.S.S → ACCEL". 2. Make sure that traction and hydraulic motors are not running and direction control switch is in NEUTRAL position and press the "ENTER" button.
2	V.A.S.S ACCEL READY MIN FORWARD 0.76V MAX FORWARD 1.76V MIN REVERSE 0.76V MAX REVERSE 1.76V	1. If “READY” appears beside ACCEL, you are in configuration process. 2. Set direction control switch in FORWARD position.
3	V.A.S.S ACCEL READY MIN FORWARD 0.90V MAX FORWARD 0.90V MIN REVERSE 0.76V MAX REVERSE 1.76V	1. Now, you can see that voltage value of MIN FORWARD and MAX FORWARD are changed. 2. Step on accel pedal fully, then Take foot off accel pedal.
4	V.A.S.S ACCEL READY MIN FORWARD 0.90V MAX FORWARD 4.47V MIN REVERSE 0.76V MAX REVERSE 1.76V	1. Now, you can see that voltage value of MAX FORWARD are changed. 2. Set direction control switch in REVERSE position. (Sometimes, depending on controller model, MIN FORWARD value looks like that it is fixed as 0.0V, which is normal.)

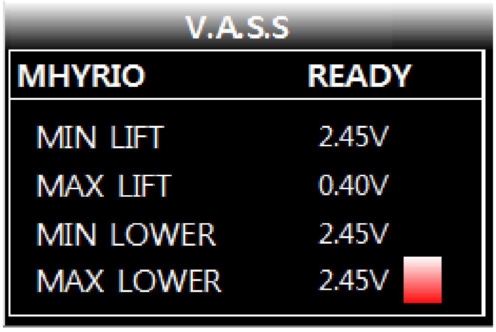
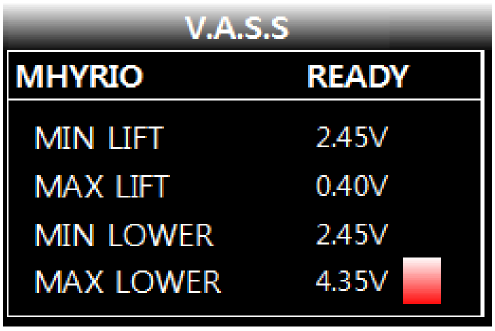
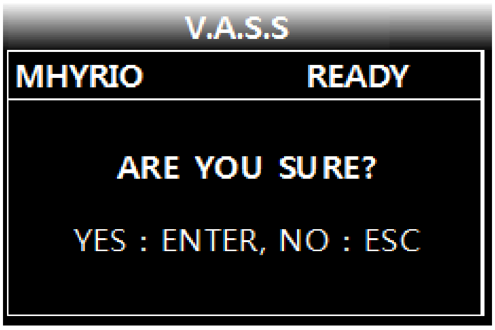
Step	Display	Description
5	V.A.S.S ACCEL READY MIN FORWARD 0.90V MAX FORWARD 4.47V MIN REVERSE 0.90V MAX REVERSE 0.90V	1. Now, you can see that voltage value of MIN REVERSE and MAX REVERSE are changed. 2. Step on accel pedal fully, then Take foot off accel pedal.
6	V.A.S.S ACCEL READY MIN FORWARD 0.90V MAX FORWARD 4.47V MIN REVERSE 0.90V MAX REVERSE 4.47V	1. Now, you can see that voltage value of MAX REVERSE are changed. 2. Make sure that traction and hydraulic motors are not running and direction control switch is in NEUTRAL position and press the "ENTER" button.
7	V.A.S.S ACCEL FINISH ARE YOU SURE ? YES : ENTER, NO : ESC	1. Press the "ENTER" button.

(2) BRAKE VASS setting method

Step	Display	Description
1		1. Access the BRAKE setting screen via "TRUCK MENU → SETTINGS → V.A.S.S → ACCEL". 2. Make sure that traction and hydraulic motors are not running and direction control switch is in NEUTRAL position and press the "ENTER" button.
2		1. When the READY indicator appears in the upper right corner of the screen, start setting. 2. Press the "ENTER" button while not to step on brake pedal to set the minimum value.
3		1. Go to brake maximum setting. 2. Step on brake pedal fully to set the maximum value.
4		1. The maximum value is rising as much as pressing the pedal. 2. Press the "ENTER" button while pressing the pedal fully.
5		1. The display will ask "ARE YOU SURE?" Press the "ENTER" button to save. ※ Check the setting values by reentering the setting screen via TRUCK MENU → SETTINGS → V.A.S.S → BRAKE.

(3) FINGERTIP LEVER VASS setting method

<table>
<tr><th>Step</th><th>Display</th><th>Description</th></tr>
<tr><td>1</td><td>
</td><td>1. Access the FINGERTIP LEVER setting screen via "TRUCK MENU → SETTINGS → V.A.S.S → MHYRIO".
2. In the left screen, use the "LEFT : MENU" and "RIGHT" button to select the LIFT, REACH, TILT, AUX lever.
Set the LEVER by pressing the ENTER button as shown below.
3-SPOOL : LIFT, REACH, TILT
4-SPOOL : LIFT, REACH, TILT, AUX
3. For illustrative purposes, following will set the LIFT lever by pressing the "ENTER" button.</td></tr>
<tr><td>2</td><td>
</td><td>1. The screen change to MIN LIFT (lift up minimum value) setting and display the present lever value.
2. Leave the lever untactly and press the ENTER button to set MIN LIFT (lift up minimum value).</td></tr>
<tr><td>3</td><td>
</td><td>1. The screen change to MAX LIFT (lift up maximum value) setting and display the present lever value.
2. Pull the lever fully because of MAX LIFT (lift up maximum value) setting.</td></tr>
<tr><td>4</td><td>
</td><td>1. You can see that the MAX LIFT (lift up maximum value) has changed.
2. While pulling the LIFT lever fully, press the "ENTER" button to set the MIN LOWER value.</td></tr>
<tr><td>5</td><td>
</td><td>1. The screen change to MIN LOWER (lift down minimum value) setting and display the present lever value.
2. Leave the lever untactly and press the ENTER button to set MIN LOWER (lift down minimum value).</td></tr>
</table>

<table>
<tr><th>Step</th><th>Display</th><th>Description</th></tr>
<tr><td>6</td><td></td><td>1. The screen change to MAX LOWER (LIFT DOWN maximum value) setting and display the present lever value.
2. Push the lever fully because of the MAX LOWER (lift down maximum value) setting.</td></tr>
<tr><td>7</td><td></td><td>1. You can see that the MAX LOWER (lift down maximum value) has changed.
2. While pushing the LIFT lever fully (while keep the MAX LOWER condition), press the "ENTER" button.</td></tr>
<tr><td>8</td><td></td><td>1. The display will ask "ARE YOU SURE?"
2. While pushing the LIFT lever fully (while keep the MAX LOWER condition), press the "ENTER" button and finish the setting.
3. Set the REACH, TILT, AUX setting same as the LIFT method.</td></tr>
</table>

(4) LOAD WEIGHT VASS setting method

① Activate the LOAD SENSOR parameter to use LOAD WEIGHT menu as below.
TRUCK MENU → SETTINGS → PUMP → SET OPTIONS → LOAD SENSOR : ON

② Set standard weight (reference weight) value to lift for setting.
TRUCK MENU → SETTINGS → PUMP → ADJUSTMENTS → REFERENCE WEIGHT

③ Set the warning weight (overload weight) to warn when the weight exceeds the set weight.
TRUCK MENU → SETTINGS → PUMP → ADJUSTMENTS → OVERLOAD WEIGHT

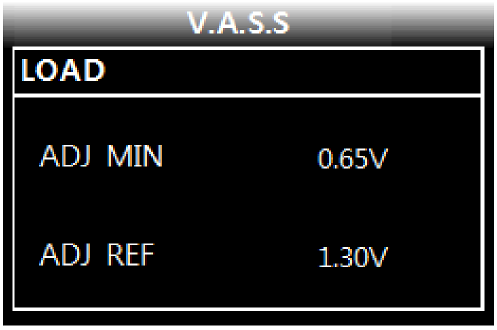
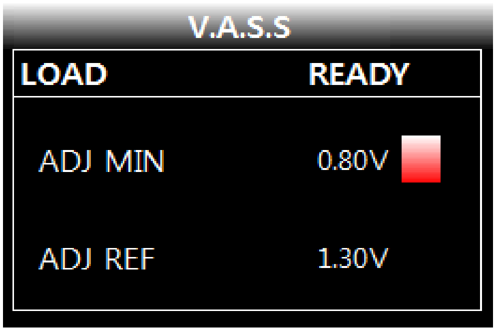
④ Set OVERLOAD TYPE to NONE to prevent occurring the warning.
TRUCK MENU -> SETTINGS -> PUMP -> SET OPTIONS -> OVERLOAD TYPE

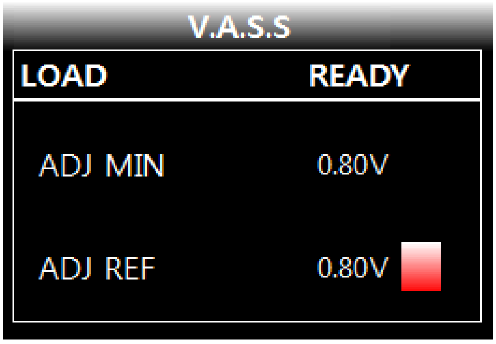
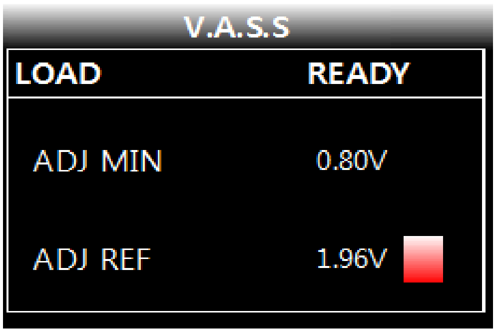
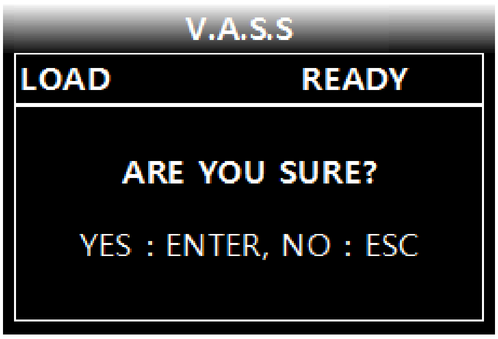
※ OVERLOAD TYPE parameter : Define the truck operation when the weight exceeds the set weight.

- NONE : No warning even if the load weight exceeds the OVERLOAD WEIGHT setting.
- OPTION #1 : OVERLOAD warning occurs when the lifting load weight exceeds the OVERLOAD WEIGHT setting value, and restriction the truck operation.
- OPTION #2 : OVERLOAD warning occurs only when the load weight exceeds the OVERLOAD WEIGHT setting.

※ The load sensor alarm occur and the truck stop when the lifting weight exceeds set the weight of the OVERLOAD WEIGHT parameter regardless of the OVERLOAD TYPE setting.

⑤ Set the LOAD SENSOR value as below.

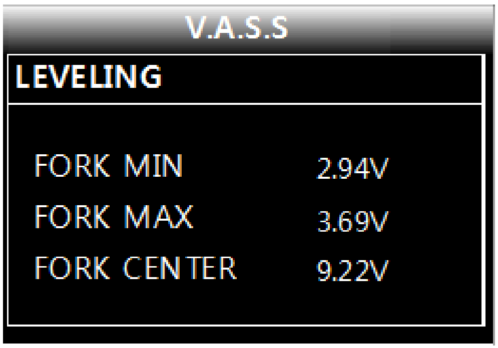
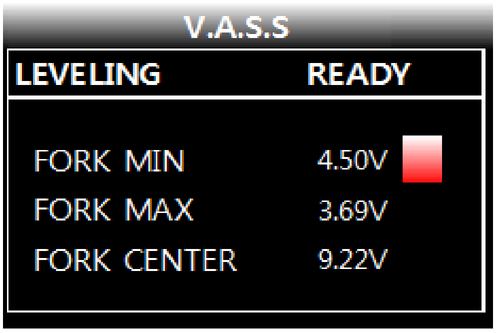
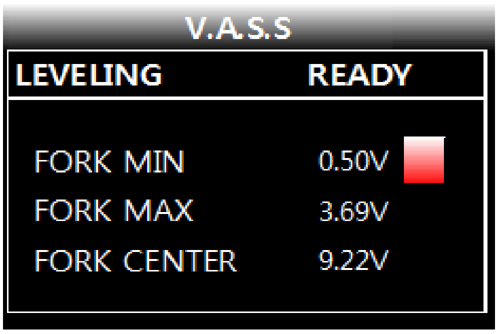
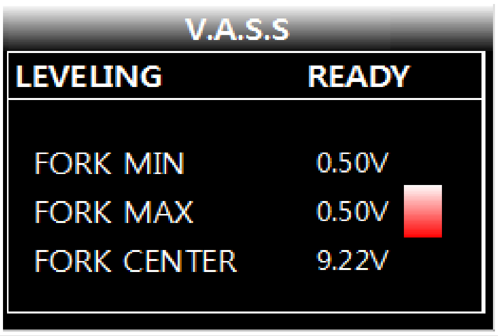
Step	Display	Description
1		1. Access the LOAD setting screen via TRUCK MENU -> SETTINGS -> V.A.S.S -> LOAD (LOAD SENSOR parameter setting : ON, see ①) 2. Make sure that traction and hydraulic motors are not running and direction control switch is in NEUTRAL position and press the "ENTER" button to start setting.
2		1. When the READY indicator appears in the upper right corner and red mark appears beside ADJ MIN of the screen, start ADJ MIN LOAD setting. Display the ADJ MIN value that LOAD SENSOR input value is the no-load condition and starting the setting. 2. Press the "ENTER" button to go to ADJ REF setting.

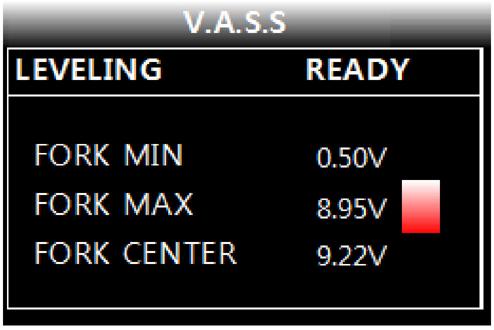
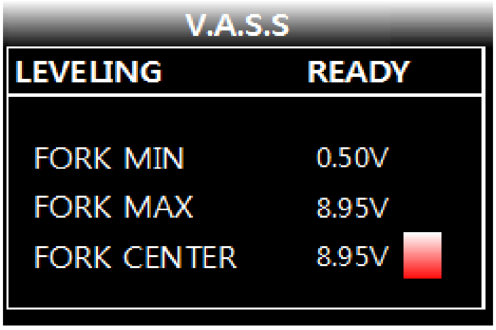
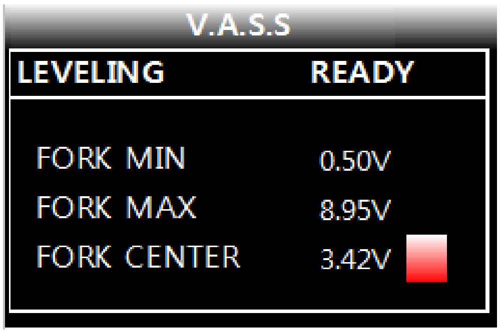
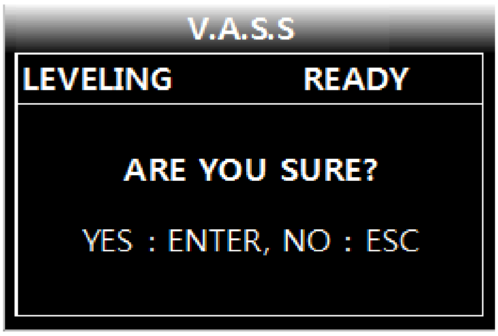
Step	Display	Description
3		1. The ADJ REF setting is started when red mark appears beside ADJ REF of the screen. 2. The ADJ REF setting defines reference weight of the LOAD SENSOR input value that the overload warning occurs. Set direction control switch in forward position and lift the reference weight up to about 50 cm from the ground. 3. You can see that the ADJ REF parameter value has changed as lifting the reference weight.
4		1. Lift the reference weight and wait about 5~10 seconds elapsed. Make sure that the ADJ REF value stabilizes, then press the ENTER button with the reference weight lifting condition.
5		1. The display will ask "ARE YOU SURE?" 2. Press the "ENTER" button to save and exit. 3. Leave the OVERLOAD TYPE parameter in step 4 as NONE. ※ For accuracy of LOAD SENSOR, the reference weight for the setting should be as heavy as possible within the range of not exceeding OVERLOAD WEIGHT.

(5) AUTO TILT LEVELING VASS setting method

① Activate the FORK LEVELING parameter to use AUTO TILT LEVELING menu as below.
TRUCK MENU → SETTINGS → PUMP → SET OPTIONS → FORK LEVELING : ON

② Set the FORK LEVELIN SENSOR value as below.

Step	Display	Description
1		1. Access the TILT SENSOR setting screen via TRUCK MENU → SETTINGS → V.A.S.S → FORK LEVELING. 2. As shown on the left screen, the TILT SENSOR setting screen appears. 3. Make sure that traction and hydraulic motors are not running and direction control switch is in NEUTRAL position and press the "ENTER" button to start the setting.
2		1. When the READY indicator appears in the upper right corner and red mark appears beside FORK MIN of the screen, start FORK MIN setting. Display the TILT SENSOR value at present. 2. Push the tilt lever forward (TILT OUT) fully to set the FORK MIN (TILT SENSOR value at maximum tilt out)
3		1. The FORK MIN value is changed as proceeding the TILT OUT. 2. Press the "ENTER" button at the maximum TILT OUT condition and go to the FORK MAX setting.
4		1. You can see that the red mark appears beside FORK MIN of the screen and the input value of the TILT SENSOR at present. 2. Pull the tilt lever backward (TILT IN) fully to set the FORK MAX (TILT SENSOR value at maximum tilt in).

