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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.

Structure and function

This group explains the structure and function of each component. It serves not only to give an understanding of the structure, but also serves as reference material for troubleshooting.

Operational checks and troubleshooting

This group explains the system operational checks and troubleshooting charts correlating problem to remedy.

Tests and adjustments

This group explains checks to be amide before and after performing repairs, as well as adjustments to be made at completion of the checks and repairs.

Disassembly and assembly

This section explains the order to be followed when removing, installing, disassembling or assembling each component, as well as precautions to be taken for these operations.

The specifications contained in this shop 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

3 - 3



Section number (3. Power train system)

Consecutive page number for each section.

- 3. Additional pages : Additional pages are indicated by a hyphen(-) and number after the page number. File as in the example.
 - 10 4

10 - 5

Revised edition mark (123...)

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

Revisions

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

Symbols

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

Symbol	Item	Remarks				
	Sofoty	Special safety precautions are necessary when performing the work.				
	Safety	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 50 in 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 \bigcirc . This point \bigcirc 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.

	Millimete	rs to inche	es				б				1mm = 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	

Millimotors to inches

Millimeters to inches

1 mm = 0.03937 in

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

Kilogram to Pound

1kg = 2.2046lb

									y	
	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
-------	---	----	-----	---	----

 $1 \text{kgf} \cdot \text{m} = 7.233 \text{lbf} \cdot \text{ft}$

	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

1kgf / cm² = 14.2233lbf / in²

								3	/ 0111 – 14.	
	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
000	00.45	0050	0070	0007	0001	0010	0000	0044	0050	0070
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		۴F	°C		°F	°C		۴F	°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

Group	1 Safety Hints	
Group	2 Specifications	0
Group	3 Operational Checkout Record Sheet1-2	4

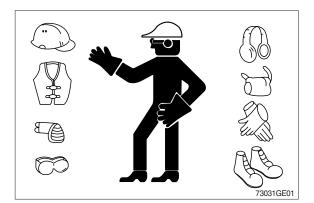
GROUP 1 SAFETY HINTS

FOLLOW SAFE PROCEDURE

Unsafe work practices are dangerous. Understand service procedure before doing work; Do not attempt shortcuts.

WEAR PROTECTIVE CLOTHING

Wear close fitting clothing and safety equipment appropriate to the job.



WARN OTHERS OF SERVICE WORK

Unexpected machine movement can cause serious injury.

Before performing any work on the wheel loader, attach a **[¬]Do Not Operate**[⊥] tag on the right side controller lever.

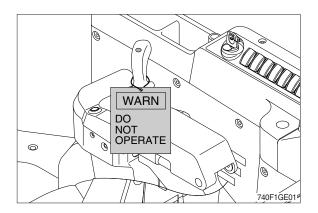
USE HANDHOLDS AND STEPS

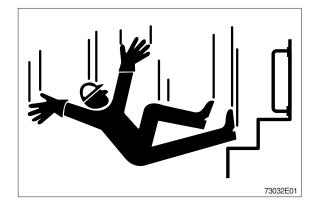
Falling is one of the major causes of personal injury.

When you get on and off the machine, always maintain a three point contact with the steps and handrails and face the machine. Do not use any controls as handholds.

Never jump on or off the machine. Never mount or dismount a moving machine.

Be careful of slippery conditions on platforms, steps, and handrails when leaving the machine.



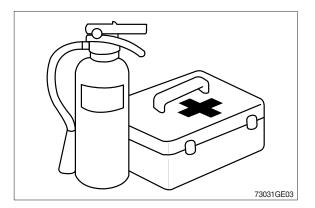


PREPARE FOR EMERGENCIES

Be prepared if a fire starts.

Keep a first aid kit and fire extinguisher handy.

Keep emergency numbers for doctors, ambulance service, hospital, and fire department near your telephone.



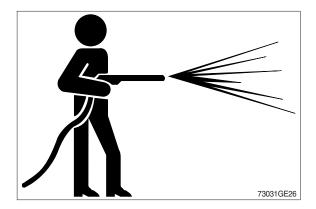
WORK IN CLEAN AREA

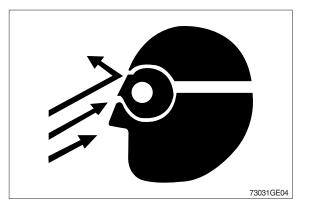
Before starting a job :

- · Clean work area and machine.
- Make sure you have all necessary tools to do your job.
- · Have the right parts on hand.
- Read all instructions thoroughly; Do not attempt shortcuts.

PROTECT AGAINST FLYING DEBRIS

Guard against injury from flying pieces of metal or debris; Wear goggles or safety glasses.

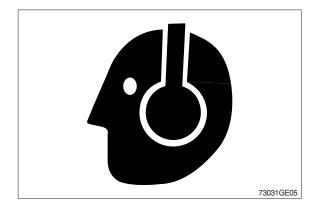




PROTECT AGAINST NOISE

Prolonged exposure to loud noise can cause impairment or loss of hearing.

Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.



PARK MACHINE SAFELY

Before working on the machine:

- · Park machine on a level surface.
- · Lower bucket to the ground.
- Turn key switch to OFF to stop engine. Remove key from switch.
- · Move pilot cut off switch to locked position.
- · Allow engine to cool.

SUPPORT MACHINE PROPERLY

Always lower the attachment or implement to the ground before you work on the machine. If you must work on a lifted machine or attachment, securely support the machine or attachment.

Do not support the machine on cinder blocks, hollow tiles, or props that may crumble under continuous load.

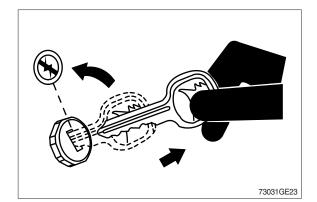
Do not work under a machine that is supported solely by a jack.

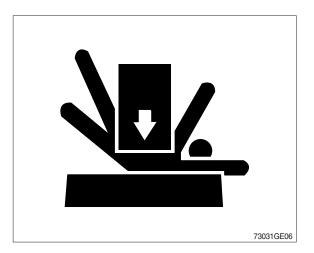
Follow recommended procedures in this manual.

SERVICE COOLING SYSTEM SAFELY

Explosive release of fluids from pressurized cooling system can cause serious burns.

Shut off engine. Only remove filler cap when cool enough to touch with bare hands.

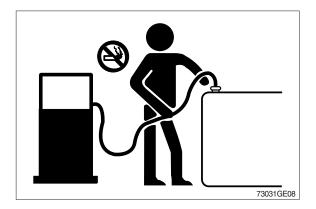






HANDLE FLUIDS SAFELY-AVOID FIRES

Handle fuel with care; It is highly flammable. Do not refuel the machine while smoking or when near open flame or sparks. Always stop engine before refueling machine. Fill fuel tank outdoors.



Store flammable fluids away from fire hazards. Do not incinerate or puncture pressurized containers.

Make sure machine is clean of trash, grease, and debris.

Do not store oily rags ; They can ignite and burn spontaneously.



Prevent asphyxiation. Engine exhaust fumes can cause sickness or death.

If you must operate in a building, be positive there is adequate ventilation. Either use an exhaust pipe extension to remove the exhaust fumes or open doors and windows to bring enough outside air into the area.

REMOVE PAINT BEFORE WELDING OR HEATING

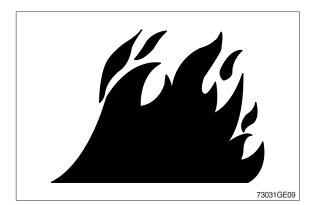
Avoid potentially toxic fumes and dust.

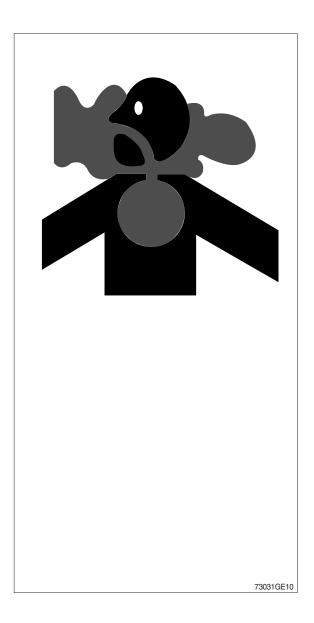
Hazardous fumes can be generated when paint is heated by welding, soldering, or using a torch.

Do all work outside or in a well ventilated area. Dispose of paint and solvent properly.

Remove paint before welding or heating:

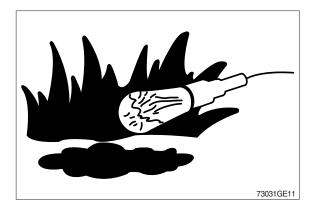
- If you sand or grind paint, avoid breathing the dust. Wear an approved respirator.
- If you use solvent or paint stripper, remove stripper with soap and water before welding. Remove solvent or paint stripper containers and other flammable material from area. Allow fumes to disperse at least 15 minutes before welding or heating.





ILLUMINATE WORK AREA SAFELY

Illuminate your work area adequately but safely. Use a portable safety light for working inside or under the machine. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite spilled fuel or oil.



SERVICE MACHINE SAFELY

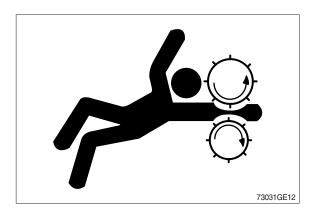
Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

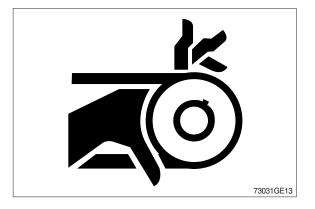
Remove rings and other jewelry to prevent electrical shorts and entanglement in moving parts.

STAY CLEAR OF MOVING PARTS

Entanglements in moving parts can cause serious injury.

To prevent accidents, use care when working around rotating parts.





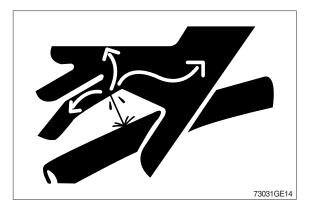
AVOID HIGH PRESSURE FLUIDS

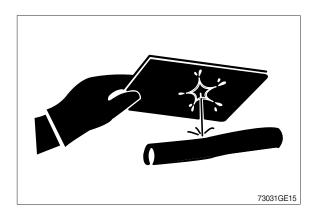
Escaping fluid under pressure can penetrate the skin causing serious injury.

Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.

Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result.





AVOID HEATING NEAR PRESSURIZED FLUID LINES

Flammable spray can be generated by heating near pressurized fluid lines, resulting in severe burns to yourself and bystanders. Do not heat by welding, soldering, or using a torch near pressurized fluid lines or other flammable materials.

Pressurized lines can be accidentally cut when heat goes beyond the immediate flame area. Install fire resisting guards to protect hoses or other materials.

1301GE18

PREVENT BATTERY EXPLOSIONS

Keep sparks, lighted matches, and flame away from the top of battery. Battery gas can explode.

Never check battery charge by placing a metal object across the posts. Use a volt-meter or hydrometer.

Do not charge a frozen battery; It may explode. Warm battery to $16^{\circ}C(60^{\circ}F)$.



PREVENT ACID BURNS

Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into eyes.

- 1. Avoid the hazard by:
- 2. Filling batteries in a well-ventilated area.
- Wearing eye protection and rubber gloves. Avoiding breathing fumes when electrolyte is added.
- 4. Avoiding spilling of dripping electrolyte.
- 5. Use proper jump start procedure.
- 1. If you spill acid on yourself:
- Flush your skin with water. Apply baking soda or lime to help neutralize the acid.
- 3. Flush your eyes with water for 10-15 minutes. Get medical attention immediately.
- 1. If acid is swallowed:
- Drink large amounts of water or milk.
 Then drink milk of magnesia, beaten eggs, or vegetable oil.
- 3. Get medical attention immediately.

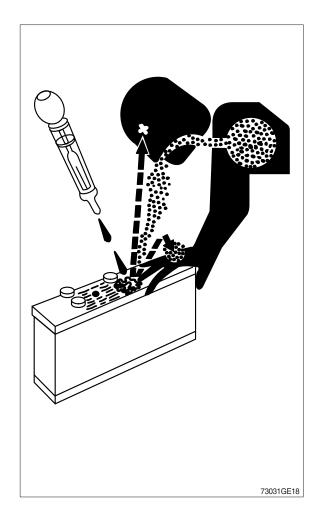
USE TOOLS PROPERLY

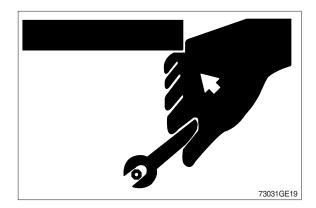
Use tools appropriate to the work. Makeshift tools, parts, and procedures can create safety hazards.

Use power tools only to loosen threaded tools and fasteners.

For loosening and tightening hardware, use the correct size tools. Avoid bodily injury caused by slipping wrenches.

Use only recommended replacement parts. (See Parts catalogue.)





SERVICE TIRES SAFELY

Explosive separation of a tire and rim parts can cause serious injury or death.

Do not attempt to mount a tire unless you have the proper equipment and experience to perform the job.

Always maintain the correct tire pressure. Do not inflate the tires above the recommended pressure. Never weld or heat a wheel and tire assembly. The heat can cause an increase in air pressure resulting in a tire explosion.

Welding can structurally weaken or deform the wheel.

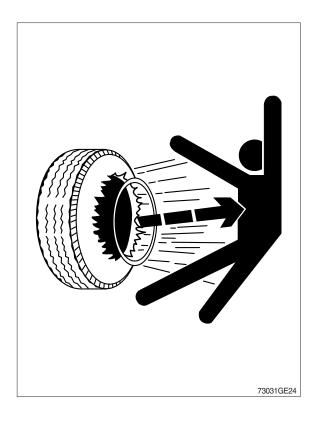
When inflating tires, use a clip-on chuck and extension hose long enough to allow you to stand to one side and not in front of or over the tire assembly. Use a safety cage if available.

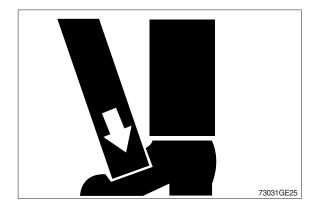
Check wheels for low pressure, cuts, bubbles, damaged rims or missing lug bolts and nuts.

USE PROPER LIFTING EQUIPMENT

Lifting heavy components incorrectly can cause severe injury or machine damage.

Follow recommended procedure for removal and installation of components in the manual.



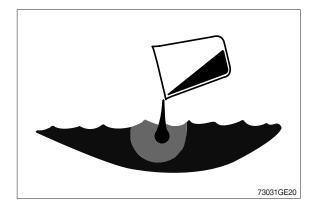


DISPOSE OF FLUIDS PROPERLY

Improperly disposing of fluids can harm the environment and ecology. Before draining any fluids, find out the proper way to dispose of waste from your local environmental agency.

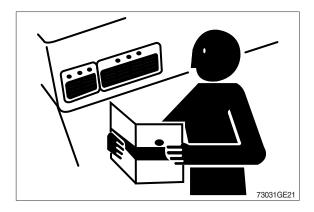
Use proper containers when draining fluids. Do not use food or beverage containers that may mislead someone into drinking from them.

DO NOT pour oil into the ground, down a drain, or into a stream, pond, or lake. Observe relevant environmental protection regulations when disposing of oil, fuel, coolant, brake fluid, filters, batteries, and other harmful waste.



REPLACE SAFETY SIGNS

Replace missing or damaged safety signs. See the machine operator's manual for correct safety sign placement.



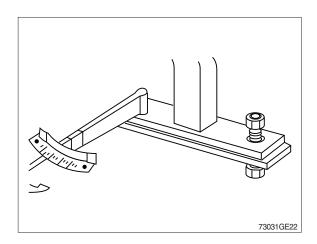
LIVE WITH SAFETY

Before returning machine to customer, make sure machine is functioning properly, especially the safety systems. Install all guards and shields.

KEEP ROPS INSTALLED PROPERLY

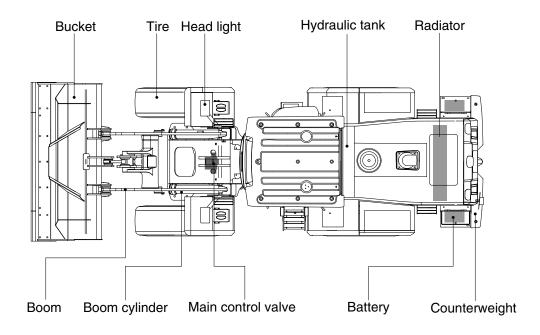
Make certain all parts are reinstalled correctly if the roll-over protective structure (ROPS) is loosened or removed for any reason. Tighten mounting bolts to proper torque.

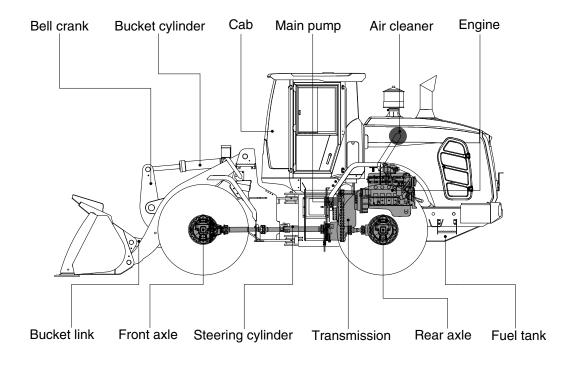
The protection offered by ROPS will be impaired if ROPS is subjected to structural damage, is involved in an overturn incident, or is in any way altered by welding, bending, drilling, or cutting. A damaged ROPS should be replaced, not reused.



GROUP 2 SPECIFICATION

1. MAJOR COMPONENT

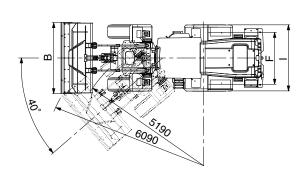


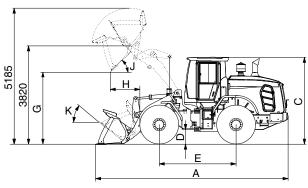


940SA2SE01

2. SPECIFICATIONS

1) WITH BOLT-ON CUTTING EDGE TYPE BUCKET (HL940 T3)

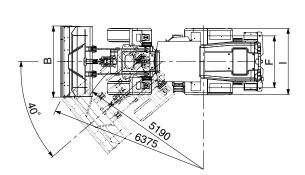


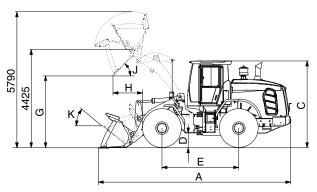


940A2SE03

	Description		Unit	Specification
Operating weig	jht		kg (lb)	13200 (29105)
D al al a servit		Struck		2.0 (2.6)
Bucket capacit	У	Heaped	m³ (yd³)	2.3 (3.0)
Overall length		A		7600 (24' 11")
Overall width		В		2600 (8' 6")
Overall height		С		3300 (10' 10")
Ground clearar	nce	D		417 (1' 5")
Wheelbase		E	mm (ft-in)	3000 (9' 10")
Tread		F		1930 (6' 4")
Dump clearanc	e at 45°	G		2765 (9' 1")
Dump reach (fu	ull lift)	Н		1095 (3' 7")
Width over tires	S	1		2450 (8' 0")
Dump angle		J	deerree (°)	48
Rollback angle (carry position)	К	degree (°)	47
		Lift (with load)		5.5
Cycle time	time Dump (with load)	sec	1.8	
		Lower (empty)		3.7
Maximum trave	el speed		km/hr (mph)	38.8 (24.1)
Braking distand	ce		res (ft in)	12.6 (41' 4")
Minimum turnir	ng radius (cente	r of outside tire)	m (ft-in)	5.19 (17' 0")
Gradeability			degree (°)	30
Breakout force			kg (lb)	11800 (26015)
		First gear		6.7 (4.2)
	F amurand	Second gear		12.1 (7.5)
	Forward	Third gear		23.5 (14.6)
Travel speed		Fourth gear	km/hr (mph)	38.8 (24.1)
		First gear		7.0 (4.3)
	Reverse	Second gear		12.8 (8.0)
		Third gear		24.7 (15.3)

WITH BOLT-ON CUTTING EDGE TYPE BUCKET (HL940XT T3)

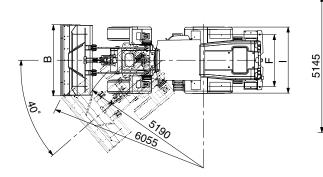


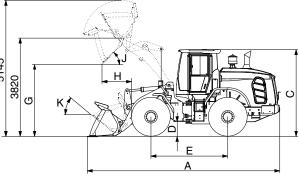


940A2SE03-2

	Description		Unit	Specification
Operating weig	iht		kg (lb)	13645 (30085)
D		Struck		2.0 (2.6)
Вискет сарасіт	Bucket capacity		m³ (yd³)	2.3 (3.0)
Overall length		A		8190 (26' 10")
Overall width		В		2600 (8' 6")
Overall height		С		3300 (10' 10")
Ground clearar	nce	D		417 (1' 4")
Wheelbase		E	mm (ft-in)	3000 (9' 10")
Tread		F		1930 (6' 4")
Dump clearance	e at 45°	G		3370 (11' 1")
Dump reach (fu	ull lift)	Н		1090 (3' 7")
Width over tires	S	I		2450 (8' 0")
Dump angle	Dump angle		deerree (°)	47
Rollback angle (carry position)	К	degree (°)	50
		Lift (with load)		5.5
Cycle time	Dump (with lo		sec	1.8
		Lower (empty)		3.7
Maximum trave	el speed		km/hr (mph)	40 (24.9)
Braking distand	ce		m (ft in)	12.6 (41' 4")
Minimum turnir	ng radius (cente	er of outside tire)	m (ft-in)	5.19 (17' 0")
Gradeability			degree (°)	30
Breakout force			kg (lb)	11940 (26325)
		First gear		6.7 (4.2)
	Forward	Second gear		12.1 (7.5)
	Forward	Third gear		23.5 (14.6)
Travel speed		Fourth gear	km/hr (mph)	38.8 (24.1)
		First gear		7.0 (4.3)
	Reverse	Second gear		12.8 (8.0)
		Third gear		24.7 (15.3)

WITH BOLT-ON CUTTING EDGE TYPE NARROW BUCKET (HL940 T3)

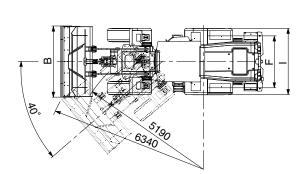


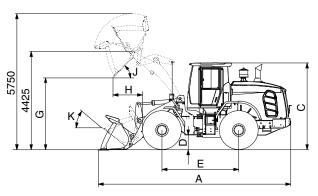


940A2SE02

	Description		Unit	Specification
Operating weig	jht		kg (lb)	13160 (29015)
D al al a servit		Struck		1.8 (2.4)
Bucket capacit	У	Heaped	m³ (yd³)	2.1 (2.7)
Overall length		A		7560 (24' 10")
Overall width		В		2550 (8' 4")
Overall height		С		3300 (10' 10")
Ground clearar	nce	D		432 (1' 5")
Wheelbase		E	mm (ft-in)	3000 (9' 10")
Tread		F		1930 (6' 4")
Dump clearance	ce at 45°	G		2795 (9' 2")
Dump reach (fu	ull lift)	Н		1065 (3' 6")
Width over tires	S	I		2450 (8' 0")
Dump angle	Dump angle		de erre e (°)	48
Rollback angle (carry position)	К	degree (°)	47
		Lift (with load)		5.5
Cycle time		Dump (with load)	sec	1.8
		Lower (empty)		3.7
Maximum trave	el speed		km/hr (mph)	40 (24.9)
Braking distand	ce		m (# in)	12.6 (41' 4")
Minimum turnir	ng radius (cente	r of outside tire)	m (ft-in)	5.19 (17' 0")
Gradeability			degree (°)	30
Breakout force			kg (lb)	12230 (26960)
		First gear		6.7 (4.2)
	Ecoword	Second gear		12.1 (7.5)
	Forward	Third gear		23.5 (14.6)
Travel speed		Fourth gear	km/hr (mph)	38.8 (24.1)
		First gear		7.0 (4.3)
	Reverse	Second gear		12.8 (8.0)
		Third gear		24.7 (15.3)

WITH BOLT-ON CUTTING EDGE TYPE NARROW BUCKET (HL940XT T3)





940A2SE02-1

	Description		Unit	Specification
Operating weig	ght		kg (lb)	13605 (30000)
D al al a servit		Struck		1.8 (2.4)
Bucket capacit	У	Heaped	m³ (yd³)	2.1 (2.7)
Overall length		A		8150 (26' 9")
Overall width		В		2550 (8' 4")
Overall height		С		3300 (10' 10")
Ground cleara	nce	D		432 (1' 5")
Wheelbase		E	mm (ft-in)	3000 (9' 10")
Tread		F		1930 (6' 4")
Dump clearand	ce at 45°	G		3400 (11' 2")
Dump reach (fi	ull lift)	Н		1060 (3' 6")
Width over tire	S	I		2450 (8' 0")
Dump angle	Dump angle		de sue e (°)	47
Rollback angle ((carry position)	К	degree (°)	50
		Lift (with load)		5.5
Cycle time		Dump (with load)	sec	1.8
		Lower (empty)		3.7
Maximum trave	el speed		km/hr (mph)	40 (24.9)
Braking distand	ce		m (ft in)	12.6 (41' 4")
Minimum turnir	ng radius (cente	er of outside tire)	m (ft-in)	5.19 (17' 0")
Gradeability			degree (°)	30
Breakout force			kg (lb)	12370 (27270)
		First gear		6.7 (4.2)
	Forward	Second gear		12.1 (7.5)
	Forward	Third gear		23.5 (14.6)
Travel speed		Fourth gear	km/hr (mph)	38.8 (24.1)
		First gear		7.0 (4.3)
	Reverse	Second gear		12.8 (8.0)
		Third gear		24.7 (15.3)

3. WEIGHT

lte	em	kg	lb	
Front frame assembly		935	2065	
Rear frame assembly		1342	2960	
Front fender (LH & RH)		61	135	
Rear fender (LH & RH)		95	210	
Countorweight	HL940 T3	300	665	
Counterweight	HL940XT T3	500	1105	
Cab assembly		726	1605	
Engine assembly		555	1225	
Transmission assembly		404	895	
Driveshaft (front)		12	30	
Driveshaft (center)		18	40	
Driveshaft (rear)		10	25	
Front axle (include different	tial)	750	1655	
Rear axle (include different	ial)	772	1705	
Tire (20.5 R25 L3 ★★)		696	1535	
Hydraulic tank assembly		150	335	
Fuel tank assembly		280	620	
Main pump assembly		23	55	
Fan & brake pump assemb	bly	23	55	
Main control valve (2/3 spo	ool)	42/55	95/125	
Steering valve (Priority valv	/e)	8	20	
Boom assembly	HL940 t3	720	1590	
Doom assembly	HL940XT t3	945	2085	
Bell crank assembly		260	575	
Bucket link		35	80	
2.3 m ³ bucket, with bolt on	cutting edge	1110	2450	
2.1 m ³ bucket, with bolt on	cutting edge	1070	2360	
Quick coupler		1040	2295	
Boom cylinder assembly		85	190	
Bucket cylinder assembly (HL940 T3/HL940XT T3)	95/115	210/255	
Steering cylinder assembly	/	17	37	
Seat (Including suspension	and armrest)	78	175	
Under guard Kit		46	105	
Engine Hood assembly		293	650	
Mud guard assembly (LH /	RH)	41	95	
Battery (1EA)		30	70	

4. SPECIFICATION FOR MAJOR COMPONENTS

1) ENGINE

Item	Specification
Model	HYUNDAI HE6.7
Туре	4-cycle turbocharged, charge air cooled diesel engine
Control type	Electronic control
Cooling method	Water cooling
Number of cylinders and arrangement	6 cylinders, in-line
Firing order	1-5-3-6-2-4
Combustion chamber type	Direct injection type
Cylinder bore $ imes$ stroke	107×124 mm (4.2"×4.9")
Piston displacement	6700 cc (408 cu in)
Compression ratio	17.2 : 1
Gross power	145 hp (108 kW) at 2100 rpm
Net power	142 hp (106 kW) at 2100 rpm
Maximum power	146 hp (109 kW) at 1900 rpm
Peak gross torque	667 N · m (492 lbf · ft) at 1400 rpm
Engine oil quantity	18 ℓ (4.8 U.S. gal)
Wet weight	552 kg (1216 lb)
Starting motor	24V-4.8kW
Alternator	24V-70Amp
Battery	2×12V×120Ah

2) MAIN PUMP

Item	Specification
Туре	Variable piston pump
Capacity	74 cc/rev
Maximum operating pressure	280 kgf/cm ² (3980 psi)
Rated output flow	160 ℓ /min (42.3 U.S.gpm)

3) FAN AND BRAKE PUMP

Item	Specification		
	Fan	Brake	
Туре	Variable piston pump		
Capacity	28 cc/rev		
Maximum operating pressure	250 bar 150 bar		
Rated output flow	56 ℓ /min (14.8 U.S.gpm)		

4) MAIN CONTROL VALVE

Item	Specification	
Туре	2 spool & 3 spool	
Operating method	Hydraulic pilot assist	
Main relief valve set pressure	280 kgf/cm ² (3980 psi)	
Overload relief valve set pressure	340 kgf/cm ² (4840 psi)	

5) REMOTE CONTROL VALVE

Item		Specification	
Туре		Joystick (or with aux lever)	
Minimum		3.7 kgf/cm ² (52.6 psi)	
Control pressure Maximum		30 kgf/cm ² (427 psi)	

6) CYLINDER

Item		Specification
Boom cylinder	Bore dia $ imes$ Rod dia $ imes$ Stroke	\emptyset 110 \times \emptyset 65 \times 738 mm
Bucket cylinder (HL940 T3)	Bore dia $ imes$ Rod dia $ imes$ Stroke	\emptyset 125 \times \emptyset 70 \times 560 mm
Bucket cylinder (HL940XT T3)	Bore dia $ imes$ Rod dia $ imes$ Stroke	\emptyset 125 \times \emptyset 75 \times 580 mm
Steering cylinder	Bore dia $ imes$ Rod dia $ imes$ Stroke	Ø 65ר40×429 mm

7) DYNAMIC POWER TRANSMISSION DEVICES

	Item	Specification
	Model	ZF 4WG160
Torque converter	Туре	Single-stage, single-phase
	Ratio	2.302 : 1
	Туре	Full-automatic power shift
Transmission	Gear shift	Forward fourth gear, reverse third gear
	Control	Electrical single lever type, kick-down system
	Drive devices	4-wheel drive
Axle	Front	Front fixed location
	Rear	Oscillation \pm 12° of center pin-loaded
Wheels	Tires	20.5 R25 L3 **
Brakes	Travel	Four-wheel, wet-disc type, full hydraulic
Diakes	Parking	Spring applied, hydraulic released brake on transmission
Stooring	Туре	Full hydraulic, articulated
Steering	Steering angle	40° to both right and left angle, respectively

No		Descriptions	Dolt oizo	Tor	que
No.		Descriptions	Bolt size	kgf ∙ m	lbf ⋅ ft
1		Engine mounting bolt, nut (rubber, 2EA)		57.9 ± 8.7	419 ± 63
2		Engine mounting bolt (bracket, 8EA)	M12×1.75	11.7 ± 1.8	84.6 ± 13
3		Engine mounting bolt (T/C plate-adapter, 4EA)	M10×1.5	$\textbf{6.9} \pm \textbf{1.4}$	49.9 ± 10.1
4	Facino	Engine mounting stud bolt,nut (flywheel, 10EA)	M10×1.5	$\textbf{6.8} \pm \textbf{1.0}$	49.2 ± 7.2
5	Engine	Engine mounting stud bolt (flywheel, 2EA)	M10×1.5	$\textbf{4.6} \pm \textbf{0.9}$	33.3 ± 6.5
6		Fan motor mounting bolt	M12×1.75	$\textbf{12.8} \pm \textbf{3.0}$	$\textbf{92.6} \pm \textbf{21.7}$
7		Radiator mounting bolt	M16×2.0	$\textbf{29.7} \pm \textbf{5.9}$	$\textbf{215} \pm \textbf{42.7}$
8		Fuel tank mounting bolt	M16×2.0	$\textbf{29.7} \pm \textbf{4.5}$	$\textbf{215} \pm \textbf{32.5}$
9		Main pump housing mounting bolt	M16×2.0	$\textbf{29.7} \pm \textbf{4.5}$	$\textbf{215} \pm \textbf{32.5}$
10		Fan & brake pump housing mounting bolt	M10×1.5	6.9 ± 1.4	50 ± 10.1
11		Main control valve mounting bolt	M10×1.5	$\textbf{6.9} \pm \textbf{1.4}$	50 ± 10.1
12		Steering unit mounting bolt	M10×1.5	6.9 ± 1.4	50 ± 10.1
13	Hydraulic system	Brake valve mounting bolt	M8×1.25	$\textbf{2.5}\pm\textbf{0.5}$	18.1 ± 3.6
14	-,	Cut-off valve mounting bolt	M8×1.25	$\textbf{2.5}\pm\textbf{0.5}$	18.1 ± 3.6
15	Remote control lever mounting bolt		M6×1.0	1.1 ± 0.2	8.0 ± 1.4
16		Safety valve	M10×1.5	6.9 ± 1.4	50 ± 10.1
17		Hydraulic oil tank mounting bolt	M16×2.0	29.7 ± 4.5	$\textbf{215} \pm \textbf{32.5}$
18		Transmission mounting bolt, nut (rubber, 2EA)	M24×3.0	100 ± 15	$\textbf{723} \pm \textbf{108}$
19		Transmission mounting bolt (bracket, 6EA)	M20×2.5	$\textbf{56.1} \pm \textbf{8.4}$	406 ± 60.8
20	Power	Front axle mounting bolt, nut	M27×2.0	$\textbf{135} \pm \textbf{20.2}$	976 ± 146
21	train system	Rear axle support mounting bolt, nut	M27×2.0	135 ± 15	976 ± 108
22	Tire mounting nut		M22×1.5	79 ± 11.9	571 ± 86.1
23	Drive shaft joint mounting bolt		3/8-24UNF	6.0 ± 0.8	$\textbf{43.4} \pm \textbf{5.8}$
24		Counterweight mounting bolt (4EA)	M30×3.5	199 ± 30	1439 ± 216
25	Otherse	Operator's seat mounting bolt	M8×1.25	3.4 ± 0.8	24.6 ± 5.0
00	Others	ROPS Cab mounting bolt (4EA)	M20×2.5	58 ± 8.7	419 ± 63
26		ROPS Cab mounting nut (4EA)	M16×2.0	$\textbf{20.5} \pm \textbf{4.7}$	148± 34

5. TIGHTENING TORQUE OF MAJOR COMPONENT

6. TORQUE CHART

Use following table for unspecified torque.

1) BOLT AND NUT

(1) Coarse thread

Bolt size	8.8	8.8T		10.9T		.9T
DOIL SIZE	kgf⋅m	lbf·ft	kgf⋅m	lbf·ft	kgf∙m	lbf·ft
M 6×1.0	0.8 ~ 1.2	5.8 ~ 8.6	1.2 ~ 1.8	8.7 ~ 13.0	1.5 ~ 2.1	10.9 ~ 15.1
M 8×1.25	2.0 ~ 3.0	14.5 ~ 21.6	2.8 ~ 4.2	20.3 ~ 30.4	3.4 ~ 5.0	24.6 ~ 36.1
M10 × 1.5	4.0 ~ 6.0	29.0 ~ 43.3	5.6 ~ 8.4	40.5 ~ 60.8	6.8 ~ 10.0	49.2 ~ 72.3
M12 × 1.75	6.8 ~ 10.2	50.0 ~ 73.7	9.6 ~ 14.4	69.5 ~ 104	12.3 ~ 16.5	89.0 ~ 119
M14 × 2.0	10.9 ~ 16.3	78.9 ~ 117	16.3 ~ 21.9	118 ~ 158	19.5 ~ 26.3	141 ~ 190
M16 × 2.0	17.9 ~ 24.1	130 ~ 174	25.1 ~ 33.9	182 ~ 245	30.2 ~ 40.8	141 ~ 295
M18 × 2.5	24.8 ~ 33.4	180 ~ 241	34.8 ~ 47.0	252 ~ 340	41.8 ~ 56.4	302 ~ 407
M20 × 2.5	34.9 ~ 47.1	253 ~ 340	49.1 ~ 66.3	355 ~ 479	58.9 ~ 79.5	426 ~ 575
M22 × 2.5	46.8 ~ 63.2	339 ~ 457	65.8 ~ 88.8	476 ~ 642	78.9 ~ 106	570 ~ 766
M24 × 3.0	60.2 ~ 81.4	436 ~ 588	84.6 ~ 114	612 ~ 824	102 ~ 137	738 ~ 991
M30 × 3.5	120 ~ 161	868 ~ 1164	168 ~ 227	1216 ~ 1641	202 ~ 272	1461 ~ 1967

(2) Fine thread

Bolt size	8.8	8.8T		10.9T		.9T
DOIL SIZE	kgf ∙ m	lbf ⋅ ft	kgf · m	lbf ⋅ ft	kgf · m	lbf ⋅ ft
M 8 × 1.0	2.1 ~ 3.1	15.2 ~ 22.4	3.0 ~ 4.4	21.7 ~ 31.8	3.6 ~ 5.4	26.1 ~ 39.0
M10 × 1.25	4.2 ~ 6.2	30.4 ~ 44.9	5.9 ~ 8.7	42.7 ~ 62.9	7.0 ~ 10.4	50.1 ~ 75.2
M12 × 1.25	7.3 ~ 10.9	52.8 ~ 78.8	10.3 ~ 15.3	74.5 ~ 110	13.1 ~ 17.7	94.8 ~ 128
M14 × 1.5	12.4 ~ 16.6	89.7 ~ 120	17.4 ~ 23.4	126 ~ 169	20.8 ~ 28.0	151 ~ 202
M16 × 1.5	18.7 ~ 25.3	136 ~ 182	26.3 ~ 35.5	191 ~ 256	31.6 ~ 42.6	229 ~ 308
M18 × 1.5	27.1 ~ 36.5	196 ~ 264	38.0 ~ 51.4	275 ~ 371	45.7 ~ 61.7	331 ~ 446
M20 × 1.5	37.7 ~ 50.9	273 ~ 368	53.1 ~ 71.7	384 ~ 518	63.6 ~ 86.0	460 ~ 622
M22 × 1.5	51.2 ~ 69.2	370 ~ 500	72.0 ~ 97.2	521 ~ 703	86.4 ~ 116	625 ~ 839
M24 × 2.0	64.1 ~ 86.5	464 ~ 625	90.1 ~ 121	652 ~ 875	108 ~ 146	782 ~ 1056
M30 × 2.0	129 ~ 174	933 ~ 1258	181 ~ 245	1310 ~ 1772	217 ~ 294	1570 ~ 2126

2) PIPE AND HOSE (FLARE type)

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

3) PIPE AND HOSE (ORFS type)

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

4) FITTING

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

7. RECOMMENDED LUBRICANTS

1) NEW MACHINE

New machine used and filled with following lubricants.

Specification				
c oil (ISO VG 46, VG 68 only) 15 ^{*2})				
se antifreeze and 50% water				
se antifreeze and 40% water ^{*2}				

- **SAE** : Society of Automotive Engineers
- **API** : American Petroleum Institute
- ISO : International Organization for Standardization CASTROL AGRI TRANS PLUS 10W-30
- **NLGI** : National Lubricating Grease Institute
- **ASTM** : American Society of Testing and Material
- * Recommended oil list
 - BP TERRAC SUPER TRANSMISSION 10W-30

 - MOBILFLUID 426
 - SHELL DONAX TD 10W-30
 - TOTAL DYNATRANS MPV
- ★2 Cold region

2) RECOMMENDED OILS

HYUNDAI genuine lubricating oils have been developed to offer the best performance and service life for your equipment. These oils have been tested according to the specifications of HYUNDAI and, therefore, will meet the highest safety and quality requirements.

We recommend that you use only HYUNDAI genuine lubricating oils and grease officially approved by HYUNDAI.

- * Using any lubricating oils other than HYUNDAI genuine products may lead to a deterioration of performance and cause damage to major components.
- * Do not mix HYUNDAI genuine oil with any other lubricating oil as it may result in damage to the systems of major components.
- ※ Do not use any engine oil other than that specified above, as it may clog the diesel particulate filter(DPF).
- * For HYUNDAI genuine lubricating oils and grease for use in regions with extremely low temperatures, please contact HYUNDAI dealers.

	Kind of fluid	id Capacity ℓ (U.S. gal)	Ambient temperature °C(°F)											
Service point			-50 (-58) (-30 -22)	-20 (-4)	-10 (14	-		-		30 40 6) (104)			
								SVE	15\1/40					
Engine oil pan	Engine oil	Engine cil	18 (4.8)		\$									
		10 (4.0)					^-0	SAE SVV-	40					
				SAE 0W-40										
	Engine oil	ngine oil 35 (9.2)							20					
Transmission							5/	AE 10W-3	30					
			()						SAE 1	5W-40	1			
Axle *4		FR : 23 (6.1) RR : 23 (6.1)	*Refer to below list											
		nn . 23 (0.1)												
	Tank:				★² S	SO VG	i 15							
Hydraulic	Hydraulic 90 (23.8) oil System:						ISO VG	46						
tank				ISO VG 68										
		130 (34.3)						Į.	50 VG 6	8				
	Diesel fuel	Diocol	Diocol	Diocol	Nigeol		★ ² AST	M D975	5 NO.1					
Fuel tank		220 (58.1)						AST	M D975					
						_		AUT						
Fitting	Grease	e Grease As required				★2	NLGI	NO.1	[I				
(grease nipple)								Ν	ILGI NO.	.2				
Radiator	Mixture of				Ethyle	ene alı	vcol bas	se perma	anent tvo	e (50 : 50))			
(reservoir tank)	antifreeze and soft water ^{★3}	37 (9.8)	★ ² Ethyle	ne glycol b		Ţ.								

- SAE : Society of Automotive Engineers
- API : American Petroleum Institute
- **ISO** : International Organization for Standardization
- NLGI : National Lubricating Grease Institute
- ASTM : American Society of Testing and Material
- UTTO : Universal Tractor Transmission Oil
- * Recommended oil list
 - BP TERRAC SUPER TRANSMISSION 10W-30
 - CASTROL AGRI TRANS PLUS 10W-30
 - MOBILFLUID 426
 - SHELL DONAX TD 10W-30
 - TOTAL DYNATRANS MPV
- *² Cold region
- *3 Soft water : City water or distilled water
- *4 If the machine is equipped with axle oil cooler, refer to page 6-38 in operator's manual.

GROUP 3 OPERATIONAL CHECKOUT RECORD SHEET

· Owner

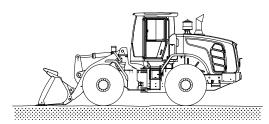
:

:

:

- · Date
- · Hours
- · Serial No. :
- \cdot Technician :
- Use this sheet to record operational checkout results.
 Perform the operational check before

installing any test equipment.



740F1GE02

Item	OK	NOT OK	Comments
------	----	-----------	----------

1. Monitor indicator and gauge checks (engine OFF)

 Hourmeter and gauge check Battery check Monitor indicator circuit check 		
Cluster turn signals and warning indicator check		
2. Transmission, axle and engine, neutral start switch and reverse warning alarm switch checks		
· Transmission control lever and neutral		
· Neutral start and reverse warning		
· Alarm circuit checks		
3. Monitor indicator and gauge checks (engine running)		
· Monitor display and alternator output checks		
 Monitor bypass circuit and seat belt indicator check 		
Monitor primary and secondary level check		
Transmission oil warm up procedure		
Transmission temperature gauge check		

4. Brake system and clutch cut off checks

· Park brake capacity check		
Park brake transmission lockout check		
· Service brake pump flow check		
· Service brake capacity check		
· Brake accumulator precharge check		
· Brake system leakage check		
· Service brake pedal check		
 Service and park brake system drag check 		
· Clutch cut off check		
5. Driving checks		
· Transmission oil warm up procedure		
· Transmission noise check		
· Speedometer check		
 Transmission kick down system check 		
$^{\cdot}$ 1st, 2nd, 3rd and 4th speed clutch pack drag check		
$^{\cdot}$ Transmission pressure, pump flow and leakage check		
 Transmission shift modulation check 		
· Torque converter check		
· Engine power check		
6. Hydraulic system checks		
· Hydraulic system warm up procedure		
· Hydraulic pump performance check		
· Pilot control valve boom float check		
· Boom down solenoid valve check		
· Control valve lift check		
· Bucket rollback circuit relief valve check		
· Bucket dump circuit relief		
Low pressure check		
High pressure check		
 Boom and bucket cylinder drift check 		
 Boom down solenoid valve leakage check 		
· Pilot controller check		
· Return to dig check		
 Boom height kickout check-if equipped 		

7. Steering system checks

· Steering unit check		
· Steering system leakage check		
Steering valve (EHPS)	_	
Low check pressure		
High check pressure		
8. Accessory checks		
· Operating lights check		
· Work light check		
· Brake light check		
· Cab light check		
· Horn circuit check		
· Windshield washer and wiper check		
· Defroster blower check		
· Heater/Air conditioner blower check		
· Heater functional check		
· Air conditioner functional check		
· Start aid system check		
9. Cab components and vandal protection checks		
· Cab door latch check		
· Cab door hold open latch check		
· Cab door release button check		
· Cab door lock check		
· Cab door window check		
· Cab window latch check		
· Steering column adjustment check		
· Seat and seat belt check		
· Air intake filter door check		
· Engine side panels check		
· Radiator cap access door check		
· Frame locking bar check		
· Boom lock check		
· Service decal check		

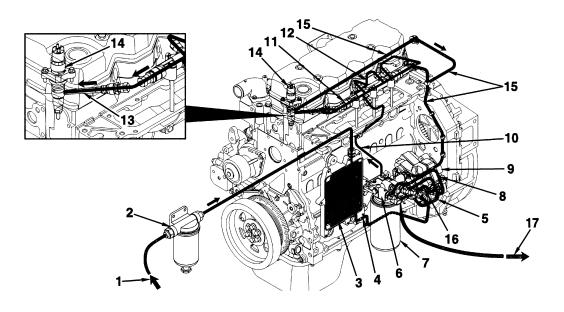
Group	1	Structure and Function	2-1
Group	2	Engine speed and Stall rpm	2-6

GROUP 1 STRUCTURE AND FUNCTION

1. SYSTEM DIAGRAMS

The following drawings show the flow through the engine systems.

1) FUEL SYSTEM

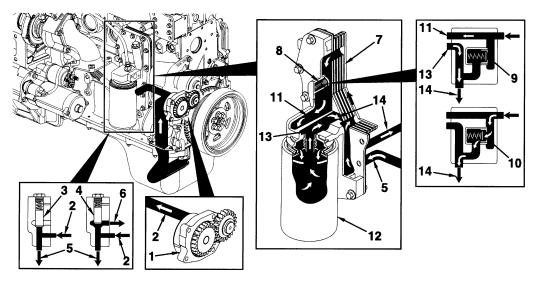


7607AEG02

- 1 From fuel tank
- 2 Water/fuel separator (not mounted on engine)
- 3 ECM cooling plate
- 4 To fuel gear pump
- 5 To fuel filter
- 6 Fuel filter head
- 7 Fuel filter
- 8 To high-pressure pump
- 9 High-pressure pump
- 10 To fuel rail

- 11 Fuel rail
- 12 To injectors
- 13 High-pressure connector
- 14 Injector
- 15 Fuel return from injectors and fuel rail to fuel filter head
- 16 Fuel return from high-pressure pump to fuel filter head
- 17 To fuel tank

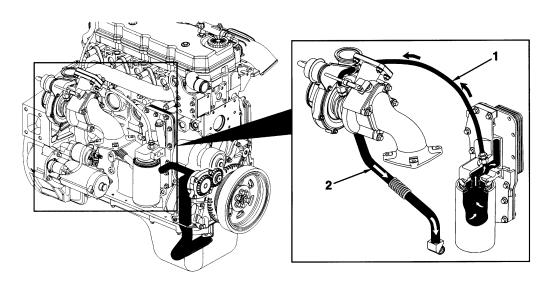
2) LUBRICATING OIL SYSTEM



7607AEG03

- 1 Gerotor lubricating oil pump
- 2 From lubricating oil pump
- 3 Pressure regulating valve closed
- 4 Pressure regulating valve open
- 5 To lubricating oil cooler
- 6 To lubricating oil pump supply
- 7 Lubricating oil cooler

- 8 Filter bypass valve
- 9 Filter bypass valve closed
- 10 Filter bypass valve open
- 11 To lubricating oil filter
- 12 Full-flow lubricating oil filter
- 13 From lubricating oil filter
- 14 Main lubricating oil rifle

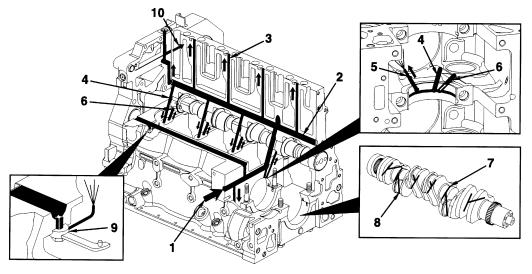


(1) Lubrication for the turbocharger

7607AEG04

- 1 Turbocharger lubricating oil supply
- 2 Turbocharger lubricating oil drain

(2) Lubrication for the power components

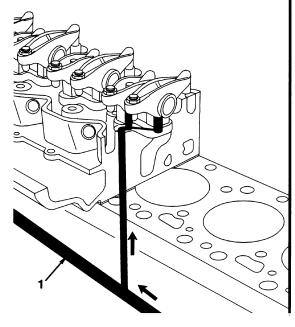


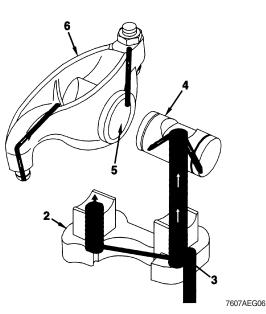
7607AEG05

- 1 From lubricating oil cooler
- 2 Main lubricating oil rifle
- 3 To valve train
- 4 From main lubricating oil rifle
- 5 To piston-cooling nozzle

- 6 To camshaft
- 7 Crankshaft main journal
- 8 Oil supply to rod bearings
- 9 Directed piston-cooling nozzle
- 10 To internal lubrication of air compressor

(3) Lubrication for the overhead

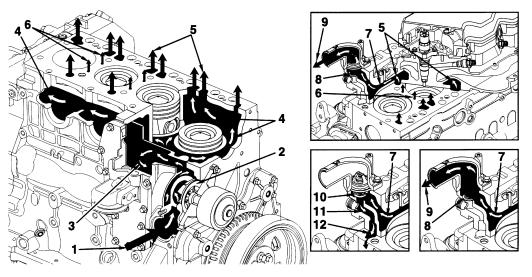




- 1 Main lubricating oil rifle
- 2 Rocker lever support
- 3 Transfer slot

- 4 Rocker lever shaft
- 5 Rocker lever bore
- 6 Rocker lever

3) COOLING SYSTEM

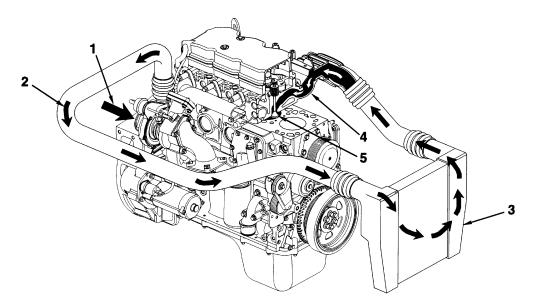


7607AEG07

- 1 Coolant inlet
- 2 Pump Impeller
- 3 Coolant flow past lubricating oil cooler
- 4 Coolant flow past cylinders
- 5 Coolant flow from cylinder block to cylinder head
- 6 Coolant flow between cylinders

- 7 Coolant flow to thermostat housing
- 8 Coolant bypass passage
- 9 Coolant flow back to radiator
- 10 Bypass closed
- 11 Coolant bypass in cylinder head
- 12 Coolant flow to water pump inlet

4) AIR INTAKE SYSTEM

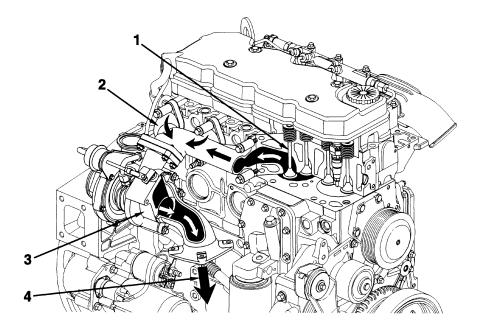


7607AEG08

- 1 Intake air inlet to turbocharger
- 2 Turbocharger air to charge air cooler
- 3 Charge air cooler

- 4 Intake manifold
 - (Integral part of cylinder head)
- 5 Intake valve

5) EXHAUST SYSTEM



7607AEG09

- 1 Exhaust valve
- 2 Exhaust manifold

- 3 Turbocharger
- 4 Turbocharger exhaust outlet

GROUP 2 ENGINE SPEED & STALL RPM

1. TEST CONDITION

- 1) Normal temperature of the whole system
 - Coolant : Approx 80°C (176°F)
 - Hydraulic oil : 45 \pm 5°C (113 \pm 10°F)
- Transmission oil : 75 \pm 5°C (167 \pm 10°F)
- 2) Normal operating pressure : See page 6-53.

2. SPECIFICATION

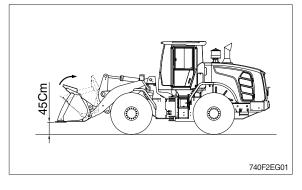
Engine speed, rpm (P mode)						
Low idle	High idle	Pump stall	Converter stall	Full stall	Fan motor	Remark
800±25	2150±50	2150±70	2050±70	1990±100	950±50	

3. ENGINE RPM CHECK

Remark : If the checked data is not normal, it indicates that the related system is not working properly. Therefore, it is required to check the related system pressure : See page 6-51.

1) Pump stall rpm

- Start the engine and raise the bucket approx 45 cm (1.5 ft) as the figure.
- Press the accelerator pedal fully and operate the bucket control lever to the retract position fully.
- Check the engine rpm at the above condition.

