SECTION 1 GENERAL

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1. STRUCTURE

This service manual has been prepared as an aid to improve the quality of repairs by giving the serviceman an accurate understanding of the product and by showing him the correct way to perform repairs and make judgements. Make sure you understand the contents of this manual and use it to full effect at every opportunity.

This service manual mainly contains the necessary technical information for operations performed in a service workshop.

For ease of understanding, the manual is divided into the following sections.

SECTION 1 GENERAL

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

SECTION 2 REMOVAL & INSTALLATION OF UNIT

This section explains the procedures and techniques of removal and installation of each component.

SECTION 3 POWER TRAIN SYSTEM

This section explains the structure of the transmission as well as control valve and drive axle.

SECTION 4 BRAKE SYSTEM

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

SECTION 5 STEERING SYSTEM

This section explains the structure of the steering unit, priority valve, trail axle as well as steering circuit and operation.

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



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.

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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
	Sofoty	Special safety precautions are necessary when performing the work.
	Salety	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 (a), then draw a horizontal line from (a).
- (2) Locate the number 5in the row across the top, take this as (b), then draw a perpendicular line down from **b**.
- (3) Take the point where the two lines cross as \odot . This point \odot 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.

Ν	/lillimete	rs to inche	es				(b)			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
							C				
a)	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

Millimotore to inchos

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

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

 $1 \ \ell = 0.2642 \ U.S.Gal$

	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 \cdot m = 7.233 lbf \cdot 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

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GROUP 1 SAFETY HINTS

Careless performing of the easy work may cause injuries.

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

• Oil is a dangerous substance. Never handle oil, grease or oily clothes in places where there is any fire of flame.

As preparation in case of fire, always know the location and directions for use of fire extinguishers and other fire fighting equipment.

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







• 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.



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.
- 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.





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



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.



- Unless you have special instructions to the contrary, maintenance should always be carried out with the machine stopped. If maintenance is carried out with the machine running, there must be two men present : one sitting in the operator's seat and the other one performing the maintenance. In such a case, never touch any moving part.
- Thoroughly clean the machine. In particular, be careful to clean the filler caps, grease fittings and the area around the dipsticks. Be careful not to let any dirt or dust into the system.
- · Always use HYUNDAI Forklift genuine parts for replacement.
- Always use the grades of grease and oil recommended by HYUNDAI 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



25BC9U0M0701

- 1 Mast
- 2 Lift cylinder
- 3 Carriage and backrest
- 4 Forks
- 5 Drive unit

- 6 Dash board
- 7 Frame
- 8 Steering axle
- 9 Counterweight
- 10 Battery cover
- 11 Seat
- 12 Steering wheel
- 13 Overhead guard

2. SPECIFICATIONS





25BC9UOM0801A

	Model		Unit	25BC-9U	30BC-9U	32BC-9U
Capa	city		kg (lb)	2500 (5000)	3000 (6000)	3200 (6500)
Load	center	R	mm (in)	500 (24)	←	\leftarrow
Weigl	ht		kg (lb)	4456 (9824)	4953(10913)	5177(11413)
	Lifting height	A	mm (in)	3300(130)	←	←
	Free lift	В	mm (in)	115(4.5)	←	←
	Lifting apood /Loodod/Liplos	dod)	mm/sec	430/640	360/530	←
Fork	Lining speed (Loaded/Offica	ueu)	ft/min	84.6/126	70.9/104.3	←
	Lowering speed		mm/sec	500/450	←	←
	(Loaded/Unloaded)		ft/min	98.4/88.6	<i>~</i>	←
	L×W×T	L,W,T	mm (inch)	1050×100×45 (41.3"×3.9"×1.8")	1050×122×45 (41.3"×4.8"×1.8")	←
	Tilt angle forward/backward	C/C'	degree	6/8	<i>~</i>	←
Mast	Max height	D	mm (in)	4495 (177")	←	←
	Min height	E	mm (in)	2135 (84')	<i>←</i>	2205 (87")
	Travel speed (Loaded/Lipload)		km/h	15/17	<i>←</i>	←
Body		iu)	mph	9.3 / 10.6	<i>←</i>	<i>~</i>
Douy	Max. gradient performance,l	oaded	%	4456 (9824) 4953(10913) 5177(114 3300(130) \leftarrow \leftarrow 115(4.5) \leftarrow \leftarrow 430/640 360/530 \leftarrow 84.6/126 70.9/104.3 \leftarrow 500/450 \leftarrow \leftarrow 98.4/88.6 \leftarrow \leftarrow 1050×100×45 1050×122×45 \leftarrow (41.3"×3.9"×1.8") (41.3"×4.8"×1.8") \leftarrow 6/8 \leftarrow \leftarrow 4495 (177") \leftarrow \leftarrow 2135 (84') \leftarrow \leftarrow 9.3 / 10.6 \leftarrow \leftarrow 19.6 17.2 16 1893 (74.52") 1983 (78.07") 2005 (78.5) 210 / 3045 \leftarrow \leftarrow 38 (10) \leftarrow \leftarrow 3215 (127) 3310 (130) 3335 (13) 1112 (44) 1114 (44) 1114 (44) 2241 (88") \leftarrow \leftarrow 90 (3.5") \leftarrow \leftarrow 1330 (52) 1400 (55) \leftarrow 896/910 (35.3/35.8) 911/910 (35.9/35.8) \leftarrow	16	
	Min turning radius (Outside)	F	mm(in)	1893 (74.52")	1983 (78.07")	2005 (78.93")
ETC	Max hydraulic pressure		kgf/cm² /psi	210/3045	←	←
	Hydraulic oil tank		l(usgal)	38 (10)	←	←
Overa	all length	G	mm (in)	3215 (127)	3310 (130)	3335 (131)
Overa	all width	Н	mm (in)	1112 (44)	1114 (44)	1114 (44)
Overł	nead guard height	I	mm (in)	2241 (88")	←	←
Grour	nd clearance (Mast)	J	mm (in)	90 (3.5")	←	←
Whee	el base	К	mm (in)	1330 (52)	1400 (55)	<i>~</i>
Whee	el tread (front/rear)	М	mm (in)	896/910 (35.3/35.8)	911/910 (35.9/35.8)	<i>~</i>

3. SPECIFICATION FOR MAJOR COMPONENTS

1) CONTROLLER

Item	Unit	Traction	Pump
Model	-	CURTIS 1236E-5621	\leftarrow
Туре	-	AC	\leftarrow
Dimension	mm	244(L)×165(W)×134.7(H)	\leftarrow
Current limit	A	600	\leftarrow
Communication	-	CAN	\leftarrow

2) MOTOR

Item	Unit	Traction	Pump
Туре	-	ASRH 4002	AMDL 4001
Rated voltage	Vac	30	30
Output	kW	14	17
Insulation	-	Class F	Class F

3) BATTERY

Item	Unit	25BC-9U	30/32BC-9U
Rated voltage	V	48	←
$\begin{array}{l} \text{Compartment dimension} \\ (\text{W} \times \text{L} \times \text{H}) \end{array}$	mm	STD : 997×783×605 SBR : 997×783×571	STD : 997×883×605 SBR : 997×883×571
Min. Battery weight	kg	(W $ imes$ L $ imes$ H)	1360
Max. Battery weight	kg	1400	1600
Connector (CE spec)	-	SB 350 c	or SR 350

4) GEAR PUMP

Item	Unit	Specification
Туре	-	Fixed displacement gear pump
Capacity	cc/rev	27.2
Maximum operating pressure	bar	230
Rated speed (max/min)	rpm	3000/500

5) MAIN CONTROL VALVE

Item	Unit	Specification
Туре	-	3 spool, 4 spool
Operating method	-	Mechanical
Main relief valve pressure	kgf/cm ²	210
2nd relief valve pressure	kgf/cm ²	130

6) DRIVE AXLE UNIT

Item	Unit	Specification
Max axle load	kgf	9,000
Max input rpm	rpm	4,000
Gear ratio	_	20.5
Weight without fluid	kg/lb	200 / 441
Oil quantity	ℓ /U.S · qt	7 / 1.8

7) WHEELS

Item	25BC-9U	30/32BC-9U
Type (front/rear)	SOLID (OPT : NON-MARKING)	
Quantity (front/rear)	2/2	
Front-drive	21×7-15 21×8-15	
Rear-steering	16×6×10.5	

8) BRAKES & STEERING

Item		Specification	
Prakaa	Travel	Front wheel, Hydraulic, Disc brake	
Drakes	Parking	Mechanical	
Steering	Туре	Hydraulic steering	

NO		Items	Size	kgf∙m	lbf·ft
1	Electric	Hyd pump motor mounting nut	M 8×1.25	3.4±0.7	24.6±5.0
2	system	Traction motor mounting bolt	M12×1.75	10±1.5	72.3±10.8
3		Hydraulic pump mounting bolt	M10×1.5	6.9±1.4	50±10
4	Hydraulic	MCV mounting bolt, nut	M10×1.5	6.9±1.4	50±10
5	system	Steering unit mounting bolt	M10×1.5	4.0	28.9
7		Brake cylinder mounting bolt	M 8×1.25	8±0.5	57.9±3.6
9		Drive axle mounting bolt, nut	M20×2.5	55±2.0	398±14.0
10	Power	Steering axle mounting bolt, nut	M20×2.5	58±3.0	419±21.7
11	system	Front wheel mounting nut	M20×1.5P	47±2.4	340±17.4
12		Rear wheel mounting nut	M16×1.5P	25±1.3	180.8±9.4
13		Counterweight mounting bolt	M24×3.0	100±15	723±108
14		Seat mounting nut	M 8×1.25	3.4±0.7	24.6±5.0
15		Head guard mounting bolt (front)	M12×1.75	12.8±3	92.5±21.5
16	ETC	Head guard mounting bolt (rear)	M16×2.0	29.7±4.5	215±32.5
17		Priority valve mounting bolt	M 6×1.0	1.0 ±0.5	7.2±3.6
18		Tilt cylinder rod-end bolt, nut	M12×1.75	9.5 ±0.5	69±3.6
19		Tilt cylinder pin mounting bolt	M10×1.5	6.9 ±0.5	50±3.6

4. TIGHTENING TORQUE FOR MAJOR COMPONENTS

5. TORQUE CHART

Use following table for unspecified torque

1) BOLT AND NUT

(1) Coarse thread

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

(2) Fine thread

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

2) PIPE AND HOSE (FLARE TYPE)

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

3) PIPE AND HOSE (ORFS TYPE)

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

4) FITTING

Thread	Hex. across flat (mm)	kgf ∙ m
1/4"	17	2
3/8"	19	3
1/0"	22	4
1/2"	24	6
E/0"	27	10
0/6	30	12
0/4"	32	15
3/4	36	18
1"	41	23
1-1/4"	50	28
1-1/2"	55	32

5) BAND CLAMP

Tag. No.	Hose size (mm)	Band width (mm)	kgf∙m
S20-15	8 ~ 14		0.2
S20-17	11 ~ 17		0.3
S20-22	13 ~ 20	9	
S20-25	15 ~ 24		0.25
S20-28	19 ~ 28		0.35
S20-32	22 ~ 32	12	
S20-40	26 ~ 38	0	0.42
S20-45	32 ~ 44	9	0.42

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

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

6. WRENCH AND SPANEER CHART

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

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

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

7. RECOMMENDED LUBRICANTS

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

				Ambient temperature °C (°F)							
point	Kind of fluid	Capacity ℓ (U.S. gal)	-50 (-58)	-30 (-22)	-20 (-4)) -1) (1-	0 4) (3	0 1 2) (50	0 2 0) (68	0 30 3) (86)	40 (104)
Axle	Gear oil	7.0 (1.8)					D	EXRON	13		
						*IS	0 VG 1	5			
Hydraulic oil tank	Hydraulic oil	31 (8.2)				19	SO VG	32	46		
							R		40		
								19	SO VG	68	
Brake	Brake oil	0.5					ISO \	/G 32			
system		(0.1)									
Fitting		0.1	*NLGI No.1								
(Grease nipple)	Grease	(0.03)						N	 JI GI No	2	
Πιρριε)											

· ISO : International Organization for Standardization

* : Cold region Russia, CIS, Mongolia

· NLGI : National Lubricating Grease Institute

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.

No.	Description	Period of replacement
1	Hyd tank - Air breather element	Every 1.5month (**Harsh)
2	Hyd tank - Air breather element	Every 3 month (*Normal)
3	Hyd tank - Return filter	Every 6 moth
4	Hyd tank - Suction strainer	Every 1 year
5	Hyd tank - Hyd oil	Every 1 year
6	Hyd tank - Hyd oil (long life)	Every 2.5 year
7	Cap & Dust seal of Master cylinder and steering cylinder	Every 1 year
8	Lift hose	Even, 1 veer (**Hareb)
9	Tilt hose	
10	Aux hose	Every 2 year (Normal)
11	Pump outlet hose	Every 2 year
12	Lift chain	Every 2 year
13	Pump seal kit	Every 3 year
14	Pressure sensor	Every 5 year

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

* Replace the O-ring and gasket at the same time when replacing the hose.

※ Replace clamp at the same time if the hose clamp is cracked when checking and replacing hose.

* Normal operation

Eight hour material handling, mostly in buildings or in clean, open air on clean paved surfaces

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

Group	1	Major components	2-1
Group	2	Removal and installation of unit	2-2

GROUP 1 MAJOR COMPONENTS



25BC9U2SM01

- 1 Lift cylinder
- 2 Mast
- 3 Steering unit
- 4 Backrest
- 5 Tilt cylinder
- 6 Main control valve
- 7 Forks
- 8 Front wheel

- 9 Drive unit
- 10 Drive motor
- 11 Hyd gear pump
- 12 Pump motor
- 13 Battery
- 14 Rear wheel
- 15 Steering axle
- 16 Steering cylinder

- 17 Counterweight
- 18 Traction controller
- 19 Pump controller
- 20 Seat
- 21 Overhead guard
- 22 Steering wheel
- 23 Fan assy

GROUP 2 REMOVAL AND INSTALLATION OF UNIT

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

1. MAST

1) REMOVAL



(1) Forks

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



(2) Backrest (If necessary)

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



(3) 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 pins and nuts from anchor pins of stationary upright.

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

- Lift chain Outer mast
- Carriage Carriage Lift chain Block
- ④ Slowly raise inner mast upright until mast clears top of fork carriage. Move carriage to work area and lower the mast.
- A Make sure that carriage remains on floor and does not bind while mast is being raised.
- Inspect all parts for wear or damage.Replace all worn or damaged parts.



(4) Piping

- ① Remove the return hoses and clamps attached to the cylinder.
- ② Remove the return hoses from the connector.
- ③ Remove hose assembly, tee, velocity fuse valve(1) from the lift cylinder.
- ④ Disconnect hose assembly from the flow regulator(2).



(5) Lift cylinder

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

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

- ③ Loosen and remove hexagon bolts and clamp securing cylinder.
- ④ Using an overhead hoist, slowly raise the inner mast high enough to clear lift cylinder.
- ⁽⁵⁾ Using an overhead hoist, draw out lift cylinder carefully and put down on the work floor.



(6) Inner mast

- ① Using an overhead hoist raise the inner mast straight and carefully draw out of outer mast section.
- A Be careful the mast not to swing or fall.



(7) Tilt cylinder pin

(8) Mast support cap

- Attach a crane to the stay at the top of the outer mast, and raise enough to sustain jacked up machine.
- * This operation is carried out from under the machine, so use a pit, or if there is no pit, jack up the machine and loosen with on impact wrench.
- ② Remove the mounting bolts from the cap. Then slowly raise the outer mast.



2) INSTALLATION

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

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

(1) Trunnion cap

- ① Check the trunnion cap and spring pin for wear.
- ② Jack up the machine so that the front is raised and then using an overhead hoist assemble outer mast to drive axle unit.
- ③ Tighten mounting bolts to trunnion cap. Apply loctite #277.
 - · Tightening torque : 19.9~26.9 kgf · m (144~195 lbf · ft)

(2) Tilt cylinder pin

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

(3) Lift cylinder installation and adjustment

- 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)
- * Lubricate the grease into the nipple sufficiently.



2. POWER TRAIN ASSEMBLY

1) REMOVAL



(1) Mast and counterweight

Refer to section on mast (page 2-2)

* After removing mast, remove the counterweight to prevent the truck from turning over.



(2) Brake piping

Disconnect the brake piping from the wheel brake assembly.



(3) Parking brake cable

Disconnect parking brake cable from the wheel brake assembly.



(4) Drive axle and motor assy

- Attach a crane to the tilt cylinder notches on the dashboard and raise the machine enough for truck to slide under drive axletransmission-drive motor assembly.
- ② Put the block between the truck and drive axle assembly.
- ③ Disconnect the harness from the drive motor terminal.
- ④ Remove drive axle mounting bolts from the frame and then slowly pull out the truck with drive axle forward the front.



- ⑤ Remove five socket bolts holding the drive motor in place.
- 6 Carefully remove the drive motor from the drive axle.



2) INSTALLATION

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

- (1) Tighten the mounting bolts and apply loctite #277.
 - \cdot Drive axle
 - 53~58 kgf · m (383~420 lbf · ft)
 - \cdot Drive motor
 - 8.5~11.5 kgf · m (61.5~83.2 lbf · ft)

3. ELECTRICAL COMPONENTS

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

1) REMOVAL



22B7RE29

(1) Battery

A Before pulling out the battery plug, tilt the mast forward a little, and lower the fork to the lowest position.

The batteries weigh from around 1180 kg to 1410 kg so the extreme care must be taken when handling them.

1 Release the battery cover latch.



- ② Pull the plunger and tilt the levers forward.
- ③ Open the battery cover.
- 4 Disconnect the battery connector.


- ⑤ Using a battery hanger, carefully raise the battery assembly.
- ▲ Put down the battery with fork lift or chain block by hang up hook at 4 links which located in right and left of the battery.
- * Be careful not to damage overhead guard or control system.
- 6 Remove the side cover.



 $\ensuremath{\overline{\mathcal{O}}}$ Loosen the battery stopper.



⑧ Put down the battery with fork lift or chain block by hang up hook at 4 links which located in right and left of the battery.



(2) Pump motor

1 Lower the fork to floor.

② Remove the left hand side cover.



③ Disconnect the wiring of pump motor and remove the gear pump from pump motor.



 ④ Remove the tightening bolts of the pump motor mounting bracket.
 Loosen the nut and remove the motor from mounting bracket.



4. STEERING AXLE

1) REMOVAL



25BC9U2SM30

1 Counterweight

Install a lifting tool in the counterweight, and raise with a crane. Remove the mounting bolts, raise slightly and move to the rear.

· Weight of counterweight (standard)

25BC-9U	1025 kg (2260 lb)	32BC-9U	1395 kg (3075 lb)
30BC-9U	1191 kg (2626 lb)	-	-

· Tightening torque : 85~115 kgf · m (615~832 lbf · ft). Apply loctite #277.

2 Hose

Disconnect the hoses from the steering cylinder.



③ Mounting bolt

Put a block under the rear axle, support on a truck, and raise the frame with a crane. Remove the mounting bolts installed to the frame, and pull out to the rear. There are shims between the support and rear axle to prevent play.



(2) INSTALLATION

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

- When replacing the bushing at the trunnion block, install so that the hole in the bushing faces down.
- ② Install the trunnion block so that the clearance is under 0.5mm when the trunnion block is pushed fully to the rear. Tightening torque of mounting bolt for trunnion block.

· 49.5~66.5 kgf · m (358~481 lbf · ft)





- 3 When installing the rear wheel, coat the hub bolt with molybdenum disulphide, and tighten the nut to 6~9 kgf \cdot m (43~65 lbf \cdot ft).
- ④ When installing the counterweight, align with the center of frame. Coat the mounting bolt with molybdenum disulphide and tighter.

GROUP 3 MAINTENANCE FOR HOSE

1) MAINTENANCE

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

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

2) HOSE LENGTH

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

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



35D9VB1GE01

3) CAUTION FOR REPLACEMENT

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

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

Group 1 Structure and Operation	3-1
Group 2 Inspection and Troubleshooting	3-3
Group 3 Disassembly and Assembly	3-4

GROUP 1 STRUCTURE AND OPERATION

1. STRUCTURE



- 1 Motor case
- 2 Brake assembly
- 3 O-ring
- 4 Dowel pin
- 5 Socket head bolt
- 6 Bracket
- 7 Socket head bolt
- 8 Parking lever
- 9 Key
- 10 Hexagonal bolt
- 11 Nut
- 12 Snap ring

- 13 Center axle assembly
- 14 Differential gear assembly
- 15 Second gear assembly
- 16 First gear assembly
- 17 LH axle housing assembly
- 18 O-ring
- 19 Ring gear
- 20 LH axle shaft
- 21 Wheel hub assembly
- 22 Socket head bolt
- 23 O-ring
- 24 RH axle housing assembly

- 25BX3PS01A
- 25 Parking stopper plate
- 26 Spring washer
- 27 Hexagonal bolt
- 28 RH axle shaft
- 29 Air breather
- 30 Air breather
- 31 Brake port
- 32 Drain A plug
- 33 Drain B plug
- 34 Axle name plate
- 35 Rivet

2. OPERATION



25BX3PS02

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

Drive axle transfers torque of drive motor to drive wheel through the following procedures:

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

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

3. SPECIFICATIONS					
Item	Unit	Specifications			
Max. axle load	kg	9000			
Max. input speed	rpm	4000			
Gear ratio	-	20.5			
Weight (excluding oil)	kg	200			
Oil volume	l	7.0			

3. SPECIFICATIONS

GROUP 2 FAILURE DIAGNOSIS AND CORRECTIVE ACTIONS

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

GROUP 3 DISASSEMBLY AND ASSEMBLY

1. WHEEL ASSEMBLY

1) DISASSEMBLING



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

- (2) Remove socket head bolt (1) from axle housing (6).
- (3) Remove wheel hub assembly (2) from axle housing (6).
- (4) Remove axle shaft (7) from axle assembly.
- * Care should be exercised to protect O-ring from damage after disassembling drain plug.
- $\,\%\,$ Store LH and RH axle shafts respectively.

2) ASSEMBLING

- (1) Mount axle shaft (7) on spline hub.
- * Assemble correct LH or RH axle shaft.



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



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



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



- (5) Care shall be exercise to protect O-ring (4) from damage when assembling it on ring gear (5).
- (6) Lubricate the surface of O-ring with grease.

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

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





25BX3PS10



3-6

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



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

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





(12) Fasten socket head bolt (1). \cdot Fastening torque : 9 \pm 0.5 kgf \cdot m



2. WHEEL HUB ASSEMBLY

1) DISASSEMBLING



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

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

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

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

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

2) ASSEMBLING

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



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



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



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



25BX3PS21

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

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



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

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



25BX3F

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

 \cdot Set preload : 0.12-0.16 kgf \cdot m



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



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

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

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







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



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





3. CARRIER SHAFT ASSEMBLY

1) DISASSEMBLING



1 Carrier shaft 2

3

- Spring pin Planetary gear shaft
- 5 Thrust washer 6 Planetary gear
- 8 Thrust needle roller bearing
- 9 Needle roller bearing
- (1) Strike spring pin (2) in vertical direction with round pin and mallet to remove planetary gear (6).
- (2) Once planetary gear is removed, remove thrust washer (7) and thrust needle roller bearing (8).

2) ASSEMBLING

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



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



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



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



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



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



4. RH AXLE HOUSING ASSEMBLY

1) DISASSEMBLING



- (1) Loosen hexagonal bolt (1), and then remove RH axle housing assembly from brake housing.
- (2) Turn RH axle housing assembly up side down, and remove snap ring (8).
- (3) Remove spline hub (9), snap ring (1) and ball bearing (11) from RH axle housing (3).
- (4) Remove snap ring (10) and ball bearing (11) from spline hub (9).

2) ASSEMBLING

- (1) Assemble ball bearing (11) on spline hub (9).
- % Check ball bearing for smooth revolution.



- (2) Make use of snap ring puller to assemble snap ring (10) on spline hub (9).
- 25BX3PS43
- (3) Mark a point on snap ring for checking for proper assembling.