Step	Display	Description
5		1. The FORK MAX value is changed as proceeding the TILT IN. 2. Press the "ENTER" button at the maximum TILT IN condition and go to the FORK CENTER setting.
6		1. You can see that the red mark appears beside FORK CENTER of the screen and the input value of the TILT SENSOR at present. 2. Adjust the tilt lever to set the FORK CENTER horizontally (TILT SENSOR value at fork horizontal condition).
7		1. The FORK CENTER value is changed as proceeding the TILT HORIZONTAL position. 2. Make sure that traction and hydraulic motors are not running and direction control switch is in NEUTRAL position and press the "ENTER" button when the FORK become a horizontal position.
8		(1) The display will ask "ARE YOU SURE?" (2) Press the "ENTER" button to save and exit

(6) HEIGHT INDICATOR setting and operation

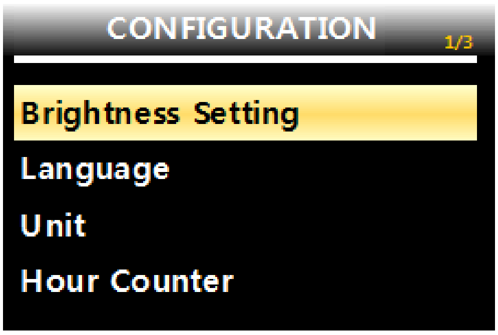
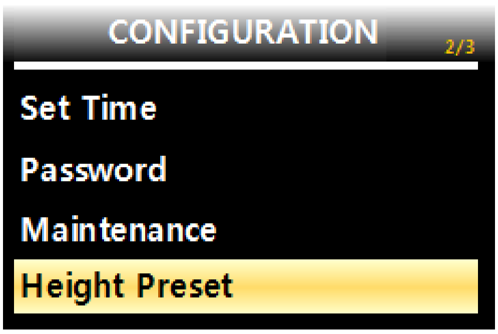
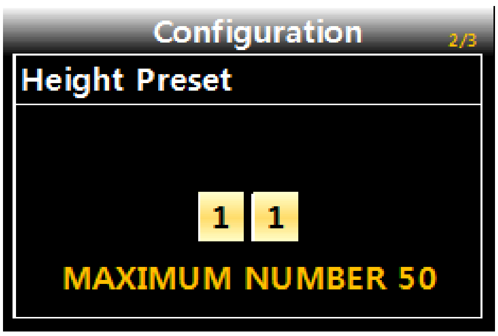
① HEIGHT INDICATOR function

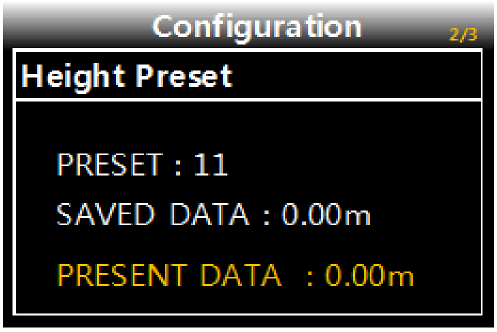
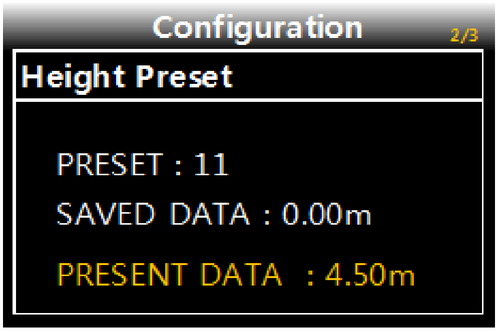
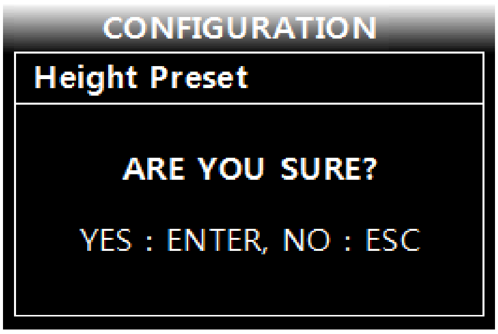
a. Display the fork height on the screen when the fork raise over the free cylinder range.

b. Set the fork height maximum 50 separate heights and call a set fork height via display and the fork stop the set fork height at the lifting up or down of fork.

② HEIGHT PRESET setting

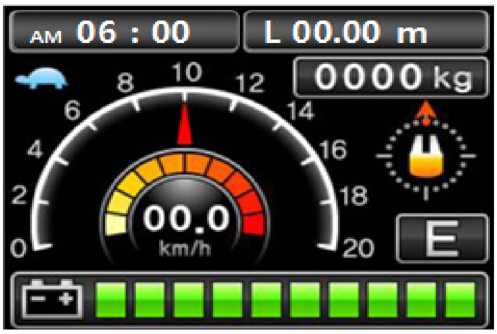
Set the HEIGHT PRESET as below.

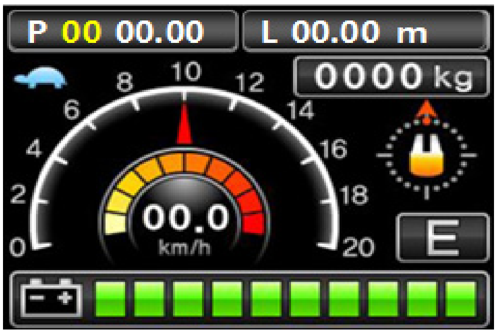
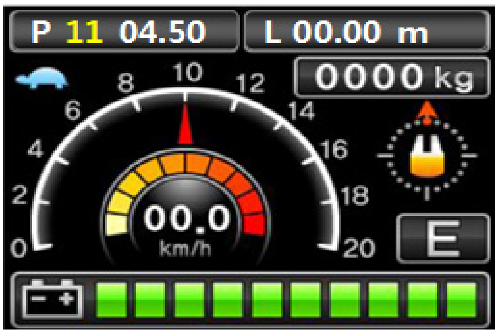
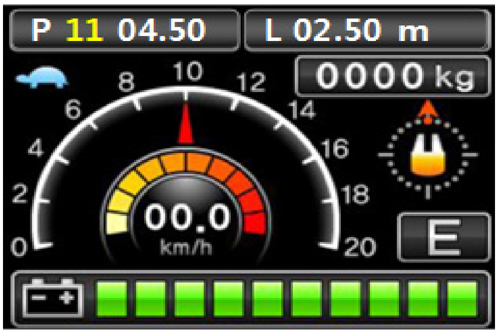
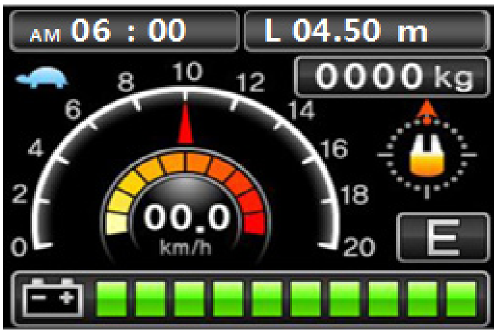
Step	Display	Description
1		1. In the main screen, access the USER menu by pressing the button "7 (M)" of the key pad. ※ Refer to page 7-89 for key pad button.
2		1. In the USER menu, find the HEIGHT PRESET menu by using "2 (UP)" button and "8 (DOWN)" button.
3		1. Press the "ENTER" button on the HEIGHT PRESET menu and go to the HEIGHT PRESET setting.
4		1. If you go to the HEIGHT PRESET setting menu, ask you the HEIGHT PRESET number for setting. 2. The HEIGHT PRESET is possible maximum 50 separate and input a number by key pad and press the "ENTER" button. (For illustrative purposes, following will select 11)

Step	Display	Description
5		1. Display the input PRESET number and the present HEIGHT PRESET of the number as white color. And display the present fork height as orange color below. ※ Note that the fork height is display zero (0) because the HEIGHT PRESET function is not operated in the free cylinder range.
6		1. Move the fork to the target height for height setting by operating the fork lift up or down. (For illustrative purposes, following will move fork to 4.5 m.) 2. Press "ENTER" button when the fork move to target height.
7		1. The display will ask "ARE YOU SURE?" 2. Press the "ENTER" button to save and finish setting.

③ HEIGHT PRESET operation

The HEIGHT PRESET is operated as below.

Step	Display	Description
1		1. Press the button "1 (H)" of the key pad in the main screen.

<table>
<tr><th>Step</th><th>Display</th><th>Description</th></tr>
<tr><td>2</td><td>
</td><td>1. The present time display change to the PRESET call screen and the number "00" blinks.
2. Input the HEIGHT PRESET number to call by using the number key of the key pad and press "ENTER" button.
(For illustrative purposes, following will call 11 (4.5 m) of the HEIGHT PRESET)</td></tr>
<tr><td>3</td><td>
</td><td>1. Stop the blink for the PRESET call screen and display the setting height. (ex: 4.5 m)
2. Move the fork height to the setting height by operating the lift lever or joystick.
※ In the set of the PRESET setting, the fork move up or down to setting height direction only.
(EX: If the present height is 3.5 m and PRESET height setting is 4.5 m, the fork move up only but does not move down.)
3. If you want to move reverse direction, cancel the PRESET condition by pressing the "ESC" button.</td></tr>
<tr><td>4</td><td>
</td><td>1. If you pull the lever or joystick continuingly, the height is measured from escaping the free cylinder range.</td></tr>
<tr><td>5</td><td>
</td><td>1. If you pull the lever or joystick continuingly, the fork stops setting height automatically and the PRESET is cancelled.</td></tr>
</table>

(7) REACH IN/OUT CUTBACK adjusting method

① Parameter description

The parameter that effort to the REACH IN/OUT CUTBACK as shown below.

A. REACH IN SPEED

Item	Description
Explanation	1) Hydraulic motor operating speed at the REACH IN operation. 2) Higher : Reach in speed up, mast stops near to the frame at CUTBACK. End operation shock become a large at CUTBACK. Lower : Reach in speed down, mast stops far from the frame at CUTBACK. End operation shock become a small at CUTBACK.
Application	1) The mast stop too near to or too far from the frame when reach in CUTBACK. 2) The REACH IN speed is too fast or too slow.
Caution	Too excessively higher, occur a noise and shock, too excessively lower, reach speed is remarkably down. If possible, leave a default value and adjust CUTBACK by using the valve opening (MIN, MAX, EVP3, 4) and delay (REIN, REOUT CTS DELAY).
Default value	14/16BRJ-9 : 19 Hz 20/25BRJ-9 : 20 Hz
Adjust range	Default value ± 1 Hz
Access	TRUCK MENU → SETTINGS → PUMP → PARAMETER CHANGE

B. REACH OUT SPEED

Item	Description
Explanation	1) Hydraulic motor operating speed at the REACH OUT operation. 2) Higher : REACH OUT speed up, mast stops near to the load wheel at CUTBACK. End operation shock become a large at CUTBACK. Lower : REACH OUT speed down, mast stops far from the frame at CUTBACK. End operation shock become a small at CUTBACK.
Application	1) The mast stop too near to or too far from the load wheel when reach in CUTBACK. 2) The REACH OUT speed is too fast or too slow.
Caution	Too excessively higher, occur a noise and shock, too excessively lower, reach speed is remarkably down. If possible, leave a default value and adjust CUTBACK by using the valve opening (MIN, MAX, EVP3, 4) and delay (REIN, REOUT CTS DELAY).
Default value	14/16/20/25BRJ-9 : 28 Hz
Adjust range	Default value ± 1 Hz
Access	TRUCK MENU → SETTINGS → PUMP → PARAMETER CHANGE

C. REACH IN CTB2

Item	Description
Explanation	1) After REACH IN CUTBACK, the REACH IN speed when the truck is re-operated. 2) Higher : After CUTBACK, the REACH IN speed up when the truck is re-operated. Shock become a large at re-operated. Lower : After CUTBACK, the REACH IN speed down when the truck is re-operated. Shock become a small at re-operated.
Application	1) After REACH IN CUTBACK, the REACH IN speed is too fast or too slow when the truck is re-operated.
Caution	Because this parameter is percent value of the valve opening, adjust the parameter after the valve opening (MIN, MAX EVP3, EVP4) adjustment is finished.
Default value	14/16/20/25BRJ-9 : 40 %
Adjust range	Default value ± 20 %
Access	TRUCK MENU → SETTINGS → PUMP → PARAMETER CHANGE

D. REACH OUT CTB2

Item	Description
Explanation	1) After REACH OUT CUTBACK, the REACH OUT speed when the truck is re-operated. 2) Higher : After CUTBACK, the REACH OUT speed up when the truck is re-operated. Shock become a large at re-operated. Lower : After CUTBACK, the REACH OUT speed down when the truck is re-operated. Shock become a small at re-operated.
Application	1) After REACH OUT CUTBACK, the REACH OUT speed is too fast or too slow when the truck is re-operated.
Caution	Because this parameter is percent value of the valve opening, adjust the parameter after the valve opening (MIN, MAX EVP3, EVP4) adjustment is finished.
Default value	14/16/20/25BRJ-9 : 30 %
Adjust range	Default value ± 20 %
Access	TRUCK MENU → SETTINGS → PUMP → PARAMETER CHANGE

E. REIN CTB CLS DEL

Item	Description
Explanation	1) Adjustment of take time until the valve is closed at REACH IN CUTBACK (ref figure at page 7-86-13). 2) Higher : The REACH IN stops slowly at CUTBACK. Higher than some level, do not operated CUTBACK and REACH IN is operated to the end. The mast stops near to the frame. Lower : The REACH IN stops fast at CUTBACK. The mast stops far from the load wheel at CUTBACK.
Application	The mast stops far from the frame because the CUTBACK dose not occur or stop too fast when REACH IN operation.
Caution	None
Default value	14/16/20/25BRJ-9 : 1.2 seconds
Adjust range	Default value ± 0.2 seconds
Access	TRUCK MENU → SETTINGS → PUMP → PARAMETER CHANGE

F. REOUT CT CLS DEL

Item	Description
Explanation	1) Adjustment of take time until the valve is closed at REACH OUT CUTBACK (ref figure at page 7-86-13). 2) Higher : The REACH OUT stops slowly at CUTBACK. Higher than some level, the CUTBACK is not operated and REACH IN is operated to the end. The mast stops near to the frame. Lower : The REACH IN stops fast at CUTBACK. The mast stops far from the load wheel at CUTBACK.
Application	The mast stops far from the frame because the CUTBACK dose not occur or stop too fast when REACH OUT operation.
Caution	None
Default value	14/16/20/25BRJ-9 : 1.2 seconds
Adjust range	Default value ± 0.2 seconds
Access	TRUCK MENU → SETTINGS → PUMP → PARAMETER CHANGE

G. MIN EVP 3

Item	Description
Explanation	1) Define the minimum opening of the REACH IN VALVE (ref figure at page 7-86-13) 2) Higher : The mast stops near to the frame at CUTBACK because the valve flow quantity is increased. Higher than some level, the CUTBACK is not operated completely and mast is moved slightly. Lower : The mast stops far from the frame at CUTBACK because the valve flow quantity is decreased.
Application	1) The mast stop too near to or too far from the frame at the REACH IN CUTBACK. 2) The mast is not stopped completely and is moved slightly.
Caution	1) Adjust that the parameter is not lower than 20 % and is not higher than 26 %.
Default value	14/16/20/25BRJ-9 : 23.5 %
Adjust range	20~26 %
Access	TRUCK MENU → SETTINGS → MHYRIO → PARAMETER CHANGE

H. MAX EVP 3

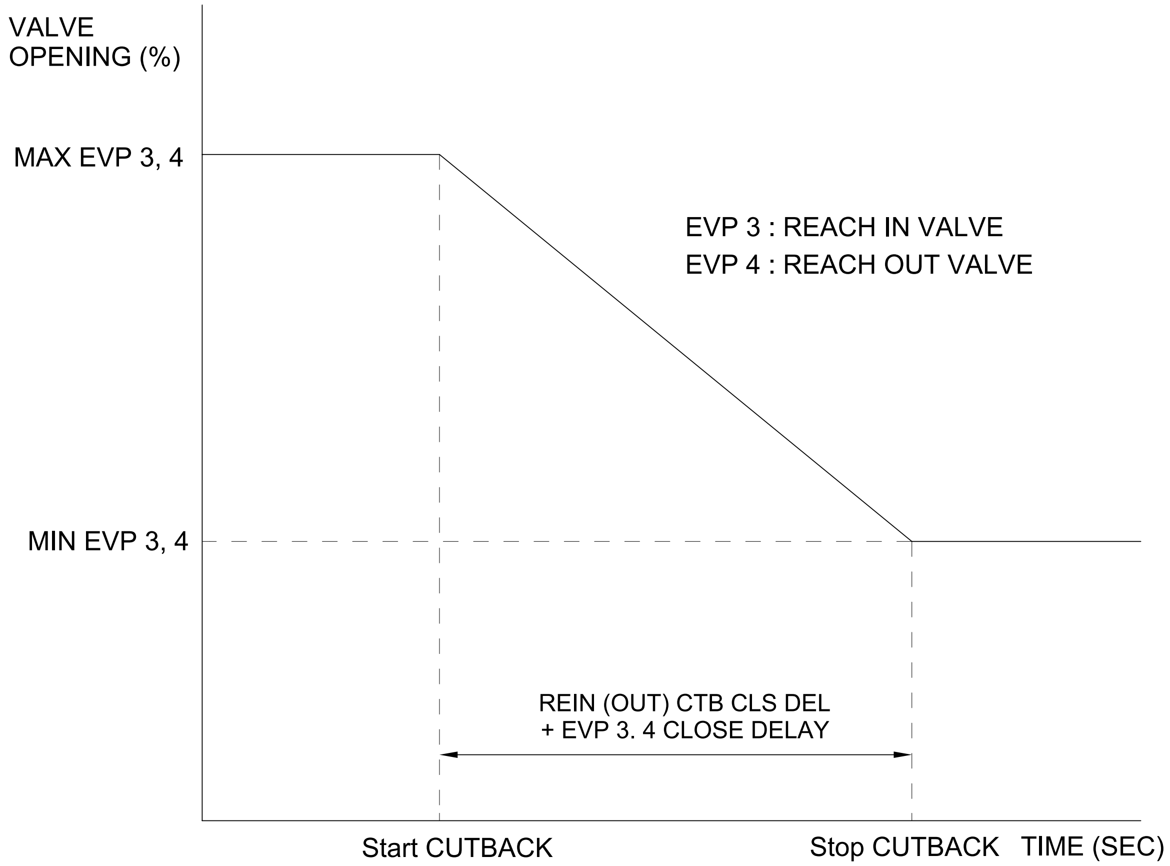
Item	Description
Explanation	1) Define the maximum opening of the REACH IN VALVE (ref figure at page 7-86-13) 2) Higher : The REACH IN speed is increased until some level because the valve opening is increased. The mast stops near to the frame at CUTBACK. Lower : The REACH IN speed is decreased until some level because the valve opening is decreased. Too excessively lowered, occur a noise and shock because of flow unbalance. The mast stops far from the frame at CUTBACK.
Application	1) The mast stop too near to or too far from the frame at the REACH IN CUTBACK. 2) If the truck has a vibration when pull the tilt lever maximally, raise a little.
Caution	1) Adjust that the parameter is not lower than 50 % and is not higher than 65 %.
Default value	14/16/20/25BRJ-9 : 58.4 %
Adjust range	50~65 %
Access	TRUCK MENU → SETTINGS → MHYRIO → PARAMETER CHANGE