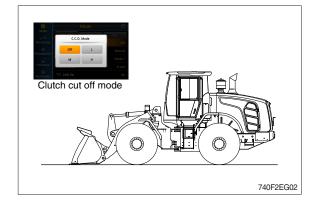


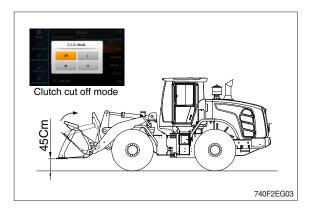
2) Convertor stall rpm

- Start the engine and lower the bucket on the ground as the figure.
- Set the clutch cut off mode at the OFF position.
- Press the brake pedal and accelerator pedal fully.
- Shift the transmission lever to the 4th forward position.
- Check the engine rpm at the above condition.

3) Full stall rpm

- Start the engine and raise the bucket approx 45 cm (1.5 ft) as the figure.
- Set the clutch cut off mode at the OFF position.
- Press the brake pedal and accelerator pedal fully .
- Shift the transmission lever to the 4th forward position and operate the bucket lever to the retract position fully.
- Check the engine rpm at the above condition.



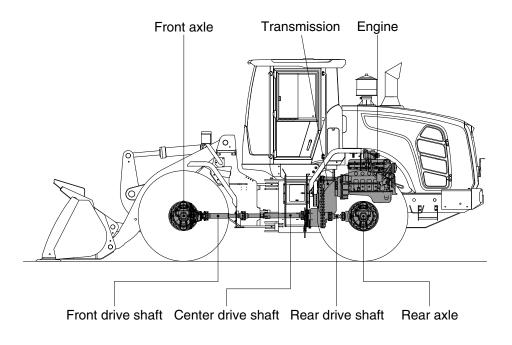


Group	1	Structure and Function	3-1
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SECTION 3 POWER TRAIN SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. POWER TRAIN COMPONENT OVERVIEW



940F3PT01

The power train consists of the following components:

- · Transmission
- · Front, center and rear drive shafts
- · Front and rear axles

Engine power is transmitted to the transmission through the torque converter.

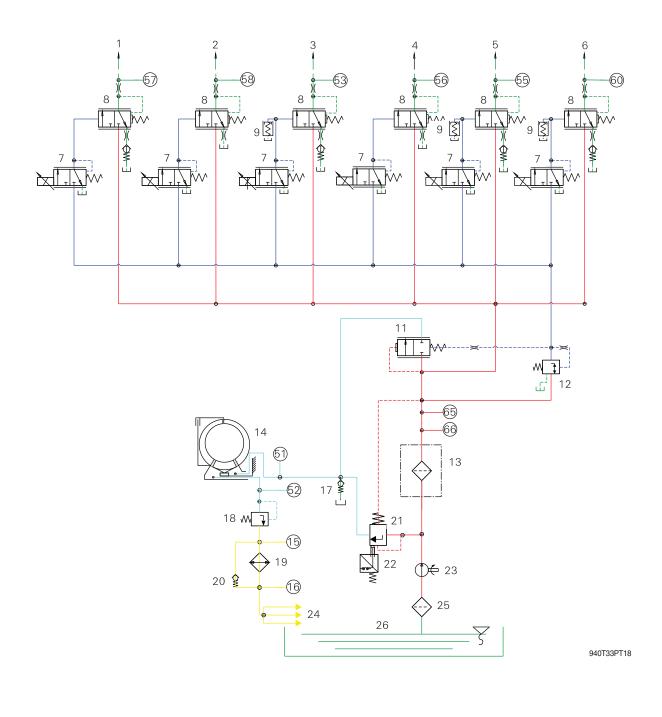
The transmission is a hydraulically engaged four speed forward, three speed reverse countershaft type power shift transmission. A calliper-disc type parking brake is located on the transmission.

The transmission outputs through universal joints to three drive shaft assemblies. The front drive shaft is a telescoping shaft which drives the front axle. The front axle is mounted directly to the loader frame. The front axle is equipped with conventional differential as standard (option : Limited slip differential). The rear axle is equipped with conventional differential as standard (option : Limited slip differential) The rear axle is mounted on an oscillating pivot.

The power transmitted to front axle and rear axle is reduced by the pinion gear and ring gear of differential. It then passes from the differential to the sun gear shaft (axle shaft) of final drive.

The power of the sun gear is reduced by a planetary mechanism and is transmitted through the planetary hub to the wheel.

HYDRAULIC CIRCUIT



1	1 Return flow to su	Imp
2	2 Pilot pressure	
3	3 Main pressure	
/	4 Lubrication	
5	5 Converter pressu	lre

Positions 15, 16, 51, 52, 53, 55, 56, 57, 58, 60, 65, 66 correspond to the numbers on the installation drawing.

- 1 Clutch K2
- 3 Clutch KV (clutch forward)
- 5 Clutch KR (clutch reverse)
- 7 Pilot valve
- 9 Damper piston
- 11 Main pressure valve
- 13 Transmission pressure filter
- 15 Connection of pressure oil to oil cooler
- 17 Converter safety valve
- 19 Oil cooler
- 21 Filter bypass valve
- 23 Transmission pump
- 25 Suction filter
- 51 Measuring point of oil pressure before converter
- 53 Measuring point of clutch pressure KV
- 56 Measuring point of clutch pressure K1
- 58 Measuring point of clutch pressure K3
- 65 Measuring point of system pressure
- 66 Temperature sensor for sump temperature

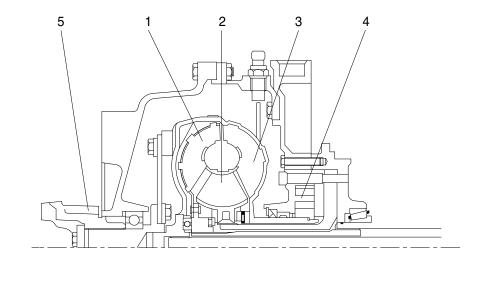
- 2 Clutch K3
- 4 Clutch K1
- 6 Clutch K4
- 8 Downstream valve
- 12 Pressure reduction valve
 - 14 Converter
 - 16 Connection of pressure oil from oil cooler
 - 18 Converter counter-pressure valve
 - 20 Oil cooler bypass valve
 - 22 Filter bypass switch
 - 24 Lubrication
 - 26 Tank
 - 52 Temperature sensor for oil temperature after the converter
 - 55 Measuring point of clutch pressure KR
 - 57 Measuring point of clutch pressure K2
 - 60 Measuring point of clutch pressure K4

					L	ive soler	noid		
			For	ward			Reverse)	Neutral
Clutch	Solenoid valve	1	2	3	4	1	2	3	
KV	Y3	Х	Х	Х					
KR	Y5					Х	Х	Х	
K1	Y4	Х				Х			
K2	Y1		Х				Х		
K3	Y2			Х	Х			Х	
K4	Y6				Х				

Assignment of clutch and solenoid valve

2. TORQUE CONVERTER

1) FUNCTION



73033TM00

Input flange

- 1 Turbine 3 Pump 5
- 2 Stator 4 Transmission pump

The converter is working according to the Trilok-system, i.e. it assumes at high turbine speed the characteristics, and with it the favorable efficiency of a fluid clutch.

The converter is designed according to the engine power so that the most favorable operating conditions are obtained for each installation case.

The Torque converter is composed of 3 main components : Pump wheel - turbine wheel - stator (reaction member)

These 3 impeller wheels are arranged in such a ring-shape system that the fluid is streaming through the circuit components in the indicated order.

Pressure oil from the transmission pump is constantly streaming through the converter. In this way, the converter can fulfill its task to multiply the torque of the engine and at the same time, the heat created in the converter is dissipated via the escaping oil.

The oil which is streaming out of the pump wheel, enters the turbine wheel and is there inversed in the direction of flow.

According to the rate of reversion, the turbine wheel and with it also the output shaft is receiving a more or less high reaction torque. The stator (reaction member), following the turbine, has the task to reverse the oil streaming out of the turbine once more and to deliver it under the suitable discharge direction to the pump wheel.

Due to the reversion, the stator receiving a reaction torque.

The relation turbine torque/pump torque is called torque multiplication.

This is the higher, the greater the speed difference of pump wheel and turbine wheel will be.

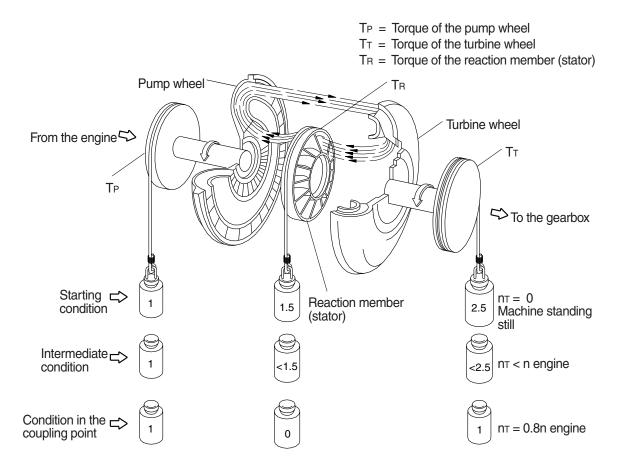
Therefore, the maximum torque multiplication is created at stationary turbine wheel.

With increasing output speed, the torque multiplication is decreasing. The adaption of the output speed to a certain required output torque will be infinitely variable and automatically achieved by the torque converter.

When the turbine speed is reaching about 80% of the pump speed, the torque multiplication becomes 1.0 i.e. the turbine torque becomes equal to that of the pump torque. From this point on, the converter is working similar to a fluid clutch.

A stator freewheel serves to improve the efficiency in the upper driving range, in the torque multiplication range it is backing-up the torque upon the housing, and is released in the clutch range. In this way, the stator can rotate freely.

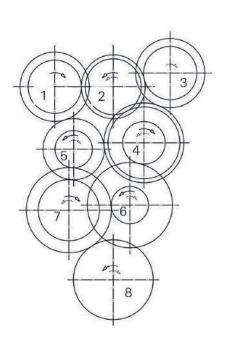
Function of a hydrodynamic torque converter (schematic view)

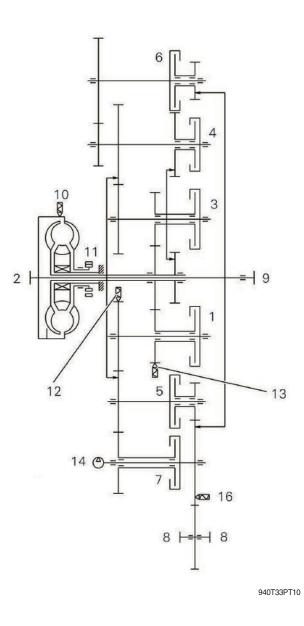


7577APT100

3. TRANSMISSION

1) DIAGRAM

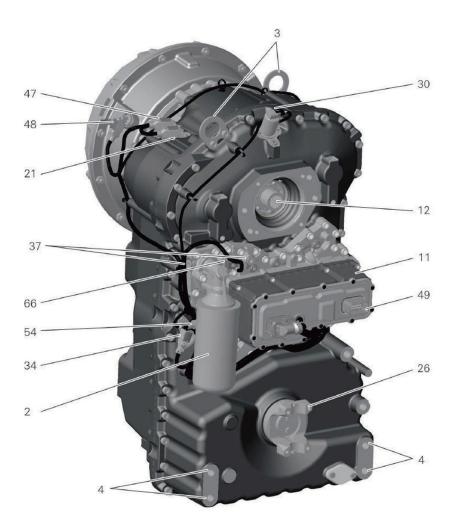




- 1 Clutch KV (clutch forward)
- 3 Clutch KR (clutch reverse)
- 5 Clutch K2
- 7 Clutch K3
- 9 Engine-dependent PTO
- 11 Pump
- 13 Inductive sensor for turbine speed
- 14 Emergency steering pump (optional)

- 2 Input
- 4 Clutch K4
- 6 Clutch K1
- 8 Output
- 10 Inductive sensor for engine speed
- 12 Inductive sensor for speed of central gear chain
- 16 Speed sensor for output speed

2) INSTALLATION VIEW

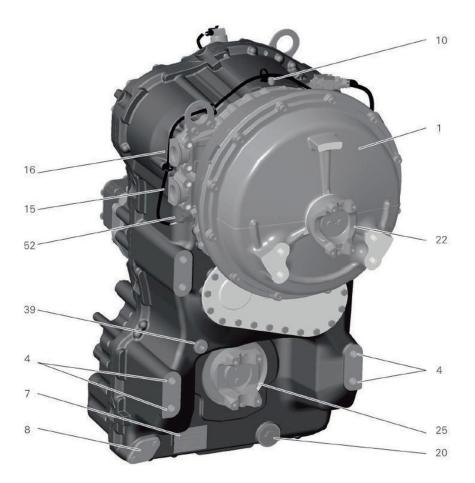


940T33PT11

- 2 Full flow filter
- 3 Lifting eye
- 4 Transmission suspension holes
- 11 Electrohydraulic transmission control unit
- 12 PTO coaxial, engine-dependent
- 21 Speed sensor for turbine speed
- 26 Output flange
- 30 Solenoid valve for torque converter lock-up clutch (not used)

- 37 System pressure connection M16 x 1.511
- 47 Speed sensor for speed/central gear hain
- 48 Speed sensor for engine speed
- 49 Plug connection for machine connector
- 54 Differential pressure switch for pressure filter
- 66 Temperature sensor for sump temperature

INSTALLATION VIEW

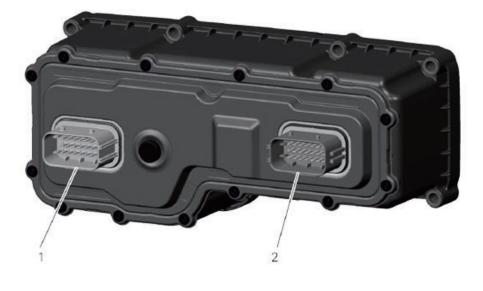


940T33PT12

- 1 Converter
- 4 Transmission suspension holes
- 7 Name plate
- 8 Connection for oil level measurement
- 10 Breather
- 15 Connection to oil cooler

- 16 Connection from oil cooler
- 20 Oil drain plug M38 x 1.5 (tightening torque : 80 Nm)
- 22 Input flange
- 25 Output flange
- 39 Connection of return flow to sump

3) ELECTRONIC TRANSMISSION CONTROL UNIT



960T33PT13

- 1 Transmission connector
- 2 Machine connector

The electronic transmission control unit controls the electro-hydraulic transmission control unit.

The electronic control unit (EC4A) is designed as on-site electronics. An internal plug connection and awiring harness (plug-in connector 1) connect the electronic transmission control unit and the internal elements of the transmission. A second slot is provided for the connection of the transmission to the machine (plug-in connector 2). This plug connection is responsible for the power supply via on-board supply system and the connection to the CAN communication network. At delivery the second plug connection is closed with a cap for protection against outside influences. Carefully remove the cap with as crewdriver or similar tool. Do not damage the detents on the plug.

4. FAULT CODE

1-1) MACHINE FAULT CODE

DTC		Discresstia Criteria			Application			
HCESPN	FMI	Diagnostic Criteria	G	С	S			
	3	10 seconds continuous, Hydraulic Oil Temp. Measurement Voltage > 3.95 V						
	4	10 seconds continuous, Hydraulic Oil Temp. Measurement Voltage < 0.3 V						
	(Resu	Its / Symptoms)						
	1. Mor	nitor – Hydraulic Oil temperature display failure						
101	2. Cor	ntrol Function – No warming up operation, No fuel warmer function operation,						
		High hydraulic oil temperature warning failure						
		king list)						
		-58B (#23) – CD-01 (#2) Checking Open/Short						
	2. CN·	-58B (#25) – CD-01 (#1) Checking Open/Short						
	0	10 seconds continuous, Steering main pump pressure Measurement Voltage > 5.3 V						
	4	10 seconds continuous, Steering main pump pressure Measurement						
	-	Voltage < 0.3 V						
	•	lts / Symptoms)						
202		nitor – Steering main pump press. Display failure						
LUL		ntrol Function – No automatic Emergency steering operation, ECO gauge displa	ay failu	lre				
		S – Working hours accumulation failure						
		king list)						
		-58B (#35) – CD-39 (B) Checking Open/Short						
		-58A (#11) – CD-39 (A) Checking Open/Short						
	3. CN-	-58B (#25) – CD-39 (C) Checking Open/Short						
	0	10 seconds continuous,						
		Boom cylinder 'head' pressure Measurement Voltage > 5.3 V						
	4	10 seconds continuous, Boom cylinder 'head' pressure Measurement Voltage < 0.3 V						
	(Rocu	lts / Symptoms)						
	•	nitor – Boom cylinder 'head' press. display failure						
204		ntrol Function – No Boom pressure calibration function operation, workload mea	euror	nont c	eve			
	2.001	operation failure	Guici	nont c	y3.			
	(Chec	king list)						
	•	-58B (#29) – CD-80 (B) Checking Open/Short						
		-58A (#11) – CD-80 (A) Checking Open/Short						
		-58B (#25) – CD-80 (C) Checking Open/Short						

DTC		Diagnostic Criteria			ion			
HCESPN	FMI	Diagnostic Criteria	G	С	S			
	0	10 seconds continuous,						
	0	Boom cylinder 'rod' pressure Measurement Voltage > 5.3V						
	4	10 seconds continuous,						
		Boom cylinder 'rod' pressure Measurement Voltage < 0.3V						
	(Resu	lts / Symptoms)						
205		nitor – Boom cylinder 'rod' press. display failure						
200	2. Cor	ntrol Function – No Boom pressure calibration function operation, workload me	asurer	nent s	sys.			
		operation failure						
	•	king list)						
		-58B(#36) – CD-81(B) Checking Open/Short						
		-58A(#11) – CD-81(A) Checking Open/Short						
		-58B(#25) – CD-81(C) Checking Open/Short	1		1			
	3	10 seconds continuous, Fuel level Measurement Voltage > 3.8V						
	4	10 seconds continuous, Fuel level Measurement Voltage < 0.3V						
	(Resu	Its / Symptoms)						
301	1. Monitor – Fuel level display failure							
001	2. Cor	ntrol Function – Fuel level low warning operation failure						
	(Chec	king list)						
	1. CN·	-58B (#22) – CD-02 (#2) Checking Open/Short						
	2. CN-	-58B (#25) – CD-02 (#1) Checking Open/Short						
		(In the startup conditions) 30 seconds continuous, Fan speed < 10 rpm in						
	8	the Remote cooling fan EPPR current reference value is in X Ma(differ by						
		model)						
318	(Resu	lts / Symptoms)						
510	1. Mor	nitor – Cooling Fan revolutions display failure						
	(Chec	king list)						
		-58A (#15) – CD-73 (#1) Checking Open/Short						
	2. CN-	-58A (#18) – CD-73 (#2) Checking Open/Short	1					
	3	10 seconds continuous,						
		Accel pedal position 1 voltage Measurement Voltage > 5.0 V						
	4	10 seconds continuous,						
		Accel pedal position 1 voltage Measurement Voltage < 0.2 V						
	`	Its / Symptoms)						
339		nitor – Accel pedal position 1 voltage display failure						
		ntrol Function – Engine rpm control failure						
	•	king list)						
		-58B(#39) – CN-162(#2) Checking Open/Short						
		-58A(#6) – CN-162(#3) Checking Open/Short						
		-58A(#8) – CN-162(#1) Checking Open/Short						

DTC		Diognostia Critaria		Application			
HCESPN	FMI	Diagnostic Criteria		С	S		
	3	10 seconds continuous,					
	3	Accel pedal position 2 voltage Measurement Voltage > 5.0 V					
	4	10 seconds continuous,					
		Accel pedal position 2 voltage Measurement Voltage < 0.2 V					
		lts / Symptoms)					
343		nitor – Accel pedal position 2 voltage display failure					
		ntrol Function – Engine rpm control failure					
		king list)					
		-58B (#40) – CN-162 (#5) Checking Open/Short -58A (#7) – CN-162 (#6) Checking Open/Short					
		-58A (#7) – CN-162 (#4) Checking Open/Short					
	0.011	10 seconds continuous, Brake oil pressure Measurement Voltage > 5.3V					
	4	10 seconds continuous, Brake oil pressure Measurement Voltage < 0.3V					
		Its / Symptoms)	-				
	· ·	nitor – Brake oil press. display failure					
503		ntrol Function – Brake oil pressure low warning display failure					
		king list)					
		-58B (#27) – CD-03 (B) Checking Open/Short					
	2. CN-	-58A (#11) – CD-03 (A) Checking Open/Short					
	3. CN-	-58B (#25) – CD-03 (C) Checking Open/Short					
	0	10 seconds continuous, Parking oil pressure Measurement Voltage > 5.3V					
	4	10 seconds continuous, Parking oil pressure Measurement Voltage < 0.3V					
	(Resu	Its / Symptoms)					
	1. Mor	nitor – Parking oil Press. display failure					
507		ntrol Function – No judgment Parking status					
		king list)					
		-58B (#34) – CD-26 (B) Checking Open/Short					
		-58A (#11) – CD-26 (A) Checking Open/Short					
	3. CN-	-58B (#25) – CD-26 (C) Checking Open/Short					
	0	10 seconds continuous, Brake oil charging priority pressure Measurement Voltage > 5.3V					
		10 seconds continuous,					
	4	Brake oil charging priority pressure Measurement Voltage < 0.3V					
	(Resu	Its / Symptoms)					
557		nitor – Brake oil charging priority press. display failure					
		ntrol Function – Cooling fan revolutions control failure, Brake oil(Accumulator) c	hargin	g failu	re		
		king list)	-				
	1. CN-	-58B (#38) – CD-31 (B) Checking Open/Short					
	2. CN-	-58A (#11) – CD-31 (A) Checking Open/Short					
	3. CN-	-58B (#25) – CD-31 (C) Checking Open/Short					

DTC		Diagnostia Critaria	Application						
HCESPN	FMI	Diagnostic Criteria	G	С	S				
	0	10 seconds continuous, Battery input Voltage > 35V							
	1	10 seconds continuous, Battery input Voltage < 18V							
	(Resu	Its / Symptoms)		1	1				
705		itrol Function – Disabled startup							
700	(Chec	king list)							
	1. Che	ecking battery voltage							
	2. CN·	-58A (#1) – CN-36 (07 fuse) Checking Open/Short							
	3. CN·	-58A (#2) – CN-36 (07 fuse) Checking Open/Short		-					
	1	(In the 500rpm or more) 10 seconds continuous,							
		Alternator Node I Measurement Voltage < 18V							
	(Resu	lts / Symptoms)							
707		trol Function – Battery charging circuit failure							
		king list)							
		58B (#33) – CN-04 (#18) Checking Open/Short							
	2. CN·	04 (#18) – CN-74 (#2) Checking Open/Short		1	1				
	3	10 seconds continuous,							
		Boom position sensor signal voltage Measurement Voltage > 5.0V							
	4	10 seconds continuous,							
	(D	Boom position sensor signal voltage Measurement Voltage < 0.3V							
	(Results / Symptoms)								
700		nitor – Boom position sensor signal voltage display failure	Ba		0+0.0+				
728		ntrol Function – No calibration angle sensor, No calibration boom pressure tion failure,	, вос	ים חוכ	eleni				
		nd stop(Boom) operation failure, Lock-up clutch operation failure							
		king list)							
		-58B (#37) – CN-100 (B) Checking Open/Short							
		-58A (#5) – CN-100 (C) Checking Open/Short							
		-58B (#25) – CN-100 (A) Checking Open/Short							
		10 seconds continuous,	_						
	3	Bucket position sensor signal voltage Measurement Voltage > 5.0V							
	4	10 seconds continuous,							
	4	Bucket position sensor signal voltage Measurement Voltage < 0.3V							
	(Resu	Its /Symptoms)							
700	1. Monitor – Bucket position sensor signal voltage display failure								
729	2. Co	ntrol Function – No calibration angle sensor, Bucket Detent operation f	ailure	, Soft	end				
	stop(Bucket) operation failure								
		king list)							
		58B(#30) – CN-101(B) Checking Open/Short							
		-58A(#5) – CN-101(C) Checking Open/Short							
	3. CN·	58B(#25) – CN-101(A) Checking Open/Short							

DTC			Application		
HCESPN	FMI	Diagnostic Criteria	G	С	S
	2	(When mounting the A/C Controller) 10 seconds continuous, A/C controller Communication Data Error			
831	(Resu	Its / Symptoms)			
	1. Cor	trol Function – A/C Controller malfunction			
	2	10 seconds continuous, ECM Communication Data Error			
841		Its /Symptoms) htrol Function – ECM operation failure			
	2	10 seconds continuous, TCU Communication Data Error			
842		Its / Symptoms) ntrol Function – TCU operation failure			
	2	10 seconds continuous, Monitor Communication Data Error			
844	(Resu	Its / Symptoms)			
	1. Cor	trol Function – Monitor operation failure			
	2	(When mounting the RMCU) 90 seconds continuous, RMCU Communication Data Error			
850	(Resu	Its / Symptoms)			
	1. Cor	ntrol Function – RMCU operation failure			
001	2	(When mounting the EHCU) 10 seconds continuous, EHCU Communication Data Error			
861	(Resu	Its / Symptoms)			
	1. Cor	ntrol Function – EHCU operation failure			
	2	(When mounting the BKCU)			
869		10 seconds continuous, BKCU Communication Data Error			
000		Its / Symptoms)			
	1. Cor	ntrol Function – BKCU operation failure			

1-2) EHCU FAULT CODE

HCESPN	FMI	Description
2333	9	Communication timeout between EHCU and TCU
2331	9	Communication timeout between EHCU and MCU
2332	9	Communication timeout between EHCU and working joystick
2317	9	Communication timeout between EHCU and steering joystick
2319	2	Steering joystick position signal error
2320	2	Steering joystick - FNR enable switch error
2321	2	Steering joystick - foward switch error
2322	2	Steering joystick - neutral switch error
2323	2	Steering joystick - reverse switch error
2324	2	Steering joystick - kick down switch error
2325	2	Steering joystick - steering on switch error
2326	5	PVE coil power current below normal or open circuit
2326	6	PVE coil power current above normal or grounded circuit
2327	0	PVE coil PWM duty cycle input value above normal operation range
2327	1	PVE coil PWM duty cycle input value below normal operation range
2327	5	PVE coil PWM duty cycle current below normal or open circuit
2327	6	PVE coil PWM duty cycle current above normal or grounded circuit
2327	14	PVE coil PWM duty cycle control block parameter invalid
2311	2	Boom joystick position signal error
2311	0	Boom joystick position input value above normal operation range
2311	1	Boom joystick position input value below normal operation range
2311	3	Boom joystick position input voltage above normal or shorted to high source
2311	4	Boom joystick position input voltage below normal or shorted to low source
2311	13	Boom joystick position control block out of calibration
2311	14	Boom joystick position control block parameter invalid
2311	31	Boom joysitck position signal redundancy lost
2313	2	Bucket joystick position signal error
2313	0	Bucket joystick position input value above normal operation range
2313	1	Bucket joystick position input value below normal operation range
2313	3	Bucket joystick position input voltage above normal or shorted to high source
2313	4	Bucket joystick position input voltage below normal or shorted to low source
2313	13	Bucket joystick position control block out of calibration
2313	14	Bucket joystick position control block parameter invalid
2313	31	Bucket joysitck position signal redundancy lost
2315	2	Aux joystick position signal error
2315	0	Aux joystick position input value above normal operation range
2315	1	Aux joystick position input value below normal operation range

HCESPN	FMI	Description	
2315	3	Aux joystick position input voltage above normal or shorted to high source	
2315	4	Aux joystick position input voltage below normal or shorted to low source	
2315	13	Aux joystick position control block out of calibration	
2315	14	Aux joystick position control block parameter invalid	
2315	31	Aux joysitck position signal redundancy lost	
2304	0	Boom up EPPR valve input value above normal operation range	
2304	1	Boom up EPPR valve input value below normal operation range	
2304	5	Boom up EPPR valve input current below normal or open circuit	
2304	6	Boom up EPPR valve input current above normal or grounded circuit	
2304	14	Boom up EPPR valve block parameter invalid	
2305	0	Boom down EPPR valve input value above normal operation range	
2305	1	Boom down EPPR valve input value below normal operation range	
2305	5	Boom down EPPR valve input current below normal or open circuit	
2305	6	Boom down EPPR valve input current above normal or grounded circuit	
2305	14	Boom down EPPR valve block parameter invalid	
2306	0	Bucket in EPPR valve input value above normal operation range	
2306	1	Bucket in EPPR valve input value below normal operation range	
2306	5	Bucket in EPPR valve input current below normal or open circuit	
2306	6	Bucket in EPPR valve input current above normal or grounded circuit	
2306	14	Bucket in EPPR valve block parameter invalid	
2307	0	Bucket dump EPPR valve input value above normal operation range	
2307	1	Bucket dump EPPR valve input value below normal operation range	
2307	5	Bucket dump EPPR valve input current below normal or open circuit	
2307	6	Bucket dump EPPR valve input current above normal or grounded circuit	
2307	14	Bucket dump EPPR valve block parameter invalid	
2308	0	Aux. Up EPPR valve input value above normal operation range	
2308	1	Aux. Up EPPR valve input value below normal operation range	
2308	5	Aux. Up EPPR valve input current below normal or open circuit	
2308	6	Aux. Up EPPR valve input current above normal or grounded circuit	
2308	14	Aux. Up EPPR valve block parameter invalid	
2309	0	Aux. Down EPPR valve input data above normal operation range	
2309	1	Aux. Down EPPR valve input data below normal operation range	
2309	5	Aux. Down EPPR valve input current below normal or open circuit	
2309	6	Aux. Down EPPR valve input current above normal or grounded circuit	
2309	14	Aux. Down EPPR valve block parameter invalid	
2328	0	EHCU sensor power voltage high	
2328	1	EHCU sensor power voltage low	
2328	3	EHCU sensor power voltage above normal or shorted to high source	

HCESPN	FMI	Description
2328	4	EHCU sensor power voltage below normal or shorted to low source
2329	0	EHCU power voltage high
2329	1	EHCU power voltage low
2329	11	EHCU safety cpu error
739	2	Armrest switch signal error
2334	0	Steering pilot pressure sensor data above normal range
2334	1	Steering pilot pressure sensor data below normal range
2335	2	Steering proportional valve moving position error
2335	14	Steering proportional valve start position error

1-3) AAVM FAULT CODE

Fault Code	Description
A01	AAVM Communication Error -AAVM
A02	AAVM Communication Error -Front Camera
A03	AAVM Communication Error -Rear Camera
A04	AAVM Communication Error -Left Camera
A05	AAVM Communication Error -Right Camera
A06	Manual Setting Fail
A07	No MCU CID
A08	MCU CID Format Error
A09	AAVM Hardware Error -AAVM
A10	AAVM Hardware Error -Front Camera
A11	AAVM Hardware Error -Rear Camera
A12	AAVM Hardware Error -Left Camera
A13	AAVM Hardware Error -Right Camera
A14	MCU CID Model is not registered
A15	MCU CID Model can't be applied

2) ENGINE FAULT CODE

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
111 629 12	Engine control module critical internal failure - Bad intelligent device or component. Error internal to the ECM related to memory hardware failures or internal ECM voltage supply circuits.	Possible no noticeable performance effects, engine dying, or hard starting.
115 612 2	Engine magnetic crankshaft speed/position lost both of two signals - Data erratic, intermittent, or incorrect. The ECM has detected the primary and backup speed sensor signals are connected backwards.	The engine will shut down or will not start.
122 102 3	Intake manifold 1 pressure sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the intake manifold pressure circuit.	Engine power derate.
123 102 4	Intake manifold 1 pressure sensor circuit - Voltage below normal, or shorted to low Source. Low signal voltage or open circuit detected at the intake manifold pressure circuit.	Engine power derate.
124 102 16	Intake manifold 1 pressure - Data valid but above normal operational range - Moderately severe level. Intake manifold pressure is above the maximum operating limit.	Engine power derate.
125 102 18	Intake Manifold 1 Pressure - Data valid but below normal operating range - Moderately severe level. Intake manifold pressure is below the minimum operating limit.	Engine power derate.
131 91 3	Accelerator pedal or lever position sensor 1 circuit - Voltage above normal, or shorted to high source. High voltage detected at accelerator pedal position number 1 circuit.	The engine will operate in limp home mode.
132 91 4	Accelerator pedal or lever position sensor 1 circuit - Voltage below normal, or shorted to low source. Low voltage detected at accelerator pedal position number 1 signal circuit.	The engine will operate in limp home mode.
133 974 3	Remote accelerator pedal or lever position sensor 1 circuit - Voltage above normal, or shorted to high source. High voltage detected at remote accelerator pedal position signal circuit.	Remote accelerator will not operate.
134 974 4	Remote accelerator pedal or lever position sensor 1 circuit - Voltage below normal, or shorted to low source. Low voltage detected at remote accelerator pedal position signal circuit.	Remote accelerator will not operate.
143 100 18	Engine oil rifle pressure - Data valid but below normal operational range - Moderately severe level. Engine oil pressure signal indicates engine oil pressure is below the engine protection warning limit.	Engine power derate.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
144 110 3	Engine coolant temperature 1 sensor circuit - Voltage above normal, or shorted to high source. High signal voltage or open circuit detected at engine coolant temperature circuit.	Fan will stay ON if controlled by ECM.
145 110 4	Engine coolant temperature 1 sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at engine coolant temperature circuit.	Fan will stay ON if controlled by ECM.
146 110 16	Engine coolant temperature - Data valid but above normal operational range - Moderately severe level. Engine coolant temperature is above engine protection warning limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red stop lamp starts flashing.
151 110 0	Engine coolant temperature - Data valid but above normal operational range - Most severe level. Engine coolant temperature signal indicates engine coolant temperature above engine protection critical limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red stop lamp starts flashing.
153 105 3	Intake manifold 1 temperature sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at intake manifold air temperature circuit.	Fan will stay ON if controlled by ECM.
154 105 4	Intake manifold 1 temperature sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at intake manifold air temperature circuit.	Fan will stay ON if controlled by ECM.
155 105 0	Intake manifold 1 temperature - Data valid but above normal operational range - Most severe level. Intake manifold air temperature signal indicates intake manifold air temperature above engine protection critical limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red stop lamp starts flashing.
175 3464 3	Electronic throttle control actuator driver circuit - Voltage above normal, or shorted to high source. A short circuit to battery or open circuit has been detected in the engine intake air throttle actuator signal circuit.	Possible reduced engine performance.
176 3464 4	Electronic throttle control actuator driver circuit - Voltage below normal, or shorted to low source. A short circuit to ground has been detected in the engine intake air throttle actuator signal circuit.	Possible reduced engine performance.
177 3464 7	Electronic throttle control actuator - Mechanical system not responding or out of adjustment. The engine intake air throttle actuator has failed the auto zero span check.	Possible reduced engine performance.
187 3510 4	Sensor supply 2 circuit - Voltage below normal, or shorted to low source. Low voltage detected at the sensor supply number 2 circuit.	Engine power derate.
195 111 3	Coolant level sensor 1 circuit - Voltage above normal, or shorted to high source. High signal voltage detected at engine coolant level circuit.	None on performance.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
196 111 4	Coolant level sensor 1 circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at engine coolant level circuit.	None on performance.
197 111 18	Coolant level - Data valid but below normal operational range - Moderately severe level. Low coolant level has been detected.	Engine power derate.
221 108 3	Barometric pressure sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at barometric pressure circuit.	Engine power derate.
222 108 4	Barometric pressure sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at barometric pressure circuit.	Engine power derate.
227 3510 3	Sensor supply 2 circuit - Voltage above normal, or shorted to high source. High voltage detected at sensor supply number 2 circuit.	Engine power derate.
234 190 0	Engine crankshaft speed/position - Data valid but above normal operational range - Most severe level. Engine speed signal indicates engine speed above engine protection limit.	Engine power derate.
238 3511 4	Sensor supply 3 circuit - Voltage below normal, or shorted to low source. Low voltage detected on the +5 volt sensor supply circuit to the engine speed sensor.	Engine may run rough, may stop running, may not start, or may be difficult to start.
239 3511 3	Sensor supply 3 circuit - Voltage above normal or shorted to high source. High voltage detected on the 5 volt sensor supply circuit to the engine speed sensor.	Engine may run rough, may stop running, may not start, or may be difficult to start.
241 84 2	Wheel-based vehicle speed - Data erratic, intermittent, or incorrect. The ECM lost the vehicle speed signal or is reading an erratic value.	Engine speed limited to ,maximum engine speed without VSS parameter value. Cruise control, gear-down protection, and road speed governor will not work.
245 647 4	Fan control circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the fan control circuit when commanded on.	The fan may stay on continuously or not run at all.
249 171 3	Ambient air temperature sensor 1 circuit - Voltage above normal or shorted to high source. High signal voltage detected at ambient air temperature circuit.	Possible reduced engine performance.
256 171 4	Ambient air temperature sensor 1 circuit - Voltage below normal or shorted to low source. Low voltage detected at ambient air temperature circuit.	Possible reduced engine performance.
271 1347 4	Fuel pump pressurizing assembly 1 circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the fuel pump actuator circuit.	Engine power derate.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
272 1347 3	Fuel pump pressurizing assembly 1 circuit - Voltage above normal, or shorted to high source. High signal voltage or open circuit detected at the fuel pump actuator circuit.	Engine may run rough, may stop running, may not start, or may be difficult to start.
285 639 9	SAE J1939 multiplexing PGN timeout error - Abnormal update rate. The ECM expected information from a multiplexed device but did not receive it soon enough or did not receive it at all.	At least one multiplexed device will not operate properly.
286 639 13	SAE J1939 multiplexing configuration error - Out of calibration. The ECM expected information from a multiplexed device but only received a portion of the necessary information.	At least one multiplexed device will not operate properly.
288 974 19	Sae J1939 multiplexing remote accelerator pedal or lever position sensor circuit - Received network data in error. The oem vehicle electronic control unit (VECM) detected a fault with the remote accelerator.	Remote accelerator will not operate.
295 108 2	Barometric pressure - Data erratic, intermittent, or incorrect. An error in the barometric pressure sensor signal was detected by the ECM.	Engine power derate.
322 651 5	Injector solenoid driver cylinder 1 circuit - Current below normal, or open circuit. Current detected at injector 1 when voltage is turned OFF.	Engine power derate.
323 655 5	Injector solenoid driver cylinder 5 circuit - Current below normal, or open circuit. Current detected at injector 5 when voltage is turned OFF.	The current to the injector is shut OFF. Engine power derate.
324 653 5	Injector solenoid driver cylinder 3 circuit - Current below normal, or open circuit. Current detected at injector 3 when voltage is turned OFF.	The current to the injector is shut OFF. Engine power derate.
325 656 5	Injector solenoid driver cylinder 6 circuit - Current below normal, or open circuit. Current detected at injector 6 when voltage is turned OFF.	The current to the injector is shut OFF. Engine power derate.
331 652 5	Injector solenoid driver cylinder 2 circuit - Current below normal, or open circuit. Current detected at injector 2 when voltage is turned OFF.	The current to the injector is shut OFF. Engine power derate.
332 654 5	Injector solenoid driver cylinder 4 circuit - Current below normal, or open circuit. Current detected at injector 4 when voltage is turned OFF.	The current to the injector is shut OFF. Engine power derate.
334 110 2	Engine coolant temperature - Data erratic, intermittent, or incorrect. The engine coolant temperature sensor is reading an erratic value at initial key ON.	None on performance.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
338 1267 3	Idle shutdown vehicle accessories relay driver circuit - Voltage above normal, or shorted to high source. Open circuit or short to voltage source detected at the idle shutdown vehicle accessory/ignition bus relay circuit.	Vehicle accessories or ignition bus loads controlled by the idle shutdown relay will not power up.
339 1267 4	Idle shutdown vehicle accessories relay driver circuit - Voltage below normal, or shorted to low source. Low voltage detected at the idle shutdown vehicle accessory or ignition bus relay circuit when commanded ON.	Vehicle accessories or ignition bus loads controlled by the idle shutdown relay will not power up.
343 629 12	Engine control module warning internal hardware failure - Bad intelligent device or component. ECM power supply errors have been detected.	Engine power derate.
346 630 12	Engine control module calibration memory software - Bad intelligent device or component. Invalid switch configuration adjustable parameter setting have been detected by the engine control module (ECM).	Various optional switch inputs to the ECM may not operate correctly.
351 627 12	Injector power supply - Bad intelligent device or component. The ECM measured injector boost voltage is low.	Engine power derate.
352 3509 4	Sensor supply 1 circuit - Voltage below normal, or shorted to low source. Low voltage detected at sensor supply number 1 circuit.	Engine power derate.
383 729 5	Engine intake air heater 1 circuit - Current below normal or open circuit. A malfunctioning engine intake air heater circuit has been detected.	Engine may not start or may be difficult to start.
386 3509 3	Sensor supply 1 circuit - Voltage above normal, or shorted to high source. High voltage detected at sensor supply number 1 circuit.	Engine power derate.
415 100 1	Engine oil rifle pressure - Data valid but below normal operational range - Most severe level. Oil pressure signal indicates oil pressure below the engine protection critical limit.	Progressive power and/or speed derate increasing in severity from time of alert. If engine protection shutdown feature is enabled, engine will shut down 30 seconds after red stop lamp starts flashing.
418 97 15	Water in fuel indicator - Data valid but above normal operational range - Least severe level. water has been detected in the fuel filter.	None on performance.
427 639 9	J1939 data link - Abnormal update rate. Communication between the engine control module (ECM) and another device on the SAE J1939 data link has been lost.	Engine will only idle.
428 97 3	Water in fuel indicator sensor circuit - Voltage above normal, or shorted to high source. High voltage detected at the water in fuel circuit.	None on performance. No water in fuel warning available.
435 100 2	Engine oil rifle pressure - Data erratic, intermittent, or incorrect. The engine oil pressure sensor is reading an erratic value.	None on performance.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
436 105 2	Intake manifold 1 temperature - Data erratic, intermittent, or incorrect. The intake manifold temperature sensor is reading an erratic value at initial key on or while the engine is running.	Possible reduced engine performance.
441 168 18	Battery 1 voltage - Data valid but below normal operational range - Moderately severe level. ECM supply voltage is below the minimum system voltage level.	Engine may run rough, may stop running, may not start, or may be difficult to start.
442 168 16	Battery 1 Voltage - Data valid but above normal operational range - Moderately severe level. ECM supply voltage is above the maximum system voltage level.	None on performance.
451 157 3	Injector metering rail 1 pressure sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the rail fuel pressure sensor circuit.	Power and/or speed derate.
452 157 4	Injector metering rail 1 pressure sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the rail fuel pressure sensor circuit.	Power and/or speed derate.
483 1349 3	Injector metering rail 2 pressure sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the fuel rail 2 pressure sensor circuit.	Possible reduced engine performance.
484 1349 4	Injector metering rail 2 pressure sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the fuel rail 2 pressure sensor circuit.	Possible reduced engine performance.
515 3514 3	Sensor supply 6 circuit - Voltage above normal or shorted to high source. High voltage detected on the +5 volt sensor supply circuit to the fuel rail pressure sensor.	Engine power derate.
516 3514 4	Sensor supply 6 circuit - Voltage below normal or shorted to low source. Low voltage detected on the +5 volt sensor supply circuit to the fuel rail pressure sensor.	Engine power derate.
553 157 16	Injector metering rail 1 pressure - Data valid but above normal operational range - Moderately severe level. The ECM has detected that fuel pressure is higher than commanded pressure.	Possible reduced engine performance.
555 101 16	Crankcase pressure - Data valid but above normal operational range - Moderately severe level. The crankcase breather filter requires maintenance.	None on performance.
556 101 0	Crankcase pressure - Data valid but above normal operational range - Most severe level. The crankcase breather filter requires maintenance.	None on performance.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
559 157 18	Injector metering rail 1 pressure - Data valid but below normal operational range - Moderately severe level. The ecm has detected that fuel pressure is lower than commanded pressure.	Possibly hard to start or low power. Engine could possibly not start.
584 677 3	Starter relay driver circuit - Voltage above normal, or shorted to high source. Open circuit or high voltage detected at starter lockout circuit.	Either the engine will not start or the engine will not have starter lockout protection.
585 677 4	Starter relay driver circuit - Voltage below normal, or shorted to low source. Low voltage detected at starter lockout circuit.	Either the engine will not start or the engine will not have starter lockout protection.
595 103 16	Turbocharger 1 speed - Data valid but above normal operating range - Moderately severe level. High turbocharger speed has been detected by the ecm.	Engine power derate.
596 167 16	Electrical charging system voltage - Data valid but above normal operational range - Moderately severe level. High battery voltage detected by the battery voltage monitor feature.	None on performance.
597 167 18	Electrical charging system voltage - Data valid but below normal operational range - Moderately severe level. Low battery voltage detected by the battery voltage monitor feature.	None on performance.
649 1378 31	Engine oil change interval - Condition exists. Change engine oil and filter.	None on performance.
687 103 18	Turbocharger 1 speed - Data valid but below normal operational range - Moderately severe level. Low turbocharger speed detected by the ECM.	Engine power derate. The ECM uses an estimated turbocharger speed.
689 190 2	Engine crankshaft speed/position - Data erratic, intermittent, or incorrect. The ECM has detected an error in the engine speed signal.	Possible reduced engine performance.
691 1172 3	Turbocharger 1 compressor inlet temperature sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at turbocharger compressor inlet air temperature circuit.	Engine power derate.
692 1172 4	Turbocharger 1 compressor inlet temperature circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at turbocharger compressor inlet air temperature circuit.	Engine power derate.
693 1172 2	Turbocharger 1 compressor intake temperature - Data erratic, intermittent, or incorrect. A temperature too high or low for the operating conditions has been detected by the turbocharger compressor intake temperature sensor.	Possible reduced engine performance.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
731 723 7	Engine speed / position camshaft and crankshaft misalignment - Mechanical system not responding properly or out of adjustment. Engine position signal from the crankshaft position sensor and camshaft position sensor do not match.	Engine power derate.
755 157 7	Injector metering rail 1 pressure - Mechanical system not responding or out of adjustment. The ecm has detected a difference in the 2 fuel rail pressure signals.	Possible reduced engine performance.
778 723 2	Engine camshaft speed / position sensor - Data erratic, intermittent, or incorrect. The ECM has detected an error in the camshaft position sensor signal.	Possible reduced engine performance.
784 1590 2	Adaptive cruise control mode - Data erratic, intermittent, or incorrect. Loss of communication with adaptive cruise control.	Adaptive cruise control will not operate. Standard cruise control may not operate.
1117 627 2	Power supply lost with ignition on - Data erratic, intermittent, or incorrect. Supply voltage to the ECM fell below 6.2 volts momentarily, or the ECM was not allowed to power down correctly (retain battery voltage for 30 seconds after key OFF).	Possible no noticeable performance.
1139 651 7	Injector solenoid driver cylinder 1 - Mechanical system not responding or out of adjustment. The ECM has detected an error with the injection timing or quantity.	Possible reduced engine performance.
1141 652 7	Injector solenoid driver cylinder 2 - Mechanical system not responding or out of adjustment. The ECM has detected an error with the injection timing or quantity.	Possible reduced engine performance.
1142 653 7	Injector solenoid driver cylinder 3 - Mechanical system not responding or out of adjustment. The ECM has detected an error with the injection timing or quantity.	Possible reduced engine performance.
1143 654 7	Injector solenoid driver cylinder 4 - Mechanical system not responding or out of adjustment. The ECM has detected an error with the injection timing or quantity.	Possible reduced engine performance.
1144 655 7	Injector solenoid driver cylinder 5 - Mechanical system not responding or out of adjustment. The ECM has detected an error with the injection timing or quantity.	Possible reduced engine performance.
1145 656 7	Injector solenoid driver cylinder 6 - Mechanical system not responding or out of adjustment. The ECM has detected an error with the injection timing or quantity.	Possible reduced engine performance.
1228 27 2	Egr valve position - Data erratic, intermittent, or Incorrect. The EGR valve is unable to meet commanded position.	Possible reduced engine performance.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
1239 2623 3	Accelerator pedal or lever position sensor 2 circuit - Voltage above normal or shorted to high source. High voltage detected at accelerator pedal position number 2 signal circuit.	The engine will operate in limp home mode.
1241 2623 4	Accelerator pedal or lever position sensor 2 circuit - Voltage below normal or shorted to low source. Low voltage detected at accelerator pedal position number 2 signal circuit.	The engine will operate in limp home mode.
1242 91 2	Accelerator pedal or lever position sensor 1 and 2 - Data erratic, intermittent, or incorrect. Accelerator position sensor number 1 and number 2 are reading different values.	The engine will only idle.
1515 91 19	Sae J1939 multiplexed accelerator pedal or lever sensor system - Received network data in error. The J1939 multiplexing controller has indicated a malfunction of the multiplexed accelerator pedal.	The engine will only idle.
1654 1323 31	Engine misfire cylinder 1- Condition exists. Engine misfire has been detected in cylinder number 1.	Possible reduced engine performance.
1655 1324 31	Engine misfire cylinder 2 - Condition exists. Engine misfire has been detected in cylinder number 2.	Possible reduced engine performance.
1656 1325 31	Engine misfire cylinder 3 - Condition exists. Engine misfire has been detected in cylinder number 3.	Possible reduced engine performance.
1657 1326 31	Engine misfire cylinder 4 - Condition exists. Engine misfire has been detected in cylinder number 4.	Possible reduced engine performance.
1658 1327 31	Engine misfire cylinder 5 - Condition exists. Engine misfire has been detected in cylinder number 5.	Possible reduced engine performance.
1659 1328 31	Engine misfire cylinder 6 - Condition exists. Engine misfire has been detected in cylinder number 6.	Possible reduced engine performance.
1668 1761 4	Aftertreatment diesel exhaust fluid tank level sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the aftertreatment diesel exhaust fluid tank level sensor circuit.	Possible reduced engine performance.
1669 1761 3	Aftertreatment diesel exhaust fluid tank level sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the catalyst tank level sensor circuit.	Possible reduced engine performance.
1673 1761 1	Aftertreatment diesel exhaust fluid tank level - Data valid but below normal operating range - Most severe level. The aftertreatment diesel exhaust fluid tank level has fallen below the critical warning level.	Possible reduced engine performance.