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

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







25BX3PS44

25BX3PS46

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



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

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

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



5. LH AXLE HOUSING ASSEMBLY

1) DISASSEMBLING



- (1) Loosen socket head bolt (1), and remove LH axle housing (2) from motor case (7).
- (2) Turn LH axle housing upside down, loosen socket head bolt (8), and then remove stopper plate(9) from LH axle housing (2).
- (3) Remove first gear sub assembly (3), second gear sub assembly (4), and differential gear sub assembly (5).
- $\ensuremath{\mathbb{X}}$ Gear parts must keep clean and prevent from damage.

2) ASSEMBLING

- (1) Assemble O-ring (12) on LH axle housing (2).
- $\ensuremath{\overset{\scriptstyle \otimes}{_{\scriptstyle \sim}}}$ Be careful not to damage the O-ring.



- (2) Never forget to lubricate the surface of O-ring (12) with grease.
- * Be careful not to damage the O-ring.



- (3) Assemble gear case (11) on LH axle housing (2).
- * Be careful not to damage the O-ring.

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





- (5) Assemble stopper plate (9) on gear case (11).
- * Spread the Loctite on the bolt thread.



- (6) Fasten 10 socket head bolts (8). \cdot Fastening torque : 6 \pm 0.5 kgf \cdot m
- 25BC9U3
- (7) Mark points on LH axle housing and the heads of socket head bolts for checking to properly installed.

- (8) Assemble first gear sub assembly (3), second gear sub assembly (4) and differential gear sub assembly (5).
- 25BC9U3PS6
- (9) Assemble 2 dowel pins (6) into gear case (11) by using a mallet.





- (10) Apply Three-bond evenly on the sealing surface of gear case (11).
- * Uneven applying may cause oil leak.



- (11)Assemble a bolt guide or a special guide(s) to prevent the Three-bond from coming off.
- * Three-bond spread out



(12)Set the case sub-assembly while being careful about the Three-bond separation.





(13) Apply the Loctite on the threads of the socket head bolts (1).



(13) Fasten 11 socket head bolts (1) to motor case ...

 \cdot Fastening torque : 9 \pm 0.5 kgf \cdot m



6. BRAKE HOUSING ASSEMBLY

1) DISASSEMBLING



25BX3PS76A

- Snap ring 1 Parking lever pushing 6 11 2 Key 7 Brake air breather 12 3 Hexagonal bolt 8 Brake port 13 4 Nut 9 Socket head bolt 14
- 5 Parking lever pulling
 - 10 Socket head bolt
- Parking cable bracket
- Brake assembly
- O-ring
- Dowel pin
- 15 Motor case
- (1) Once snap ring (1) is removed, remove parking lever pulling (5) from parking lever pushing (6).
- (2) Remove brake air breather (7) and port (8) from brake assembly (12).
- (3) Loosen socket head bolt (10), and then remove parking cable bracket (11) from motor case (15).
- (4) Loosen socket head bolt (9), and then remove parking assembly (12) from motor case (15).

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



- (2) Assemble O-ring (13) on brake assembly (12).
- Image: Contract of the second seco
- (3) Lubricate the surface of O-ring with grease.



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



- (5) Fasten 2 socket head bolts (10) lubricated with Loctite 277 on parking cable bracket (11) and brake assembly (12).
 - \cdot Fastening torque : 9 \pm 0.5 kgf \cdot m
- (6) Fasten 7 socket head bolts (9) lubricated with Loctite 277 on brake assembly (12) and motor case (15).
 - \cdot Fastening torque : 9 \pm 0.5 kgf \cdot m

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



25BX3PS83



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



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



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



7. BRAKE ASSEMBLY

1) DISASSEMBLING



- 1 Socket head bolt
- 7 Brake spring spacer8 Brake return spring
- 2 Bearing metal
- 3 Guide pin
- 4 Brake reaction plate
- 5 Friction plate
- 6 Hexagonal bolt
- 9 Brake Piston
- 10 D-ring (large)
- 11 D-ring (small)
- 12 Parking pin

- 13 Brake housing
- 14 Snap ring
- 15 O-ring
- 16 Parking lever
- 17 O-ring
- 18 Parking lever pushing

25BX3PS89A

- (1) Loosen socket-head bolt (1), and then remove bearing metal (2) from brake housing (13).
- (2) Once guide pin (3) is removed, remove brake reaction plate (4) and friction plate (5).
- (3) Once hexagonal bolt (6) is loosened, remove brake piston (9).
- (4) Remove snap ring (14) and O-ring (15) from brake housing (13).
- (5) Remove parking spacer (16) and O-ring (17) from brake housing (13).
- (6) Remove parking lever pushing (18) from brake housing (13).

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

 Vi
- (2) Lubricate assembly surface with grease.

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

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

Loctite 277.







(5) Fasten hexagonal bolts (6) on brake piston (9).

 \cdot Fastening torque : 1.5 \pm 0.2 kgf \cdot m



- (6) Assemble friction plate (5) and brake reaction plate (4) on brake housing (13)
- Never forget to assemble reaction plate only after assembling friction plate.

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





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



(9) Fasten socket head bolt (1) on brake housing (13).

 \cdot Fastening torque : 6 \pm 0.5 kgf \cdot m



- (10) Assemble parking pin (12) on brake housing (13).
- EBX3PS99
- (11) Assemble parking lever pushing (18) on brake housing (13).



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



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



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







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


- (13)Assemble O-ring (17) on parking space (16), and lubricate it with grease.Mark a point for checking for proper assembling.
- EBX3PS106
- (14) Assemble assembly on brake housing (13).

- (15) Assemble hexagonal bolt on parking lever pulling.
- 25BX3PS107



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



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



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



8. DIFFERENTIAL GEAR ASSEMBLY

1) DISASSEMBLING



- 1 Center axle assembly
- 6 Socket head bolt
- 2 Snap ring Brake hub

Ball bearing

Ball bearing

3

4

5

- 7 Differential gear case
- 8 Dowel pin
- 9 Differential cover gear
- 10 Differential pinion shaft (A)

- 25BX3PS112A
- 11 Differential pinion shaft (B)
- 12 Differential side gear
- 13 Thrust washer
- 14 Differential pinion gear
- 15 Differential pinion washer
- (1) Remove center shaft assembly (1) from differential gear assembly.
- (2) Remove snap ring (2) and brake hub (3) from differential gear case (7).
- (3) Remove ball bearing (4) from differential gear case (7).
- (4) Remove ball bearing (5) from differential cover gear (9).
- (5) Remove socket head bolt (6) and differential gear case (7) from differential cover gear (9).
- (6) Remove differential gear and pinion.

2) ASSEMBLING

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



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



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

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



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



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



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

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





25BX3P





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



9. FIRST AND SECOND GEAR ASSEMBLIES



- Gear shaft
- 5 Key

(1) Disassembling first gear assembly

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

(2) Disassembling second gear assembly

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

2) ASSEMBLING

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



(2) Assembling second gear assembly

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



- ② Make use of heating device to assemble ball bearing (1) on gear shaft (4).
- * Check ball bearing for smooth revolution.



10. CENTER SHAFT ASSEMBLY

1) DISASSEMBLING



25BX3PS128A

- 1 Snap ring
- 2 Brake hub
- 3 Center shaft
- (1) Remove snap ring (1) and brake hub (2) from center shaft (3).

2) ASSEMBLING

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



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



Group 1 Structure and Functions	4-1
Group 2 Operational checks and troubleshooting	4-5
Group 3 Testing and Adjustment	4-6

GROUP 1 STRUCTURE AND FUNCTIONS

1. INTRODUCTION

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

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

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

2. SPECIFICATIONS

1) SERVICE BRAKE

Item	Unit	Specifications
Туре	-	Wet disk brake
Brake fluid	-	Hydraulic oil ISO VG32 (AZOLLA ZS32)
Max. torque	N·m (at 50 bar)	3600

2) PARKING BRAKE

Item	Dimensions
Туре	Latched, inner-expanding mechanical type
Parking lever stroke	29 deg.
Parking cable stroke	90 mm

3. BRAKE PEDAL AND PIPING



4 Brake valve assy

4. BRAKE CONNECTION

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

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

1) Connecting hydraulic brake

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

 \cdot Fastening torque : 1.4 - 1.8 kgf \cdot m

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

2) Connecting parking brake cable

Fasten parking brake cable to lever with screws.

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

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

A Once brake fluid is filled, bleed the brake (see page 4-6).

5. BRAKE VALVE

1) STRUCTURE



- 1 Rod assembly
- 2 Boot

3

- Snap ring
- 4 Body
- 5 Piston

- 6 Union
- 7 Elbow
- 8 O-ring
- Second cup
 First cup
- 13 Spring
- 14 Spring sheet
- 15 Spring sheet

2) DISASSEMBLING

- (1) Remove boot (2) and rod assembly (1).
- (2) Remove snap ring (3), and then disassemble piston (5), second cup (11), first cup (12), spring (13), and spring sheets (14, 15).
- (3) Specifications of brake valve
 - · Cylinder bore diameter : 19.05 mm
 - · Piston stroke : 23.0 mm

3) INSPECTION

- (1) Clean components, and check them for conditions.
- * Use isopropyl alcohol or brake fluid only. Never use gasoline, kerosene, or other mineral oil. Do not keep rubber component in alcohol in alcohol for 30 seconds or longer.
- (2) If defect is found on the inner wall of the body, replace the brake valve assembly.
- (3) If deformation or other defect is found, replace boot (2), second cup (11), first cup (12) and piston (5).

4) ASSEMBLING

- Make sure again the parts are not contaminated before assembling. Apply thin film of brake oil on parts.
 - \cdot Assembling is done in reverser order of disassembling.

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECK

1) BRAKE PIPING

- (1) Check pipe, hose and joint for damage, oil leak or interference.
- (2) Press brake pedal to check force required for pressing.

Check for any variation of operating force and pedal position with the pedal kept pressed.

2) BRAKING FORCE

(1) Drive the truck at max. speed on hard, flat and paved surface. If any signal is alarmed, immediately stop the truck, and measure the distance from signal alarming pint to stopped point (under no load).

· Stopping distance: 5 m or less

(2) Make sure that there is no inclination of steering wheel or bake, or no noise during sudden braking.

3) PARKING BRAKE

- (1) Operating force of parking lever is 20-30 kgf \cdot m.
- (2) Make sure that the loaded truck is kept standstill on slope of 15% gradient when applying the parking brake.

If there is no slope, drive the truck at low speed and check operation of the parking brake.

2. OPERATION INSPECTION, AND FAILURE DIAGNOSIS AND TROUBLESHOOTING

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

GROUP 3 TESTING AND ADJUSTMENT

1. BRAKE BLEEDING

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

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



- ※ Put discharged brake fluid into a container. Do not spill brake fluid on the floor, or discharge it into drain.
- A Close bleeding valve before releasing brake pedal.
- Repeat this process until brake fluid shows no bubble.
 Check the level of brake fluid in a container, and make up the fluid, if required.
- 4) Once brake fluid is discharged without indication of bubble, fasten the bleeding valve, remove hose, and install dust prevention cap on bleeding valve.
 - \cdot Fastening torque : 1.5 \pm 0.2 kgf \cdot m

2. ADJUSTMENT OF PEDAL

1) BRAKE PEDAL

- (1) Adjust the height of pedal from the floor plate with a stopper bolt.
 - · Pedal height : 122 mm (4.8 in)
- (2) Play

Adjust play with rod of master cylinder. \cdot Idle stroke : 0.5~1.5 mm (0.02~0.06 in)



SECTION 5 STEERING SYSTEM

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SECTION 5 STEERING SYSTEM

GROUP 1 STRUCTURE AND FUNCTIONS

1. INTRODUCTION



25BC9U5SS01

The steering system for this machine is composed of hydraulic gear pump, steering wheel assembly, steering unit, steering cylinder, steering axle and pipings. The steering force given to the steering wheel enters the steering unit through the steering column. The required oil flow is sensed by the function of the control section of the unit, and pressurized oil delivered from the hydraulic gear pump is fed to the steering cylinder through the priority valve. The force produced by the steering cylinder moves the knuckle of steering tires through the intermediate link.

The axle body is unit structure having steering knuckles installed to its both ends by means of king pins.

Hub and wheel are mounted through bearing to spindle of knuckle.

2. HYDRAULIC CIRCUIT



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

1) NEUTRAL



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

2) TURING LEFT OR RIGHT



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

3. STEERING UNIT

1) STRUCTURE



22

25BX5SS05

- 1 Dust sealing ring
- 2 Housing spool and sleeve
- 3 Ball
- 5 Shaft seal
- 7 Bearing assembly
- 10 Ring
- 11 Cross pin
- 12 Spring set
- 13 Cardan shaft
- 16 Distributor plate
- 17 Gear wheel set

- 18 O-ring
- 19 End cover
- 20 Washer
- 22 Pin bolt screw
- 23 Screw
- 24 Model/code label
- 25 Adjusting screw
- 26 Spring
- 27 Ball
- 28 Seat
- 30 Adjusting screw

- 31 Spring 32 Piston
- 32 Pistor
- 33 Ball
- 34 Bushing
- 35 Ball stop thread
- 36 Ball (Ø3)
- 37 Check valve
- 39 Sealing ring
- 40 O-ring
- 41 O-ring
- 42 Plug

* Seal kit: 1, 5, 18, 20, 40, 41

2) OPERATION



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

- · Manual steering check valve : Converts unit to manual operating pump for limited manual steering.
- Check valve (P port) : Used for blocking return of hydraulic oil to steering unit when pressure inside cylinder is higher than pressure inside the inlet for the purpose of preventing kickback of steering wheel.
- · LS relief valve : Limits maximum pressure inside steering circuit.

3) MANUAL STEERING IN EMERGENCY



35D9VBSS77

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

4. PRIORITY VALVE

1) STRUCTURE

			5	4 3		8	9	
	A	B	Port	Port dimensi	ons	Fastenin	g torque	_
	D	ZB	EF	7/8-14UN	=	10	72.3	-
	1	9	CF	3/4-16 UN	F	4	28.9	
	1		LS	7/16-20 UN	IF	2	14.5	1
Housing Model/code label Orifice Spool	5 6 7 8	Orifice Orifice Spring O-ring		9 10 12	Plug Plug O-rii)) ng	25BX	(5SS08A

* Seal kit : 8, 12

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

5. STEERING AXLE

1) STRUCTURE



25LC95SS01A

- 1 Hub cap
- 2 Hub bolt
- 3 Nipple
- 4 Steering link
- 6 Steering axle
- 7 Nipple
- 8 Block
- 9 Steering knuckle
- 10 Rod ring
- 11 Upper cover
- 12 Bearing
- 13 Oil seal
- 14 Oil seal

- 15 Bearing
- 16 Nut
- 17 Washer
- 18 Pin
- 19 Wheel hub
- 20 Shim (0.2t)
- 21 Shim (0.1t)
- 22 Shim (0.5t)
- 23 Pin
- 24 Bolt
- 25 Washer
- 26 Adjusting shim
- 27
- - Adjusting shim

- 28 Bushing
- 29 Screw
- 30 Nut
- 31 Grease nipple
- 32 Steering link pin
- 33 Bushing
- 34 Oscillating bearing
- 35 Bolt
- 36 Washer
- 52 Hex bolt
- 53 Harden washer
- 54 Wheel nut
- 55 Steering cylinder

2) TIGHTENING TORQUE AND SPECIFICATION





25BC9U5SS09

Туре	Unit	Center pin support single shaft
Structure of knuckle	-	Elliott type
Toe-in	degree	0
Camber	degree	0
Caster	degree	0
King pin angle	degree	0
Max steering angle of wheels (Inside / Outside)	degree	80.79 / 56.49
Tread	mm (in)	901 (35.5)

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

Check item	Checking procedure
Steering wheel 30-60mm (1.2-2.4 in)	 Set rear wheels facing straight forward, then turn steering wheel to left and right. Measure range of steering wheel movement before rear wheel starts to move. Range should be 30~60 mm at rim of steering wheel. If play is too large, adjust at gear box. Test steering wheel play with forklift stopped.
Knuckle	Check knuckle visually or use crack detection method. If the knuckle is bent, the tire wear is uneven, so check tire wear.
Steering axle	 Put camber gauge in contact with hub and measure camber. If camber is not within 1±0.5°; rear axle is bent. Ask assistant to drive machine at minimum turning radius. Fit bar and a piece of chalk at outside edge of counterweight to mark line of turning radius. If minimum turning radius is not within±100 mm (±4 in) of specified value, adjust turning angle stopper bolt. Min turning radius (Outside) : Refer to page 1-5 (Specifications)
Hydraulic pressure of power steering	Remove plug from outlet port of flow divider and install oil pressure gauge. Turn steering wheel fully and check oil pressure. ※ Oil pressure : 100 kgf/cm ² (1420 psi)

2. TROUBLESHOOTING

1) STEERING SYSTEM

Problem	Cause	Remedy
Steering wheel drags.	· Low oil pressure.	· Check lockout. Repair.
	· Bearing faulty.	· Clean or replace.
	 Spring spool faulty. 	· Clean or replace.
	· Reaction plunger faulty.	· Replace.
	· Ball-and-screw assembly faulty.	· Clean or replace.
	· Sector shaft adjusting screw excessi-	· Adjust.
	vely tight.	
	· Gears poorly meshing.	· Check and correct meshing.
	· Flow divider coil spring fatigued.	· Replace.
Steering wheel fails to return	· Bearing faulty.	· Clean or replace.
smoothly.	· Reaction plunger faulty.	· Replace.
	· Ball-and-screw assy faulty	· Clean or replace.
	· Gears poorly meshing.	· Check and correct meshing.

Problem	Cause	Remedy
Steering wheel turns unstea- dily.	 Lockout loosening. Metal spring deteriorated. 	· Retighten. · Replace.
Steering system makes abn- ormal sound or vibration.	 Gear backlash out of adjustment. Lockout loosening. Air in oil circuit. 	 Adjust. Retighten. Bleed air.
Abnormal sound heard when steering wheel is turned fully	Valve Faulty. (Valve fails to open.) Piping Pipe(from pump to power steering cylinder) dented or clogged. 	 Adjust valve set pressure and check for specified oil pressure. Repair or replace.
Piping makes abnormal sounds.	Oil pump · Lack of oil. · Oil inlet pipe sucks air. · Insufficient air bleeding.	 Add oil. Repair. Bleed air completely.
Valve or valve unit makes abnormal sounds.	 Oil pump Oil inlet pipe sucks air. Valve Faulty. (Unbalance oil pressure) Piping Pipe(from pump to power steering) dented or clogged. Insufficient air bleeding. 	 Repair or replace. Adjust valve set pressure and check specified oil pressure. Repair or replace. Bleed air completely.
Insufficient or variable oil flow.	· Flow control valve orifice clogged.	· Clean
Insufficient or variable dischar- ge pressure.	 Pipe(from tank to pipe) dented or clogged. 	· Repair or replace.
Steering cylinder head leakage (Piston rod)	 Packing foreign material. Piston rod damage. Rod seal damage and distortion. Chrome gilding damage. 	 Replace Grind surface with oil stone. Replace Grind
Steering cylinder head thread (A little bit leak is no problem)	· O-ring damage.	· Replace
Welding leakage	· Cylinder tube damage.	· Tube replace.
Rod	 Tube inside damage. Piston seal damage and distortion 	 Grind surface with oil store. Replace
Piston rod bushing inner diameter excessive gap	· Bushing wear.	· Replace

2) STEERING UNIT

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

3) PREFERENTIAL VALVE

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

4) STEERING CYLINDER

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

GROUP 3 DISASSEMBLY AND ASSEMBLY

1. STEERING UNIT

1) STRUCTURE



25BX5SS05

- 1 Dust sealing ring
- 2 Housing spool and sleeve
- 3 Ball
- 5 Shaft seal
- 7 Bearing assembly
- 10 Ring
- 11 Cross pin
- 12 Spring set
- 13 Cardan shaft
- 16 Distributor plate
- 17 Gear wheel set
- * Seal kit: 1, 5, 18, 20, 40, 41

- 18 O-ring
- 19 End cover
- 20 Washer
- 22 Pin bolt screw
- 23 Screw
- 24 Model/code label
- 25 Adjusting screw
- 26 Spring
- 27 Ball
- 28 Seat
- 30 Adjusting screw

- 32 Piston
- 33 Ball

31

34 Bushing

Spring

- 35 Ball stop thread
- 36 Ball (Ø3)
- 37 Check valve
- 39 Sealing ring
- 40 O-ring
- 41 O-ring
- 42 Plug

2) TOOL

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



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



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



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



3) Fastening torque

- L : Left port
- R : Right port
- T : Tank port
- P : Pump port
- LS : Load sensing port



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

4) DISASSEMBLING

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



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



(3) Remove spring (31).







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



(6) Remove spring (26).



(7) Remove ball (27).



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



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



(10) Remove end cover (19).



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






(13) Remove distributor plate (16).



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



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



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



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



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





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



(20) Remove cross pin (11).



(21) Remove ring (10).



(22) Carefully remove spool from sleeve.



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



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



- (25) Fully disassembled steering unit
- * Clean all of parts with solvent.
- * Replace seal and washer. Inspect all of parts, and replace parts, if required.



5) ASSEMBLING

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



- (2) Number of curved springs may vary dependent upon configuration of leaf spring set (12). There may be 2, 4 or 66 curved springs.
- (3) Spool and sleeve set for steering unit should precisely be aligned to each other for mounting., Small marks are on the nearest slot of spring set, and all of sleeves. There are no marks on most of spools and sleeve sets. They are arranged facing each other on 1 of 2 available locations.
- (4) Mount spool on sleeve, and make sure that leaf spring (12) is mounted on slot.





(5) Align leaf spring (12).



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



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



(8) Mount bearing assembly (7).



(9) Assemble parts in order as shown below:
1 Outer bearing race → 2 Needle bearing
→ 3 Inner bearing race → 4 Spool → 5 Sleeve.

The inside corner of inner bearing race should be aligned with the inside corner of spool.

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

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

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











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



(15) Withdraw assembling tool from steering unit.



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



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



- (18) Put steering unit housing on assembly fastening device toward the tip of steering column. Insert ball (3) into indicated hole.
- (19) Insert ball (36) into indicated hole.
- 35D9VB5SS44
- (21) Insert ball (33) into two indicated holes respectively.

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

 \cdot Fastening torque : 0.1 \pm 0.01 kgf \cdot m

fasten the thread.



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



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



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



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



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

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

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

- (29) Insert new washer (20) and 6 screws (23), and make use of 13-mm wrench to fasten screws (22, 23).
 - \cdot Fastening torque : 3.1 \pm 0.6 kgf \cdot m









- (30) Make use of Torx bit of size T50 to fasten check valve (37).
 - \cdot Fastening torque : 2.6 \pm 0.5 kgf \cdot m



- Manually test functional operation of VSP. Inner shaft should rotate at torque less than 3.5 N·m.
- (31) Put steering unit assembly on assembling device on opposite side. Assemble piston (32) on housing.

(32) Insert spring (31) into piston.



25BX5SS32

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



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



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



(36) Insert spring (26) onto ball.



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



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



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



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



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



2. PRIORITY VALVE



1 Housing

4

2 Name plate

Spool

- 3 Orifice, Dynamic
- Orifice, PP
 Orifice, LS
 Spring
 O-ring
- 9 Plug, LS10 Plug, PP12 O-ring

1) DISASSEMBLY

- (1) Screw out the plug (9) using a 22 mm spanner. O-ring (8) is fitted on plug.
- (2) Remove the spring \bigcirc using a hook.
- (3) Remove the spool ④ using a incide snap ring pliers. Orifices ③, ⑤ are includ to the spool. *** Before removing orifices ③, ⑤, fix the spool ④ in a vice with aluminum jaws.**
- (4) Remove the PP orifice 5 using a 2 mm allen-wrench.
- (5) Remove the dynamic orifice 3 using a 3 mm allen-wrench.
- (6) Screw out the plug 10 using an 8 mm allen-wrench. O-ring (8) is fitted on plug.
- (7) Remove the LS orifice ③ from LS-port of housing ① using a 2 mm allen-wrench.