I. MIN EVP 4

Item	Description
Explanation	1) Define the minimum opening of the REACH OUT VALVE (ref figure at page 7-86-13) 2) Higher : The mast stops near to the load wheel at CUTBACK because the valve flow quantity is increased. Higher than some level, the CUTBACK is not operated completely and mast is moved slightly. Lower : The mast stops far from the frame at CUTBACK because the valve flow quantity is decreased.
Application	1) The mast stop too near to or too far from the frame at the REACH IN CUTBACK. 2) The mast is not stopped completely and is moved slightly.
Caution	1) Adjust that the parameter is not lower than 20 % and is not higher than 26 %.
Default value	14/16/20/25BRJ-9 : 23.5 %
Adjust range	20~26 %
Access	TRUCK MENU → SETTINGS → MHYRIO → PARAMETER CHANGE

J. MAX EVP 4

Item	Description
Explanation	1) Define the minimum opening of the REACH OUT VALVE (ref figure at page 7-86-13) 2) Higher : The REACH OUT speed is increased until some level because the valve opening is increased. The mast stops near to the load wheel at CUTBACK. Lower : The REACH OUT speed is decreased until some level because the valve opening is decreased. Too excessively lowered, occur a noise and shock because of flow unbalance. The mast stops far from the load wheel at CUTBACK.
Application	1) The mast stop too near to or too far from the load wheel at the REACH OUT CUTBACK. 2) If the truck has a vibration when pull the tilt lever maximally, raise a little.
Caution	1) Adjust that the parameter is not lower than 65 % and is not higher than 75 %.
Default value	14/16/20/25BRJ-9 : 71.8 %
Adjust range	65~75 %
Access	TRUCK MENU → SETTINGS → MHYRIO → PARAMETER CHANGE



(Definition of each parameter for REACH IN/OUT)

BRJ97RC01

② REACH IN/OUT CUTBACK adjusting method

※ Each procedure carry out step by step in order and if the adjustment is not acceptable, go to the next method.

a. When the REACH IN/OUT CUTBACK is not to operated
   - Check that the reset switch is normal for REACH IN/OUT sensor.
   - Decrease 0.1 for the REIN/OUT CTB CLS DEL value.
   - Decrease 1 % once for the MIN EVP3/4 value until allowable range.
   - Decrease 0.1 for the REIN/OUT CTB CLS DEL value.
   - Decrease 1 Hz for the REACH IN/OUT SPEED value.

b. When the mast is not stop but is moved slightly at the REACH IN/OUT CUTBACK.
   - Decrease the MIN EVP3/4 value within allowable range until the mast dose not move any more.

c. When the mast stop far from the frame/load wheel at the REACH IN/OUT CUTBACK.
   - Increase the MIN EVP3/4 value within the mast no moving when the truck stop.
   - Increase 1 % once for the MIN EVP3/4 value within allowable range.
   - Increase 0.1 once for the REIN/OUT CTB CLS DEL value within allowable range.
   - Increase 1 Hz for the REACH IN/OUT SPEED value.

d. When the mast stop too near to the frame/load wheel at the REACH IN/OUT CUTBACK.
   - Decrease the MIN EVP3/4 value within allowable range.
   - Decrease 1 % once for the MIN EVP3/4 value within allowable range.
   - Decrease 0.1 once for the REIN/OUT CTB CLS DEL value within allowable range.
   - Decrease 1 Hz for the REACH IN/OUT SPEED value.

e. When the REACH IN/OUT speed slow after the REACH IN/OUT CUTBACK stop and re-operated.
   - Increase the REACH IN/OUT CTB2 value within allowable range.

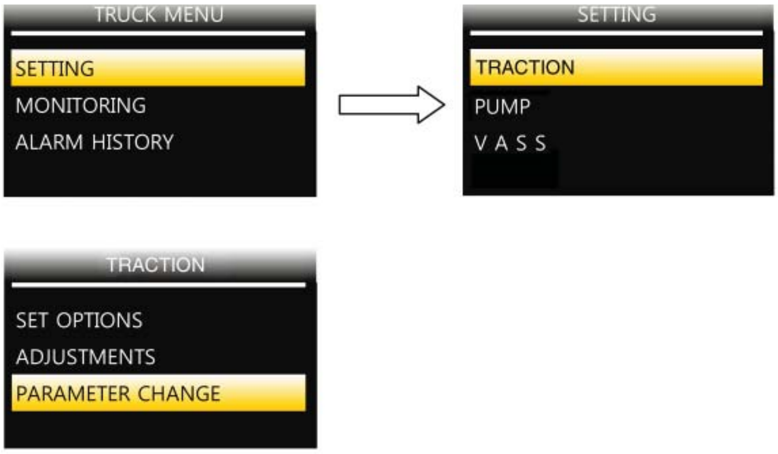
f. When the REACH IN/OUT speed fast after the REACH IN/OUT CUTBACK stop and re-operated.
   - Decrease the REACH IN/OUT CTB2 value within allowable range.

9) STRUCTURE OF TRUCK MENU

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

[To know how to get in to TRUCK MENU, refer to 6-6)-(1) “ACCESS TO TRUCK MENU” page 7-80]

(1) Settings



20BC9EL42

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

① TRACTION->SET OPTIONS
Refer to 5-4)- ■ “TRACTION CONTROLLER”-(1) “SET OPTIONS” (page 7-32)

② TRACTION->ADJUSTMENTS
Refer to 5-4)- ■ ”TRACTION CONTROLLER”-(2) “ADJUSTMENTS” (page 7-33)

③ TRACTION->PARAMETER CHANGE
Refer to 5-4)- ■ ”TRACTION CONTROLLER”-(3) “PARAMETER CHANGE” (page 7-35)

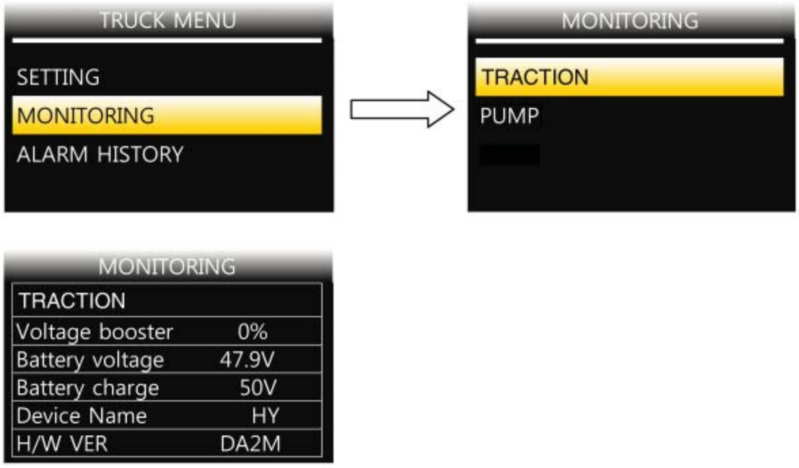
④ PUMP->SET OPTIONS
Refer to 5-4)- ■ “PUMP CONTROLLER”-(1) “SET OPTIONS” (page 7-36)

⑤ PUMP->ADJUSTMENTS
Refer to 5-4)- ■ ”PUMP CONTROLLER”-(2) “ADJUSTMENTS” (page 7-38)

⑥ PUMP->PARAMETER CHANGE
Refer to 5-4)- ■ ”PUMP CONTROLLER”-(3) “PARAMETER CHANGE” (page 7-40)

⑦ V.A.S.S
Refer to 6-8) “VASS SETUP USING DISPLAY MENU” (page 7-85)

(2) Monitoring



20BC9EL43

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

① TRACTION

Refer to 5-6)-(1) "Traction controller" (page 7-46)

② PUMP

Refer to 5-6)-(2) "Pump controller" (page 7-47)

③ EPS

Refer to 7-6) "EPS controller" (page 7-61)

④ FINGER TIP

Refer to 8-7) "FINGER TIP controller" (page 7-71)

(3) Alarm history

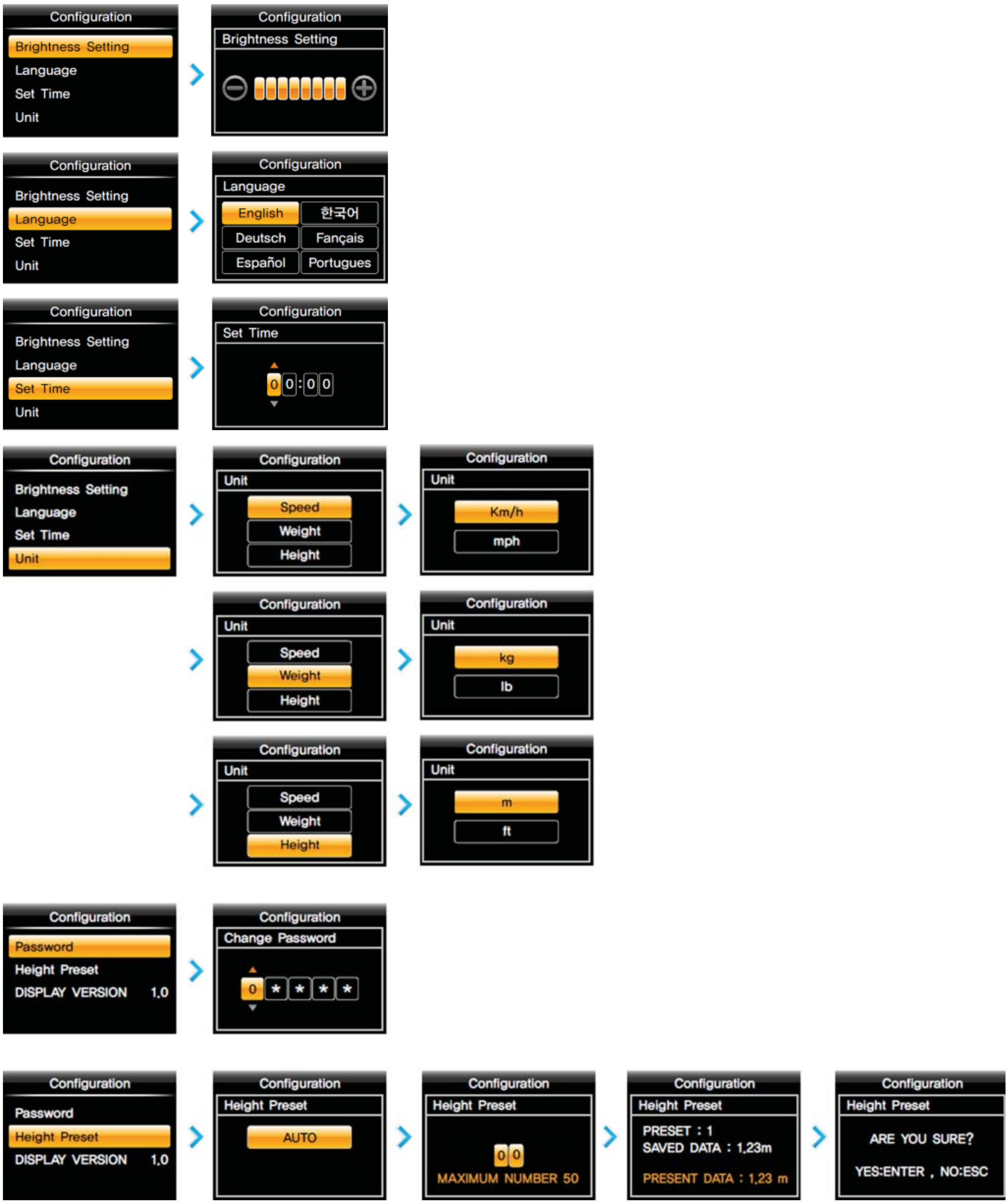
Refer to 6-7) "ALARM & ALARM HISTORY" (page 7-82)

10) LCD FUNCTION (for height indicator, OPTION)

(1) Main

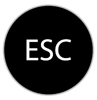
14BRJ9EFD01

(2) User menu



14BRJ9EFD02/03

(3) Button

No.	Button	Function
1		1. Number 1 input button 2. Go into the HEIGHT PRESELECTOR menu
2		1. Number 2 input button 2. Upward move button in menu
3		1. Number 3 input button
4		1. Number 4 input button 2. Leftward move button in menu
5		1. Number 5 input button
6		1. Number 6 input button 2. Rightward move button in menu
7		1. Number 7 input button 2. Go into the menu
8		1. Number 8 input button 2. Downward move button in menu
9		1. Number 9 input button 2. Go into the POWER mode
10		1. Go into the ENGINEER/SERVICE password input menu 2. Return to previous/parent menu and cancel button
11		1. Number 0 input button 2. Go into the TURTLE mode
12		1. MENU/PARAMETER select button in menu

11) DESCRIPTION OF PROGRAMMABLE MENU

In truck menu → display, service engineer can adjust several parameters related to display as follows ;

① Password

This parameter turns on the password function.

- ON : Operater should enter the password which can be set in user menu, before operating truck.
- OFF : Password function is deactivated.

② Maintenance

This parameter turns on the maintenance alarm function, and sets the alarm period.

- ON : Maintenance alarm function is activated and followed by alarm period screen where service engineer can enter the alarm period.
- OFF : Maintenance alarm function is deactivated.

③ Hour counter

This parameter determines which hour counter is supposed to be shown in main screen.

- HK : Key on counter
- HP : Pump counter
- HT : Traction counter

④ Seat belt

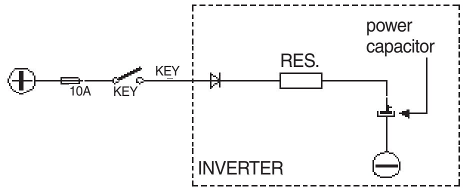
This parameter determines how seat belt lamp works.

- Option #1 : Seat belt lamp blinks for 5 seconds after truck starts on.
- Option #2 : Seat belt lamp lights unless seat & seat belt switch is closed.

12) DIAGNOSTIC FAULT CODES

Code	Alarm	Traction (T)	Pump (P)	Mhyrio (V)	EPS (E)	Description
6	SERIAL ERR#1				○	Main uC and Slave uC communicate via a local serial interface. This alarm occurs when the slave uC does not receive the communication from the main uC through this serial interface. It is necessary to replace the controller.
8	WATCHDOG	○	○	○		The test is made in both running and standby. It is a self-diagnosing test within the logic. If an alarm should occur, replace the logic.
D	EEPROM	○	○	○	○	Fault in the area of memory in which the adjustment parameters are stored; this alarm inhibits machine operation. If the defect persists when the key is switched OFF and ON again, replace the logic. If the alarm disappears, remember that the parameters stored previously have been cancelled and replaced by the default values.
10	LOGIC FAILURE #4				○	This alarm occurs in the rest state if the output of the voltage amplifier of the phase Vw-Vv have a drift larger than ±0.25 V. It is necessary to replace the controller.
11	LOGIC FAILURE #3	○				Fault in the hardware section of the logic board which manages the hardware current protection. Replace the logic board.
					○	This alarm occurs in the rest state if the output of the voltage amplifier of the phase Vu-Vw have a drift larger than ±0.25 V. It is necessary to replace the controller.
12	LOGIC FAILURE #2	○	○			Fault in the hardware section of the logic board which manages the phase' s voltage feedback. Replace the logic board.
					○	This alarm occurs when the real voltage between phases W and V of the motor is different from the desired. It is necessary to replace the controller.
13	LOGIC FAILURE #1	○	○			This alarm signals that an undervoltage / overvoltage protection operation has occurred. Two possible reasons: A) A real undervoltage / overvoltage situation happened. B) Fault in the hardware section of the logic board which manages the overvoltage protection. Replace the logic card.
					○	This alarm occurs when the real voltage between phases W and U of the motor is different from the desired. It is necessary to replace the controller.
1E	VMN LOW	○	○			The test is carried out during initial diagnosis and in standby. Possible causes: A) Problem with the motor connections or the motor power circuit; check if the 3 phases are correctly connected; check if there's a dispersion of the motor towards ground; B) Inverter failure, replace it

Code	Alarm	Traction (T)	Pump (P)	Mhyrio (V)	EPS (E)	Description
1F	VMN HIGH	○	○			The test is carried out during initial diagnosis and in standby. Possible causes: A) Problem with the motor connections or the motor power circuit; check if the 3 phases are correctly connected; check if there's a dispersion of the motor towards ground; B) Inverter failure, replace it
20	VMN NOT OK				○	This alarm occurs in the initial rest state after key on if the outputs of the motor voltage amplifiers are not in the window from 2.2 to 2.8 Vdc. It is necessary to replace the controller.
25	CONTACTOR CLOSED	○				This alarm occurs. Before driving the MC coil, the controller checks if the contactor is stuck. The controller drives the bridge for some tens milliseconds, trying to discharge the capacitors bank. If the capacitor voltage does decrease by 20% of the key voltage the alarm is generated. It is suggested to verify the power contacts of line contactor ; to replace the LC is necessary.
26	CONTACTOR OPEN	○				The main contactor coil has been driven by the logic board, but the contactor does not close. Two possible reasons: A) The wires to the coil are interrupted or not well connected. B) The contact of the contactor is not properly working.
30	MAIN CONT.OPEN				○	This alarm occurs only when the setting CAN BUS is PRESENT. Then the eps-ac0 waits for a via CAN information that the traction controller has closed the main contactor. If this information lacks more than about 1.5 secs, this alarm occurs. Find, on the traction controller, the reason for keeping the main contactor open.
31	I=0 EVER	○	○			Traction or pump controller current too low
35	STBY I HIGH	○	○			Test carried out in standby. Check if the current is 0. If not verified, an alarm is signalled which inhibits machine operations. Possible causes: A) Current sensor failure; B) Logic failure: first replace the logic; if the defect persists, replace the power unit.
					○	This alarm occurs two ways: 1) In the initial rest state after key on, if the outputs of the current amplifiers are not comprised in the window 2.2 to 2.8 Vdc. 2) After the initial diagnosis this alarm occurs when the outputs of the current amplifiers at rest have a drift larger than $\pm$0.15 V. It is necessary to replace the controller.