 $\, \mbox{\ensuremath{\mathbb X}} \,$ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
1677 3031 4	Aftertreatment diesel exhaust fluid tank temperature sensor - Voltage below normal or shorted to low source. Low signal voltage detected at the diesel exhaust fluid tank temperature sensor circuit.	Possible reduced engine performance.
1678 3031 3	Aftertreatment diesel exhaust fluid tank temperature sensor - Voltage above normal or shorted to high source. High signal voltage or open circuit detected at the diesel exhaust fluid tank temperature sensor circuit.	Possible reduced engine performance.
1679 3031 2	Aftertreatment diesel exhaust fluid tank temperature - Data erratic, intermittent, or incorrect. The diesel exhaust fluid tank temperature sensor has indicated a tank temperature too high or too low for the ambient conditions.	Possible reduced engine performance.
1682 3362 31	Aftertreatment diesel exhaust fluid dosing unit input lines - Condition exists. The aftertreatment diesel exhaust fluid dosing unit is unable to prime.	Possible reduced engine performance.
1683 3363 3	Aftertreatment diesel exhaust fluid tank heater - Voltage above normal or shorted to high source. High signal voltage detected at the aftertreatment diesel exhaust fluid tank heater circuit.	Possible reduced engine performance.
1684 3363 4	Aftertreatment diesel exhaust fluid tank heater - Voltage below normal, or shorted to low source. Low signal voltage detected at the aftertreatment diesel exhaust fluid tank heater circuit.	Possible reduced engine performance.
1691 100 18	Aftertreatment diesel oxidation catalyst conversion efficiency - Data valid but below normal operating range - Moderately severe level. The temperature increase across the aftertreatment catalyst is lower than expected.	Possible frequent need for aftertreatment regeneration.
1695 3513 3	Sensor supply 5 - Voltage above normal or shorted to high source. High voltage detected at sensor supply 5 circuit in the oem harness.	the engine will operate in limp home mode.
1696 3513 4	Sensor supply 5 - Voltage below normal or shorted to low source. Low voltage detected at sensor supply number 5 circuit in the oem harness.	the engine will operate in limp home mode.
1712 3363 18	Aftertreatment diesel exhaust fluid tank heater - Data valid but below normal operating range - Moderately severe level. The aftertreatment diesel exhaust fluid tank heater is unable to thaw the frozen diesel exhaust fluid.	Possible reduced engine performance.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
1713 3363 16	Aftertreatment diesel exhaust fluid tank heater - Data valid but above normal operating range - Moderately severe level. The diesel exhaust fluid tank heater is continuously in the on position.	None on performance.
1718 1322 31	Engine misfire for multiple cylinders - Condition exists. Engine misfire has been detected in multiple cylinder numbers.	Possible reduced engine performance.
1776 2634 3	Power relay driver circuit - Voltage above normal or shorted to high source. High voltage detected at power relay driver circuit.	Possible reduced engine performance.
1777 2634 4	Power relay driver circuit - Voltage below normal or shorted to low source. An open circuit or low voltage has been detected at the power relay circuit.	Possible reduced engine performance.
1843 101 3	Crankcase pressure circuit - Voltage above normal or shorted to high source. High signal voltage detected at the crankcase pressure circuit.	None on performance.
1844 101 4	Crankcase pressure circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the crankcase pressure circuit.	None on performance.
1866 411 2	Exhaust gas recirculation valve delta pressure - Data erratic, intermittent, or incorrect. An error in the egr delta pressure signal was detected at initial key on or the sensor failed the autozero test.	possible reduced engine performance.
1867 412 2	Engine gas recircuilation temperature - Data erratic, intermittent, or incorrect. Engine misfire has been detected in multiple cylinder numbers.	Possible reduced engine performance.
1879 3251 3	Aftertreatment diesel particulate filter differential pressure sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the aftertreatment differential pressure sensor circuit.	possible reduced engine performance.
1881 3251 4	Aftertreatment diesel particulate filter differential pressure sensor circuit - Voltage below normal or shorted to low source. Low signal voltage or open circuit detected at the aftertreatment differential pressure sensor circuit.	possible reduced engine performance.
1883 3251 2	Aftertreatment diesel particulate filter differential pressure sensor - Data erratic, intermittent, or incorrect. The aftertreatment diesel particulate filter differential pressure sensor is reading an erratic value at initial key on or during engine operation.	possible reduced engine performance.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
1885 3216 4	Aftertreatment intake NOx sensor circuit - Voltage below normal or shorted to low source. An internal circuit error has been detected by the aftertreatment intake NOx sensor.	Possible reduced engine performance.
1887 3226 4	Aftertreatment outlet NOx sensor circuit - Voltage below normal or shorted to low source. An internal circuit error has been detected by the aftertreatment outlet NOx sensor.	Possible reduced engine performance.
1896 2791 13	EGR valve controller - Out of calibration. The EGR valve has failed the automatic calibration procedure at initial key ON.	Possible reduced engine performance.
1921 3251 0	Aftertreatment diesel particulate filter differential pressure - Data valid but above normal operating range - Moderately severe level. The soot load of the aftertreatment diesel particulate filter has exceeded the recommended limits.	Possible reduced engine performance.
1922 3251 0	Aftertreatment diesel particulate filter differential pressure - Data valid but above normal operating range - Most severe level. The soot load of the aftertreatment diesel particulate filter has exceeded the recommended limits. Engine protection derate is enabled.	Possible reduced engine performance.
1938 3597 1	Ecu power output supply voltage 1 - Data valid but below normal operational range - Moderately severe level. Low battery voltage detected by the VGT actuator.	Possible reduced engine performance.
1942 101 2	Crankcase pressure - Data erratic, intermittent, or incorrect. The ECM has detected that the crankcase pressure signal is reading an erratic value at initial key ON or during engine operation.	None on performance.
1961 2791 0	EGR valve control circuit calculated over temperature - Data valid but above normal operational range - Least severe level. High EGR valve driver temperature has been detected.	Possible reduced engine performance.
1962 641 0	VGT Actuator driver over temperature (calculated) - Data valid but above normal operating range - Least severe level. High internal VGT actuator temperature has been detected.	None on performance.
1974 101 16	Crankcase pressure - Data valid but above normal operating range - Moderately severe level. The crankcase breather filter requires maintenance.	None on performance.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
1993 4795 31	Aftertreatment diesel particulate filter missing - Condition exists. The aftertreatment diesel particulate filter in the exhaust system is not present.	Active aftertreatment diesel particulate filter regeneration will be disabled.
2185 3512 3	Sensor supply 4 circuit - Voltage above normal, or shorted to high source. High voltage detected at 5 VDC sensor supply circuit to the accelerator pedal position sensor.	Engine will only idle.
2186 3512 4	Sensor supply 4 circuit - Voltage below normal, or shorted to low source. Low voltage detected at 5 VDC sensor supply circuit to the accelerator pedal position sensor.	Engine will only idle.
2198 641 11	VGT Actuator driver circuit - Root cause not known. Intermittent communication between the smart VGT controller and the ECM has been detected. The VGT controller is not interpreting the J1939 message from the ECM correctly.	Possible reduced engine performance.
2272 27 4	EGR Valve position circuit - Voltage below normal or shorted to low source. Low signal voltage has been detected at the EGR valve position sensor circuit	Possible reduced engine performance.
2273 411 3	Exhaust gas recirculation valve delta pressure sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the EGR differential pressure sensor circuit.	Possible reduced engine performance.
2274 411 4	Exhaust gas recirculation valve delta pressure sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the EGR differential pressure sensor circuit.	Possible reduced engine performance.
2288 103 15	Turbocharger 1 speed - Data valid but above normal operating range - Least severe level. High turbocharger speed has been detected by the ECM.	Possible reduced engine performance.
2311 633 31	Electronic fuel injection control valve circuit - Condition exists. Fuel pump actuator circuit resistance too high or too low, or an intermittent connection has been detected.	Possible reduced engine performance.
2322 723 2	Engine camshaft speed / position sensor - Data erratic, intermittent, or incorrect. Camshaft engine speed sensor intermittent synchronization.	None on performance.
2349 2791 5	EGR Valve control circuit - Current below normal or open circuit. Motor terminal or motor coil open circuit has been detected by the ECM.	Possible reduced engine performance.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
2353 2791 6	EGR Valve control circuit - Current above normal or grounded circuit. A short circuit to ground has been detected in the EGR valve motor circuit.	Possible reduced engine performance.
2372 95 16	Fuel filter differential pressure - Data valid but above normal operational range - Moderately severe level. Excessive fuel flow restriction to the high pressure fuel pump has been detected.	Possible reduced engine performance.
2373 1209 3	Exhaust gas pressure sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the exhaust gas pressure circuit.	Possible reduced engine performance.
2374 1209 4	Exhaust gas pressure sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the exhaust gas pressure circuit.	Possible reduced engine performance.
2375 412 3	Exhaust gas recirculation temperature sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at EGR temperature circuit.	Possible reduced engine performance.
2376 412 4	Exhaust gas recirculation temperature sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at EGR temperature circuit.	Possible reduced engine performance.
2377 647 3	Fan control circuit - Voltage above normal, or shorted to high source. Open circuit or high voltage detected at the fan control circuit.	The fan can stay on continuously or not run at all.
2387 641 7	VGT Actuator driver circuit (motor) - Mechanical system not responding or out of adjustment. The smart VGT controller has detected incorrect stop limits, or the VGT is unable to move to the closed position.	Possible reduced engine performance.
2398 171 2	Ambient air temperature - Data erratic, intermittent, or incorrect. The ambient air temperature sensor is reading an erratic value.	Possible reduced engine performance.
2448 111 17	Coolant level - Data valid but below normal operational range - Least severe level. Low engine coolant level detected.	none on performance.
2449 641 13	Vgt actuator controller - Out of calibration. The VGT actuator has been installed incorrectly.	Possible reduced engine performance.
2468 102 3	Engine crankshaft speed/position - Data valid but above normal operating range - Moderately severe level. The engine speed has exceeded a critical limit.	Engine will be shut down.
2554 1209 2	Exhaust gas pressure - Data erratic, intermittent or incorrect. The exhaust gas pressure sensor is reading an erratic value.	possible reduced engine performance.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
2555 729 3	Intake air heater 1 circuit - Voltage above normal, or shorted to high source. High voltage detected at the intake air heater signal circuit.	The intake air heaters may be ON or OFF all the time.
2556 729 4	Intake air heater 1 circuit - Voltage below normal, or shorted to low source. Low voltage detected at the intake air heater signal circuit.	The intake air heaters may be ON or OFF all the time.
2634 641 12	VGT Actuator controller - Bad intelligent device or component. An internal error has been detected by the smart VGT controller.	Possible reduced engine performance.
2636 641 9	VGT Actuator driver circuit - abnormal update rate. No communications on the J1939 data link between the engine ECM and the smart VGT controller.	Possible reduced engine performance.
2638 5298 17	Aftertreatment diesel oxidation catalyst conversion efficiency - Data valid but below normal operating range - Least severe level. The temperature increase across the aftertreatment diesel oxidation catalyst is lower than expected.	Possible frequent need for aftertreatment regeneration.
2639 3251 15	Aftertreatment diesel particulate filter differential pressure - Data valid but above normal operating range - Least severe level. The soot load of the aftertreatment diesel particulate filter has exceeded the recommended limits.	Possible reduced engine performance.
2646 110 32	Engine coolant temperature - Condition exists. The EGR valve was closed to reduce engine coolant temperature.	Possible reduced engine performance.
2718 520325 31	Brake switch and accelerator pedal position incompatible - Condition exists. The ECM has detected the brake pedal and accelerator pedal were depressed simultaneously.	The engine will operate in limp home mode.
2771 3226 9	Aftertreatment outlet NOx sensor - Abnormal update rate. No communications or an invalid data transfer rate detected on the J1939 data link between the ECM and the aftertreatment outlet NOx sensor.	Possible reduced engine performance.
2777 3703 31	Particulate trap active regeneration inhibited due to inhibit switch - Condition exists. Regeneration of the diesel particulate filter has been prevented due to the permit switch being disabled.	Possible frequent need for aftertreatment regeneration.
2961 412 15	Exhaust gas recirculation temperature - Data valid but above normal operational range - Least severe level. EGR temperature has exceeded the engine protection limit.	Possible reduced engine performance.
2962 412 16	Exhaust gas recirculation temperature - Data valid but above normal operational range - Moderately severe level. EGR temperature has exceeded the engine protection limit.	Possible reduced engine performance.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
2963 110 15	Engine coolant temperature - Data valid but above normal operational range - Least severe level. Engine coolant temperature is above the engine protection warning limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the Engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
2964 105 15	Intake manifold 1 temperature - Data valid but above normal operational range - Least severe level. Intake manifold air temperature signal indicates intake manifold air temperature is above engine protection warning limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the Engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
2973 102 2	Intake manifold 1 pressure - Data erratic, intermittent, or incorrect. The intake manifold pressure sensor is reading an erratic value.	Possible reduced engine performance.
2976 3361 2	Aftertreatment diesel exhaust fluid dosing unit temperature - Data erratic, intermittent, or incorrect. An internal error has been detected in the aftertreatment diesel exhaust fluid dosing unit.	Possible reduced engine performance.
3133 3610 3	Aftertreatment diesel particulate filter outlet pressure sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the aftertreatment diesel particulate filter outlet pressure sensor circuit.	Possible reduced engine performance.
3134 3610 4	Aftertreatment diesel particulate filter outlet pressure sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the aftertreatment diesel particulate filter outlet pressure sensor circuit.	Possible reduced engine performance.
3135 3610 2	Aftertreatment diesel particulate filter outlet pressure - Data erratic, intermittent or incorrect. The aftertreatment diesel particulate filter outlet pressure sensor is reading an erratic value at initial key ON or during engine operation.	
3146 4363 3	Aftertreatment SCR outlet temperature sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the SCR outlet temperature sensor circuit.	Possible reduced engine performance.
3147 4363 4	Aftertreatment SCR outlet temperature sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the SCR outlet temperature sensor circuit.	Possible reduced engine performance.
3148 4363 2	Aftertreatment SCR outlet temperature sensor - Data erratic, intermittent, or incorrect. The SCR outlet temperature sensor is not changing with engine operating conditions.	Possible reduced engine performance.
3151 4794 31	Aftertreatment SCR catalyst system missing - Condition exists. The aftertreatment SCR catalyst in the exhaust system is not present.	Possible reduced engine performance.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3165 4363 0	Aftertreatment SCR outlet temperature - Data valid but above normal operational range - Most severe level. The SCR outlet temperature sensor reading has exceeded the maximum engine protection temperature limit.	Possible reduced engine performance.
3168 3936 16	Aftertreatment diesel particulate filter system - Data valid but above normal operating range - Moderately severe level. The system has detected a malfunction in the filtering capability of the aftertreatment diesel particulate filter.	None on performance.
3186 1623 9	Tachograph output shaft speed - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the tachograph output shaft speed sensor.	None on performance.
3213 1623 19	Tachograph output shaft speed - Received network data in error. The J1939 multiplexing controller has indicated a malfunction of the tachograph output shaft speed sensor.	None on performance.
3228 3216 2	Aftertreatment Intake NOx sensor - Data erratic, intermittent, or incorrect. An incorrect NOx sensor reading has been detected by the aftertreatment intake NOx sensor.	Possible reduced engine performance.
3232 3216 9	Aftertreatment Intake NOx sensor - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the aftertreatment intake NOx sensor.	Possible reduced engine performance.
3235 4363 16	Aftertreatment SCR outlet temperature - Data valid but above normal operating range - Moderately severe level. The SCR outlet temperature sensor reading has exceeded the maximum temperature limit.	Possible reduced engine performance.
3237 4340 3	Aftertreatment diesel exhaust fluid line heater 1 circuit - Voltage above normal or shorted to high source. High signal voltage detected at the diesel exhaust fluid line heater 1 circuit.	Possible reduced engine performance.
3238 4340 4	Aftertreatment diesel exhaust fluid line heater 1 circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the diesel exhaust fluid line heater 1 circuit.	Possible reduced engine performance.
3239 4342 3	Aftertreatment diesel exhaust fluid line heater 2 circuit - Voltage above normal or shorted to high source. High signal voltage detected at the diesel exhaust fluid line heater 2 circuit.	Possible reduced engine performance.
3241 4342 4	Aftertreatment diesel exhaust fluid line heater 2 circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the diesel exhaust fluid line heater 2 circuit.	Possible reduced engine performance.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3242 3363 7	Aftertreatment diesel exhaust fluid tank heater - Mechanical system not responding or out of adjustment. The aftertreatment diesel exhaust fluid temperature did not increase when the aftertreatment diesel exhaust fluid tank heater was commanded ON.	Possible reduced engine performance.
3243 3060 18	Engine cooling system monitor - Data valid but below normal operating range - Moderately severe level. The engine is not warming up as expected.	None on performance.
3251 4765 16	Aftertreatment diesel oxidation catalyst intake temperature - Data valid but above normal operating range - Moderately severe level. The diesel oxidation catalyst intake temperature sensor reading has exceeded the maximum temperature limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the Engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
3253 3242 16	Aftertreatment diesel particulate filter intake temperature - Data valid but above normal operating range - Moderately severe level. The aftertreatment diesel particulate filter intake temperature sensor reading has exceeded the maximum engine protection temperature limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the Engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
3254 3242 15	Aftertreatment diesel particulate filter intake temperature - Data valid but above normal operating range - Least severe level. The aftertreatment diesel particulate filter intake temperature sensor reading has exceeded the maximum engine protection temperature limit.	Possible reduced engine performance.
3255 3246 16	Aftertreatment diesel particulate filter outlet temperature - Data valid but above normal operating range - Moderately severe level. The aftertreatment diesel particulate filter outlet temperature sensor reading has exceeded the maximum engine protection temperature limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
3256 3246 15	Aftertreatment diesel particulate filter outlet temperature - Data valid but above normal operating range - Least severe level. The aftertreatment diesel particulate filter outlet temperature sensor reading has exceeded the maximum engine protection temperature limit.	Possible reduced engine performance.
3258 4340 5	Aftertreatment diesel exhaust fluid line heater 1 circuit - Current below normal or open circuit. Open circuit detected in the diesel exhaust fluid line heater 1.	Possible reduced engine performance.
3261 4342 5	Aftertreatment diesel exhaust fluid line heater 2 circuit - Current below normal or open circuit. Open circuit detected in the diesel exhaust fluid line heater 2.	Possible reduced engine performance.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3311 3242 0	Aftertreatment diesel particulate filter intake temperature - Data valid but above normal operating range - Most severe level. The aftertreatment diesel particulate filter intake temperature sensor reading has exceeded the maximum engine protection temperature limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
3312 3246 0	Aftertreatment diesel particulate filter outlet temperature - Data valid but above normal operating range - Most severe level. The aftertreatment diesel particulate filter outlet temperature sensor reading has exceeded the maximum engine protection temperature limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
3313 4765 4	Aftertreatment diesel oxidation catalyst intake temperature sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the catalyst intake sensor circuit.	Possible reduced engine performance.
3314 4765 3	Aftertreatment diesel oxidation catalyst intake temperature sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the catalyst intake temperature sensor circuit.	Possible reduced engine performance.
3315 4765 2	Aftertreatment diesel oxidation catalyst intake temperature - Data erratic, intermittent, or incorrect. The aftertreatment diesel oxidation catalyst intake temperature sensor is not changing with engine operating conditions.	Possible reduced engine performance.
3316 3242 4	Aftertreatment diesel particulate filter intake temperature sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the aftertreatment diesel particulate filter intake temperature sensor circuit.	Possible reduced engine performance.
3317 3242 3	Aftertreatment diesel particulate filter intake temperature sensor circuit - Voltage above normal or shorted to high source. High signal voltage or open circuit detected at the aftertreatment diesel particulate filter intake temperature sensor circuit.	Possible reduced engine performance.
3318 3242 2	Aftertreatment diesel particulate filter intake temperature - Data erratic, intermittent, or incorrect. The aftertreatment diesel particulate filter intake temperature is not changing with engine operating conditions.	Possible reduced engine performance.
3319 3246 3	Aftertreatment diesel particulate filter outlet temperature sensor circuit - Voltage above normal or shorted to high source. High signal voltage or open circuit detected at the aftertreatment diesel particulate filter outlet temperature sensor circuit.	Possible reduced engine performance.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3321 3246 4	Aftertreatment diesel particulate filter outlet temperature sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the aftertreatment diesel particulate filter outlet temperature sensor circuit.	Possible reduced engine performance.
3322 3246 2	Aftertreatment diesel particulate filter outlet temperature - Data erratic, intermittent, or incorrect. The aftertreatment diesel particulate filter outlet temperature is not changing with engine operating conditions.	Possible reduced engine performance.
3326 91 9	SAE J1939 Multiplexed accelerator pedal or lever sensor system - Abnormal update rate. The ECM expected information from a multiplexed accelerator pedal or lever sensor but did not receive it soon enough or did not receive it at all.	Engine will only idle.
3328 191 9	Transmission output shaft speed - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the transmission output shaft speed sensor.	None on performance.
3342 4752 18	Engine exhaust gas recirculation cooler efficiency - Data valid but below normal operating range - Moderately severe level. The EGR cooler is not cooling the recirculated exhaust gas sufficiently.	None on performance.
3343 5285 18	Engine charge-air cooler efficiency - Data valid but below normal operating range - Moderately severe level. The engine charge air cooler is not cooling the intake air flow sufficiently.	None on performance.
3361 102 10	Intake manifold 1 pressure - Abnormal rate of change. The VGT position reading is stuck.	Possible reduced engine performance.
3366 111 18	Coolant level - Data valid but below normal operating range - Moderately severe level. Very low engine coolant level detected.	None on performance.
3374 1818 31	Roll over protection brake control active - Condition exists. The ECM received a message from the anti-lock braking (ABS) controller, inhibiting cruise control operation.	Cruise control could possibly not operate.
3375 5397 31	Aftertreatment diesel particulate filter regeneration too frequent - Condition exists. The system has detected the need for an active regeneration has occurred too soon following the last active regeneration.	None on performance.
3376 5319 31	Aftertreatment diesel particulate filter incomplete regeneration - Condition exists. The system has detected that the aftertreatment diesel particulate filter differential pressure is too high following an active regeneration.	Possible frequent need for aftertreatment regeneration.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3382 3058 18	Engine exhaust gas recirculation (EGR) system - Data valid but below normal operating range - Moderately severe level. Measured egr flow is lower than commanded.	Possible reduced engine performance.
3383 3058 16	Engine exhaust gas recirculation (EGR) system - Data valid but above normal operating range - Moderately severe Level. Measured EGR flow is higher than commanded.	Possible reduced engine performance.
3394 4766 18	Aftertreatment 1 diesel oxidation catalyst outlet gas temperature - Data valid but below normal operating range - Moderately severe level. The diesel oxidation catalyst outlet Temperature is below the operating limit	Possible frequent need for aftertreatment regeneration.
3396 3750 31	Diesel particulate filter 1 conditions not met for active regeneration - Condition exists. The aftertreatment temperatures are not warm enough for aftertreatment injection.	Possible frequent need for aftertreatment regeneration.
3418 191 19	Transmission output shaft speed - Received network data in error. The J1939 multiplexing controller has indicated a malfunction of the transmission output shaft speed sensor.	None on performance.
3422 4344 3	Aftertreatment diesel exhaust fluid line heater 3 circuit - Voltage above normal or shorted to high source. High signal voltage detected at the diesel exhaust fluid line heater 3 circuit.	Possible reduced engine performance.
3423 4344 4	Aftertreatment diesel exhaust fluid line heater 3 circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the diesel exhaust fluid line heater 3 circuit.	Possible reduced engine performance.
3425 4344 5	Aftertreatment diesel exhaust fluid line heater 3 circuit - Current below normal or open circuit. Open circuit detected in the diesel exhaust fluid line heater 3.	Possible reduced engine performance.
3488 563 9	Anti-lock braking (ABS) controller - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the anti- lock braking (ABS) controller.	None on performance.
3492 251 10	Real time clock - Abnormal rate of change. The real time clock indicates a stuck engine off timer.	None on performance.
3494 1081 7	Engine wait to start lamp - Mechanical system not responding or out of adjustment. Wait to Start lamp has malfunction.	None on performance.
3497 1761 17	Aftertreatment diesel exhaust fluid tank level - Data valid but below normal operating range - Least severe level. The aftertreatment diesel exhaust fluid tank level is low.	None on performance.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3498 1761 18	Aftertreatment diesel exhaust fluid tank level - Data valid but below normal operating range - Moderately severe level. The aftertreatment diesel exhaust fluid tank level is very low.	None on performance.
3525 84 19	Wheel-based vehicle speed - Received network data in error. The J1939 multiplexing controller has indicated a malfunction of the wheel-based vehicle speed sensor.	Engine speed limited to maximum engine speed without VSS parameter value. Cruise control, gear-down protection, and road speed governor will not work.
3526 84 9	Wheel-Based vehicle speed - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the wheel- based vehicle speed sensor.	Engine speed limited to maximum engine speed without VSS parameter value. Cruise control, gear-down protection, and road speed governor will not work.
3527 558 19	Accelerator pedal or lever idle validation switch - Received network data in error. The J1939 multiplexing controller has indicated a malfunction of the accelerator pedal or lever idle validation switch.	The engine will only idle.
3528 558 9	Accelerator pedal or lever idle validation switch - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the accelerator pedal or lever idle validation switch.	Engine will only idle.
3531 171 9	Ambient air temperature - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the ambient air temperature sensor.	Possible reduced engine performance.
3532 171 19	Ambient air temperature - Received network data in error. The J1939 multiplexing controller has indicated a malfunction of the ambient air temperature sensor.	Possible reduced engine performance.
3539 51 3	Engine intake throttle actuator position sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the engine intake air throttle position sensor circuit.	Possible reduced engine performance.
3541 51 4	Engine intake throttle actuator position sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the engine intake air throttle position sensor circuit.	Possible reduced engine performance.
3542 51 2	Engine intake throttle actuator position sensor - Data erratic, intermittent or incorrect. The engine intake air throttle posistion feedback is erratic or incorrect.	Possible reduced engine performance.
3545 3226 10	Aftertreatment outlet NOx sensor circuit - Abnormal rate of change. The aftertreatment outlet NOx sensor reading is not valid.	None on performance.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3547 4096 31	Aftertreatment diesel exhaust fluid tank empty - Condition exists. The diesel exhaust fluid tank is empty.	Possible reduced engine performance.
3555 1081 9	Engine wait to start lamp - Abnormal update rate. A loss of communication has been detected.	None on performance.
3556 1081 19	Engine wait to start lamp - Received network data in error. The ECM received an invalid signal on the SAE J1939 datalink.	None on performance.
3558 3361 3	Aftertreatment diesel exhaust fluid dosing unit - Voltage above normal or shorted to high source. High signal voltage detected at the aftertreatment diesel exhaust fluid dosing unit.	Possible reduced engine performance.
3559 3361 4	Aftertreatment diesel exhaust fluid dosing unit - Voltage below normal or shorted to low source. Low signal voltage detected at the aftertreatment diesel exhaust fluid dosing unit.	Possible reduced engine performance.
3562 5491 3	Aftertreatment diesel exhaust fluid line heater relay - Voltage above normal or shorted to high source. High signal voltage detected at the diesel exhaust fluid line heater relay.	Possible reduced engine performance.
3563 5491 4	Aftertreatment diesel exhaust fluid line heater relay - Voltage below normal or shorted to low source. Low signal voltage detected at the diesel exhaust fluid line heater relay.	Possible reduced engine performance.
3567 5394 5	Aftertreatment diesel exhaust fluid dosing valve - Current below normal or open circuit. A circuit error has been detected in the aftertreatment diesel exhaust fluid dosing valve circuit.	Possible reduced engine performance.
3568 5394 7	Aftertreatment diesel exhaust fluid (DEF) Dosing valve - Mechanical system not responding or out of adjustment. A mechanical malfunction has been detected in the DEF dosing valve.	Possible reduced engine performance.
3571 4334 3	Aftertreatment diesel exhaust fluid pressure sensor - Voltage above normal or shorted to high source. High signal voltage detected at the aftertreatment diesel exhaust fluid pressure sensor circuit.	Possible reduced engine performance.
3572 4334 4	Aftertreatment diesel exhaust fluid pressure sensor - Voltage below normal or shorted to low source. Low signal voltage detected at the diesel exhaust fluid pressure sensor circuit.	Possible reduced engine performance.
3574 4334 18	Aftertreatment diesel exhaust fluid pressure sensor - Data valid but below normal operating range - Moderately severe level. Low diesel exhaust fluid pressure has been detected in the dosing unit.	Possible reduced engine performance.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3575 4334 16	Aftertreatment diesel exhaust fluid pressure sensor - Data valid but above normal operating range - Moderately severe level. The diesel exhaust fluid dosing unit has detected a blockage in the diesel exhaust fluid return flow.	Possible reduced engine performance.
3577 4376 3	Aftertreatment diesel exhaust fluid return valve - Voltage above normal or shorted to high source. High signal voltage detected at the aftertreatment diesel exhaust fluid return valve.	Possible reduced engine performance.
3578 4376 4	Aftertreatment diesel exhaust fluid return valve - Voltage below normal, or shorted to low source. Low signal voltage detected at the diesel exhaust fluid return valve.	Possible reduced engine performance.
3582 4364 18	Aftertreatment SCR catalyst conversion efficiency - Data valid but below normal operating range - Moderately severe level. NOx conversion across the SCR catalyst is too low.	Possible reduced engine performance.
3583 5031 10	Aftertreatment outlet NOx sensor heater - Abnormal rate of change. The aftertreatment outlet NOx sensor heater is unable to maintain its normal operating temperature.	None on performance.
3596 4334 2	Aftertreatment diesel exhaust fluid pressure sensor - Data erratic, intermittent, or incorrect. The diesel exhaust fluid pressure sensor has reported a reading too high or low for the operating conditions.	Possible reduced engine performance.
3649 5024 10	Aftertreatment Intake NOx sensor heater - Abnormal rate of change. The aftertreatment intake NOx sensor heater is unable to maintain its normal operating temperature.	None on performance.
3681 3228 2	Aftertreatment outlet NOx sensor power supply - Data erratic, intermittent, or incorrect. The aftertreatment outlet NOx sensor indicates that the power supply to the sensor is incorrect.	None on performance.
3682 3218 2	Aftertreatment Intake NOx sensor power supply - Data erratic, entermittent or encorrect. The aftertreatment intake NOx sensor indicates that the power supply to the sensor is incorrect.	None on performance.
3697 630 12	Engine control module calibration memory - Bad intelligent device or component. Error internal to the ECM related to engine software failures.	Engine may not start or may be difficult to start.
3712 5246 0	Aftertreatment SCR operator inducement - Data valid but above normal operational range - Most severe level. Critical SCR related fault codes have been active for an extended period of time and require immediate attention.	Vehicle speed will be limited to 8 km [5 miles] per hour.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3714 1569 31	Engine protection torque derate - Condition exists. Critical fault codes related to engine operation are active.	Possible reduced engine performance.
3715 188 16	Engine speed at idle - Data valid but below normal operating range - Moderately severe level. The engine speed at idle has exceeded the governed idle speed.	Possible reduced engine performance.
3716 188 18	Engine speed at idle - Data valid but below normal operational range - Moderately severe level. Engine is not maintaining the governed idle speed.	None on performance.
3717 3226 13	Aftertreatment outlet NOx sensor - Out of calibration. A calibration mismatch between the aftertreatment outlet NOx sensor and the ECM has been detected.	None on performance.
3718 3216 13	Aftertreatment intake NOx - Out of calibration. A calibration mismatch between the aftertreatment intake NOx sensor and the ECM has been detected.	None on performance.
3724 168 17	Battery 1 voltage - Data valid but below normal operating range - Least severe level. Low voltage to the EGR valve device driver has been detected.	Possible reduced engine performance.
3725 3216 10	Aftertreatment Intake NOx sensor - Abnormal rate of change. The aftertreatment intake NOx sensor reading is not valid.	None on performance.
3727 5571 7	High pressure common rail fuel pressure relief valve - Mechanical system not responding or out of adjustment. The fuel rail high-pressure relief valve has opened at a lower than expected pressure.	Possible reduced engine performance.
3737 1675 31	Engine starter mode overcrank protection - Condition exists. The starter motor has been temporarily disabled in order to prevent starter damage.	Starter operation is prohibited until the starter motor has adequately cooled.
3741 5571 0	High pressure common rail fuel pressure relief valve - Data valid but above normal operational range - Most severe level. The fuel rail pressure relief valve has opened due to high fuel rail pressure.	Engine may run rough, may stop running, may not start, or may be difficult to start.
3749 3226 20	Aftertreatment outlet NOx sensor - Data not rational - Drifted high. An offset in the outlet NOx sensor reading has been detected.	None on performance.
3838 2978 9	Estimated engine parasitic losses - Percent torque - Abnormal update rate. A loss of communication has been detected.	None on performance.
3843 5603 9	Cruise control disable command - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the cruise control.	None on performance.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3844 5605 31	Cruise control pause command - Condition exists. The adaptive cruise control has dropped out and must be manually engaged.	Cruise control could possibly not operate.
3845 5603 31	Cruise control disable command - Condition exists. The adaptive cruise control has dropped out and must be manually engaged.	Cruise control could possibly not operate.
3899 5848 4	Aftertreatment 1 SCR Intermediate NH3 sensor - Voltage below normal, or shorted to low source. A circuit error has been detected in the NH3 sensor.	None on performance.
3911 5848 9	Aftertreatment SCR Intermediate NH3 sensor - Abnormal update rate. Loss of communication with the aftertreatment SCR intermediate NH3 sensor.	Possible reduced engine performance.
3912 5853 10	Aftertreatment SCR Intermediate NH3 sensor heater - Abnormal rate of change. A malfunction of the aftertreatment SCR intermediate NH3 sensor heater has been detected.	Possible reduced engine performance.
3932 5851 16	Aftertreatment SCR Intermediate NH3 gas sensor power supply - Data valid but above normal operating range - Moderately severe level. High battery voltage supply detected at the aftertreatment SCR intermediate NH3 sensor.	Possible reduced engine performance.
3933 5851 18	Aftertreatment SCR Intermediate NH3 gas sensor power supply - Data valid but below normal operating range - Moderately severe level. Low battery voltage supply detected at the aftertreatment SCR intermediate NH3 sensor.	Possible reduced engine performance.
3934 5851 2	Aftertreatment SCR Intermediate NH3 gas sensor power supply - Data erratic, intermittent or incorrect. Intermittent battery voltage supply detected at the aftertreatment SCR intermediate NH3 sensor.	
3935 5848 13	Aftertreatment SCR Intermediate NH3 sensor - Out of calibration. Incorrect trim resistance has been detected in the aftertreatment SCR intermediate NH3 sensor.	Possible reduced engine performance.
3936 5848 12	Aftertreatment SCR Intermediate NH3 sensor - Bad intelligent device or component. An internal error of the aftertreatment SCR intermediate NH3 sensor has been detected.	Possible reduced engine performance.
3937 5848 10	Aftertreatment 1 SCR Intermediate NH3 sensor - Abnormal rate of change. The aftertreatment SCR intermediate NH3 sensor reading is NOT valid.	Possible reduced engine performance.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
4149 2623 8	Accelerator pedal or lever position sensor 2 circuit frequency - Abnormal frequency or pulse width or period. The accelerator pedal position sensor reading is out of range.	The engine will operate in Limp Home mode.
4151 5742 9	Aftertreatment diesel particulate filter temperature sensor module - Abnormal update rate. No communications on the J1939 data link between the ECM and the aftertreatment diesel particulate filter temperature sensor module.	Possible reduced engine performance.
4152 5743 9	Aftertreatment selective catalytic reduction temperature sensor module - Abnormal update rate. No communications on the J1939 data link between the ECM and the aftertreatment SCR temperature sensor module.	Possible reduced engine performance.
4155 5746 3	Aftertreatment 1 diesel exhaust fluid dosing unit heater relay - Voltage above normal, or shorted to high source. High signal voltage detected at the aftertreatment diesel exhaust fluid dosing unit heater relay circuit.	Possible reduced engine performance.
4156 5746 4	Aftertreatment 1 diesel exhaust fluid dosing unit heater relay - Voltage below normal, or shorted to low source. Low signal voltage detected at the aftertreatment diesel exhaust fluid dosing unit heater relay circuit.	Possible reduced engine performance.
4157 4376 7	Aftertreatment diesel exhaust fluid return valve - Mechanical system not responding or out of adjustment. A stuck aftertreatment diesel exhaust fluid return valve has been detected.	None on performance.
4158 5742 12	Aftertreatment diesel particulate filter temperature sensor module - Bad intelligent device or component. An internal error has been detected in the aftertreatment diesel particulate filter temperature sensor module.	Possible reduced engine performance.
4159 5743 12	Aftertreatment selective catalytic reduction temperature sensor module - Bad intelligent device or component. An internal error has been detected in the aftertreatment SCR temperature sensor module.	Possible reduced engine performance.
4161 5742 3	Aftertreatment diesel particulate filter temperature sensor module - Voltage above normal, or shorted to high source. High battery supply voltage detected at the aftertreatment diesel particulate filter temperature sensor module.	Possible reduced engine performance.
4162 5742 4	Aftertreatment diesel particulate filter temperature sensor module - Voltage below normal, or shorted to low source. Low battery supply voltage detected at the aftertreatment diesel particulate filter temperature sensor module.	Possible reduced engine performance.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
4163 5742 16	Aftertreatment diesel particulate filter temperature sensor module- Data valid but above normal operating range - Moderately severe level. High internal temperature detected in the aftertreatment diesel particulate filter temperature sensor module.	Possible reduced engine performance.
4164 5743 3	Aftertreatment selective catalytic reduction temperature sensor module - Voltage above normal, or shorted to high source. High battery supply voltage detected at the aftertreatment SCR temperature sensor module.	Possible reduced engine performance.
4165 5743 4	Aftertreatment selective catalytic reduction temperature sensor module - Voltage below normal, or shorted to low source. Low battery supply voltage detected at the aftertreatment SCR temperature sensor module.	Possible reduced engine performance.
4166 5743 16	Aftertreatment selective catalytic reduction temperature sensor module - Data valid but above normal operating range - Moderately severe level. High internal temperature detected in the aftertreatment SCR temperature sensor module.	Possible reduced engine performance.
4168 5745 3	Aftertreatment diesel exhaust fluid dosing unit heater - Voltage above normal, or shorted to high source. The aftertreatment diesel exhasut fluid dosing unit heater is detected to be stuck on.	None on performance.
4169 5745 5	Aftertreatment diesel exhaust fluid dosing unit heater - Voltage below normal, or shorted to low source. The aftertreatment diesel exhasut fluid dosing unit heater is detected to be stuck off.	Possible reduced engine performance.
4171 5745 18	Aftertreatment diesel exhaust fluid dosing unit heater - Data valid but below normal operating range - Moderately severe level. The aftertreatment diesel exhaust fluid dosing unit failed to thaw.	Possible reduced engine performance.
4213 3695 2	Aftertreatment diesel particulate filter regeneration inhibit switch - Data erratic, intermittent or incorrect. The diesel particulate filter regeneration permit switch is stuck in the OFF or INHIBIT position.	Possible frequent need for aftertreatment regeneration.
4215 563 31	Anti-lock braking (ABS) Active - Condition exists. Cruise control was paused due to an anti-wheel slip message from teh ABS controller.	Adaptive cruise control will not operate. Standard cruise control may not operate.
4244 4337 2	Aftertreatment diesel exhaust fluid dosing temperature - Data erratic, intermittent or incorrect. The aftertreatment diesel exhaust fluid dosing temperature is irrational.	None on performance.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
4245 5798 2	Aftertreatment diesel exhaust fluid dosing unit heater temperature - Data erratic, intermittent or incorrect. The aftertreatment diesel exhaust fluid dosing unit heater temperature is irrational.	None on performance.
4249 4337 10	Aftertreatment diesel exhaust fluid dosing temperature - Abnormal rate of change. The aftertreatment diesel exhaust fluid dosing unit temperature is stuck.	None on performance.
4251 5798 10	Aftertreatment 1 diesel exhaust fluid dosing unit heater temperature - Abnormal rate of change. The aftertreatment diesel exhaust fluid dosing unit heater temperature sensor reading is stuck.	None on performance.
4252 1081 31	Engine wait to start lamp - Condition exists. The received signal does not match the commanded signal.	None on performance.
4259 5742 11	Aftertreatment diesel particulate filter temperature sensor module - Root cause not known. Intermittent battery voltage supply detected at the aftertreatment diesel particulate filter temperature sensor module.	Possible reduced engine performance.
4261 5743 11	Aftertreatment selective catalytic reduction temperature sensor module - Root cause not known. Intermittent battery voltage supply detected at the aftertreatment SCR temperature sensor module.	Possible reduced engine performance.
4279 5848 21	Aftertreatment 1 SCR Intermediate NH3 - Data not rational - Drifted low. An in range low failure has been detected.	Possible reduced engine performance.
4281 5848 2	Aftertreatment SCR Intermediate NH3 - Data erratic, intermittent or incorrect. The aftertreatment SCR intermediate NH3 sensor reading is stuck.	None on performance.
4284 5793 9	Desired engine fueling state - Abnormal update rate. A valid message from the transmission ECU has NOT been received.	Engine may not start or may be difficult to start.
4289 91 8	Accelerator pedal or lever position sensor 1 circuit frequency - Abnormal frequency or pulse width or period. The accelerator pedal position sensor reading is out of range.	The engine will operate in limp home mode.
4452 520668 31	Aftertreatment outlet NOx sensor closed loop operation - Condition exists. The maximum dosing adjustment has been reached.	Possible reduced engine performance.
4453 520669 31	Aftertreatment intermediate NH3 sensor closed loop operation - Condition exists. The maximum dosing adjustment has been reached.	None on performance.
4517 237 13	Vehicle Identification number - Out of calibration. The vehicle identification number has not been programmed into the ECM.	None on performance.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
4518 5862 3	Aftertreatment SCR Intermediate gas temperature sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the aftreatment SCR intermediate temperature sensor circuit.	Possible reduced engine performance.
4519 5862 4	Aftertreatment SCR Intermediate gas temperature sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the aftertreatment SCR intermediate temperature sensor circuit.	Possible reduced engine performance.
4521 5862 2	Aftertreatment SCR Intermediate gas temperature sensor - Data erratic, intermittent or incorrect. The aftertreatment SCR intermediate temperature sensor reading is irrational.	Possible reduced engine performance.
4524 5862 0	Aftertreatment SCR intermediate gas temperature - Data valid but above normal operational range - Most severe level. The aftertreatment SCR intermediate temperature sensor reading is above the engine protection limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
4525 5862 16	Aftertreatment 1 SCR intermediate gas temperature - Data valid but above normal operating range - Moderately severe level. High SCR Intermediate temperature detected.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
4526 521 2	Brake pedal position - Data erratic, intermittent or incorrect. The values of the 2 brake switch signals do not match.	None on performance.
4572 3031 9	Aftertreatment diesel exhaust fluid tank temperature - Abnormal update rate. The ECM lost communication with the aftertreatment diesel exhaust fluid tank temperature sensor.	Possible reduced engine performance.
4584 3936 14	Aftertreatment diesel particulate filter system - Special instructions. The incorrect aftertreatment diesel particulate filter system has been installed with the engine.	Engine will be shut down.
4585 4792 14	Aftertreatment 1 SCR catalyst system - Special instructions. The incorrect SCR system has been Installed.	Engine will be shut down.
4612 520701 31	Engine intake manifold pressure system monitor - Condition exists. The engine is unable to meet the air handling system commands.	Possible reduced engine performance.
4658 4331 18	Aftertreatment SCR actual dosing reagent quantity - Data valid but below normal operating range - Moderately severe level. Low aftertreatment diesel exhaust fluid flow detected.	Possible reduced engine performance.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
4691 5585 18	Engine injector metering rail 1 cranking pressure - Data valid but below normal operating range - Moderately severe level. The fuel rail pressure during cranking is too low for the engine to start.	Engine may not start or may be difficult to start.
4713 5357 31	Engine fuel injection quantity error for multiple cylinders - Condition exists. A malfunction of all fuel injectors has been detected.	Engine may run rough, may stop running, may not start, or may be difficult to start.
4726 1239 16	Engine fuel leakage - Data valid but above normal operating range - Moderately severe level. Fuel rail pressure decay has been detected.	Engine may run rough, may stop running, may not start, or may be difficult to start.
4727 157 15	Injector metering rail 1 pressure - Data valid but above normal operating range - Least severe level. A self pumping condition has been detected in the fuel system.	Possible reduced engine performance.
4731 3031 13	Aftertreatment diesel exhaust fluid tank temperature sensor - Out of calibration. The received datalink message was not valid.	Possible reduced engine performance.
4732 1761 13	Aftertreatment diesel exhaust fluid tank level sensor - Out of calibration. The received datalink message was not valid.	None on performance.
4739 1761 11	Aftertreatment 1 diesel exhaust fluid tank level sensor - Root cause not known. An unknown error has been detected with the aftertreatment diesel exhaust fluid tank level sensor.	Possible reduced engine performance.
4769 1761 10	Aftertreatment 1 diesel exhaust fluid tank level sensor - Abnormal rate of change. A valid diesel exhaust fluid tank level reading has NOT been received.	Possible reduced engine performance.
4865 6303 3	Engine coolant level 2 sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the engine coolant level 2 circuit.	None on performance.
4866 6303 4	Engine coolant level 2 sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the engine coolant level 2 circuit.	None on performance.
4956 520750 13	Engine variable geometry turbo (VGT) software - Out of calibration. VGT software does not match application.	Possible reduced engine performance.
4957 520750 31	Engine variable geometry turbo (VGT) software - Condition exists. The VGT actuator and ECM software is not compatible.	Possible reduced engine performance.

3) DEFINITION OF OPERATING MODES

(1) Normal

There's no failure detected in the transmission system or the failure has no or slight effects on transmission control. TCU will work without or in special cases with little limitations. (See following table)

(2) Substitute clutch control

TCU can't change the gears or the direction under the control of the normal clutch modulation.

TCU uses the substitute strategy for clutch control. All modulations are only time controlled. (Comparable with EST 25)

(3) Limp-home

The detected failure in the system has strong limitations to transmission control. TCU can engage only one gear in each direction. In some cases only one direction will be possible.

TCU will shift the transmission into neutral at the first occurrence of the failure. First, the operator must shift the gear selector into neutral position.

If output speed is less than a threshold for neutral to gear and the operator shifts the gear selector into forward or reverse, the TCU will select the limp-home gear.

If output speed is less than a threshold for reversal speed and TCU has changed into the limphome gear and the operator selects a shuttle shift, TCU will shift immediately into the limp-home gear of the selected direction.

If output speed is greater than the threshold, TCU will shift the transmission into neutral.

The operator has to slow down the vehicle and must shift the gear selector into neutral position.

(4) Transmission-shutdown

TCU has detected a severe failure that disables control of the transmission.

TCU will shut off the solenoid valves for the clutches and also the common power supply (VPS1). Transmission shifts to neutral.

The park brake will operate normally, also the other functions which use ADM1 to ADM8.

The operator has to slow down the vehicle. The transmission will stay in neutral.

(5) TCU-shutdown

TCU has detected a severe failure that disables control of system.

TCU will shut off all solenoid valves and also both common power supplies (VPS1, VPS2).

The park brake will engage, also functions are disabled which use ADM 1 to ADM 8.

The transmission will stay in neutral.

※ Abbreviations

- OC : Open circuit
- SC : Short circuit

OP mode : Operating mode

- TCU : Transmission control unit
- EEC : Electronic engine controller
- PTO : Power take off

4) TRANSMISSION FAULT CODES

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				The control unit detects a voltage of < 7.00 volt (12 V device) or < 9.00 volt (24 volt device) on the supply input of terminal 30. 1. The alternator control unit has an internal defect. 2. Vehicle battery not sufficiently charged. 3. Wiring or plug connection defective (supply or	 The cause of the missing or insufficient voltage on terminal 30 must be located. 1. Check the fuse of the terminal 30 control units. 2. If the error occurs after a (sluggish) vehicle start, check the vehicle battery. Recharge the battery to ensure that it is sufficiently charged. 3. Make sure that the control unit has a stable voltage supply. Check the stability of the voltage with Testman. 4. Check the wiring between the alternator and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. Pay special attention to the ground wiring. 5. Check the function of the alternator as well as the
523000	1	Battery low undervoltage	Trm Shutdown	ground cable). 4. Control unit parameters incorrectly set.	settings of the alternator control unit and replace both if necessary.
				The control unit detects a voltage of > 18.00 volt (12 volt device) or > 32.50 volt (24 volt device) on the supply input terminal 30. 1. The alternator control unit has an internal defect. 2. Wiring or plug connection defective (supply or ground cable).	The cause of the excessive voltage on terminal 30 must be located. 1. Make sure that the control unit has a stable voltage supply. Check the voltage on the terminal tester with a voltmeter. • Target voltage ignition ON: Vehicle power supply. • Target voltage ignition OFF: Vehicle power supply. 2. With the ignition off, use a voltmeter to check the voltage on the connection of terminal 30 (steady plus) to terminal 31 (ground). The measured voltage must correspond to the vehicle power supply. 3. With the engine running, check the voltage in the same manner as described in the point above. The measured voltage must correspond to the vehicle power supply.
523000	3	Battery overvoltage	Trm Shutdown	3. Control unit parameters incorrectly set.	4. Check the wiring between the alternator and the

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					control unit, in particular with regard to defective plug
					connections such as corroded or damaged plug
					contacts. Pay special attention to the ground wiring.
					5. Check the function of the alternator as well as the
					settings of the alternator control unit and replace both
					if necessary.
					The cause of the missing or insufficient voltage on
					terminal 30 must be located.
					1. Check the fuse of the terminal 30 control units.
					2. If the error occurs after a (sluggish) vehicle start,
					check the vehicle battery. Recharge the battery to
					ensure that it is sufficiently charged.
				The control unit detects a voltage of < 9.00 volt	3. Make sure that the control unit has a stable voltage
				(12 V device) or < 16.00 volt (24 volt device) on	supply. Check the stability of the voltage with Testman.
				the supply input terminal 30.	4. Check the wiring between the alternator and the
				1. The alternator control unit has an internal	control unit, in particular with regard to defective plug
				defect.	connections such as corroded or damaged plug
				2. Vehicle battery not sufficiently charged.	contacts. Pay special attention to the ground wiring.
				3. Wiring or plug connection defective (supply or	5. Check the function of the alternator as well as the
				ground cable).	settings of the alternator control unit and replace both
523000	4	Battery undervoltage	Trm Shutdown	4. Control unit parameters incorrectly set.	if necessary.
					The cause of the incorrect voltage must be located.
					1. Check the wiring, in particular with regard to
					defective plug connections such as corroded or
					damaged plug contacts.
					2. Check the correct wiring of the pins.
				The measured voltage is too high.	3. Check the function of the sensor or replace the
		EC3: Supply for speed		1. Wiring or plug connection is defective.	sensor.
		sensors (AU3)		2. Sensor has an internal defect.	4. Replace the control unit if the error continues to
523020	3	overvoltage	Trm Shutdown	3. Control unit has an internal defect.	occur.
523020	4	EC3: Supply for speed	Trm Shutdown	The measured voltage is too low.	The cause of the incorrect voltage must be located.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
		sensors (AU3)		1. Wiring or plug connection is defective.	1. Check the wiring, in particular with regard to
1		undervoltage		2. Sensor has an internal defect.	defective plug connections such as corroded or
1				3. Control unit has an internal defect.	damaged plug contacts.
					2. Check the correct wiring of the pins.
1					3. Check the function of the sensor or replace the
					sensor.
1					4. Replace the control unit if the error continues to
					occur.
				The measured line resistance between the	
1				connected component and the control unit is too	1. Switch the ignition off, unplug the control unit and
1				high or the voltage on the control unit output is	measure the resistance of the connected component
1				too low.	using a terminal tester.
1				1. Wiring or plug connection contacts vehicle	2. Check the wiring between the connected
1				ground.	component and the control unit, in particular with
1				2. Component has an internal defect.	regard to defective plug connections such as corroded
1				3. Control unit has an internal defect.	or damaged plug contacts.
1				Note: If this error occurs, calculations are	3. Check the function of the connected component and
1		EC3: Supply for speed		partially being made with replacement values.	replace it if needed.
1		sensors (AU3) short to		The transmission functions are limited and the	4. Replace the control unit if the error continues to
523020	6	ground	Trm Shutdown	shifting quality is reduced.	occur.
1					The cause of the incorrect voltage must be located.
1		EC3: Supply for			1. Check the wiring, in particular with regard to
1		temperature sensors			defective plug connections such as corroded or
1		and oil filter restriction			damaged plug contacts.
1		switch (AU2)			2. Check the correct wiring of the pins.
1		overvoltage		The measured voltage is too high.	3. Check the function of the sensor or replace the
1		EC4: Supply for speed		1. Wiring or plug connection is defective.	sensor.
1		sensors (AU2)		2. Sensor has an internal defect.	4. Replace the control unit if the error continues to
523021	3	overvoltage	Trm Shutdown	3. Control unit has an internal defect.	occur.
		EC3: Supply for		The measured voltage is too low.	The cause of the incorrect voltage must be located.
523021	4	temperature sensors	Trm Shutdown	1. Wiring or plug connection is defective.	1. Check the wiring, in particular with regard to

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
		and oil filter restriction		2. Sensor has an internal defect.	defective plug connections such as corroded or
		switch (AU2)		3. Control unit has an internal defect.	damaged plug contacts.
		undervoltage			Check the correct wiring of the pins.
		EC4: Supply for speed			3. Check the function of the sensor or replace the
		sensors (AU2)			sensor.
		undervoltage			4. Replace the control unit if the error continues to
					occur.
				The measured line resistance between the	
				connected component and the control unit is too	1. Switch the ignition off, unplug the control unit and
				high or the voltage on the control unit output is	measure the resistance of the connected component
				too low.	using a terminal tester.
		EC3: Supply for		1. Wiring or plug connection contacts vehicle	2. Check the wiring between the connected
		temperature sensors		ground.	component and the control unit, in particular with
		and oil filter restriction		2. Component has an internal defect.	regard to defective plug connections such as corroded
		switch (AU2) short to		3. Control unit has an internal defect.	or damaged plug contacts.
		ground		Note: If this error occurs, calculations are	3. Check the function of the connected component and
		EC4: Supply for speed		partially being made with replacement values.	replace it if needed.
		sensors (AU2) short to		The transmission functions are limited and the	4. Replace the control unit if the error continues to
523021	. 6	ground	Trm Shutdown	shifting quality is reduced.	occur.
					The cause of the incorrect voltage must be located.
					1. Check the wiring, in particular with regard to
					defective plug connections such as corroded or
					damaged plug contacts.
					2. Check the correct wiring of the pins.
				The measured voltage is too high.	3. Check the function of the sensor or replace the
		EC4: Supply for oil filter		1. Wiring or plug connection is defective.	sensor.
		restriction switch (AU1)		2. Sensor has an internal defect.	4. Replace the control unit if the error continues to
523022	. 3	overvoltage	Limp Home	3. Control unit has an internal defect.	occur.
		EC4: Supply for oil filter		The measured voltage is too low.	The cause of the incorrect voltage must be located.
		restriction switch (AU1)		1. Wiring or plug connection is defective.	1. Check the wiring, in particular with regard to
523022	. 4	undervoltage	Limp Home	2. Sensor has an internal defect.	defective plug connections such as corroded or