2) ASSEMBLY

- (1) Assemble the orifices $(3),\,(5)$ to the spool (4).
- * Before assembling orifices ③, ⑤ to the spool : fix the spool in a vice with aluminum jaws.
- (2) Screw in PP orifice 5 using a 2 mm allen-wrench.
 - · Tightening torque : 0.1±0.01 kgf·m (0.72±0.07 lbf·ft)
- (3) Screw in dynamic orifice 3 using a 3 mm allen-wrench.
 - · Tightening torque : 0.35±0.05 kgf·m (2.53±0.36 lbf·ft)
- (4) Assemble the LS orifice 6 into the thread hole in the LS-port of housing 1 using a 2 mm allenwrench.
 - · Tightening torque : 0.1±0.01 kgf·m (0.72±0.07 lbf·ft)
- (5) Assemble the plug ${\rm I}{\rm O}$ using an 8 mm allen-wrench. O-ring ${\rm (8)}$ is fitted on plug.
 - · Tightening torque : 4±1 kgf·m (28.9±3.6 lbf·ft)
- (6) Insert the priority valve spool 4 with orifices 3, 5.
- (7) Insert the spring \bigcirc .
- (8) Assemble the plug (9) using a 22 mm spanner. O-ring (8) is fitted on plug. • Tightening torque : 4±1 kgf·m (28.9±3.6 lbf·ft)

3. STEERING CYLINDER

1) STRUCTURE



2) DISASSEMBLY

* Before disassembling steering cylinder, release oil in the cylinder first.

- (1) First remove the external circlips (14).
- (2) Tap the rod cover (15) into the tube (12) and remove the snap rings (13).
- (3) Remove the rod cover (15).
- (4) Repeat steps 1-3, disassembly the other rod cover.
- (5) Remove the piston rod (16) and piston (11) from the tude (12).
- (6) Check wear condition of the sealing parts. If there are some damage, replace with new parts.

3) CHECKING AND INSPECTION

			()	
Chaokitam	Crite	Demodu		
Check lien	Standard size Repair limit		nemeuy	
Clearance between piston & cylinder tube	0.08~0.22 (0.003~0.009)	0.3 (0.012)	Replace piston seal	
Clearance between cylinder rod & bushing	0.024~0.174 (0.0009~0.007)	0.2 (0.008)	Replace bushing	
Seals, O-ring	Dam	Replace		
Cylinder rod	De	Replace		
Cylinder tube	Biti	Replace		

4) ASSEMBLY

(1) Put the piston (11) into the piston rod (16)



(2) Put the steel ball (9) into the piston (11) until it is s full,and then install the support ring (10) to the groove on the piston,last install the piston sealing (8).





mm (in)

(3) Set a special tool on the piston rod (16), then put the piston rod into the tube (12), last put the rod cover (15) into both side of the tube (12).

- (4) Install the roundwire snap rings (13) to the groove on the tube. Then move the piston rod (16) to the limit position, last install the external circlips (14).
 - s (13) to the he piston rod Il the external
- (5) Move the piston rod (16) back and forth several times for the full distance of its stroke. This helps to seat the O-ring and seals before applying full hydraulic pressure to the cylinder. Install cylinder into trail axle.



25BX5SS19



4. STEERING AXLE

1) STRUCTURE



- 1 Hub cap
- 2 Hub bolt
- 3 Nipple
- 4 Steering link
- 6 Steering axle
- 7 Nipple
- 8 Block
- 9 Steering knuckle
- 10 Rod ring
- 11 Upper cover
- 12 Bearing
- 13 Oil seal
- 14 Oil seal

- 15 Bearing
- 16 Nut
- 17 Washer
- 18 Pin
- 19 Wheel hub
- 20 Shim (0.2t)
- 21 Shim (0.1t)
- 22 Shim (0.5t)
- 23 Pin
- 24 Bolt
- 25 Washer
- 26 Adjusting shim kit
- 27 Adjusting shim kit

- 28 Bushing
- 29 Screw
- 30 Nut
- 31 Grease nipple
- 32 Sterring link pin
- 33 Bushing
- 34 Oscillating bearing

25LC95SS01A

- 35 Bolt
- 36 Washer
- 52 Hex bolt
- 53 Harden washer
- 54 Wheel nut
- 55 Steering cylinder

2) CHECK AND INSPECTION





25BX5SS20A

unit : mm (in)

		Cha		Criteria		Demedia
INO.			Standard size	Repair limit	Remedy	
^	A Shaft	A1	OD of shaft	Ø50 (1.97)	Ø49.5 (1.95)	Replace
		A2	ID of bushing	Ø50 (1.97)	Ø49.5 (1.95)	
В	OD of king pin		Ø30 (1.18)	Ø29.8 (1.17)		
С	OD of steering cylinder pin		Ø16 (0.63)	Ø15.8 (0.62)		
		D1	OD of pin	Ø16 (0.63)	Ø15.8 (0.62)	
D Knu	Knuckle	D2	Verical play	-	-	
		D3	ID of bushing	Ø16 (0.63)	Ø15.8 (0.62)	Adjust with shims

· OD : Outer diameter

· ID : Inner diameter

3) DISASSEMBLY

- Servicing work on the knuckle part can be carried out without removing the axle assy from chassis. The work can be done by jacking up the counter weight part of the truck.
- (1) Loosen the hub nut (54) and take off the steering wheel tire.



- (2) Remove hub cap (1).
- (3) Pull out split pin (18) and remove slotted nut (16) and washer (17).
- (4) Using the puller, take off the hub (19) together with the taper roller bearing (12, 15).
- * Be very careful because just before the hub comes off, taper roller bearing will fall out.
- (5) After hub (19) is removed take off the inner race of the taper roller bearing (12, 15).
- (6) Pull out oil seal (14).
- * Do not use same oil seal twice.
- (7) Repeat the same procedure for the other side. Moreover, when disassembling is completed, part the slotted nut (16) in the knuckle (9) to protect the threaded portion.
- (8) Loosen the bolt (29) and the nut (30).
- (9) Remove the cover (11).
- (10) Push out the king pin (23) without damaging the knuckle arm (9).
- (11) If defect is observed in taper roller bearing (12), pull it out by using extractor.
- (12) Loosen the bolt (35). Remove the link pin (32) and the washer spring (36).
- (13) Remove the steering link (4) and remove the bushing (33) and oscillating bearing in turn with the tool.





4) ASSEMBLY

- In reassembling, have all parts washed, grease applied to lubricating parts, and all expendable items such as oil seal and spring washers replaced by new ones. Perform the disassembly in reverse order.
- (1) Tighten the bolt (29) and the nut (30) of the king pin (23).
- (2) There is a notch in the middle of the king pin(23), make sure that this notch is on the bolt side(29).
- (3) Do not hammer to drive in the bearing (5) because it will break.
- ※ Always use drive-in tool. Be sure that the fixed ring of the bearing is placed in position facing the knuckle (9).

(4) Hub

- Press the bolt (2) into the hub (19) mating hole with special tools.
- ② Press the outer ring of large (15) and small (12) bearing into the hub (19) mating hole respectively with special tools to ensure that the outer ring and the hub are in place.
- ③ Install hub bearing and fill the hub with grease.
- The amount of which is 1/3~1/2 of the hub's inner cavity
- ④ Apply grease to the working surface of oil seal (15), then install it into the hub mating hole.
- (5) Install hub assembly on the knuckle (9), set into the washer (17), tighten the nut (16) of hub, then loose it, adjust the starting force of the wheel hub until 40-70n, last install the pin cotter (18). Finally install hub cap (1) with special tooling.
 - Tightening torque : 15.3±5.1 kgf·m (111±36.9 lbf·ft)



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Group	3	Disassembly and assembly	6-24

GROUP 1 STRUCTURE AND FUNCTION

1. HYDRAULIC CIRCUIT

1) MANUAL LEVER TYPE



3ZBD-01000-001

- 1 Hydraulic gear pump with priority valve
- 2 Main control valve
- 3 Steering unit
- 4 Steering cylinder
- 5 Tilt cylinder
- 6 Lift cylinder

- 7 Suction strainer
- 8 Down control valve
- 9 Down safety valve
- 10 Return filter
- 11 Hydraulic oil tank

2) FINGERTIP TYPE



3200-01000-00

- 1 Hydraulic gear pump with priority valve
- 2 Main control valve
- 3 Steering unit
- 4 Steering cylinder
- 5 Tilt cylinder
- 6 Lift cylinder

- 7 Suction strainer
- 8 Down control valve
- 9 Down safety valve
- 10 Return filter
- 11 Hydraulic oil tank

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



25BC9U6HS01

When the lift control lever is pulled back, the spool on the first block is moves to lift position. The oil from hydraulic gear pump (1) flows into main control valve (2) and then goes to the large

chamber of lift cylinder (6) by pushing the load check valve of the spool.

The oil from the small chamber of lift cylinder (6) returns to hydraulic oil tank (11) at the same time. When this happens, the forks go up.

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



25BC9U6HS02

When the lift control lever is pushed forward, the spool on the first block is moved to lower position. The work port (1A) and the small chamber and the large chamber are connected to the return passage, so the forks will be lowered due to its own weight.

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



25BC9U6HS03

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 large chamber of tilt cylinder (5) by pushing the load check valve of the spool.

The oil at the small chamber of tilt cylinder (5) returns to hydraulic tank (11) through return filter (10) at the same time.

When this happens, the mast tilt forward.

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



25BC9U6HS04

When the tilt control lever is pulled back, 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 small chamber of tilt cylinder (5) by pushing the load check valve of spool.

The oil at the large chamber of tilt cylinder (5) returns to hydraulic tank (11) through return filter (10) at the same time.

When this happens, the mast tilt backward.

2. HYDRAULIC GEAR PUMP

1) STRUCTURE



1 Front cover

- 2 Body
- 3 Drive gear
- 4 Driven gear
- 5 Side plate
- 6 Bushing
- 10 Gasket
- 11 Gasket

Back up ring

31HA-01530

- 15 Socket bolt
- 18 Oil seal

12

19 Retaining ring

3. MAIN CONTROL VALVE (MANUAL)

1) STRUCTURE (4 Spool, with mast tilting, lifting and lowering OPSS)





	INLET	LIFT 1.	TILT A 2B 2A	AUX1 3B3A	AUX2 4B4A	OUTLET
P -	210bar					130bar
T						
		OPSS	Hydraulio	c circuit		

Port name	Size	Port
Inlet port	7/8-14UNF	Р
Outlet port	7/8-14UNF	Т
Work port	7/8-14UNF	1A
Work port	3/4-16UNF	2A, 2B, 3A, 3B, 4A, 4B

25BC9U6HS08

- Inlet block assy 1
 - Lift block assy
- 3 Tilt block assy

2

- 4 Aux 1 block assy
- Aux 2 block assy 5
- Outlet block assy 6
- 7 Main relief valve assy
- 8 Auxiliary relief valve assy
- Long bolt 9
- Nut 10
- Solenoid valve 11

6-8

2) INLET SECTION

(1) Operation

The inlet section contains the pump inlet connection and main relief valve.



22B7HS09

(2) Operation of relief valve at setting pressure

When the pressure at inlet reaches to setting pressure, the pilot poppet which is in the main relief valve is opened by pressure. At this condition the flow divert from the pump directly to the outlet tank.



22B7HS10

3) LIFT SECTION

(1) Operation

The lift section has a single work port to direct flow to the lift cylinder. Only one work port is used, because the lift cylinder is single-acting (gravity returns the mast to the lowered position).

The lift section also contains part of the components which comprise the safety features. There is a lift lock check valve. At the neutral position, pressures in the lock valve are equalized across the lift lock poppet. In this manner, the spring bias keeps the lift lock valve closed and prevents lowering of the mast.

1) Lifting

When the operator shifts the lever backwards, the spool is extended out of the valve, and this opens the internal fluid passages that lift the mast. Oil flows through the high pressure parallel cavity, past the load check valve, through the spool metering notches, past the lift lock check valve, and to the head side of the lift cylinder.



25BC9U6HS11

2 Lowering

When the seated operator shifts the lever forwards, the spool retracts into the valve, and the oil is directed from the cylinder, past the lift lock check valve, past the spool metering notches, and to the common tank cavity.



Pressure is limited by the main relief valve.

25BC9U6HS12

4) TILT SECTION

(1) Operation

The tilt spool contains an internal plunger which acts to stop tilt forward actuation when the battery power is off.

1 Tilt forward

When the seated operator shifts the lever forward, pressure is applied to the head of the tilt cylinder, and the forks tilt forward. Oil is directed from the high pressure parallel passage past the load check valve, past the spool metering notches, and towards the cylinder head.

Simultaneously, the high pressure acts upon the end of the tilt lock plunger to move it towards the spring end of the spool. This plunger movement opens additional spool metering notches which control oil flow from the rod end of the cylinder to the tank return line.



2 Tilt Back

When the seated operator shifts the lever back, the high pressure oil from the parallel passage is directed past the load check valve, past the spool metering notches, and to the rod side of the cylinder. Exhaust oil from the head side of the cylinder is directed past the spool metering notches to tank.



Pressure is limited by the main relief valve.

5) AUXILIARY SECTIONS

(1) Operation

Many different functions can be controlled by the auxiliary spool sections. In general, one work port is pressurized by high pressure oil from the parallel passage, past the load check valve, past the metering notches, and to the cylinder. Simultaneously, oil from the other work port is directed across the spool metering notches to tank.



25BC9U6HS15



25BC9U6HS16

Pressure is limited by the secondary main relief valve.
6) OUTLET SECTION

(1) Operation

The outlet section contains the tank port and the secondary relief valve (with built-in anticavitation feature).



22B7HS17

(2) Operation of relief valve at setting pressure

When the pressure at outlet reaches to setting pressure, the pilot poppet which is in the main relief valve is opened by pressure. At this condition the flow divert from the pump directly to the tank line.



22B7HS18

7) MAIN RELIEF VALVE

This valve is a type of pilot piston to prevent hydraulic components and pipes from being broken by high pressure so, it keeps under pressure limited.

Relief valve pressure varies by 130 kgf/cm² in accordance with 1 revolution of adjust bolt.



5 O-ring

O-ring

1

2

3

4

6 Socket

- 11 Back up ring
- 12 O-ring

17 Lock nut

4. MAIN CONTROL VALVE (FINGERTIP)







25BC9U6HS09

Port name	Size	Port
Inlet port	7/8-14UNF	Р
Outlet port	1 1/16-12UN	Т
Work port	7/8-14UNF	А
Work port	3/4-16UNF	2A, 2B, 3A, 3B, 4A, 4B
Gauge port	9/16-18UNF	G

5. LIFT CYLINDER

1) V MAST



D255HS18

1 Tube 2 Rod

Piston

Back up ring

3

4

5

6 Wear ring

Gland

Retaining ring

- Piston seal
 - 9 Dust wiper

7

8

10 Rod seal

- 11 O-ring
- 12 Stopper
- 13 DU bushing
- 14 Spacer
- 15 O-ring

2) TF MAST



22B9FHS21

- 1 Tube assembly
- 2 Rod
- 3 Piston
- 4 U-packing
- 5 Back up ring
- 6 Wear ring
- 7 Check valve
- * Seal kit : 4 ~ 6, 14, 15, 19

- 8 Spacer
- 9 Retaining ring
- 10 Stop ring
- 11 Cushion seal
- 12 Retaining ring
- 13 Rod cover
- 14 U-packing

- 15 Dust wiper
- 16 Retaining ring
- 17 Rod bushing
- 18 Spacer
- 19 O-ring
- 20 Stop ring



- Tube assembly 1
- 8
- Rod assembly 2
- 3 Stop ring
- 4 Set screw
- 5 Piston
- 6 U-packing
- 7 Back up ring

* Seal kit : 6 ~ 8, 14, 15, 17 ~ 19

- Wear ring
- Check valve 9
- Retaining ring 10
- 11 Cushion seal
- Retaining ring 12
- 13 Rod cover
- 14 U-packing

- Dust wiper 15
- 16 Retaining ring

22B9FHS22

- 17 Wear ring
- Dust ring 18
- 19 O-ring

- 6-17

6. FREE LIFT CYLINDER

1) TF MAST



1 Tube assembly

Rod

Piston

U packing

Abrasion ring

Check valve

2

3

4

5

6

- 7 Retainer ring
- 8 Set screw
- 9 Rod cover
- 10 U packing
- 11 Dust wiper
- 12 Retainer ring

- 13 O-ring
- 14 Backup ring
- 15 Pipe
- 16 Backup ring
- 17 U packing

2) QF MAST



- 1 Tube assembly
- 2 Rod
- 3 Piston
- 4 U packing
- 5 Abrasion ring
- 6 Check valve

- 7 Retainer ring
- 8 Set screw
- 9 Rod cover
- 10 U packing
- 11 Dust wiper
- 12 Retainer ring

3CHN-07503

37B1-07612

- 13 O-ring
 14 Backup ring
- 15 Pipe
- 16 Backup ring

7. TILT CYLINDER



- 1 Tube
- 2 Rod
- 3 Piston
- 4 Piston seal
- 5 Dust wiper
- 6 O-ring
- 7 Nylon nut
- 8 Rod cover

- 9 DU bushing
- 10 U-packing
- 11 Back up ring
- 12 Wiper ring
- 13 Stop ring
- 14 O-ring
- 15 Back up ring
- 16 O-ring

17 Lock washer

22B7HS24

- 18 Rod eye
- 19 Spherical bearing
- 20 Hexagon bolt
- 21 Spring washer
- 22 Lock nut
- 23 Grease nipple
- 24 O-ring

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

1) CHECK ITEM

- (1) Check visually for deformation, cracks or damage of rod.
- (2) Set mast vertical and raise 1 m from ground. Wait for 10 minutes and measure hydraulic drift (amount forks move down and amount mast tilts forward).
 - \cdot Check condition
 - Hydraulic oil : Normal operating temp (45±5°C)
 - Mast substantially vertical.
 - Rated capacity load.
 - · Hydraulic drift
 - Down (Downward movement of forks)
 - : Within 100 mm (3.9 in)
 - Forward (Extension of tilt cylinder)
 - : Within 5°
- (3) If the hydraulic drift is more than the specified value, replace the control valve or cylinder packing.

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

Standard Under 0.6 (0.02)

2) HYDRAULIC OIL

- (1) Using dipstick, measure oil level, and oil if necessary.
- (2) When changing hydraulic oil, clean suction strainer(screwed into outlet port pipe) and line filter(screwed into inlet pipe). Line filter uses paper element, so replace periodically(every 6 months or 1000 hours)

3) MAIN CONTROL VALVE

 (1) Raise forks to maximum height and measure oil pressure. Check that oil pressure is 210 kgf/cm². (2987 psi)







2. FAILURE DIAGNOSIS AND TROUBLESHOOTING

1) HYDRAULIC SYSTEM

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

2) HYDRAULIC GEAR PUMP

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

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

* If pump is destructed, replace the assembly.

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

3) 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.
- $\cdot\,$ If desired pressure setting cannot be achieved, add or remove shims as required.
- · Tighten lock nut.
- · Retest in similar manner as above.

Problem	Cause	Remedy
Oil leaks out from rod cover	· Foreign matters on packing.	· Replace packing.
through rod	· Unallowable score on rod.	\cdot Smooth rod surface with an oil stone.
	· Unusual distortion of dust seal.	· Replace dust seal.
	· Chrome plating is striped.	· 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.	· Smooth rod surface with an oil stone.
	· Unallowable score on the inner	· Replace cylinder tube.
	surface of tube.	
	· Foreign matters in piston seal.	· Replace piston seal.
Wear (clearance between	· Excessive clearance between	· Replace wear ring.
cylinder tube and wear ring)	cylinder tube and wear ring.	
Abnormal noise is produced	· Insufficient lubrication of anchor pin	· Lubricate or replace.
during tilting operation	or worn bushing and pin.	
	· Bent tilt cylinder rod.	· Replace.

4) LIFT CYLINDER

GROUP 3 DISASSEMBLY AND ASSEMBLY

Check immediately that any spare parts you receive have not been damaged in shipment. Always work in a clean environment.

Wash all components in solvent and blow dry with compressed air before refitting.

Take care not to damage rubber seals.

Avoid damaging precision machined surfaces.

Components should fit into their housings without excessive force. If force is necessary, this normally means that the component does not have the correct dimensional tolerances of is aligned incorrectly.

When hand pressure is insufficient, only use press or rubber hammer to fit components.

Never strike components with steel hammers.

Steel bush must be fitted only with a suitable press.

Do not use hammers to fit bearings.

Always respect the direction of rotation when assembling components.

1. HYDRAULIC GEAR PUMP

1) STRUCTURE



15BRXHS26

1 Front cover

Driving gear

Inverted gear

2 Body

3

4

- 5 Side plate
- 6
- Bushing 10 Gasket
 - 11 O-ring

- Backup ring 12
- 15 Bolt
- Oil seal 18
- 19 Retaining ring

* Seal kit : 10 (2EA), 11 (1EA), 12 (2EA), 18 (1EA), 19 (1EA)

2) DISASSEMBLY AND ASSEMBLY

- (1) Safety Precautions
 - When pump installation, piping, disassembly for repair and inspection, etc. are required, they shall be performed by the technical expert or performed through instruction by the technical expert.
 - Stop the system operation including the pump for removing the pump, and remove the pipings and devices after the surface of the pump is cooled completely to approximately 40 or less. If not, there may be risk of oil leakage or burn.
 - * Pump shall not be used when the appropriate performance is not shown after re-assembly. Use by force may damage the device or the system.
 - * Discharge the oil when disposing the pump, and handle as industrial waste.
 - * Follow the safety regulations for safe use of the pump.
- (2) Disassembling
 - * Check for oil leakage on the oil seal, pump body and cover joint before disassembling the pump.
 - ▲ Remove the rust, dust and foreign substances on the shaft end and pump body. If not, the parts may be damaged, or it may penetrate into the pump during reassembly for inappropriate diagnosis of the pump.
 - ※ Pump has a symmetrical part. For proper reassembly, the parts are marked through the method indicated on the disassembly procedure before disassembling the pump. Oil paint that does not damage the parts is used for this purpose.
 - ※ Disassembly is a method of discovering the cause of issues. The pump disassembly procedure is followed.
 - * Prepare the new packing, gasket and oil seal before the disassembly.
- ① Fix the front cover mounting part with a vice to enable the body side to be facing upwards.
- 2 Mark the contact section of the front cover (1) and body (2) before the disassembly.
- ③ Loosen 4 bolts (15) and start the disassembly of the parts in order starting from the body. The following instructions shall be followed.
- ④ Mark the shaft end on the body side.
- ⑤ One pair of the side plate (5), type 3 gasket (10) and backup ring (12) is assembled on another direction, so each pair is attached with a tag to distinguish the place of use. (These are indicated as F and B on the diagram.)



⑥ After disassembling the C-type retaining ring, the end of screwdriver is inserted into the oil seal for disassembly.



(3) Assembling

- ① These parts (10, 11, 12, 18, 19) are replaced with new parts.
- ② Each part must be removed with dust before the reassembly.
- ③ The body is placed on the work bench while the holes for the gear are facing upwards.
- ④ Parts are reassembled in order except for the oil seal, retaining ring and bolt.
 - Grease is used to fix the type 3 gasket
 (1) and backup ring (12) to the side plate (5) to prevent the twisting or interlocking.



• Driving gear and inverted gear are fixed according to the joint mark.



- (5) Turn the assembled pup to have the front cover facing down, and the mounting parts are fixed to the vice.
- 6 Fasten 4 bolts in 9.0~9.5 kgf·m torque.
- ⑦ Turn the assembled pump again to have the front cover facing up, and fix the body on the vice.
- ⑧ Fill with grease on the grooved part between the main lip and dust lip on the oil seal.



(9) Use the oil seal guide and oil seal snap to assemble the oil seal on the body.



10 Insert the C-type retaining ring on the hole.



2. MAIN CONTROL VALVE

* 4-spool, ISO type and non-application of the OPSS are used as the standard for description.

1) ASSEMBLY

(1) General

- ① The work space for assembly must be clean without any contamination.
- ② Flat working surface (Within 0.2 mm) is used for bolting with the valve section.
- ③ Calibrated torque wrench and instrument are used.
- 4 Refer to the component manual for the details of the components.