Code	Alarm	Traction (T)	Pump (P)	Mhyrio (V)	EPS (E)	Description
3C	CAPACITOR CHARGE	○	○			Follows the charging capacitor system:  When the key is switched ON, the inverter tries to charge the capacitor through a power resistance, and check if the capacitor are charged within a timeout. If this is not true: an alarm is signalled; the main contactor is not closed. Possible reasons: A) The charging resistance is opened; if it is opened. B) The charging circuit has a failure. C) There is a problem on the power modules.
3D	HIGH TEMPERATURE	○	○		○	Inverter temperature is greater than 75°C. The maximum current is reduced proportionally to the temperature increase. The inverter stops at 100°C. If the alarm is signalled when the inverter is cold: A) Check the wiring of the thermal sensor; B) Thermal sensor failure; C) Logic failure.
41	MOTOR TEMPERATURE	○	○		○	This warning is signalled if the motor temperature switch opens (digital sensor) or if the analog signal overtakes the cut off level. If it happens when the motor is cold, check the wiring. If all is ok, replace the logic board.
42	BATTERY LOW	○	○			If the "battery check" option is ON, a battery discharge algorithm is carried out. When the charge level is 10%, this alarm is signalled and the current is reduced to the half of the programmed level.
46	HIGH CURRENT				○	This alarm occurs if the circuit to limit via hardware the current in the motor is either always active at key-on or repeatedly active when the motor is turning. Check the motor is suited to work with the eps-ac 0 (not oversized). Otherwise it is necessary to replace the controller.
47	POWER FAILURE #3				○	This alarm occurs when the current in the phase V of the motor is zero and the motor is commanded for moving. Check the power fuse is OK. Check the battery positive arrives to the controller. Check the continuity of the wire in the phase V of the motor. Otherwise it is necessary to replace the controller.
48	POWER FAILURE #2				○	This alarm occurs when the current in the phase U of the motor is zero and the motor is commanded for moving. Check the power fuse is OK. Check the battery positive arrives to the controller. Check the continuity of the wire in the phase U of the motor. Otherwise it is necessary to replace the controller.

Code	Alarm	Traction (T)	Pump (P)	Mhyrio (V)	EPS (E)	Description
49	POWER FAILURE #3				○	This alarm occurs when the current in the phase W of the motor is zero and the motor is commanded for moving. Check the power fuse is OK. Check the battery positive arrives to the controller. Check the continuity of the wire in the phase W of the motor. Otherwise it is necessary to replace the controller.
4A	DRIVER SHORTED	○	○			When the key is switched ON, the μ P checks that the MC coil driver is not shorted; if it is, this alarm is signalled; replace the logic board.
4B	CONTACTOR DRIVER		○			When the initial diagnosis is finished, the traction logic closes the MC and checks the voltage on the drain of the driver. If this is not low, an alarm is signalled. Replace the logic.
4C	COIL SHORTED	○	○			When the key is switched ON the μ P checks the MC driver FF SR. If it does not react in a correct way to the μ P stimulus, the alarm is signalled. Replace the logic board. The FF SR makes an hardware control of the current in the MC coil. If this is too high, it opens the MC and the alarm is signalled.Check if there are external shortcircuit and if the ohmic value of the MC is correct; otherwise replace the logic.
4D	COIL INTERRUPTED	○	○			Main contactor line is interrupted
4E	VACC NOT OK	○	○			The test is made in standby. This alarm indicates that the accelerator voltage is 1 V greater than the minimum value programmed by the PROGRAM VACC function. Possible causes: A) The potentiometer is not correctly calibrated; B) The potentiometer is defective.
4F	INCORRECT START	○	○			This alarm signals an incorrect starting sequence. Possible causes: A) Running microswitch failure; B) Error in sequence made by the operator; C) Incorrect wiring; D) If the default persists, replace the logic.
50	FORW + BACK	○				The test is carried out continuously. An alarm is signalled when a double running request is made simultaneously. Possible causes: A) Defective wiring; B) Running microswitch failure; C) Incorrect operation; D) If the defect persists, replace the logic.
52	ENCODER ERROR	○	○			Two consecutive readings of the encoder speed are too much different in between: because of the inertia of the system it is not possible the encoder changes its speed a lot in a short period. Probably an encoder failure has occurred (e.g. one or two channels of the encoder are corrupted or disconnected). Check both the electric and the mechanical encoder functionality. Also the electromagnetic noise on the sensor bearing can be a cause for the alarm.

Code	Alarm	Traction (T)	Pump (P)	Mhyrio (V)	EPS (E)	Description
53	BAD ENCODER SIGN				○	It occurs when the ENC SPEED in the tester menu has opposite sign than FREQUENCY in the tester menu. Swap the channels of the encoder (CNB#8 with CNB#7).
54	STEER SENSOR KO				○	This alarm occurs if the command potentiometer (CPOC1 on CNA#9 or CPOC2 on CNA#8) changes with a jerk larger than MAX SP SLOPE . This alarm is used to catch a discontinuity in the voltages of the command potentiometer.
55	STEER HAZARD				○	This is just a warning to inform that the steering controller is limiting the angle in the steering direction. No speed reduction occurs on the traction.
56	PEDAL WIRE KO	○	○			This alarm is signalled if a fault is detected in the accelerator unit wiring (NPOT or PPOT cable is interrupted).
63	INPUT ERROR #1				○	It occurs when the voltage on CNA#4 (NK1: Lower potential terminal of the safety contacts is higher than 12 V before to turn the safety contacts closed. When the safety contacts are open, the voltage on CNA#4 is expected to be close to 0 Vdc and this is independent from whether the safety contacts are connected to a plus battery or to a minus battery. In the first case (safety contacts connected to a plus battery), when the safety contacts are open, CNA#4 is connected to a minus battery through a load. Only a harness mistake may connect NK1 to a higher than 12 V voltage.
D3	WRONG CONFIG				○	This alarm occurs when EPS configuration setting does'nt mach with traction controller. Please check the truck type setting. For BRJ-9 model, setting value is "4"
D4	TRUCK NOT CONFIG				○	
D5	TILT SENS. OUTRNG		○			Potentiometer tilt angle value are not in the setting range (between MIN and MAX).
	SL CENTERING				○	This alarm occurs when an automatic centering is requested from steady state condition. Then the slave uC expects the angle measured on the steered wheel goes into a window from -20 to +20 degrees before the traction turns moving. In case the traction turns moving with a steered wheel outside that window, this alarm occurs. It is necessary to replace the controller.
D6	HEIGHT MAX LIFT		○			This alarm occurs if the measured height is same as set max height. It is just warnning. But if the height is diffirent from real max height, please set max height again.
	SL EPS NOT ALL				○	This alarm occurs at key on: A) When the initial automatic centering is expected. B) The slave uC detects the encoder is at rest longer than two secs C) Within this two secs delay, the main uC does not communicate that the automatic centering was successfully ended. It is necessary to replace the controller.

Code	Alarm	Traction (T)	Pump (P)	Mhyrio (V)	EPS (E)	Description
D7	TILT WRONG DIR.		○			This alarm occurs if the user operate the tilt lever in a wrong direction, when the auto fork leveling function is activated. (for example, if tilt is backward, the user is doing backward tilt. It can cause this alarm. Because of wrong operation direction.)
	CAN BUS KO SL				○	This alarm occurs when the slave uC does not receive any CAN BUS frame from the main uC. It is necessary to replace the controller.
D8	OVERLOAD		○			Load weight sensor detects that loaded weight exceeds the weight limited in OVERLOAD WEIGHT programming. Remove the warning condition.
	MICRO SLAVE #8				○	It occurs when the encoder counting of the main uC is not matched with the encoder counting of the slave uC. It is necessary to replace the controller.
DA	CAN ENCODER		○			There is a problem related to the CAN-BUS line. The error is signalled if the pump controller does not receive any message from CAN ENCODER. First of all, check the wiring. If it is ok, the problem is on the logic board of CAN ENCODER, which must be replaced.
	CLOCK PAL NOT OK				○	The main uC sends an analog signal towards the slave uC to reset the slave uC on demand. When the slave uC detects this analog signal external to a window from 2.2 to 2.8 and not in the range to generate the reset on demand, the slave uC raises this alarm. It is necessary to replace the controller.
DB	ZERO POS RESET		○			After key on, Pump controller checks the status of zero reset switch. If the reset switch is open. This alarm occurs. Check the wire connection to the reset switch and sensing bracket. If they are fine, replace the switch.
	STEPPER MOTOR MISM				○	This alarm occurs if the frequency and the amplitude of the voltages from the stepper motor lines are mismatched in between (i.e. the voltage from the D and Q line of the stepper motor have high amplitude but with very low frequency). In normal condition when the amplitude of the stepper motor lines increases, the frequency of the stepper motor lines must increase too. This alarm occurs also if a stepper motor line (D or Q) is short circuited to minus battery. Check if a stepper motor line is short circuited to minus battery. Otherwise it is necessary to replace the controller.
DC	HEIGHT ENC LOCK		○			This alarm occurs if there is no signal from the height encoder for 3 sec for lift operation. check the wire to encoder sensor. If it is ok, change the encoder. This alarm occurs in case of lift end stroke, please set the max height again.
	MOTOR LOCKED				○	This alarm occurs if the current in the steering motor stays higher than 90% of the maximum current longer than 1 sec. Search for a mechanical problem locking the motor. To make easier the fault catching, set DEBUG OUTPUT to level 11.

Code	Alarm	Traction (T)	Pump (P)	Mhyrio (V)	EPS (E)	Description
DD	WRONG DIRECTION		○			This alarm occurs if the user operate the lift lever in a wrong direction, when the preset function is activated. (for example, if preset height is 3m and present height is 5m, the user is doing lifting. It can cause this alarm. Because of wrong operation direction.)
	MICRO SLAVE #4				○	It occurs in one of the following conditions : If the slave uC detects the stator voltage phasor rotates in the opposite direction respect to the sign of the stepper motor speed, this alarm occurs. (i.e. slave uC detects the actual sign of the frequency in the motor opposes the sign that the frequency should have according the command). It is necessary to replace the controller.
DE	FBSENS LOCKED				○	This alarm occurs only when option ENCODER CONTROL is off. Then, if the encoder is frozen and the steering motor is demanded for moving at higher than 40% of the maximum motor speed, this alarm occurs. Check the encoder is right working. This alarm may be masked (for the trouble shooting activity only) by setting special adjustment DEBUG OUTPUT to level 11 and recycling the key . Then it is possible to verify the reading ENC SPEED is frozen or not meanwhile the steering motor is turning.
E1	CURRENT GAIN				○	This alarm occurs when the parameters to compensate for the gain of the current amplifiers (ADJUSTMENT #03 and ADJUSTMENT #04) have the default values (i.e. the maximum current was not regulated). It is necessary to send the controller to Zapi to perform the maximum current regulation.
E2	NO SYNC				○	Every 16msec, inside the code cycle, the main uC rises and then lowers an input for the slave uC (SYNC). When the slave uC detects no edge for more than 100 msec on this input, this alarm occurs. This is just a watch dog function: when the main uC does not execute the code cycle it does not update the SYNC signal and the slave uC cuts off the steer and traction. It is necessary to replace the controller.
E3	SLIP PROFILE		○			Slip profile is wrong (es.slip freq0 >slip freq1)
	SLAVE COM. ERROR				○	Main uC and Slave uC communicate via a local serial interface. This alarm occurs when the main uC does not receive the communication from the slave uC through this serial interface. It is necessary to replace the controller.

<table>
<tr><th>Code</th><th>Alarm</th><th>Traction (T)</th><th>Pump (P)</th><th>Mhyrio (V)</th><th>EPS (E)</th><th>Description</th></tr>
<tr><td>E4</td><td>POSITION ERROR</td><td></td><td></td><td></td><td>○</td><td>This alarm occurs for an error in the redundant test of the feedback sensors. Here we have an encoder and two toggle switches. This alarm occurs whether the sector (toggle switches configuration) and the encoder counting are not matched. The sector is provided with the FEEDBACK SECTOR reading in the tester menu ; the encoder counting is provided with the WHEEL ANGLE reading in the tester menu.
<table>
<tr><th>WHEEL ANGEL (degrees)</th><th>Admitted SECTOR</th><th>Admitted PEEDBACK SECTOR</th></tr>
<tr><td>-22 to +22</td><td>1^{st} or 4^{th}</td><td>3.13V or 1.88V</td></tr>
<tr><td>+23 to +67</td><td>1^{ST}</td><td>3.13V</td></tr>
<tr><td>+68 to +112</td><td>1^{st} or 2^{nd}</td><td>3.13V to 4.39V</td></tr>
<tr><td>+113 to +157</td><td>2^{nd}</td><td>4.39V</td></tr>
</table>
<table>
<tr><th>WHEEL ANGEL (degrees)</th><th>Admitted SECTOR</th><th>Admitted PEEDBACK SECTOR</th></tr>
<tr><td>+158 to -158</td><td>2^{nd} or 3^{rd}</td><td>4.39V or 0.62V</td></tr>
<tr><td>-157 to -113</td><td>3^{rd}</td><td>0.62V</td></tr>
<tr><td>-112 to -68</td><td>3^{rd} or 4^{th}</td><td>0.62V to 1.88V</td></tr>
<tr><td>-67 to -23</td><td>4^{th}</td><td>1.88V</td></tr>
</table>
When the FEEDBACK SECTOR and WHEEL ANGLE don't meet the above correspondence, an alarm POSTION ERROR occurs in less than 100msec. If the alarm occurs when installing a new controller, be sure the AUX FUNCTION 11 corresponds to the toggle switches arrangement you have and SET ENC AT 360 was correctly set .</td></tr>
<tr><td></td><td>MODEL MISMATCH</td><td></td><td>○</td><td></td><td></td><td>Model truck selected for the pump is not the same of traction one</td></tr>
<tr><td></td><td>EVPG1 DRIV SHORT</td><td></td><td></td><td>○</td><td></td><td>One of the group 1 valves drivers is shorted; check the external connection, if it is ok the driver is probably damaged.</td></tr>
<tr><td>E5</td><td>AUX FUCNT KO</td><td></td><td>○</td><td></td><td></td><td>Potentiometer aux value and its complementer are not matched</td></tr>
<tr><td></td><td>EVPG2 DRIV SHORT</td><td></td><td></td><td>○</td><td></td><td>One of the group 2 valves drivers is shorted; check the external connection, if it is ok the driver is probably damaged.</td></tr>
<tr><td>E6</td><td>SHIFT FUCNT KO</td><td></td><td>○</td><td></td><td></td><td>Potentiometer shift value and its complementer are not matched</td></tr>
<tr><td></td><td>EVPG3 DRIV SHORT</td><td></td><td></td><td>○</td><td></td><td>One of the group 3 valves drivers is shorted; check the external connection, if it is ok the driver is probably damaged.</td></tr>
<tr><td>E7</td><td>TILT FUCNT KO</td><td></td><td>○</td><td></td><td></td><td>Potentiometer tilt value and its complementer are not matched</td></tr>
<tr><td></td><td>EVPG4 DRIV SHORT</td><td></td><td></td><td>○</td><td></td><td>One of the group 4 valves drivers is shorted; check the external connection, if it is ok the driver is probably damaged.</td></tr>
</table>

Code	Alarm	Traction (T)	Pump (P)	Mhyrio (V)	EPS (E)	Description
E8	LIFT FUCNT KO		○			Potentiometer lift value and its complementer are not matched
	EVP DRIVER SHORT			○		One of the on/off valves driver is shorted; check the external connection, if it is ok the driver is probably damaged.
E9	AUX OUT OF RNG		○			Potentiometer aux value is out of range
	EV DRIVER SHORT			○		One of the on/off valves driver is shorted; check the external connection, if it is ok the driver is probably damaged.
EA	SHIFT OUT OF RNG		○			Potentiometer shift value is out of range
EB	TILT OUT OF RNG		○			Potentiometer tilt value is out of range
EC	CAN KO JOYSTICK	○				There is a problem related to the CAN-BUS line. The error is signalled if the traction controller does not receive any message from JOYSTICK. First of all, check the wiring. If it is ok, the problem is on the logic board of JOYSTICK, which must be replaced.
	LIFT OUT OF RNG		○			Potentiometer lift value is out of range
ED	WAITING DATA				○	This warning occurs only if CAN BUS is PRESENT. At key-on the eps-ac0 asks to the traction controller to send a list of parameters via CAN BUS. From the request until the parameters are correctly relieved, this warning occurs. The steer is not activated yet, and the safety relays remain open when this warning is present.
	SAFETY	○				This alarm is signalled when the "SAFETY" input is open. The "SAFETY" circuit gets active and opens the drivers of LC and EB and stops the machine. Verify the "SAFETY" input connection.
	ACQUIRE AUX		○			Acquired aux function value is not valid
EE	SAFETY KO	○				This alarm is present in combi systems (traction + pump). If a stopping alarm is detected on the pump, the traction also stops. The failure must be looked for in the pump inverter.
	ACQUIRE SHIFT		○			Acquired shift function value is not valid
	EPS NOT ALIGNED				○	This is a real alarm that cut off the traction. It occurs when the system tries to perform an automatic centering at key on but no straight ahead edge is detected within 6 secs. Check the straight ahead switch (SW1 to CNA#3) is right working.

Code	Alarm	Traction (T)	Pump (P)	Mhyrio (V)	EPS (E)	Description
EF	SLIP PROFILE	○				Slip profile is wrong (es.slip freq0 >slip freq1)
	ACQUIRE TILT		○			Acquired tilt function value is not valid
	WAITING FOR PEV			○		EVP Coil line is interrupet
	WAITING FOR TRAC				○	This warning occurs only if CAN BUS is PRESENT. At key-on the eps-ac0 needs an assent from the traction controller to close the safety contacts and to turn onto operational mode. Until this assent is not relieved, this warning occurs. The steer is not activated yet and the safety relays remain open when this warning is present.
F0	MOTOR STALL	○				Encoder locked
	ACQUIRE LIFT		○			Acquired lift function value is not valid
	KEY OFF				○	This fault is displayed when the controller detects a low logic level of Key-Off signal during Start-Up diagnosis. It is very likely the fault is due to an under voltage, so it is suggested to check: - Key input signal down-going pulses (below under voltage threshold) due to external loads, like DC/DC converters starting-up, relays or contactor switching, solenoids energizing / de-energizing. - Check the connection of power cables to the battery terminal, positive and negative, to MC and to controller +Batt and –Batt, which must be screwed with a torque comprised in the range 13 Nm÷15 Nm. - If no voltage transient is detected on the supply line and the alarm is present every time the key is switched ON, the failure is probably in the controller hardware, so it is necessary to replace the logic board.
F1	DATA ACQUSITION	○	○			This alarm is signalled in the current gain acquisition phase. Wait the end of the acquisition activity.
	CAN BUS KO			○		There is a problem related to the CAN-BUS line. The error is signalled if the MHYRIO controller does not receive any message from the CAN-BUS line. First of all, check the wiring. If it is ok, the problem is on the logic board, which must be replaced.
	ENCODER ERROR				○	It occurs when ENCODER CONTROL is set ON and the real frequency does not pursuit the commanded frequency. This condition is several times due to either, a mismatching between the Encoder resolution used in the SW and the real encoder resolution, or a wrong connection between the two encoder channels. In this latest case swap the channels of the encoder (CNB#8 with CNB#7).