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				3. Control unit has an internal defect.	damaged plug contacts.
					2. Check the correct wiring of the pins.
					3. Check the function of the sensor or replace the
					sensor.
					4. Replace the control unit if the error continues to
					occur.
					1. Switch the ignition off, unplug the control unit and
					measure the resistance of the connected component
					using a terminal tester.
				The measured line resistance between the	2. Check the wiring between the connected
				connected component and the control unit is too	component and the control unit, in particular with
				high or the voltage on the control unit output is	regard to defective plug connections such as corroded
				too low.	or damaged plug contacts.
				1. Wiring or plug connection contacts vehicle	3. Check the function of the connected component and
		EC4: Supply for oil filter		ground.	replace it if needed.
		restriction switch (AU1)		2. Component has an internal defect.	4. Replace the control unit if the error continues to
523022	6	short to ground	Limp Home	3. Control unit has an internal defect.	occur.
					The cause of the incorrect voltage must be located.
					1. Check the wiring, in particular with regard to
					defective plug connections such as corroded or
					damaged plug contacts.
					2. Check the correct wiring of the pins.
				The measured voltage is too high.	3. Check the function of the connected component or
		Propvalve power		1. Wiring or plug connection is defective.	replace the component.
		supply 1 (VPS1)		2. Component has an internal defect.	4. Replace the control unit if the error continues to
523030	3	overvoltage	TCU Shutdown	3. Control unit has an internal defect.	occur.
					The cause of the incorrect voltage must be located.
				The measured voltage is too high.	1. Check the wiring, in particular with regard to
		Propvalve power		1. Wiring or plug connection is defective.	defective plug connections such as corroded or
		supply 2 (VPS2)		2. Component has an internal defect.	damaged plug contacts.
523031	3	overvoltage	TCU Shutdown	3. Control unit has an internal defect.	2. Check the correct wiring of the pins.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					3. Check the function of the connected component or
					replace the component.
					4. Replace the control unit if the error continues
					to occur.
					The cause of the increased temperature input in the
					control unit must be located.
				The measured temperature on the control unit	1. Check if outside influences have caused the
				of the transmission is too high.	excessive temperature.
				1. Overheating due to outside influences.	2. If the error continues to occur then the control unit
523040	0	TCU overtemperature	TCU Shutdown	2. Temperature sensor has an internal defect.	needs to be replaced.
				The measured temperature on the control unit	
		TCU temperature		of the transmission is invalid.	
523040	2	invalid value	TCU Shutdown	1. Control unit has an internal defect.	1. Replace the control unit.
				There are 3 startup self-tests concerning power	
				lines	
				1. Watch dog cut-off test – WD chip allow VPS to	
				be enabled only if it is activated (armed) and	
				disable all VPSs before it resets MCU. The self-	The cause of the incorrect behavour must be located.
				test check it.	1.Check the wiring, in particular with regard to
				2. VPS cut off test – SW is able to control VPS via	defective plug connections such as corroded or
				power supply manager component – self test	damaged plug contacts.
				check it	2.Check the correct wiring of the pins.
				OCG off test – it check if when VPS is on and	3.Check the function of the connected component or
				OCG/AIM channels are disable (requested	replace the component.
				current = 0), there really is no current on the	4.Replace the control unit if the error continues to
523044	12	Internal TCU Error 5	TCU Shutdown	lines.	occur.
					Read out the operating data with Testman and send
523045	12	Internal TCU Error 1	TCU Shutdown	The control unit detects an internal error.	them to your ZF contact.
					Read out the operating data with Testman and send
523046	12	Internal TCU Error 2	TCU Shutdown	The control unit detects an internal error.	them to your ZF contact.
523049	12	Unknown transmission	TCU Shutdown	Wrong TCU mounted. The TCU doesn't fit to the	Contact your ZF representative.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
		controller hardware		application.	
		detected			
					The cause of the incorrect voltage must be located.
					1. Switch the ignition off, wait 10 seconds and switch
					the ignition back on. Check if the error is still active.
					2. Check the wiring, in particular with regard to
					defective plug connections such as corroded or
					damaged plug contacts.
					3. Check the correct wiring of the pins.
				The measured voltage at the input is too high.	4. Check the function of the connected component or
		Speed sensor input 1		1. Wiring or plug connection is defective.	replace the component.
		(EF1) overvoltage:		2. Component has an internal defect.	5. Replace the control unit if the error continues to
523100	3	Turbine speed	Limp Home	3. Control unit has an internal defect.	occur.
					1. Switch the ignition off, unplug the control unit and
					measure the resistance of the connected component
					using a terminal tester.
					2. Check the wiring between the connected
					component and the control unit, in particular with
				The measured line resistance between the	regard to defective plug connections such as corroded
				connected component and the control unit is too	or damaged plug contacts.
				high.	3. Check the function of the connected component and
		Speed sensor input 1		1. Wiring or plug connection is defective.	replace it if needed.
		(EF1) open or short to		2. Component has an internal defect.	4. Replace the control unit if the error continues to
523100	6	ground: Turbine speed	Limp Home	3. Control unit has an internal defect.	occur.
					The cause of the unknown rotational direction must be
				The control unit does not recognize the	located.
				rotational direction at the input.	1. Check the wiring from the sensor to the control unit,
		Speed sensor input 1		1. Wiring or plug connection is defective.	in particular with regard to defective plug connections
		(EF1) direction of		2. Wiring or plug connection has a poor contact.	such as corroded or damaged plug contacts.
		rotation unknown:		3. Distance sensor – sensor ring too large.	2. Check the function of the sensor and, if necessary,
523100	8	Turbine speed	Limp Home	4. Sensor has an internal defect.	replace it.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					The cause of the unknown speed must be located.
				The control unit does not recognize the speed at	1. Check the wiring from the speed sensor to the
				the input.	control unit, in particular with regard to defective plug
				1. Wiring or plug connection is defective.	connections such as corroded or damaged plug
		Speed sensor input 1		2. Wiring or plug connection has a poor contact.	contacts.
		(EF1) speed unknown:		3. Distance speed sensor – sensor ring too large.	2. Check the function of the sensor and, if necessary,
523100	9	Turbine speed	Limp Home	4. Speed sensor has an internal defect.	replace it.
					The cause of the incorrect voltage must be located.
					1. Switch the ignition off, wait 10 seconds and switch
					the ignition back on. Check if the error is still active.
					2. Check the wiring, in particular with regard to
					defective plug connections such as corroded or
					damaged plug contacts.
					3. Check the correct wiring of the pins.
				The measured voltage at the input is too high.	4. Check the function of the connected component or
		Speed sensor input 2		1. Wiring or plug connection is defective.	replace the component.
		(EF2) overvoltage:		2. Component has an internal defect.	5. Replace the control unit if the error continues to
523105	3	Internal speed	Limp Home	3. Control unit has an internal defect.	occur.
					1. Switch the ignition off, unplug the control unit and
					measure the resistance of the connected component
					using a terminal tester.
					2. Check the wiring between the connected
					component and the control unit, in particular with
				The measured line resistance between the	regard to defective plug connections such as corroded
				connected component and the control unit is too	or damaged plug contacts.
				high.	3. Check the function of the connected component and
		Speed sensor input 2		1. Wiring or plug connection is defective.	replace it if needed.
		(EF2) open or short to		2. Component has an internal defect.	4. Replace the control unit if the error continues to
523105		ground: Internal speed	Limp Home	3. Control unit has an internal defect.	occur.
		Speed sensor input 2		The control unit does not recognize the	The cause of the unknown rotational direction must be
523105	8	(EF2) direction of	Limp Home	rotational direction at the input.	located.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
		rotation unknown:		1. Wiring or plug connection is defective.	1. Check the wiring from the sensor to the control unit,
		Internal speed		2. Wiring or plug connection has a poor contact.	in particular with regard to defective plug connections
				3. Distance sensor – sensor ring too large.	such as corroded or damaged plug contacts.
				4. Sensor has an internal defect.	Check the function of the sensor and, if necessary, replace it.
					The cause of the unknown speed must be located.
				The control unit does not recognize the speed at	1. Check the wiring from the speed sensor to the
				the input.	control unit, in particular with regard to defective plug
				1. Wiring or plug connection is defective.	connections such as corroded or damaged plug
		Speed sensor input 2		2. Wiring or plug connection has a poor contact.	contacts.
		(EF2) speed unknown:		3. Distance speed sensor – sensor ring too large.	2. Check the function of the sensor and, if necessary,
523105	9	Internal speed	Limp Home	4. Speed sensor has an internal defect.	replace it.
					The cause of the incorrect voltage must be located.
					1. Switch the ignition off, wait 10 seconds and switch
					the ignition back on. Check if the error is still active.
					2. Check the wiring, in particular with regard to
					defective plug connections such as corroded or
					damaged plug contacts.
					3. Check the correct wiring of the pins.
				The measured voltage at the input is too high.	4. Check the function of the connected component or
		Speed sensor input 3		1. Wiring or plug connection is defective.	replace the component.
		(EF3) overvoltage:		2. Component has an internal defect.	5. Replace the control unit if the error continues to
523110	3	Output speed	Limp Home	3. Control unit has an internal defect.	occur.
					1. Switch the ignition off, unplug the control unit and
					measure the resistance of the connected component
				The measured line resistance between the	using a terminal tester.
				connected component and the control unit is too	2. Check the wiring between the connected
				high.	component and the control unit, in particular with
		Speed sensor input 3		1. Wiring or plug connection is defective.	regard to defective plug connections such as corroded
		(EF3) open or short to		2. Component has an internal defect.	or damaged plug contacts.
523110	6	ground: Output speed	Limp Home	3. Control unit has an internal defect.	3. Check the function of the connected component and

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					replace it if needed.
					4. Replace the control unit if the error continues to
					occur.
					The cause of the unknown rotational direction must be
				The control unit does not recognize the	located.
				rotational direction at the input.	1. Check the wiring from the sensor to the control unit,
		Speed sensor input 3		1. Wiring or plug connection is defective.	in particular with regard to defective plug connections
		(EF3) direction of		2. Wiring or plug connection has a poor contact.	such as corroded or damaged plug contacts.
		rotation unknown:		3. Distance sensor – sensor ring too large.	2. Check the function of the sensor and, if necessary,
523110	8	Output speed	Limp Home	4. Sensor has an internal defect.	replace it.
					The cause of the unknown speed must be located.
				The control unit does not recognize the speed at	1. Check the wiring from the speed sensor to the
				the input.	control unit, in particular with regard to defective plug
				1. Wiring or plug connection is defective.	connections such as corroded or damaged plug
		Speed sensor input 3		2. Wiring or plug connection has a poor contact.	contacts.
		(EF3) speed unknown:		3. Distance speed sensor – sensor ring too large.	2. Check the function of the sensor and, if necessary,
523110	9	Output speed	Limp Home	4. Speed sensor has an internal defect.	replace it.
					The cause of the incorrect voltage must be located.
					1. Switch the ignition off, wait 10 seconds and switch
					the ignition back on. Check if the error is still active.
					2. Check the wiring, in particular with regard to
					defective plug connections such as corroded or
					damaged plug contacts.
					3. Check the correct wiring of the pins.
				The measured voltage at the input is too high.	4. Check the function of the connected component or
		Speed sensor input 4		1. Wiring or plug connection is defective.	replace the component.
		(EF4) overvoltage:		2. Component has an internal defect.	5. Replace the control unit if the error continues to
523115	3	Engine speed	Limp Home	3. Control unit has an internal defect.	occur.
		Speed sensor input 4		The measured line resistance between the	1. Switch the ignition off, unplug the control unit and
		(EF4) open or short to		connected component and the control unit is too	measure the resistance of the connected component
523115	6	ground: Engine speed	Limp Home	high.	using a terminal tester.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				1. Wiring or plug connection is defective.	2. Check the wiring between the connected
				2. Component has an internal defect.	component and the control unit, in particular with
				3. Control unit has an internal defect.	regard to defective plug connections such as corroded
					or damaged plug contacts.
					3. Check the function of the connected component and
					replace it if needed.
					4. Replace the control unit if the error continues to
					occur.
					The cause of the unknown rotational direction must be
				The control unit does not recognize the	located.
				rotational direction at the input.	1. Check the wiring from the sensor to the control unit,
		Speed sensor input 4		1. Wiring or plug connection is defective.	in particular with regard to defective plug connections
		(EF4) direction of		2. Wiring or plug connection has a poor contact.	such as corroded or damaged plug contacts.
		rotation unknown:		3. Distance sensor – sensor ring too large.	2. Check the function of the sensor and, if necessary,
523115	8	Engine speed	Limp Home	4. Sensor has an internal defect.	replace it.
					The cause of the unknown speed must be located.
				The control unit does not recognize the speed at	1. Check the wiring from the speed sensor to the
				the input.	control unit, in particular with regard to defective plug
				1. Wiring or plug connection is defective.	connections such as corroded or damaged plug
		Speed sensor input 4		2. Wiring or plug connection has a poor contact.	contacts.
		(EF4) speed unknown:		3. Distance speed sensor – sensor ring too large.	2. Check the function of the sensor and, if necessary,
523115	9	Engine speed	Limp Home	4. Speed sensor has an internal defect.	replace it.
					1. Switch the ignition off, unplug the control unit and
					measure the resistance of the connected component
					using a terminal tester.
				The measured line resistance between the	2. Check the wiring between the connected
				connected component and the control unit is too	component and the control unit, in particular with
		Resistance sensor input		high.	regard to defective plug connections such as corroded
		1 (ER1) open circuit or		1. Wiring or plug connection is defective.	or damaged plug contacts.
		short to high source:		2. Component has an internal defect.	3. Check the function of the connected component and
523140	3	Sump temperature	Normal	3. Control unit has an internal defect.	replace it if needed.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					4. Replace the control unit if the error continues to
					occur.
					1. Switch the ignition off, unplug the control unit and
					measure the resistance of the connected component
					using a terminal tester.
				The measured line resistance between the	2. Check the wiring between the connected
				connected component and the control unit is too	component and the control unit, in particular with
				high or the voltage on the control unit output is	regard to defective plug connections such as corroded
				too low.	or damaged plug contacts.
		Resistance sensor input		1. Wiring or plug connection contacts vehicle	3. Check the function of the connected component and
		1 (ER1) short to		ground.	replace it if needed.
		ground: Sump		2. Component has an internal defect.	4. Replace the control unit if the error continues to
523140	6	temperature	Normal	3. Control unit has an internal defect.	occur.
					The cause of the incorrect voltage must be located.
					1. Check the wiring, in particular with regard to
					defective plug connections such as corroded or
					damaged plug contacts.
					2. Check the correct wiring of the pins.
		Current sensor input 2		The measured voltage at the input is too high.	3. Check the function of the connected component or
		(EI2) overvoltage:		1. Wiring or plug connection is defective.	replace the component.
		Oil Filter Restriction		2. Component has an internal defect.	4. Replace the control unit if the error continues to
523155	3	Switch	Normal	3. Control unit has an internal defect.	occur.
					1. Switch the ignition off, unplug the control unit and
					measure the resistance of the connected component
					using a terminal tester.
				The measured line resistance between the	2. Check the wiring between the connected
		Current seonsr input 2			component and the control unit, in particular with
		(EI2) open circuit or		high.	regard to defective plug connections such as corroded
		short to ground:		1. Wiring or plug connection is defective.	or damaged plug contacts.
		Oil Filter Restriction		2. Component has an internal defect.	3. Check the function of the connected component and
523155	6	Switch	Normal	3. Control unit has an internal defect.	replace it if needed.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					4. Replace the control unit if the error continues to
					occur.
				The measured voltage at the sensor input 3 is	
				too high:	
				cable is defective and is contacted to battery	
				voltage clutch cut off / inch pedal sensor has an	check the cable from TCU to the sensor
		Voltage sensor input 3		internal defect connector pin is contacted to	check the connectors
523160	3	(EU3) overvoltage	TCU Shutdown	battery voltage.	3 check the sensor
				The measured voltage at the sensor input 3 is	
				too low:	
				cable is defective and is contacted to vehicle	
				ground cable has no connection to TCU clutch	
		Voltage sensor input 3		cut off / inch pedal sensor has an internal defect	1 check the cable from TCU to the sensor
		(EU3) open or short to		connector pin is contacted to vehicle ground or	2 check the connectors
523160	6	ground	TCU Shutdown	is broken.	3 check the sensor
		Voltage sensor input 3		The measured sensor voltage is out of the	check the cable from TCU to the sensor check the
523160	12	(EU3) defect	TCU Shutdown	allowed thresholds.	connectors check the sensor 4 Change the sensor
				The measured voltage at the sensor input 3 is	
				too high:	
				cable is defective and is contacted to battery	
				voltage clutch cut off / inch pedal sensor has an	1 check the cable from TCU to the sensor
		Voltage sensor input 4		internal defect connector pin is contacted to	2 check the connectors
523165	3	(EU4) overvoltage	Normal	battery voltage.	3 check the sensor
				The measured voltage at the sensor input 3 is	
				too low:	
				cable is defective and is contacted to vehicle	
				ground cable has no connection to TCU clutch	
		Voltage sensor input 4		cut off / inch pedal sensor has an internal defect	1 check the cable from TCU to the sensor
		(EU4) open or short to		connector pin is contacted to vehicle ground or	2 check the connectors
523165	6	ground	Normal	is broken.	3 check the sensor
523165	12	Voltage sensor input 4	Normal	The measured sensor voltage is out of the	check the cable from TCU to the sensor check the

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
		(EU4) defect		allowed thresholds.	connectors check the sensor 4 Change the sensor
					1. Using the circuit diagram, check if a component is
					assigned to the output.
					2. Check the wiring, in particular that it is wired
					correctly.
					3. Check the wiring, in particular with regard to
					defective plug connections such as corroded or
		Current output driver 1		If this error occurs, then an electrical component	damaged plug contacts
		(AIM01) unknown		has been connected at the output although the	4. Replace the control unit if the error continues to
523200	2	electrical component	Trm Shutdown	input should not be used.	occur.
					1. Switch the ignition off, wait 10 seconds and switch
					the ignition back on. Check if the error is still active.
					2. Switch the ignition off, unplug the control unit and
					measure the resistance of the connected component
					using a terminal tester.
				The measured line resistance between the	3. Check the wiring between the connected
				proportional valve and the control unit is too	component and the control unit, in particular with
				high or the voltage on the control unit output is	regard to defective plug connections such as corroded
				too high.	or damaged plug contacts.
				1. Wiring or plug connection contacts battery	4. Check the function of the connected component and
		Current output driver 1		voltage.	replace it if needed.
		(AIM01) short to		2. Proportional valve has an internal defect.	5. Replace the control unit if the error continues to
523200	3	battery	Limp Home	3. Control unit has an internal defect.	occur.
					1. Switch the ignition off, wait 10 seconds and switch
					the ignition back on. Check if the error is still active.
				The measured line resistance between the	2. Switch the ignition off, unplug the control unit and
				connected component and the control unit is too	measure the resistance of the connected component
				high.	using a terminal tester.
				1. Wiring or plug connection is defective.	3. Check the wiring between the connected
		Current output driver 1		2. Component has an internal defect.	component and the control unit, in particular with
523200	5	(AIM01) open circuit	Limp Home	3. Control unit has an internal defect.	regard to defective plug connections such as corroded

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					or damaged plug contacts.
					4. Check the function of the connected component and
					replace it if needed.
					5. Replace the control unit if the error continues to
					occur.
					1. Switch the ignition off, wait 10 seconds and switch
					the ignition back on. Check if the error is still active.
					2. Switch the ignition off, unplug the control unit and
					measure the resistance of the connected component
					using a terminal tester.
				The measured line resistance between the	3. Check the wiring between the connected
				connected component and the control unit is too	component and the control unit, in particular with
				high or the voltage on the control unit output is	regard to defective plug connections such as corroded
				too low.	or damaged plug contacts.
				1. Wiring or plug connection contacts vehicle	4. Check the function of the connected component and
		Current output driver 1		ground.	replace it if needed.
		(AIM01) short to		2. Component has an internal defect.	5. Replace the control unit if the error continues to
523200	6	ground	TCU Shutdown	3. Control unit has an internal defect.	occur.
					1. Switch the ignition off, wait 10 seconds and switch
					the ignition back on. Check if the error is still active.
					2. Check if the error occurs with an additional
					proportional valve or with which valve the error is
					bypassed.
				The measured line resistance between the	3. Check the wiring between the proportional valve
				proportional valve and the control unit is too	and the control unit, in particular with regard to
				high or the voltage on the control unit output is	defective plug connections such as corroded or
				too low.	damaged plug contacts.
ļ				1. Wiring or plug connection contacts another	4. Switch the ignition off, unplug the control unit, and
ļ		Current output driver 1		proportional valve.	measure the resistance of the proportional valve using
	_	(AIM01) short to		2. Proportional valve has an internal defect.	a terminal tester.
523200	8	another valve	Trm Shutdown	3. Control unit has an internal defect.	5. Check the function of the proportional valve and

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					replace it if needed.
					6. Replace the control unit if the error continues to
					occur.
					1. Using the circuit diagram, check if a component is
					assigned to the output.
					2. Check the wiring, in particular that it is wired
					correctly.
					3. Check the wiring, in particular with regard to
					defective plug connections such as corroded or
		Current output driver 2		If this error occurs, then an electrical component	damaged plug contacts
		(AIM02) unknown		has been connected at the output although the	4. Replace the control unit if the error continues to
523205	2	electrical component	Trm Shutdown	input should not be used.	occur.
					1. Switch the ignition off, wait 10 seconds and switch
					the ignition back on. Check if the error is still active.
					2. Switch the ignition off, unplug the control unit and
					measure the resistance of the connected component
					using a terminal tester.
				The measured line resistance between the	3. Check the wiring between the connected
				connected component and the control unit is too	component and the control unit, in particular with
				high or the voltage on the control unit output is	regard to defective plug connections such as corroded
				too high.	or damaged plug contacts.
				1. Wiring or plug connection contacts battery	4. Check the function of the connected component and
		Current output driver 2		voltage.	replace it if needed.
		(AIM02) short to		2. Component has an internal defect.	5. Replace the control unit if the error continues to
523205	3	battery	Limp Home	3. Control unit has an internal defect.	occur.
				The measured line resistance between the	1. Switch the ignition off, wait 10 seconds and switch
				connected component and the control unit is too	the ignition back on. Check if the error is still active.
				high.	2. Switch the ignition off, unplug the control unit and
				1. Wiring or plug connection is defective.	measure the resistance of the connected component
		Current output driver 2		2. Component has an internal defect.	using a terminal tester.
523205	5	(AIM02) open circuit	Limp Home	3. Control unit has an internal defect.	3. Check the wiring between the connected

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					component and the control unit, in particular with
					regard to defective plug connections such as corroded
					or damaged plug contacts.
					4. Check the function of the connected component and
					replace it if needed.
					5. Replace the control unit if the error continues to
					occur.
					1. Switch the ignition off, wait 10 seconds and switch
					the ignition back on. Check if the error is still active.
					2. Switch the ignition off, unplug the control unit and
					measure the resistance of the connected component
					using a terminal tester.
				The measured line resistance between the	3. Check the wiring between the connected
				connected component and the control unit is too	component and the control unit, in particular with
				high or the voltage on the control unit output is	regard to defective plug connections such as corroded
				too low.	or damaged plug contacts.
				1. Wiring or plug connection contacts vehicle	4. Check the function of the connected component and
		Current output driver 2		ground.	replace it if needed.
		(AIM02) short to		2. Component has an internal defect.	5. Replace the control unit if the error continues to
523205	6	ground	TCU Shutdown	3. Control unit has an internal defect.	occur.
					1. Switch the ignition off, wait 10 seconds and switch
					the ignition back on. Check if the error is still active.
					2. Check if the error occurs with an additional
				The measured line resistance between the	proportional valve or with which valve the error is
				proportional valve and the control unit is too	bypassed.
				high or the voltage on the control unit output is	3. Check the wiring between the proportional valve
				too low.	and the control unit, in particular with regard to
				1. Wiring or plug connection contacts another	defective plug connections such as corroded or
		Current output driver 2		proportional valve.	damaged plug contacts.
	_	(AIM02) short circuit to		2. Proportional valve has an internal defect.	4. Switch the ignition off, unplug the control unit, and
523205	8	another valve	Trm Shutdown	3. Control unit has an internal defect.	measure the resistance of the proportional valve using

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					a terminal tester.
					5. Check the function of the proportional valve and
					replace it if needed.
					6. Replace the control unit if the error continues to
					occur.
					1. Using the circuit diagram, check if a component is
					assigned to the output.
					2. Check the wiring, in particular that it is wired
					correctly.
					3. Check the wiring, in particular with regard to
					defective plug connections such as corroded or
		Current output driver 3		If this error occurs, then an electrical component	damaged plug contacts
		(AIM03) unknown		has been connected at the output although the	4. Replace the control unit if the error continues to
523210	2	electrical component	Trm Shutdown	input should not be used.	occur.
					1. Switch the ignition off, wait 10 seconds and switch
					the ignition back on. Check if the error is still active.
					2. Switch the ignition off, unplug the control unit and
					measure the resistance of the connected component
					using a terminal tester.
				The measured line resistance between the	3. Check the wiring between the connected
				connected component and the control unit is too	component and the control unit, in particular with
				high or the voltage on the control unit output is	regard to defective plug connections such as corroded
				too high.	or damaged plug contacts.
				1. Wiring or plug connection contacts battery	4. Check the function of the connected component and
		Current output driver 3		voltage.	replace it if needed.
		(AIM03) short to		2. Component has an internal defect.	5. Replace the control unit if the error continues to
523210	3	battery	Limp Home	3. Control unit has an internal defect.	occur.
				The measured line resistance between the	1. Switch the ignition off, wait 10 seconds and switch
				•	the ignition back on. Check if the error is still active.
		Current output driver 3		high.	2. Switch the ignition off, unplug the control unit and
523210	5	(AIM03) open circuit	Limp Home	1. Wiring or plug connection is defective.	measure the resistance of the connected component

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				2. Component has an internal defect.	using a terminal tester.
				3. Control unit has an internal defect.	3. Check the wiring between the connected
					component and the control unit, in particular with
					regard to defective plug connections such as corroded
					or damaged plug contacts.
					4. Check the function of the connected component and replace it if needed.
					5. Replace the control unit if the error continues to
					occur.
					1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active.
					2. Switch the ignition off, unplug the control unit and
					measure the resistance of the connected component
					using a terminal tester.
				The measured line resistance between the	3. Check the wiring between the connected
				connected component and the control unit is too	component and the control unit, in particular with
				high or the voltage on the control unit output is	regard to defective plug connections such as corroded
				too low.	or damaged plug contacts.
		Current output driver 3		 Wiring or plug connection contacts vehicle ground. 	4. Check the function of the connected component and replace it if needed.
		(AIM03) short to		2. Component has an internal defect.	5. Replace the control unit if the error continues to
523210	6	ground	TCU Shutdown	3. Control unit has an internal defect.	occur.
					1. Switch the ignition off, wait 10 seconds and switch
				The measured line resistance between the	the ignition back on. Check if the error is still active.
				proportional valve and the control unit is too	2. Check if the error occurs with an additional
				high or the voltage on the control unit output is	proportional valve or with which valve the error is
ſ				too low.	bypassed.
				1. Wiring or plug connection contacts another	3. Check the wiring between the proportional valve
		Current output driver 3		proportional valve.	and the control unit, in particular with regard to
		(AIM03) short circuit to		2. Proportional valve has an internal defect.	defective plug connections such as corroded or
523210	8	another valve	Trm Shutdown	3. Control unit has an internal defect.	damaged plug contacts.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					4. Switch the ignition off, unplug the control unit, and
					measure the resistance of the proportional valve using
					a terminal tester.
					5. Check the function of the proportional valve and
					replace it if needed.
					6. Replace the control unit if the error continues to
					occur.
					1. Using the circuit diagram, check if a component is
					assigned to the output.
					2. Check the wiring, in particular that it is wired
					correctly.
					3. Check the wiring, in particular with regard to
					defective plug connections such as corroded or
		Current output driver 4		If this error occurs, then an electrical component	damaged plug contacts
		(AIM04) unknown		has been connected at the output although the	4. Replace the control unit if the error continues to
523215	2	electrical component	Trm Shutdown	input should not be used.	occur.
					1. Switch the ignition off, wait 10 seconds and switch
					the ignition back on. Check if the error is still active.
					2. Switch the ignition off, unplug the control unit and
					measure the resistance of the connected component
					using a terminal tester.
				The measured line resistance between the	3. Check the wiring between the connected
				connected component and the control unit is too	component and the control unit, in particular with
				high or the voltage on the control unit output is	regard to defective plug connections such as corroded
				too high.	or damaged plug contacts.
				1. Wiring or plug connection contacts battery	4. Check the function of the connected component and
		Current output driver 4		voltage.	replace it if needed.
		(AIM04) short to		2. Component has an internal defect.	5. Replace the control unit if the error continues to
523215	3	battery	Limp Home	3. Control unit has an internal defect.	occur.
		Current output driver 4		The measured line resistance between the	1. Switch the ignition off, wait 10 seconds and switch
523215	5	(AIM04) open circuit	Limp Home	connected component and the control unit is too	the ignition back on. Check if the error is still active.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				high.	2. Switch the ignition off, unplug the control unit and
				1. Wiring or plug connection is defective.	measure the resistance of the connected component
				2. Component has an internal defect.	using a terminal tester.
				3. Control unit has an internal defect.	3. Check the wiring between the connected
					component and the control unit, in particular with
					regard to defective plug connections such as corroded
					or damaged plug contacts.
					4. Check the function of the connected component and
					replace it if needed.
					5. Replace the control unit if the error continues to
					occur.
					1. Switch the ignition off, wait 10 seconds and switch
					the ignition back on. Check if the error is still active.
					2. Switch the ignition off, unplug the control unit and
					measure the resistance of the connected component
					using a terminal tester.
				The measured line resistance between the	3. Check the wiring between the connected
				connected component and the control unit is too	component and the control unit, in particular with
				high or the voltage on the control unit output is too low.	regard to defective plug connections such as corroded or damaged plug contacts.
				1. Wiring or plug connection contacts vehicle	4. Check the function of the connected component and
		Current output driver 4		ground.	replace it if needed.
		(AIM04) short to		2. Component has an internal defect.	5. Replace the control unit if the error continues to
523215	6	ground	TCU Shutdown	3. Control unit has an internal defect.	occur.
		0		The measured line resistance between the	1. Switch the ignition off, wait 10 seconds and switch
				proportional valve and the control unit is too	the ignition back on. Check if the error is still active.
				high or the voltage on the control unit output is	2. Check if the error occurs with an additional
				too low.	proportional valve or with which valve the error is
		Current output driver 4		1. Wiring or plug connection contacts another	bypassed.
		(AIM04) short circuit to		proportional valve.	3. Check the wiring between the proportional valve
523215	8	another valve	Trm Shutdown	2. Proportional valve has an internal defect.	and the control unit, in particular with regard to

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				3. Control unit has an internal defect.	defective plug connections such as corroded or
					damaged plug contacts.
					4. Switch the ignition off, unplug the control unit, and
					measure the resistance of the proportional valve using
					a terminal tester.
					5. Check the function of the proportional valve and
					replace it if needed.
					6. Replace the control unit if the error continues to
					occur.
					1. Using the circuit diagram, check if a component is
					assigned to the output.
					2. Check the wiring, in particular that it is wired
					correctly.
					3. Check the wiring, in particular with regard to
					defective plug connections such as corroded or
		Current output driver 5		If this error occurs, then an electrical component	damaged plug contacts
	_	(AIM05) unknown		has been connected at the output although the	4. Replace the control unit if the error continues to
523220	2	electrical component	Trm Shutdown	input should not be used.	occur.
					1. Switch the ignition off, wait 10 seconds and switch
					the ignition back on. Check if the error is still active.
					2. Switch the ignition off, unplug the control unit and
					measure the resistance of the connected component
					using a terminal tester.
				The measured line resistance between the	3. Check the wiring between the connected
				connected component and the control unit is too	component and the control unit, in particular with
				high or the voltage on the control unit output is	regard to defective plug connections such as corroded
				too high.	or damaged plug contacts.
		Current output driver 5		1. Wiring or plug connection contacts battery	4. Check the function of the connected component and
		Current output driver 5		voltage. 2. Component has an internal defect.	replace it if needed.
E 22220	2	(AIM05) short to	Limn Homo		5. Replace the control unit if the error continues to
523220	3	battery	Limp Home	3. Control unit has an internal defect.	occur.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					1. Switch the ignition off, wait 10 seconds and switch
					the ignition back on. Check if the error is still active.
					2. Switch the ignition off, unplug the control unit and
					measure the resistance of the connected component using a terminal tester.
					3. Check the wiring between the connected
					component and the control unit, in particular with
				The measured line resistance between the	regard to defective plug connections such as corroded
				connected component and the control unit is too	or damaged plug contacts.
				high.	4. Check the function of the connected component and
				1. Wiring or plug connection is defective.	replace it if needed.
		Current output driver 5		2. Component has an internal defect.	5. Replace the control unit if the error continues to
523220	5	(AIM05) open circuit	Limp Home	3. Control unit has an internal defect.	occur.
					1. Switch the ignition off, wait 10 seconds and switch
					the ignition back on. Check if the error is still active.
					2. Switch the ignition off, unplug the control unit and
					measure the resistance of the connected component
					using a terminal tester.
				The measured line resistance between the	3. Check the wiring between the connected
				connected component and the control unit is too	component and the control unit, in particular with
				high or the voltage on the control unit output is too low.	regard to defective plug connections such as corroded or damaged plug contacts.
				1. Wiring or plug connection contacts vehicle	4. Check the function of the connected component and
		Current output driver 5		ground.	replace it if needed.
		(AIM05) short to		2. Component has an internal defect.	5. Replace the control unit if the error continues to
523220	6	ground	TCU Shutdown	3. Control unit has an internal defect.	occur.
		-		The measured line resistance between the	1. Switch the ignition off, wait 10 seconds and switch
				proportional valve and the control unit is too	the ignition back on. Check if the error is still active.
		Current output driver 5		high or the voltage on the control unit output is	2. Check if the error occurs with an additional
		(AIM05) short circuit to		too low.	proportional valve or with which valve the error is
523220	8	another valve	Trm Shutdown	1. Wiring or plug connection contacts another	bypassed.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				proportional valve.	3. Check the wiring between the proportional valve
				2. Proportional valve has an internal defect.	and the control unit, in particular with regard to
				3. Control unit has an internal defect.	defective plug connections such as corroded or
					damaged plug contacts.
					4. Switch the ignition off, unplug the control unit, and
					measure the resistance of the proportional valve using
					a terminal tester.
					5. Check the function of the proportional valve and
					replace it if needed.
					6. Replace the control unit if the error continues to
					occur.
					1. Using the circuit diagram, check if a component is
					assigned to the output.
					2. Check the wiring, in particular that it is wired
					correctly.
					3. Check the wiring, in particular with regard to
					defective plug connections such as corroded or
		Current output driver 6		If this error occurs, then an electrical component	damaged plug contacts
		(AIM06) unknown		has been connected at the output although the	4. Replace the control unit if the error continues to
523225	2	electrical component	Trm Shutdown	input should not be used.	occur.
					1. Switch the ignition off, wait 10 seconds and switch
					the ignition back on. Check if the error is still active.
					2. Switch the ignition off, unplug the control unit and
				The measured line resistance between the	measure the resistance of the connected component
				connected component and the control unit is too	using a terminal tester.
				high or the voltage on the control unit output is	3. Check the wiring between the connected
				too high.	component and the control unit, in particular with
				1. Wiring or plug connection contacts battery	regard to defective plug connections such as corroded
		Current output driver 6		voltage.	or damaged plug contacts.
		(AIM06) short to		2. Component has an internal defect.	4. Check the function of the connected component and
523225	3	battery	Limp Home	3. Control unit has an internal defect.	replace it if needed.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					5. Replace the control unit if the error continues to
					occur.
					1. Switch the ignition off, wait 10 seconds and switch
					the ignition back on. Check if the error is still active.
					2. Switch the ignition off, unplug the control unit and
					measure the resistance of the connected component
					using a terminal tester.
					3. Check the wiring between the connected
					component and the control unit, in particular with
				The measured line resistance between the	regard to defective plug connections such as corroded
				connected component and the control unit is too	or damaged plug contacts.
				high.	4. Check the function of the connected component and
				1. Wiring or plug connection is defective.	replace it if needed.
		Current output driver 6		2. Component has an internal defect.	5. Replace the control unit if the error continues to
523225	5	(AIM06) open circuit	Limp Home	3. Control unit has an internal defect.	occur.
					1. Switch the ignition off, wait 10 seconds and switch
					the ignition back on. Check if the error is still active.
					2. Switch the ignition off, unplug the control unit and
					measure the resistance of the connected component
					using a terminal tester.
				The measured line resistance between the	3. Check the wiring between the connected
				connected component and the control unit is too	component and the control unit, in particular with
				high or the voltage on the control unit output is	regard to defective plug connections such as corroded
				too low.	or damaged plug contacts.
				1. Wiring or plug connection contacts vehicle	4. Check the function of the connected component and
		Current output driver 6		ground.	replace it if needed.
		(AIM06) short to		2. Component has an internal defect.	5. Replace the control unit if the error continues to
523225	6	ground	TCU Shutdown	3. Control unit has an internal defect.	occur.
		Current output driver 6		The measured line resistance between the	1. Switch the ignition off, wait 10 seconds and switch
		(AIM06) short circuit to		proportional valve and the control unit is too	the ignition back on. Check if the error is still active.
523225	8	another valve	Trm Shutdown	high or the voltage on the control unit output is	2. Check if the error occurs with an additional

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				too low.	proportional valve or with which valve the error is
				1. Wiring or plug connection contacts another	bypassed.
				proportional valve.	3. Check the wiring between the proportional valve
				2. Proportional valve has an internal defect.	and the control unit, in particular with regard to
				3. Control unit has an internal defect.	defective plug connections such as corroded or
					damaged plug contacts.
					4. Switch the ignition off, unplug the control unit, and
					measure the resistance of the proportional valve using
					a terminal tester.
					5. Check the function of the proportional valve and
					replace it if needed.
					6. Replace the control unit if the error continues to
					occur.
					1. Using the circuit diagram, check if a
					component is assigned to the output.
					2. Check the wiring, in particular that it is
					wired correctly.
		Current output driver 7		If this error occurs, then an electrical component	3. Check the wiring, in particular with regard to
		(AIM07) unknown		has been connected at the output although the	defective plug connections such as corroded or
523230	2	electrical component	Trm Shutdown	input should not be used.	damaged plug contacts
					1. Switch the ignition off, wait 10 seconds and switch
					the ignition back on. Check if the error is still active.
					2. Switch the ignition off, unplug the control unit and
				The measured line resistance between the	measure the resistance of the connected component
				connected component and the control unit is too	using a terminal tester.
				high or the voltage on the control unit output is	3. Check the wiring between the connected
				too high.	component and the control unit, in particular with
				1. Wiring or plug connection contacts battery	regard to defective plug connections such as corroded
		Current output driver 7		voltage.	or damaged plug contacts.
		(AIM07) short to		2. Component has an internal defect.	4. Check the function of the connected component and
523230	3	battery	Limp Home	3. Control unit has an internal defect.	replace it if needed.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					5. Replace the control unit if the error continues to
					occur.
					1. Switch the ignition off, wait 10 seconds and switch
					the ignition back on. Check if the error is still active.
					2. Switch the ignition off, unplug the control unit and
					measure the resistance of the connected component
					using a terminal tester.
					3. Check the wiring between the connected
					component and the control unit, in particular with
				The measured line resistance between the	regard to defective plug connections such as corroded
				connected component and the control unit is too	or damaged plug contacts.
				high.	4. Check the function of the connected component and
				1. Wiring or plug connection is defective.	replace it if needed.
		Current output driver 7		2. Component has an internal defect.	5. Replace the control unit if the error continues to
523230	5	(AIM07) open circuit	Limp Home	3. Control unit has an internal defect.	occur.
					1. Switch the ignition off, wait 10 seconds and switch
					the ignition back on. Check if the error is still active.
					2. Switch the ignition off, unplug the control unit and
					measure the resistance of the connected component using a terminal tester.
				The measured line resistance between the	3. Check the wiring between the connected
				connected component and the control unit is too	component and the control unit, in particular with
				high or the voltage on the control unit output is	regard to defective plug connections such as corroded
				too low.	or damaged plug contacts.
				1. Wiring or plug connection contacts vehicle	4. Check the function of the connected component and
		Current output driver 7		ground.	replace it if needed.
		(AIM07) short to		2. Component has an internal defect.	5. Replace the control unit if the error continues to
523230	6	ground	TCU Shutdown	3. Control unit has an internal defect.	occur.
		Current output driver 7		The measured line resistance between the	1. Switch the ignition off, wait 10 seconds and switch
		(AIM07) short circuit to		proportional valve and the control unit is too	the ignition back on. Check if the error is still active.
523230	8	another valve	Trm Shutdown	high or the voltage on the control unit output is	2. Check if the error occurs with an additional

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
1				too low.	proportional valve or with which valve the error is
1				1. Wiring or plug connection contacts another	bypassed.
1				proportional valve.	3. Check the wiring between the proportional valve
1				2. Proportional valve has an internal defect.	and the control unit, in particular with regard to
1				3. Control unit has an internal defect.	defective plug connections such as corroded or
1					damaged plug contacts.
					4. Switch the ignition off, unplug the control unit, and
					measure the resistance of the proportional valve using
1					a terminal tester.
					5. Check the function of the proportional valve and
1					replace it if needed.
					6. Replace the control unit if the error continues to
ļ					occur.
				TCU detected a wrong voltage at the output pin,	
				that looks like a s.c. to battery voltage cable is	
1		Digital current output		defective and is contacted to battery voltage	check the cable from TCU to the device at ADM1 check
		driver 1 (ADM1) short		device has an internal defect connector pin is	the connectors check the resistance of the device at
523280	3	to battery	Trm Shutdown	contacted to battery voltage	ADM1
				TCU detected a wrong voltage at the output pin,	
1				that looks like a o.c. for this output pin cable is	
		Digital current output		defective and has no connection to TCU device	check the cable from TCU to the device at ADM1 check
	_	driver 1 (ADM1) open		has an internal defect connector has no	the connectors check the resistance of the device at
523280	5	circuit	Trm Shutdown	connection to TCU	ADM1
				TCU detected a wrong voltage at the output pin,	
1				that looks like a s.c. to vehicle ground cable is	
ł		Digital current output		defective and is contacted to vehicle ground	check the cable from TCU to the device at ADM1 check
500000		driver 1 (ADM1) short	T C L	device has an internal defect connector pin is	the connectors check the resistance of the device at
523280	6	to ground	Trm Shutdown	contacted to vehicle ground	ADM1
522262	10	Digital current output	The Charles	TCU detected overtemperature or an internal	
523280		driver 1 (ADM1) defect	Trm Shutdown	error at the digital output	Change TCU
523281	3	Digital current output	Trm Shutdown	TCU detected a wrong voltage at the output pin,	check the cable from TCU to the device at ADM2 check

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
		driver 2 (ADM2) short		that looks like a s.c. to battery voltage cable is	the connectors check the resistance of the device at
		to battery		defective and is contacted to battery voltage	ADM2
				device has an internal defect connector pin is	
				contacted to battery voltage	
				TCU detected a wrong voltage at the output pin,	
				that looks like a o.c. for this output pin cable is	
		Digital current output		defective and has no connection to TCU device	check the cable from TCU to the device at ADM2 check
		driver 2 (ADM2) open		has an internal defect connector has no	the connectors check the resistance of the device at
523281	5	circuit	Trm Shutdown	connection to TCU	ADM2
				TCU detected a wrong voltage at the output pin,	
				that looks like a s.c. to vehicle ground cable is	
		Digital current output		defective and is contacted to vehicle ground	check the cable from TCU to the device at ADM2 check
		driver 2 (ADM2) short		device has an internal defect connector pin is	the connectors check the resistance of the device at
523281	6	to ground	Trm Shutdown	contacted to vehicle ground	ADM2
		Digital current output		TCU detected overtemperature or an internal	
523281	12	driver 2 (ADM2) defect	Trm Shutdown	error at the digital output	Change TCU
					1. Switch the ignition off, unplug the control unit and
					measure the resistance of the connected component
					using a terminal tester.
					2. Check the wiring between the connected
					component and the control unit, in particular with
				The measured line resistance between the	regard to defective plug connections such as corroded
		Resistance sensor input		connected component and the control unit is too	or damaged plug contacts.
		2 (ER2) open circuit or		high.	3. Check the function of the connected component and
		short to high source:		 Wiring or plug connection is defective. 	replace it if needed.
		Torque converter		Component has an internal defect.	4. Replace the control unit if the error continues to
523145	3	temperature	Normal	3. Control unit has an internal defect.	occur.
		Resistance sensor input		The measured line resistance between the	1. Switch the ignition off, unplug the control unit and
		2 (ER2) short to		connected component and the control unit is too	measure the resistance of the connected component
		ground: Torque		high or the voltage on the control unit output is	using a terminal tester.
523145	6	converter temperature	Normal	too low.	2. Check the wiring between the connected

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				1. Wiring or plug connection contacts vehicle	component and the control unit, in particular with
				ground.	regard to defective plug connections such as corroded
				2. Component has an internal defect	or damaged plug contacts.
				3. Control unit has an internal defect.	3. Check the function of the connected component and
					replace it if needed.
					4. Replace the control unit if the error continues to
					occur.
				The measured voltage at the sensor input 1 is	
				too high:	
				cable is defective and is contacted to battery	
				voltage	
				clutch cut off / inch pedal sensor has an internal	check the cable from TCU to the sensor
		Voltage sensor input 1		defect	check the connectors
523125	3	(EU1) overvoltage	Limp Home	connector pin is contacted to battery voltage	check the sensor
				The measured voltage at the sensor input 1 is	
				too low:	
				cable is defective and is contacted to vehicle	
				ground	
				cable has no connection to TCU	
				clutch cut off / inch pedal sensor has an internal	
		Voltage sensor input 1		defect	check the cable from TCU to the sensor
		(EU1) open or short to		connector pin is contacted to vehicle ground or	check the connectors
523125	6	ground	Limp Home	is broken	check the sensor
				The measured voltage from sensor output signal	
				1 and output signal 2 don't match or are out of	
		N/-11		range.	check the cable from TCU to the sensor
500405		Voltage sensor input 1		1. Cable is defective	check the connectors
523125	12	(EU1) defect	Limp Home	2. Sensor has an internal defect	check the sensor
		Supply for temperature		The measured voltage is too high.	The cause of the incorrect voltage must be located.
500000		sensors (AU_ER)		1. Wiring or plug connection is defective.	1. Check the wiring, in particular with regard to
523023	3	overvoltage	Limp Home	2. Sensor has an internal defect.	defective plug connections such as corroded or

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				3, Control unit has an internal defect.	damaged plug contacts.
					2. Check the correct wiring of the pins.
					3. Check the function of the sensor or replace the
					sensor.
					4. Replace the control unit if the error continues to
					occur.
					The cause of the incorrect voltage must be located.
					1. Check the wiring, in particular with regard to
					defective plug connections such as corroded or
					damaged plug contacts.
					2. Check the correct wiring of the pins.
				The measured voltage is too low.	3. Check the function of the sensor or replace the
		Supply for temperature		1. Wiring or plug connection is defective.	sensor.
		sensors (AU_ER)		2. Sensor has an internal defect.	4. Replace the control unit if the error continues to
523023	4	undervoltage	Limp Home	3. Control unit has an internal defect.	occur.
				The measured voltage at the sensor input 2 is	
				too high:	
				cable is defective and is contacted to battery	
				voltage	
				clutch cut off / inch pedal sensor has an internal	check the cable from TCU to the sensor
		Voltage sensor input 2		defect	check the connectors
523130	3	(EU2) overvoltage	Limp Home	connector pin is contacted to battery voltage	check the sensor
				The measured voltage at the sensor input 2 is	
				too low:	
				cable is defective and is contacted to vehicle	
				ground	
				cable has no connection to TCU	
				clutch cut off / inch pedal sensor has an internal	
		Voltage sensor input 2		defect	1. Check the cable from TCU to the sensor
		(EU2) open or short to		connector pin is contacted to vehicle ground or	2. Check the connectors
523130	6	ground	Limp Home	is broken	3. Check the sensor

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				The measured voltage from sensor output signal	
				1 and output signal 2 don't match or are out of	
				range.	1. Check the cable from TCU to the sensor
		Voltage sensor input 2		1. Cable is defective	2. Check the connectors
523130	12	(EU2) defect	Limp Home	2. Sensor has an internal defect	3. Check the sensor
523050	0	Internal TCU Error 6	TCU Shutdown		
					Read out the operating data with Testman and send
523047	12	Internal TCU Error 3	TCU Shutdown	The control unit detects an internal error.	them to your ZF contact.
					The cause of the increased temperature input in the
					transmission must be located.
					1. Check the oil level and correct it as needed.
					2. Check the function of the cooler fan.
					3. Check the transmission oil cooler for contaminants
					and damage.
					4. Check the connection lines from the transmission to
					the transmission oil cooler for damage.
				The measured temperature in the oil sump of	5. Check the transmission oil temperature using the
				the transmission is too high.	diagnosis unit. If the measured oil temperature does
		Transmission sump oil		1. The oil level is incorrect.	not drop when the vehicle is operated at idle even
		most severe		2. The cooling system is faulty.	after a longer period of time, then the temperature
523300	0	overtemperature	Normal	3. Load is permanently too high.	sensor needs to be replaced.
					The cause of the increased temperature input in the
					transmission must be located.
					1. Check the oil level and correct it as needed.
					2. Check the function of the cooler fan.
					3. Check the transmission oil cooler for contaminants
				The measured temperature in the oil sump of	and damage.
				the transmission is too high.	4. Check the connection lines from the transmission to
		Transmission sump oil		1. The oil level is incorrect.	the transmission oil cooler for damage.
		moderately severe		2. The cooling system is faulty.	5. Check the transmission oil temperature using the
523300	16	overtemperature	Normal	3. Load is permanently too high.	diagnosis unit. If the measured oil temperature does

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					not drop when the vehicle is operated at idle even
					after a longer period of time, then the temperature
					sensor needs to be replaced.
					If this error occurs while driving, then remain at a
					standstill, switch the ignition off, then on again and
					wait another 40 seconds.
					1. Replace the filter.
					2. Check the wiring of the switch, in particular with
				1. Filter clogged.	regard to defective plug connections such as corroded
523305	0	Oil Filter contaminated	Normal	2. Sensor has an internal defect.	or damaged plug contacts.
				The control unit receives a transmission input	
				torque via the CAN bus that exceeds the	
				permissible maximum.	1. Reduce the applied engine torque.
		Transmission input		1. Engine torque too high.	2. If this error continues to occur, please contact your
523310	0	torque too high	Normal	2. CAN bus signal is faulty.	vehicle manufacturer.
		Transmission input		TCU calculates an transmission input power	engine controller may ignore Torque or speedlimit
523311	0	power too high	Normal	above the defined thresholds	command from TCU via TSC1 message
		Transmission output		The speed at the transmission output exceeds	The speed at the transmission output exceeds the
523320	15	speed too high	Normal	the permissible maximum.	permissible maximum.
					Reduce the engine speed.
		Transmission input		The speed at the transmission input exceeds the	In order to prevent long-term damage, stay within the
523330	15	speed too high	Trm Shutdown	permissible maximum.	permissible speed range.
				The control unit calculates a torque at the	
				transmission output that exceeds the	
		Transmission output		permissible maximum.	
523340	0	torque too high	Trm Shutdown	1. Engine torque too high.	Reduce the applied engine torque.
		Clutch adjustment data			
523360	9	invalid	Normal	The clutch calibration was not performed.	Perform the clutch calibration.
		Clutch calibration			
523361	13	process failed	TCU Shutdown	The clutch calibration did fail	Check oil level and run calibration again.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					If the control unit resets the error itself, then this is a
					matter of a sporadically occurring error.
					Check the following points only when the error is
					active.
					1. Check the CAN connection for interruptions, in
					particular with regard to defective plug connections
					such as corroded or damaged plug contacts.
					2. Replace the ZF control unit.
					3. Check the terminating resistor of the CAN
					connection (CAN 1). Using an ohmmeter, also
					determine the resistance on the control unit and on
					the adapter when the ignition is off. The resistance
				An electrical error exists on the vehicle CAN bus.	value must be 120 Ohm ± 10 Ohm for each.
				1. Malfunction on the CAN bus.	4. If this error continues to occur, please contact the
523400	9	Vehicle CAN failure	Trm Shutdown	2. ZF control unit has an internal defect.	vehicle manufacturer.
					The cause of the missing connection must be located.
					1. If error vehicle can failure occurs, then repair this
				The control unit no longer transfers any	first.
				information.	2. If this error continues to be active, please contact
523402	9	ECU connection loss	Limp Home	1. Engine control unit has an internal defect.	your vehicle manufacturer.
					Check CAN Connection, check source Adress of the
523403	9	VCU connection loss	Trm Shutdown	No communication to the Vehicle Controller	VCU
					The cause of the missing connection must be located.
					1. If error vehicle can failure occurs, then repair this
				The extension no longer transfers any	first.
		I/O-Extension		information.	2. If this error continues to be active, please contact
523405	9	connection loss	Trm Shutdown	1. I/O extension has an internal defect.	your appropriate ZF service partner.
				The control unit does not receive the CAN	If the control unit resets the error itself, then this is a
				message or the message contains faulty data.	matter of a sporadically occurring error or an excessive
		Message ZFTC1 invalid		1. Sporadic electrical error.	bus load.
523411	9	or timeout	Trm Shutdown	2. CAN bus overloaded.	1. If error VCU Connection loss occurs, then repair this

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				3. Sending control unit has an internal defect.	first.
				4. Receiving control unit has an internal defect.	2. If this error continues to be active, please contact
					your vehicle manufacturer.
					If the control unit resets the error itself, then this is a
				The control unit does not receive the CAN	matter of a sporadically occurring error or an excessive
				message or the message contains faulty data.	bus load.
				1. Sporadic electrical error.	1. If error ECU Connection lost occurs, then repair this
				2. CAN bus overloaded.	first.
		Message EEC1 invalid		3. Sending control unit has an internal defect.	2. If this error continues to be active, please contact
523413	9	or timeout	Limp Home	4. Receiving control unit has an internal defect.	your vehicle manufacturer.
					If the control unit resets the error itself, then this is a
				The control unit does not receive the CAN	matter of a sporadically occurring error or an excessive
				message or the message contains faulty data.	bus load.
				1. Sporadic electrical error.	1. If error ECU Connection lost occurs, then repair this
				2. CAN bus overloaded.	first.
		Message EEC2 invalid		3. Sending control unit has an internal defect.	2. If this error continues to be active, please contact
523414	9	or timeout	Limp Home	4. Receiving control unit has an internal defect.	your vehicle manufacturer.
					If the control unit resets the error itself, then this is a
				The control unit does not receive the CAN	matter of a sporadically occurring error or an excessive
ļ				message or the message contains faulty data.	bus load.
				1. Sporadic electrical error.	1. If error ECU Connection lost occurs, then repair this
				2. CAN bus overloaded.	first.
		Message EEC3 invalid		3. Sending control unit has an internal defect.	2. If this error continues to be active, please contact
523415	9	or timeout	Limp Home	4. Receiving control unit has an internal defect.	your vehicle manufacturer.
					If the control unit resets the error itself, then this is a
				The control unit does not receive the CAN	matter of a sporadically occurring error or an excessive
				message or the message contains faulty data.	bus load.
				1. Sporadic electrical error.	1. If error ECU Connection lost occurs, then repair this
				2. CAN bus overloaded.	first.
		Message EC1 invalid or		3. Sending control unit has an internal defect.	2. If this error continues to be active, please contact
523416	9	timeout	Limp Home	4. Receiving control unit has an internal defect.	your vehicle manufacturer.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					If the control unit resets the error itself, then this is a
				The control unit does not receive the CAN	matter of a sporadically occurring error or an excessive
ľ				message or the message contains faulty data.	bus load.
ľ				1. Sporadic electrical error.	1. If error VCU connection lost occurs, then repair this
ľ				2. CAN bus overloaded.	first.
ľ		Message B invalid or		3. Sending control unit has an internal defect.	2. If this error continues to be active, please contact
523417	9	timeout	Normal	4. Receiving control unit has an internal defect.	your vehicle manufacturer.
				The control unit does not receive the CAN	
ľ				message or the message contains faulty data.	
ľ				1. Sporadic electrical error.	1. If error VCU connection lost occurs, then repair this
ľ				2. CAN bus overloaded.	first.
ľ		Message EBC1 invalid		3. Sending control unit has an internal defect.	2. If this error continues to be active, please contact
523418	9	or timeout	Normal	4. Receiving control unit has an internal defect.	your vehicle manufacturer.
ľ				One or more signals of the messages from	1. Check the software version of the transmission
ľ		Signal actual engine		engine controller contains faulty data.	control unit and program the current software version
ľ		torque or signal engine		1. Incorrect software on the transmission control	if required.
ľ		speed (EEC1) are		unit.	2. If this error continues to occurs, please contact your
523419	9	defective	Limp Home	2. Incorrect software on the engine controller.	vehicle manufacturer.
ľ					If the control unit resets the error itself, then this is a
ľ				The control unit does not receive the CAN	matter of a sporadically occurring error or an excessive
ľ				message or the message contains faulty data.	bus load.
ľ				1. Sporadic electrical error.	1. If error Vehicle CAN error occurs, then repair this
ľ				2. CAN bus overloaded.	first.
ľ		Message CCVS invalid		3. Sending control unit has an internal defect.	2. If this error continues to be active, please contact
523420	9	or timeout	Normal	4. Receiving control unit has an internal defect.	your vehicle manufacturer.
				The control unit does not receive the CAN	If the control unit resets the error itself, then this is a
ľ				message or the message contains faulty data.	matter of a sporadically occurring error or an excessive
				1. Sporadic electrical error.	bus load.
				2. CAN bus overloaded.	1. If error Vehicle CAN error occurs, then repair this
		Message JBERC1 invalid		3. Sending control unit has an internal defect.	first.
523426	9	or timeout	Limp Home	4. Receiving control unit has an internal defect.	2. If this error continues to be active, please contact