(2) Sub-block



- 1 Inlet block assy
- 2 Lilt block assy
- 3 Tilt block assy
- 4 Aux 1 block assy
- 5 Aux 2 block assy
- 6 Outlet block asy
- 7 Long bolt
- 8 Nut

25BC9U6HS30

- ① All O-rings are assembled to the appropriate groove between the spool sections.
- ② All work ports must be facing up and spool ends must be in the same direction to place the valve section, and all sections are placed on the flat (Within 0.2 mm) surface.
- 3 Tie rod is inserted through the drill hole on each housing.
- ④ Caution is required on preventing the damage of the sealing surface or seal to press with the section.
- (5) Nut is inserted on all tie rod ends for fastening in the diagonal direction in 2.4~2.9 kgf·m torque. It is checked periodically whether the valve is maintained horizontally while the torque is applied.



(3) Inlet section

- ① Install the main relief valve assembly into the lower side cavity of the inlet section, as illustrated. Torque to 4.5~5.0 kgf \cdot m (32.5~36.2 lbf \cdot ft).
- $^{(2)}$ Install the plug assembly in the tank port of the inlet section. Torque to 4.5~5.0 kgf \cdot m (32.5~36.2 lbf \cdot ft)

(4) Lift section

- ① The spool assembly should already consist of the lift spool, the return spring, one spring seat on either end of the spring, the seal plate, a spool seal, and a dust wiper. All of these are assembled on the end of the spool opposite the clevis.
- ② Insert the clevis end of the spool into the right-hand side of the spool bore(the tallest end of the housing). Place the spool cap over the spool and spring assembly and connect the cap to the housing using two bolts. Torque both bolts alternatively until a torque of 1.0~1.5 kgf · m (7.2~10.8 lbf · ft) is reached on both bolts.
- ③ Install the second spool seal and dust wiper over the clevis end of the spool and retain with a seal plate and two bolts. Torque both bolts alternatively until a torque of 1.0~1.5 kgf · m (7.2~10.8 lbf · ft) is reached on both bolts.
- (4) The load check assembly is inserted into the top center cavity. Torque to 3.5~4.0 kgf \cdot m (25.3~30 lbf \cdot ft)
- (5) The normally closed solenoid is installed in the rightmost cavity on the top of the section. Torque to 3.5~ $4.0 \text{ kgf} \cdot \text{m}$ (25.3~ $30 \text{ lbf} \cdot \text{ft}$)
- ⑥ Install the lift lock check valve assembly in the remaining open cavity in the top of the housing. Torque to 4.5~5.0 kgf · m(32.5~36.2 lbf · ft)
- \bigcirc Install the needle valve subassembly in the cavity on the inlet-facing surface of the housing. Torque to 1.0~1.5 kgf \cdot m (7.2~10.8 lbf \cdot ft)



25BC9UHS25

(5) Tilt section

- ① The spool assembly should already consist of the tilt spool(with tilt plunger and spring inserted into the bore on the spring end), the return spring, one spring seat on either end of the spring, the seal plate, a spool seal, and a dust wiper. All of these are assembled on the end of the spool opposite the clevis.
- ② Insert the clevis end of the spool into the right-hand side of the spool bore(the tallest end of the housing). Place the spool cap over the spool and spring assembly and connect the cap to the housing using two bolts. Torque both bolts alternatively until a torque of 1.0~1.5 kgf · m (7.2~10.8 lbf · ft) is reached on both bolts.
- ③ Install the second spool seal and dust wiper over the clevis end of the spool and retain with a seal plate and two bolts. Torque both bolts alternatively until a torque of 1.0~1.5kgf · m(7.2~10.8lbf · ft) is reached on both bolts.
- (4) The load check assembly is inserted into the top center cavity. Torque to 3.5~4.0 kgf \cdot m (25.3~30 lbf \cdot ft).
- ⑤ Install the anti-cavitation check valve in the housing cavity on the clevis end directly above the spool assembly. Torque to 4.5~5.0 kgf ⋅ m (32.5~36.2 lbf ⋅ ft).
- 6 Install the plug in the housing cavity above the spool assembly. Torque to 3.5~4.0 kgf \cdot m (25.3~30 lbf \cdot ft).



25BC9UHS25

(6) Auxiliary section

- * Same procedure for all aux sections, but spool assembly components may vary.
- ① The spool assembly should already consist of the proper aux spool, the return spring, one spring seat on either end of the spring, the seal plate, a spool seal, and a dust wiper. All of these are assembled on the end of the spool opposite the clevis.
- ② Insert the clevis end of the spool into the right-hand side of the spool bore (the tallest end of the housing). Place the spool cap over the spool and spring assembly and connect the cap to the housing using two bolts. Torque both bolts alternatively until a torque of 1.0~1.5 kgf · m (7.2~10.8 lbf · ft) is reached on both bolts.
- ③ Install the second spool seal and dust wiper over the clevis end of the spool and retain with a seal plate and two bolts. Torque both bolts alternatively until a torque of 1.0~1.5 kgf · m(7.2~10.8 lbf · ft) is reached on both bolts.
- (4) The load check assembly is inserted into the top center cavity. Torque to 3.5~4.0 kgf \cdot m (25.3~30 lbf \cdot ft).

(7) Outlet section

1 Install the secondary main relief valve into the cavity on the clevis end of the housing. Torque to 4.5~5.0 kgf \cdot m (32.5~36.2 lbf \cdot ft)

2) DISASSEMBLY

(1) General

- ① Subassemblies (such as relief valves, check valves, and spools) may be removed without having to loosen the tie rods and disassembling the entire valve.
- O Disassemble the valve sections on a flat working surface.
- 3 Ensure that the disassembly area will be clean and free of contamination.
- 4 Keep the disassembly area neat to avoid loss or damage of parts.

(2) Disassembly

- 1 Loosen the tie rod nuts and remove the tie rods from the valve sections.
- ② Remove O-rings between valve sections and set aside to avoid damage.
- ③ Spools, relief valves, load check valves, lift lock poppet, solenoid valves, and plugs can all be removed from the valve sections. Refer to the associated assembly procedures, above, for specific torque and handling details. Inspect and repair or replace the assemblies as complete units, as may be necessary.
- ④ Valve components are precision items, and care must be taken when handing them to avoid damage or the introduction of contamination that could adversely affect performance.

4. LIFT CYLINDER

1) STRUCTURE



22B7HS26

- 1 Tube
- 2 Rod
- 3 Piston
- 4 Piston seal
- 5 Back up ring
- 6 Wear ring
- 7 Retaining ring
- 8 Gland
- 9 Dust wiper
- 10 Rod seal

- 11 O-ring
- 12 Stopper
- 13 DU bushing
- 14 Spacer
- 15 O-ring

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 stopper, then turn the stopper in again and the stopper can be removed.



3) CHECK AND INSPECTION

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

 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 stopper and rotate it to install the stopper completely.



mm (in)

5. TILT CYLINDER

1) STRUCTURE



22B7HS23

- 1 Tube
- 2 Rod
- 3 Piston
- 4 Piston seal
- 5 Dust wiper
- 6 O-ring
- 7 Nylon nut
- 8 Rod cover

- 9 DU bushing
- 10 U-packing
- 11 Back up ring
- 12 Wiper ring
- 13 Stop ring
- 14 O-ring
- 15 Back up ring
- 16 O-ring

- 17 Lock washer
- 18 Rod eye
- 19 Spherical bearing
- 20 Hexagon bolt
- 21 Spring washer
- 22 Lock nut
- 23 Grease nipple
- 24 O-ring

2) DISASSEMBLY

(1) Hold the parallel parts of the cylinder tube bottom in a vice and mark the rod cover end to show how much it is screwed in, then remove the rod cover. Next, hook a wrench into the notch at the rod cover and remove the rod cover from cylinder tube.
When doing this, wind tape round the threaded part of the rod and be careful not to damage the dust seal and rod seal inside rod cover.



3) CHECK AND INSPECTION

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

mm (in)

Group	1	Component location	7-1
Group	2	Electrical circuit ·····	7-2
Group	3	Electric components	7-27

GROUP 1 COMPONENT LOCATION



- 1 Combination switch
- 2 Parking micro switch
- 3 Accelerator assy
- 4 Fan assy
- 5 High horn
- 6 Drive motor
- 7 Contactor
- 8 Fuse box assy
- 9 Pump motor

- 10 Pump controller
- 11 Traction controller
- 12 RMCU assy
- 13 Fan assy
- 14 Contactor
- 15 Back up alarm
- 16 Flasher unit assy
- 17 Relay
- 18 Working lamp (opt)

- 19 Beacon lamp (opt)
- 20 Head lamp switch (opt)
- 21 Working lamp switch (opt)
- 22 Beacon switch (opt)
- 24 Emergency switch assy
- 25 Display
- 26 DC-DC converter

GROUP 2 ELECTRIC CIRCUIT DIAGRAMS

1. CODES IN ELECTRIC CIRCUIT DIAGRAMS

Code	Name
С	Frame harness (manual)
D	Frame harness (fingertip)
E	Dashboard harness
F	Cabin harness
GB	Overhead guard LH harness (LED)
GD	Overhead guard RH harness (LED)
JK	Red zone harness
K	Fingertip harness
L	Armrest harness
ME	RMCU harness
VA	Interlock clamp harness
Y	Lithium harness
ZC	Charging cable RH (Pb)
ZE	Drive motor cable (U)
ZF	Drive motor cable (V)
ZG	Drive motor cable (W)
ZH	Pump motor cable (U)
ZJ	Pump motor cable (V)
ZK	Pump motor cable (W)
ZU	Traction B+ cable
ZV	Pump B+ cable
ZW	L. contactor cable

2. ELECTRIC CIRCUIT DIAGRAMS

1) CONTROLLER AND MOTOR (25BC-9U : -#0002)



1 E UL1569_20_Y/W	→ 5. CD-105/Sensor-Brake oil (2)
-122 E UL1569_20_Or -122a E UL1569_20_Or	→ 4. CS-86/SW-Combi(FNR) (4) → 4. CN-109A/Cont-FNR1 (6)
-133 E UL1569_20_P	→ 4. CS-86/SW-Combi(FNR) (5)

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CONTROLLER AND MOTOR (25BC-9U : #0003-, 30/32BC-9U : #0001-)



411 E UL1569_20_Y/W	→ 5. CD-105/Sensor-Brake oll (2)
122 E UL1569_20_Or	→4. CS-86/SW-Combl(FNR) (4)→4. CN-109A/Cont-FNR1 (6)
133 E UL1569_20_P 133a E UL1569_20_P	→ 4. CS-86/SW-Combl(FNR) (5) → 4. CN-109A/Cont-FNR1 (5)

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2) FUSE BOX (25BC-9U : -#0002)





⇒2. S_P28/ (1) ≥2. S_P29a/ (1)
→ 6. CI-D2-R/Fra-Ftip2 (6) 6. CI-D2-R/Fra-Ftip2 (7)
8. S_126/ (1)
→ 8. S_441/(1)

>> 2. S_T25b/ (1) >> 2. S_T28/ (1) >> 2. S_T28/ (1) >> 2. S_T29/ (1) >> 2. S_7d/ (1)

FUSE BOX (25BC-9U : #0003-, 30/32BC-9U : #0001-)





→ 6. CI-D2-R/Fra-Ftip2 (6) → 6. CI-D2-R/Fra-Ftip2 (7)
UL1569T_C1

2. S_T25/ (1)
 2. CN-32/Cont-Traction (28)
 2. CN-32/Cont-Traction (29)
 2. S_T7/ (1)

3) START AND DRIVE (25BC-9U : -#0002)



у	
DC iverter	
	_

8000 bc C,D UL1569_20_B	
0d C,D UL1569_18_B≫13. S_90/ (1) 43	
e1(UL) (13 214 C,D UL1569_18_W 21b D UL1569_18_W 21c C UL1569_20_W 21d C UL1569_20_W 21d C UL1569_20_W 21f C UL1569_20_W 21f C,D UL1569_20_W 21h C,D UL1569_20_W 21h C,D UL1569_20_W 21h D UL1569_18_W 21h D UL1569_18_W 21h D UL1569_18_W	→ 3. CN-41/Box-Fuse2(UL) (20) → 3. CN-41/Box-Fuse2(UL) (22) → 6. CN-174/Lever-Lift (1) → 6. CN-175/Lever-Tilt (1) → 6. CN-175/Lever-Aux1 (1) → 6. CN-177/Lever-Aux2 (1) → 12. Cl-C10-R/Frame-Limit10 (1) → 5. CS-83/SW-Brake (1) → 5. CS-83/SW-Brake (1) → 7. Cl-D3-R/Fra-Arm4 (4) → 7. Cl-D3-R/Fra-Arm3 (5) → 6. Cl-D2-R/Fra-Ftip2 (1) → 2. CN-33/Cont-Pump (1)

START AND DRIVE (25BC-9U : #0003-, 30/32BC-9U : #0001-)



DC verter	
i	
30000 c C,D UL1569_20_B≫ 13. S_90/ (1)	
d C,D UL1569_18_B	
5.21	
21a C,D UL1569_18_W	UL) (20) UL) (22) 1) 1) 1 (1)
e1(UL) (13211C 0L1569_20_W> 8. CN-17//Level-Aux 21g C,D UL1569_20_W> 12. Cl-Cl0-R/Frame-I 21h C,D UL1569_20_W> 5. CS-83/SW-Brake (* 21k C UL1569_20_W> 6. CS-36A/SW-Tilt lev 21m D UL1569_20_W> 7. Cl-D4-R/Fra-Arm4	2 (1) _imit10 (1) 1) rel1 (1) (4)
21n D UL1569_18_W >> 7. Cl-D3-R/Fra-Arm3 21p D UL1569_18_W >> 6. Cl-D2-R/Fra-Ftip2 (21r C,D UL1569_18_W >> 2. CN-33/Cont-Pump	(5) [1) (1)



SW-Parking (Cluster)



→>> 2. CI-E1-R/Dash-Fra1 (17)

START AND STOP (25BC-9U: #0003-, 30/32BC-9U: #0001-)






5) FINGERTIP, MCV (25BC-9U : -#0002)



F/TIP



7-11

FINGERTIP, MCV (25BC-9U : #0003-, 30/32BC-9U : #0001-)





F/TIP



6) FINGERTIP, ARMREST (25BC-9U : -#0002)



FINGERTIP, ARMREST (25BC-9U : #0003-, 30/32BC-9U : #0001-)



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7) CLUSTER AND SENSOR (25BC-9U : -#0002)



CLUSTER AND SENSOR (25BC-9U : #0003-, 30/32BC-9U : #0001-)





RMCU



RMCU	
G	
N	
-11	
-0	

9) HORN AND SEAT (25BC-9U : -#0002)



SEAT



HORN AND SEAT (25BC-9U : #0003-, 30/32BC-9U : #0001-)





10) LAMP (25BC-9U : -#0002)



LAMP (25BC-9U : #0003-, 30/32BC-9U : #0001-)



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11) FORK AND MAST (25BC-9U : -#0002)

AUTO TILT



SPEED LIMIT



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AUTO TILT



SPEED LIMIT









GND-Frame

G-8 08000





	EARTH (START KEY)	
G-11		
208000		

GROUP 3 ELECTRIC COMPONENTS

1. FUNCTIONS OF BATTERY FORKLIFT TRUCK AND ELECTRIC COMPONENTS

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

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

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

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

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

2. BATTERY

1) STRUCTURE



20BC7EL03

- 1 Cells
- 2 Steel box
- 3 Cell connector
- 4 Common connector
- 5 Row connector
- 6 Positive leading cable

- 7 Negative leading cable
- 8 Plug
- 9 Handle (Red)
- 10 Screw
- 11 Spring washer
- 12 Nut

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.



Item	Unit	25BC-9U 30/32BC-9L	
Туре	_	Lead Acid	
Rated voltage	V	48	
Capacity	AH/hr	740 845	
Electrolyte	_	WET	
Dimension (W×D×H)	mm	996×782×605	996×884×605
Connector	_	SB 350 or SR 350 (SBE 320 BLUE)	
Weight	kg	1180 1410	

3) SPECIFICATION AND SERVICE DATA

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

4) SAFETY PRECAUTIONS

(1) When sulfuric acid contact with skin

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

(2) Strict prohibition of fire and ventilation

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

(3) Never place metallic articles on the batteries

If done so, it may cause "short circuit" accidents (dangerous especially while charging) (Especially dangerous while charging).

Sparks will be generated which is equally dangerous as open fires.

(4) Handling of charger

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

5) OPERATION PRECAUTIONS

(1) Avoid over-discharge

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

(2) Avoid over-charge

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

(3) Avoid excessive elevation of temperature

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

6) CHECKING

(1) Unpacking

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

(2) Performance and maintenance of batteries

1 Initial charge

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

a. By modified constant voltage charger

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

b. By constant voltage constant current charger (standard)

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

c. By constant current charger

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

- \cdot When a constant value is indicated for more than 1 hour after the battery voltage has reached the maximum value.
- \cdot When more than 1 hour of charge is continued after the electrolyte specific gravity has risen fully and becomes constant.

② Discharge and capacity

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

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

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

③ Specific gravity of electrolyte

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

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

Where, S25 : Specific gravity at 25°C

- St~ : Actually measured specific gravity at t°C $\,$
- t : Electrolyte temperature (°C)

The standard specific gravity for this type of battery is $1.280\pm0.01(25^{\circ}C)$ at full charge condition. If the electrolyte is decreased naturally while using, distilled water shall be replenished up to the specified level. (Never refill sulfuric acid).

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

④ Normal charge

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

a. Charging by modified constant voltage automatic charger

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

b. Charging by constant current constant voltage automatic charger

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

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

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

c. Charging by constant current charger

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

5 Equalizing charge

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

6 Replenishment of distilled water

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

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

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

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



\bigcirc Cleaning

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

8 Notice on charging

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

9 Repair of failure cell

- a. To remove a cell from the circuit or battery from steel tray, it is first necessary that the intercell connector be removed.
- b. Before performing any repairs, you must open one-touch caps for gas purging of all cells. After you have finished that, must remove connector covers and on-touch caps from failure cell including surrounding cells. All vent holes of cells removed of one-touch caps must cover by four layers of water dampened cloth and then proceed with repairs. Using an acid syringe withdraw sufficient electrolyte from failure cell to reduce the liquid levels until minimum level indicating of one touch caps.
- c. The safe and most efficient method of removing a connector from failure cell as well as all surrounding cells is with hand or electric drill (25 mm).
- ▲ You must make sure to clear of explosive hydrogen gas in the cells before repairs. Be careful not to drill to far into the cell and damage the unit. During drilling operation make sure lead curls produced do not contact opposite cell poles and cause a spark.
- d. Upon completion of drilling the intercell connectors, can be lifted off.
- e. Lifted off the failure cell from circuit after removing of intercell connector.
- f. Installing new cell and connector.
- g. With surfaces properly cleaned and neutralized, position the connectors.
- h. Place damp rags around each lead head. Hold tip of the welder in center of post move welder completely around top of post and out to the area where the post meets the connector. Move welder back to center of post and add molten lead until area is filled to top of connector. Again, move welder completely around area, with tip on molten lead. If you have jig for welding connector, have easier and better welding work.
- i. When replacing electrolyte in a repaired cell, use sulphuric acid of the same specific gravity that is found in the balance of the battery.
- j. Finally, rejoin connector covers and one-touch caps to the cells.

10 Summary of daily maintenance

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

(3) Others

1 Storage of batteries

When batteries are stored, keep them away from room heaters or other heat generating sources. Clean, cool and dry place where no direct sunlight is suited for battery storage. Before putting into storage, it is important to charge the batteries and keep the electrolyte level at the specified level.

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

2 Maintenance record

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

③ Electrolyte temperature

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

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

7) TROUBLESHOOTING

Nature of trouble	Symptoms	Causes	Corrective Action
Deformation	 Deformation of container. Lid or one touch cap 	· Excessive temperature rising or external impact	· Replace
Breakage	 Electrolyte leakage acco- rding to breakage of cont- ainer, lid or one touch cap Termination of connector or polo post atc. 	 External impact, improper handling, excessive vibrat- ion Excessive temperature rising or external impact 	 Replace or install a new one Replace
Sulfate	 Specific gravity drops and capacity is decreased. 	 When left in state of disch- arge or left long without equalizing charge. 	• Need equalizing charge
	 Charge voltage rises rapi- dly with immature gassing in earlier stage but specific gravity does not rise and 	 Insufficient charge. When electrolyte is so decreased that plate is deposed. 	 Need equalizing charge Need equalizing charge
	charge can't be carried out.	 When concentration of electrolyte rises. When impurities are mixed in electrolyte. 	 Adjust specific gravity Replace electrolyte
Decrease and falling of specific gravity	 May be easily detected by measurement of the spec- ific gravity. 	 Rise of temperature due to such trouble. When left long period with- out refilling of water. Short circuit. 	 Replace Refill water in regular per- iod Replace
Rise of specific gravity	 May be easily detected by measurement of the spec- ific 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
- 2 Stator assy
- 3 Endbell
- 4 End cap

- 5 Bearing
- 6 Bearing
- 7 Stud bolt
- 8 Terminal block
- 9 Speed sensor kit
- 10 Temperature sensor

2YBD-92080

- 11 Terminal protector
- 12 Oil seal

2) SPECIFICATION

Item	Unit	Specification
Туре	-	ASRH4002
Rated voltage	Vac	30
Rated output	kW	14
Insulation	-	Class F

3) MAINTENANCE INSTRUCTION

* Before starting the maintenance please disconnect the power supply.

(1) Ball bearing

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

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

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

(2) Disassembly and assembly

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

4. PUMP MOTOR

1) STRUCTURE



- Rotor assy 1
- 2 Stator assy
 - Endbell
- Endbell 4

3

- Terminal block 5
- 6 Speed sensor kit
- 7 Stud bolt
- 8 Terminal protector

- 21FH-92020
- Bearing 9
- Oil seal 10
 - Flange nut 11

2) SPECIFICATION

ltem	Unit	Specification
Туре	-	AMDL4001
Rated voltage	Vac	30
Rated output	kW	17
Insulation	-	Class F

3) INTERNAL INVOLUTE SPLINE DATA

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

4) MAINTENANCE INSTRUCTION

* Before starting the maintenance please disconnect the power supply.

(1) Ball bearing

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

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

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

(2) Disassembly and assembly

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

5. CONTROLLER SYSTEM

1) STRUCTURE



Fingertip controller



25BC9U7EL10

Model	Model	Application	Туре	Power	Current limit
	CURTIS 1236SE-5621	Traction	MOSFET	36-48V, 600A	600A/3 min
25/30/32BC-9U	CURTIS 1236SE-5621	Pump	MOSFET	36-48V, 600A	600A/3 min
	CURTIS 1353-6101	Fingertip	Valve controller	36-80V, 70A	-

2) OPERATIONAL FEATURES (TRACTION AND PUMP CONTROLLER)

(1) Features

- The controller controls closed circuit speed and torque for induction (ACIM) and surface permanent magnet (SPM) motor.
- · Field-oriented motor control algorithm of high efficiency capable of exerting max. motor torque in any working environments
- Hi-end pulse-width modification technology ensuring efficient consumption of battery voltage, low motor harmonics, low torque ripple, and min. conversion loss
- · Very large-scope torques and speeds including full playing function
- · Smooth low-speed control including zero speed
- ACIM motor mitigating field, an d SPM motor capable of controlling speeds including non-load basic speed

Control algorithm is applied to motor temperature variation for keeping optimal capabilities in conditions of wide range and high diversity.

- Power limit map reduces heat generated from motor, and is capable of satisfying capability requirements for keeping capability constant under various battery charging conditions.
- · The functions of overheat prevention, warning and auto stop protect motor and controller.
- · Power base of metal insulation substrate of excellent heat transfer enhances reliability.
- · Embedded auto characterization routine for optimizing trucks for motor capabilities and efficiency
- Powerful operating system is capable of performing control of truck and motor, and parallel processing of user-defined programmable logic (VCL).
- · Wide-range input/out are applied whenever required for controlling distributed systems to the largest extent.
- · Embedded dual drive software easily sets and controls of common dual drive trucks without VCL.
- · Battery charging indicator, hour meter and service timer
- · CANopen compatible with CAN bus (CAN bus protocol configured through VCL)
- · Increased CAN master capabilities (VCL execution speed and code space)
- · Field programming mode allowing flash download of main operation codes.
- · Programming facilitated by portable Curtis 1311 programmer, and 1314 PC programming.
- Stubbornly sealed housing and connector satisfy IP65 environmental sealing standards in severe environments.
- · Compliant with 2006/42/EC and EN13849

3) DESCRIPTION OF THE CONNECTORS

(1) Traction and pump controller

Every low-power connection is connected through single 35-in AMPSEAL connector.