Code	Alarm	Traction (T)	Pump (P)	Mhyrio (V)	EPS (E)	Description
F2	STEAR DEAD ANGLE	○				EPS Relay is open
	MOTOR STALL		○			Encoder locked
	COIL SHORTED			○		N/OFF valves drivers are protected against coil short circuit; if a short is present across the coil, the flip-flop circuit is set and the alarm is signalled.
	Q LINE SENSOR KO				○	This alarm occurs when the mean voltage on the quadrature line of the stepper motor (connection CNA#8) is not null: the voltage on every stepper motor line is a sine wave with null mean voltage. Check the continuity of the stepper motor connections. In particular the resistance between CNA#8 and the minus battery (with the stepper motor at rest) is expected being very low (close to 30 ohms).
F3	SEQUENCE FAULT	○				Wrong Sequence to begin traction(es. First pedal activated and then forward switch activated
	EV DRIVER KO			○		One of the On/Off valves drivers is open (it does not close when it is commanded by the microcontroller).
	D LINE SENSOR KO				○	This alarm occurs when the mean voltage on the direct line of the stepper motor (connection CNA#9) is not null: the voltage on every stepper motor line is a sine wave with null mean voltage. Check the continuity of the stepper motor connections. In particular the resistance between CNA#9 and the minus battery (with the stepper motor at rest) is expected being very low (close to 30 ohms).
F4	ANGLE NOT VALID	○				Angle from EPS is not valid
	JOYSTICK NOT OK		○			"The test is made in standby. This alarm indicates that the joystick can signal is different from can protocol. Possible causes: the joystick is defective."
	EVPG1 DRIVER KO			○		One of the Group 1 valves drivers is open (it does not close when it is commanded by the microcontroller).
	GAIN EEPROM KO				○	The parameters to compensate for the gain of the current amplifiers (ADJUSTMENT #03 and ADJUSTMENT #04) are recorded in a not volatile memory (eeprom) with a redundant handling. In fact every adjustment is recorded in three eeprom locations. If the values in these three locations are different in between this alarm occurs. It is necessary to send the controller to sevice man to perform the maximum current regulation.

Code	Alarm	Traction (T)	Pump (P)	Mhyrio (V)	EPS (E)	Description
F5	WRONG SET BATT.	○	○			When the key is turned ON, the controller check the battery voltage and verifies it is within a window around the nominal value. Replace the battery with a correct battery.
	EVPG2 DRIVER KO			○		One of the group 2 valves drivers is open (it does not close when it is commanded by the microcontroller).
	DATA ACQUISITION				○	This alarm occurs two ways: 1) When hardware setting AUTOTEACHING is turned On and the key recycled.Then, during the consequent autoteaching procedure,a DATA ACQUISITION alarm occurs 2) When acquiring the motor resistance or when adjusting the parameters to compensate for the gain of the current amplifiers (maximum current factory adjusted). Recycle the key.
F6	EPS IN ALARM	○				This alarm occurs in case EPS occur alarms. Because of EPS alarm, Traction function is disabled. This alarm warn this.
	SAFETY		○			This alarm is signalled when the "SAFETY" input is open. The "SAFETY" circuit gets active and opens the drivers of LC and EB and stops the machine. Verify the "SAFETY" input connection.
	EVPG3 DRIVER KO			○		One of the group 3 valves drivers is open (it does not close when it is commanded by the microcontroller).
	MICRO SLAVE KO				○	In stepper motor application, this alarm occurs if the main uC is detecting a direction of the stepper motor not matched with the one that the slave uC is detecting. In closed loop application, this alarm occurs if the main uC is detecting a direction of the steering error not matched with the one that the slave uC is detecting. Furthermore, this alarm occurs also if the main uC is detecting no steering limitation meanwhile the slave uC is detecting steering limitation. It is necessary to replace the controller.
F7	CAN BUS KO	○			○	The diagnosis of the CAN-BUS line is present only if the inverter uses this link (depends on the software version). It is signalled if the inverter does not receive any message from the CAN-BUS line. First of all, check the wiring. If it is ok, the problem is on the logic board, which must be replaced.
	NO CAN MSG N.		○			
	EVPG4 DRIVER KO			○		One of the group 4 valves drivers is open (it does not close when it is commanded by the microcontroller).

Code	Alarm	Traction (T)	Pump (P)	Mhyrio (V)	EPS (E)	Description
F8	DISPLAY ENABLE	○				Comunication with display ok but waiting for display message
	UNDER VOLTAGE			○		This fault is signalled if an undervoltage condition is detected in the MHYRIO power supply
	S.P OUT OF RANGE				○	This alarm occurs for a fault on the command potentiometer (CPOC1 on CNA#9, CPOC2 on CNA#8). When a single command pot is chosen, the alarm occurs if its wiper (CPOC1) exits the range from 0.8 Vdc to 4.2 Vdc. When the twin pot is chosen, the alarm occurs if the sum of the two wiper voltages (CPOC1+CPOC2) exits the range from 4.5 Vdc to 5.5 Vdc.Check the connections of the potentiometer. This alarm occurs when one connection of the command potentiometer is broken.
F9	THERMIC SENS. KO	○	○			The range of inverter temperature sensor is always checked and a warning is signalled if it is out of range. When this alarm is signalled, check the connection of the sensors.
	EVP DRIVER KO			○		The single proportional valve driver is open (it does not close when it is commanded by the microcontroller).
FA	HANDBRAKE	○				The truck does not start because the handbrake switch is opened. Possible causes: A) Defective wiring; B) Failure of the microswitch; C) Incorrect operation of the operator; D) If the defect persist, replace the logic.
	HI SIDEDRIVER KO			○		The high side driver which supply the valves coils positive is shorted or open. Check the wire connection to CNB2 (PAUX) and fuse. If it is ok, change MHYRIO CB.
	MICRO SLAVE				○	It occurs two ways: A) In steady state condition, when the main uC finds the safety contact controlled by the slave uC has been opened, but no alarm information has been communicated from the slave uC to justify the opening of the safety contact. B) at key on,when the main uC has closed its own safety contact, it grants the local status bus to the slave uC that is expected to change properly the status bus configuration within 300msec. In case it doesn't, this alarm occurs. It is necessary to replace the controller.

Code	Alarm	Traction (T)	Pump (P)	Mhyrio (V)	EPS (E)	Description
FB	WAITING FOR NODE	○				The controller receives from a remote module via CAN BUS the information that it isn¡¯t possible to close the LC (the module isn¡¯t ready locked in an alarm state). Verify the other modules to determinate in which of them there is the problem.
	WAITING FOR TRAC		○			
	WAITING FOR TRAC			○		This fault is signalled if the battery voltage is non consistent with the set battery programmed in the 'set option' menu.
	KM OPEN				○	This alarm occurs if the slave uC detects the safety contact, of the main uC, open when expected being closed. It is necessary to replace the controller.
FC	CHAT MODE	○				No command (traction or pump) for CHAT TIME minutes
	HW PROTECTION		○			
	FF VALVES			○		Flip-flop circuit, that manages on/off valve drivers short-circuit protection, does not reset in the correct way. The problem is probably in the hardware circuit.
	KS OPEN				○	This alarm occurs if the main uC detects the safety contact, of the slave uC, open when expected being closed. It is necessary to replace the controller.
FD	AUX OUTPUT KO	○	○			The μ P checks the driver of the electromechanical brake. If the status of the driver output does not correspond to the signal coming from the μ P, the alarm is signalled. Replace the logic.
	KM CLOSED				○	This alarm occurs at key on if the slave uC detects the safety contact, of the main uC, closed prior to be commanded. This alarm occurs if the connection CNA#5 (K1) is around a voltage of 12 Vdc when switching on the key. In fact, when the safety contacts are open, K1 is expected being connected to a battery voltage (not 12 V). Search for a harness problem or replace the controller.
FE	CAN BUS DISP KO	○				No Can Comunication with display
	DISPLAY ENABLE		○			Comunication with display ok but waiting for display message
	KS CLOSED				○	This alarm occurs if the main uC detects the safety contact, of the slave uC, closed prior to be commanded. This alarm occurs if the connection CNA#4 (NK1) is around a voltage of 12 Vdc when switching on the key. In fact, when the safety contacts are open, NK1 is expected being connected to a minus battery voltage (not 12 V). Search for a harness problem or replace the controller.

10. BATTERY CHARGER

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

1) BASIC INFORMATION

(1) What is charger

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

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

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

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

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

④ It prevents from under charging and overcharging.

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

(2) Notice on caring chargers

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

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

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

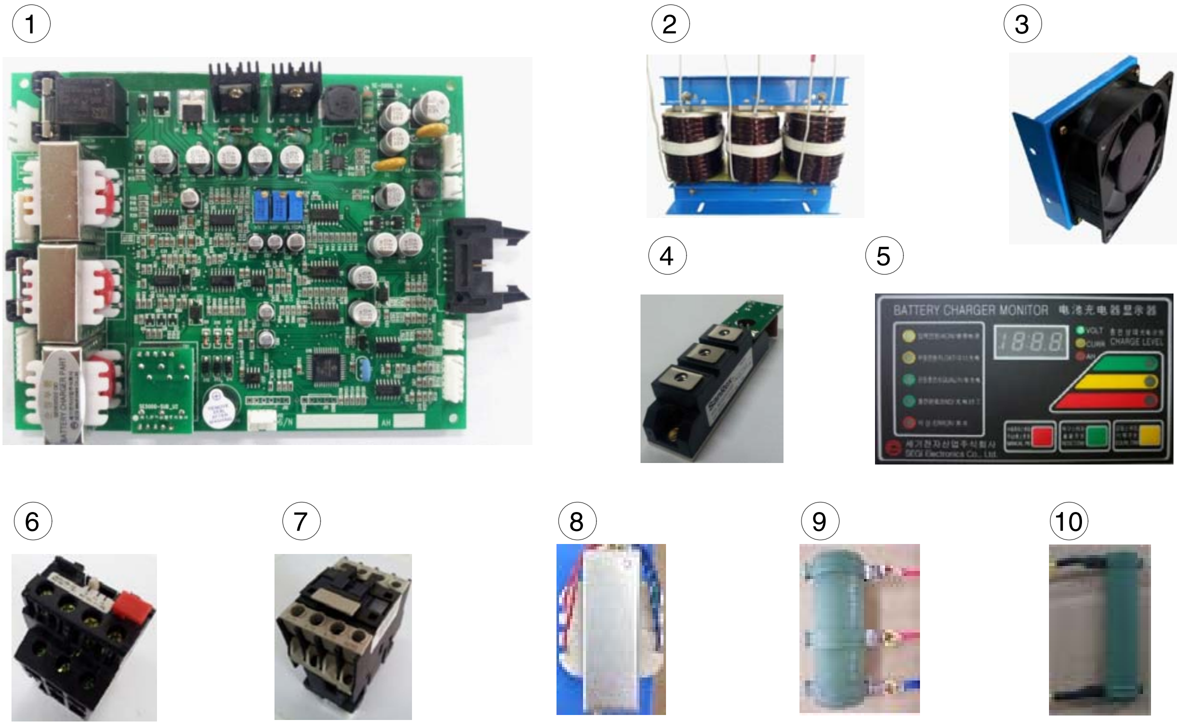
④ Check the electrolyte of the battery every week and provide distilled water immediately if it is required. (Electrolyte has to be provided between 10~12 mm level on the positive plate inside storage battery)

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

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

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

(3) Names of each part (independent items)



22B9BAT30

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

2) CHARGER INSTALLATION METHOD

(1) Location for charger installation

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

(2) Check points before installing charger

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

(3) Table for capacity of charger input cable

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

3) HOW TO USE A CHARGER

(1) General charging method (Floating charging)

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

② Connect battery connecter and charger connecter.

22B9BAT01

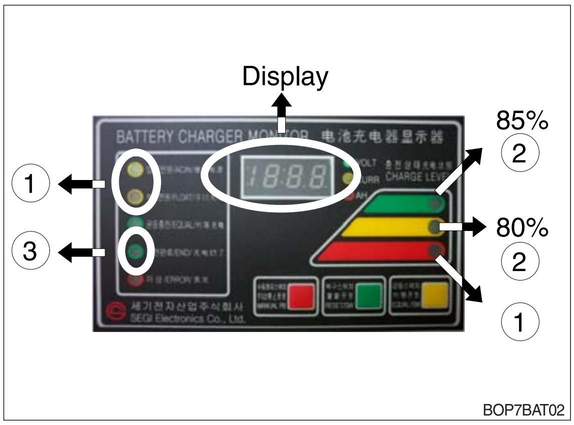
· According to charging condition

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.



BOP7BAT02

(2) Equalized charging

① Equalized charging is

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

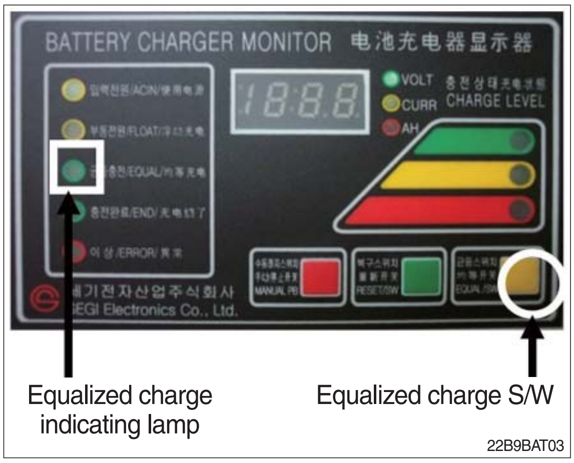
When equalized charging is required?

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

② Tips for equalized charging

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

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



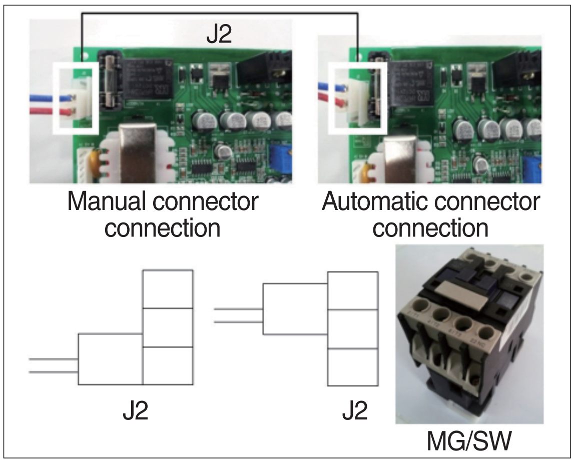
22B9BAT03

(3) Automatic/Manual switching method

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

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

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



22B9BAT04

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

① Plug it into a manual connector and input after 5 sec., a floating charge, charging status red LED lights up.

② After 15 sec., charging status yellow LED lights up.

③ After a green LED lights up, if measured voltage comes out as Iulua63V ~ Iula64V by measuring output voltage of battery connector side with multi-meter, then it is normal.

④ After 30 sec. of switching to a manual connector, if a buzzer sound rings continuously for 10 sec. and completion LED lights up, then it is normal.

⑤ If you confirm that the charger operates in normal after checking manual switching of the charger, make sure that the charger is switched to automatic.

BOP7BAT10

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

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

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

22B9BAT11

No	Code	Description of error
1	E.F	EPROM fail
2	O.V	Over voltage - Refer to page 7-117
3	O.C	Over current - Refer to page 7-116, 7-118.
4	F.B	Battery error (After starting charging, the voltage doesn't go over 52V for 2 hours.) Check the battery.
5	O.T	Transformer over heat (Stop charging when it is over 160°C). - If input voltage is high, output current is over normal value and there is heat in the trans because of SCR control part fault. - Check the output current and PCB control board
6	O.H	Heatsink over heat (Stop charging when it is over 100°C). - Check the cooling fan, SCR connection cable contact point and control part.
7	A.O	Power supply error (input power 220/380V wrong wiring). - Refer to page 7-115.
8	A.F	Power supply error (absent phase) - Check if input cable is open.
9	A.C	AC fail (black out) - Check if input voltage is right.
10	L.C	Low current (If this sign is on for setting value (60 sec), charging is over).
11	F	Manual stop.

4) CHECK POINTS BEFORE APPLYING A/S

(1) AC input power source switch is input.

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

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

(4) Check the front cover indicator.

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

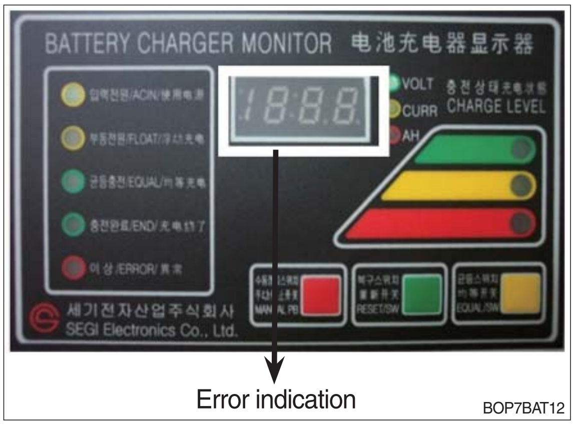
② A.O : Error on selection of input power source of 220V or 380V - Check it appropriately with full three phases.

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

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

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

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



BOP7BAT12

5) ERROR DETECTION

(1) Error list

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

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

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

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

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

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

⑦ SCR module checking method

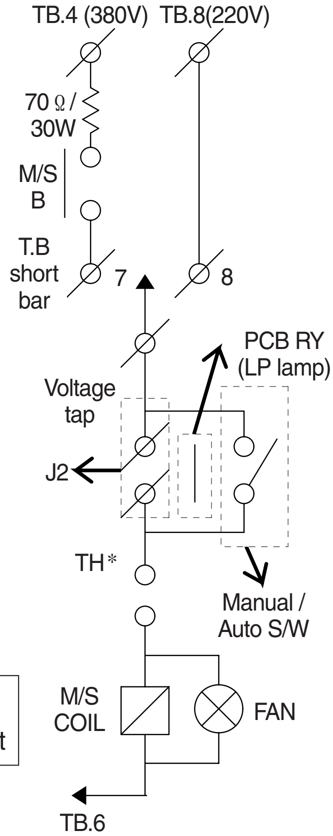
(2) Troubleshooting

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

- 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 socket

Manual/Auto TAP (J2)



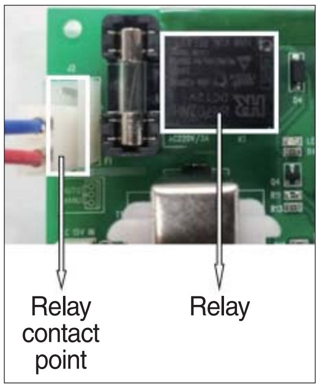
M/S electrical circuit

Check the rated voltage
- NO → Input power supply is not supplied.
  - Check external lead cable.
  - Check the connection of external input connecter
  - Check external NFB TRIP
- YES → Insert automatic/ manual connector (J2) at the upper part of PCB to manual, after separating battery connector.