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					HCE.
					If the control unit resets the error itself, then this is a
				The control unit does not receive the CAN	matter of a sporadically occurring error or an excessive
				message or the message contains faulty data.	bus load.
				1. Sporadic electrical error.	1. If error Vehicle CAN error occurs, then repair this
				2. CAN bus overloaded.	first.
		Message JBRC invalid		3. Sending control unit has an internal defect.	2. If this error continues to be active, please contact
523427	9	or timeout	Limp Home	4. Receiving control unit has an internal defect.	HCE.
				The operating mode assigned by the vehicle	1. Check the software version of the transmission
				control unit is invalid for the transmission.	control unit and program the current software version
				1. Incorrect software on the transmission control	if required.
		Operation Mode		unit.	2. If this error continues to occurs, please contact HCE.
523470	19	command invalid	Trm Shutdown	2. Incorrect software on the vehicle computer.	
				The transmission mode assigned by the vehicle	1. Check the software version of the transmission
				control unit is invalid for the transmission.	control unit and program the current software version
				1. Incorrect software on the transmission control	if required.
		Transmission command		unit.	2. If this error continues to occurs, please contact HCE.
523471	19	invalid	Trm Shutdown	2. Incorrect software on the vehicle computer.	
		Machine configuration			Check version of vehicle controller (it has to support
523480	9	invalid	TCU Shutdown	The startup handshake has not been successful.	handshaking).
		Testmode requested			Take back the test mode request, set the conditions to
		but conditions not			the allowed thresholds and request the Test Mode
523481	0	complied	Trm Shutdown	The conditions for Testmode are not fulfilled	again
					1. Reduce the engine speed.
				3	2. If this error continues to occur, please contact your
				CAN bus that exceeds the permissible maximum.	vehicle manufacturer.
				1. Engine speed too high.	Note: In order to prevent permanent damage, stay
523500	0	Overspeed engine	Normal	2. CAN bus signal is faulty.	within the permissible speed range.
		Engine speed limit		The transmission control unit requires a limited	
		request does not take		engine speed; the engine does not maintain the	If this error continues to be active, please contact
523501	0	effect	Normal	limit;	HCE.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
		Engine speed control		The transmission control unit requires a certain	
ľ		request does not take		engine speed; the engine controller does not set	If this error continues to be active, please contact
523502	C	effect	Normal	this speed;	HCE.
		Engine torque limit		The transmission control unit requires a limited	
ľ		request does not take		engine torque; the engine does not maintain the	If this error continues to be active, please contact
523503	C	effect	Normal	limit;	HCE.
		Engine torque control		The transmission control unit requires a certain	
ľ		request does not take		engine torque; the engine controller does not set	If this error continues to be active, please contact
523504	C	effect	Normal	this torque;	HCE.
ľ		Protection related			Read out the operating data with Testman and send
523600	C	error detected	Trm Shutdown	The control unit detects a safety-relevant error.	them to your ZF contact.
		Protection Function 1			
ľ		(SF01) Unwanted			Read out the operating data with Testman and send
523600	1	driveaway	TCU Shutdown	Unexpected vehicle movement detected	them to your ZF contact.
ľ		Protection Function 2			
ľ		(SF02) Unwanted			Read out the operating data with Testman and send
523600	2	driving direction	Trm Shutdown	Driving in the wrong direction detected	them to your ZF contact.
ľ		Protection Function 3			
ľ		(SF03) Safely limited			
ľ		acceleration (blocked			Read out the operating data with Testman and send
523600	3	Transmission)	Trm Shutdown	Transmission blocking detected	them to your ZF contact.
ľ		Protection Function 4			
ľ		(SF04) Safely limited			
ľ		acceleration			Read out the operating data with Testman and send
523600	4	(Downshift)	Trm Shutdown	Unalowed speeds at transmission input detected	them to your ZF contact.
		Protection Function 5			
		(SF05) Safe Output at			Read out the operating data with Testman and send
523600	5	reverse driving	Trm Shutdown	Wrong Reverse signal broadcasted	them to your ZF contact.
		Protection Function 6			Read out the operating data with Testman and send
523600	6	(SF06) Safely limited	Trm Shutdown	Unalowed speed or gear in Reverse detected	them to your ZF contact.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
		speed in Reverse			
		Protection Function 7			
		(SF07) Unwanted			Read out the operating data with Testman and send
523600	7	direction change	Trm Shutdown	Unwanted change of driving direction detected	them to your ZF contact.
		Protection Function 8			Read out the operating data with Testman and send
523600	8	(SF08)	Trm Shutdown	Safely limited torque	them to your ZF contact.
		Protection Function 9			
		(SF09) Safely limited			Read out the operating data with Testman and send
523600	9	torque	Trm Shutdown	Unalowed engine control request detected	them to your ZF contact.
		Protection Function 10			
		(SF10) Delayed gear			Read out the operating data with Testman and send
523600	10	engagement	Trm Shutdown	Unalowed delayed get into gear detected	them to your ZF contact.
		Protection Function 11		Unalowed Difflock acutation at too high speeds	Read out the operating data with Testman and send
523600	11	(SF11) Safe Difflock	Trm Shutdown	detected	them to your ZF contact.
		Protection Function 12			
		(SF12) Safe			
		Transmission Output			Read out the operating data with Testman and send
523600	12	Signals	TCU Shutdown	Safe Transmission Output	them to your ZF contact.
		Protection Function 16			Read out the operating data with Testman and send
523600	16	(SF16) Safe Inching Exit	TCU Shutdown	Safe Inchen Exit	them to your ZF contact.
		Protection Function 18			Read out the operating data with Testman and send
523600	18	(SF18) Safe Speedlimit	Trm Shutdown	Unallowed speed limit overrun	them to your ZF contact.
				The control unit detects a clutch shift although	1. Check the proportional valves.
				no gear change is requested.	2. If this error continues to occur, contact your ZF
		Protection related		1. Energization proportional valve faulty.	representative and give us the error code and the
		error in transmission		2. Proportional valve faulty.	conditions under which the error occurs. Read out the
523601	0	detected	TCU Shutdown	3. Control unit has an internal defect.	operating data with Testman and send them to us.
		Protection related		The control unit detects a faulty check sum, a	1. Check if the TC1 CAN bus message is present. In
		error in vehicle		faulty message counter, or a faulty requirement	addition, create a CAN bus measurement on the
523602	0	communication	TCU Shutdown	from the vehicle control unit.	vehicle CAN.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
		detected		1. CAN bus message is faulty.	2. If this error continues to occur, please contact HCE.
				The control unit requires that the internal supply	
		Protection error		voltage is switched off but this does not happen.	
523603	0	reaction failed	TCU Shutdown	1. Control unit has an internal defect.	1. Replace the control unit.
1					If the control unit resets the error itself, then this is a
				The control unit does not receive the CAN	matter of a sporadically occurring error or an excessive
				message or the message contains faulty data.	bus load.
				1. Sporadic electrical error.	1. If error Vehicle CAN error occurs, then repair this
1		No response to request		2. CAN bus overloaded.	first.
		of Time and Date		3. Sending control unit has an internal defect.	2. If this error continues to be active, please contact
523421	9	message	Normal	4. Receiving control unit has an internal defect.	your dealer.
					If the control unit resets the error itself, then this is a
				The control unit does not receive the CAN	matter of a sporadically occurring error or an excessive
				message or the message contains faulty data.	bus load.
				1. Sporadic electrical error.	1. If error Vehicle CAN error occurs, then repair this
				2. CAN bus overloaded.	first.
		Message VehcCFG		3. Sending control unit has an internal defect.	2. If this error continues to be active, please contact
523423	9	invalid or timeout	Trm Shutdown	4. Receiving control unit has an internal defect.	your dealer.
					If the control unit resets the error itself, then this is a
				The control unit does not receive the CAN	matter of a sporadically occurring error or an excessive
				message or the message contains faulty data.	bus load.
				1. Sporadic electrical error.	1. If error Vehicle CAN error occurs, then repair this
		Message CCSS or		2. CAN bus overloaded.	first.
		ZFCCSS invalid or		3. Sending control unit has an internal defect.	2. If this error continues to be active, please contact
523424	9	timeout	Trm Shutdown	4. Receiving control unit has an internal defect.	your dealer.
		Application program		The control unit does not receive the ZFVI or VI	Read out the operating data with Testman and send
523482	9	verification failed	TCU Shutdown	message or the message contains faulty data.	them to your ZF contact.
		EF1 speed does not		The control unit measures a speed at the input	The cause of the different speeds must be located.
1		match with other		which does not agree with the other speeds.	1. Check the wiring from the speed sensor to the
523100	7	speeds	Trm Shutdown	1. Wiring or plug connection is defective.	control unit, in particular with regard to defective plug

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				2. Wiring or plug connection has a poor contact.	connections such as corroded or damaged plug
				3. Distance speed sensor – sensor ring too large.	contacts.
				4. Speed sensor has an internal defect.	2. Check the function of the sensor and, if necessary,
					replace it.
				The control unit recognizes a rotational direction	The cause of the different rotational directions must be
				at the input, which does not agree with the	located.
				other rotational directions.	1. Check the wiring from the sensor to the control unit,
		EF1 direction of		1. Wiring or plug connection is defective.	in particular with regard to defective plug connections
		rotation does not		2. Wiring or plug connection has a poor contact.	such as corroded or damaged plug contacts.
		match with other		3. Distance speed sensor – sensor ring too large.	2. Check the function of the sensor and, if necessary,
523100	11	directions of rotation	Limp Home	4. Speed sensor has an internal defect.	replace it.
					The cause of the different speeds must be located.
				The control unit measures a speed at the input	1. Check the wiring from the speed sensor to the
				which does not agree with the other speeds.	control unit, in particular with regard to defective plug
				1. Wiring or plug connection is defective.	connections such as corroded or damaged plug
		EF2 speed does not		2. Wiring or plug connection has a poor contact.	contacts.
		match with other		3. Distance speed sensor – sensor ring too large.	2. Check the function of the sensor and, if necessary,
523105	7	speeds	Trm Shutdown	4. Speed sensor has an internal defect.	replace it.
				The control unit recognizes a rotational direction	The cause of the different rotational directions must be
				at the input, which does not agree with the	located.
				other rotational directions.	1. Check the wiring from the sensor to the control unit,
		EF2 direction of		1. Wiring or plug connection is defective.	in particular with regard to defective plug connections
		rotation does not		2. Wiring or plug connection has a poor contact.	such as corroded or damaged plug contacts.
		match with other		3. Distance speed sensor – sensor ring too large.	2. Check the function of the sensor and, if necessary,
523105	11	directions of rotation	Limp Home	4. Speed sensor has an internal defect.	replace it.
				The control unit measures a speed at the input	The cause of the different speeds must be located.
				which does not agree with the other speeds.	1. Check the wiring from the speed sensor to the
				1. Wiring or plug connection is defective.	control unit, in particular with regard to defective plug
		EF3 speed does not		2. Wiring or plug connection has a poor contact.	connections such as corroded or damaged plug
		match with other		3. Distance speed sensor – sensor ring too large.	contacts.
523110	7	speeds	Trm Shutdown	4. Speed sensor has an internal defect.	2. Check the function of the sensor and, if necessary,

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					replace it.
				The control unit recognizes a rotational direction	The cause of the different rotational directions must be
				at the input, which does not agree with the	located.
				other rotational directions.	1. Check the wiring from the sensor to the control unit,
		EF3 direction of		1. Wiring or plug connection is defective.	in particular with regard to defective plug connections
		rotation does not		2. Wiring or plug connection has a poor contact.	such as corroded or damaged plug contacts.
		match with other		3. Distance speed sensor – sensor ring too large.	2. Check the function of the sensor and, if necessary,
523110	11	directions of rotation	Trm Shutdown	4. Speed sensor has an internal defect.	replace it.
					The cause of the different speeds must be located.
				The control unit measures a speed at the input	1. Check the wiring from the speed sensor to the
				which does not agree with the other speeds.	control unit, in particular with regard to defective plug
				1. Wiring or plug connection is defective.	connections such as corroded or damaged plug
		EF4 speed does not		2. Wiring or plug connection has a poor contact.	contacts.
		match with other		3. Distance speed sensor – sensor ring too large.	2. Check the function of the sensor and, if necessary,
523115	7	speeds	Limp Home	4. Speed sensor has an internal defect.	replace it.
				The control unit recognizes a rotational direction	The cause of the different rotational directions must be
				at the input, which does not agree with the	located.
				other rotational directions.	1. Check the wiring from the sensor to the control unit,
		EF4 direction of		1. Wiring or plug connection is defective.	in particular with regard to defective plug connections
		rotation does not		2. Wiring or plug connection has a poor contact.	such as corroded or damaged plug contacts.
		match with other		3. Distance speed sensor – sensor ring too large.	2. Check the function of the sensor and, if necessary,
523115	11	directions of rotation	Normal	4. Speed sensor has an internal defect.	replace it.
					The cause of the increased temperature at the
					converter must be located.
					1. Check the oil level and correct it as needed.
					2. Check the function of the cooler fan.
				The measured oil temperature at the converter	3. Check the transmission oil cooler for contaminants
				is too high.	and damage.
				1. The oil level is incorrect.	4. Check the connection lines from the transmission to
		Torque converter oil		2. The cooling system is faulty.	the transmission oil cooler for damage.
523302	0	temperature critical	Normal	3. Load is permanently too high.	5. Check the transmission oil temperature using the

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					diagnosis unit. If the measured oil temperature does
					not drop when the vehicle is operated at idle even
					after a longer period of time, then the temperature
					sensor needs to be replaced.
					The cause of the increased temperature at the
					converter must be located.
					1. Check the oil level and correct it as needed.
					2. Check the function of the cooler fan.
					3. Check the transmission oil cooler for contaminants
					and damage.
					4. Check the connection lines from the transmission to
					the transmission oil cooler for damage.
				The measured oil temperature at the converter	5. Check the transmission oil temperature using the
				is too high.	diagnosis unit. If the measured oil temperature does
				1. The oil level is incorrect.	not drop when the vehicle is operated at idle even
		Torque converter oil		2. The cooling system is faulty.	after a longer period of time, then the temperature
523302	16	overtemperature	Normal	3. Load is permanently too high.	sensor needs to be replaced.
				Signal 'Engine Reference Torque from engine	1. Check the software version of the transmission
				controller contains faulty data.	control unit and program the current software version
				1 .Incorrect software on the transmission control	if required.
		Engine reference		unit.	2.If this error continues to occurs, please contact HCE.
523450	19	torque signal invalid	Limp Home	2. Incorrect software on the engine controller.	
				Signal 'Actual Engine Torque' from engine	1. Check the software version of the transmission
				controller contains faulty data.	control unit and program the current software version
				1 .Incorrect software on the transmission control	if required.
		Actual engine torque		unit.	
523451	19	signal invalid	Limp Home	2. Incorrect software on the engine controller.	2.If this error continues to occurs, please contact HCE.
				Signal 'Engine Nominal Friction Torque' from	1. Check the software version of the transmission
				engine controller contains faulty data.	control unit and program the current software version
		Engine nominal friction		1 .Incorrect software on the transmission control	if required.
523452	19	torque signal invalid	Normal	unit.	2.If this error continues to occurs, please contact your

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				2. Incorrect software on the engine controller.	HCE.
				Signal 'Requested Launch Gear' from vehicle	1. Check the software version of the transmission
				controller contains faulty data.	control unit and program the current software version
				1 .Incorrect software on the transmission control	if required.
		Launch gear request		unit.	2.If this error continues to occurs, please contact HCE.
523454	19	invalid	Normal	2. Incorrect software on the vehicle controller.	
		Message ZFSL1 invalid		Shift Lever message is missing or provides wrong	
523455	19	or timed out	Trm Shutdown	signals	Check CAN Bus, Check Shift Lever
		Invalid FNR extension			
523456	19	switches signal	Trm Shutdown	Invalid output signals from FNR switch	Check Shift Lever, FNR switch
		Neutral selected while			
		vehicle moves with		Shift Lever message is missing or provides wrong	
523650	0	overspeed	Normal	signals	Check CAN Bus, Check Shift Lever
					The cause of the occurring speed difference must be
				The TCU calculates a speed difference although	located.
				the clutch is closed. If this value is too high, it is	1. Check the existing system pressure.
				interpreted as slip on the clutch.	2. Check the filter and replace it if needed (compare
				1. Insufficient pressure on the clutch.	error 195).
				2. Insufficient system pressure.	3. Check the function of the clutch.
				3. Filter clogged.	4. Check the function of the proportional valves and
				4. Clutch faulty.	replace them if needed.
				5. Transmission input speed signal faulty.	5. Check if all speeds are present and correct.
				6. Transmission output speed signal faulty.	6. Check the wiring, in particular with regard to
		Clutch K1 slipping		7. Distance speed sensor – sensor ring too large.	defective plug connections such as corroded or
523700	0	unintendedly	Limp Home	8. Significant oscillation of the engine speed.	damaged plug contacts.
				The TCU calculates a speed difference although	The cause of the occurring speed difference must be
				the clutch is closed. If this value is too high, it is	located.
				interpreted as slip on the clutch.	1. Check the existing system pressure.
				1. Insufficient pressure on the clutch.	2. Check the filter and replace it if needed (compare
		Clutch K2 slipping		2. Insufficient system pressure.	error 195).
523705	0	unintendedly	Limp Home	3. Filter clogged.	3. Check the function of the clutch.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
1				4. Clutch faulty.	4. Check the function of the proportional valves and
1				5. Transmission input speed signal faulty.	replace them if needed.
1				6. Transmission output speed signal faulty.	5. Check if all speeds are present and correct.
1				7. Distance speed sensor – sensor ring too large.	6. Check the wiring, in particular with regard to
1				8. Significant oscillation of the engine speed.	defective plug connections such as corroded or
1					damaged plug contacts.
					The cause of the occurring speed difference must be
1				The TCU calculates a speed difference although	located.
1				the clutch is closed. If this value is too high, it is	1. Check the existing system pressure.
1				interpreted as slip on the clutch.	2. Check the filter and replace it if needed (compare
1				1. Insufficient pressure on the clutch.	error 195).
1				2. Insufficient system pressure.	3. Check the function of the clutch.
1				3. Filter clogged.	4. Check the function of the proportional valves and
1				4. Clutch faulty.	replace them if needed.
1				5. Transmission input speed signal faulty.	5. Check if all speeds are present and correct.
				6. Transmission output speed signal faulty.	6. Check the wiring, in particular with regard to
		Clutch K3 slipping		7. Distance speed sensor – sensor ring too large.	defective plug connections such as corroded or
523710	0	unintendedly	Limp Home	8. Significant oscillation of the engine speed.	damaged plug contacts.
					The cause of the occurring speed difference must be
1				The TCU calculates a speed difference although	located.
				the clutch is closed. If this value is too high, it is	1. Check the existing system pressure.
1				interpreted as slip on the clutch.	2. Check the filter and replace it if needed (compare
1				1. Insufficient pressure on the clutch.	error 195).
				2. Insufficient system pressure.	3. Check the function of the clutch.
1				3. Filter clogged.	4. Check the function of the proportional valves and
				4. Clutch faulty.	replace them if needed.
1				5. Transmission input speed signal faulty.	5. Check if all speeds are present and correct.
1				6. Transmission output speed signal faulty.	6. Check the wiring, in particular with regard to
1		Clutch KV slipping		7. Distance speed sensor – sensor ring too large.	defective plug connections such as corroded or
523715	0	unintendedly	Limp Home	8. Significant oscillation of the engine speed.	damaged plug contacts.
523720	0	Clutch K4 slipping	Limp Home	The TCU calculates a speed difference although	The cause of the occurring speed difference must be

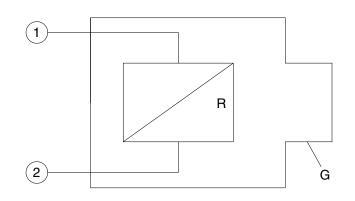
SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
		unintendedly		the clutch is closed. If this value is too high, it is	located.
				interpreted as slip on the clutch.	1. Check the existing system pressure.
				1. Insufficient pressure on the clutch.	2. Check the filter and replace it if needed (compare
				2. Insufficient system pressure.	error 195).
				3. Filter clogged.	3. Check the function of the clutch.
				4. Clutch faulty.	4. Check the function of the proportional valves and
				5. Transmission input speed signal faulty.	replace them if needed.
				6. Transmission output speed signal faulty.	5. Check if all speeds are present and correct.
				7. Distance speed sensor – sensor ring too large.	6. Check the wiring, in particular with regard to
				8. Significant oscillation of the engine speed.	defective plug connections such as corroded or
					damaged plug contacts.
					The cause of the occurring speed difference must be
				The TCU calculates a speed difference although	located.
				the clutch is closed. If this value is too high, it is	1. Check the existing system pressure.
				interpreted as slip on the clutch.	2. Check the filter and replace it if needed (compare
				1. Insufficient pressure on the clutch.	error 195).
				2. Insufficient system pressure.	3. Check the function of the clutch.
				3. Filter clogged.	4. Check the function of the proportional valves and
				4. Clutch faulty.	replace them if needed.
				5. Transmission input speed signal faulty.	5. Check if all speeds are present and correct.
				6. Transmission output speed signal faulty.	6. Check the wiring, in particular with regard to
		Clutch KR slipping		7. Distance speed sensor – sensor ring too large.	defective plug connections such as corroded or
523725	0	unintendedly	Limp Home	8. Significant oscillation of the engine speed.	damaged plug contacts.
				The TCU calculates a speed difference although	The cause of the occurring speed difference must be
				the clutch is closed. If this value is too high, it is	located.
				interpreted as slip on the clutch.	1. Check the existing system pressure.
				1. Insufficient pressure on the clutch.	2. Check the filter and replace it if needed (compare
				2. Insufficient system pressure.	error 195).
				3. Filter clogged.	3. Check the function of the clutch.
		LUC slipping		4. Clutch faulty.	4. Check the function of the proportional valves and
523730	0	unintendedly	Normal	5. Transmission input speed signal faulty.	replace them if needed.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				6. Transmission output speed signal faulty.	5. Check if all speeds are present and correct.
				7. Distance speed sensor – sensor ring too large.	6. Check the wiring, in particular with regard to
				8. Significant oscillation of the engine speed.	defective plug connections such as corroded or
					damaged plug contacts.
				Normally an upshift would have been necessary	
				to protect the motor due to the increased motor	
		Upshift by engine		speed. Since no shift can be performed in mode	
		overspeed not		Limp Home, transmission shifts to neutral	Do not overspeed engine in Limp Home. Use service
523385	0	supported in limphome	Trm Shutdown	instead.	brakes.
					1. Wait for 20s to cool down clutches
		Clutch KV temperature			2. Train operator to avoid unnecessary direction
523355	0	critical	Trm Shutdown	Failure related to overheated clutch KV	changes
					1. Wait for 20s to cool down clutches
		Clutch KR temperature			2. Train operator to avoid unnecessary direction
523356	0	critical	Trm Shutdown	Failure related to overheated clutch KR	changes
				The measured voltage of CCO and CCO2 signals	
				don't match or are out of range. Or received	
				signals via CAN do not correlate.	1. Check the cable from TCU to the sensor
		CCO or inch pedal		1. Cable is defective	2. Check connectors
523171	12	signals missmatch	Normal	2. Sensor has an internal defect	3. Check sensor
				TCU was not able to read correct inchpedal	
				adjustment parameters	
				1. Interference during saving data on non	
				volatile memory	
		Inchpedal calibration		2. TCU is brand new, the inchpedal calibration	
523171	13	failed	Normal	was not performed	Perform the inchpedal calibration process.
525171					1. Check transmission harness, cables between TCU
		More than one internal		More than one internal speed sensor is not	and speed sensors
		speed sensors are		working properly. In this case limp home mode is	2. Check connectors
523118	11	defective	Trm Shutdown	not possible anymore.	3. Check sensor
723110	<u> </u>		init shatao wit		

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					1. Check CAN bus
					2. Check the software version of the transmission
					control unit and program the current software version
					if required.
		Message ZFTC2 invalid		ZFTC2 message is missing or provides wrong	3. If this error continues to occurs, please contact your
523431	19	or timed out	Trm Shutdown	signals.	vehicle manufacturer.
					1. Check CAN bus
					2. Check shift lever
					3. Check the software version of the transmission
					control unit and program the current software version
					if required.
		Message ZFSL1_FNR		Shift Lever message is missing or provides wrong	4. If this error continues to occurs, please contact your
523432	19	invalid or timed out	Trm Shutdown	signals.	vehicle manufacturer.
		CCO or inch pedal		A problem with the signals required for CCO or	1. Check cable from TCU or the sensor
		signal fault during CCO		inching occured while the vehicle was in CCO or	2. Check connectors
523171	11	or inching	Limp Home	inching operation.	3. Check sensor

5) MEASURING OF RESISTANCE AT ACTUATOR/SENSOR AND CABLE

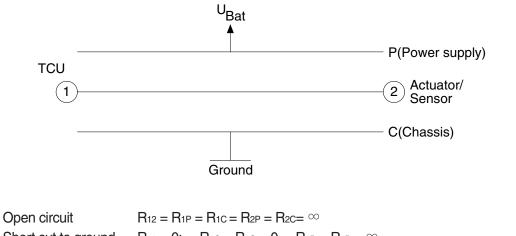
(1) Actuator



76043PT19

76043PT20

(2) Cable



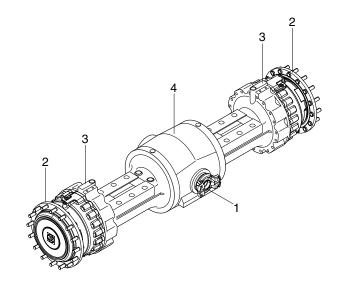
Short cut to ground $R_{12} = 0$; $R_{1C} = R_{2C} = 0$, $R_{1P} = R_{2P} = \infty$ Short cut to battery $R_{12} = 0$; $R_{1C} = R_{2C} = 0$, $R_{1P} = R_{2P} = 0$

5. AXLE

1) OPERATION

- The power from the engine passes through torque converter, transmission and drive shafts, and is then sent to the front and rear axles.
- Inside the axles, the power passes from the bevel pinion to the bevel gear and is sent at right angles. At the same time, the speed is reduced and passes through the both differentials to the axle shafts. The power of the axle shafts is further reduced by planetary-gear-type final drives and is sent to the wheels.

(1) Front axle

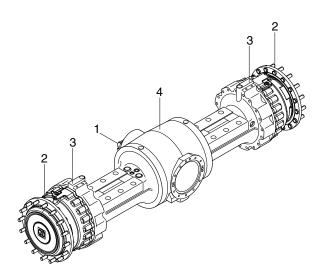


7609A3PT15

1 Input

- 2 Output
- 4 Axle housing





7609A3PT16

- 1 Input
- 4 Axle housing

3

Brake

3

2) DIFFERENTIAL

(1) Description

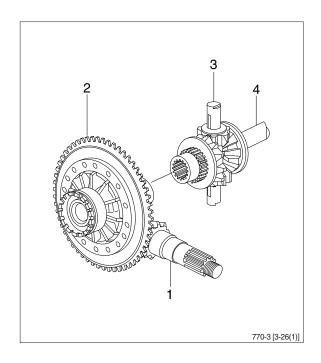
When the machine makes a turn, the outside wheel must rotate faster than the inside wheel. A differential is a device which continuously transmits power to the right and left wheels while allowing them to turn a different speeds, during a turn.

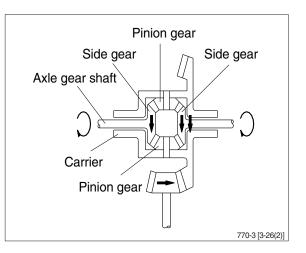
The power from the drive shaft passes through bevel pinion (1) and is transmitted to the bevel gear (2). The bevel gear changes the direction of the motive force by 90 degree, and at the same time reduces the speed.

It then transmits the motive force through the differential (3) to the axle gear shaft (4).

(2) When driving straight forward

When the machine is being driven straight forward and the right and left wheels are rotating at the same speed, so the pinion gear inside the differential assembly do not rotate. The motive force of the carrier is send through the pinion gear and the side gear, therefore the power is equally transmitted to the left and right axle gear shaft.

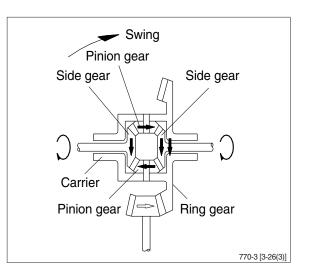




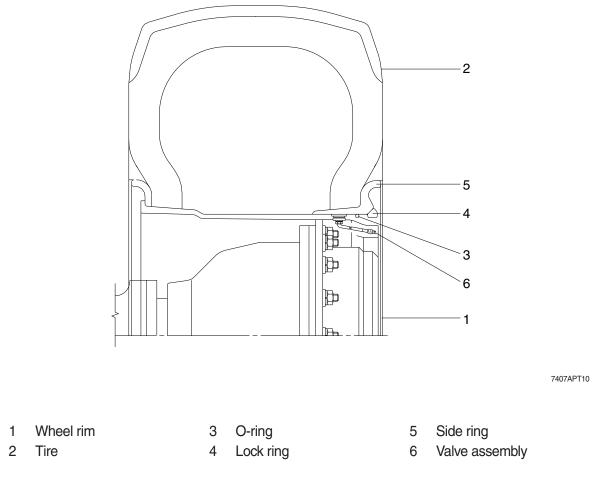
(3) When turning

When turning, the rotating speed of the left and right wheels is different, so the pinion gear and side gear inside the differential assembly rotate in accordance with the difference between the rotating speed of the left and right wheels.

The power of the carrier is then transmitted to the axle gear shafts.



6. TIRE AND WHEEL



- 1) The tire acts to absorb the shock from the ground surface to the machine, and at the same time they must rotate in contact with the ground to gain the power which drives the machine.
- 2) Various types of tires are available to suit the purpose. Therefore it is very important to select the correct tires for the type of work and bucket capacity.

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. POWER TRAIN OPERATIONAL CHECKS

This procedure is designed so that the mechanic can make a quick check of the system using a minimum amount of diagnostic equipment. If you need additional information, read Structure and function, Group 1.

A location will be required which is level and has adequate space to complete the checks.

The engine and all other major components must be at operating temperature for some checks.

Locate system check in the left column and read completely, following the sequence from left to right. Read each check completely before performing.

At the end of each check, if no problem is found(OK), that check is complete or an additional check is needed. If problem is indicated(NOT OK), you will be given repair required and group location. If verification is needed, you will be given next best source of information :

Chapter 2 : Troubleshooting Group 3 : Tests and adjustments

* Transmis	ssion oil must be at	operating temp	erature for these checks.
------------	----------------------	----------------	---------------------------

Transmission oil warm-up procedure		Start engine. Apply service brakes	OK
		and release parking brake.	Check completed.
		Select T/M shift mode to MANUAL mode.	
		Move gear selector lever to 3rd speed.	
		Move gear selector lever to forward "F" position.	
		Increase engine speed to high idle for 30 seconds.	
		Move gear selector lever to neutral "N" position and run for 15 seconds.	
		Repeat procedure until transmission temperature gauge arrow points to bar above dial.	
Gear selector lever and neutral lock latch checks		Move gear selector lever to each position.	OK Check completed.
Engine OFF.		NOTE : Gear selector lever position changes slightly as steering column is tilted.	NOT OK Repair lock or replace switch.
		FEEL : Lever must move freely through all positions.	
		Engage neutral lock.	
		Apply slight effort to move lever into forward (F) and reverse (R).	
		LOOK : Neutral lock must stay engaged.	
Automatic shifting check		Start engine.	OK Chask completed
		Move gear selector lever to 4th speed.	Check completed.
	AL mode	Select T/M shift mode to AL (auto light) mode.	Go to transmission fault code group at page 3-50~
		LOOK : Automatic sign on cluster.	3-66. Repair or replace the
	Automatic mode	Move gear selector lever to forward or reverse position.	monitor or harness.
		Increase engine rpm.	
	DEF LEVEL : 0%	LOOK : Speed on cluster must vary with machine speed.	

Item		Description	Service action
Transmission noise check Engine running.		Run engine at approximately 1600 rpm. Drive unit with transmission in each forward and reverse speed. LISTEN : Transmission must not make excessive noise in any range. Engine rpm must not "lug down" as unit is shifted between gears.	Check completed.
Transmission "quick shift" check Engine running.	Release MANUAL mode INTERNATIONAL MANUAL MODE MANUAL MODE INTERNATIONAL MANUAL MODE MANUAL MODE MANUAL MODE MANUAL MODE MANUAL MODE	 unit is shifted between gears. Release parking brake and select T/M shift mode to MANUAL mode. Shift to 2nd forward. Drive machine at approximately 5km/h and press gear selector lever kick down switch or RCV levers switch once. LOOK/FEEL : Transmission must shift to and remain in 1st gear. Press gear selector lever kick down switch once. LOOK/FEEL : Transmission must shift to (3rd or 4th) gear and press gear selector lever kick down switch once. LOOK/FEEL : Transmission must shift back to 2nd gear. Shift to (3rd or 4th) gear and press gear selector lever kick down switch once. LOOK/FEEL : Transmission must not shift down. Select T/M shift mode to AL (auto light) mode. Drive machine at approximately 90% speed of max speed in each gear (2nd or 3rd or 4th). Shift to (2nd or 3rd or 4th) gear in each forward and reverse speed and press gear selector kick down lever switch or RCV lever switch once. LOOK/FEEL : If shift down quickly from current gear to one step lower speed and recover to original speed quickly when push the switch one more time. (mode 1) If shifts down from current gear to one step lower speed when push 	Check completed. NOT OK Check connector at base of control valve. IF OK Go to transmission controller circuit in group 1.
	AL mode	light) mode. Drive machine at approximately 90% speed of max speed in each gear (2nd or 3rd or 4th). Shift to (2nd or 3rd or 4th) gear in each forward and reverse speed and press gear selector kick down lever switch or RCV lever switch once. LOOK/FEEL : If shift down quickly from current gear to one step lower speed and recover to original speed quickly when push the switch one more time. (mode 1)	

Item		Description	Service action
Forward, reverse and 4th	_	Park unit on level surface.	OK
speed clutch pack drag		Apply service brakes.	Check completed.
* Transmission must		Move gear selector lever to neutral.	NOT OK If unit moves, repair
be warmed up for this check.	Release	Move gear selector lever to 1st.	transmission.
Engine running.		Release parking brake and service brakes.	
		Run engine at low idle.	
		LOOK : Unit must not move in either direction.	
		NOTE : If unit moves forward, either the forward pack or the 4th speed pack is dragging.	
Transmission shift modulation check		Run engine at approximately 1300 rpm.	OK Check completed.
Engine running.		Put transmission in 1st forward, shift several times from forward to reverse and reverse to forward. Repeat check in 2nd gear.	Go to unit shifts too fast,
		LOOK : Unit must slow down and change direction smoothly.	
Torque converter check		Start engine. Apply service brakes and release parking brake.	OK Check completed.
		Move gear selector lever to 3rd speed.	If stall rpm are too low or
		Move gear selector control lever to forward "F" position.	too high, problem may be engine power or torque converter.
		Increase engine speed to high idle.	IF OK
		$\begin{array}{l} \textbf{LOOK}: \text{Torque converter stall rpm} \\ \text{must be within the following range.} \\ \text{Stall rpm}: \ 2050 {\pm} 70 \text{ rpm} \end{array}$	
		Move gear selector control lever to neutral "N" position and run for 15 seconds.	

2. TROUBLESHOOTING

- 1) TRANSMISSION
- * Diagnose malfunction charts are arranged from most probable and simplest to verify, to least likely, more difficult to verify. Remember the following steps when troubleshooting a problem :

Step 1. Operational check out procedure (See group 3 in section 1.)

Step 2. Operational checks (In this group.)

Step 3. Troubleshooting

Step 4. Tests and/or adjustments (See group 3.)

Problem	Cause	Remedy
Transmission slippage	Low oil level.	Add oil.
	Wrong oil grade.	Change oil.
	Restricted transmission pump suction screen.	Remove and clean screen.
	Leak in transmission control valve or gasket.	Remove valve and inspect gaskets.
	Low transmission pump flow due to worn pump.	Do transmission pump flow test.
	Weak or broken pressure regulat- ing valve spring.	Do transmission system pressure test.
Error code on display	Something wrong in transmission.	Go to transmission fault code group at page 3-50~3-66.

Problem	Cause	Remedy
Machine will not move	Low oil level.	Add oil.
	Applied park brake.	Check parking brake fuse. Check continuity to parking brake switch.
	No power to transmission contro- ller.	Check transmission controller fuse.
	Malfunctioning parking brake solenoid valve.	Remove and inspect parking brake solenoid valve. Check for power to solenoid valve.
	Restricted orifice of PPC valve.	Remove orifice and check for contamination and/or plugging. (Do not remove valve housing for this purpose.)
	Excessive leakage in transmission element.	Do transmission element leakage test using system pressure.
	Worn clutch disks.	Repair transmission.
	Low or no transmission pressure.	See transmission pressure is low in this group.
	Service brake will not release.	Do brake pedal operational check. Do service and park system drag checks.
	Failed torque converter.	Do torque converter stall test. If engine pulldown in normal, torque converter is good.
	Broken shafts or gears.	Drain transmission to determine if large pieces of metal contamination are present.
	Broken drive shafts.	Inspect drive shafts and universal joints for external damage. Repair.
	Broken ring or pinion gear.	If drive shaft rotate with transmission in gear but machine does not move, a differential failure is indicated. Repair.
Machine does not engage in low gear	Malfunctioning transmission control solenoid valve.	Check solenoid valve.
	Stuck spool in transmission control valve.	Remove and inspect transmission control valve spools.
	Stuck PPC valve.	Remove end cover to inspect PPC valve. Replace if necessary.
	Malfunctioning transmission speed sensor.	Check speed sensor.

Problem	Cause	Remedy
Transmission pressure is low (all gears)	Low oil level.	Check transmission oil level and refill if necessary.
	Failed transmission pressure switch.	Verify transmission system pressure. Do transmission system pressure test.
	Plugged suction strainer.	Transmission pump may be noisy if transmission suction screen is clogged. Drain transmission. Remove and clean suction screen. Also, check condition of transmission filter.
	Stuck transmission pressure regulating valve or broken spring.	Remove transmission pressure regulating valve. Inspect for damage (See transmission control valve).
	Failed control valve gasket.	Inspect transmission control valve for external leakage. Remove control valve. Inspect or replace gasket.
	Stuck PPC valve.	Remove end cover to inspect modulation spool and check torque on cap screws retaining control valve to transmission.
Transmission system	Failed transmission pump.	Do pump flow test.
pressure is low (one or two gears)	Failed transmission control valve gasket.	Inspect transmission control valve for external leakage. Remove control valve. Inspect or replace gasket.
	Leakage in clutch piston or seal ring.	Disassemble and repair.
Transmission shifts too	Low oil level (aeration of oil).	Add oil.
low	Low transmission pressure.	Do transmission system pressure test.
	Restricted transmission pump suction screen.	Remove and clean screen.
	Low transmission pump flow.	Do transmission pump flow test.
	Excessive transmission element leakage.	Do transmission element leakage test using system pressure.
	Stuck PPC valve.	Remove end cover to inspect modulation spool. Replace if necessary.
	Restricted PPC valve orifice.	Remove orifice and inspect for contamination and /or plugging.
	Restricted oil passages between control valve and transmission elements.	Remove control valve and inspect oil passage.
	Incorrect transmission oil.	Change oil (SAE 10W-30/15W-40)

Problem	Cause	Remedy
Transmission shifts too fast	Wrong transmission controller.	Check if transmission controller has been changed
	System pressure too high.	Do transmission system pressure test.
	Stuck PPC valve.	Remove and inspect PPC valve. Replace if necessary. Also remove end cover to inspect PPC valve and control valve housing. Replace if necessary.
	Stuck or missing check valves.	Inspect transmission control valve.
	Missing O-ring from end of modulation orifice.	Remove orifice and inspect port for O-ring.
	Broken piston return spring.	Disassemble and inspect clutch.
	Incorrect transmission oil.	Change oil (SAE 10W-30/15W-40).
Machine "creeps" in neutral	Warped disks and plates in transmission.	Check transmission.
Transmission hydraulic system overheats	High oil level.	Transmission overfilled or hydraulic pump seal leaking.
	Low oil level.	Add oil.
	Wrong oil grade.	Change oil.
	Park brake dragging.	Check for heat in park brake area.
	Pinched, restricted or leaking lube lines.	Check cooler lines.
	Machine operated in too high gear range.	Operate machine in correct gear range.
	Malfunction in temperature gauge or sensor.	Install temperature sensor the verify temperature. Do tachometer/temperature reader installation procedure.
	Restricted air flow through oil cooler or radiator.	Do radiator air flow test.
	Failed oil cooler bypass valve (In thermal bypass valve).	Disassemble and inspect.
	Failed thermal bypass valve.	Remove thermal bypass valve and check to see if machine still overheats. Do transmission oil cooler thermal bypass valve test.
	Internally restricted oil cooler.	Do oil cooler restriction test.
	Leakage in transmission hydraulic system.	Do transmission system pressure, element leakage test.
	Malfunction in converter relief valve.	Do converter out pressure test.
	Low transmission pump output.	Do transmission pump flow test.

Problem	Cause	Remedy
Excessive transmission	Too low engine low idle.	Check engine low idle speed.
noise (Under load or no load)	Worn parts or damaged in transmission.	Remove transmission suction screen. Inspect for metal particles. Repair as necessary.
	Warped drive line between engine and torque converter.	Inspect drive line.
	Low or no lube.	Do converter-out and lube pressure test. Do transmission pump flow test.
Foaming oil	Incorrect type of oil.	Change oil.
	High oil level.	Transmission overfilled or hydraulic pump seal leaking.
	Low oil level.	Add oil.
	Air leak on suction side of pump.	Check oil pickup tube on side of transmission.
Oil ejected from dipstick	Plugged breather.	Inspect breather on top of transmission. Replace.
Machine vibrates	Aerated oil.	Add oil.
	Low engine speed.	Check engine speed.
	Failed universal joints on transmission drive shaft or differential drive shafts.	Check universal joints.
Machine lacks power and acceleration	Engine high idle speed set too low.	Check high idle adjustment.
	Incorrect transmission oil.	Change oil.
	Aerated oil.	Add oil.
	Low transmission pressure.	Do transmission system pressure test.
	Warped transmission clutch.	Do transmission clutch drag checks.
	Torn transmission control valve gasket.	Inspect gasket.
	Brake drag.	Do brake drag check.
	Failed torque converter.	Do torque converter stall speed test.
	Low engine power.	Do engine power test.
Torque converter stall RPM too high	Aerated oil.	Put clear hose on thermal bypass outlet port. Run machine to check for bubbles in oil.
	Stuck open converter relief valve.	Do converter-out pressure test.
	Leakage in torque converter seal.	Do converter-out pressure test.
	Torque converter not transferring power (Bent fins, broken starter).	Replace torque converter.

Problem	Cause	Remedy
Torque converter stall	Low engine power.	Do engine power test.
RPM too low	Mechanical malfunction.	Remove and inspect torque converter.
Transmission pressure	Low oil level.	Add oil.
light comes ON when shifting from forward to	Cold oil.	Warm oil to specification.
reverse (all other gears OK)	Leak in reverse pack.	Do transmission pressure, pump flow, and leakage check.
Transmission pressure	Cold oil.	Warm oil to specification.
light comes ON for each shift	No time delay in monitor.	Do monitor check.
	Restriction in modulation orifice.	Remove orifice and inspect for restriction and/or plugging.
	Stuck PPC valve.	Remove and inspect.
	Low transmission pressure circuit.	Do transmission system pressure test.
	Leak in transmission pressure circuit.	Do converter out pressure test.
	Failed transmission pump.	Do transmission pump flow test.
	Clogged filter.	Inspect filter. Replace.

2) DIFFERENTIAL / AXLE

Problem	Cause	Remedy
Differential low on oil	External leakage.	Inspect axle and differential for leaks.
Excessive differential and/or axle noise	Low oil level in differential.	Check oil. Remove drain plug and inspect for metal particles in differential case. Disassemble and determine cause.
	Incorrect type of oil.	Change oil
	Dragging brakes.	Do brake check.
	Failed pinion bearing.	Remove and inspect pinion. Check to ensure pinion housing was indexed.
	Incorrect gear mesh pattern between ring and pinion gear.	Remove pinion gear housing and inspect ring and pinion gear.
	Failed differential pinion gears and/or cross shafts.	Remove differential housing drain plug and inspect for metal particles. Disassemble and inspect.
	Failed axle bearing.	Do axle bearing adjustment check.
	Mechanical failure in axle planetary.	Remove differential. Inspect, repair.
Oil seeping from outer	Excessive end play in axle.	Do axle bearing adjustment check.
axle seal	Worn outer bearing and/or cup.	Disassemble and inspect outer axle bearing, cup, spacer, and seal. Replace, if necessary.
	Overfilled differential.	Check differential oil return system for excessive internal restriction.
Axle overheats	Low differential oil.	Add oil.
	Overfilled differential.	See differential overfills with oil in this group.
	Brake drag.	See brakes drag in this group.

3) DRIVE LINE

Problem	Cause	Remedy
	Yokes not in line on drive shafts.	Inspect. Align drive shaft yokes.
vibration or noise	Worn front drive line support bearing.	Inspect, repair.
	Bent drive shaft.	Inspect all drive shafts. Replace.
	Loose yoke retaining nuts (drive shafts wobble at high speed).	Inspect. Replace.
	Rear axle oscillating support.	Inspect, repair.
	Lack of lubrication.	Lubricate with proper grade of grease.

GROUP 3 TESTS AND ADJUSTMENTS

1. TRANSMISSION MEASURING POINTS AND CONNECTIONS

The measurements have to be carried out at hot transmission (about 80~95°C).



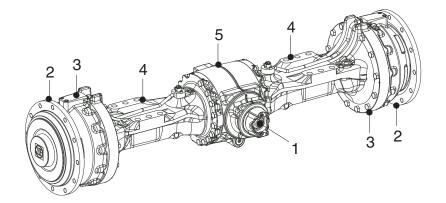
Measuring point	Measurement variable pressure/ temperature
51	11 + 2 bar
52 (not shown)	4.3 + 3 bar
53	16 + 3 bar
55	16 + 3 bar
56	16 + 3 bar
57	16 + 3 bar
58	16 + 3 bar
60	16 + 3 bar
65	16 + 3 bar
67	15 + 1 bar

940T33PT14

- 51 Measuring point for pressure before converter, M12 x 1.5
- 53 Measuring point for clutch KV, M12 x 1.5
- 55 Measuring point for pressure oil of clutch KR, M12 x 1.5
- 56 Measuring point for pressure oil of clutch K1, M12 x 1.5
- 57 Measuring point for pressure oil of clutch K2, M12 x 1.5
- 58 Measuring point for pressure oil of clutch K3, M12 x 1.5
- 60 Measuring point for pressure oil of clutch K4, M12 x 1.5
- 65 Measuring point for system pressure, M12 x 1.5
- 67 Measuring point for pressure in torque converter lock-upclutch, M12 x 1.5 (not used)

1. AXLE

- 1) DISASSEMBLY
- (1) Output and brake disassembly



7409AAX001

1 Input

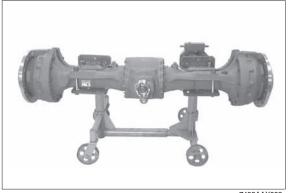
Output

2

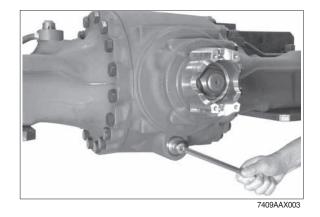
- 3 Brake4 Axle housing
- 5 Axle drive housing

① Mount axle on assembly truck.

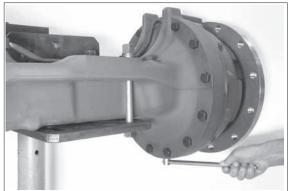
Assembly truck	5870 350 000
Supporting bracket (2EA)	5870 350 106



- ② Drain oil from axle.
- * Use suitable reservoir-environmental protection.



- 3 Drain oil from both outputs.
- * Use suitable reservoir-environmental protection.



7409AAX004

Disassembly output assy /brake

For any replacement of components you can remove the output assy (with brake) as one unit.

In this context refer to work steps on figure AX007~AX009 and assembly steps page 3-128~130.

* Please consider, however, that multi discs of the brake must be replaced on both outputs each.

Replacement combi seal ring (output)

* The combi seal ring (output) can also be replaced on the installed axle for this purpose remove output shaft.

For the installation of the combi seal ring, refer to work steps on figure AX303 ~AX305.

Pry bar

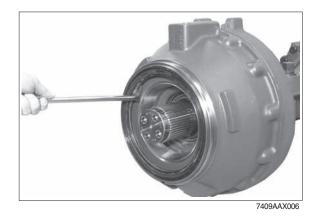
5870 345 071

Output /brake

1 Disassemble brake tube.



7409AAX005





② Take up output by means of a lifting bracket.

Loosen bolted connection (output /axle housing) and separate output from axle housing.

Pay attention to releasing end plate and multi discs.

Lifting bracket

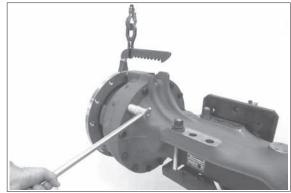
5870 281 043

- 3 Remove stub shaft and sun gear shaft.
- * Pay attention to shim (placed in sun gear shaft) and mark allocation of shim to sun gear shaft and output side assembly aid.

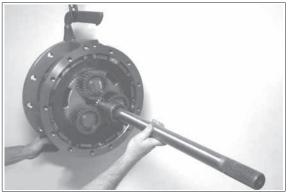
In certain cases the stub shaft /sun gear shaft could get stuck in the axle housing (gearing of axle bevel gear /differential).

④ Mount output assy on assembly truck.
 Remove end plate (1), brake breather valve (2) and screw neck (3).

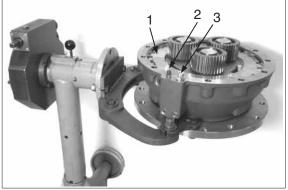
Assembly truck	5870 350 000
Fixture	5870 350 112



7409AAX008



7409AAX009

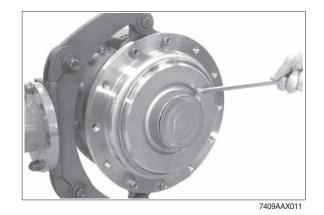


7409AAX010

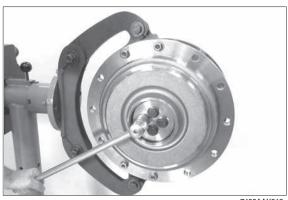
5 Remove lid (with O-ring).

Pry bar

5870 345 071



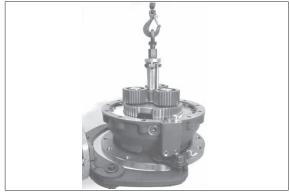
- 6 Loosen locking screws and remove lid.
- * Pay attention to releasing planetary carrier, risk of accident.



7409AAX012

⑦ Lift compl. planetary carrier out of brake housing.

Inner extractor	5870 300 019
Eye nut	5870 204 073



7409AAX013

8 Snap out retaining ring.Set of external pliers 5870 900 015



9 Pull off planetary gear.
 Disassemble the remaining planetary gears in the same way.

Three armed puller 5870 971 002



10 Pull bearing inner ring off the planetary carrier.

5873 003 033

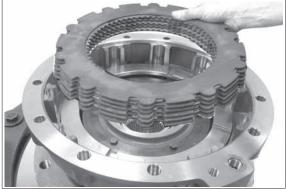
5873 003 001

Grab sleeve

Basic tool

7409AAX016

1 Take disc package out of brake housing.



7409AAX017

1 Loosen threaded joint.



7409AAX018



3-88

(13) Remove lid, cup spring and disk.

(14) Lift piston off with lever.

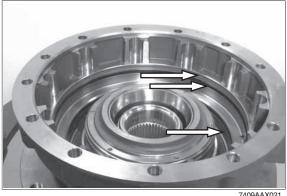
Adjusting device

5870 400 001



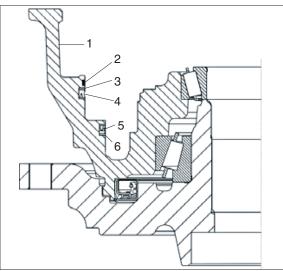
7409AAX020

15 Remove sealing elements (arrows also refer to AX022) from annular grooves of brake housing.



7409AAX021

- 1 Brake housing
- 2 Guide ring
- 3 Support ring
- 4 Grooved ring
- 5 Grooved ring
- 6 Support ring



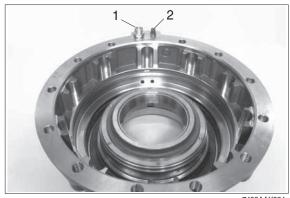
7409AAX022

6 Lift brake housing off the output shaft by means of lifting device.

Lifting chain	5870 281 047
Eyebolts	5870 204 071



O Remove screw neck (1) and breather valve (2).



7409AAX024

(B) Lift off shaft seal by lever and remove both bearing outer rings from brake housing, if required.

Pry bar

5870 345 071



7409AAX025

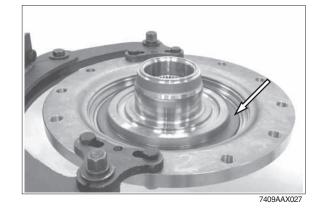
(9) Pull bearing inner ring from output shaft.

Rapid grip	5873 014 016
Basic tool	5873 004 001



7409AAX026

② If required, disassemble wear sleeve (arrow) of combi seal ring.

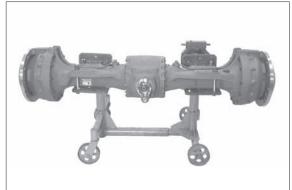


(2) Differential and input disassembly

Differential

1 Mount axle on assembly truck.

Assembly truck	5870 350 000
Supporting bracket (2EA)	5870 350 106



7409AAX101

- The following illustration shows the removal of the differential in the course of a complete disassembly of the axle.
 To remove the differential, however, it is possible to separate the axle half assy (axle housing with output) from the axle drive housing.
- Secure axle by means of a support (arrow), risk of accident.
- ② Take up axle housing half on crown wheel side with lifting chain (see AX103) and loosen bolted connection (axle housing /axle drive housing).

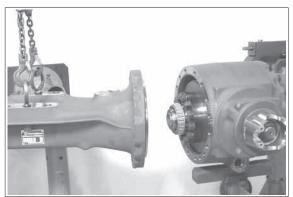
Lifting chain	5870 281 047
Eyebolts	5870 204 071



7409AAX102

- ③ Separate axle housing from axle drive housing.
- * Pay attention to releasing axial roller ring and differential.
- Pay attention to releasing stub shaft and sun gear shaft with inserted shim (sun gear shaft clearance).