Plug housing for coupling is AMP P/N 776164-1, and contact pin is AMP P/N 770520-3.

Connector accommodates 0.5-1.25 mm (20-16 AWG) wire having thin wall insulator of 1.7-2.7 mm diameter. The wire is sealed in unused connector of silo-diagram together with seal plug 77068-1.



25BX7ES11

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

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

(2) Fingertip controller

Every low-power connection is connected through single 23-in AMPSEAL connector.

Plug housing for coupling is AMP P/N 770680-1, and contact pin is AMP P/N 770520-3.

Connector accommodates 1.7-2.7 mm (20-16 AWG) wire having thin wall insulator of 1.7-2.7 mm diameter.

Pins of 1353 are not sealed until connector is fully latched and locked. Cable harness connector include silicone rubber, an essential part for module sealing.



25BX7ES11

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

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

(3) Encoder connection (drive and pump)

Two control lines are configured inside for reading quadrature type position encoder. Power supply of encoder is commonly 5V (Pin 26) or 12V (Pin 25), and power can be supplied by 5V - B+ by external source only when logic critical value is satisfied.

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

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



25BX7ES12
4) PROGRAMING AND ADJUSTMENT

It is allowed to adjustment parameters through portable 1313 programmer or cluster. *** Refer to Display Section for adjustment of variables on cluster. (page 7-75)**

Adjusting with portable programmer (opt)

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



(1) Connected

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



desired soft key menu.

25BX7ES15

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

(2) Key description



25BX7ES16

(3) How to adjust variables

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

(4) Monitor

This menu displays real-time values. Refer to the user's manual of the controller for description of the values. This menu is useful for setup, testing, diagnosis and troubleshooting. (see page 7-80.)

Diagnosis

(5) This menu displays current errors and defects records. (see page 7-52.)

5) SAFETY INSTRUCTIONS

- · Make sure that battery is disconnected before use.
- Driving wheel should be prompted or deactivated during driving to prevent unexpected operation or moving in wrong direction during initial startup of the truck. Open the value during hydraulic operation to prevent excessive rise of pressure if the relief valve pressure malfunctions.
- · Prerequisite actions should be taken for safety for ensuring prevention of damage to workers or equipments.
- The inside battery is kept charged for a certain period even when the key switch is kept open after starting operation. Separate the battery for safety drive, and use resistance of 10-100 Ω to make short circuit between power terminals of positive and negative electrodes of the inverter battery.

6. CLUSTER

1) TRUCK MENU

(1) Access to truck menu



2) ALARMS AND 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 "ENTER", "ESC" buttons as follows :



(2) Detail description of ALARM SCREEN



15BRXEL25

First green capital letter shows in which controller the alarm happens as below;

- T : Traction, P : Pump
- O Following two digits show alarm code.

③ This shows a name of ALARM.

(3) Alarm history

Alarm History can be looked up as follows ;



- ① Step 1 : Service man can check the alarm history on ALARM HISTORY menu in Maintenance menu.
- ② Step 2 : Service man can choose each controller to read the alarm history.
- ③ Step 3 : service man can check simply up to 20 alarms and see detail alarm information.
- ④ Step 4 : When service man press "Enter" button at Step 3, service man can see a alarm clear menu. If service man press "Enter" button, Recorded alarms of selected controller will be erased.

If operator press "ESC" button, just escape to step 3 without clearing

(4) Alarm code

- ① Drive and pump controller (manual)
- * SET conditions : It is the conditions that the fault occurs.
- * CLEAR conditions : It is the conditions to clear the fault.
- * Cycle KSI : Truck key off and on
- * Cycle interlock :

: Seat switch on (In case of truck equipped with optional seat belt switch, seat switch ON and belt switch ON))

Code	Alarm	Traction	Pump	Possible cause	Set/clear conditions
18	Controller Overcurrent	0	0	 External short of phase U,V, or W motor connections. Motor parameters are mis-tuned. Controller defective. Speed encoder noise problems. 	Set : Phase current exceeded the current measurement limit. Clear : Cycle KSI.
19	Current Sensor Fault	0	0	 Leakage to vehicle frame from phase U, V, or W (short in motor stator). Controller defective. 	Set : Controller current sensors have invalid offset reading. Clear : Cycle KSI.
20	Precharge Failed	0	0	 See Monitor menu » Battery: Capacitor Voltage. External load on capacitor bank (B+ connection terminal) that prevents the capacitor bank from charging. 	Set : The precharge failed to charge the capacitor bank. Clear : Cycle Cycle Interlock input.
21	Controller Severe Undertemp	0	0	 See Monitor menu » Controller: Temperature. Controller is operating in an extreme environment. 	Set : Heatsink temperature below -40°C. Clear : Bring heatsink temperature above -40°C, and cycle interlock or KSI.
22	Controller Severe Overtemp	0	0	 See Monitor menu » Controller: Temperature. Controller is operating in an extreme environment. Excessive load on vehicle. Improper mounting of controller. 	Set : Heatsink temperature above +95°C. Clear : Bring heatsink temperature below +95°C, and cycle interlock or KSI.

* Please see the diagnostics menu with CURTIS 1313 hand programer to know which error (B+ or KSI) occurred when the code 18 is occurred.

Code	Alarm	Traction	Pump	Possible cause	Set/clear conditions
23	Severe B+ Undervoltage	0	0	 Battery parameters are misadjusted. Non-controller system drain on battery. Battery resistance too high. Battery disconnected while driving. See Monitor menu » Battery: Capacitor Voltage. Blown B+ fuse or main contactor did not close. 	Set : Capacitor bank voltage dropped below the Severe Undervoltage limit with FET bridge enabled. Clear : Bring capacitor voltage above Severe Undervoltage limit *Severe Undervoltage = Either drive current cut back to 0% for 64 ms or Brownout Voltage is reached, whichever comes first.
	Severe KSI Undervoltage	0	0	 See Monitor menu » Battery: Keyswitch Voltage. Non-controller system drain on battery/KSI circuit wiring. KSI disconnected while driving. Blown KSI fuse. 	Set : When below Brownout Voltage for 2 seconds. Clear : Bring KSI voltage above Brownout Voltage.
04	Severe B+ Overvoltage	0	0	 See Monitor menu » Battery: Capacitor Voltage. Battery parameters are misadjusted. Battery resistance too high for given regen current. Battery disconnected while regen braking. 	Set : Capacitor bank voltage exceeded the Severe Overvoltage limit with FET bridge enabled. Clear : Bring capacitor voltage below Severe Overvoltage limit, and then cycle KSI.
24	Severe KSI Overvoltage	(SI O O	 Incorrect (to high) battery-voltage applied to KSI (pin 1) See Monitor menu » Battery: Keyswitch Voltage. Note: Prevents the Main Contactor closure if KSI is greater than the Severe Overvoltage limit. 	Set : KSI voltage exceeded Severe Overvoltage limiit Clear : Bring KSI voltage below the Severe Overvoltage limit.	
34	Controller Overtemp Cutback	0	0	 See Monitor menu » Controller: Temperature. Controller is performance-limited at this temperature. Controller is operating in an extreme environment. Excessive load on vehicle. Improper mounting of controller. 	Set : Heatsink temperature exceeded 85°C. Clear : Bring heatsink temperature below 85°C.

Code	Alarm	Traction	Pump	Possible cause	Set/clear conditions		
35	B+ Undervoltage Cutback	0	0	 Normal operation. Fault indicates the batteries need recharging. Controller is performance limited at this voltage. Battery parameters are misadjusted. Non-controller system drain on battery. Battery resistance too high. Battery disconnected while driving. See Monitor menu » Battery: CapacitorVoltage. Blown B+ fuse or main contactor did not close. 	Set : Capacitor bank voltage dropped below the Undervoltage limit with the FET bridge enabled. Clear : Bring capacitor voltage above the Undervoltage limit.		
36	B+ Overvoltage Cutback	0	0	 Normal operation. Fault shows that regen braking currents elevated the battery voltage during regen braking. Controller is performance limited at this voltage. Battery parameters are misadjusted. Battery resistance too high for given regen current. Battery disconnected while regen braking. See Monitor menu » Battery: Capacitor Voltage. 	Set : Capacitor bank voltage exceeded the Overvoltage limit with the FET bridge enabled. Clear : Bring capacitor voltage below the Overvoltage limit.		
* Ove	* Overvoltage = Either Max Voltage (see Table D-1) or User Overvoltage × Nominal Voltage, whichever is lower.						
* Sev	/ere Overvoltage =	Over	voltag	e (see previous item) + 10V.	ade x Nominal Voltade, whichever in		
	higher.						
∦ Sev	/ere Undervoltage =	Eithe reac	er driv hed. v	ve current cut back to 0% for 64 ms or whichever comes first.	Brownout Voltage * (see Table D-1) is		
N	Jominal voltage	Min v	/oltag	e Max voltage Brownout voltage			

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

Code	Alarm	Traction	Pump	Possible cause	Set/clear conditions
37	+5V Supply Failure	0	0	 External load impedance on the +5V supply (pin 26) is too low. See Monitor menu » outputs: 5 Volts and Ext Supply Current. 	Set : +5V supply (pin 26) outside the 5 V±10% range. Clear : Bring voltage within range.
38	Digital Out 6 Open/Short	0	0	1. External load impedance on Digital Output 6 driver (pin 19) is too low.	Set : Digital Output 6 (pin 19) current exceeded 1 Amp. Clear : Remedy the overcurrent cause.
39	Digital Out 7 Open/Short	0	0	1. External load impedance on Digital Output 7 driver (pin 20) is too low.	Set : Digital Output 7 (pin 20) current exceeded 1 Amp. Clear : Remedy the overcurrent cause.
40	Motor Temp Hot Cutback	0	0	 Motor temperature is at or above the programmed Temperature Hot setting, and the current is being cut back. Motor Temperature Control Menu parameters are mis-tuned. See Monitor menu » Motor: Temperature and » Inputs: Analog2. If the application doesn't use a motor thermistor, Temp Compensation and Temp Cutback should be programmed Off." 	Set : Motor temperature is at or above the Temperature Hot parameter setting. Clear : Bring the motor temperature within range.
41	Motor Temp Sensor Fault	0	0	 Motor thermistor is not connected properly. If the application doesn't use a motor thermistor, Motor Temp Sensor Enable should be programmed Off. See Monitor menu » Motor: Temperature and » Inputs: Analog2." 	Set : Motor thermistor input (pin 8) is at the voltage rail (0 V or 10 V). Clear : Bring the motor thermistor input voltage within range.
	Coil1 Driver Open/Short	0	0	 Open or short on driver load. Dirty connector pins. Bad crimps or faulty wiring. 	Set : Driver 1 (pin 6) is either open or shorted. This fault can be set only when Main Enable = Off. Clear : Correct open or short, and cycle driver.
49	Main Open/Short	0	0	 Open or short on driver load. Dirty connector pins. Bad crimps or faulty wiring. 	Set : Main contactor driver (pin 6) is either open or shorted. This fault can be set only when Main Enable = On. Clear : Correct open or short, and cycle driver

Code	Alarm	Traction	Pump	Possible cause	Set/clear conditions
	Coil2 Driver Open/Short	0	0	 Open or short on driver load. Dirty connector pins. Bad crimps or faulty wiring. 	Set : Driver 2 (pin 5) is either open or shorted. This fault can be set only when EM Brake Type = 0. Clear : Correct open or short, and cycle driver.
50	EMBrake Open/ Short	0	0	 Open or short on driver load. Dirty connector pins. Bad crimps or faulty wiring. 	Set : Electromagnetic brake driver (pin 5) is either open or shorted. This fault can be set only when EM Brake Type >0. Clear : Correct open or short, and cycle driver.
51	Coil3 Driver Open/Short	0	0	 Open or short on driver load. Dirty connector pins. Bad crimps or faulty wiring. 	Set : Driver 3 (pin 4) is either open or shorted. Clear : Correct open or short, and cycle driver.
52	Coil4 Driver Open/Short	0	0	 Open or short on driver load. Dirty connector pins. Bad crimps or faulty wiring. 	Set : Driver 4 (pin 3) is either open or shorted. Clear : Correct open or short, and cycle driver.
53	PD Open/Short	0	0	 Open or short on driver load. Dirty connector pins. Bad crimps or faulty wiring. 	Set : Proportional driver (pin 2) is either open or shorted. Clear : Correct open or short, and cycle driver.
54	Encoder Fault	0	0	 Motor encoder failure. Bad crimps or faulty wiring. See Monitor menu » Motor: Motor RPM. 	Set : Motor encoder phase failure detected. This fault can be set only when Feedback Options = 1(Encoder). Clear : Either cycle KSI, or if parameter LOS Upon Encoder Fault = On and Interlock has been cycled, then the Encoder Fault is cleared and Encoder LOS fault (code 93) is set, allowing limited motor control.
	Sin/Cos Sensor Fault	0	0	 Sin/Cos sensor failure. Bad crimps or faulty wiring. See Monitor menu » Motor: Motor RPM. 	Set : Greater than Sin_Cos_ Fault_Threshold % difference from expected value between two phases seen 5 times within one second. This fault can be set only when Feedback Options = 2(Sin/Cos). Clear : Cycle KSI or Entry into LOS mode if enabled. *Feedback Options is 1(Encoder) in BC-9U

Code	Alarm	Traction	Pump	Possible cause	Set/clear conditions
55	Motor Open	0	0	 Motor phase is open. Bad crimps or faulty wiring. 	Set : Motor phase U, V, or W detected open. Clear : Cycle KSI.
56	Main Contactor Welded	0	0	 Main contactor tips are welded closed. Motor phase U or V is disconnected or open. An alternate voltage path (such as an external precharge resistor) is providing a current to the capacitor bank (B+ connection terminal). 	Set : Just prior to the main contactor closing, the capacitor bank voltage (B+ connection terminal) was loaded for a short time and the voltage did not discharge. Clear : Cycle KSI.
57	Main Contactor Did Not Close	0	0	 Main contactor did not close. Main contactor tips are oxidized, burned, or not making good contact.* External load on capacitor bank (B+ connection terminal) that prevents capacitor bank from charging. Blown B+ fuse. 	Set : With the main contactor commanded closed, the capacitor bank voltage (B+ connection terminal) did not charge to B+. Clear : Cycle KSI.
65	Throttle Wiper High	0	0	 See Monitor menu » Inputs: Throttle Pot. Throttle pot wiper voltage too high. 	Set : Throttle pot wiper (pin 16) voltage is higher than the high fault threshold. Clear : Bring throttle pot wiper voltage below the fault threshold.
66	Throttle Wiper Low	0	0	 See Monitor menu » Inputs: Throttle Pot. Throttle pot wiper voltage too low. 	Set : Throttle pot wiper (pin 16) voltage is lower than the low fault threshold. Clear : Bring throttle pot wiper voltage above the fault threshold.
67	Pot2 Wiper High	0	0	 See Monitor menu » Inputs: Pot2 Raw. Pot2 wiper voltage too high. 	Set : Pot2 wiper (pin 17) voltage is higher than the high fault threshold. Clear : Bring Pot2 wiper voltage below the fault threshold.
68	Pot2 Wiper Low	0	0	 See Monitor menu » Inputs: Pot2 Raw. Pot2 wiper voltage too low. 	Set : Pot2 wiper (pin 17) voltage is lower than the low fault threshold. Clear : Bring Pot2 wiper voltage above the fault threshold.
69	Pot Low OverCurrent	0	0	 See Monitor menu » Outputs: Pot Low. Combined pot resistance connected to pot low is too low. 	Set : Pot low (pin 18) current exceeds 10 mA. Clear : Clear pot low overcurrent condition and cycle KSI. *Pin18 is not used in BC-9U. Pin18 is for the resistance accelerator type only.

Code	Alarm	Traction	Pump	Possible cause	Set/clear conditions
70	EEPROM Failure	0	0	 Failure to write to EEPROM memory. This can be caused by EEPROM memory writes initiated by VCL, by the CAN bus, by adjusting parameters with the programmer, or by loading new software into the controller. 	Set : Controller operating system tried to write to EEPROM memory and failed. Clear : Download the correct software (OS) and matching parameter default settings into the controller and cycle KSI.
	HPD/ Sequencing Fault	0	0	 KSI, interlock, direction, and throttle inputs applied in incorrect sequence. (eg. KEY ON with forward or backward switch on) Faulty wiring, crimps, or switches at KSI, interlock, direction, or throttle inputs. See Monitor menu » Inputs. 	Set : HPD (High Pedal Disable) or sequencing fault caused by incorrect sequence of KSI, interlock, direction, and throttle inputs. Clear : Re-apply inputs in correct sequence.
71	Emer Rev HPD	0	0	 Emergency Reverse operation has concluded, but the throttle, forward and reverse inputs, and interlock have not been returned to neutral. 	Set : At the conclusion of Emer gency Reverse, the fault was set because various inputs were not returned to neutral. This fault can be set only when EMR_Interlock = On. Clear : If EMR_Interlock = On, clear the interlock, throttle, and direction inputs. If EMR_ Interlock = Off, clear the throttle and direction inputs. *EMR_Interlock is OFF in BC-9U.
73	Parameter Change Fault	0	0	 This is a safety fault caused by a change in certain parameter set- tings so that the vehicle will not operate until KSI is cycled. For example, if a user changes the Throttle Type this fault will appear and require cycling KSI before the vehicle can operate. 	Set : Adjustment of a param eter setting that requires cycling of KSI. Clear : Cycle KSI.

Code	Alarm	Traction	Pump	Possible cause	Set/clear conditions
	CAN Communications Fault	0		 Bad crimps or faulty wiring be- tween traction and pump control- ler. Dirty connector pins. Pump controller failure. 	Set : CAN communication Fault between traction and pump when cycling KSI. Traction con- troller checks the pump CAN message when cycling KSI and If there is a fault with the check, the alarm will occur. Clear : Cycle KSI.
81	Level HPD Fault		0	 KSI, interlock, direction, and throttle inputs applied in incorrect sequence. (eg. KEY ON while pulling the lift lever) 	Set : HPD (High Pedal Disable) or sequencing fault caused by incorrect sequence of KSI, interlock, direction, and throttle inputs The manual Lever or finger tip is operated before power-on. Clear : Re-apply inputs in correct sequence. Release the finger tip and manual lever to neutral state
	Pump CAN PDO Timeout	0		 Bad crimps or faulty wiring be- tween traction and pump control- ler. Dirty connector pins. Pump controller failure. 	Set : Time between CAN PDO messages from pump control- ler received exceeded the PDO Timeout Period. Clear : Cycle KSI or receive CAN NMT message.
82	Pump Level PDO Timeout	0 Ier. 2. Dirty connector pins. 3. Pump controller failure. 0 I. KSI, interlock, direction, and throttle inputs applied in incorrect sequence. (eg. KEY ON while pulling the lift lever) Set 0 I. Bad crimps or faulty wiring between traction and pump controller. Set 0 I. Bad crimps or faulty wiring between traction and pump controller. Set 0 I. Bad crimps or faulty wiring between traction and pump controller. Set 1 Bad crimps or faulty wiring between pump and fingertip controller. Set 0 I. Bad crimps or faulty wiring between pump and fingertip controller. Set 0 I. Bad crimps or faulty wiring between pump and fingertip controller. Set 0 I. Accelerator pedal failure. Set 0 I. Accelerator menu » Inputs: Throttle Pot. Set 0 I. KSI, interlock, direction, and throttle inputs applied in incorrect sequence. (eg. Pulling the lift lever without s	Set : Time between CAN PDO mes sages from fingertip controller received exceeded the PDO Timeout Period. The checked time that CAN data from finger tip Subcon- troller is over 500ms Clear : Cycle KSI or receive CAN NMT message. Check the CAN bus and make the finger Subcontroller PDO cycle time normal		
	Accel Pedal A&B Fault	0		 Accelerator pedal failure. Bad crimps or faulty wiring. See Monitor menu » Inputs: Throttle Pot. See Monitor menu » Inputs: Pot2 Raw. 	Set : It occurs when the sum of Throttle Pot and Pot2 Raw input voltages do not match the supply voltage of the sensor. Clear : Cycle KSI.
83	Pump SRO Fault		0	 KSI, interlock, direction, and throttle inputs applied in incorrect sequence. (eg. Pulling the lift lever without seat switch on) The manual Lever or finger tip is operated before the seat switch is on" 	Set : HPD (High Pedal Disable) or sequencing fault caused by incorrect sequence of KSI, interlock, direction, and throttle inputs. Clear : Re-apply inputs in cor rect sequence. Release the finger tip and manual lever to neutral state

Code	Alarm	Traction	Pump	Possible cause	Set/clear conditions
84	BMS PDO TimeOut	0		 Bad crimps or faulty wiring between traction controller and BMS(Battery Management Sys- tem) 	Set : Time between CAN PDO mes sages from BMS(Battery Management System) received exceeded the PDO Timeout Period. Clear : Cycle KSI or receive CAN NMT message.
	SASA PDO Timeout			1. Bad crimps or faulty wiring be- tween pump controller and SASA steering sensor.	Set : Time between CAN PDO mes sages from SASA steering sensor received exceeded the PDO Timeout Period. Clear : Cycle KSI or receive CAN NMT message.
ł	Break oil	0		 Lack of brake oil. Brake oil sensor failure. Bad crimps or faulty wiring. See Monitor menu » Inputs: Switch (Traction controller)" 	Set : It occurs when switch (Pin10) in the traction controller is On. Clear : Check the brake oil tank & sensor.
00	Tilt Sensor Fualt		0	1. Tilt Lever or Tilt Sensor Fault	Set : The tilt sensor voltage is out of range Clear : Check the sensor(Pump controller Pin 24) wiring or adjust the related parameters
86	Battery Out	0		 SBR(Side Battery Removal) switch is opened. SBR switch failure. Bad crimps or faulty wiring. See Monitor menu » Inputs: Switch 16 (Traction controller) 	Set : It occurs when switch 16 (pin14) in the traction controller is Off. Clear : Check the SBR switch.
	Lift Pot Fault		0	1. Lift Lever or Lift Sensor Fault	Set : The lift pot voltage is out of range Clear : Check the lift pot wiring(Pump Controller Pin 16) or adjust the related parameters
	BMS Not Ready	0		1. The battery monitoring system is in BMS NOT READY status.	Set : The battery monitoring system is in BMS NOT READY status. It is received through CAN mgs. Clear : Check the BMS(Battery Man agement System).
87	Fingertip CAN PDO Timeout		0	 Fintertip Controller Fault CAN Line Fault 	Set : The checked time that CAN data from Fingertip Controller is over 500ms Clear : Check the CAN bus line and make the Fingertip CAN PDO cycle time normal

Code	Alarm	Traction	Pump	Possible cause	Set/clear conditions
88	BMS Warning 0	0		1. The battery monitoring system is in WARNING 0 status.	Set : The battery monitoring system is in WARNING 0 status. It is received through CAN mgs. Clear : Check the BMS (Battery Man agement System).
	Traction CAN PDO Timeout	0		 Traction Controller Fault CAN Line Fault 	Set : The checked time that CAN data from Traction controller is over 500ms Clear : Check the CAN bus and make the Traction controller CAN PDO cycle time normal
	Wrong Model Display	0		Not used.	Not used.
89	Incorrect Start (Lever, Seat, Belt)		0	1. incorrect seat belt sequence state	Set : The manual Lever or finger tip is operated in incorrect seat belt sequence state Clear : Release the finger tip and manual lever to neutral state and loosen the seat belt or operate it in correct sequence
97	Unmatched Dis- play	0		Not used.	Not used.
98	BMS Warning 1	0		1. The battery monitoring system is in WARNING 1 status.	Set : The battery monitoring system is in WARNING 1 status. It is received through CAN mgs. Clear : Check the BMS (Battery Man agement System).
99	BMS Fault	0		1. The battery monitoring system is in FAULT status.	Set : The battery monitoring system is in FAULT status. It is re- ceived through CAN mgs. Clear : Check the BMS (Battery Man agement System).
100	Release Parking Brake	0		1. Incorrect Start Sequence state (when occur throttle On Parking)	Set : The parking switch is off but the throttle is in operated volt- age range Clear : Check the SBR switch.
101	Incorrect Start (Fwd/Rev, Accel)	0		 Incorrect Start Sequence state (Fwd/Rev/Throttle SRO Fault) 	Set : 1. The fwd, rev switch or throttle is operated before power-on 2. The fwd, rev or throttle is operated before the seat switch is on Clear : Release the throttle to deadband state and reset the fwd & rev to neutral state

Code	Alarm	Traction	Pump	Possible cause	Set/clear conditions
102	Incorrect Start (Fwd/Rev, Accel)	0		 Incorrect Start Sequence state (Fwd/Rev Exchange Timeout) 	Set : When the throttle is operated but the direction switch exchange time is over Direction Exchange Delay Clear : Release the throttle to deadband state or Exchange slowly.
103	Incorrect Start (Seat, Belt)	0		1. Incorrect Start Sequence state (Safety Belt SRO Fault)	Set : Incorrect seat belt operation sequence Clear : Reset the fwd & rev to neutral state
104	VCL Run Time Error	0	0	 VCL code encountered a runtime VCL error. See Monitor menu » Controller: VCL Error Module and VCL Er- ror. This error can then be compared to the runtime VCL module ID and error code definitions found in the specific OS system infor- mation file. 	Set : Runtime VCL code error condi tion. Clear : Edit VCL application software to fix this error condition; flash the new compiled software and matching parameter defaults; cycle KSI.
105	External Supply Out of Range	0	0	 External load on the 5V and 12V supplies draws either too much or too little current. Fault Checking Menu parameters Ext Supply Max and Ext Supply Min are mis-tuned. See Monitor menu » Outputs: Ext Supply Current. 	Set : The external supply current (combined current used by the 5V supply [pin 26] and 12V supply [pin 25]) is either greater than the upper current threshold or lower than the lower current threshold. Clear : Bring the external supply current within range. *External Supply Max is 200mA in BC-9U.
113	OS General	0	0	1. Internal controller fault.	Set : Internal controller fault detected. Clear: Cycle KSI.
114	PDO Timeout	0	0	1. Time between CAN PDO messages received exceeded the PDO Timeout Period.	Set : Time between CAN PDO messages received exceeded the PDO Timeout Period. Clear : Cycle KSI or receive CAN NMT message.
115	Stall Detected	0	0	 Stalled motor. Motor encoder failure. Bad crimps or faulty wiring. Problems with power supply for the motor encoder. See Monitor menu » Motor: Motor RPM. 	Set : No motor encoder movement detected. Clear : Either cycle KSI, or if parameter LOS Upon Encoder Fault = On and Interlock has been cycled, then the Stall Detected fault is cleared and Encoder LOS fault (code 93) is set, allowing limited motor control.