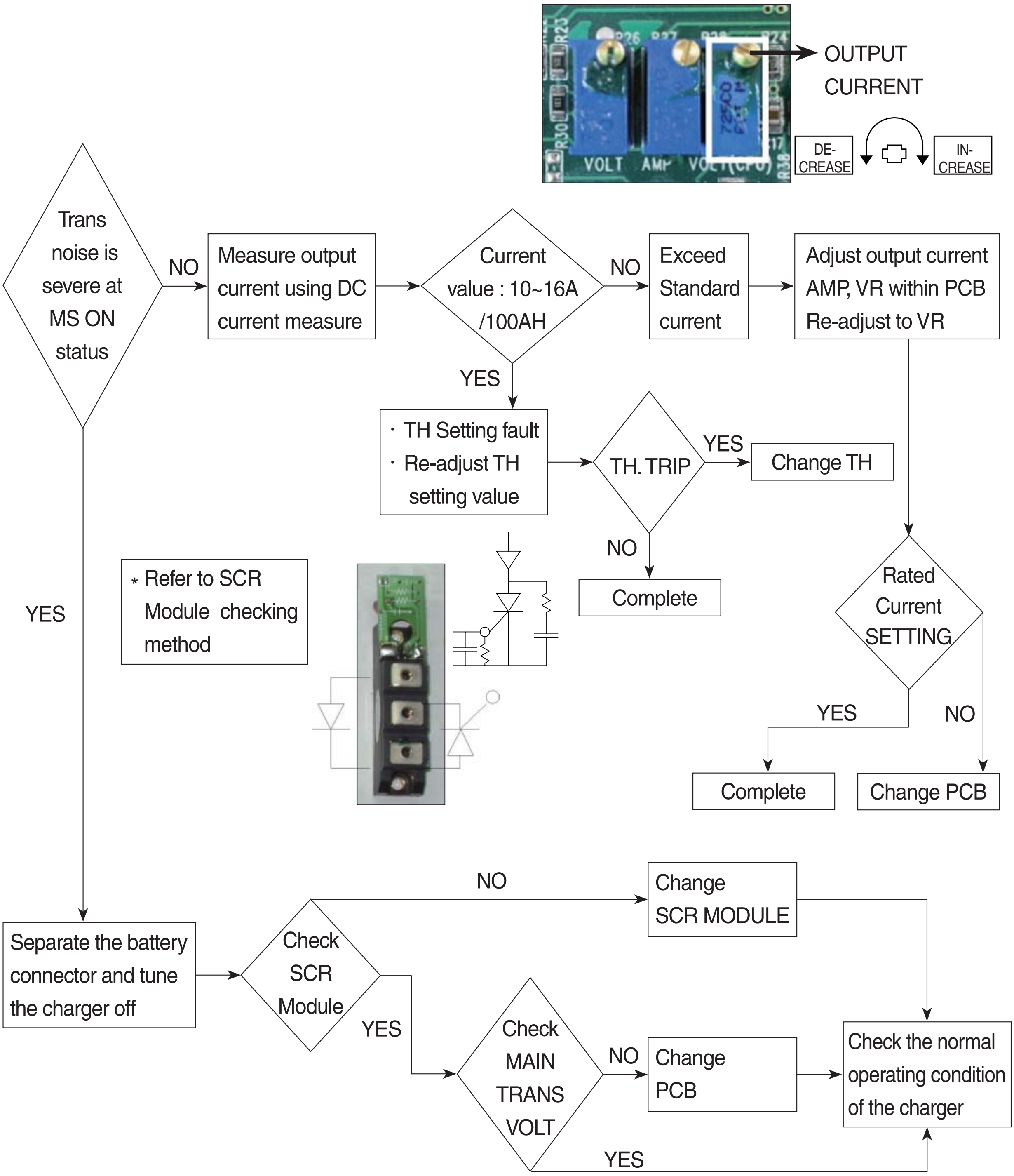
AC INPUT MS switch ON
- NO → Put a black lead of multi-tester to input voltage switch No. 6 and measure voltage between tab No.8,PCB CN4,TH contact points with a red lead.
- YES → PCB LP lamp lights up

PCB LP lamp lights up
- NO → Change PCB
- YES → CN4 contact fault PCB RY contact fault

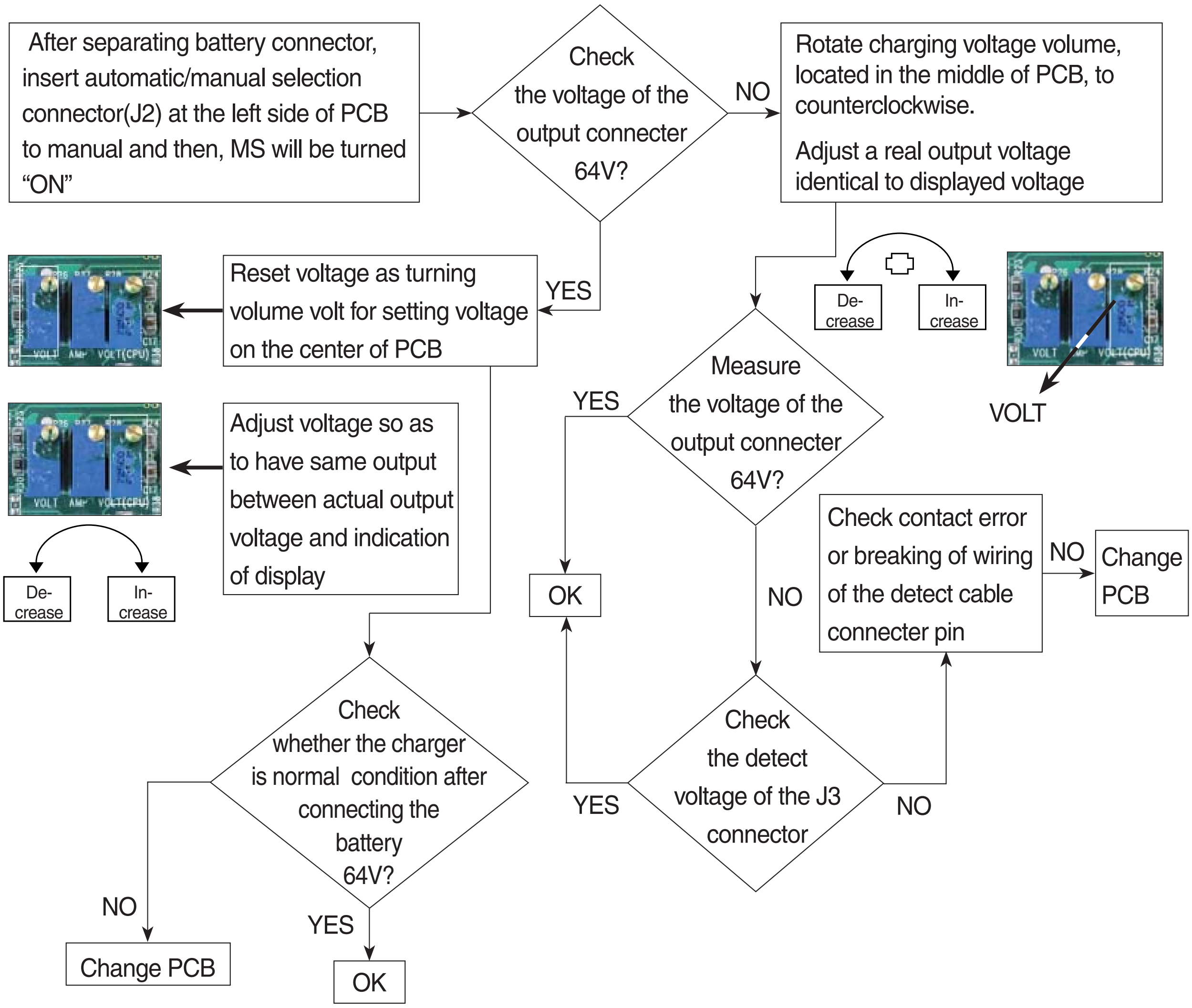
Voltage 220V
- NO → TH contact fault; CN4 contact fault; PCB RELAY fault; TH manual restoration release
- YES → MS COIL fault



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



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



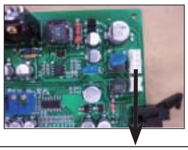
④ Charger TRIP is occurred after abnormality lamp is on.
After opening the cover which is located on the front bottom side of the charger.
In case error code is "O.C" → Output over current, established as 110~120% of the rated current.

Restart the charger as pushing reset switch in the monitor.

Monitor display

Measure the output current by DC current measure 10~16A/100AH

NO → Check poor contact of current connector (J1), located right side of PCB; check if there is disconnection (cleaning and wiring)

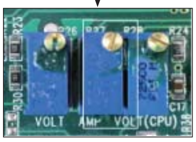


Measure the output current by DC current measure

YES → OK

NO → Change PCB

YES → Re-establish charge current volume (AMP) on the center side of PCB as turning it anti clockwise rotation

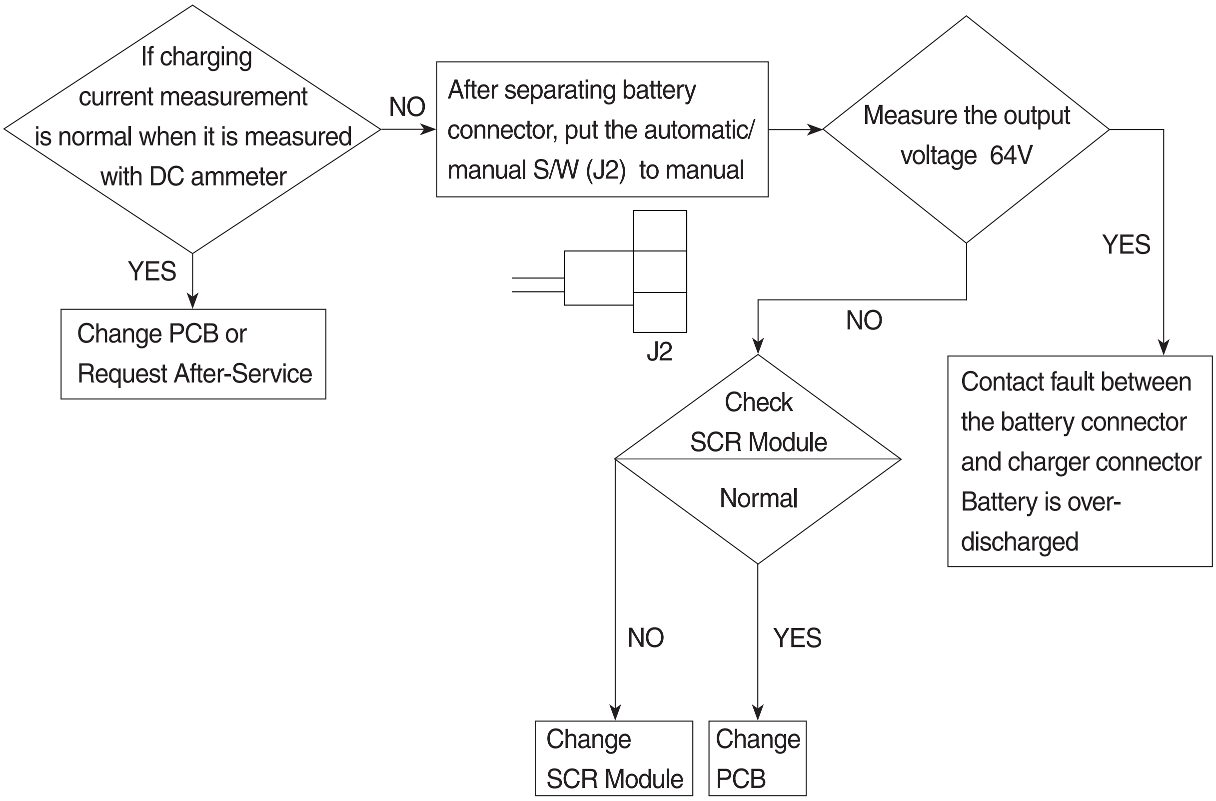


De-crease

In-crease

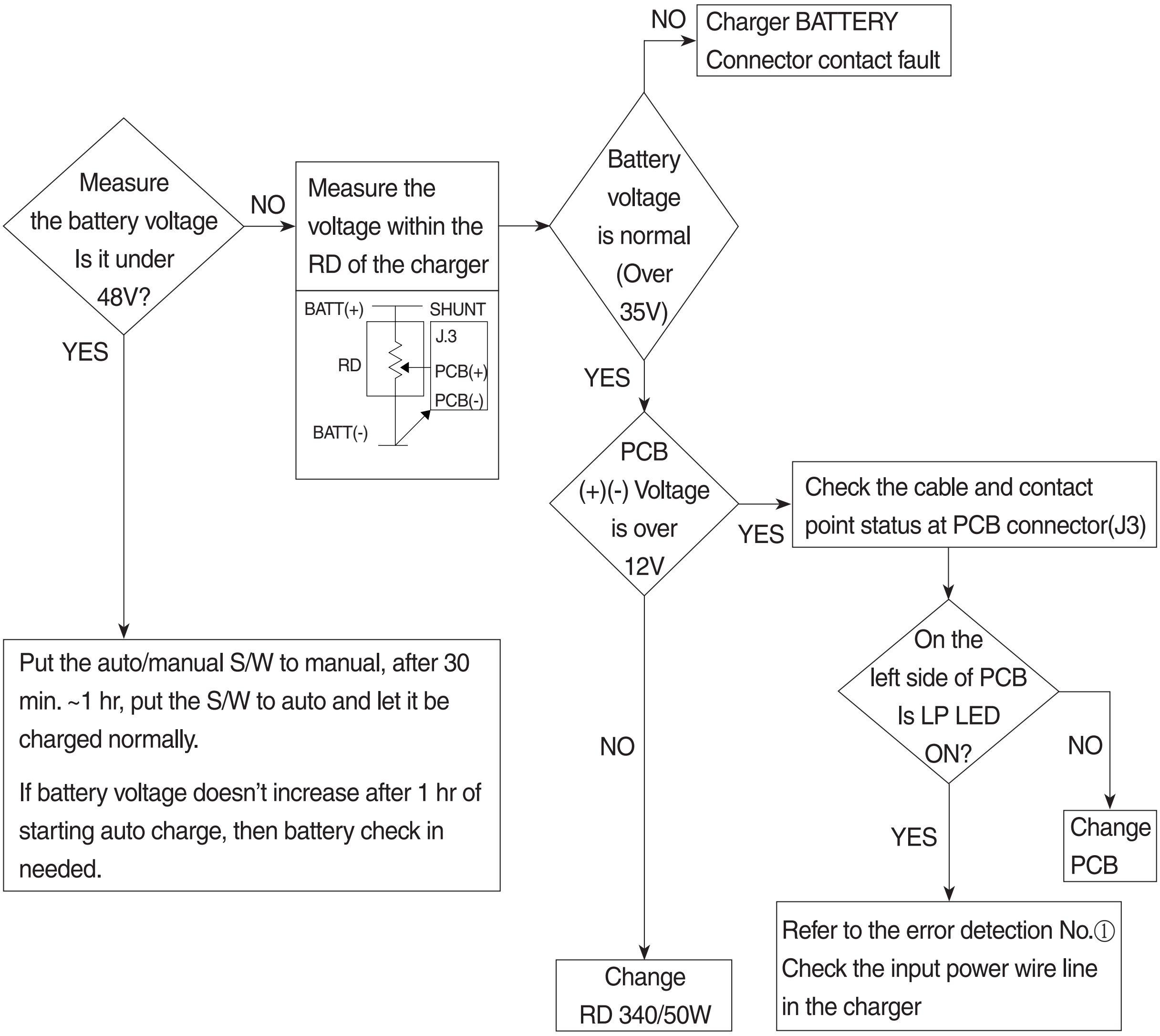
Request A/S if problem persists after adjustment

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



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

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



BATT(+)

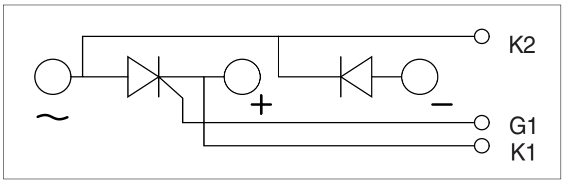
70Ω 12V or higher

BATT(-)

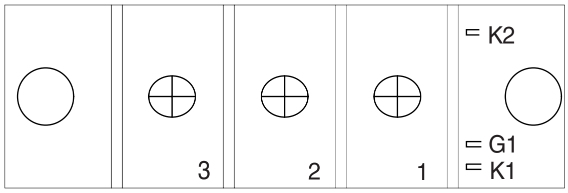
(based on 48V)

7) HOW TO CHECK THE SCR MODULE

Circuit

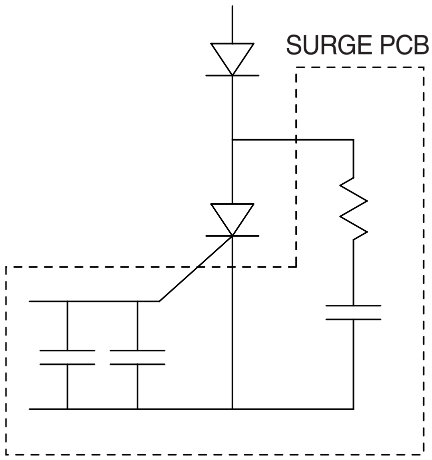


Real diagram

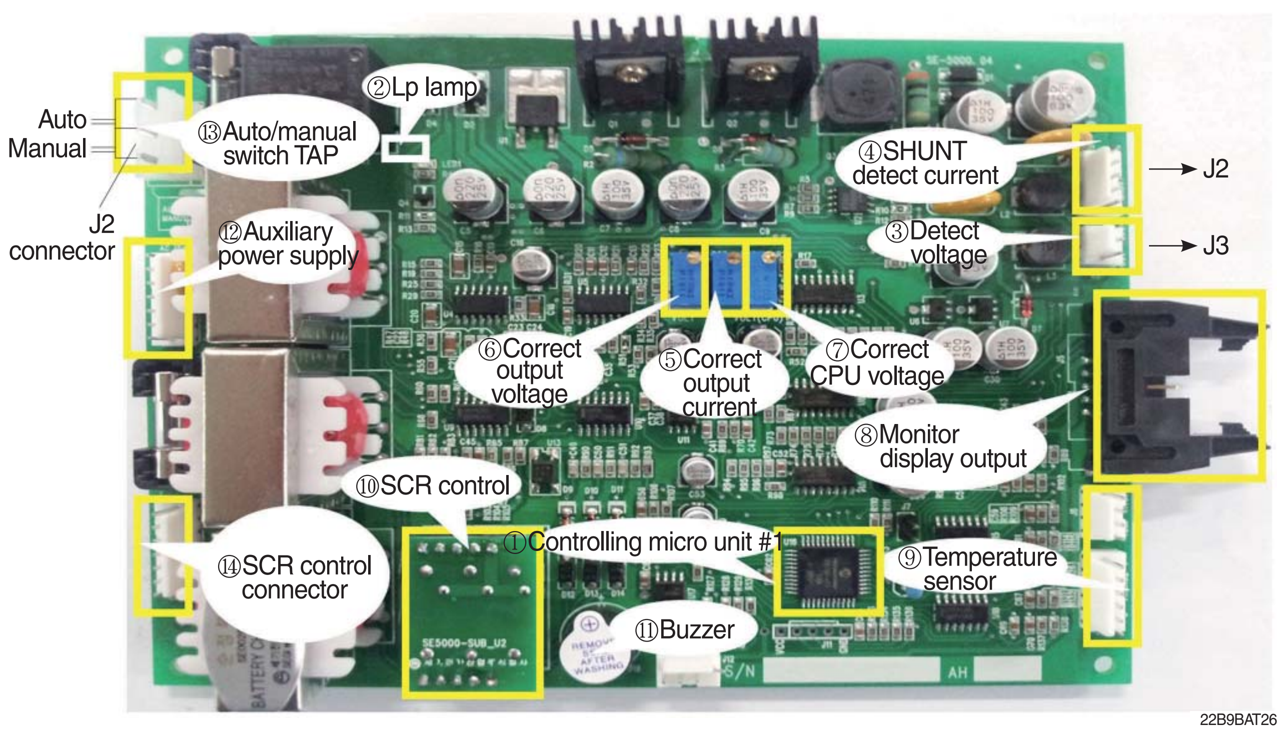


* Before checking SCR MODULE, be sure to disconnect bus bar and wire on the terminal.