Mark allocation of shim versus sun gear shaft /stub shaft and output side, assembly aid.



7409AAX103

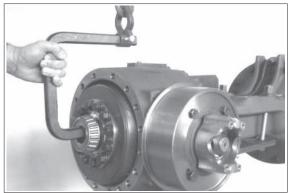
Conventional differential (STD)

- * Description of disassembly and reassembly of the limited slip differential from page 3-94.
- ① Lift differential assy out of axle drive housing.

Lifting bracket 5870 281 033

2 Pull both taper roller bearings off the differential carrier.

Grab sleeve	5873 002 035
Basic tool	5873 002 001
Pressure piece	5873 100 047

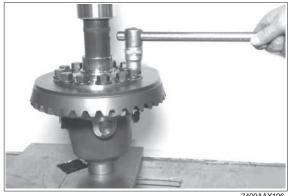


7409AAX104



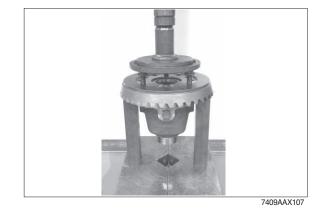
7409AAX105

- ③ Hold differential by means of a press. Loosen locking screws and remove lid.
- * Locking screws permitted for one time use only.

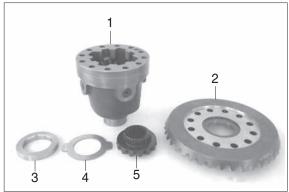


7409AAX106

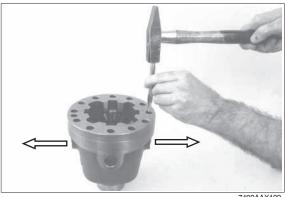
④ Insert some locking screws, position pressure plate and press differential carrier off the crown wheel.



- (5) Remove axle bevel gear, thrust washer and constant spacer.
 - 1 Differential carrier
 - 2 Crown wheel
 - 3 Constant spacer
 - 4 Thrust washer
 - 5 Axle bevel gear
- 6 Force slotted pin (fixing) out of both spider shaft halves (split version), then remove both spider shaft halves in arrow direction and take components (see AX110) out of differential carrier.



7409AAX108

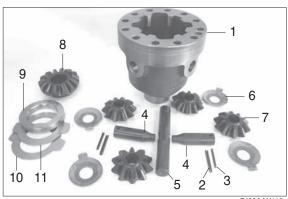


7409AAX109

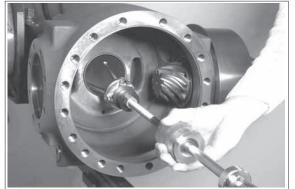
- 1 Differential carrier
- 2 Slotted pin (2EA)
- 3 Slotted pin (2EA)
- 4 Spider shaft (split version)
- 5 Spider shaft (one piece)
- 6 Spider gear (4EA)
- 7 Thrust washer (4EA)
- 8 Axle bevel gear
- 9 Constant spacer
- 10 Outer disc
- 11 Thrust washer
- ⑦ Pull bearing outer ring out of hole by means of the striker and remove shim behind (backlash).
- Mark shim (position /bearing allocation) assembly aid.

Striker

5870 650 004



7409AAX110



7409AAX111

8 Remove O-ring (arrow).

Remove bearing outer ring and shim behind (rolling torque differential bearing) from axle housing.

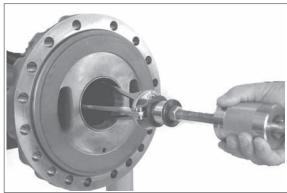
Mark shim (position/bearing allocation), assembly aid.

Striker

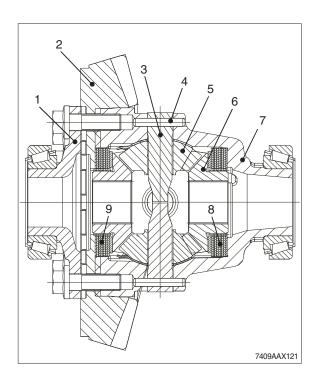
5870 650 004

Limited slip differential (option)

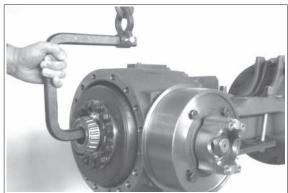
- 1 Housing cover
- 2 Crown wheel
- 3 Spider shaft (split version) (2EA)
- 4 Double slotted pins
 - $(5 \times 50 \text{ and } 8 \times 50 \text{ mm})$
- 5 Spider gear
- 6 Axle bevel gear
- 7 Differential carrier
- 8 Disk package "A"
- 9 Disk package "B"



7409AAX112



① Use the lifting device to lift the differential out of the axle drive housing.



② Pull the tapered roller bearing from the housing cover /differential carrier.

5873 002 035

5873 002 001

5873 100 047

Grab sleeve

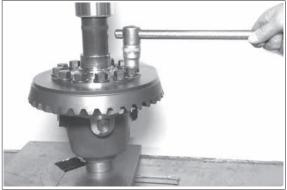
Pressure piece

Basic tool

	1	
	Con-St	
	Garle	

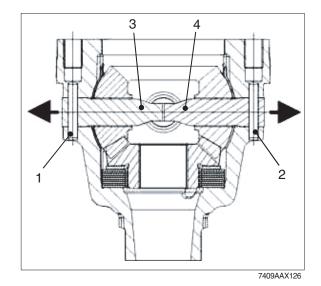
7409AAX123

③ Use the press to fix the differential ; loosen the locking screws and remove the cover.



7409AAX124

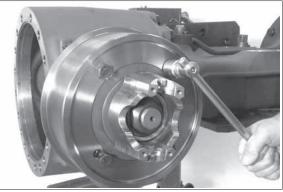
- Mount some locking screws, position the pressure plate and press the differential carrier from the crown wheel.
 Remove the releasing disk package, thrust washer and axle bevel gear.
- ۲409AAX125
- (5) Force the double slotted pins out (position 1 and 2) and pull the spider shafts (position 3 and 4) in direction of arrow out of the holes. Then remove the remaining single parts.



Input

For axle version with pivot bearing only (see AX128)

 Loosen bolted connection and pull off bearing flange.

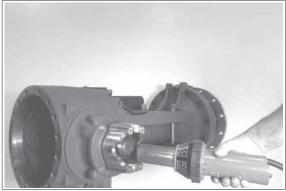


7409AAX128

② Heat up hex nut (loctite locking compound) by means of hot air blower disassembly aid.

 Hot air blower 230 V
 5870 221500

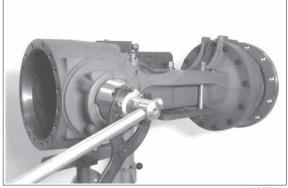
 Hot air blower 115 V
 5870 221501



7409AAX129

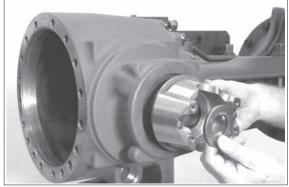
- ③ Fix input flange by means of a clamping fork, loosen hex nut.
- A Secure axle by means of a support, risk of accident.

Clamping fork 5870 240 025



7409AAX130

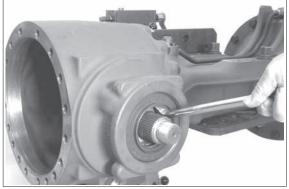
④ Remove disc and pull off flange.
 Remove screen sheet from output flange, if required.



5 Lift shaft seal off.

Pry bar

5870 345 071

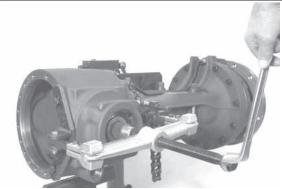


7409AAX132

⁽⁶⁾ Press input pinion out by means of press off tool and remove releasing bearing inner ring.

Press-off tool

5870 280 044



7409AAX133

0 Remove spacer ring from pinion.



7409AAX134

8 Pull bearing inner ring off the pinion.

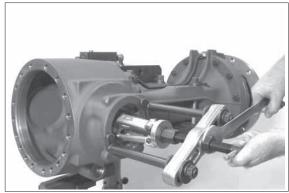
Grab sleeve	5873 012 013
Basic tool	5873 002 001



9 Pull-off outside bearing outer ring.

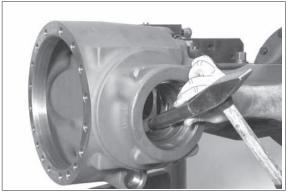
Internal extractor
Counter support

5870 300 019 5870 300 020



7409AAX136

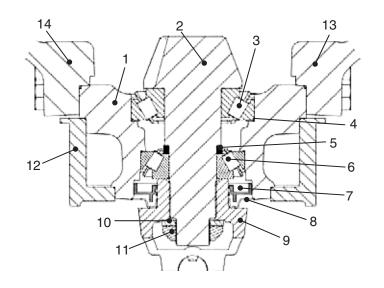
- ID Force bearing outer ring out of inner bearing hole, pay attention to shim behind (contact pattern/bevel gear set).
- Mark shim (thickness/position and bearing allocation), assembly aid.



7409AAX137

2) ASSEMBLY

(1) Input assembly



7409AA201

- 1 Axle drive housing
- 2 Input pinion
- 3 Tapered roller bearing
- 4 Shim for contact pattern (bevel gear set)
- 5 Spacer ring (bearing roller torque/ pinion bearing)
- 6 Tapered roller bearing
- 7 Shaft seal

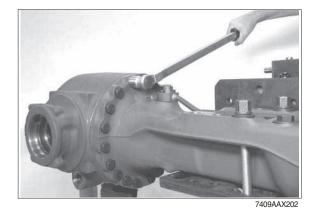
- 8 Protection plate
- 9 Input flange
- 10 Disc
- 11 Hexagon nut
- 12 Bearing flange (only for axle version with pivot bearing)
- 13 Axle housing/ part I
- 14 Axle housing/ part II (crown-wheel side)
- Depending on the version, crown wheel and bevel pinion may be mounted as a bevel gear set (for production reasons, crown wheel and pinion are paired and show an identical pairing number see AX204) or as single parts, the respective version has to be taken from the specification of the corresponding spare parts list.

If a bevel gear set is specified, the crown wheel must only be replaced together with the pinion.

Only for assembly of new parts or if disassembled :

Mount O-ring on axle housing /part I and install axle drive housing, pay attention to radial installation position.

 \cdot Tightening torque (M18 \times 1.5/10.9) : 39.8 kgf \cdot m (288 lbf \cdot ft)



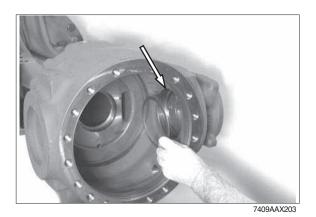
Determine shim for pinion position required to obtain an optimum contact pattern on the bevel gear set (crown wheel /pinion):

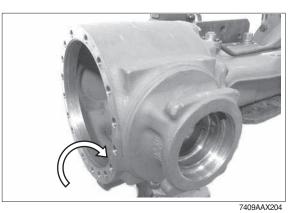
- We recommend to reinstall the shim found during disassembly (e.g. "S" = 1.20 mm, see disassembly instructions, AX137) into the inner bearing hole / pinion bearing.
- * The contact pattern required on the bevel gear set, however, is decisive. If this is not achieved, see contact pattern check on figure AX237, correct the pinion position with a corresponding shim.
- * As an alternative, a basic setting of the required pinion position can be made, e.g. when assembling a new part, as shown below (see AX204~AX206).

Basic setting of pinion position :

 Read dimension "I" = production dimension /axle drive housing (from axle center to bearing contact /inner bearing hole) from the axle drive housing (position, see arrow).

Dimension I e.g. 182.81 mm





2 Read pinion dimension "X" (pinion basic dimension e.g. = 148) from pinion, or determine it in case of a + or - deviation from pinion dimension due to production (value concerned is marked by hand on the pinion, e.g.+ 0.1).

Pinion dimension "X" (without + or deviation value) = 148.0 mm Pinion dimension "X" with indication of + 0.1 deviation = 148.1 mm Pinion dimension "X" with indication of -0.1 deviation = 147.9 mm

Dimension II (pinion dimension X) e.g. 148.00 mm

- * Pairing number e.g. 7 only for version with bevel gear set, see note AX201.
- 3 Determine dimension "III" bearing width, ensure here that the rollers are located without any play (rotate bearing inner ring in both directions several times, roller setting).

Since the installed roller bearing is subject to a pre-load in installation position, deduct an experience value of -0.05 mm.

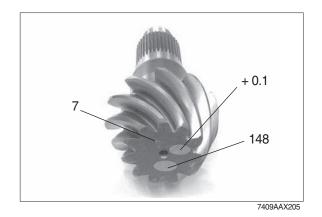
Dimension III = e.g. 33.67 mm - 0.05 mm \rightarrow 33.62 mm

CALCULATION EXAMPLE :

Dimension I	182.81 mm	
Dimension II + III (148.00 + 33.62)		
	-181.62 mm	
Result	= 1.19 mm	
Required shim "S"	\rightarrow 1.20 mm	

Insert determined shim into the hole of the axle drive housing, see AX203.

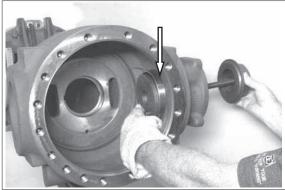
Digital depth gauge	5870 200 072
Gauge blocks	5870 200 066





④ Undercool bearing outer ring (see arrow) and bring it into contact position in the inner bearing hole /pinion bearing by means of the fixture.

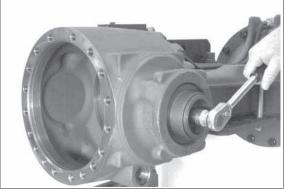
Assembly fixture 5870 345 049



7409AAX207

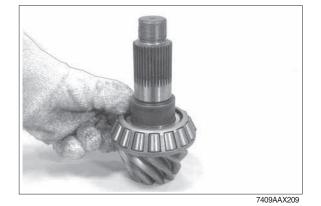
(5) Install outside bearing outer ring /pinion bearing.

Assembly fixture 5870 345 049



7409AAX208

⁽⁶⁾ Mount heated bearing inner ring until contact position and adjust after cooling down.

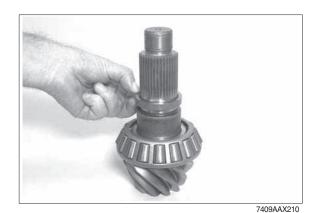


Set rolling torque of input pinion bearing $0.11 \sim 0.23 \text{ kgf} \cdot \text{m} (0.81 \sim 1.70 \text{ lbf} \cdot \text{ft})$ (without shaft seal) :

- \bigcirc Mount spacer ring (s = optional).
- We recommend to reinstall the spacer ring found during disassembly (e.g. s = 8.7 mm).

If the originally installed shim was replaced (contact pattern /bevel gear set), see figure AX203, also install a spacer ring adjusted by the same correction value.

- * The required bearing rolling torque of 0.11~0.23 kgf · m (0.81~1.70 lbf · ft) (without shaft seal), however, is decisive, in case it is not achieved, see bearing rolling torque check (see AX213), correct the bearing rolling torque with a corresponding shim.
- (8) Insert preassembled input pinion, mount heated bearing inner ring until contact is obtained.



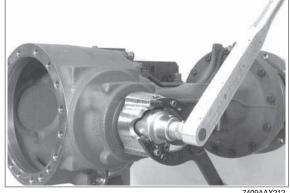
 Υθολετι

- (9) Mount flange, fix with disc and hex. nut.
- While tightening, rotate pinion in both directions several times (roller setting).

 \cdot Tightening torque (M36 \times 1.5) : 71.4 kgf \cdot m (516 lbf \cdot ft)

Clamping fork

5870 240 025



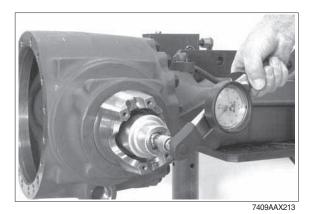
- Check rolling torque of the pinion bearing.
 Bearing rolling torque (without shaft seal) : 0.11~0.23 kgf · m (0.81~1.70 lbf · ft).
 Try to achieve upper value.
- In case of a deviation from the required rolling torque correct it with a corresponding spacer ring (see AX210)

 Torque wrench
 5870 203 031

 Reducing adapter ¼" to ½"
 5870 656 056

 Reducing adapter ½" to ¾"
 5870 656 057

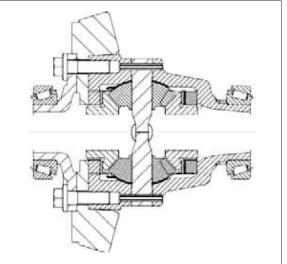
For assembly of shaft seal stick to description in page 3-115 (after completed differential assembly and positive contact pattern check).



(2) Differential assembly

Conventinaol differential (STD)

- ① Illustration in figure AX214 shows conventional differential.
- * Description of the reassembly of the limited slip differential from page 3-112.

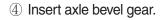


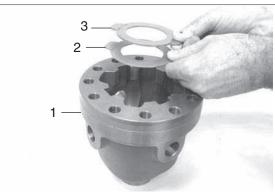
7409AAX214

② Insert constant spacer into differential carrier.



- ③ Insert steel outer disc (2) and thrust washer (3) into the differential carrier (1)
- * Pay attention to installation position of outer disc and thrust washer see position/figure.



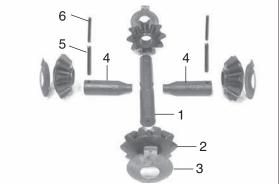


7409AAX216



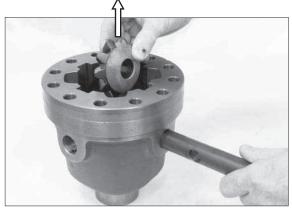
7409AAX217

- (5) Differential spider single parts :
 - 1 Spider shaft (one part)
 - 2 Spider gear (4EA)
 - 3 Thrust washer (4EA)
 - 4 Spider shaft (split version)
 - 5 Slotted pin (2EA)
 - 6 Slotted pin (2EA)



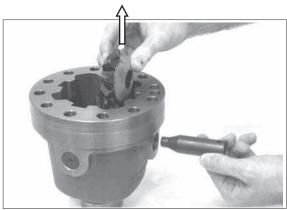
7409AAX218

- ⑥ Insert one part spider shaft (1) into hole / differential (without slotted pin location hole) thereby mounting two spider gears (2) with thrust washers (3).
- Insert thrust washers with tabs showing upwards (see arrow) and being located in recess.

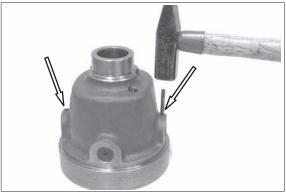


7409AAX219

- ⑦ Install split spider shaft (4) with spider gears (2) and thrust washers (3).
- * Insert thrust washers with tabs showing upwards (see arrow) and being located in recess.
- * Pay attention to installation position of spider shaft/ halves-slotted pin/location holes of spider shaft towards differential carrier.
- 8 Fix spider shaft half (arrows) with double slotted pins.
- Install double slotted pins, always with slots in a 180° offset position to each other.



7409AAX220



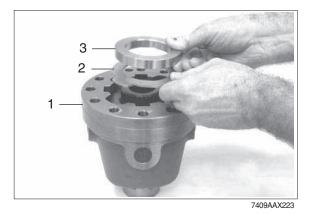
7409AAX221

Insert second axle bevel gear into differential carrier.



7409AAX222

- Insert thrust washer (2) and constant spacer (3) into differential carrier (1).
- * Pay attention to installation position of thrust washer and constant spacer, see position /figure.



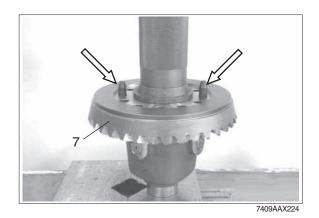
 Install two adjusting screws (M16) (see arrows) and press crown wheel to contact position.

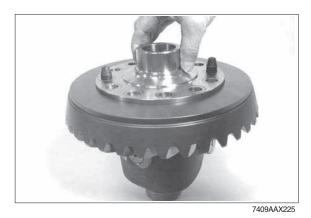
For input version with bevel gear set only, see specification in the corresponding spare parts list :

If a bevel gear set is specified, the pairing number/crown wheel (e.g. "7") must be identical with pairing number/ input pinion (also refer to note on page 3-101, AX205).

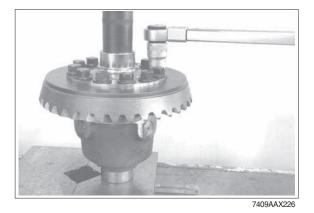
Adjusting screws (M16×1.5) 5870 204 040

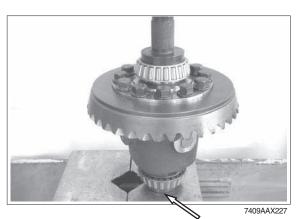
12 Mount housing lid.





- ⁽³⁾ Fix differential by means of a press and fix lid with new locking screws.
- * Locking screws permitted for one time use only.
 - \cdot Tightening torque (M16 \times 1.5/12.9) : 42.8 kgf \cdot m (302 lbf \cdot ft)
- Press both bearing inner rings to contact position.
- * Use suitable support (arrow) for provisionally mounted bearing ring, roller bearing cage, risk of damage.





Determine shims for bearing rolling torque /differential bearing and backlash /bevel gear set

Is Read crown wheel labeling (test dimension) from crown wheel rear side.

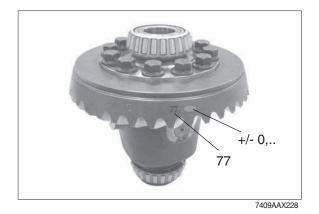
Determine required shims by means of the read value (crown wheel) and the relating specifications of the following table :

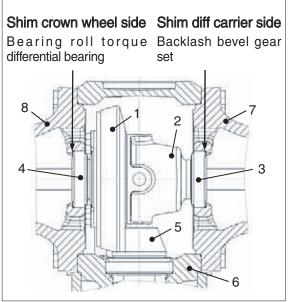
Test dimension, e.g. "77" mm is stamped on the crownwheel rear side, without + or - deviation, which corresponds to the real value/test dimension "77" in the following table. The required shims according to this real value /test dimension are allocated in the following table.

(6) Any + or - deviation from the test dimension due to production is manually applied on the crown wheel rear side (e.g. - 20 or - 10 or 10).

The required shims according to this real value /test dimension are allocated in the following table.

- 1 Crown wheel
- 2 Differential carrier
- 3 Tapered roller bearing (crown wheel side)
- 4 Tapered roller bearing (differential carrier side)
- 5 Input pinion
- 6 Axle drive housing
- 7 Axle housing
- 8 Axle housing





Shims for differential				
Crown wheel marking	- 20	- 10	-	10
Deviation	- 0.2	- 0.1	0	0.1
Shim / Differential cage side Shim thickness	0.8	0.9	1.0	1.1
Shim	ZGAQ-02566	ZGAQ-02567	ZGAQ-02568	ZGAQ-02569
Shim / Crown wheel side Shim thickness	1.2	1.1	1.0	0.9
Shim Conventional, Limited slip	ZGAQ-02570	ZGAQ-02569	ZGAQ-02568	ZGAQ-02567

- Insert determined shim (e.g. s = 1.00 mm) and bearing outer ring into hole of axle housing on crown wheel side.
- * Observe allocation of shim regarding installation position.

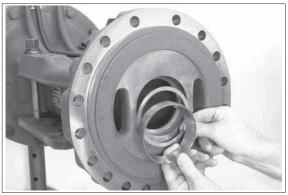
Driver tool	5870 058 021
Handle	5870 260 002

- Insert determined shim (e.g. s = 1.00 mm) and bearing outer ring into hole of axle housing on differential carrier side.
- * Observe allocation of shim regarding installation position.

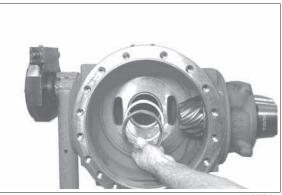
Driver tool	5870 058 021
Handle	5870 260 002

Contact pattern check of bevel gear set :

Over some tooth flanks of crown wheel with marking ink (contact pattern check).



7409AAX230



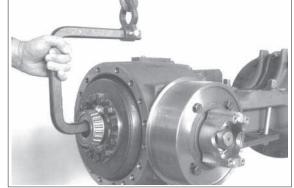
7409AAX231



② Insert preassembled differential.

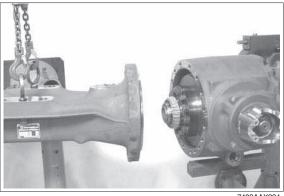
Lifting bracket

5870 281 033



② Position axle housing of crown wheel side (without O-ring) on axle drive housing, pay attention to radial installation position.

Lifting chain	5870 281 047
Eyebolts	5870 204 071



7409AAX234

- Bring axle housing to contact position with hexagon screw and fix temporarily.
 Rotate differential several times in both directions, roller setting (also see AX236).
 - Tightening torque (M18/10.9) : 39.8 kgf · m (288 lbf · ft)

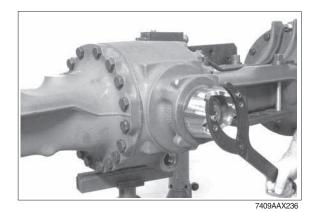


7409AAX235

② Roll input pinion over crown wheel in both directions (coast-drive flank meshing-contact pattern).

Clamping fork

5870 240 025



- Disassemble differential.
 Compare contact pattern.
- ** If contact pattern differs considerably, use a suitable shim for correction (see AX203, page 3-224).



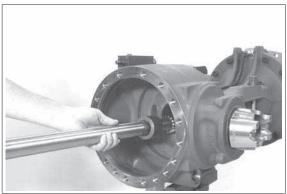
3 If disassembled :

Insert shim(s) (2) into sun gear shaft (1) and mount stub shaft (3).

- If position was not allocated, as specified in disassembly instructions on AX103, sun gear shaft clearance (see AX330~AX334) must be set on both output sides.
- Insert preassembled stub shafts into both outputs (considering allocation to the correct output side).



7409AAX238

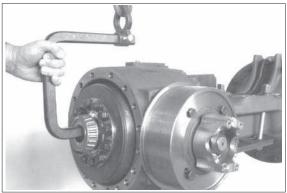


7409AAX239

Remount differential by mounting stub shaft into gearing of axle bevel gear (differential).

Lifting bracket

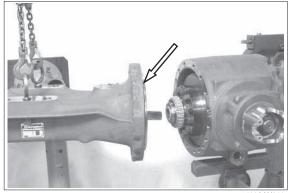
5870 281 033



7409AAX240

- Oil O-ring (arrow) and mount it. Position complete axle half on the axle drive housing by mounting the stub shaft into the gearing of the axle bevel gear (differential).
- ※ Pay attention to radial installation position of output towards axle drive housing.

Lifting chain	5870 281 047
Eyebolts	5870 204 071



7409AAX241

② Fix axle housing finally by means of hexagon screws.

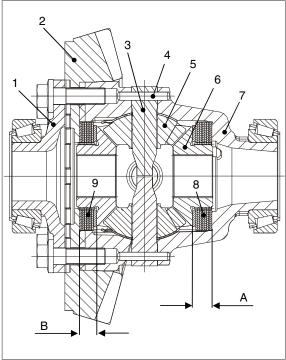
Rotate differential several times in both directions roller setting.

 Tightening torque (M18/10.9) : 39.8 kgf · m (288 lbf · ft)



(3) Limited slip differential (OPT) assembly

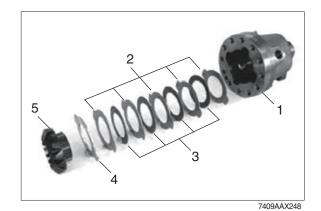
- 1 Housing cover
- 2 Crown wheel
- 3 Spider shaft (split version) (2EA)
- 4 Double slotted pins
 - (5 \times 50 and 8 \times 50 mm)
- 5 Spider gear
- 6 Axle bevel gear
- 7 Differential carrier
- 8 Disk package "A"
- 9 Disk package "B"
- A Installation dimension = 18.6 0.2 mm
- B Installation dimension = 16.7 0.2mm



7409AAX247

- ① Mount the single parts as indicated on the figure right.
 - 1 Differential carrier
 - 2 5 outer disks (optional)
 - 3 4 inner disks
 - 4 Thrust washer (brass)
 - 5 Axle bevel gear
- Determine the installation dimension "A"= 18.6 - 0.2mm with the different outer disks (s =1.8~2.0 mm), see also AX247. Pay attention to the disk arrangement, AX248.

Oil the single parts.

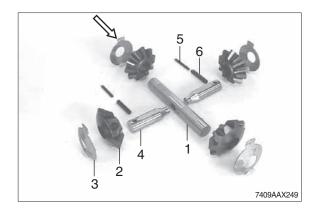


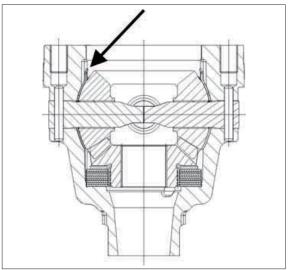
② Mount the single parts, see AX249 and AX250.

Single parts differential spider :

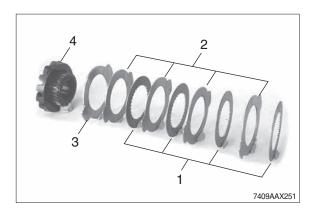
- 1 Spider shaft (one piece)
- 2 Spider gear (4EA)
- 3 Thrust washer (4EA)
- 4 Spider shaft (two pieces)
- 5 Slotted pins (2 pieces, 5×50 mm)
- 6 Slotted pins (2 pieces, 8×50 mm)
- ③ Pay attention to the radial installation position of the thrust washers (3). The torsional stop must show upwards, see arrow /AX250.

The two spider shafts (4) are fixed by means of double slotted pins (5 and 6). Thereby mount the slots of the slotted pins 180° offset to each other.

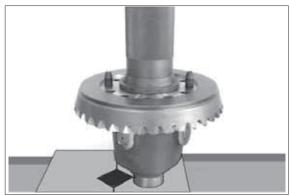




- ④ Mount the single parts as indicated on the figure right.
 - 1 4 inner disks
 - 2 4 outer disks (optional)
 - 3 Thrust washer (brass)
 - 4 Axle bevel gear
- Determine the installation dimension ("B" = 16.7 - 0.2 mm) with the different outer disks =1.8~2.0 mm), see also AX247.
 Pay attention to the disk arrangement, see AX251.
 Oil the single parts.



(5) Mount two adjusting screws and press the crown wheel until contact is obtained.



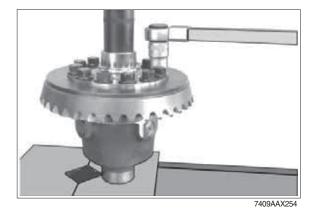
7409AAX252

6 Mount the housing cover.

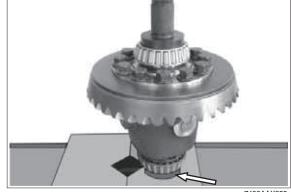


7409AAX253

- ⑦ Bolt housing cover, crown wheel and differential housing.
 - \cdot Tightening torque (M16 \times 1.5/12.9) : 42.8 kgf \cdot m (302 lbf \cdot ft)
- It is only permitted to use new locking screws.



- ⑧ Press both bearing inner rings until contact position is obtained.
- Support the lower tapered roller bearing appropriately (arrow), pay attention that the roller cage is not damaged.



(4) Shaft seal /input flange assembly

① Remove flange.

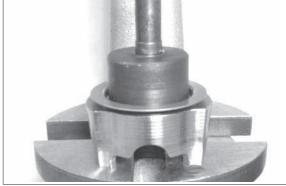
Clamping fork

5870 240 025



7409AAX289

- ② For new parts assembly only : Mount protection plate on screen sheet on input flange and bring to contact position.
- * Pay attention to installation position of screen sheet also see AX292.



7409AAX290

 ③ Insert shaft seal (1), considering the required installation position (dimension "X") see detailed AX292.

Contact face (outer diameter) of shaft seal :

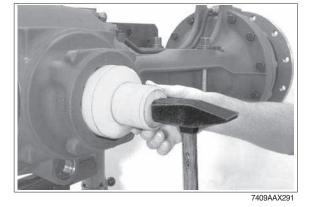
- if rubber - coated :

wet with spirit (assembly aid)

- if made of metal :

apply sealing agent (loctite no. 574) Grease the shaft seal around the sealing and dust lip.

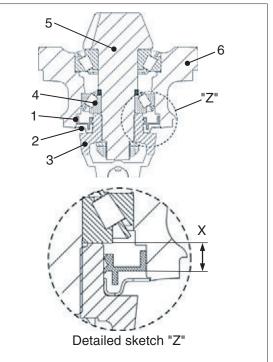
Ensure plane installation position of shaft seal use the specified driver tool to obtain an exact installation position of the shaft seal.



Driver tool

5870 048 225

- 1 Shaft seal
- 2 Protection plate
- 3 Input flange
- 4 Tapered roller bearing
- 5 Input pinion
- 6 Axle drive housing
- X = Install. dimension 16.6 \pm 0.2 mm



7409AAX292

④ Mount flange, fix with washer and hexagon nut.

During tightening, rotate pinion several times in both directions (roller setting).

* Install hexagon nut with locking compound (loctite #262).

 \cdot Tightening torque (M36 \times 1.5) : 71.4 kgf \cdot m (516 lbf \cdot ft)

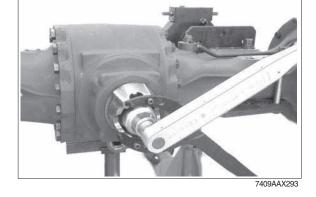
Clamping fork 5870 240 025

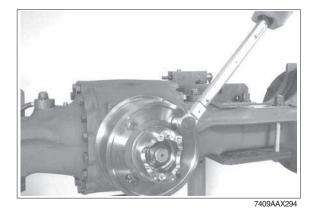


For version with pivot bearing only (AX294):

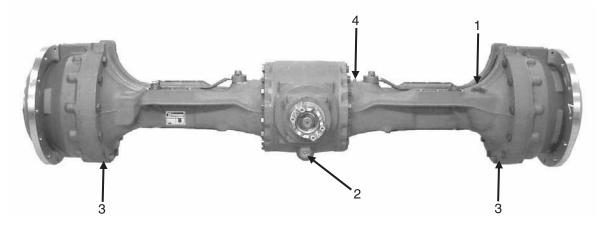
Mount bearing flange and fix with hexagon screws.

 \cdot Tightening torque (M14/10.9) : 18.7 kgf \cdot m (136 lbf \cdot ft)





(6) Oil dipstick, drain plugs and breather valve assembly



7409AAX295

- 1 Oil dipstick
- 2 Drain plug /axle drive housing(Axle version with pivot bearing is fitted with another drain plug)
- 3 Drain plug/output
- 4 Depending on version Breather valve or screw plug

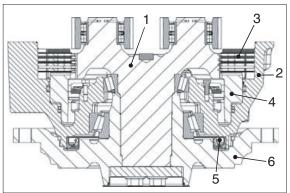
Provide oil dipstick and drain plugs with new O-ring and install them. Mount breather valve or screw plug, depending on version.

 $\begin{array}{l} \cdot \text{ Tightening torque} \\ \text{Oil dipstick } (\text{M36} \times 1.5): 5.1 \text{ kgf} \cdot \text{m} (36.9 \text{ lbf} \cdot \text{ft}) \\ \text{Drain plug } (\text{M36} \times 1.5): 5.1 \text{ kgf} \cdot \text{m} (36.9 \text{ lbf} \cdot \text{ft}) \\ \text{Drain plug } (\text{M24} \times 1.5): 5.1 \text{ kgf} \cdot \text{m} (36.9 \text{ lbf} \cdot \text{ft}) \\ \text{Breather valve /screw plug } (\text{M10} \times 1): 0.6 \text{ kgf} \cdot \text{m} (4.4 \text{ lbf} \cdot \text{ft}) \\ \end{array}$

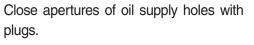
(7) Output and brake assembly

- 1 Planetary carrier
- 2 Brake housing
- 3 Disc package
- 4 Piston
- 5 Combi seal ring
- 6 Output shaft

Assembly truck	5870 350 000
Fixture	5870 350 112



7409AAX301



Hand tool	5870 320 014
Ratchet wrench	5870 320 018



7409AAX302

Installation combi seal ring

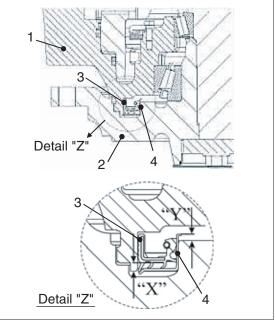
- Mount shaft seal (part I /combi seal ring) considering installation dimension "X", see detailed sketch AX304.
- Wet contact faces of shaft seal /brake housing with spirit right before assembly, assembly aid.
- % Grease shaft seal around the dust and sealing lips.
- * Observe plane installation position of shaft seal, use the specified driver to ensure an exact shaft seal installation position.



Driver tool 58

5870 051 065

- 1 Brake housing
- 2 Output shaft
- 4 Wear sleeve (part II) ⊥ seal ring
- "X" = installation dimension /shaft seal 4.1 + 0.2 mm
- "Y" = installation dimension /wear sleeve 2.6 + 0.2 mm

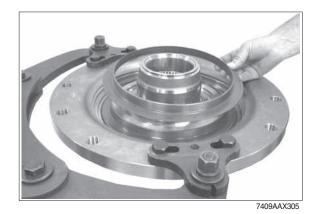


7409AAX304

② Apply sealing agent (loctite #574) on contact faces of wear sleeve /output shaft and mount wear sleeve (part I / combi seal ring) considering installation dimension "Y" see detailed AX304.

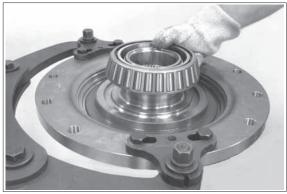
Pressing device

5870 506 172



Output shaft /brake housing

- ① Mount heated bearing inner ring until contact.
- * Adjust bearing inner ring after cooling down.



7409AAX306

② Press outside bearing outer ring into brake housing until contact.

Driver tool 5870 050 010



7409AAX307

③ Press inside bearing outer ring into brake housing until contact.

Driver tool

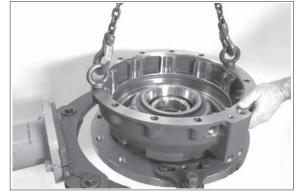
5870 050 003



7409AAX308

④ Position preassembled brake housing on the output shaft.

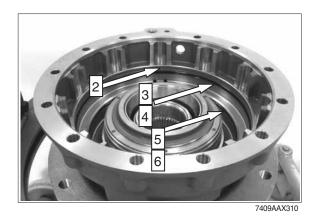
Lifting chain	5870 281 047
Eyebolts	5870 204 071



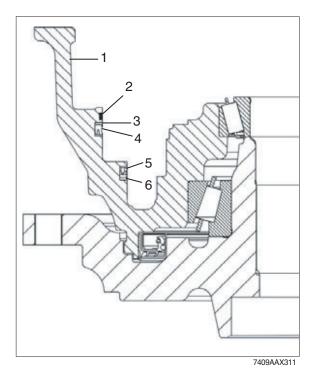
- (5) Insert sealing elements (arrows) into annular grooves of brake housing paying attention to installation position and arrangement, in this context refer to AX311.
- * Guide ring installation :

Clean annular groove of brake housing with spirit. Then insert guide ring into annular groove - Ensure an exact contact position of the whole guide ring circumference - afterwards stick guide ring with glue (loctite #415) on its endpoints.

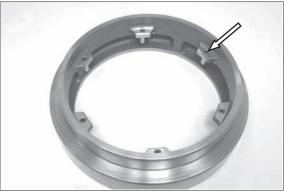
Ensure a correct installation position of the guide ring - Endpoints of guide ring to be in 12 o'clock position in the axle installed in the vehicle (radial position in brake housing - area of brake oil supply and vent hole).



- 1 Brake housing
- 2 Guide ring
- 3 Support ring
- 4 Grooved ring
- 5 Grooved ring
- 6 Support ring



⑥ Flush-mount slotted pins (for installation position refer to arrow) into the piston, if not disassembled, adjust adequately (flushfitting).



7409AAX312

⑦ Oil sealing/sliding surface of piston and sealing elements.

Carefully bring piston in contact position.



7409AAX313

- ⑧ Insert disc, cup spring and lid considering the installation position, see detail sketch.
 - 1 Disc
 - 2 Cup spring
 - 3 Lid
 - 4 Hexagon screw
 - 5 Brake housing
 - 6 Piston
 - 7 Slotted pin



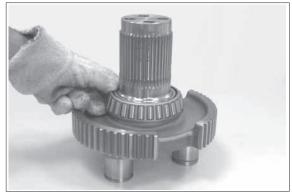
7409AAX314

- 9 Fix lid with hexagon screws evenly until contact is obtained (cup spring pre load).
 Finally tighten hexagon screws.
 - \cdot Tightening torque (M8/10.9) : 3.47 kgf \cdot m (25 lbf \cdot ft)



3-122

- 10 Mount heated bearing inner ring until contact.
- * Adjust bearing inner ring after cooling down.

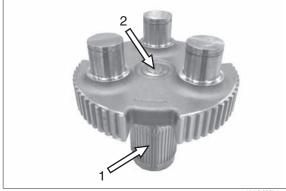


7409AAX316

 Apply anti-corrosive agent on spline (arrow 1).

Only for assembly of a new planetary carrier or if disassembled :

Insert shim (arrow 2) into planetary carrier until contact.



7409AAX317

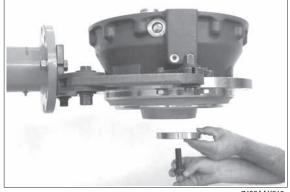
12 Insert pre assembled planetary carrier.

Lifting chain	5870 281 047
Lifting device	5870 281 082



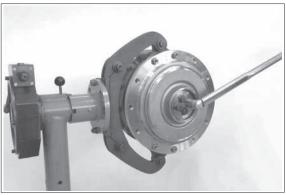
7409AAX318

- ⁽³⁾ Fix planetary carrier with disc and new locking screws.
- * Do not reuse locking screws, just one time installation is permitted.



- Evenly tighten locking screws crosswise while rotating the brake housing in both directions several times (roller setting).
 - \cdot Tightening torque (M8/12.9) :
 - 51.0 kgf · m (369 lbf · ft)

(5) Apply a screw safety marking paint on correctly installed locking screws.







7409AAX321



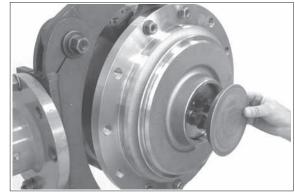
(6) Mount O-ring (arrow) on lid.

409AAX322

Insert pre-assembled lid into output shaft.

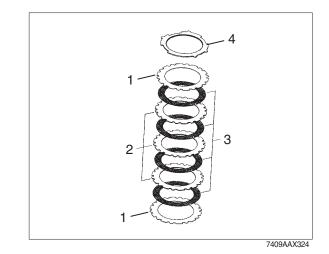
Plastic hammer

5870 280 004



Brake

- * Possible other versions could have a deviating equipment (number and arrangement of single discs), the illustration in the relating spare parts list forms the basis for the required equipment.
 - 1 Outer disc s = 2.0 mm
 - 2 Outer disc s = 4.0 mm
 - 3 Inner disc (lined disc)
 - 4 End plate
- Insert disc package, considering disc arrangement and installation position of outer discs, see AX324.



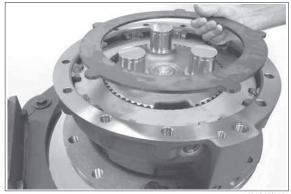


7409AAX325

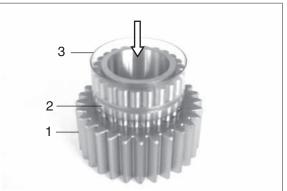
- ② Insert end plate (item 4, see AX324) fix by means of grease assembly aid.
- Ensure radial installation position driving tabs of end plate must be positioned in recessed grooves of the brake housing.

Locating screw 5870 204 078

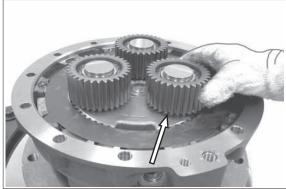
- Make leakage test on brake hydraulics see page 3-130.
- ③ Only for assembly of new parts : Install cylindrical roller bearing into planetary gear by pressing roller bearing into planetary gear by means of assembly sleeve (arrow) until snap ring engages into annular groove of planetary gear.
 - 1 Planetary gear
 - 2 Roller bearing (with bearing inner ring /cylindical rollers /axial discs and snap ring)
 - 3 Assembly sleeve



7409AAX326



- ④ Heat up planetary gears and mount to the pin of the planetary carrier until contact is obtained, with the large radius /bearing inner ring showing downwards (arrow).
- * Adjust bearing after cooling down.



7409AAX328

- 5 Fix planetary gears with retaining ring.
- % Check contact position of retaining ring on groove base and readjust, if required.

Set of external pliers 5870 900 015

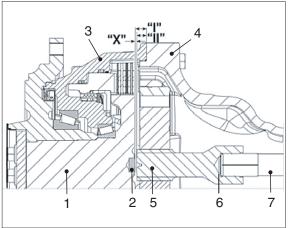


7409AAX329

Axial play setting of sun gear shaft :

- 1 Planetary carrier
- 2 Stop pin
- 3 Brake housing
- 4 Axle housing
- 5 Sun gear shaft
- 6 Shim (s = optional)
- 7 Stub shaft

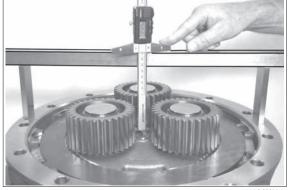
"X" = axial play - sun gear shaft 0.5~2.0 mm



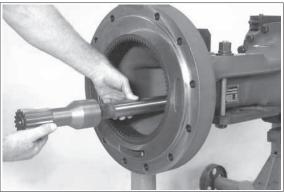
7409AAX330

 Determine dimension "I" from mounting face (brake housing/axle housing) to stop pin.

Dimension I e.g	21.25 mm
Digital-depth gauge	5870 200 072
Gauge blocks	5870 200 066
Straightedge	5870 200 022



② Mount stub shaft with fitted sun gear shaft (without shim) into differential /axle bevel gear until contact.



7409AAX332

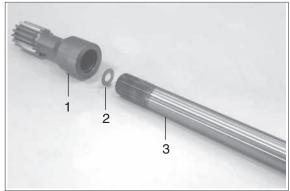
③ Determine dimension "II" from mounting face (brake housing /axle housing) to front face /sun gear shaft.

Dimension II e.g 19.00 r	nm
CALCULATION EXAMPLE:	
Dimension I 21.25 r	nm
Dimension II 19.00 r	nm
Difference 2.25 r	nm
Required axial play e.g. (average)	
- 1.25 ו	nm
$\frac{\text{Result} = \text{shim required e.g.}}{s = 1.00 \text{ r}}$	nm

7409AAX333

④ Pull stub shaft with sun gear shaft out of axle housing.

Insert determined shim(s) (2) into sun gear shaft (1) and mount stub shaft (3).



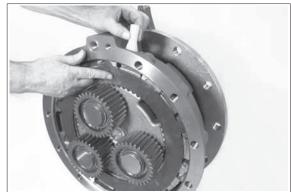
7409AAX334

Assemble output assy

 Fix disc package by means of locating screw, assembly aid.

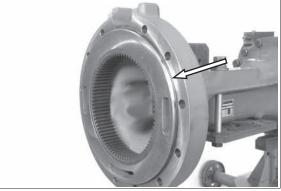
Locating screw

5870 204 078



7409AAX335

② Oil O-ring and mount on collar of axle housing.

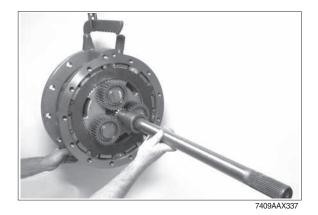


7409AAX336

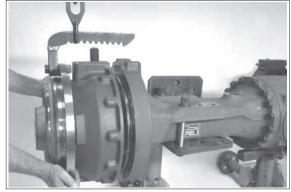
③ Take up output by means of lifting bracket.

Mount pre-assembled sun gear /stub shaft into teeth of planetary gears.

Lifting bracket 5870 281 043



- ④ Bring output assy into contact position with axle housing by mounting the stub shaft into the gearing of the axle bevel gear /differential.
- % Pay attention to end plate see AX326, page 3-125.



(5) Connect output with axle housing evenly by means of hex. screws.

 \cdot Tightening torque (M18 \times 1.5/10.9) : 39.8 kgf \cdot m (288 lbf \cdot ft)



7409AAX339

6 Install screw plug (1) with new O-ring.

· Tightening torque (M24 \times 1.5) :

5.1 kgf \cdot m (36.9 lbf \cdot ft)

Mount breather valve (2).

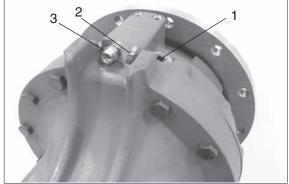
· Tightening torque :

0.6 kgf · m (4.4 lbf · ft)

Install screw neck (3) with new O-ring.

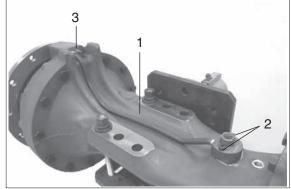
· Tightening torque :

3.7 kgf \cdot m (26.6 lbf \cdot ft)



7409AAX340

⑦ Install brake tube (1).



Make leakage test on brake hydraulics

% Prior to starting the test, completely breathe brake hydraulics.

High pressure test :

Build up testing pressure p = 100 - 10bar maximum and close connection to HP pump by means of a shutoff valve A pressure drop by maximum 3% (3 bar) is permissible during a 5 minute test duration.

Low pressure test :

Reduce testing pressure to p = 5 bar and close shut off valve again.

No pressure drop is permitted during a 5-minute test duration.

Test medium : SAE 15W-40

 HP-pump
 5870 287 007

 Straight screw-in connection
 0637 842 518

 Measuring fitting (M18×1.5)
 5870 950 139

 Oil collector bottle
 5870 286 072



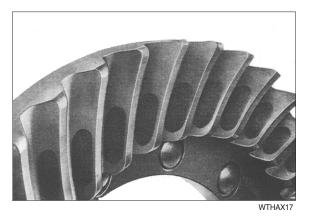
7409AAX342

*** BACKLASH CHECK**

- Applied the paint (or red lead) on the surface of several bevel gear teeth.
- Turn the pinioin gear and check the contact pattern.

Correct pattern



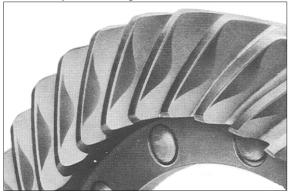


Concave side

Convex side

*** ADJUSTMENT**

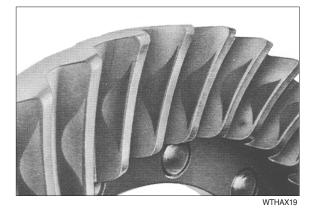
Incorrect pattern : high contact



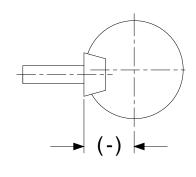
WTHAX18

Concave side

- Reduce the distance (-)

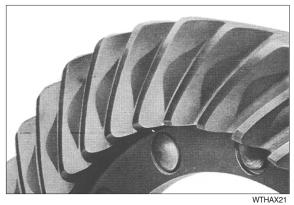




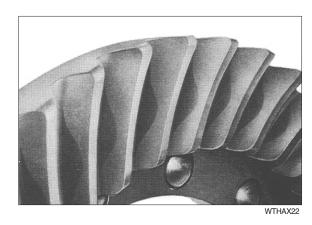


WTHAX20

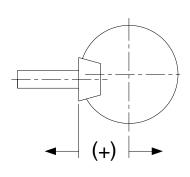
Incorrect pattern, low contact



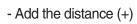
Concave side



Convex side



WTHAX23



2. TRANSMISSION

Preparatory Activities

Mounting transmission on assembly truck

Special tools:

- 5870.350.090 Connection plate
- 5870.350.063 Clamping plate
- 5870.350.000 Assembly truck

<u>A</u> CAUTION

Risk of injury due to uncontrolled motion of the load.

Death or serious injury possible.

- ⇒ Only use the suspension points intended for transportation purposes.
- Only use secure, permitted, and tested means of transport, chain hoist, and lifting equipment with sufficient load capacity and suitable lifting technology.
- Ensure that lifting equipment such as ropes and belts are not in contact with sharp edges and are not knotted or twisted.
- ⇒ Properly attach lifting appliances to load.
- ⇒ Observe the load's center of gravity! The crane hook must be located above the load's center of gravity.
- Lift load slowly and observe whether the load tilts or swivels out laterally. If required, immediately put down load and modify attachment.
- ⇒ Keep distance.

Draining oil

- ⇒ Do not walk under suspended loads.
- ⇒ Only ever move load under supervision.

Use 5870.350.090 [Connection plate] and 5870.350.063 [Clamping plate] to fix transmission to 5870.350.000 [Assembly truck].

Fig. 21



Observe the environmental regulations (see General safety instructions).

1. Loosen screw plug (1) and drain oil from the transmission.

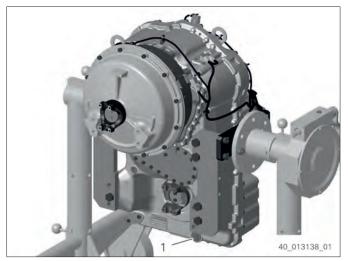


Fig. 22

Dismantling

Dismantling

Removing the pressure filter

1. Loosen the pressure filter (1).

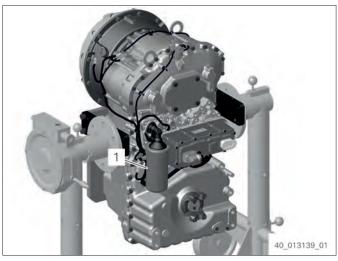


Fig. 23

2. Loosen internal hexalobular bolts and remove filter head (1).

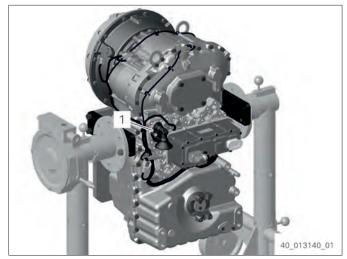


Fig. 24

Removing cover plate (filler neck)

1. Loosen hexagon screws and remove cover sheet (1) with seal.

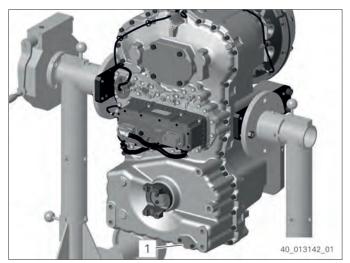


Fig. 25

 Loosen hexagon screws and remove cover sheet (1) with seal.