Code	Alarm	Traction	Pump	Possible cause	Set/clear conditions
116	Fault On Other Traction Controller	0	0	1. Dual Drive fault : see Dual Drive manual.	*BC-9U has a single drive.
117	Dual Severe Fault	0	0	1. Dual Drive fault : see Dual Drive manual.	*BC-9U has a single drive.
119	Supervisor Fault	0	0	 The Supervisor has detected a mismatch in redundant readings. Internal damage to Supervisor microprocessor. Switch inputs allowed to be within upper and lower thresholds for over 100 milliseconds. (for recurring errors, check the switches for moisture). 	Set : Mismatched redundant readings; damaged Supervisor; illegal switch inputs. Clear : Check for noise or voltage drift in all switch inputs; check connections; cycle KSI.
120	Supervisor Incompatible	0	0	1. The main OS is not compatible with the Supervisor OS.	Set : Incompatible software. Clear : Load properly matched OS code or update the Supervisor code; cycle KSI.
130	Bad Calibrations	0	0	1. Internal controller fault.	Set : Internal controller fault detection. Clear : Cycle KSI.
131	Driver Supply	0	0	 Internal controller fault in the voltage supply for the driver circuits. 	Set : Internal controller fault detection. Clear : Cycle KSI.

Code	Alarm	Traction	Pump	Possible cause	Set/clear conditions
135	Motor characterization error	0	0	 Motor characterization failed during characterization process. See Monitor menu » Controller: Motor Characterization Error for cause : a sequencing error. Normally caused by turning off Motor Characterization Test Enable before running the test. a encoder signal seen but step size not auto-detected; set up Encoder Steps manually a motor temp sensor fault a motor temp hot cutback fault a controller overtemp cutback fault a controller undertemp cutback fault a encoder signal not seen, or one or both channels missing a motor parameters out of characterization range a Sin/Cos sensor characterization failure a started characterization procedure while motor rotating. 	Set : Motor characterization failed during the motor characterization process. Normally caused by turning off Motor_Characterization_Test_ Enable before running test. Needs controller reset. Clear : Correct fault; cycle KSI, or VCL reset.
136	Encoder Pulse Count Fault	0	0	 Encoder Steps parameter does not match the actual motor encoder. 	Set : Detected wrong setting of the Encoder Steps parameter. Clear : Ensure the Encoder Steps parameter matches the actual encoder; cycle KSI.
137	Motor Type Fault	0	0	1. The Motor_Type parameter value is out of range.	Set : Motor_Type parameter is set to an illegal value. Clear : Set Motor_Type to correct value and cycle KSI.
145	VCL/OS Mismatch	0	0	1. The VCL software in the controller does not match the OS software in the controller.	Set : VCL and OS software do not match; when KSI cycles, a check is made to verify that they match and a fault is issued when they do not. Clear : Download the correct VCL and OS software into the controller.

Code	Alarm	Traction	Pump	Possible cause	Set/clear conditions
146	EM Brake Failed to Set	0	0	 Vehicle movement sensed after the EM Brake has been commanded to set. EM Brake will not hold the motor from rotating. 	Set : After the EM Brake was commanded to set and time has elapsed to allow the brake to fully engage, vehicle movement has been sensed. Clear : Activate the Throttle (EM Brake type 2). 2. Activate the Interlock (EM Brake type 1). *BC-9U doesn't have EM Brake.
147	Encoder LOS (Limited Operating Strategy)	0	0	 Limited Operating Strategy (LOS) control mode has been activated, as a result of either an Encoder Fault (Code 36) or a Stall Detected fault (Code 73). Motor encoder failure. Bad crimps or faulty wiring. Vehicle is stalled. 	Set : Encoder Fault (code 36) or Stall Detected (code 73) was activated, if parameter LOS Upon Encoder Fault = On and Interlock has been cycled, then the Encoder LOS (code 93) control mode is activated, allowing limited motor control. Clear : Cycle KSI or, if LOS mode was activated by the Stall Detected fault, clear by ensuring encoder senses proper operation, Motor RPM = 0, and Throttle Command = 0.
148	Emer Rev Timeout	0	0	 Emergency Reverse was activated and concluded because the EMR Timeout timer has expired. The emergency reverse input is stuck On. 	Set : Emergency Reverse was activated and ran until the EMR Timeout timer expired. Clear : Turn the emergency reverse input Off. *EMR_Interlock is OFF in BC-9U.
152	Illegal Model Number	0	0	 Model_Number variable contains illegal value. Software and hardware do not match. Controller defective. 	Set : Illegal Model_Number variable; when KSI cycles, a check is made to confirm a legal Model_ Number, and a fault is issued if one is not found. Clear : Download appropriate software for your controller model.

Code	Alarm	Traction	Pump	Possible cause	Set/clear conditions
153	Parameter Mismatch	0	0	 Dual drive enabled on only one controller. Incorrect position feedback type chosen for motor technology in use. Dual drive is enabled in torque mode. 	Set : When the Dual Drive software is enabled, the controller must be set to either Speed Mode Express or Speed Mode; otherwise this fault is set. Motor Techology=0 must be paired with Feedback Type=1, and Motor Technology=1 must be paired with Feedback Type=2; otherwise this fault is set. Clear : Adjust parameters to appropriate values and cycle KSI. *BC-9U has a single drive.

② Drive and pump controller (fingertip)

Code	Alarm	Description	Results	Troubleshooting
23	Internal Fault	Encryption failure.	1353 in Stopped state.	Requires repair and ATS test.
24	EEPROM Fault	EEPROM did not properly write, or Checksum did not match.	All outputs stopped.	Write to failed location.
25	5V Supply Fail	External load impedance on +5V Supply is too low.	None.	Bring voltage within range.
32	12V Supply Fail	External load impedance on +12V Supply is too low.	None.	Bring voltage within range.
33	External Supply Out of Range	External load on +5V or +12V exceeds 200 mA.	None.	Bring external supply currentwithin range.
34	Flash Fault	The flash did not properly write.	1353 in Stopped state.	Write to failed location.
35	Analog Input Fault	Analog input exceeds 15.5V (voltage input) or 7.5k Ω (resistance input).	None.	Bring analog input within range.
36	Encoder Fault	Encoder wire open.	Encoder count stopped.	Cycle KSI.
51	Overvoltage	Battery over limit. Limit = (Nominal Voltage * 1.25) + 5V.	All outputs stopped.	Battery returns to normal range for >1 second.
52	Undervoltage	Battery under limit. Limit = (Nominal Voltage * 0.7) - 5V when Nominal Voltage ≥24V. Limit = (Nominal Voltage * 0.7) - 0.6V when Nominal Voltage =12V.	All outputs stopped.	Battery returns to normal range for >1 second.
53	Overtemp	Heatsink over allowed temperature.	All outputs stopped.	Temperature returns to normal range (<95°C).
54	Undertemp	Heatsink below allowed temperature.	All outputs stopped.	Temperature returns to normal range (>-50°C).
55	Overcurrent	Total current exceeds 18A.	All outputs stopped.	Temperature returns to normal range (<95°C).
73	Driver 1 Fault			
80	Driver 2 Fault			
81	Driver 3 Fault			
82	Driver 4 Fault		Output on the	
83	Driver 5 Fault	Driver is in overcurrent (>3.5 amps).	faulted driver	to the faulted driver.
84	Driver 6 Fault		stopped.	
85	Driver 7 Fault			
86	Driver 8 Fault			
87	Driver 9 Fault			

Code	Alarm	Description	Results	Troubleshooting
101	Coil 1 Fault		Output on the faulted driver not functional.	Driver pin is reconnected
102	Coil 2 Fault			
103	Coil 3 Fault			
104	Coil 4 Fault	Driver output pin is low when driver is		
105	Coil 5 Fault	Off. This implies the pin has been left		
112	Coil 6 Fault	open.		
113	Coil 7 Fault			
114	Coil 8 Fault			
115	Coil 9 Fault			
129	PDO Timeout	PDO from master has not been received within the time-out period.	All drivers disabled and commands cleared.	New PDO received within proper timing.
130	CAN Bus Fault	Too many CAN bus errors detected.	1353 in Stopped state.	NMT received, or bus reception & transmission restored.

3) PARAMETER CHANGE

Service man can change and check the traction and pump controller parameters.



(1) Traction inverter

Set options	Description
Lithium Battery Enable	This option set the communication check between traction and Li-ion Battery Management System. - ON : using BMS with Lithium Battery - OFF : not using BMS with Lithium Battery
Safety Belt Sequence Option	 None : need to only 'Taking a seat' for Driving and Lifting. Option #1 : need to 'Taking a seat' and 'Fastening a seat belt' for driving and lifting. The order is not matter. Option #2 : need to 'Taking a seat' and 'Fastening a seat belt' for Driving and Lifting. It must meet the order.
BDI Lockout Enable	 ON : BDI lockout is enabled. OFF : BDI lockout is not enabled. (default) *BDI lockout : controller locks out lift if battery charge < [BDI LockOut Level].
Motor Fan Working Type	 Cooling fans installed on nearby motors will work as follows; Option #1 : fans work always. Option #2 : fans work in case a temperature of controller or motor exceeds a temperature set in [Traction Motor Fan Starting Temp] and [Pump Motor Fan Starting Temp]. Option #3 : fans work when motors work.
Position Hold Enable	 ON : The stop on ramp feature (truck electrically hold on a ramp) is is managed for [Position Hold Timeout Time]. OFF : The stop on ramp feature is not performed.
Traction Cutback Enable	If the mast is lifted the height over free lift, traction speed reduction is working depends on the setting status of this function. - ON : Traction speed control [Traction Cutback Speed] is performed. - OFF : Traction speed control [Traction Cutback Speed] is not performed.

Parameter	Description
Cluster Enable	 ON : The forklift works normally only when The cluster is activated. OFF : You can use The forklift regardless of The cluster.
BDI LockOut Level	(This parameter is used for that [BDI Lockout Enable] is ON) This parameter defines BDI LockOut Level. Controller locks out lift if battery charge < [BDI LockOut Level].
Seat Switch Delay	This parameter defines the delay time after the seat switch is off.
Traction Cutback Speed	It sets the traction motor speed when lift cutback switch is on.
BMS Warning Speed	This parameter defines the maximum speed performed when the BMS warning 1 is active.
BMS Warning Current	This parameter defines the maximum current performed when the BMS warning 0 is active.
Brake Rate Foot Pedal	Sets the rate (in seconds) at which the vehicle slows down from high speeds when brake is applied or when full throttle is applied in the opposite direction.
Brake Rate Else	Sets the rate (in seconds) at which the vehicle slows down from high speeds when brake is not applied or a small amount of throttle is applied in the opposite direction.
T mode Speed	(Turtle mode) Defines the maximum requested motor rpm at full throttle. Partially-applied throttle is scaled proportionately; e.g., 40% applied throttle corresponds to a request for 40% of the set Max Speed Value.
T mode Drive Current	(Turtle mode) Sets the maximum RMS current the controller will supply to the motor during drive operation, as a percentage of the controller's full rated current. *Reducing this value will reduce the maximum drive torque.
H mode Fwd Max Speed	(H mode, Forward direction) Defines the maximum requested motor rpm at full throttle. Partially-applied throttle is scaled proportionately; e.g., 40% applied throttle corresponds to a request for 40% of the set Max Speed Value.
H mode Rev Max Speed	(H mode, Reverse direction) Defines the maximum requested motor rpm at full throttle. Partially-applied throttle is scaled proportionately; e.g., 40% applied throttle corresponds to a request for 40% of the set Max Speed Value.
H mode Drive Current	(H mode) Sets the maximum RMS current the controller will supply to the motor during drive operation, as a percentage of the controller's full rated current. *Reducing this value will reduce the maximum drive torque.
N mode Fwd Max Speed	(H mode, Forward direction) Defines the maximum requested motor rpm at full throttle. Partially-applied throttle is scaled proportionately; e.g., 40% applied throttle corresponds to a request for 40% of the set Max Speed Value.

Parameter	Description
N mode Rev Max Speed	(H mode, Reverse direction) Defines the maximum requested motor rpm at full throttle. Partially-applied throttle is scaled proportionately; e.g., 40% applied throttle corresponds to a request for 40% of the set Max Speed Value.
N mode Drive Current	(H mode) Sets the maximum RMS current the controller will supply to the motor during drive operation, as a percentage of the controller's full rated current. *Reducing this value will reduce the maximum drive torque.
E mode Fwd Max Speed	(H mode, Forward direction) Defines the maximum requested motor rpm at full throttle. Partially-applied throttle is scaled proportionately; e.g., 40% applied throttle corresponds to a request for 40% of the set Max Speed Value.
E mode Rev Max Speed	(H mode, Reverse direction) Defines the maximum requested motor rpm at full throttle. Partially-applied throttle is scaled proportionately; e.g., 40% applied throttle corresponds to a request for 40% of the set Max Speed Value.
E mode Drive Current	 (H mode) Sets the maximum RMS current the controller will supply to the motor during drive operation, as a percentage of the controller's full rated current. *Reducing this value will reduce the maximum drive torque.
T mode Full Accel Rate HS	(Turtle mode) Sets the rate (in seconds) at which the speed command increases when full throttle is applied at high vehicle speeds. Larger values represent slower response.
T mode Full Accel Rate LS	(Turtle mode) Sets the rate (in seconds) at which the speed command increases when full throttle is applied at low vehicle speeds.
H mode Full Accel Rate HS	(H mode) Sets the rate (in seconds) at which the speed command increases when full throttle is applied at high vehicle speeds. Larger values represent slower response.
H mode Full Accel Rate LS	(H mode) Sets the rate (in seconds) at which the speed command increases when full throttle is applied at low vehicle speeds.
N mode Full Accel Rate HS	(N mode) Sets the rate (in seconds) at which the speed command increases when full throttle is applied at high vehicle speeds. Larger values represent slower response.
N mode Full Accel Rate LS	(N mode) Sets the rate (in seconds) at which the speed command increases when full throttle is applied at low vehicle speeds.
E mode Full Accel Rate HS	(E mode) Sets the rate (in seconds) at which the speed command increases when full throttle is applied at high vehicle speeds. Larger values represent slower response.
E mode Full Accel Rate LS	(E mode) Sets the rate (in seconds) at which the speed command increases when full throttle is applied at low vehicle speeds.

Parameter	Description
Low Accel Rate	Sets the rate (in seconds) at which the speed command increases when a small amount of throttle is applied. This rate is typically adjusted to affect low speed maneuverability.
Neutral Decel Rate HS	Sets the rate (in seconds) that is used to slow down the vehicle when the throttle is released to neutral at high vehicle speeds.
Neutral Decel Rate LS	Sets the rate (in seconds) that is used to slow down the vehicle when the throttle is released to neutral at slow vehicle speeds.
Position Hold Timeout Time	This parameter plus the Position Hold Settling Time parameter sets the maximum time the vehicle will stay in Position Hold before releasing the hold and going into Restraint mode. Setting the parameter to zero disables this timeout function, which means the Position Hold will be held. Activating the interlock resets the timer.
Partial Decel Rate	Sets the rate (in seconds) that is used to slow down the vehicle when the throttle is reduced without being released to neutral. Larger values represent slower response.
Forward Map	Modifies the vehicle's response to the throttle input. Setting the throttle map at 50% provides a linear output response to throttle position. Values below 50% reduce the controller output at low throttle settings, providing enhanced slow speed maneuverability. Values above 50% give the vehicle a faster, more responsive feel at low throttle settings. The map value is the percentage of controller output at half throttle [(deadband + max)/2].
Reverse Map	Same as throttle forward counterpart and applies when throttle direction is reversed.
Speed to RPM	The value entered for Speed to RPM is a conversion factor that scales motor speed to vehicle speed. It does not affect actual vehicle performance.
	KPH to RPM: (G/d) *5305, where G = gear ratio, d = tire diameter [mm]. MPH to RPM: (G/d) *336.1, where G = gear ratio, d = tire diameter [in].

Adjustment	Description
Battery Nominal Voltage	Must be set to the vehicle's nominal battery pack voltage. This parameter is used in determining the overvoltage and undervoltage protection thresholds for the electronic system. NOTE: In all cases the OS default Nominal Voltage is the highest value in the controller's range Always check and adjust this parameter whenever using a lower nominal voltage. Scaling is 64 counts per volt. For example, controller 1238E-65XX has a 48–80 voltage range. Therefore, when using a 48 volt battery, the Nominal_Voltage parameter will be 3072 (64 × 48 = 3072) in your VCL program, or as the raw (decimal) value in TACT. Must be changed according to 36V, 48V.
Contactor Pull In Voltage	The main contactor pull-in voltage parameter allows a high initial voltage when the main contactor driver first turns on, to ensure contactor closure. After 1 second, this peak voltage drops to the contactor holding voltage. NOTE: The Battery Voltage Compensated parameter (below) controls whether the pull- in and holding voltages are battery voltage compensated. Must be changed according to 36V, 48V.
Contactor Holding Voltage	The main contactor holding voltage parameter allows a reduced average voltage to be applied to the contactor coil once it has closed. This parameter must be set high enough to hold the contactor closed under all shock and vibration conditions the vehicle will be subjected to. NOTE: The Battery Voltage Compensated parameter (below) controls whether the pull- in and holding voltages are battery voltage compensated. Must be changed according to 36V, 48V.
Fan Relay Driving Voltage	This function controls the fan relay voltage. Must be changed according to 36V, 48V.
Traction Motor Fan Starting Temp	(This parameter is used for that [Motor Fan Working Type] is option #2) If the temperature of traction motor exceeds the temperature indicated in this paramter.
Pump Motor Fan Starting Temp	(This parameter is used for that [Motor Fan Working Type] is option #2) If the temperature of pump motor exceeds the temperature indicated in this paramter.