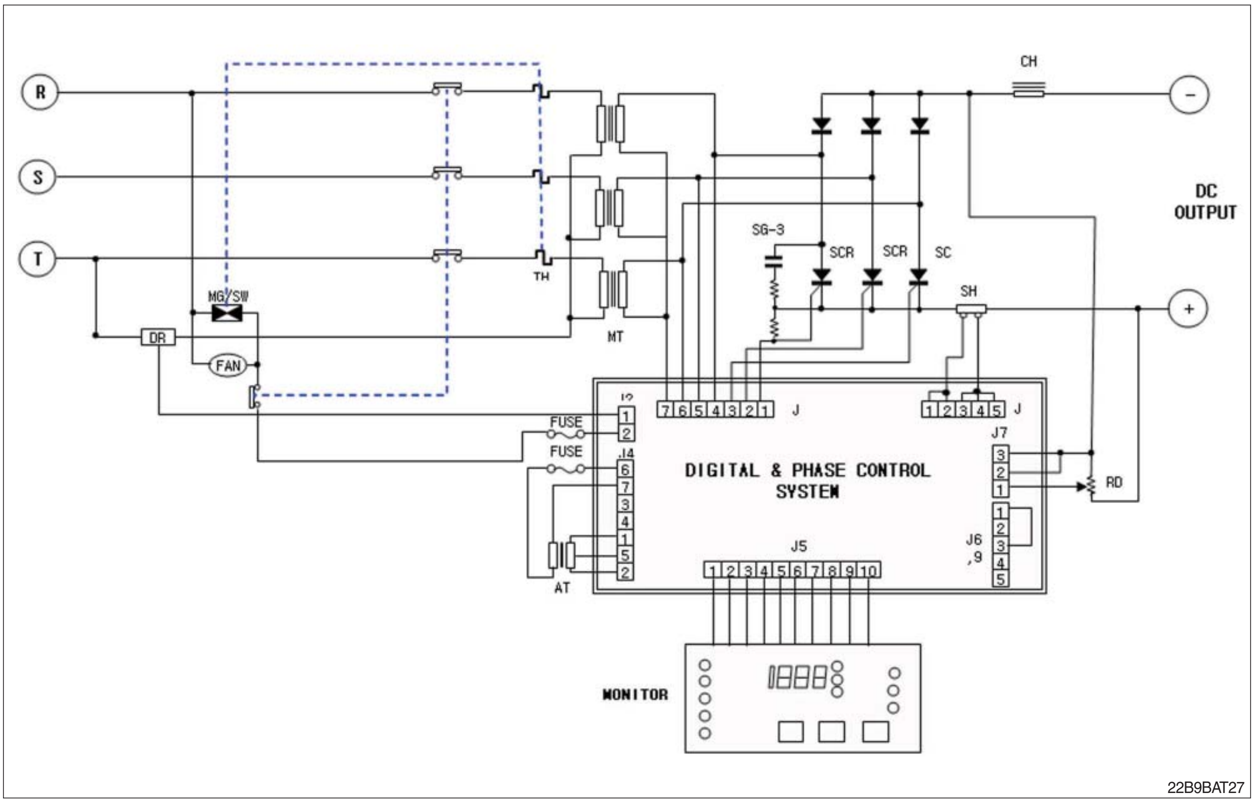
No.	Measuring point (Real diagram)	Measure value (Measurement of digital tester)
1	No.1 ~ No.3	Forward : Under 100 k ohm Reverse : Infinity (∞)
2	No.2 ~ No.3	Forward : Infinity (∞) Reverse : Infinity (∞)
3	G1 ~ K1	Forward : Under 100 ohm Reverse : Under 100 ohm But It depends on the module. If it is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



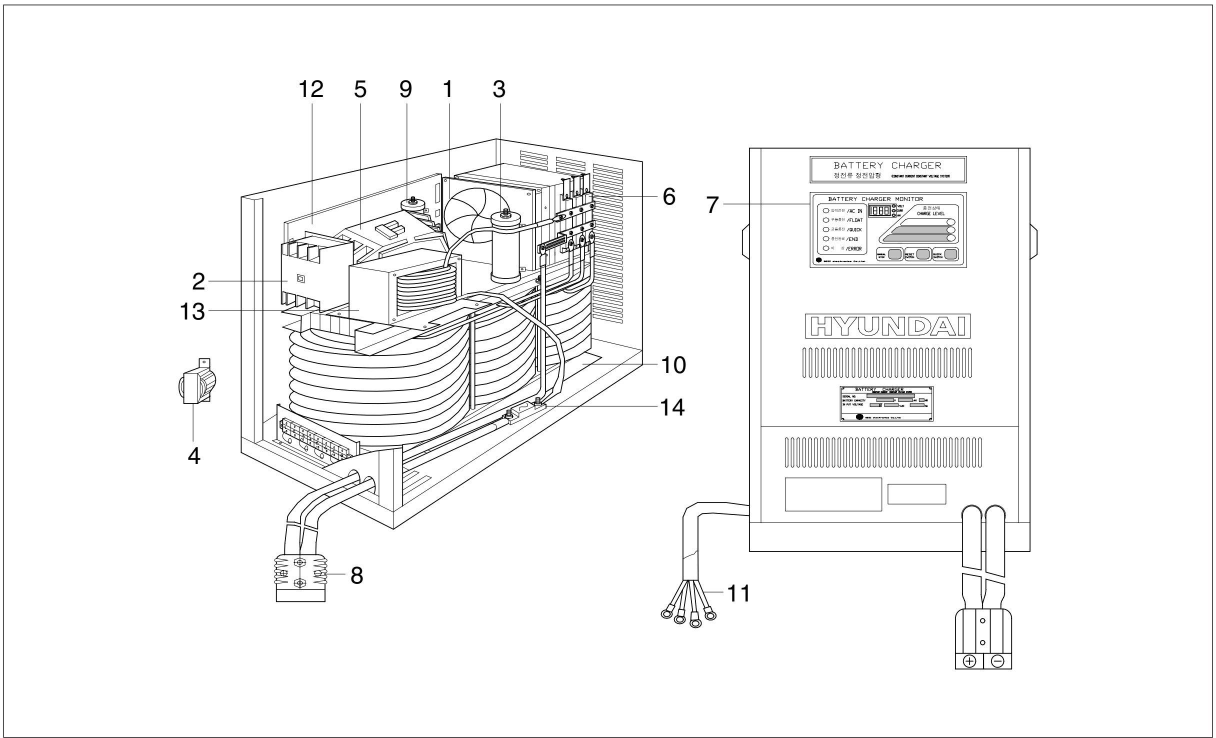
8) PCB MAJOR PARTS (NAME AND LOCATION)



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


R
S
T
CH
DC
OUTPUT
SG-3
SCR
SCR
SC
TH
MG/SW
DR
FAN
MT
SH
FUSE
FUSE
J4
J7
RD
DIGITAL & PHASE CONTROL
SYSTEM
J6
,9
J5
AT
MONITOR
1888
22B9BAT27

CHARGER INTERIOR PARTS



22B9BAT28

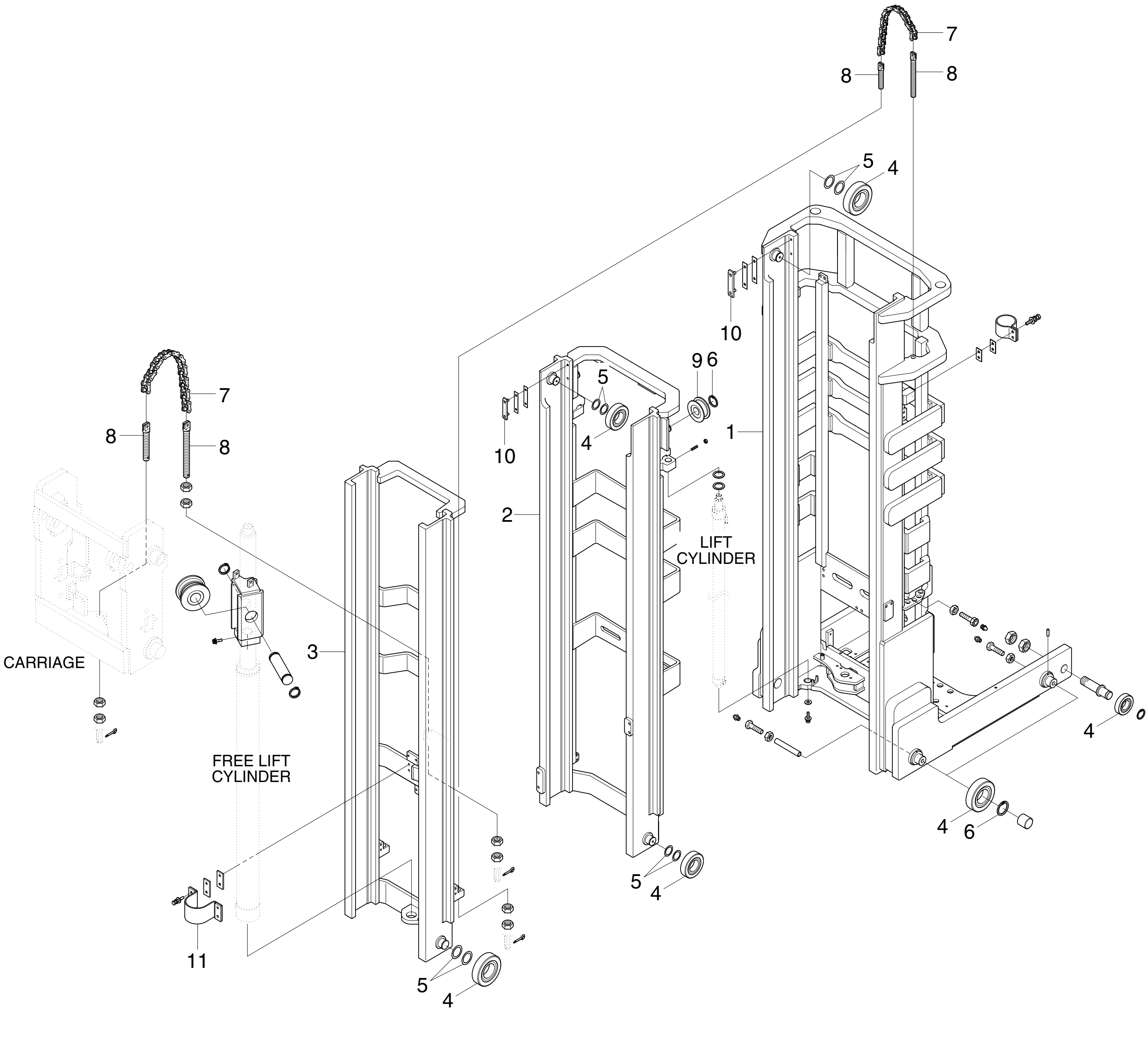
No	Part name	Remarks
1	AC fan	
2	Over load	
3	Resister RD	
4	Trans-aux	
5	Magnet switch	
6	SCR module	
7	Monitor	
8	DC out cable	
9	Resister DR	
10	Main transformer	
11	AC input cable	
12	Main control board	
13	Filter	
14	Fuse	

SECTION 8 MAST

GROUP 1 STRUCTURE

1. 3 STAGE MAST (TF MAST)

1) 14/16/20/25BRJ-9

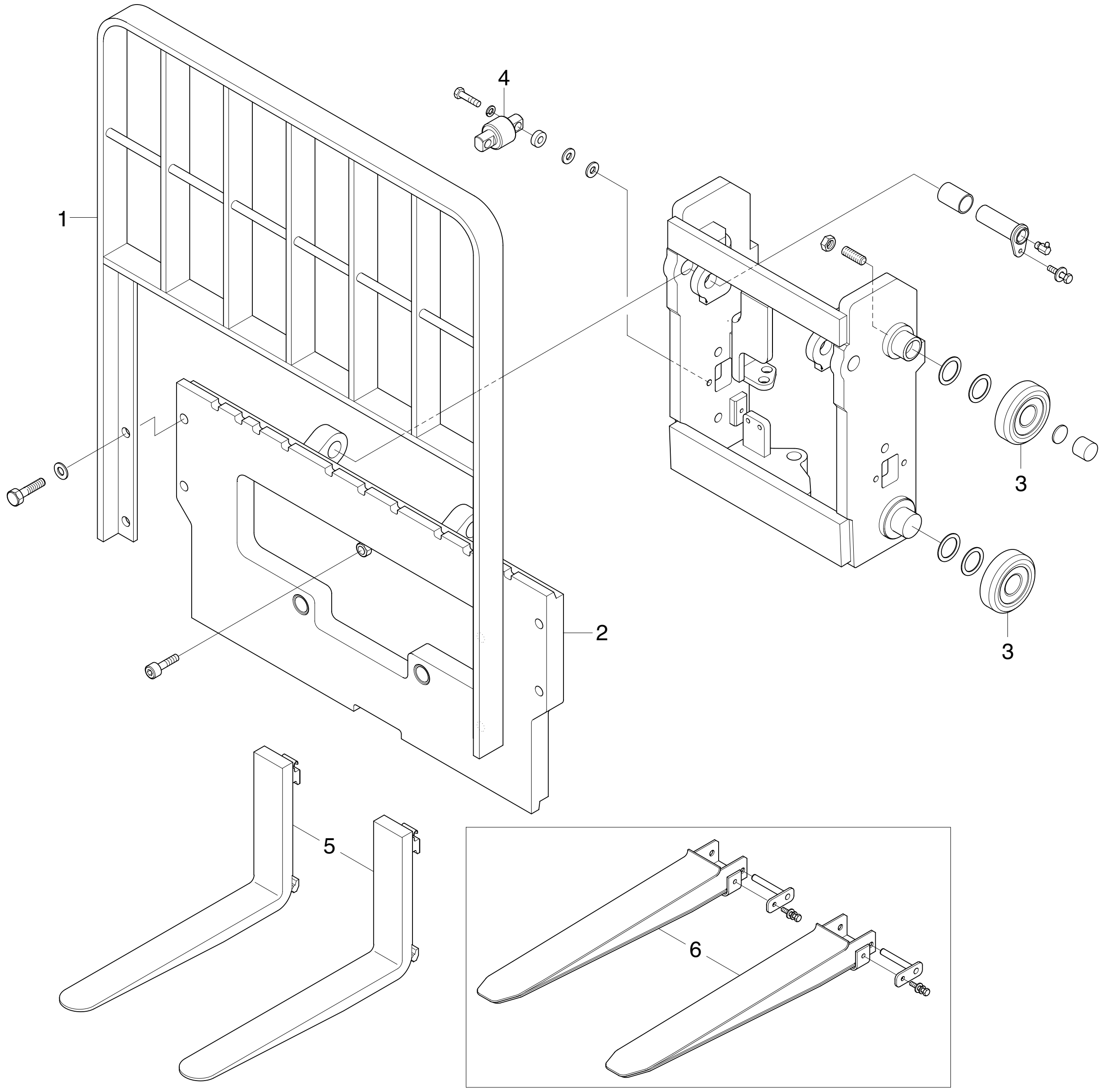


14BRJ9MS03

1	Outer mast	5	Shim (0.5, 1.0t)	9	Chain sheave
2	Middle mast	6	Retaining ring	10	Back up liner
3	Inner mast	7	Lift chain	11	Clamp
4	Roller	8	Anchor bolt		

2. CARRIAGE, BACKREST AND FORK

1) 14/16/20/25BRJ-9



14BRJ9MS05

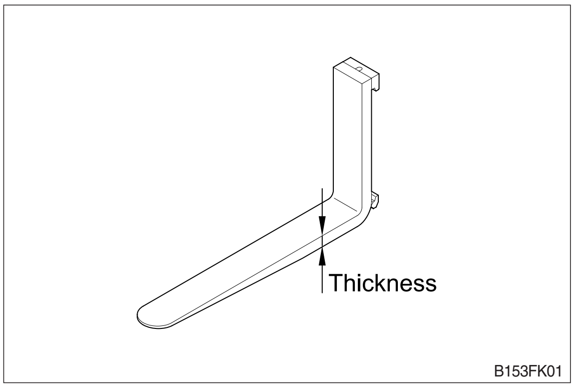
1	Backrest	4	Side roller
2	Carriage	5	Fork assy
3	Load roller	6	Extension fork

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

1) FORKS

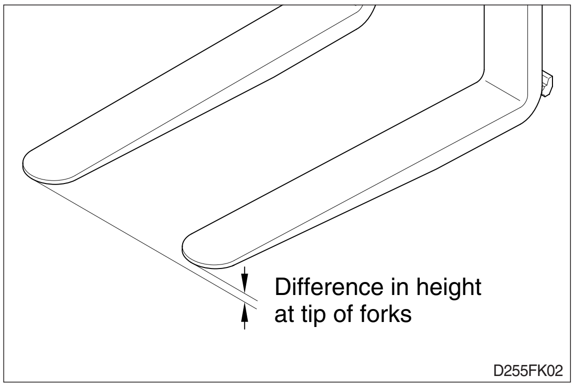
(1) Measure thickness of root of forks and check that it is more than specified value.
EX : l =1050 mm (41.3 in)



mm (in)

STD Fork assy	Applicable model	Standard	Limit
64HM-11060	14/16BRJ-9	40 (1.6)	36 (1.4)
64HN-13030	20/25BRJ-9	45 (1.8)	40 (1.6)

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



mm

Model	Fork length	Height difference
14/16/20/25BRJ-9	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 (0.08 in)
   · Left-to-right clearance : Within 2.5 mm (0.10 in)
3) Check that there is an oil groove in bushing at mast support.
4) Set mast vertical, raise forks about 10 cm 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.