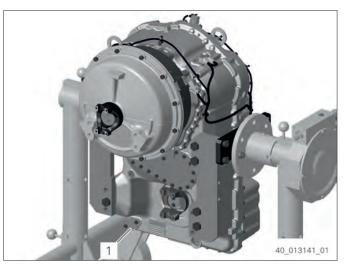


Fig. 26

Dismantling

Removing pressure controller and speed sensors

- 1. Remove the cable ties.
- 2. Disconnect plug connections and remove cable (1).

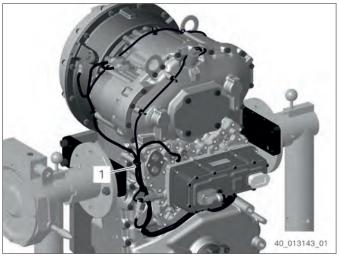
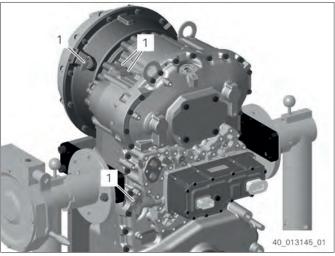


Fig. 27

Fig. 28





- 3. Loosen cap screws.
- 4. Pull the pressure controller (1) out of the housing hole.

- 5. Loosen cap screws.
- 6. Pull the speed sensors (1) out of the housing holes.

Removing the temperature sensors and the breather

- 1. Loosen the breather (1).
- 2. Loosen the temperature sensors (2).

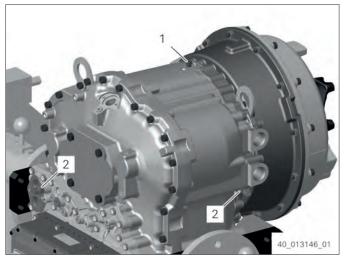


Fig. 30

Removing output flanges

Removing output flange on input side

- 1. Loosen hexagon screws (1).
- 2. Remove washer (2).

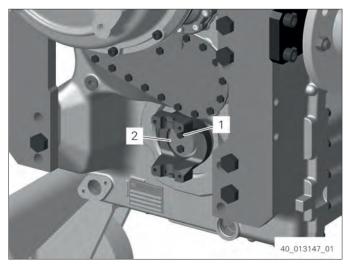


Fig. 31

Dismantling

3. Remove O-ring (1).

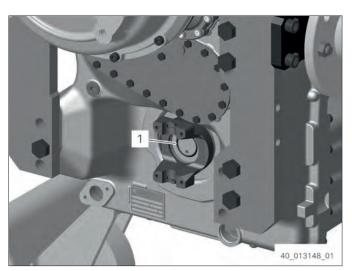


Fig. 32

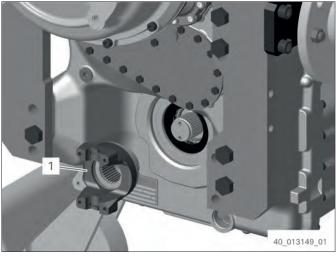


Fig. 33

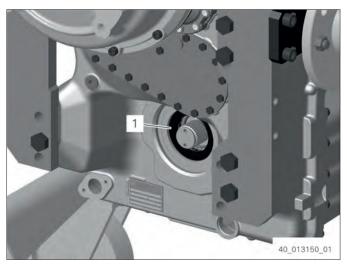


Fig. 34

4. Pull off output flange (1).

5.

Remove shaft seal (1) from the housing hole.

Removing output flange on gearshift side

- 6. Loosen hexagon screws (1).
- 7. Remove washer (2).

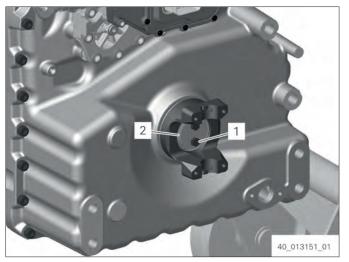


Fig. 35

8. Remove O-ring (1).

Pull off output flange (1).

9.

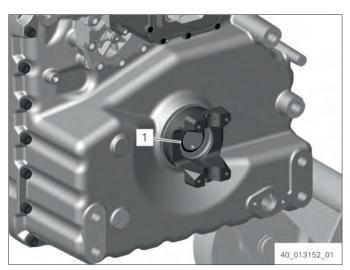


Fig. 36

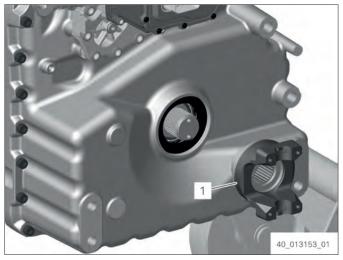


Fig. 37

3-140

10. Remove shaft seal (1) from the housing hole.

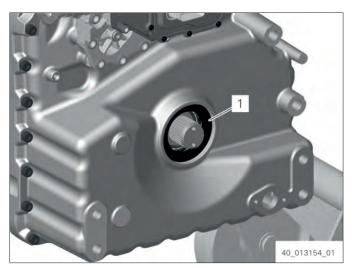


Fig. 38

Removing and dismantling shift system

Removing filter bypass valve

1. Loosen the tappet switch (1).

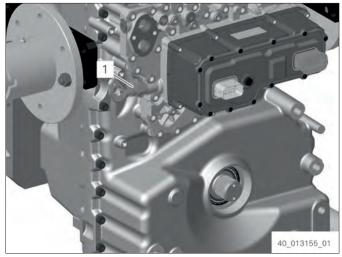


Fig. 39

- 2. Remove piston (3) from hole (1).
- Remove compression spring (2) from hole (1).

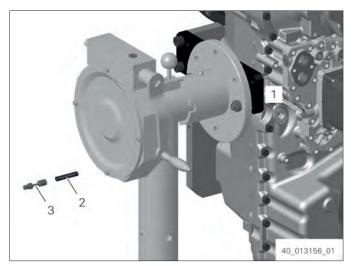


Fig. 40

Removing control unit (ECA4)

- 1. Loosen internal hexalobular bolts.
- 2. Remove control unit (1).

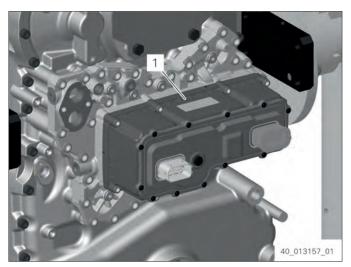


Fig. 41

Removing the pressure controllers

- 1. Separate plug connections (1) on the pressure controllers.
- 2. Loosen internal hexalobular bolts and remove fixing plate (3).
- 3. Remove cable (2).

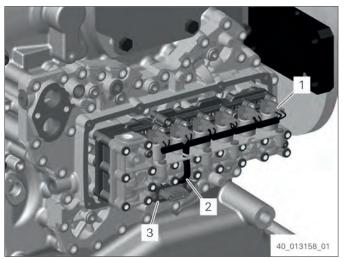


Fig. 42

- 4. Loosen internal hexalobular bolts and remove clamping plate (1).
- 5. Pull out the pressure controllers (2).

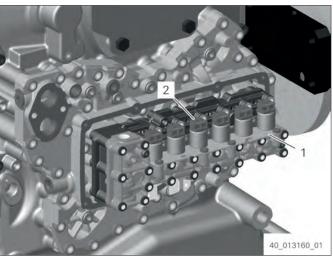


Fig. 43

Removing and dismantling valve blocks

Special tools:

- AA02.414.200 Driver tool
- AA02.416.754 Driver tool
- AA02.416.230 Driver tool

 Loosen internal hexalobular bolts. Remove valve block (1) and intermediate plate.

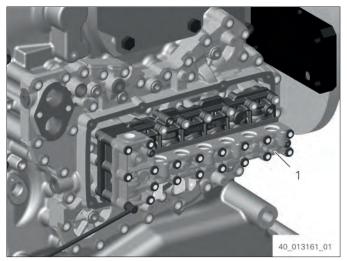


Fig. 44

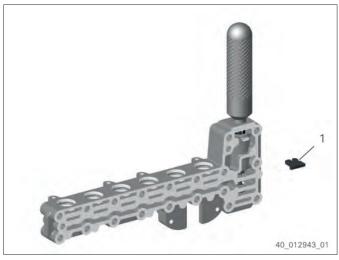


Fig. 45

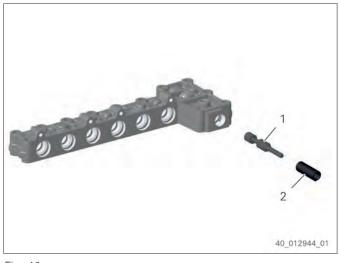


Fig. 46

2. Press the piston inwards with AA02.414.200 [Driver tool] and remove the fixing plate.

Remove compression spring (2) and piston (1) from the hole.

4. Loosen internal hexalobular bolts. Remove valve block (1) and intermediate plate.

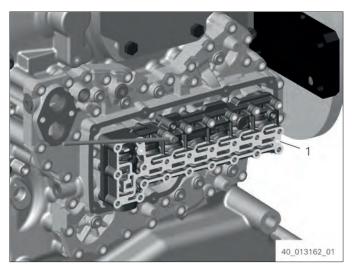


Fig. 47

5. Press the plug inwards with AA02.416.754 [Driver tool] and remove the spring clip (1).

Pull the plug (3) out of the hole.

spring (1) from the hole.

Remove control piston (2) and compression

6.

7.

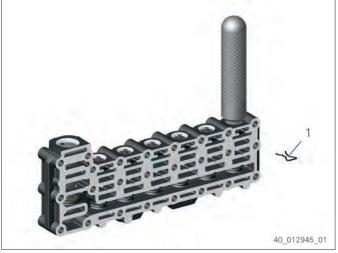


Fig. 48

3 40_012947_01



 Press the plug inwards using AA02.416.230 [Driver tool] and remove fixing plate (1).

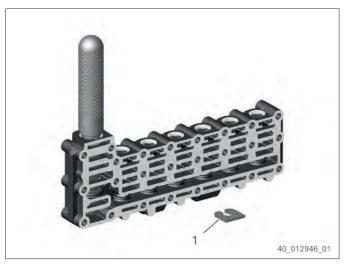


Fig. 50



10. Remove compression spring (2) and control piston (1) from the hole.

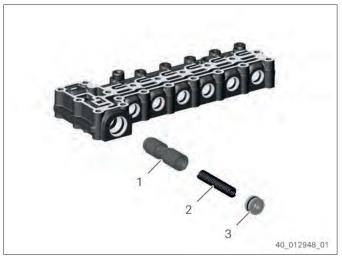
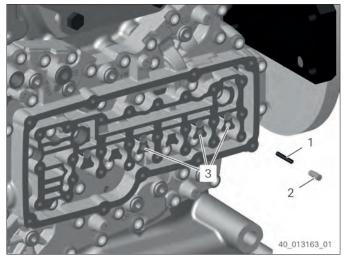


Fig. 51

Removing duct plate

 Remove piston (2) and compression spring (1) from holes (3).





2. Remove valves (1) from duct plate.

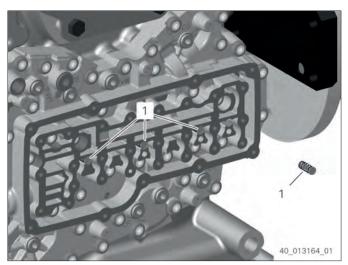


Fig. 53

Fig. 54





 Loosen internal hexalobular bolts. Remove duct plate and seal.

4. Remove screw plugs from duct plate.

Removing cover plate (PTO)

1. Loosen hexagon screws and remove cover plate (1).

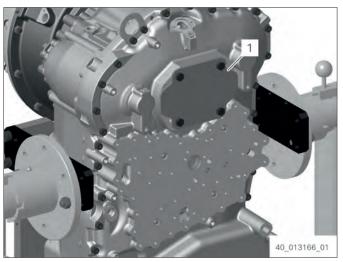


Fig. 56

2. Remove O-ring (1).

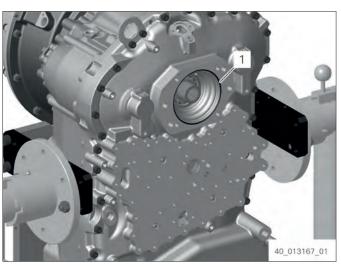


Fig. 57

Removing and dismantling engine connection

Removing the converter

Special tools:

• AA02.676.915 Load ring

- Mark installation position of the cover towards the torque converter bell housing.
- 2. Loosen hexagon nuts (2).
- 3. Remove cap screws (1).



Fig. 58



Fig. 59



Fig. 60

4. **CAUTION**

Risk of crushing due to moving parts. Slight or moderate injury possible. ⇒ Do not reach into danger area!

Lift off the cover and the converter using two AA02.676.915 [Load ring] and the crane.

- 5. Loosen hexagon screws.
- 6. Remove washer.
- 7. Use two-armed extractor to pull yoke off the input shaft.

8. **AUTION**

Risk of crushing due to hydraulic tool.Slight to moderate injury possible.⇒ Do not reach into danger area.

Force input shaft and the converter out of the cover.



Fig. 61

9. Remove V-ring (1).

11.

12.

10. Pull the ball bearing (2) out of the cover.

Loosen hexagon screws (1).

Remove input shaft with flexplates (2).



Fig. 62



- 13. Loosen hexagon screws.
- 14. Remove flexplates (1).

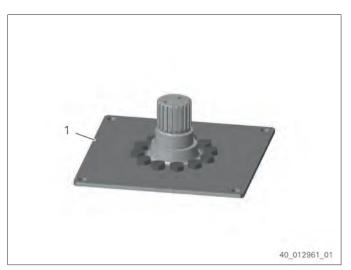


Fig. 64

Removing torque converter bell housing

Special tools:

- AA02.247.426 Eyebolt
- 1. Loosen hexagon screws (1).



Fig. 65

2. Lift torque converter bell housing with two AA02.247.426 [Eyebolt] and a crane.



Fig. 66

Removing the oil feed housing and pressure oil pump

Special tools:

- 5870.345.036 Pry bar
- 5870.450.003 Magnetic holder
- 1. Loosen internal hexalobular bolts.
- Loosen cap screws and remove fixing plate (1).
- 3. Loosen cap screws (2).



Fig. 67

4. Pull off the oil feed housing and gear pump evenly with 5870.345.036 [Pry bar].



Fig. 68



Fig. 69

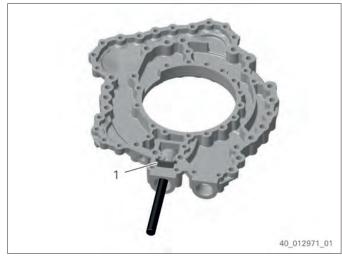


Fig. 70

 Place the oil feed housing on 5870.450.003 [Magnetic holder].

Push pressure plate inwards with a mandrel

and remove fixing plate (1).

6. Force out the gear pump.

7.

- 8. Remove pressure plate (3).
- Remove compression spring (2) and piston
 (1) from housing hole.

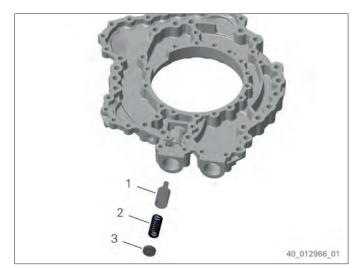


Fig. 71

Checking gear pump

- 10. Remove shaft sealing ring (1).
- 11. Remove O-ring (2).





The gear pump is only available as a complete unit.

Loosen cap screws (1).



Fig. 73

- 13. Lift off cover (1).
- 14. Check the cover (1), outer rotor (2), inner rotor (3) and the housing (4) for wear marks. In case of any damage, install new gear pump.
- Insert the outer rotor (2) and inner rotor (3) with the chamfered tooth side facing the housing (4).
- 16. Place the cover (1).
- 17. Screw in cap screws by hand until contact is obtained and loosen again by 180°.
- 18. Remove seal (1).
- 19. Remove stator shaft (2).



Fig. 74

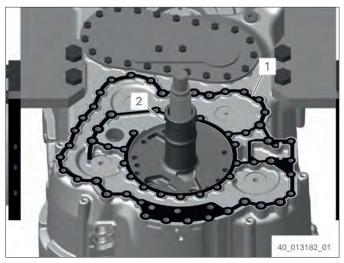


Fig. 75

Removing pump shaft

1. Remove securing ring.

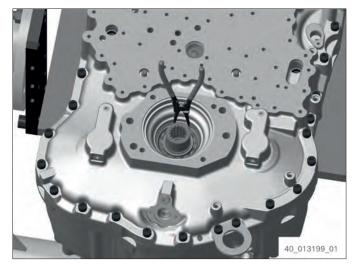


Fig. 76

2. Pull pump shaft (1) out of the transmission.



Fig. 77

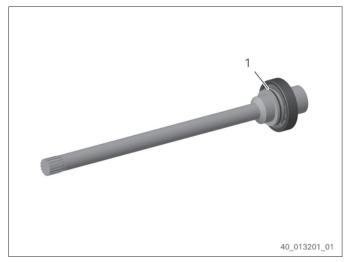


Fig. 78

1 2 40_013202_01



3. Remove R-ring (1) from radial groove of the pump shaft.

- 4. Remove securing ring (1).
- 5. Press off the ball bearing (2).

Removing the cover (emergency steering pump)

- 1. Loosen hexagon screws.
- 2. Remove cover (1).
- 3. Remove seal.

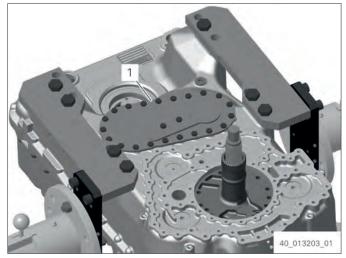


Fig. 80

Separating the housings

Special tools:

- AA02.691.822 Handle
- 5870.204.083 Eyebolt
- 5870.204.086 Eyebolt



Risk of injury due to parts flying away. Slight or moderate injury possible. ⇒ Wear protective goggles.

Force out both cylindrical pins.

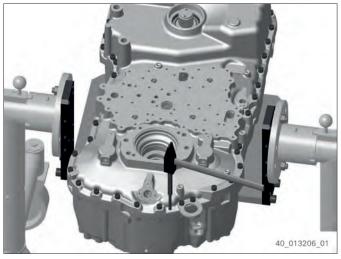


Fig. 81

- 2. Loosen cap screws (1).
- 3. Remove fixing plate (2).

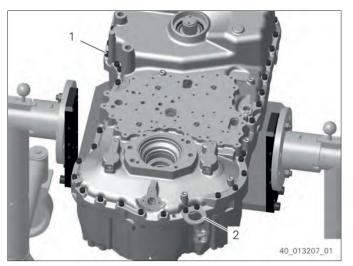


Fig. 82

Fig. 83

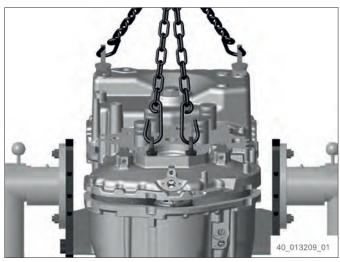


Fig. 84

4. Fasten clutches K1, K2, K3 and K4 in the housing rear section with AA02.691.822 [Handle].

- 5. Screw two 5870.204.083 [Eyebolt] into the housing rear section.
- 6. Screw in two 5870.204.086 [Eyebolt].

7.

Risk of injury due to uncontrolled motion of the load.

Death or serious injury possible.

- ⇒ Only use the suspension points intended for transportation purposes.
- Only use secure, permitted, and tested means of transport, chain hoist, and lifting equipment with sufficient load capacity and suitable lifting technology.
- Ensure that lifting equipment such as ropes and belts are not in contact with sharp edges and are not knotted or twisted.
- ⇒ Properly attach lifting appliances to load.
- ⇒ Observe the load's center of gravity! The crane hook must be located above the load's center of gravity.
- Lift load slowly and observe whether the load tilts or swivels out laterally. If required, immediately put down load and modify attachment.
- ⇒ Keep distance.
- \Rightarrow Do not walk under suspended loads.
- ⇒ Only ever move load under supervision.

Lift off housing rear section and clutches using a crane.

Removing and dismantling output shaft

Special tools:

- AA01.100.718 Eyebolt
- 5873.001.058 Gripping device
- 5873.001.001 Basic tool

1. Loosen cap screws.

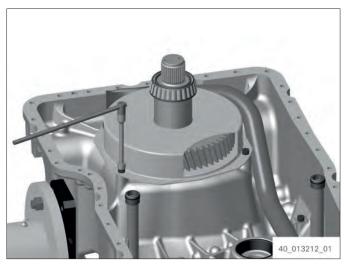


Fig. 85

2. Remove output shaft from the front part of the housing using AA01.100.718 [Eyebolt] and crane.



Fig. 86



Fig. 87

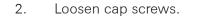
- 3. Use 5873.001.058 [Gripping device] and 5873.001.001 [Basic tool] to pull off both bearing inner rings from the output shaft.
- 4. Remove screen sheet (1).

Dismantling housing front part

1. Remove screen sheet (1).



Fig. 88



Remove oil tubes (1).
 X No further dismantling possible.

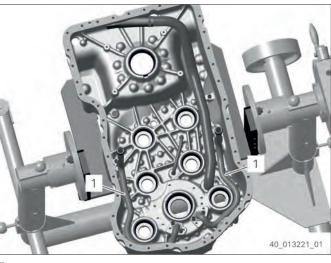


Fig. 89

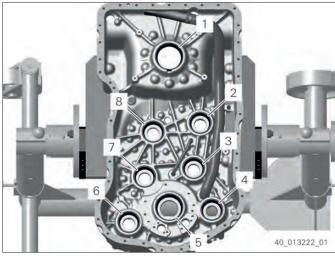


Fig. 90

- Pull bearing outer rings out of housing holes. The Figure shows the positions of the bearing outer rings.
 - 1 = Output shaft
 - 2 = Clutch K3
 - 3 = Clutch K2
 - 4 = Clutch KV
 - 5 = Input shaft
 - 6 = Clutch KR
 - 7 = Clutch K4
 - 8 = Clutch K1

Removing and dismantling clutches and input shaft

Removing clutches

Special tools:

- 5870.350.000 Assembly truck
- AA02.415.533 Assembly fixture
- AA02.691.822 Handle
- 1.

Risk of injury due to uncontrolled motion of the load.

Death or serious injury possible.

- ⇒ Only use the suspension points intended for transportation purposes.
- Only use secure, permitted, and tested means of transport, chain hoist, and lifting equipment with sufficient load capacity and suitable lifting technology.
- Ensure that lifting equipment such as ropes and belts are not in contact with sharp edges and are not knotted or twisted.
- ⇒ Properly attach lifting appliances to load.
- ⇒ Observe the load's center of gravity! The crane hook must be located above the load's center of gravity.
- Lift load slowly and observe whether the load tilts or swivels out laterally. If required, immediately put down load and modify attachment.
- ⇒ Keep distance.
- \Rightarrow Do not walk under suspended loads.
- ⇒ Only ever move load under supervision.

Secure the housing rear section to the 5870.350.000 [Assembly truck] with AA02.415.533 [Assembly fixture].



Fig. 91

- 2. Rotate the housing rear section 180.
- 3. Remove four AA02.691.822 [Handle].
- 4. Remove clutches from the housing rear section in the sequence specified.
 - 1 = Clutch K1
 - 2 = Clutch K2
 - 3 = Clutch K3
 - 4 = Clutch K4
 - 5 = Clutch KR
 - 6 = Clutch KV
 - 7 = Input shaft

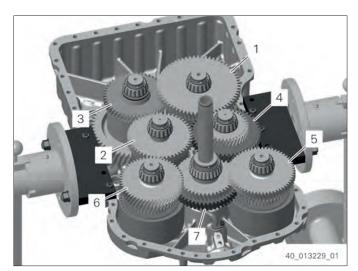


Fig. 92

Dismantling clutch KV

Special tools:

- 5873.001.057 Gripping device
- 5873.001.001 Basic tool
- 5870.345.088 Assembly fixture
- 5870.300.024 Disassembly device
- 5870.300.033 Extractor
- 1. Remove stud bolt (1).
- 2. Remove piston ring (2).



Fig. 93

 Pull off bearing inner ring with 5873.001.057 [Gripping device] and 5873.001.001 [Basic tool].



Fig. 94

40_013232_01

Fig. 95

1

Fig. 96

4. Pull off clutch from shaft.

- 5. Remove snap ring (1).
- 6. Remove end shim from the disk carrier.
- 7. Remove disk pack.

- Preload compression spring with 5870.345.088 [Assembly fixture] and press.
- 9. Remove L-ring (1).



Fig. 97

10. Remove supporting ring, compression spring and shim.



Fig. 98

11. Press the piston (1) out of the disk carrier using compressed air.



Fig. 99

12. Remove securing ring.

13.



Fig. 100



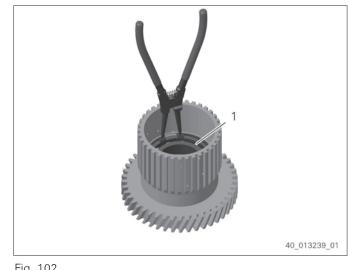
Fig. 101

- 14. Remove securing ring.
- 15. Pull out the ball bearing (1).

Pull off idler gear from shaft with

5870.300.033 [Extractor].

5870.300.024 [Disassembly device] and



16. Remove needle cage (1).

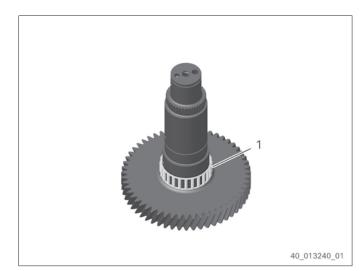


Fig. 103

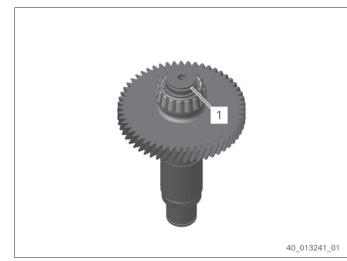


Fig. 104



Fig. 105

17. Remove piston ring (1).

Pull off bearing inner ring with

5873.001.001 [Basic tool].

5873.001.057 [Gripping device] and

18.

Dismantling KR clutch

Special tools:

- 5873.001.057 Gripping device
- 5873.001.001 Basic tool
- 5870.345.088 Assembly fixture
- 5870.300.024 Disassembly device
- 5870.300.033 Extractor
- 1. Remove stud bolt (1).
- 2. Remove piston ring (2).



Fig. 106

 Pull off bearing inner ring with 5873.001.057 [Gripping device] and 5873.001.001 [Basic tool].



Fig. 107

4. Pull off clutch from shaft.



Fig. 108

- 5. Remove snap ring (1).
- 6. Remove end shim from the disk carrier.
- 7. Remove disk pack.



Fig. 109

- Preload compression spring with 5870.345.088 [Assembly fixture] and press.
- 9. Remove L-ring (1).



Fig. 110

10. Remove supporting ring, compression spring and shim.





11. Press the piston (1) out of the disk carrier using compressed air.

Remove securing ring.

12.



Fig. 112



Fig. 113

 Pull off idler gear from shaft with 5870.300.024 [Disassembly device] and 5870.300.033 [Extractor].

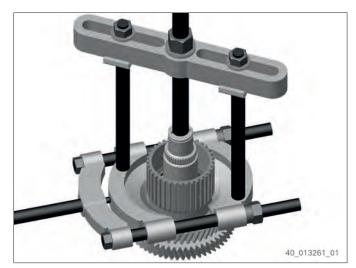


Fig. 114

- 14. Remove securing ring.
- 15. Pull out the ball bearing (1).

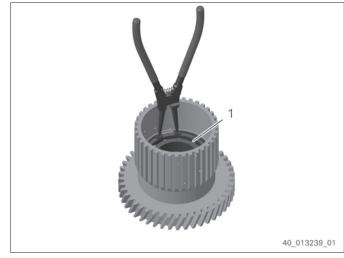


Fig. 115

16. Remove needle cage (1).

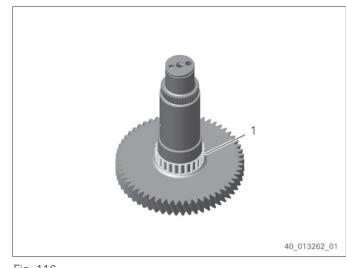


Fig. 116

17. Remove piston ring (1).





 Pull off bearing inner ring with 5873.001.057 [Gripping device] and 5873.001.001 [Basic tool].



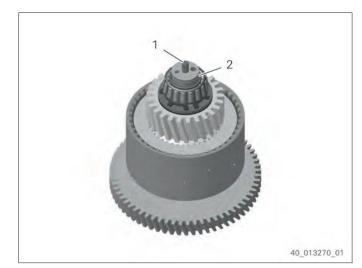
Fig. 118

9.15.4 Dismantling clutch K1

Special tools:

- 5873.001.057 Gripping device
- 5873.001.001 Basic tool
- 5870.345.088 Assembly fixture

- 1. Remove stud bolt (1).
- 2. Remove piston ring (2).





 Pull off bearing inner ring with 5873.001.057 [Gripping device] and 5873.001.001 [Basic tool].

Remove securing ring.

4.



Fig. 120

Fig. 121

5. Remove thrust washer (1), axial needle cage(2) and axial washer (3).



Fig. 122

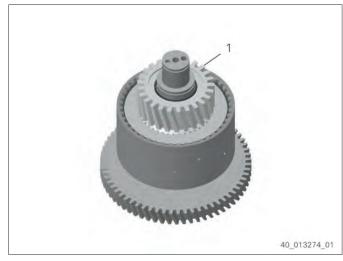


Fig. 123



Fig. 124

6. Remove idler gear (1).

7. Remove needle cage (1).

Remove axial washer (1), axle needle cage
 (2) and thrust washer (3).

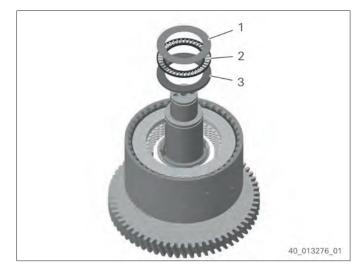


Fig. 125



Fig. 126



Fig. 127

9. Pull off clutch from shaft.

Remove snap ring (1).

Remove disk pack.

Remove end shim from the disk carrier.

10.

11.

12.

- Preload compression spring with
 5870.345.088 [Assembly fixture] and press.
- 14. Remove securing ring (1).





15. Remove guide rings and compression spring.



Fig. 129

16. Press the piston (1) out of the disk carrier using compressed air.



Fig. 130

17. Remove piston ring (1).



Fig. 131



Fig. 132

Dismantling clutch K2

Special tools:

• 5873.001.057 Gripping device

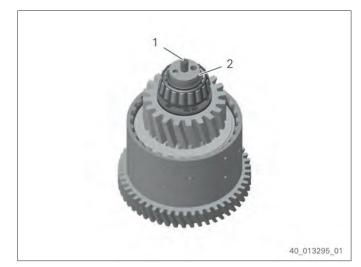
18. Pull off bearing inner ring with

5873.001.001 [Basic tool].

5873.001.057 [Gripping device] and

- 5873.001.001 Basic tool
- 5870.345.085 Assembly aid

- 1. Remove stud bolt (1).
- 2. Remove piston ring (2).





40_013296_01

Fig. 134



Fig. 135

 Pull off bearing inner ring with 5873.001.057 [Gripping device] and 5873.001.001 [Basic tool].

4. Remove securing ring.

5. Remove thrust washer (1), axial needle bearing (2) and axial washer (3).

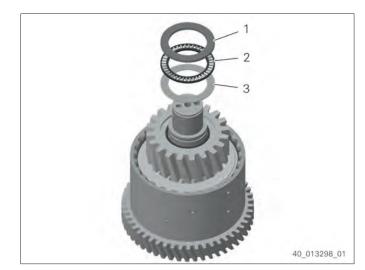


Fig. 136



Fig. 137



Fig. 138

6. Remove idler gear (1).

Remove needle cages (1).

7.

8. Remove axial washer (1), axial needle bearing (2) and thrust washer (3).



Fig. 139



Fig. 140

Fig. 141

9. Pull off clutch from shaft.

- 10. Remove snap ring (1).
- 11. Remove end shim from the disk carrier.
- 12. Remove disk pack.

- Preload compression spring with
 5870.345.085 [Assembly aid] and press.
- 14. Remove securing ring (1).





15. Remove guide rings and compression spring.



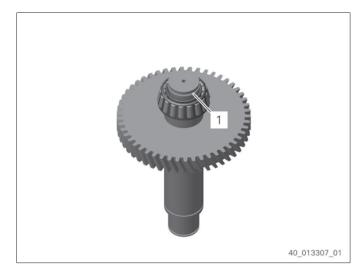
Fig. 143

16. Press the piston (1) out of the disk carrier using compressed air.



Fig. 144

17. Remove piston ring (1).





Pull off bearing inner ring with
 5873.001.057 [Gripping device] and
 5873.001.001 [Basic tool].



Fig. 146

Dismantling clutch K3

Special tools:

- 5873.001.058 Gripping device
- 5873.001.001 Basic tool
- 5873.001.057 Gripping device
- 5870.345.085 Assembly aid

- 1. Remove stud bolt (1).
- 2. Remove piston ring (2).

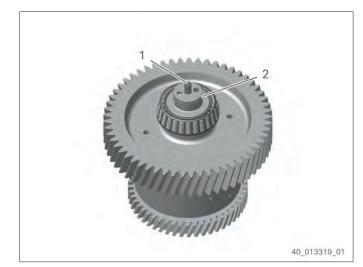


Fig. 147



Fig. 148



Fig. 149

 Pull off bearing inner ring with 5873.001.058 [Gripping device] and 5873.001.001 [Basic tool].

Remove piston ring (1).

4.

 Pull off bearing inner ring with 5873.001.057 [Gripping device] and 5873.001.001 [Basic tool].



Fig. 150

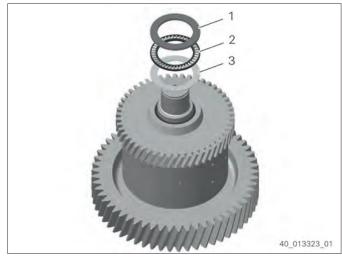


Fig. 151

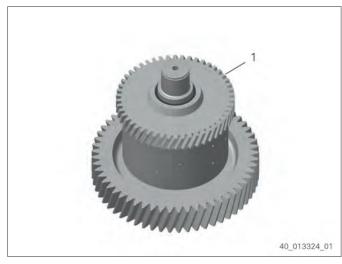


Fig. 152

6. Remove thrust washer (1), axial needle bearing (2) and axial washer (3).

7. Remove idler gear (1).

8. Remove needle cages (1).



Fig. 153

9. Remove axial washer (1), axial needle bearing (2) and thrust washer (3).

10. Pull off clutch from shaft.



Fig. 154



Fig. 155

- 11. Remove snap ring (1).
- 12. Remove end shim from the disk carrier.
- 13. Remove disk pack.



Fig. 156

- Preload compression spring with 5870.345.085 [Assembly aid] and press.
- 15. Remove securing ring (1).



Fig. 157

16. Remove guide rings and compression spring.





17. Press the piston (1) out of the disk carrier using compressed air.



Fig. 159

Dismantling clutch K4

Special tools:

- 5873.001.057 Gripping device
- 5873.001.001 Basic tool
- 5870.345.085 Assembly aid
- 1. Remove stud bolt (1).
- 2. Remove piston ring (2).

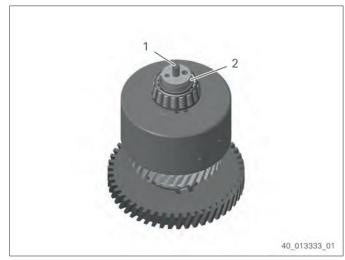


Fig. 160

 Pull off bearing inner ring with 5873.001.057 [Gripping device] and 5873.001.001 [Basic tool].



Fig. 161



Fig. 162



Fig. 163

4. Remove securing ring.

Pull off clutch from shaft.

5.

- 6. Remove snap ring (1).
- 7. Remove end shim from the disk carrier.
- 8. Remove disk pack.



Fig. 164

- Preload compression spring with 5870.345.085 [Assembly aid] and press.
- 10. Remove securing ring (1).



Fig. 165

11. Remove guide rings and compression spring.



Fig. 166

12. Press the piston (1) out of the disk carrier using compressed air.



Fig. 167

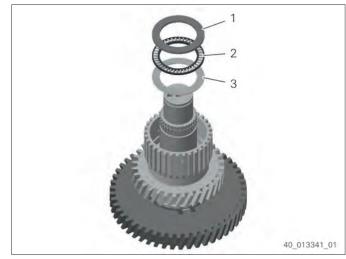


Fig. 168

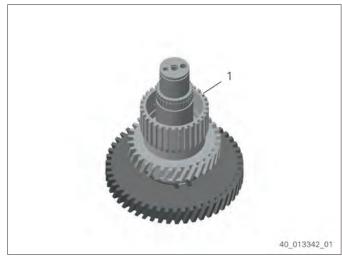


Fig. 169

 Remove thrust washer (1), axial needle bearing (2) and axial washer (3).

14. Remove idler gear (1).

15. Remove needle cages (1).



Fig. 170

16. Remove axial washers (1) and axial needle bearing (2).

Remove piston ring (1).

17.

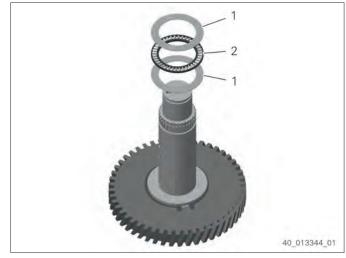


Fig. 171

1

Fig. 172

3-191

- Pull off bearing inner ring with 5873.001.057 [Gripping device] and 5873.001.001 [Basic tool].
 - * No further dismantling possible.



Fig. 173

Dismantling input shaft

Special tools:

- 5873.001.058 Gripping device
- 5873.001.001 Basic tool
- 1. Remove R-rings (1).
- Pull off bearing inner rings (2) with 5873.001.058 [Gripping device] and 5873.001.001 [Basic tool].

* No further dismantling possible.

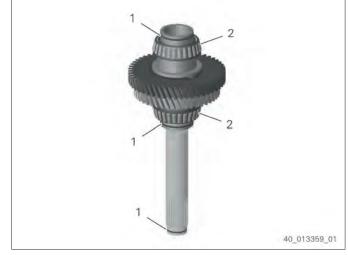


Fig. 174

9.16 Dismantling housing rear section

1. Force the converter safety valve out of the housing hole.

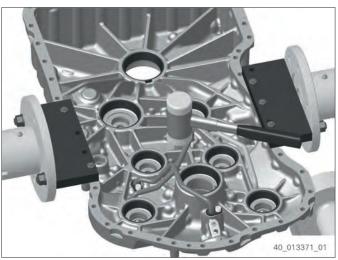


Fig. 175

- Pull bearing outer rings out of housing holes. The Figure shows the positions of the bearing outer rings.
 - 1 = Output shaft
 - 2 = Clutch K1
 - 3 = Clutch K4
 - 4 = Clutch KR
 - 5 = Input shaft
 - 6 = Clutch KV
 - 7 = Clutch K2
 - 8 = Clutch K3

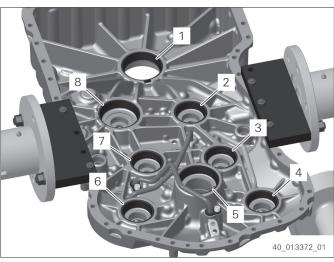


Fig. 176



Fig. 177

- 3. Loosen cap screws.
- 4. Remove oil tube (1)
 - * No further dismantling possible.

10.1 Assembling housing rear section

- 1. Grease O-rings.
- 2. Slide O-rings (1) onto the oil tube



Fig. 178

3. Insert oil tube (1) in housing holes.

Insert bearing outer rings in housing holes

The Figure shows the positions of the bearing

4. Fix oil tube with cap screws. Tightening torque: **23 Nm**

until contact is obtained.

1 = Output shaft

2 = Clutch K1

3 = Clutch K4

4 = Clutch KR

5 = Input shaft

6 = Clutch KV

7 = Clutch K2

8 = Clutch K3

outer rings.

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•

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5.

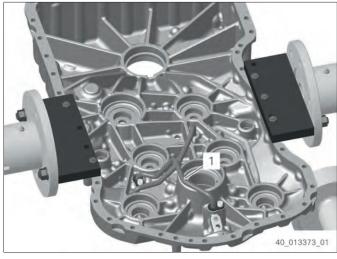


Fig. 179

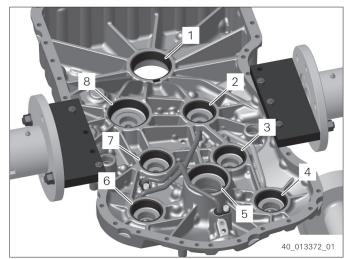


Fig. 180

Assembly

Assembling and installing clutches and input shaft

Assembling clutch KV

Special tools:

- 5870.345.124 Assembly fixture
- 5870.345.088 Assembly fixture
- Carry out the following two work steps immediately one after the other.

Risk of burn injuries due to contact with hot surfaces. Slight or moderate injury possible. ⇒ Wear protective gloves.

Heat the bearing inner ring.

- 2. Slide bearing inner ring (1) onto shaft until contact is obtained.
- 3. Let bearing inner ring cool down.
- 4. Adjust bearing inner ring.
- 5. Insert piston ring (1).

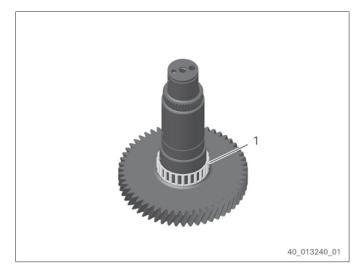


Fig. 181



Fig. 182

6. Slide on needle cage (1).





- 7. Insert ball bearing (1) into idler gear until contact is obtained.
- 8. Insert securing ring.

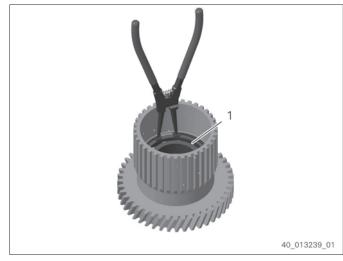


Fig. 184

9. Press idler gear onto the shaft until contact is obtained.

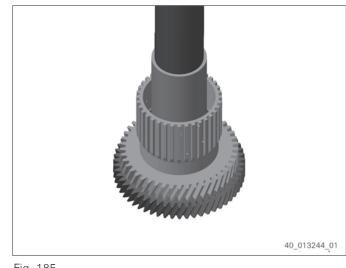


Fig. 185

10. Insert securing ring in the shaft.



Fig. 186

- 11. Check clearance of the ball in the drain valve (1).
- 12. Oil O-rings (2) and insert them twist-free in the radial grooves.



Fig. 187

- 13. Oil O-rings and piston bearing surfaces.
- 14. Insert piston (1) into the disk carrier until contact is obtained.



Fig. 188

15. Insert shim (2) and compression spring (1).



Fig. 189

- 16. Insert 5870.345.124 [Assembly fixture] (1) in the disk carrier.
- 17. Slide on supporting ring (2).
- Slide on **new** L-ring (3) with the offset front face facing downwards.

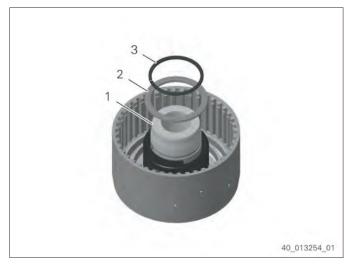


Fig. 190

 Push L-ring downwards with 5870.345.124 [Assembly fixture] and 5870.345.088 [Assembly fixture] until it engages in the radial groove of the disk carrier.



Fig. 191

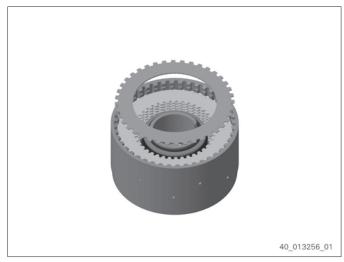
Setting disk clearance

20. Insert outer disk (1) with the uncoated side facing the piston.



Fig. 192

- 21. Insert inner disks and outer disks. Insert last outer disk with the uncoated side facing the end shim.
 - * For the arrangement refer to the current spare parts list.





- 22. Insert end shim (1).
- 23. Insert snap ring e. g. 2.70 mm.





- 24. Position dial gauge on the end shim.
- 25. Push end shim downwards with 100 N and set dial gauge to zero.
- 26. Lift end shim on the snap ring until contact is obtained and check the necessary Disk clearance 2.45 mm until 2.75 mm.
 If the disk clearance is too small, install a thinner snap ring.
 If the disk clearance is too big, install a thicker snap ring.
- 27. X Carry out the following two work steps immediately one after the other.

Risk of burn injuries due to contact with hot surfaces.

Slight or moderate injury possible.

 \Rightarrow Wear protective gloves.

Heat internal spline of the disk carrier.

28. Slide clutch onto shaft until contact is obtained. Insert idler gear into the disk pack by short mutual rotary motions.

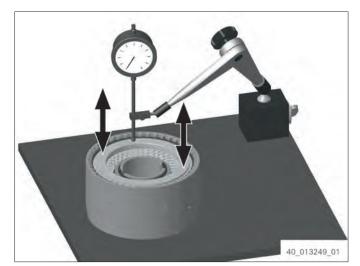


Fig. 195



Fig. 196



Fig. 197

29. X Carry out the following two work steps immediately one after the other.

Risk of burn injuries due to contact with hot surfaces. Slight or moderate injury possible. ⇒ Wear protective gloves.

Heat the bearing inner ring.

- 30. Slide on bearing inner ring (1) until contact is obtained.
- 31. Let bearing inner ring cool down.
- 32. Adjust bearing inner ring.
- Screw in stud bolt (1) and tighten.
 Tightening torque: 17 Nm
- 34. Insert piston ring (2).



Fig. 198



Fig. 199

- 35. Check function of the clutch with compressed air.
 - → Closing and opening of the clutch is clearly audible.

If closing and opening is not audible, remove and check clutch.



Fig. 200

Assembling clutch KR

Special tools:

- 5870.345.124 Assembly fixture
- 5870.345.088 Assembly fixture
- Carry out the following two work steps immediately one after the other.

Risk of burn injuries due to contact with hot surfaces. Slight or moderate injury possible. ⇒ Wear protective gloves.

Heat the bearing inner ring.

- 2. Slide bearing inner ring (1) onto shaft until contact is obtained.
- 3. Let bearing inner ring cool down.
- 4. Adjust bearing inner ring.



Fig. 201

6.

5. Insert piston ring (1).

Slide on needle cage (1).



Fig. 202

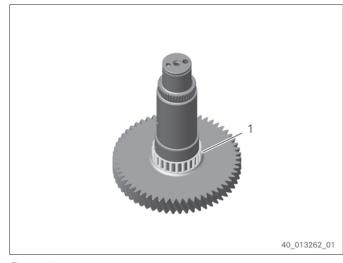


Fig. 203

- Insert ball bearing (1) into idler gear until 7. contact is obtained.
- 8. Insert securing ring.



3-203

9. Press idler gear onto the shaft until contact is obtained.



Fig. 205



Fig. 206



10. Insert securing ring in the shaft.

- 11. Check clearance of the ball in the drain valve (1).
- 12. Oil O-rings (2) and insert them twist-free in the radial grooves.

- 13. Oil O-rings and piston bearing surfaces.
- 14. Insert piston (1) into the disk carrier until contact is obtained.



Fig. 208

15. Insert shim (2) and compression spring (1).



Fig. 209

- 16. Insert 5870.345.124 [Assembly fixture] (1) in the disk carrier.
- 17. Slide on supporting ring (2).
- 18. Slide on **new** L-ring (3) with the offset front face facing downwards.



Fig. 210

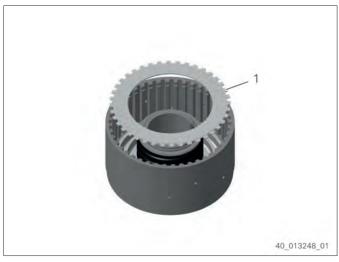
 Push L-ring downwards with 5870.345.124 [Assembly fixture] and 5870.345.088 [Assembly fixture] until it engages in the radial groove of the disk carrier.



Fig. 211

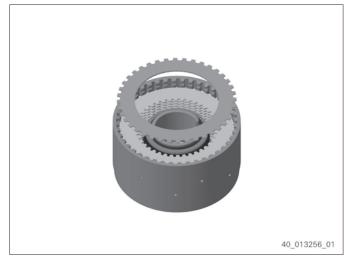
Setting disk clearance

20. Insert outer disk (1) with the uncoated side facing the piston.





- 21. Insert inner disks and outer disks. Insert last outer disk with the uncoated side facing the end shim.
 - * For the arrangement refer to the current spare parts list.





- 22. Insert end shim (1).
- 23. Insert snap ring e. g. 2.70 mm.



Fig. 214

- 24. Position dial gauge on the end shim.
- 25. Push end shim downwards with 100 N and set dial gauge to zero.
- 26. Lift end shim on the snap ring until contact is obtained and check the necessary Disk clearance 2.45 mm until 2.75 mm.
 If the disk clearance is too small, install a thinner snap ring.
 If the disk clearance is too big, install a thicker snap ring.
- 27. X Carry out the following two work steps immediately one after the other.

Risk of burn injuries due to contact with hot surfaces.

Slight or moderate injury possible.

 \Rightarrow Wear protective gloves.

Heat internal spline of the disk carrier.

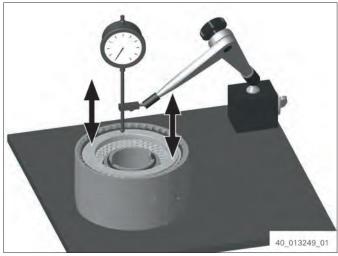


Fig. 215



Fig. 216

 Slide clutch onto shaft until contact is obtained. Insert idler gear into the disk pack by short mutual rotary motions.



Fig. 217

Risk of burn injuries due to contact with hot surfaces. Slight or moderate injury possible.

⇒ Wear protective gloves.

Heat the bearing inner ring.

- 30. Slide on bearing inner ring (1) until contact is obtained.
- 31. Let bearing inner ring cool down.
- 32. Adjust bearing inner ring.

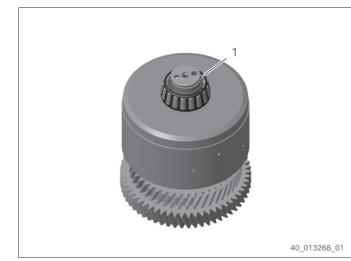


Fig. 218

- Screw in stud bolt (1) and tighten.
 Tightening torque: 17 Nm
- 34. Insert piston ring (2).



Fig. 219

- 35. Check function of the clutch with compressed air.
 - → Closing and opening of the clutch is clearly audible.

If closing and opening is not audible, remove and check clutch.



Fig. 220

Assembling clutch K1

Special tools:

• 5870.345.088 Assembly fixture

 X Carry out the following two work steps immediately one after the other.

Risk of burn injuries due to contact with hot surfaces. Slight or moderate injury possible. ⇒ Wear protective gloves.

Heat the bearing inner ring.

- 2. Slide bearing inner ring (1) onto shaft until contact is obtained.
- 3. Let bearing inner ring cool down.
- 4. Adjust bearing inner ring.
- 5. Insert piston ring (1).



Fig. 221



Fig. 222

- Check clearance of the ball in the drain valve (1).
- 7. Oil O-rings (2) and insert them twist-free in the radial grooves.

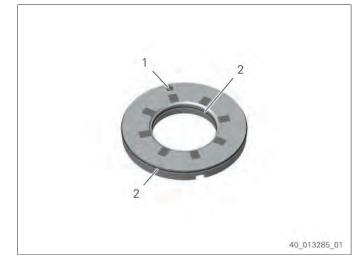


Fig. 223

- 8. Oil O-rings and piston bearing surfaces.
- 9. Insert piston (1) into the disk carrier until contact is obtained.



Fig. 224

- 10. Slide on guide ring (3) with the offset front face facing upwards.
- 11. Slide on compression spring (2).
- 12. Slide on guide ring (1) with the offset front face facing downwards.



Fig. 225

- Preload compression spring with
 5870.345.088 [Assembly fixture] and press.
- 14. Insert securing ring (1).



Fig. 226

Setting disk clearance

15. Insert outer disk (1) with the uncoated side facing the piston.





- 16. Insert inner disks and outer disks. Insert last outer disk with the uncoated side facing the end shim.
 - * For the arrangement refer to the current spare parts list.



Fig. 228

- 17. Insert end shim (1).
- 18. Insert snap ring e. g. 2.85 mm.



Fig. 229

- 19. Position dial gauge on the end shim.
- 20. Push end shim downwards with 100 N and set dial gauge to zero.
- 21. Lift end shim on the snap ring until contact is obtained and check the necessary Disk clearance 2.05 mm until 2.35 mm.
 If the disk clearance is too small, install a thinner snap ring.
 If the disk clearance is too big, install a thicker snap ring.
- 22. X Carry out the following two work steps immediately one after the other.

Risk of burn injuries due to contact with hot surfaces.

Slight or moderate injury possible.

 \Rightarrow Wear protective gloves.

Heat internal spline of the disk carrier.

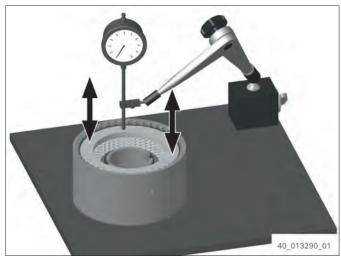


Fig. 230



Fig. 231

23. Slide clutch onto shaft until contact is obtained.



Fig. 232

- 24. Slide on thrust washer (3) with the chamfer facing the axle needle cage.
- 25. Slide on axial needle cage (2).
- 26. Slide on the axial washer (1).

Slide on needle cage (1).

27.



Fig. 233



Fig. 234

28. Slide idler gear (1) onto shaft until contact is obtained. Insert idler gear into the disk pack by short mutual rotary motions.



Fig. 235

- 29. Slide on the axial washer (3).
- 30. Slide on axial needle cage (2).
- 31. Slide on thrust washer (1) with the chamfer facing the axle needle cage.