Adjustment	Description
OCV 10 Percent Voltage OCV 100 Percent	 At the start Controller get the battery voltage from key input. BDI is changed to the new BDI matching with [OCV 10 Percent Voltage] and
Voltage	[OVC 100 Percent Voltage]. But, if the new BDI is within the range 'Last BDI ±[BDI RESET 1]', it is discarded.
BDI Reset 1	
BDI Reset 2	 Stand-by (during no running motor) Controller get the batteny voltage from B+ input when the all motors do not run for
Standby Time	[Standby Time].
Reset Volts Per Cell	2) BDI is changed to the new BDI matching with [OCV 10 Percent Voltage] and
Full Volts Per Cell	[OVC 100 Percent Voltage]. But, If the new BDI is within the range 'Last BDI ±[BDI
Empty Volts Per Cell	RESET 2]', it is discarded.
Discharge Time	3. Discharging (during running motor)
BDI Reset Percent	 Full Volts Per Cell : The full voltage level sets the B+ (capacitor voltage) that is considered to be 100% state-of-charge; when a loaded battery drops below this voltage, it begins to lose charge. *Full Voltage Level = Full Volts Per Cell × number of cells in the battery pack(24). Empty Volts Per Cell : The empty voltage level sets the Capacitor Voltage that is considered to be 0% state-of-charge. *Empty Voltage Level = Empty Volts Per Cell × number of cells in the battery pack(24). Discharge Time : Sets the minimum time for the BDI algorithm to count down the BDI Percentage from 100% to 0%. The BDI algorithm integrates the time the filtered capacitor voltage is below the state of charge voltage level. When that cumulative time exceeds the Discharge Time / 100, the BDI Percentage is decremented by one percentage point and a new state of charge voltage level is calculated. *State of Charge Level = [(Full Voltage Level - Empty Voltage Level) x BDI Percentage / 100] + Empty Voltage Level. Reset Volts Per Cell : not used. BDI Reset Percent : not used. OCV 10 Percent Voltage, OCV 100 Percent Volatge Must be changed according to 36V, 48V.
Direction Exchange	Define the permitted neutral time when exchange fwd / rev with pressing the throttle. If
Deadband Voltage	value at power-on, T101 error will appear

(2) Pump inverter

Set options	Description
Fingertip Enable	 ON : The truck model includes electro-hydraulic distributor and finger tips. Can communication with 1353-6101 (fingertip controller) and 1236SE-5621(pump controller) is enabled. OFF : The truck model includes mechanical lever distributor.
Fingertip Clamp Interlock Enable	 ON : Clamp interlock function via finger tip is activated. (Clamp is only available when the clamp enable button is pressed) OFF : Clamp interlock function via finger tip is disabled (available regardless of clamp enable button)
Fingertip Aux 2 Lever Enable	 ON : When Fingertip is 4spool (4lever), you have to turn it on. OFF : When Fingertip is 3spool (3lever) you have to turn it off.
Lift Cutback Enable	If the mast is lifted the height over free lift, pump speed reduction is working depends on the setting status of this function. - ON : Pump speed control [Pump Cutback Speed) is performed. - OFF : Pump speed control [Pump Cutback Speed) is not performed.
Driver 1 Checks Enable	The two Checks Enable parameters are used to enable driver and coil fault detection at the five individual drivers (at Pins J1-6, J1-5). When a Driver Checks parameter is enabled, the associated driver, driver wiring, and driver load are checked to verify that the driver correctly drives the load both high and low. The checks will occur regardless of the PWM output of the driver. The checks will detect both open and shorted conditions. When a fault is detected, the controller opens the driver and issues a fault code. If nothing is connected to a driver, its Checks Enable parameter should be set Off.
Driver 2 Checks Enable	NOTE : Short circuit protection is always active at these five drivers, regardless of how Checks Enable is set. when fingertip, manual & Auto tilt option : X Driver 1 Checks Enable: OFF, Driver 2 Checks Enable: ON when manual & Auto tilt option : O

Parameter	Description
Max Total Speed	This parameter defines the motor speed limit. Motor speed is sum of lift, tilt, aux and steering request. If the request is higher than this value, it will be limited to this value.
BMS Warning Current	This parameter defines the maximum current performed when the BMS warning 0 is active.
Lift Speed BMS Warning Mode	This parameter defines the maximum speed performed when the BMS warning 1 is active.
Lift Speed High Mode	(H mode) This parameter defines the maximum speed of the pump motor during lift.
Lift Speed Normal Mode	(N mode) This parameter defines the maximum speed of the pump motor during lift.
Lift Speed Low Mode	(E mode) This parameter defines the maximum speed of the pump motor during lift.
Lift Cutback Speed	It sets the pump motor speed when lift cutback switch is on.
Tilt UP Speed (Manual)	This parameter defines the maximum speed of the pump motor during tilt in/out
AUX1 Speed (Manual)	This parameter defines the maximum speed of the pump motor during AUX1.
AUX2 Speed (Manual)	This parameter defines the maximum speed of the pump motor during AUX2.
Tilt UP Speed (Fingertip)	This parameter defines the maximum speed of the pump motor during tilt (in) with fingertip lever
Tilt Down Speed (Fingertip)	This parameter defines the maximum speed of the pump motor during tilt (out) with fingertip lever
AUX1 Speed (Fingertip)	This parameter defines the maximum speed of the pump motor during AUX1 with fingertip lever
AUX2 Speed (Fingertip)	This parameter defines the maximum speed of the pump motor during AUX2 with fingertip lever
Decel Rate Lift	Sets the rate (in seconds) that is used to slow down the motor speed when the lift throttle is released to neutral.
Decel Rate Else	Sets the rate (in seconds) that is used to slow down the motor speed when the throttle other than the lift is released to neutral.
Accel Rate When Speed Below 500	Sets the rate (in seconds) at which the speed command increases when the motor speed is lower than 500rpm. Larger values represent slower response.
Full Accel Rate HS	Sets the rate (in seconds) at which the speed command increases when full throttle is applied at high motor speeds. Larger values represent slower response.
Full Accel Rate LS	Sets the rate (in seconds) at which the speed command increases when full throttle is applied at low motor speeds. Larger values represent slower response.
Low Accel Rate	Sets the rate (in seconds) at which the speed command increases when a small amount of throttle is applied.
Lift Pot Fault Min Voltage	Define the min lift potentiometer voltage, if the lift potentiometer is less than it, P85 error will appear

Parameter	Description
Lift Pot Fault Max Voltage	Define the max lift potentiometer voltage, if the lift potentiometer is more than it, P85 error will appear
Fingertip Clamp Interlock Switch Hold Time	If the time that Aux 2 lever keep in neutral zone is more than this parameter, means Aux 2 lever is neutral
Battery Nominal Voltage	Must be set to the vehicle's nominal battery pack voltage. This parameter is used in determining the overvoltage and undervoltage protection thresholds for the electronic system. NOTE: In all cases the OS default Nominal Voltage is the highest value in the controller's range Must be changed according to 36V, 48V. Always check and adjust this parameter whenever using a lower nominal voltage. Scaling is 64 counts per volt. For example, controller 1238E-65XX has a 48–80 voltage range. Therefore, when using a 48 volt battery, the Nominal_Voltage parameter will be 3072 (64 × 48 = 3072) in your VCL program, or as the raw (decimal) value in TACT. Must be changed according to 36V, 48V.
Auto Tilt Coil Driving	This function controls the fan relay voltage.
OPSS Coil Driving	This function controls the fan relay voltage
Voltage	Must be changed according to 36V, 48V.

4) MONITORING

Service man can check the traction, pump, fingertip controller monitoring status.



(1) Traction inverter

Monitoring	Description
Seat Belt Input	Status of the Seatbelt switch Input on Pump Controller Pin 17.
Seat Input	Status of the Seat switch Input on PIN 7.
Brake Switch Input	Status of the Brake pressure switch input on PIN 10.
Forward Switch Input	Status of the Forward switch input on PIN 22.
Reverse Switch Input	Status of the Backward switch input on PIN 33.
Throttle Command	Throttle request % of accelerate pedal.
Throttle Pot_Accel 1	Input voltage from the accelerator pedal(Increasing analog signal) on PIN 16.
Pot2 Raw_Accel 2	Input voltage from the accelerator pedal(decreasing analog signal) on PIN 24.
SW4_Brake oil SW	Status of the Brake oil switch Input on PIN10.
SW5_Pedal brake SW	Status of the Brake pressure switch input on PIN 11.
Dig7 Input_Parking brake SW	Status of the Parking brake switch input on PIN 20.
SW16_SBR SW	Status of the SBR switch input on PIN 14.
Driver 1 PWM_M.C.	Voltage applied over the main contactor coil on PIN 6(driver 1 PWM). It corresponds to the duty cycle value of PWM applied and it is expressed in percentage.
Driver 2 PWM Fan.R.	Voltage applied over the Motor fan relay on PIN 5(driver 2 PWM). It corresponds to the duty cycle value of PWM applied and it is expressed in percentage.
5 Volts	Voltage at +5V output (pin 26).
12 Volts	Voltage at +12V output (pin 25).
Ext Supply Current	Combined current of the external +12V and +5V voltage supplies (PIN 25 and 26).
BDI	Estimation of the battery charge based on the battery voltage.
Capacitor Voltage	Voltage of controller's internal capacitor bank at B+ terminal.
Keyswitch Voltage	Voltage at KSI (PIN 1).
Motor RPM	Motor speed in revolutions per minute.
Motor Temperature	Traction motor temperature sensor readout.
MotorSpeed A	Motor encoder phase A speed in revolutions per minute.

Monitoring	Description
MotorSpeed B	Motor encoder phase B speed in revolutions per minute.
Battery Current	The current on controller DC side
Current (RMS)	RMS current of the controller, taking all three phases into account.
Frequency	Controller electrical frequency.
Controller Temp.	Controller internal temperature.
Controller SW ver	Controller software version.

(2) Pump inverter

Monitoring	Description
Pressure Sensor	Status of the Load sensor potentiometer (analog signal) input on cluster pin34.
Weight	This shows the measured load weight.
Mast Angle	The calculated angle with (Mast Angle From Sensor) and (Mast Angle Offset).
Manual_Lift Pot	The lift lever throttle pot of MCV sensor box.
SW3_LIFT Switch	Status of the lift switch input on PIN 9
SW7_Tilt Switch	Status of the Tilt switch input on PIN 22
SW5_AUX1 Switch	Status of the Aux1 switch input on PIN 11
SW6_AUX2 Switch	Status of the Aux2 switch input on PIN 12
F.tip_Lift Lower Pot	The lift lever throttle pot from the CAN data of finger-tip sub controller.
F.tip_Tilit Pot	The Tilt lever throttle pot from the CAN data of finger-tip sub controller.
F.tip_Aux1 Pot	The Aux1 lever throttle pot from the CAN data of finger-tip sub controller.
F.tip_Aux2 Pot	The Aux2 lever throttle pot from the CAN data of finger-tip sub controller.
SW16_Tilt Leveling SW	Status of the auto tilt leveling switch input on PIN 14
Fingertip Clamp Interlock Switch	Fingertip clamp Interlock switch input is available with data from the finger-tip sub controller.
Driver 1 PWM_Auto	The value is output when the autotilt is operated through the finger-tip.
tilt	It corresponds to the duty cycle value of PWM applied and it is expressed in percentage.PIN 6(driver 1 PWM).
Driver 2 PWM_OPSS	Voltage applied over the traction motor fan relay on PIN 5(driver 2 PWM).
	It corresponds to the duty cycle value of PWM applied and it is expressed in
	percentage.
5 Volts	Voltage at +5V output (pin 26).
12 Volts	Voltage at +12V output (pin 25).
Ext Supply Current	Combined current of the external +12V and +5V voltage supplies (PIN 25 and 26).
Capacitor Voltage	Voltage of controller's internal capacitor bank at B+ terminal.
Keyswitch Voltage	Voltage at KSI (PIN 1).
Motor RPM	Motor speed in revolutions per minute.
Motor Temperature	Traction motor temperature sensor readout.
MotorSpeed A	Motor encoder phase A speed in revolutions per minute.
MotorSpeed B	Motor encoder phase B speed in revolutions per minute.
Battery Current	The current on controller DC side
Current (RMS)	RMS current of the controller, taking all three phases into account.
Frequency	Controller electrical frequency.
Controller Temp.	Controller internal temperature.
Controller SW ver	Controller software version.

(3) Fingertip inverter

Monitoring	Description
Battery Voltage	Voltage at KSI (PIN 1).
Driver 1 Current_Lift Up	Driver 1 Current output. (PIN 23)
Driver 1 PWM_Lift Up	Driver 1 PWM output. It corresponds to the duty cycle value of PWM applied
	and it is expressed in percentage.
Driver 2 Current_Lift Lowering	Driver 2 Current output. (PIN 22)
Driver 2 PWM_Lift	Driver 2 PWM output. It corresponds to the duty cycle value of PWM applied
Lowering	and it is expressed in percentage.
Driver 3 Current_Tilt In	Driver 3 Current output. (PIN 21)
Driver 3 PWM_Tilt In	Driver 3 PWM output. It corresponds to the duty cycle value of PWM applied
	and it is expressed in percentage.
Driver 4 Current_Tilt Out	Driver 4 Current output. (PIN 20)
Driver 4 PWM_Tilt Out	Driver 4 PWM output. It corresponds to the duty cycle value of PWM applied
	and it is expressed in percentage.
Driver 5 Current_Aux1 In	Driver 5 Current output. (PIN 19)
Driver 5 PWM_Aux1 In	Driver 5 PWM output. It corresponds to the duty cycle value of PWM applied
	and it is expressed in percentage.
Driver 6 Current_Aux1	Driver 6 Current output. (PIN 18)
Out	
Driver 6 PWM_Aux1 Out	Driver 6 PWM output. It corresponds to the duty cycle value of PWM applied
	and it is expressed in percentage.
Driver 7 Current_Aux2 In	Driver 7 Current output. (PIN 17)
Driver 7 PWM_Aux2 In	Driver 7 PWM output. It corresponds to the duty cycle value of PWM applied
	and it is expressed in percentage.
Driver 8 Current_Aux2	Driver 8 Current output. (PIN 16)
Out	
Driver 8 PWM_Aux2 Out	Driver 8 PWM output. It corresponds to the duty cycle value of PWM applied
	and it is expressed in percentage.
Driver 9 Current	Driver 9 Current output. (PIN 15)
Driver 9 PWM	Driver 9 PWM output. It corresponds to the duty cycle value of PWM applied
	and it is expressed in percentage.
Controller SW ver	Controller software version.

5) SETTING

(1) Access the display menu

The instrument panel (cluster) has fifteen built-in LED (red, green, amber), which provide the operator with an easy information about the status of some truck devices.

1 Buttons and lamps



- 1 ESC button
- 2 LEFT/PERFORMANCE button
- 3 HOME button
- 4 RIGHT/SPEED button
- 5 ENTER button
- 6 High Temp Controller Lamp
- 7 Seat belt Lamp

- 8 Wrench Lamp
- 9 High Temp Motor Lamp
- 10 Seat Lamp
- 11 Warning Lamp
- 12 Forward Lamp
- 13 Parking brake Lamp
- 14 Reverse Lamp

- 15 Consumable Exchange Lamp
- 16 Brake Oil Lamp
- 17 Battery Level Lamp
- 18 High Mode Lamp
- 19 Normal Mode Lamp
- 20 ECO Mode Lamp
- 21 LCD Function
2 Access the screen setting menu

Step	Cluster	Description
1	04:27 рм 123.0 шк 2587ЕS17	 When starting the truck, a screen is prompted as shown on the left. On the first screen, press "HOME" button.
2	Display Setting Adjustment Unit Setting Language(언어)	1. Display Setting menu screen is displayed as shown on the left.

3 Access the truck menu

Step	Cluster	Description
1	04:27 рм 123.0 шк	 When starting the truck, a screen is prompted as shown on the left. On the first screen, press "ESC" button for one second or longer.
2	 Enter user pa ***** 0 1 2 3 4 5 6 7 8 9 E25BX7ES18 	 Password input screen is displayed as shown on the left. Input the password by using "LEFT/RIGHT/ENTER" buttons and press "ENTER"button. The first screen of 1st step is displayed, press "HOME" button.
3	Menu Equipment Maintenance Display Setting	 Truck Menu screen is displayed as shown on the left. Select desired menu by using "LEFT/RIGHT" button and press "ENTER" button to access the menu. Press "ESC" to move to the previous menu.

(2) Setting current time and language

- The 2 inch display of X-series battery truck has can be set the screen by 2 languages.

1 Setting the language for each country

You can set the language of the display as below.

Step	Cluster	Description
1	Display Setting Adjustment Unit Setting Language(언어)	 In Display Setting menu screen, select language setting menu by using "LEFT/RIGHT" buttons. Go into the language setting by pressing the "Enter" button.
2	□ Language(언어) 한국어 ENGLISH 25BC9U7ST08	1. Select language by using "LEFT/RIGHT" buttons and press the "Enter" button.
3	Display Setting Adjustment Unit Setting Language(언어)	1. The screen of changed language will display as shown on the left.

2 Current time setting

You can set the current time of the display as below

Step	Cluster	Description
1	Display Setting HOUR COUNTER Time Setting Buzzer	 In Display Setting menu screen, select Time Setting menu by using "LEFT/RIGHT" buttons. Go into the Time Setting setting by pressing the "Enter" button.
2	 Time Setting Date Setting Time Setting 	1. Select Date Setting by using "LEFT/RIGHT" buttons and press the "Enter" button.
3	 ▶날짜 설정 년 월 일 	1. Set Current Date by using "LEFT/RIGHT" buttons and press the "Enter" button.
4	 ▶ 시간 설정 ▶ 날짜 설정 시간 설정 	1. Select Time Setting by using "LEFT/RIGHT" buttons and press the "Enter" button.
5	□ 시간 설정 시 분	1. Set Current Time by using "LEFT/RIGHT" buttons and press the "Enter" button.

(3) Alarm history deleting

You can delete the alarm history of the controllers as below.

Step	Cluster	Description
1	Menu Equipment Maintenance Display Setting	1. In Truck menu screen, select Maintenance menu by using "LEFT/RIGHT" buttons and press the "Enter" button.
2	Maintenance ALARM HISTORY USER PASSWOR MONITORING	1. In Maintenance menu screen, select Alarm History menu by using "LEFT/RIGHT" buttons and press the "Enter" button.
3	ALARM HISTORY TRACTION PUMP FINGERTIP	1. Select controller by use "LEFT/RIGHT" buttons and check the alarm history of the controller.
4	TRACTION T 12 (Occur: 1) Controller Overcurrent 123.0 / 123.0hk 258C9U7AH04	 The stored alarm lists in the controller are displayed as shown on the left. To delete the alarms, press "ECS" button.
5	TRACTION Clear Logbook Yes No	 The display will ask " Clear Logbook" as shown on the left. To delete the alarms, press "ENTER" button.

(4) Fan working type setting

You can check and set the fan working type as below.

Step	Cluster	Description
1	Menu Equipment Maintenance Display Setting	1. In Truck menu screen, select Equipment menu by using "LEFT/RIGHT" buttons and press the "Enter" button.
2	 Equipment TRACTION PUMP V.A.S.S. 	 The Controller selecting menu screen is displayed as shown on the left. Select items as below by using "LEFT/RIGHT" buttons and press the "Enter" button. TRACTION - SET OPTION
3	SET OPTION 6/8 Motor Fan Working Type OPTION #2 25BC9U7ST10	 Find the "Motor fan working type" by using "LEFT/ RIGHT" buttons. You can set 3 kinds of the motor fan working type as below. OPTION #1 : Operated always OPTION #2 : Operated when the temperature of the controller or motor exceeds set values (default) OPTION #3 : Operated when the motor running. Press the "Enter" button to change the "Motor Fan Working Type".
4	SET OPTION OPTION #1 OPTION #2 OPTION #3 25BC9U7ST11	 The Setting Option menu of the cooling fan will display as shown on the left. Select "Option type" by using "LEFT/RIGHT" buttons and press the "Enter" button.

Step	Cluster	Description
5	SET OPTION WAIT	 The display will ask "Set option" as shown on the left. Press the "Enter" button to save the "Motor fan working type".
6	 SET OPTION 6/8 Motor Fan Working Type OPTION #1 258C9U7ST13 	1. The parameter of the motor fan working type will change "OPTION #1".

(5) Controller and display version confirming

You can confirm the version of the controllers and display as below.

- * Refer to (1) Access the display menu at page 7-84 for the method of accessing into the menu.
- 1 Controller version

Step	Cluster	Description	
1	Maintenance ALARM HISTORY USER PASSWOR MONITORING	 Truck menu -> In Maintenance menu screen, select Monitoring menu by using "LEFT/RIGHT" buttons and press the "Enter" button. 	
2	ALARM HISTORY TRACTION PUMP FINGERTIP	1. The Monitoring menu screen is displayed as shown on the left and select the Traction and press the "Enter" button.	
3	Seat Belt Input OFF Seat Input OFF 258C9U7ST21	 The first screen of the Traction monitoring menu is displayed as shown on the left. Find the "Controller SW ver" by using "LEFT/RIGHT" buttons. (The monitoring menu is located last position in generally) 	
4	TRACTION 15/15 Controller SW ver 0.00	 Check the software version item of the traction controller. Press "ESC" to move to the previous menu. To check the software version of other controllers, repeat above 2~4 steps. 	

- \bigcirc Display version
- * Refer to (1) Access the display menu at page 7-84 for the method of accessing into the menu.



(6) Battery voltage and model setting (1/2)

You can change the parameter value of the controllers by setting the voltage and model of the battery as below.

- * Refer to (1) Access the display menu at page 7-84 for the method of accessing into the menu.
- 1 Controller version

Step	Cluster	Description	
1	Menu Equipment Maintenance Display Setting	1. In Truck menu screen, select Equipment menu by using "LEFT/RIGHT" buttons and press the "Enter" button.	
2	 Equipment TRACTION PUMP V.A.S.S. 	1. In Equipment menu screen, select V.A.S.S. menu by using "LEFT/RIGHT" buttons and press the "Enter" button.	
3	V.A.S.S. LOAD ACCEL MODEL SELECT	 In V.A.S.S. menu screen, select model select menu by using "LEFT/RIGHT" buttons and press the "Enter" button. 	
4	MODEL SELECT 36V 48V 258C9U7ST32	 Select the model and set the battery voltage and then press the "Enter" button. 	
5	 MODEL SELECT 25BC-9U 30BC-9U 32BC-9U 	1. Select the model and press the "Enter" button to save the model.	

For 25/30/32BC-9U model, the parameter value in need of change is set on the display automatically.

After 5 step, the items in need change as voltage are set done automatically, the "Download Success" will display on the screen.

Battery voltage and model setting (2/2)

- * 31 items are changed through the cluster automatically and it completed, Setting Done" will display on the screen.
- * See below table and progress work if you want to change the parameter value by manually.



Menu				Change of parameter value		Demeril
Menu	1st Depth	th 2nd Depth Description		48V	36V	Remark
		ADJUSTMENT	Battery Nominal Voltage	48	36	(Volt)
			Contactor Pull In Voltage	75	100	(%)
			Contactor Holding Voltage	60	80	(%)
			Fan Relay Driving Voltage	25	33	(%)
			OCV 10 Percent Voltage	46.8	35.1	(Volt)
			OCV 100 Percent Voltage	51.1	38.3	(Volt)
Equipment	TRAC	PARAMETER	T mode Speed	1760	1320	(rpm)
			H mode Fwd Max Speed	3520	2640	(rpm)
			H mode Rev Max Speed	3520	2640	(rpm)
			N mode Fwd Max Speed	3000	2244	(rpm)
			N mode Rev Max Speed	3000	2244	(rpm)
			E mode Fwd Max Speed	2465	1848	(rpm)
			E mode Rev Max Speed	2465	1848	(rpm)
	PUMP	ADJUSTMENT	Battery Nominal Voltage	48	36	(Volt)
			Auto Tilt Coil Driving Voltage	25	33	(%)
Fauipment			OPSS Coil Driving Voltage	25	33	(%)
Equipment		PARAMETER	Lift Speed High Mode	2900	2175	(rpm)
			Lift Speed Normal Mode	2465	1850	(rpm)
			Lift Speed Low Mode	2030	1525	(rpm)

(7) Lithium-Ion Battery Option Setting

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

Step	Cluster	Description
1	Menu Equipment Maintenance Display Setting	1. In Truck menu screen, select Equipment menu by using "LEFT/RIGHT" buttons and press the "Enter" button.
2	 Equipment TRACTION PUMP V.A.S.S. 	 The Controller selecting menu screen is displayed as shown on the left. Select items as below by using "LEFT/RIGHT" buttons and press the "Enter" button. TRACTION - SET OPTION
3	SET OPTION 2/8 Lithium Battery Enable OFF 25BX7ES61	 Find "Lithium Battery Enable" parameter by using "LEFT/ RIGHT" buttons. You see the "Lithium Battery Enable" parameter is OFF status (default). Select ON by using "LEFT/RIGHT" buttons and press the "Enter" button to change parameter.
4	SET OPTION 2/8 Lithium Battery Enable ON 25BX7ES62	 You see the "Lithium Battery Enable" parameter is changed ON. Turn the key off and on one time.

(8) Fingertip lever option setting

If the truck is applied fingertip lever option, the fingertip enable parameter setting is needed as below.

Step	Cluster	Description
1	Menu Equipment Maintenance Display Setting	1. In Truck menu screen, select Equipment menu by using "LEFT/RIGHT" buttons and press the "Enter" button.
2	 Equipment TRACTION PUMP V.A.S.S. 25BC9U7ST40 	 The Controller selecting menu screen is displayed as shown on the left. Select items as below by using "LEFT/RIGHT" buttons and press the "Enter" button. PUMP - SET OPTION
3	SET OPTION 1/3 Fingertip Enable OFF 25BC9U7ST41	 Find "Fingertip Enable" parameter by using "LEFT/ RIGHT" buttons. Press the "Enter" button to change the parameter and select the ON by using "LEFT/RIGHT" buttons and press the "Enter" button once more.
4	SET OPTION 1/3 Fingertip Enable ON 25BC9U7ST42	 You will see the "Fingertip Enable" parameter is changed ON. Turn the key off and on one time.
5	SET OPTION Fingertip AUX 2 Lever Enable FINGERTIP Clamp Interlock Enable 25BC9U7ST43	 Fingertip Enable parameter option is as below. Fingertip AUX 2 Lever Enable (FFV) 3SP & 3LEVER (FFV05) : OFF 4SP & 4LEVER (FFV06) : ON Fingertip Clamp Interlock Enable (FOE) Clamp Interlock without (FOE00) : OFF Clamp Interlock 4SP (FOE02) : ON Turn the key off and on one time.

(9) Lift lever setting

If the truck is applied manual lever, the manual lever parameter setting is needed as below.

- $\,\%\,$ This setting have to carry out after checking the the "Fingertip Enable" is OFF status.
- * Refer to (1) Access the display menu at page 7-84 for the method of accessing into the menu.

Step	Cluster	Description
1	Menu Equipment Maintenance Display Setting	1. In Truck menu screen, select Equipment menu by using "LEFT/RIGHT" buttons and press the "Enter" button.
2	 Equipment TRACTION PUMP V.A.S.S. 	1. In the Equipment menu screen, select V.A.S.S. menu by using "LEFT/RIGHT" buttons and press the "Enter" button.
3	V.A.S.S. LIFT ACCEL FORK LEVELING	1. In V.A.S.S. menu screen, select LIFT menu by using "LEFT/RIGHT" buttons and press the "Enter" button.
4	LIFT 1/3 LIFT Deadband Voltage 2.5V 2.81V 25BC9U7ST46	 The screen will display in order to set as shown on the left. The calibration will start by pressing the "Enter" button. In progressing the calibration, the current voltage value is displayed left lower side. Locate lift lever in the middle position and pull the lever toward body side and maintenance for more than one second and then release the lever. Keep the lever in the middle position for more than one second and press the "Enter" button.
5	UIFT Wait CLIFT Download Success 25BC9U7ST47	 In above 4 clause, "Wait>Download success" will displayed on the screen when the "Enter" button is pressed. It is normal if the voltage is similar as below figure. It is normal if the voltage is similar as below figure.