3. 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 masts 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)	· Disassembly, 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.

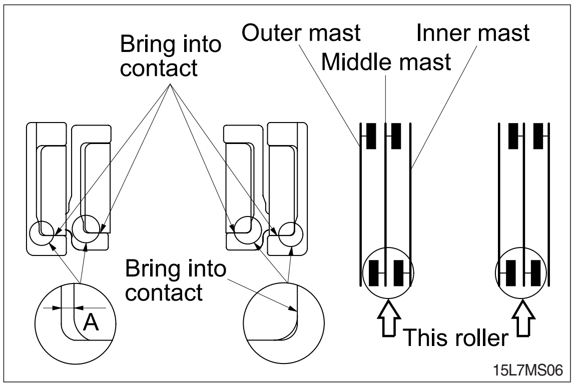
2) FORKS

<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>

GROUP 3 ADJUSTMENT

1. MAST LOAD ROLLER (TF MAST)

1) INNER AND MIDDLE MAST ROLLER CLEARANCE ADJUSTMENT



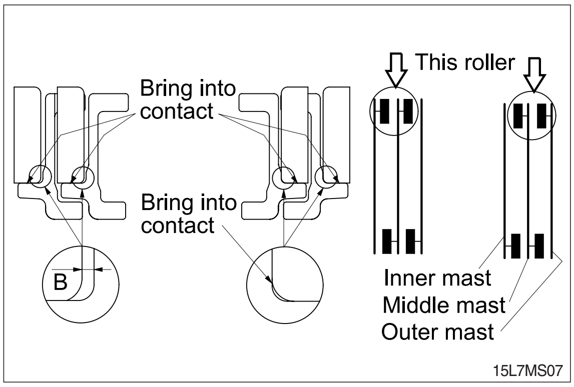
(1) Measure the clearance with the mast overlap at near 480 mm.

(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 = 0.3~0.6 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 UPPER ROLLER CLEARANCE ADJUSTMENT.



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

(2) Shift the inner mast to one side to bring the roller into contact with the middle mast and the inner 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 = 0.3~0.6 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.

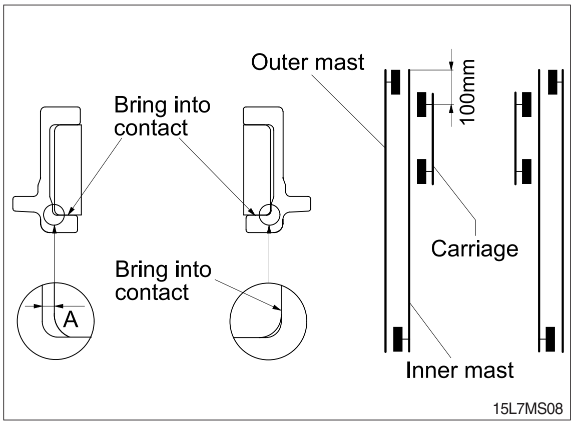
3) CARRIAGE LOAD ROLLER

(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, 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 = 0.3~0.6 mm
  - Shim thickness 0.5, 1.0 mm

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

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

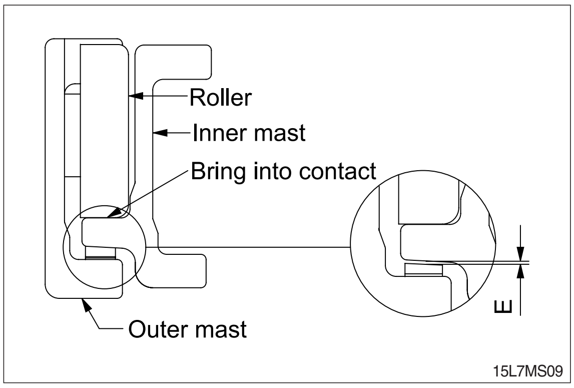


4) MAST BACK UP LINER

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

(2) With the inner mast in contact with the outer mast roller, adjust the clearance between the mast back up liner and inner mast to the following value by inserting the back up liner shim.
  - Standard clearance E = 0.5~1.0 mm
  - Shim thickness 0.5, 1.0 mm

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



5) REACH ROLLER BEARING

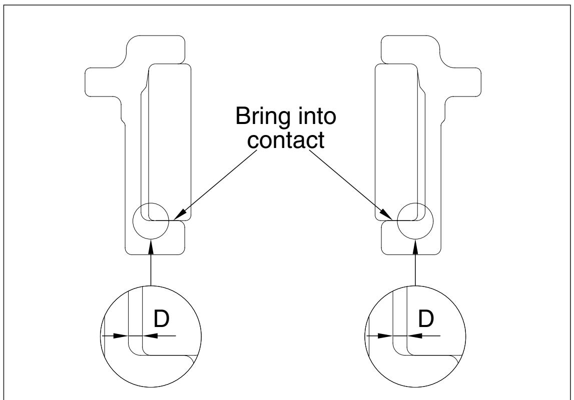
(1) With the round of the reach roller bearing contact with in side of the frame rail.

(2) Measure the clearance between the reach roller bearing and inside of the frame rail.

(3) Select the reach roller bearing to adjust the following clearance value.
 · Standard clearance D = 0.3~0.6 mm
 · Size : std, under, over and large

※ **Use the same size bearing of the LH and RH.**

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



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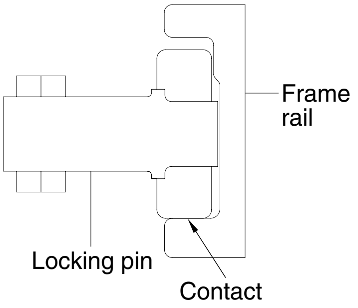
6) LOCKING PIN

(1) Adjust the clearance between the reach roller bearing and the convex point of the bottom side of the frame rail to 0 mm by the locking pin and tighten the nut.

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



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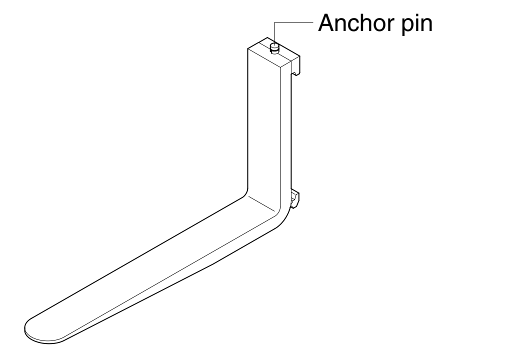
GROUP 4 REMOVAL AND INSTALLATION

1. FORKS

1) Lower the fork carriage until the forks are approximately 25 mm (1 inch) from the floor.
2) Release fork anchor pins 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.



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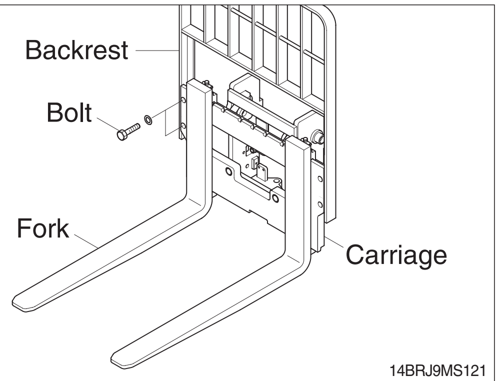
2. BACKREST

1) Remove bolts securing backrest to fork carriage. Lift backrest straight up and remove from carriage.
2) Position backrest on carriage and lower in place. Install and tighten bolts.



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3. CARRIAGE ASSEMBLY

1) CARRIAGE

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

(2) While supporting lift chains, remove the split pin and slide out chain anchor pins from the chain anchors of stationary upright.

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

(4) Slowly raise elevating upright until mast clears top of fork carriage. Move carriage to work area and lower mast.

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

(5) Inspect all parts for wear or damage. Replace all worn or damaged pars.

(6) Reverse the above steps to reinstall.

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

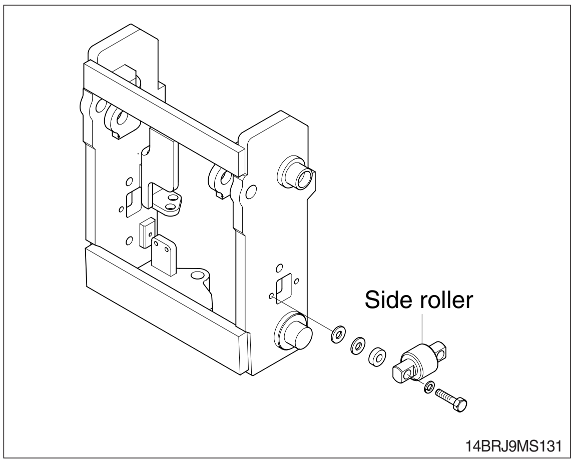
2) SIDE ROLLER

(1) Remove carriage as outlined in the carriage assembly and removal paragraph.

(2) Loosen and remove nuts, adjust screws and side rollers from carriage side pate.

(3) Thoroughly clean, inspect and replace all worn or damaged parts.

(4) Reverse the above procedure to assembly.

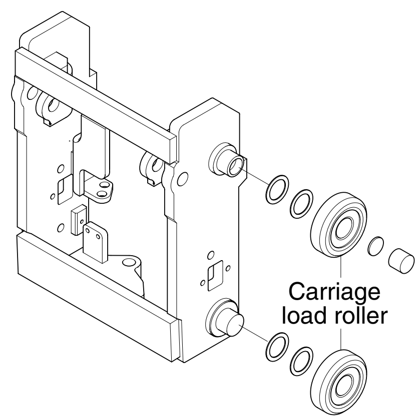


※ Adjustment

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

3) CARRIAGE LOAD ROLLER

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



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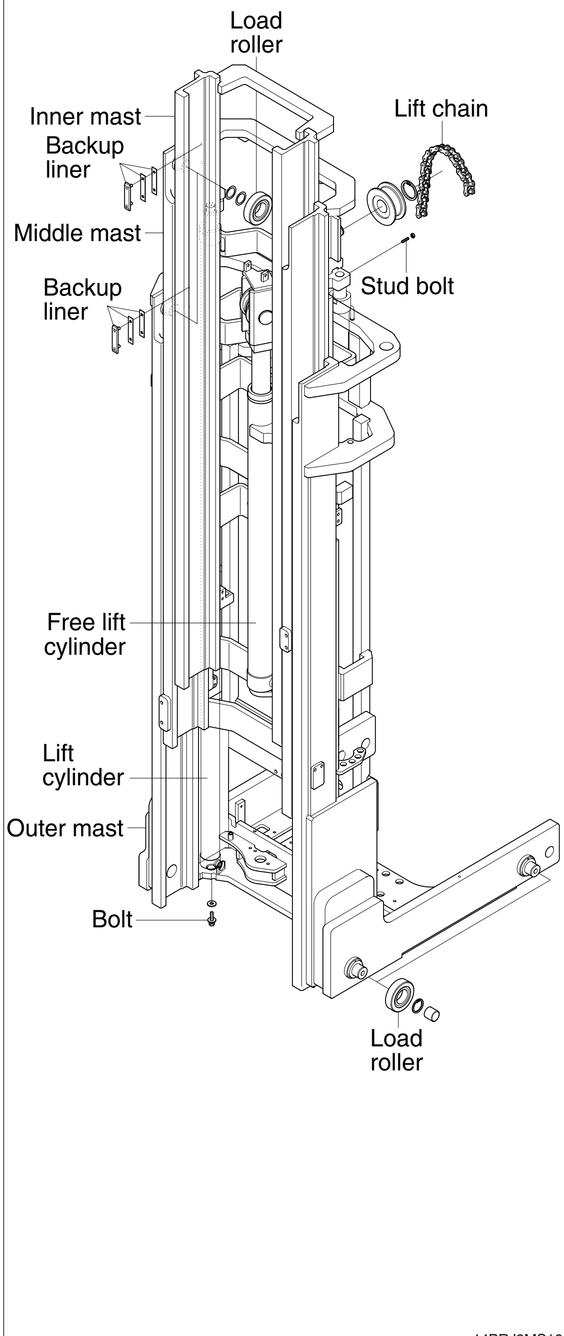
4) MAST LOAD ROLLER AND BACK UP LINER

(1) 3 stage mast (TF mast)

① Remove the carriage assembly and move to one side.
② Loosen and remove hexagon bolt securing bottom cylinder from outer mast.
③ Loosen and remove bolts and special washers securing lift cylinders to middle mast.
④ Attach chains or sling to the inner and middle mast section at top crossmember. Using an overhead hoist, slowly raise the uprights high enough to clear lift cylinder.
⑤ After lowering the lift cylinder rods, and disconnecting lift cylinder hose, tilt the lift cylinders LH and RH and tie them with ropes to the outer mast.
⑥ Using the overhead hoist raise inner and middle masts. Place 4 inch block of wood under the free lift cylinder bracket of the inner mast then lower mast sections (this will create slack in the chains).
⑦ Remove retaining rings securing chain sheaves to sheave support brackets. While support chains, remove chain sheaves and let chains hang free. The upper outer and lower middle mast rollers and back up liners are now exposed.
⑧ Using a pryer, 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 player, remove load rollers from load roller bracket.
⑪ Thoroughly clean, inspect and replace all worn or damaged parts.
⑫ Reverse the above procedure to assemble. Refer to MAST LOAD ROLLER ADJUSTMENT paragraph.



5) ELEVATING MAST

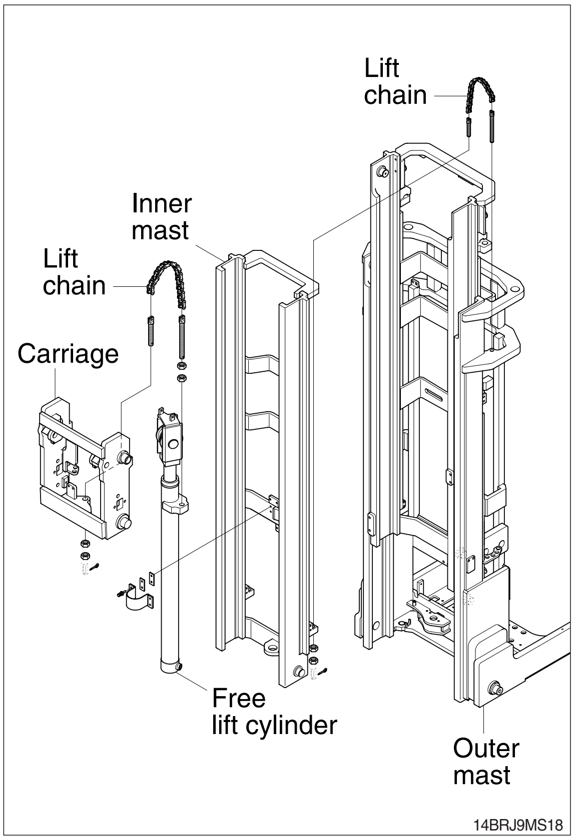
(1) Inner and middle mast (TF mast)

① After completing all necessary steps for load rollers and back up liner removal. Remove rear chains and sheave support if not already done.
② Disconnect free lift cylinder hose. Drain hose into a suitable pan or container and cap hose.
③ While supporting free lift cylinder assembly, remove bolts and washers securing cylinder to mast crossmember.
④ Place a sling around free lift cylinder and attach to an overhead hoist. Slowly raise and move cylinder to one side.
⑤ Attach chains or sling to the inner mast section at top crossmember. Using an overhead hoist slowly raise the upright straight up and out of middle mast section.
⑥ Attach chains or sling to the middle mast section at top crossmember. Using an overhead hoist slowly raise the upright straight up and out of outer mast section.
⑦ Replace upright and reverse above procedure to install. Make all necessary measurements and adjustments.

6) CHAIN

(1) Rear chain sheave (TF mast)

① Raise and securely block carriage and inner mast section.
② Remove the split pin securing the chain anchor pins and discard. While supporting the chains, remove the chain anchor pins from outer mast section.
③ Remove chains.
④ Remove retaining ring securing chain sheaves to sheave support. Pry off sheaves with bearings.
⑤ Remove bearing retaining ring from sheave and press bearings from sheaves.
⑥ Thoroughly clean, inspect and replace all worn or damaged parts.
⑦ Reverse the above procedure to assemble and install. Use new split pins in chain anchor pins.



(2) Chain wheel bearing support (TF mast)

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

(3) Rear chain (TF mast)

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

(4) Carriage chain

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

(5) Load chain inspection and maintenance

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

① Wear

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

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

② **Rust and corrosion**

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

③ **Cracked plate**

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

④ **Tight joints**

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

Tight joints in lift chains can be caused by :

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

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

⑤ **Protruding or turned pins**

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

⑥ **Chain side wear**

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

⑦ **Chain anchors and chain wheel bearings**

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

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

⑧ Chain wear scale

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

· Determine pitch length of chain using 6 inch scale on one side of wear scale.
· If pitch is 1/2 (12.7 mm), 3/4 (19.05 mm), 1 (25.4 mm), 1-1/2 (38.1 mm), 2 (50.8 mm), use side A of scale.
· If pitch is 5/8 (15.875 mm), 1-1/4 (31.75 mm) or 2 (50.8 mm), 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.

(6) Load chain lubrication and adjustment

① Lubrication

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

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

⚠ Wear eye protection.

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

② Replacement

Replace chains as a pair. It will be virtually impossible to maintain uniform loading between the strands if a new chain is put into service opposite an old chain. The jonts in the old chain will be greater than that on the new chain, greatly complicating the problem of maintaining equal chain tension. The new chain will wear more slowly causing it to bear the major portion of the load resulting in premature wear and fatigue failure. Don’t steam clean or decrease new chains.
The manufacturer’s grease is effective in reducing wear and corrosion. If the original factory lube is dried out or wiped off, soak the new chain in heavy engine oil for at 1/2 hour prior to installing on truck. After the old chains have been stripped from the mast, very carefully inspect chain anchors and chain wheel bearing. Broken, cracked or worn anchor must be replaced using the new anchor pin and split pin. Do not paint newly replaced chain after it has been installed.

③ Adjustment

Chain adjustments are important for the following reasons :

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

④ Adjustment procedure

· With mast in its fully collapsed and vertical position, lower the fork to the floor.
· Adjust the chain length by loosening or tightening nut on the chain anchor.
  After making adjustment on the mast, be sure to tighten the nut.