(10) Fork leveling option setting (1/2)

The fork leveling option setting is base on the Auto tilt (FAL00, FAL01) option.

Step	Cluster		C	escription		
1	Menu Equipment Maintenance Display Setting	1.	In Truck menu screen, "LEFT/RIGHT" buttons	select Equipmen and press the "E	t menu by using Inter" button.	
2	 Equipment TRACTION PUMP V.A.S.S. 	1.	In Equipment menu sc using "LEFT/RIGHT" b button.	reen, select V.A.S uttons and press	S.S. menu by the "Enter"	
	Image: set option 1 1/3 Fingertip Enable OFF 25BC9U7ST50	1.	1. Change the items according to the Auto Tilt (FAL).			
			Items	Auto Tilt E	nable	
3			(FAL00)	OFF		
			Auto Tilt O (FAL01)	ON		
	SET OPTION 5/6 Driver 1 Checks Enable OFF 25BC9U7ST51	1.	STD parameter of the I	Driver 1 Check er	nable : OFF	
		In case of the manual and FAL01 conditions, change to				
4			ltomo	Driver 1 checks	Driver 2 checks	
				enable	enable	
			Manual & Auto tilt (X)	OFF		
	SET OPTION 6/6 Driver 2 Checks Enable ON 25BC9U7ST52		(FAL00)	OFF	ON	
5			(FAL01)	ON	ON	

Fork leveling option setting (2/2)

Fork leveling (Auto tilt leveling) option setting makes the fork arrange horizontal conditions. This setting must be performed before the truck shipment, and on replacing the controllers and the tilt sensor.

Step	Cluster	Description
1	Menu Equipment Maintenance Display Setting	1. In Truck menu screen, select Equipment menu by using "LEFT/RIGHT" buttons and press the "Enter" button.
2	 Equipment TRACTION PUMP V.A.S.S. 	1. In Equipment menu screen, select V.A.S.S. menu by using "LEFT/RIGHT" buttons and press the "Enter" button.
3	V.A.S.S. LEVER FINGERTIP FORK LEVELING 25BC9U7ST53	1. In V.A.S.S. menu screen, select fork leveling menu by using "LEFT/RIGHT" buttons and press the "Enter" button.
4	FORK LEVELING 1/3 Sensor Voltage at Gentry Mounting 0 Degree 2.5V 2.81V 25BC9U7ST54	 The screen will display in order to set as shown on the left. The calibration will start by pressing the "Enter" button. In progressing the calibration, the current voltage value is displayed left lower side. Check the voltage value is changed as moving the lever positions. Locate the fork to horizontal condition with the truck and press the "Enter" button then the setting is completed.
5	FORK LEVELING Wait FORK LEVELING Download Success 25BC9U7ST55	 In above 4 clause, "Wait>Download success" will displayed on the screen when the "Enter" button is pressed. It is normal if the set value, negative and positive are not differ within ±1 V. FORK LEVELING FORK LEVELING

(11) Load sensor option setting

If the truck is applied load weight option, the load weight setting is needed as below.

- * Refer to (1) Access the display menu at page 7-84 for the method of accessing into the menu.
- * Menu tree for reference on load sensor option setting



25BC9U7ST60

Load sensor option setting

If the truck is applied load weight option, the load weight setting is needed as below.

Step	Cluster	Description
1	Menu Equipment Maintenance Display Setting	1. In Truck menu screen, select Equipment menu by using "LEFT/RIGHT" buttons and press the "Enter" button.
2	 Equipment TRACTION PUMP V.A.S.S. 	1. In Equipment menu screen, select V.A.S.S. menu by using "LEFT/RIGHT" buttons and press the "Enter" button.
3	V.A.S.S. LOAD ACCEL MODEL SELECT 25BC9U7ST61	1. In V.A.S.S. menu screen, select load menu by using "LEFT/RIGHT" buttons and press the "Enter" button.
4	LOAD 1/4 Enter Cross-Section 39.27 cm ²	 In Load menu screen, select Enter Cross-section (Cylinder cross-section input menu) by using "LEFT/ RIGHT" buttons and press the "Enter" button.
5	 LOAD 66.49 cm² 1 2 3 4 . 5 6 7 8 9 4 	 A screen for entering cylinder cross-section is displayed as shown on the left. Refer to the table of cylinder cross-sections to input cross section, and press "Enter" image button to save the input.

* Cylinder cross-section table

Model	Mast	Cross-section (cm ²)	Remark	
	MBS(V)	39.27	Lift cylinder	
25BC-9U	MBT(TF)	44.18	- Free lift cylinder	
	MBQ(QF)	44.18		
	MBS(V)	47.52	Lift cylinder	
30/32BC-9U	MBT(TF)	56.75	Erec lift oulinder	
	MBQ(QF)	44.18	Free int Cylinder	

Step	Cluster	Description
6	LOAD DOWNLOAD SUCCESS 25BC9U7ST64	1. Make sure that setting has been complete as shown on the left.
7	LOAD 2/4 Load Weight Adjust	 In Load menu screen, select the Load weight adjust menu by using "Left/Right" button and press the "Enter" button.
8	 LOAD Unloaded Status Loaded Status Initialization 	1. In Load menu screen, select the Unload status menu by using "Left/Right" button and press the "Enter" button.

Step	Cluster	Description
9	 LOAD Unloaded Status 1. Please remove the load. 2. Locate the fork at about 300mm from the ground. 3. After about 3 seconds, Please press the Enter button. 	 A screen for setting is displayed as shown on the left. Press the "Right" button to move to page as shown on the left. Do lift the unloaded fork to 300 mm position from the ground, and press the "Enter" button after waiting for 3 seconds.
10	LOAD Unloaded Status DOWNLOAD SUCCESS	1. Make sure that setting has been complete as shown on the left.
11	 LOAD Unloaded Status Loaded Status Initialization 	 In Load menu screen, select Loaded status menu by using "Left/Right" button and press the "Enter" button.
12	 LOAD 3500 kg 0 1 2 3 4 . 5 6 7 8 9 258C9U7ST70 	 A screen for entering load weight is displayed as shown on the left. Input the load weight to be used for setting, and select the "Enter" button image.
13	 LOAD Locate the fork with load at about 300mm from the ground within 30s. 3500 kg 28s 258C9U7ST71 	 A screen for setting is displayed as shown on the left. Do lift the loaded fork to 300 mm position from the ground, and press the "Enter" button after waiting for 3 seconds.



Step	Cluster	Description
16	LOAD 3/4 Weight Display Setting 100 kg SECOUTSTR LOAD 100 kg 100 kg 10 kg	 It is possible to change unit of weight in the third menu of Weight display setting. 100 kg : Weight rounded off from the second digit is indicated 10 kg : Weight rounded off from the first digit is indicated Press "Enter" button to check weight indication functions of respective settings, and change the value to default 100 kg (round off from the second digit).
17	LOAD 4/4 OVERLOAD WEIGHT 3700 kg 25BC9U7ST78	 In Load menu screen, select Overload input menu by using "LEFT/RIGHT" buttons and press the "Enter" button.
18	 LOAD 3500 kg 1 2 3 4 . 5 6 7 8 9 25007570 	 A screen for inputting load weight is displayed as shown on the left. Input the over load for each model and select the "Enter" button image (e.g. 25BC-9U=2500 kg, 32BC- 9U=3200 kg).
19	LOAD DOWNLOAD SUCCESS 258C9U7ST79	 Make sure that setting has been complete as shown on the left.

Verification method of overload buzzer function



(12) Seat and seat belt interlock option setting

If the truck is seat and seat belt interlock option, the seat and seat belt interlock option setting is needed as below.

Step	Cluster	Description
1	Menu Equipment Maintenance Display Setting	1. In Truck menu screen, select Equipment menu by using "LEFT/RIGHT" buttons and press the "Enter" button.
2	Equipment TRACTION PUMP V.A.S.S.	 The Controller selecting screen of the Equipment menu is displayed as shown on the left. Select items as below by using "LEFT/RIGHT" buttons and press the "Enter" button. TRACTION - SET OPTION
3	<section-header><image/><image/><image/><image/><image/><image/><image/><image/><image/><image/><image/><image/><image/><image/><image/><image/><image/><image/><image/><image/><image/><image/><image/><image/><image/><image/><image/><image/><image/><image/><image/><image/><image/><section-header><section-header><section-header><text><text><text><text></text></text></text></text></section-header></section-header></section-header></section-header>	 Find the Safety belt sequence option parameter by using "LEFT/RIGHT" buttons. The screen of the Safety belt sequence option parameter will displayed NONE (default). You can set 3 kinds of the Safety belt sequence option as below. NONE : Truck is operated when the seat switch is ON. *FG17/36/38/40/43, BI00 OPTION #1 : Truck is operated when the seat and belt switch is ON. *FG37/39, BI00 OPTION #2 : Seat switch ON -> Truck is operated when the belt switch is ON. *FG37/39. BI01 *Option #2 must be satisfied with the operating order of seat switch and belt switch. Press "Enter" button to change the value and select the suitable option by using "LEFT/RIGHT" buttons and press the "Enter" button.

7. 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)



- SCR module 4
- 8 Assistant trans

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2) CHARGER INSTALLATION METHOD

(1) Location for charger installation

- 1 Dry and well ventilated place.
- 0 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		
400-580 AH	4P - 4 mm ²		For 3 0 220V
600-800 AH	4P - 6 mm ²		one step
850-1000 AH	4P - 10 mm ²	Based on	higher
24 V battery	-	3Ø380 V	capacity
200-600 AH	4P - 2.5 mm ²	3Ø440 V	cable should
700-1000 AH	4P - 4 mm ²		be used.
80V battery	-		$(2.5 \text{ mm}^2 \rightarrow$
500-600 AH	4P - 6 mm ²		4mm²)
700-800 AH	4P - 10 mm ²		

3) HOW TO USE A CHARGER

(1) General charging method (Floating charging)

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

· According to charging condition

- If there is no abnormality found when the charger checks itself for 3-4 seconds after inputting AC input power source, the charger slowly increases the electric flow for charging and the charging condition lamp in the lower part of the front panel for floating charging of "input" is on.
- ② A charging voltage, current, amount and time are displayed in order on a monitor display window.
- ③ When charging is processed about 80%, yellow lamp in the middle of the front panel, which shows that the charging condition is in the middle, is on and then green lamp is on when charging is processed over 85% until charging is completed.
- ④ When charging is completed, "charging is completed" lamp is on in the monitor and other lamps of all monitors become off.

(2) Equalized charging

1 Equalized charging is

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

When equalized charging is required?

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





2 Tips for equalized charging

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

- When the green charging condition lamp is on (over 85% charged), the equalized charging switch is locked that it does not operate even pushing the button.
- (3) Automatic/Manual switching method Automatic connector. Manual switching connector (J2) is located on a left top corner of PCB.
- In case of manual switching for charger checking, make sure that the battery connector is separated beforehand.
- MG/SW operation (Refer to the charger trouble SHEET components manual)

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

- 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 lula64V by measuring output voltage of battery connector side with multi-meter, then it is normal.
- ④ After 30 sec. of switching to a manual connector, if a buzzer sound rings continuously for 10 sec. and completion LED lights up, then it is normal.
- (5) If you confirm that the charger operates in normal after checking manual switching of the charger, make sure that the charger is switched to automatic.





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- 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.



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No	Code	Description of error	
1	E.F	EPROM fail	
2	O.V	Over voltage - Refer to page 7-116	
3	O.C	Over current - Refer to page 7-115, 7-117	
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 7-114.	
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.
- 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 overstandards condition.
- ⑤ O.V : Check the voltage, as charging voltage of the battery is over-voltage condition (66V).
 Normally it is 64V±1.0V.
- (5) Check other abnormalities as well. Then apply for A/S when on-site measurements are not applicable.



5) ERROR DETECTION

(1) Error list

- 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.
- O SCR module checking method

(2) Troubleshooting

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



② ON and OFF is repeated with a few minutes intervals after starting charging. Indicate "O.C" on the monitor.

- TH is operated (AC input over-current TRIP).





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



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


- 6 Charger has no response even if the battery connector is connected.
 - In case only floating LED is on, charger input power is cut off or doesn't connect. (In case the input voltage is normal Refer to the error detection No. (1))



7) HOW TO CHECK THE SCR MODULE





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

No.	Measuring point (Real diagram)	Measure value (Measurement of digital tester)
1	No.1 ~ No.3	Forward : Under 100 k ohm Reverse : Infinity ($^\infty$)
2	No.2 ~ No.3	Forward : Infinity (∞) 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
- 2 Lp lamp
- 3 Detect voltage
- 4 SHUNT detect current
- 5 Correct output current
- 6 Correct output voltage
- 7 Correct CPU voltage
- 8 Monitor display output
- 9 Temperature sensor
- 10 SCR control

- 11 Buzzer
- 12 Auxiliary power supply
- 13 Auto/manual switch TAP
- 14 SCR control connector



CHARGER INTERIOR PARTS



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	

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GROUP 1 STRUCTURE

1.2 STAGE MAST (V MAST)



- 1 Outer mast
- 2 Inner mast
- 3 Roller
- 4 Tilt cylinder pin
- 5 Trunnion cap
- 6 Bushing

- 7 Chain sheave
- 8 Lift chain
- 9 Anchor bolt
- 10 Roller
- 11 Retaining ring
- 12 Chain guard

- 13 Clamp
- 14 Back up liner
- 15 Shim (0.5, 1.0t)
- 16 Shim (0.5, 1.0t)

2.3 STAGE MAST (TF MAST)



- 1 Outer mast
- 2 Middle mast
- 3 Inner mast
- 4 Roller

- 5 Shim (0.5, 1.0t)
- 6 Lift chain
- 7 Anchor bolt
- 8 Sheave bracket
- 10 Chain sheave
- 11 Retaining ring
- 12 Trunnion cap
 - 13 Tilt cylinder pin

3. CARRIAGE, BACKREST AND FORK



- 1 Backrest
- 2 Carriage

- 3 Load roller
- 4 Side roller
- 5 Fork assembly

4. INTEGRAL SIDE SHIFT, BACKREST AND FORK



- 1 Backrest
- 2 Integral side shift
- 3 Load roller
- 4 Side roller
- 5 Fork assembly

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)

STD Fork assy	Applicable model	Standard	Limit
F173796-02	25BC-9U	45 (1.8)	40 (1.6)
64FG-31020G	30/32BC-9U	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
	equal or below 1500	3
25/30/3260-90	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.
- Set mast vertical, raise forks about 10 cm from ground and check front-to-rear clearance and left-toright 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.
- Set mast vertical, raise forks about 10cm from ground, and push center of lift chain with finger to check for difference in tension.

If there is any difference in tension, adjust chain stopper bolt.

5) Check visually for abnormalities at thread of chain anchor bolt, and at contact surface between chain wheel and chain.

Rotate chain wheel by hand and check for any play of bearing.

2. TROUBLESHOOTING

1) MAST

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

2) FORKS

Problem	Cause		Remedy
Abrasion	Long-time operations c wear and reduces the t fork. Inspection for thickness · Wear limit : Must be s	auses the fork to hickness of the s is needed. 90% of fork	If the measured value is below the wear limit, replace fork.
Distortion	thicknessForks 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 heightFork length (mm)Height difference (mm)equal or below 15003above 1500		If the measured value exceeds the allowance, replace fork.
Fatigue	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.		Repair fork by expert. In case of excessive distortion, replace fork.

GROUP 3 ADJUSTMENT

1. MAST LOAD ROLLER (V MAST)

1) INNER/OUTER MAST ROLLER CLEAR-ANCE ADJUSTMENT

- (1) Measure the clearance with the mast overlap at near 480 mm.
- (2) Shift the inner mast to one side to bring the roller into contact with the outer mast, and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the inner/outer mast roller shim.

 \cdot Standard clearance A, B = 0.3 \sim 0.6 mm \cdot Shim thickness 0.5, 1.0 mm

- (3) Distribute the shim thickness equally to the left and right roller. Refer to Mast load roller and back up liner, removal and Installation.
- (4) After the adjustment, check that the inner mast moves smoothly in the outer mast.





2. MAST LOAD ROLLER (TF MAST)

1) INNER AND MIDDLE MAST ROLLER CLEARANCE ADJUSTMENT

- (1) Measure the clearance with the mast overlap at near 480 mm.
- (2) Shift the inner mast to one side to bring the roller into contact with the outer mast and the middle mast, and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the inner and middle mast roller shim, respectively.
 - \cdot 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

- 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

- 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.
 - \cdot Standard clearance E = 0.2 ~ 0.6 mm
 - · Shim thickness 0.5, 1.0 mm
- (3) After the adjustment, the mast should move smoothly.





GROUP 4 REMOVAL AND INSTALLATION

1. FORKS

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



2. BACKREST

- 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.



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.

A 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.

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

2) SIDE ROLLER

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

* Adjustment

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

3) CARRIAGE LOAD ROLLER

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





4) MAST LOAD ROLLER AND BACK UP LINER

(1) 2 stage mast (V mast)

- ① Remove the carriage assembly and move them to one side.
- ② Loosen and remove bolts and spacer securing lift cylinders to outer mast.
- ③ Loosen and remove hexagon bolts and nuts securing lift cylinders to inner mast.
- ④ Attach chains or sling to the inner mast section at top crossmember. Using an overhead hoist, slowly raise the inner mast high enough to clear lift cylinder.
- ⑤ After lowering the lift cylinder rods, and disconnecting lift cylinder hose, tilt the lift cylinders LH and RH and them with ropes to the outer mast.
- ⑥ Using the overhead hoist, lower inner mast until top and bottom rollers and back up liners are exposed.
- ⑦ Using a pryer, remove load rollers from load roller bracket. Remove back up liners and shims.
- 8 Thoroughly clean, inspect and replace all worn or damaged parts.
- ④ Reverse the above procedure to assemble. Refer to MAST LOAD ROLLER ADJUSTMENT paragraph.



(2) 3 stage mast (TF mast)

- Remove the carriage assembly and move it to one side.
- ② Loosen and remove hexagon bolt securing bottom cylinder from outer mast.
- ③ Loosen and remove band and special washers securing lift cylinders to middle mast. Remove the spring pin.
- ④ Attach chains or sling to the inner and middle mast section at top crossmember. Using an overhead hoist, slowly raise the uprights high enough to clear lift cylinder.
- ⑤ After lowering the lift cylinder rods, and disconnecting lift cylinder hose, tilt the lift cylinders LH and RH and tie them with ropes to the outer mast.
- 6 Using the overhead hoist raise inner and middle masts. Place 4 inch block of wood under the free lift cylinder bracket of the inner mast then lower mast sections (this will create slack in the chains).
- ⑦ Remove retaining rings securing chain sheaves to sheave support brackets. While support chains, remove chain sheaves and let chains hang free. The upper outer and lower middle mast rollers and back up liners are now exposed.
- ⑧ Using a player, remove load rollers from load bracket. Remove back up liners and shims.
- ④ Attach chains or sling to the middle mast section at top crossmember. Using an overhead hoist, slowly raise the middle mast until top and bottom rollers are exposed.
- 10 Using a pryer, remove load rollers from load roller bracket.
- Thoroughly clean, inspect and replace all worn or damaged parts.
- Reverse the above procedure to assemble. Refer to MAST LOAD ROLLER ADJUSTMENT paragraph.



5) ELEVATING MAST

(1) Inner mast (V mast)

- ① After completing all necessary steps for load rollers and back up liner removal use an overhead hoist and sling or chain around upper crossmember of the inner mast section.
- ② Lift inner mast upright straight up and out of outer mast section.
- ③ Replace and reverse above procedure to install. Make all necessary measurements and adjustments.

(2) Inner and middle mast (TF mast)

- ① After completing all necessary steps for load rollers and back up liner removal. Remove rear chains and sheave support if not already done.
- 2 Disconnect free lift cylinder hose. Drain hose into a suitable pan or container and cap hose.
- ③ While supporting free lift cylinder assembly, remove bolts and washers securing cylinder to mast crossmember.
- ④ Place a sling around free lift cylinder and attach to an overhead hoist. Slowly raise and move cylinder to one side.
- ^⑤ Attach chains or sling to the inner mast section at top crossmember. Using an overhead hoist slowly raise the upright straight up and out of middle mast section.
- ⁽⁶⁾ Attach chains or sling to the middle mast section at top crossmember. Using an overhead hoist slowly raise the upright straight up and out of outer mast section.
- ⑦ Replace upright and reverse above procedure to install. Make all necessary measurements and adjustments.

6) CHAIN

(1) Chain sheave (V mast)

- Place a sling around carriage and attach to an overhead hoist. Lift carriage high enough so that the tension on the chain over sheaves is relieved after the carriage is blocked. Position wooden blocks under the carriage and lower it.
- Remove the split pin securing the chain anchor pins and discard.
 While supporting the chains, remove the chain anchor pins and drape the chains over the carriage.
- ③ Remove retaining ring securing sheaves to sheave support. Remove sheaves with bearings.
- ④ Remove bearing retaining ring from sheave and press bearings from sheaves.
- (5) Thoroughly clean, inspect and replace all worn or damaged parts.
- 6 Reverse the above to assemble and install. Use new split pins in chain anchor pins.

(2) Rear chain sheave (TF mast)

- Raise and securely block carriage and inner mast section.
- ② Remove the split pin securing the chain anchor pins and discard. While supporting the chains, remove the chain anchor pins from outer mast section.
- 3 Remove chains.
- ④ Remove retaining ring securing chain sheaves to sheave support. Pry off sheaves with bearings.
- ⑤ Remove bearing retaining ring from sheave and press bearings from sheaves.
- ⑥ Thoroughly clean, inspect and replace all worn or damaged parts.
- ⑦ Reverse the above procedure to assemble and install. Use new split pins in chain anchor pins.





(3) Chain wheel bearing support (TF mast)

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

(4) Rear chain (TF mast)

- ${\rm (I)}$ Remove the carriage assembly and move to one side. Refer to carriage removal and installation.
- $\ensuremath{\textcircled{O}}$ 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.
- 0 Remove chains.
- ⑦ Reverse the above to assemble and install. Use new split pins in chain anchor pins. Refer to this section for Load chain lubrication and adjustment.

(5) Carriage chain

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

(6) Load chain inspection and maintenance

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

1) Wear

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

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

② Rust and corrosion

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

③ Cracked plate

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

④ Tight joints

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

Tight joints in lift chains can be caused by :

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

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

5 Protruding or turned pins

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

6 Chain side wear

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

⑦ Chain anchors and chain wheel bearings

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

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

8 Chain wear scale

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

- · Determine pitch length of chain using 6 inch scale on one side of wear scale.
- · If pitch is 1/2 (12.7 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.
- \cdot 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.
- \cdot If other point also lines up with a pin, the chain is worn and should be replaced.

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

(7) Load chain lubrication and adjustment

1 Lubrication

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

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

A Wear eye protection.

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

2 Replacement

Replace chains as a pair. It will be virtually impossible to maintain uniform loading between the strands if a new chain is put into service opposite an old chain. The joints in the old chain will be greater than that on the new chain, greatly complicating the problem of maintaining equal chain tension. The new chain will wear more slowly causing it to bear the major portion of the load resulting in premature wear and fatigue failure. Don't steam clean or decrease new chains. The manufacturer's grease is effective in reducing wear and corrosion. If the original factory lube is dried out or wiped off, soak the new chain in heavy engine oil for at 1/2 hour prior to installing on truck. After the old chains have been stripped from the mast, very carefully inspect chain anchors and chain wheel bearing. Broken, cracked or worn anchor must be replaced using the new anchor pin and split pin. Do not paint newly replaced chain after it has been installed.

③ Adjustment

Chain adjustments are important for the following reasons :

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

④ Adjustment procedure

- \cdot 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.