Fig. 236

32. Insert securing ring in the shaft.

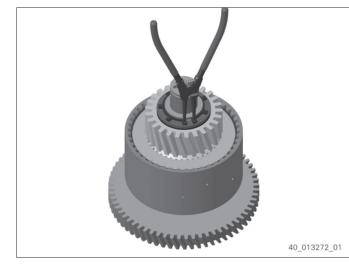


Fig. 237

33. X Carry out the following two work steps immediately one after the other.

Risk of burn injuries due to contact with hot surfaces. Slight or moderate injury possible. ⇒ Wear protective gloves.

Heat the bearing inner ring.

- 34. Slide bearing inner ring (1) onto shaft until contact is obtained.
- 35. Let bearing inner ring cool down.
- 36. Adjust bearing inner ring.
- 37. Screw in stud bolt (1) and tighten. Tightening torque: **17 Nm**
- 38. Insert piston ring (2).



Fig. 238

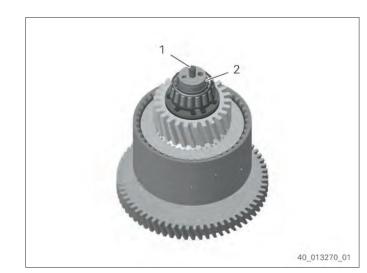


Fig. 239

- 39. Check function of the clutch with compressed air.
 - → Closing and opening of the clutch is clearly audible.

If closing and opening is not audible, remove and check clutch.



Fig. 240

Assembling clutch K2

Special tools:

- 5870.345.085 Assembly aid
- Carry out the following two work steps immediately one after the other.

Risk of burn injuries due to contact with hot surfaces. Slight or moderate injury possible. ⇒ Wear protective gloves.

Heat the bearing inner ring.

- 2. Slide bearing inner ring (1) onto shaft until contact is obtained.
- 3. Let bearing inner ring cool down.
- 4. Adjust bearing inner ring.



Fig. 241

5. Insert piston ring (1).

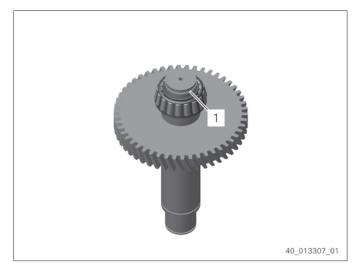


Fig. 242

- Check clearance of the ball in the drain valve (1).
- 7. Oil O-rings (2) and insert them twist-free in the radial grooves.

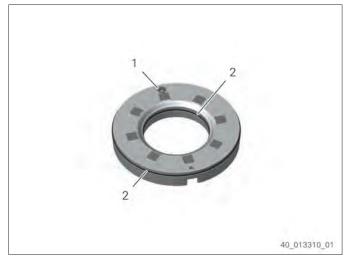


Fig. 243

- 8. Oil O-rings and piston bearing surfaces.
- 9. Insert piston (1) into the disk carrier until contact is obtained.



Fig. 244

- 10. Slide on guide ring (3) with the offset front face facing upwards.
- 11. Slide on compression spring (2).
- 12. Slide on guide ring (1) with the offset front face facing downwards.

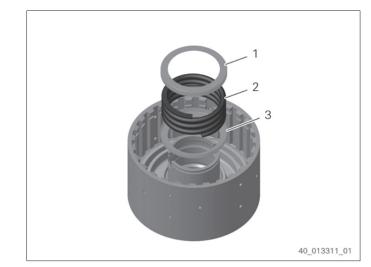


Fig. 245

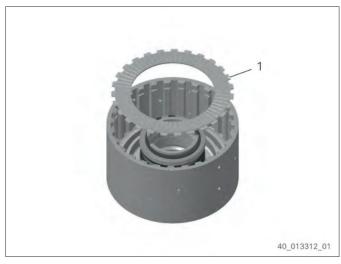
- Preload compression spring with
 5870.345.085 [Assembly aid] and press.
- 14. Insert securing ring (1).



Fig. 246

Setting disk clearance

15. Insert friction disk (1) with the uncoated side facing the piston.





- 16. Insert inner disks and outer disks.
 - * For the arrangement refer to the current spare parts list.
- 17. Insert friction disk (1) with the uncoated side facing the end shim.

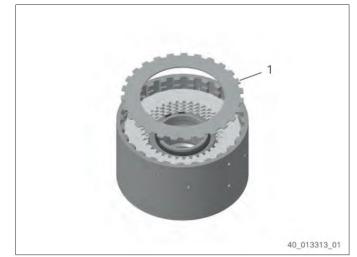


Fig. 248

- 18. Insert end shim (1).
- 19. Insert snap ring e. g. 3.15 mm.



Fig. 249

- 20. Position dial gauge on the end shim.
- 21. Push end shim downwards with 100 N and set dial gauge to zero.
- 22. Lift end shim on the snap ring until contact is obtained and check the necessary Disk clearance 2.00 mm until 2.30 mm.If the disk clearance is too small, install a thinner snap ring.If the disk clearance is too big, install a thicker snap ring.

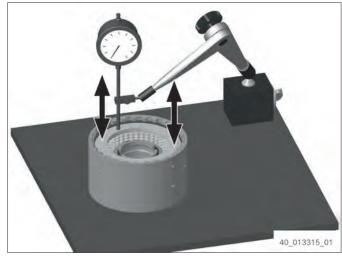


Fig. 250

23. X Carry out the following two work steps immediately one after the other.

Risk of burn injuries due to contact with hot surfaces. Slight or moderate injury possible.

 \Rightarrow Wear protective gloves.

Heat internal spline of the disk carrier.

24. Slide clutch onto shaft until contact is obtained.



Fig. 251



Fig. 252

- 25. Slide on thrust washer (3) with the chamfer facing the axial needle bearing.
- 26. Slide on the axial needle bearing (2).
- 27. Slide on the axial washer (1).



Fig. 253

28. Slide on needle cages (1).

29.



Fig. 254

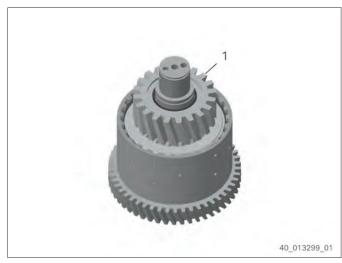


Fig. 255

- 30. Slide on the axial washer (3).
- 31. Slide on the axial needle bearing (2).
- 32. Slide on thrust washer (1) with the chamfer facing the axial needle bearing.

Slide idler gear (1) onto shaft until contact is obtained. Insert idler gear into the disk pack

by short mutual rotary motions.



Fig. 256

33. Insert securing ring in the shaft.



Fig. 257

34. X Carry out the following two work steps immediately one after the other.



Risk of burn injuries due to contact with hot surfaces. Slight or moderate injury possible.

 \Rightarrow Wear protective gloves.

Heat the bearing inner ring.

- 35. Slide bearing inner ring (1) onto shaft until contact is obtained.
- 36. Let bearing inner ring cool down.
- 37. Adjust bearing inner ring.

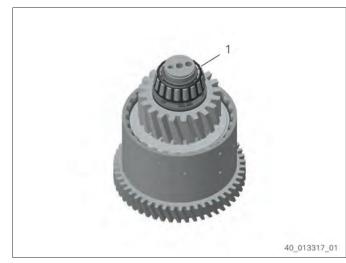


Fig. 258

- Screw in stud bolt (1) and tighten.
 Tightening torque: 17 Nm
- 39. Insert piston ring (2).

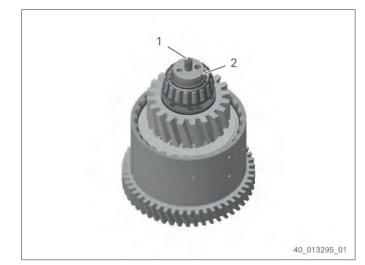


Fig. 259

- 40. Check function of the clutch with compressed air.
 - → Closing and opening of the clutch is clearly audible.

If closing and opening is not audible, remove and check clutch.



Fig. 260

Assembling clutch K3

Special tools:

• 5870.345.085 Assembly aid

- Check clearance of the ball in the drain valve (1).
- 2. Oil O-rings (2) and insert them twist-free in the radial grooves.





- 3. Oil O-rings and piston bearing surfaces.
- 4. Insert piston (1) into the disk carrier until contact is obtained.



Fig. 262

- 5. Slide on guide ring (3) with the offset front face facing upwards.
- 6. Slide on compression spring (2).
- 7. Slide on guide ring (1) with the offset front face facing downwards.



Fig. 263

- Preload compression spring with 5870.345.085 [Assembly aid] and press.
- 9. Insert securing ring (1).



Fig. 264

Setting disk clearance

10. Insert friction disk (1) with the uncoated side facing the piston.





- 11. Insert inner disks and outer disks.
 - * For the arrangement refer to the current spare parts list.
- 12. Insert friction disk (1) with the uncoated side facing the end shim.

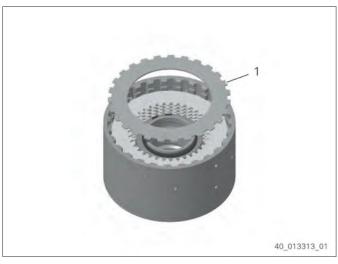


Fig. 266

- 13. Insert end shim (1).
- 14. Insert snap ring e. g. 3.15 mm.



Fig. 267

- 15. Position dial gauge on the end shim.
- 16. Push end shim downwards with 100 N and set dial gauge to zero.
- 17. Lift end shim on the snap ring until contact is obtained and check the necessary Disk clearance 2.00 mm until 2.30 mm.
 If the disk clearance is too small, install a thinner snap ring.
 If the disk clearance is too big, install a thicker snap ring.
- 18. % Carry out the following two work steps immediately one after the other.

Risk of burn injuries due to contact with hot surfaces.

Slight or moderate injury possible.

 \Rightarrow Wear protective gloves.

Heat internal spline of the disk carrier.



Fig. 268



Fig. 269

19. Slide clutch onto shaft until contact is obtained.



Fig. 270

- 20. Slide on thrust washer (3) with the chamfer facing the axial needle bearing.
- 21. Slide on the axial needle bearing (2).
- 22. Slide on the axial washer (1).

Slide on needle cages (1).

23.

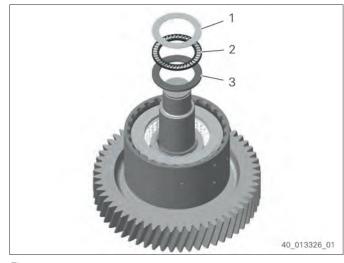


Fig. 271



Fig. 272

24. Slide idler gear (1) onto shaft until contact is obtained. Insert idler gear into the disk pack by short mutual rotary motions.

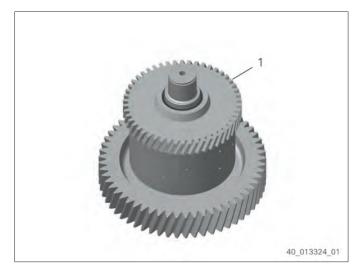


Fig. 273

- 25. Slide on the axial washer (3).
- 26. Slide on the axial needle bearing (2).
- 27. Slide on thrust washer (1) with the chamfer facing the axial needle bearing.



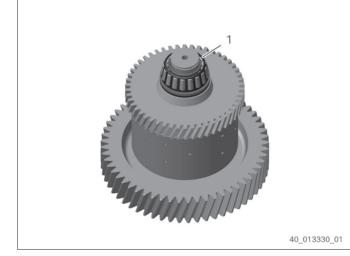
Fig. 274

Risk of burn injuries due to contact with hot surfaces. Slight or moderate injury possible.

 \Rightarrow Wear protective gloves.

Heat the bearing inner ring.

- 29. Slide bearing inner ring (1) onto shaft until contact is obtained.
- 30. Let bearing inner ring cool down.



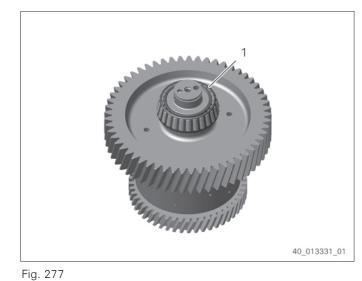


- 31. Adjust bearing inner ring.
- 32. Insert piston ring (1).



Fig. 276

33. X Carry out the following two work steps immediately one after the other.



Risk of burn injuries due to contact with hot surfaces. Slight or moderate injury possible. ⇒ Wear protective gloves.

Heat the bearing inner ring.

- 34. Slide bearing inner ring (1) onto shaft until contact is obtained.
- 35. Let bearing inner ring cool down.
- 36. Adjust bearing inner ring.



- 37. Screw in stud bolt (1) and tighten. Tightening torque: **17 Nm**
- 38. Insert piston ring (2).

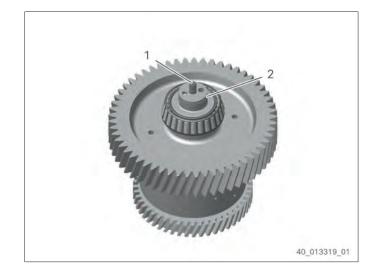


Fig. 278

- 39. Check function of the clutch with compressed air.
 - → Closing and opening of the clutch is clearly audible.

If closing and opening is not audible, remove and check clutch.



Fig. 279

Assembling clutch K4

Special tools:

• 5870.345.085 Assembly aid

 Carry out the following three work steps immediately one after the other.

Risk of burn injuries due to contact with cold surface. Slight to moderate injury possible.

 \Rightarrow Wear protective gloves.

Cool down shaft.

2. **CAUTION**

Risk of burn injuries due to contact with hot surfaces. Slight or moderate injury possible.

 \Rightarrow Wear protective gloves.

Heat up gear.

- 3. Slide gear (1) onto shaft until contact is obtained.
- 4. Insert securing ring in the shaft.



Fig. 280



Fig. 281

5. X Carry out the following two work steps immediately one after the other.

Risk of burn injuries due to contact with hot surfaces. Slight or moderate injury possible. ⇒ Wear protective gloves.

Heat the bearing inner ring.

- 6. Slide bearing inner ring (1) onto shaft until contact is obtained.
- 7. Let bearing inner ring cool down.
- 8. Adjust bearing inner ring.
- 9. Insert piston ring (1).

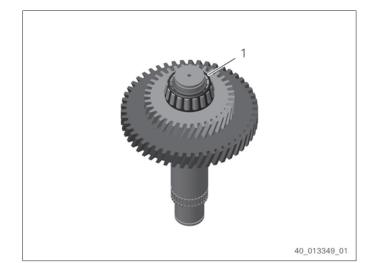


Fig. 282



Fig. 283

- 10. Slide on the axial washer (1).
- 11. Slide on the axial needle bearing (2).
- 12. Slide on the axial washer (1).

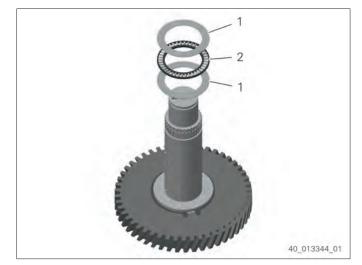


Fig. 284

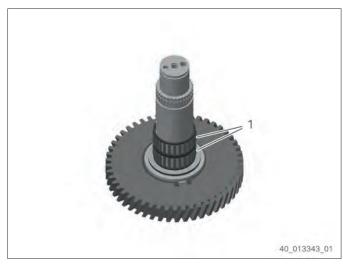


Fig. 285

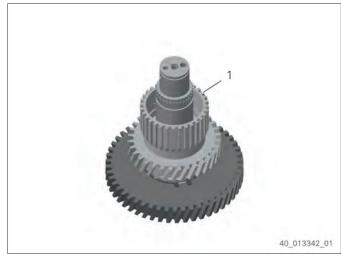


Fig. 286

13. Slide on needle cages (1).

14. Slide on idler gear (1).

- 15. Slide on the axial washer (3).
- 16. Slide on the axial needle bearing (2).
- Slide on thrust washer (1) with the chamfer 17. facing the axial needle bearing.

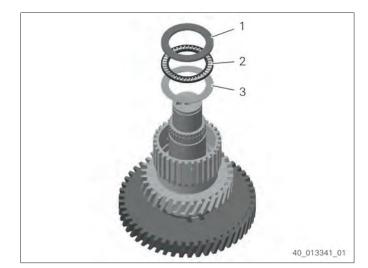


Fig. 287

- 18. Check clearance of the ball in the drain valve (1).
- Oil O-rings (2) and insert them twist-free in 19. the radial grooves.

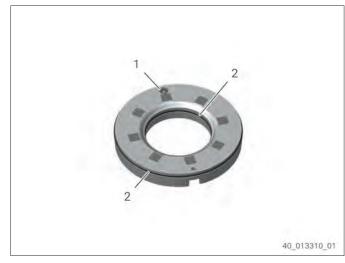


Fig. 288

- 20. Oil O-rings and piston bearing surfaces.
- 21. Insert piston (1) into the disk carrier until contact is obtained.



- 22. Slide on guide ring (3) with the offset front face facing upwards.
- 23. Slide on compression spring (2).
- 24. Slide on guide ring (1) with the offset front face facing downwards.



Fig. 290

- Preload compression spring with
 5870.345.085 [Assembly aid] and press.
- 26. Insert securing ring (1).



Fig. 291

Setting disk clearance

27. Insert friction disk (1) with the uncoated side facing the piston.



Fig. 292

- 28. Insert inner disks and outer disks.* For the arrangement refer to the current spare parts list.
- 29. Insert friction disk (1) with the uncoated side facing the end shim.



Fig. 293

- 30. Insert end shim (1).
- 31. Insert snap ring e. g. 3.15 mm.



Fig. 294

- 32. Position dial gauge on the end shim.
- 33. Push end shim downwards with 100 N and set dial gauge to zero.
- 34. Lift end shim on the snap ring until contact is obtained and check the necessary Disk clearance 1.35 mm until 1.65 mm.
 If the disk clearance is too small, install a thinner snap ring.
 If the disk clearance is too big, install a thicker snap ring.

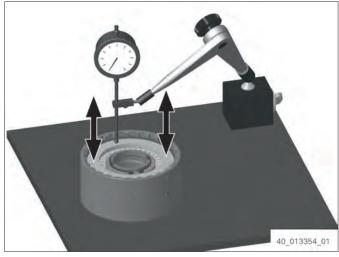


Fig. 295

Risk of burn injuries due to contact with hot surfaces. Slight or moderate injury possible.

⇒ Wear protective gloves.

Heat internal spline of the disk carrier.

Fig. 296

 Slide clutch onto shaft until contact is obtained. Insert idler gear into the disk pack by short mutual rotary motions.



Fig. 297

37. Insert securing ring in the shaft.



Fig. 298

Risk of burn injuries due to contact with hot surfaces. Slight or moderate injury possible. ⇒ Wear protective gloves.

Heat the bearing inner ring.

- 39. Slide bearing inner ring (1) onto shaft until contact is obtained.
- 40. Let bearing inner ring cool down.
- 41. Adjust bearing inner ring.
- 42. Screw in stud bolt (1) and tighten. Tightening torque: **17 Nm**
- 43. Insert piston ring (2).



Fig. 299

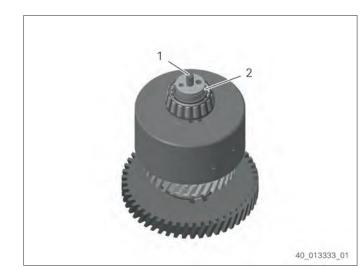


Fig. 300

- 44. Check function of the clutch with compressed air.
 - → Closing and opening of the clutch is clearly audible.

If closing and opening is not audible, remove and check clutch.



Fig. 301

Assembling input shaft

 Carry out the following three work steps immediately one after the other.

Risk of burn injuries due to contact with cold surface.

Slight to moderate injury possible. ⇒ Wear protective gloves.

Undercool input shaft.

2. **CAUTION**

Risk of burn injuries due to contact with hot surfaces.

Slight or moderate injury possible.

 \Rightarrow Wear protective gloves.

Heat up input gear.

3. Slide input gear onto input shaft until contact is obtained.



Fig. 302

4. Insert securing ring (1) in the input shaft.

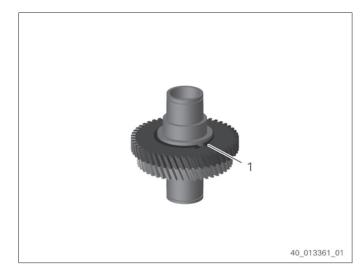


Fig. 303

- 5. Grease O-ring.
- 6. Insert O-ring (1) in the radial groove of the input shaft.

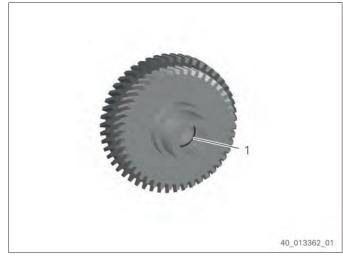
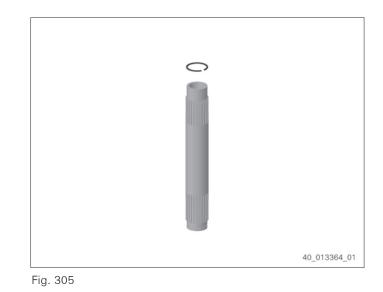


Fig. 304

7. Insert snap ring in the radial groove on the turbine shaft.



8. Insert turbine shaft in the input shaft until the snap ring audibly engages.



Fig. 306

9. **(AUTION**

Risk of burn injuries due to contact with hot surfaces.

Slight or moderate injury possible.

 \Rightarrow Wear protective gloves.

Slide the heated bearing inner rings (2) on until contact is obtained.

- * Adjust bearing inner rings after coolingdown.
- 10. Insert R-rings (1).

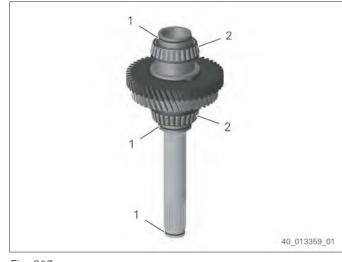


Fig. 307

Installing clutches

Special tools:

• AA02.691.822 Handle

 Insert clutch KV (1), input shaft (2) and clutch KR (3) together in the housing rear section.



Fig. 308

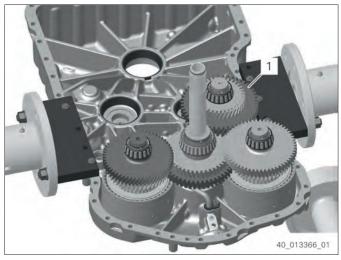


Fig. 309

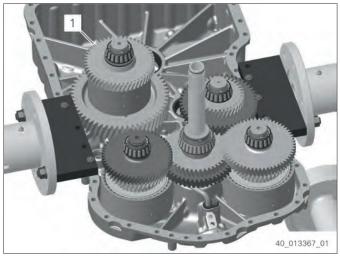


Fig. 310

2. Insert clutch K4 (1).

3. Insert clutch K3 (1).

4. Insert clutch K2 (1).

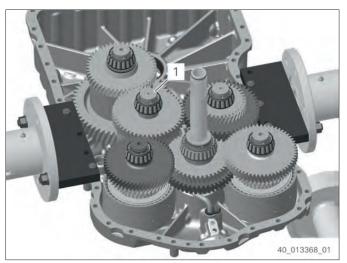


Fig. 311

 Lift up clutch K4 (2) slightly and insert clutch K1 (1).

Fasten clutches K1, K2, K3 and K4 in the

housing rear section with AA02.691.822 [Handle].

6.

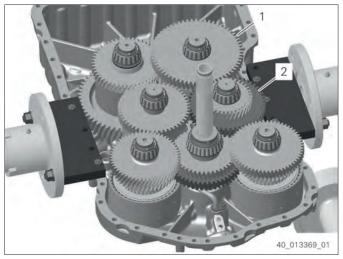


Fig. 312

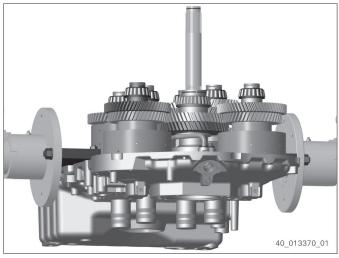


Fig. 313

Assembling housing front part

Special tools:

- AA02.068.532 Pipe roller
- 1. Insert suction tube (1) in housing front part.
- 2. Fasten suction tube with cap screw. Tightening torque: **23 Nm**

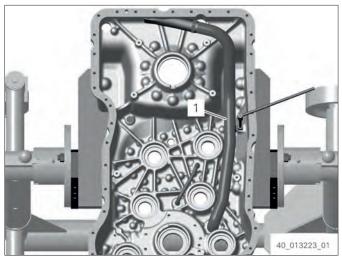


Fig. 314

ipe

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Fig. 315

- 3. Apply oil to inner diameter of the suction tube and to rollers of AA02.068.532 [Pipe roller].
- 4. Insert AA02.068.532 [Pipe roller] in suction tube.
- Fasten suction tube with AA02.068.532 [Pipe roller] in the front part of the housing. Tightening torque: 40 Nm

- 6. Grease O-rings.
- 7. Insert O-rings (1) in radial grooves of the oil tube.



Fig. 316

8. Grease O-rings.

Insert oil tubes (1).

Fix oil tubes with cap screws. Tightening torque: **23 Nm**

10.

11.

9. Insert O-rings (1) in radial grooves of the oil tube.



Fig. 317

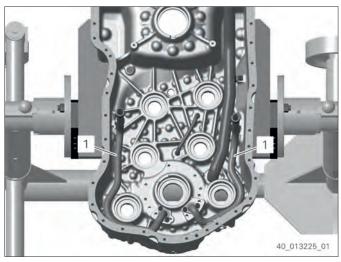


Fig. 318

- 12. Insert bearing outer rings in housing holes until contact is obtained. The Figure shows the positions of the bearing outer rings.
 - 1 = Output shaft
 - 2 = Clutch K3
 - 3 = Clutch K2
 - 4 = Clutch KV
 - 5 = Input shaft
 - 6 = Clutch KR
 - 7 = Clutch K4
 - 8 = Clutch K1

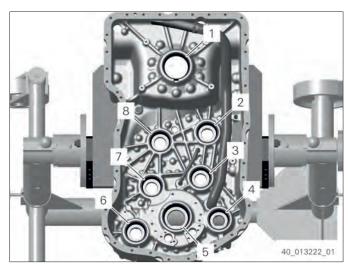


Fig. 319

Assembling and installing output shaft

Special tools:

- AA01.100.718 Eyebolt
- Carry out the following two work steps immediately one after the other.

Risk of burn injuries due to contact with hot surfaces. Slight or moderate injury possible.

 \Rightarrow Wear protective gloves.

Heat the bearing inner ring.

- 2. Slide bearing inner ring (1) onto the output shaft until contact is obtained.
- 3. Let bearing inner ring cool down.
- 4. Adjust bearing inner ring.



Fig. 320

5. Slide on screen sheet (1).



Fig. 321

6. X Carry out the following two work steps immediately one after the other.



Risk of burn injuries due to contact with hot surfaces. Slight or moderate injury possible.

 \Rightarrow Wear protective gloves.

Heat the bearing inner ring.

7. Slide on bearing inner ring (1) until contact is obtained.



Fig. 322

- 8. Let bearing inner ring cool down.
- 9. Adjust bearing inner ring.

10. Place on screen sheet (1).



Fig. 323

Fig. 324

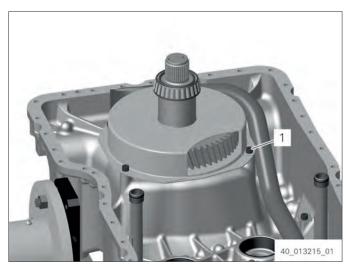


Fig. 325

11. Insert output shaft with AA01.100.718 [Eyebolt] and crane.

12. Fasten screen sheets with cap screws (1). Tightening torque: **23 Nm**

Assembling the housings

Special tools:

- 5870.204.083 Eyebolt
- 5870.204.086 Eyebolt
- AA02.691.822 Handle

Operating supplies and auxiliary materials:

- 0666.790.033 LOCTITE 574
- 1. Apply 0666.790.033 [LOCTITE 574] onto the mounting face (1).

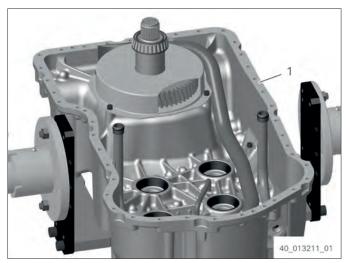


Fig. 326

- 2. Screw two 5870.204.083 [Eyebolt] into the housing rear section.
- 3. Screw in two 5870.204.086 [Eyebolt].

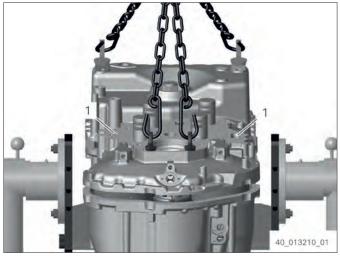


Fig. 327

4.

Risk of injury due to uncontrolled motion of the load.

Death or serious injury possible.

- ⇒ Only use the suspension points intended for transportation purposes.
- Only use secure, permitted, and tested means of transport, chain hoist, and lifting equipment with sufficient load capacity and suitable lifting technology.
- Ensure that lifting equipment such as ropes and belts are not in contact with sharp edges and are not knotted or twisted.
- ⇒ Properly attach lifting appliances to load.
- ➡ Observe the load's center of gravity! The crane hook must be located above the load's center of gravity.
- Lift load slowly and observe whether the load tilts or swivels out laterally. If required, immediately put down load and modify attachment.
- ⇒ Keep distance.
- \Rightarrow Do not walk under suspended loads.
- \Rightarrow Only ever move load under supervision.

Install housing rear section and clutches with a crane. Insert oil tubes in housing holes (1).

5. Remove four AA02.691.822 [Handle].

6. **CAUTION**

Risk of injury due to parts flying away. Slight or moderate injury possible. ⇒ Wear protective goggles.

Insert both cylindrical pins centrally.

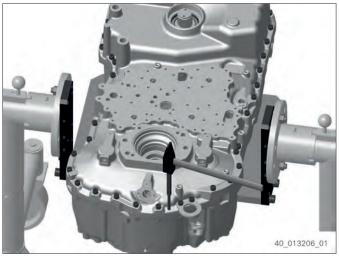


Fig. 328

- Bolt in and tighten cap screws (1).
 Tightening torque: 46 Nm
- 8. Fasten fixing plate (2) with cap screws. Tightening torque: **46 Nm**

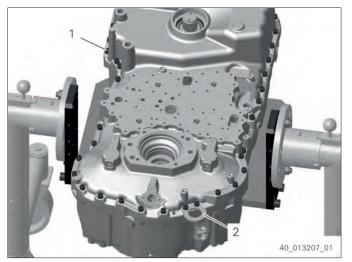


Fig. 329

Mounting cover (emergency steering pump)

Special tools:

- 5870.204.011 Fixing pin
- 1. Screw two 5870.204.011 [Fixing pin] into the housing.
- 2. Put on seal (1).

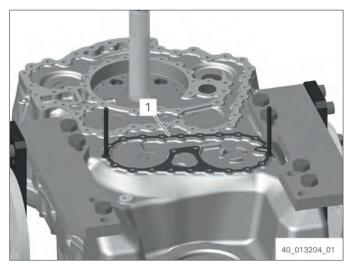


Fig. 330

- 3. Place the cover (1).
- 4. Fasten cover with hexagon screws. Tightening torque: 23 Nm

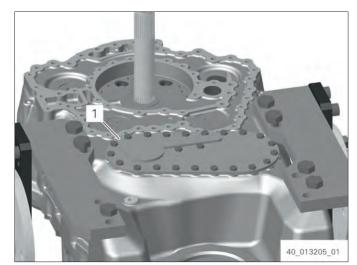


Fig. 331

Mounting the oil feed housing and oil pressure pump

Special tools:

- 5870.204.007 Locating pin
- 5870.204.011 Locating pin
- 5870.055.070 Driver tool
- 5870.260.002 Handle
- 5870.345.126 Assembly fixture

Operating supplies and auxiliary materials:

- 0666.690.191 PHÖNIX SPIRITUS
- 1. Screw two 5870.204.007 [Locating pin] into the housing.
- 2. Insert the stator shaft (1).
 - * Observe radial installation position.

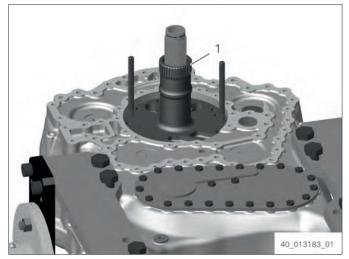


Fig. 332

- 3. Bolt in four 5870.204.011 [Locating pin].
- 4. Put on seal (1).

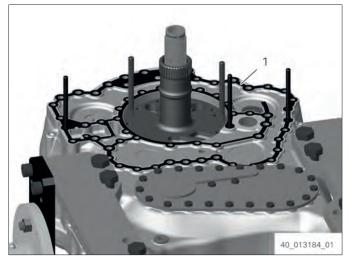


Fig. 333

- 5. Insert the piston (1) in the oil feed housing.
- 6. Insert compression spring (2).
- 7. Insert pressure plate (3).

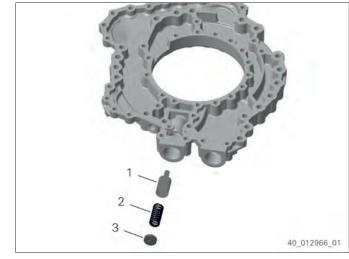


Fig. 334

8. Push pressure plate inwards with a mandrel and insert fixing plate (1).

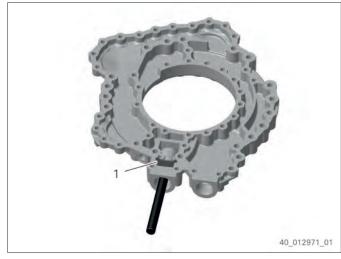


Fig. 335

9. Slide on the oil feed housing (1).

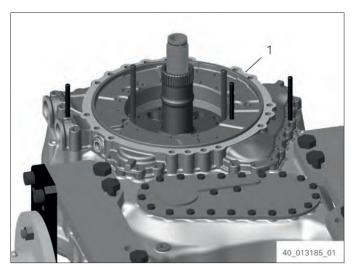


Fig. 336

Checking gear pump

- 10. Remove shaft sealing ring (1).
- 11. Remove O-ring (2).



Fig. 337

The gear pump is only available as a complete unit.

Loosen cap screws (1).



Fig. 338

- 13. Lift off cover (1).
- 14. Check the cover (1), outer rotor (2), inner rotor (3) and the housing (4) for wear marks. In case of any damage, install new gear pump.
- Insert the outer rotor (2) and inner rotor (3) with the chamfered tooth side facing the housing (4).
- 16. Place the cover (1).
- 17. Screw in cap screws by hand until contact is obtained and loosen again by 180°.

Apply 0666.690.191 [PHÖNIX SPIRITUS] to outer diameter of the shaft sealing ring.

- 19. Use 5870.055.070 [Driver tool] and5870.260.002 [Handle] to insert shaft seal(1) with the seal lip facing the oil chamber.
- 20. Apply oil to O-ring.
- 21. Insert O-ring (2) into radial groove.
- Insert gear pump with
 5870.345.126 [Assembly fixture] into oil feed housing until contact is obtained.

* Observe radial installation position.

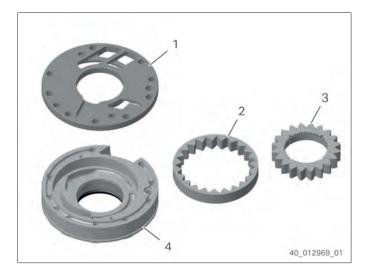


Fig. 339



Fig. 340



Fig. 341

- 23. Slide O-rings onto cap screws.
- 24. Fasten gear pump (1) with cap screws. Tightening torque: **46 Nm**

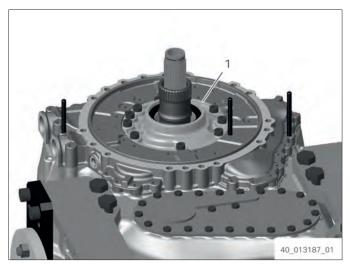


Fig. 342

- 25. Fasten the oil feed housing (1) with internal hexalobular bolts.Tightening torque: 23 Nm
- 26. Fasten fixing plate (2) with cap screws. Tightening torque: **46 Nm**

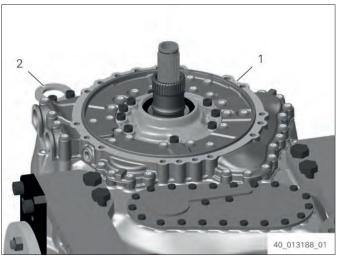


Fig. 343

Assembling and mounting motor connection

Installing torque converter bell housing

Special tools:

- 5870.204.007 Locating pin
- AA02.247.426 Eyebolt

- 1. Screw in two 5870.204.007 [Locating pin].
- 2. Mount torque converter bell housing with two AA02.247.426 [Eyebolt] and a crane.

Screw in and tighten hexagon screws (1).

Tightening torque: 65 Nm



Fig. 344



Fig. 345

Installing the converter

Special tools:

3.

• AA02.676.915 Load ring

Operating supplies and auxiliary materials:

• 0666.690.022 LOCTITE 262

- 1. Position flexplate (1) on the input shaft.
- 2. Apply 0666.690.022 [LOCTITE 262] to threads of the hexagon screws.
- Screw in and tighten hexagon screws. Tightening torque: 115 Nm

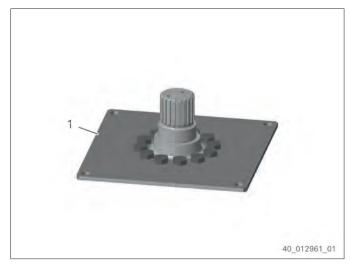


Fig. 346

- 4. Place the input shaft with flexplate (2) on the converter.
- 5. Apply 0666.690.022 [LOCTITE 262] to threads of the hexagon screws.
- Screw in and tighten hexagon screws (1). Tightening torque: 115 Nm

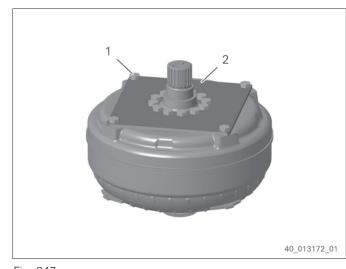


Fig. 347

- 7. Insert the ball bearing (2) in the cover until contact is obtained.
- 8. Insert V-ring (1).



Fig. 348

9. **CAUTION**

Risk of crushing due to hydraulic tool.Slight to moderate injury possible.⇒ Do not reach into danger area.

Use suitable tool to force the cover onto input shaft until contact is obtained.



Fig. 349

10. Force screen sheet (1) onto yoke until contact is obtained.



Fig. 350

11. X Carry out the following two work steps immediately one after the other.

Risk of burn injuries due to contact with hot surfaces.

Slight or moderate injury possible.

 \Rightarrow Wear protective gloves.

Heat internal spline of the yoke.



Fig. 351

12. Slide yoke (1) onto input shaft until contact is obtained.

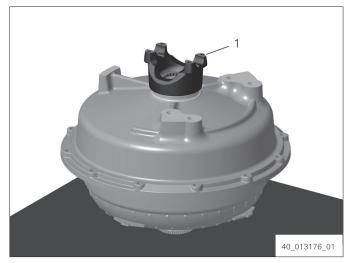


Fig. 352

- 13. Position washer (1).
- Screw in and tighten hexagon screws (2).
 Tightening torque: 40 Nm

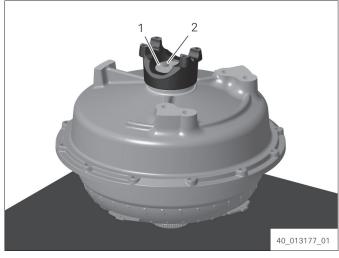


Fig. 353



Fig. 354

15. **CAUTION**

Risk of crushing due to moving parts. Slight or moderate injury possible. ⇒ Do not reach into danger area!

Use two AA02.676.915 [Load ring] and a crane to slide on the converter until contact is obtained. Mount the cover according to the marking.

 Insert cap screws (1) into the holes and tighten nuts.
 Tightening torque: 46 Nm



Fig. 355

Installing pump shaft

- 1. Press ball bearing (2) onto pump shaft until contact is obtained.
- Set Axial clearance of the ball bearing 0.00 mm to 0.05 mm. Insert securing ring e. g. 2.35 mm (1) into radial groove of the pump shaft.
- Check play-free seating of the securing ring. If securing ring has play, install thicker securing ring. If securing ring cannot be inserted into radial groove, use thinner securing ring.
- 4. Insert R-ring (1) in radial groove.

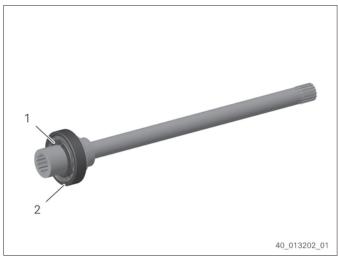


Fig. 356

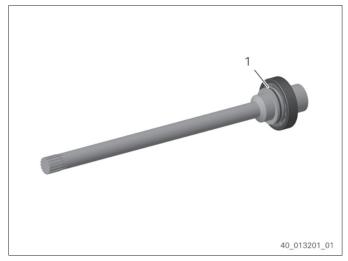


Fig. 357

5. Insert pump shaft (1) into the transmission until contact is obtained. Insert the pump shaft in the gearing of the converter.



Fig. 358



Fig. 359

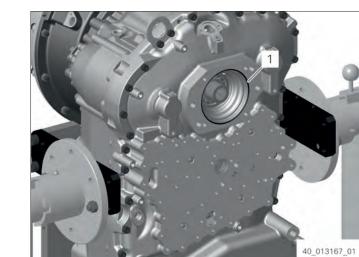


Fig. 360

6. Insert securing ring.

Mounting cover plate (PTO)

- 1. Grease O-ring.
- 2. Insert the O-ring (1) into the countersink of the housing.

Fix cover plate (1) with hexagon screws.
 Tightening torque: 46 Nm

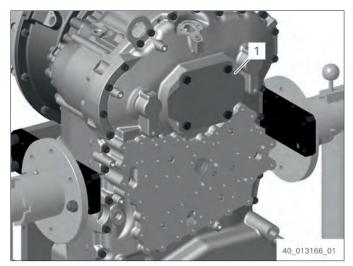


Fig. 361

Assembling and installing shift system

Installing duct plate

Special tools:

- 5870.204.037 Fixing pin
- 1. Insert converter safety valve (1) into the housing hole until contact is obtained.

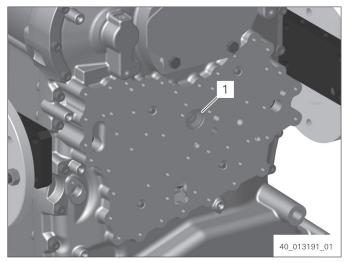


Fig. 362

Bolt in screw plugs into the duct plate and tighten.
 Tightening torque: 25 Nm
 Tightening torque: 30 Nm



Fig. 363

- 3. Screw in two 5870.204.037 [Fixing pin].
- 4. Slide on seal (1).

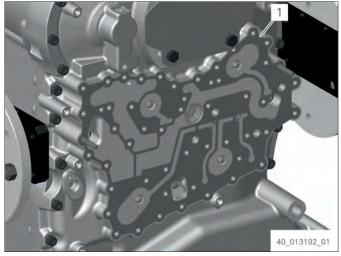


Fig. 364

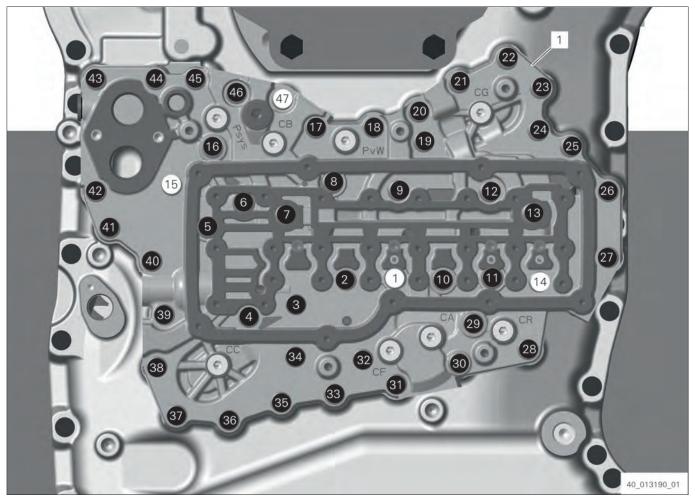


Fig. 365

- 5. Slide on duct plate (1).
- 6. Fix duct plate with internal hexalobular bolts in the specified order. Tightening torque: **23 Nm**
- 7. Insert valves (1) in duct plate.

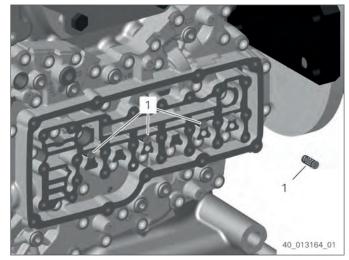


Fig. 366

- 8. Insert compression springs (1) in holes (3).
- 9. Insert pistons (2) in holes (3).

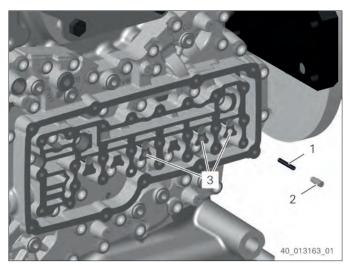


Fig. 367

Assembling and mounting valve blocks

Special tools:

- 5870.204.063 Fixing pin
- AA02.416.230 Driver tool
- AA02.416.754 Driver tool
- AA02.414.200 Driver tool
- AA02.318.019 Torque wrench
- 1. Bolt two 5870.204.063 [Fixing pin] into the duct plate.
- 2. Push on intermediate plate (1).

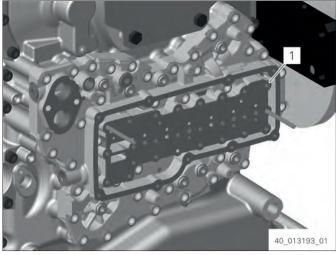


Fig. 368

- 3. Insert the control piston (1) in the hole.
- 4. Insert compression spring (2).
- 5. Apply oil to O-ring
- Insert O-ring in the radial groove of the plug (3).
- 7. Insert the plug (3) in the hole.

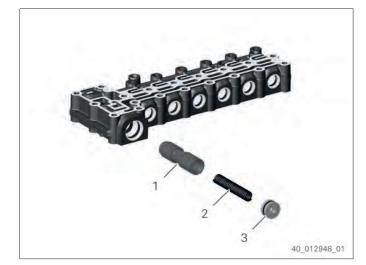


Fig. 369

 Press the plug inwards with AA02.416.230 [Driver tool] until contact is obtained and insert fixing plate (1).



Fig. 370

- 9. Insert the compression spring (1) into the bore.
- 10. Insert the control piston (2).
- 11. Apply oil to O-ring
- 12. Insert O-ring in the radial groove of the plug (3).
- 13. Insert the plug (3) in the hole.



Fig. 371

14. Push the plug inwards with the AA02.416.754 [Driver tool] until contact is obtained and insert the spring clip (1).

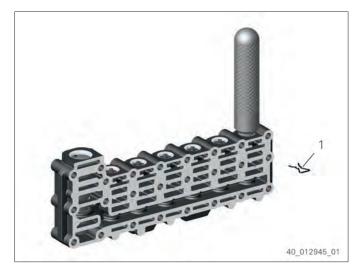


Fig. 372

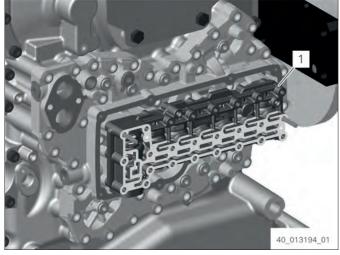


Fig. 373

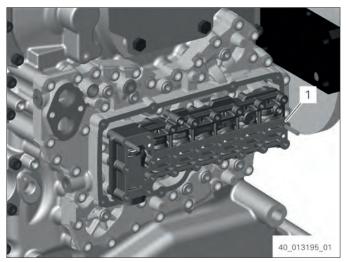


Fig. 374

15. Push on valve block (1).

16. Push on intermediate plate (1).

- 17. Insert piston (1) in the hole.
- 18. Insert compression spring (2).

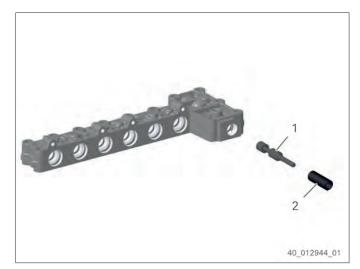


Fig. 375

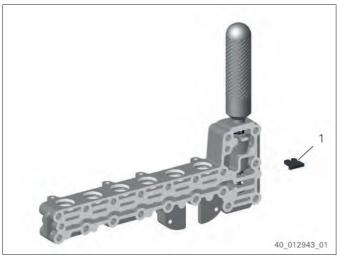


Fig. 376

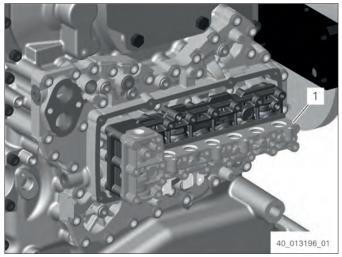


Fig. 377

19. Push the compression spring inwards with AA02.414.200 [Driver tool] until contact is obtained and insert the fixing plate (1).

20. Push on valve block (1).

21. Screw in and tighten the hexalobular driving screws (1).Tightening torque: 3 Nm

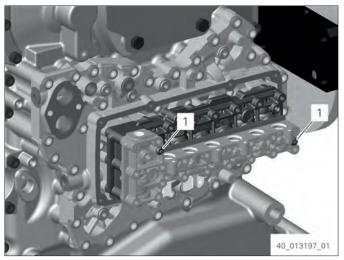


Fig. 378

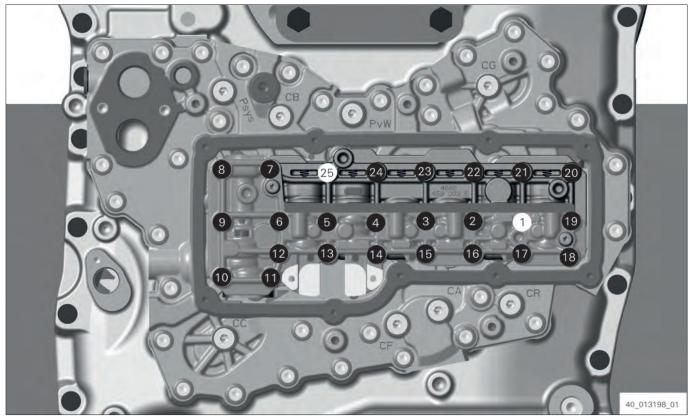


Fig. 379

Bolt in internal hexalobular bolts (1) to (19) and tighten with AA02.318.019 [Torque wrench] in the specified order.
Tightening torque: 3 Nm and 60° additional angle (tightening torque must be between 7 Nm and 13 Nm)

* If the tightening torque is not within the range specified, fit a new screw.

23. Bolt in internal hexalobular bolts (20) to (25) and tighten with AA02.318.019 [Torque wrench] in the specified order.

Tightening torque: **3** Nm and **45°** additional angle (tightening torque must to be between 7 Nm and 13 Nm)

* If the tightening torque is not within the range specified, fit a new screw.

Installing the pressure controllers

 Pay attention to radial installation position of the pressure controllers.

Insert pressure controllers with O-rings (2) in valve block.

 Fix the pressure controllers with clamping plate (1) and internal hexalobular bolts. Tightening torque: 9.5 Nm

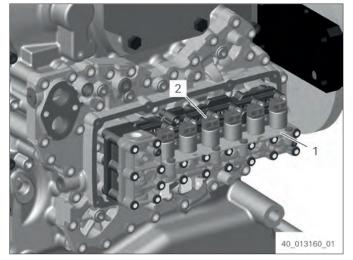


Fig. 380

- 3. Insert plugs (1) on the pressure controllers.
- 4. Fix plug (3) with fixing plate (4) and internal hexalobular bolts.Tightening torque: 9.5 Nm
- 5. Insert cable (2) in cable routing on the clamping plate.

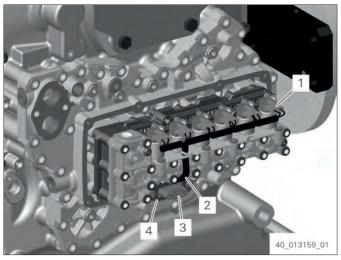


Fig. 381

Installing control unit (EC4A)

Special tools:

• 5870.204.063 Fixing pin

1. Insert seal (1) in control unit (2).



Fig. 382

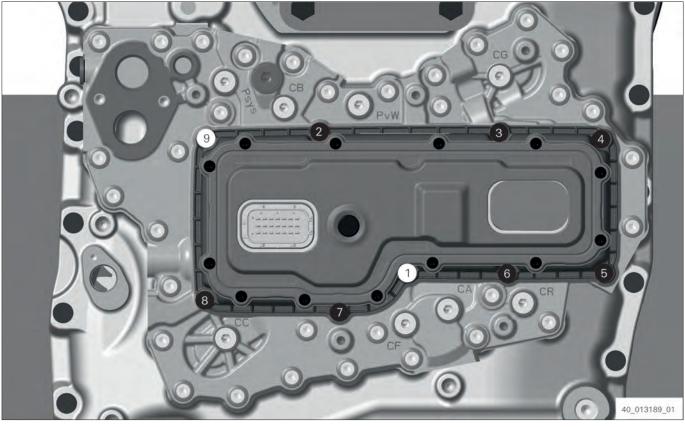


Fig. 383

- 2. Bolt two 5870.204.063 [Fixing pin] into the duct plate.
- 3. Slide on control unit.
- 4. Bolt in internal hexalobular bolts and tighten in the specified order. Tightening torque: **9.5 Nm**

Installing filter bypass valve

1. Insert compression spring (2) and piston (3) in hole (1).

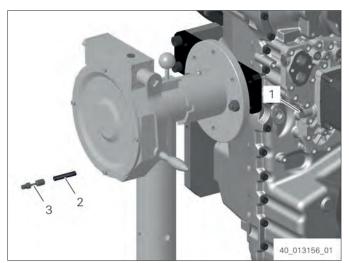


Fig. 384

Screw in tappet switch with O-ring (1) and tighten.
 Tightening torque: 30 Nm

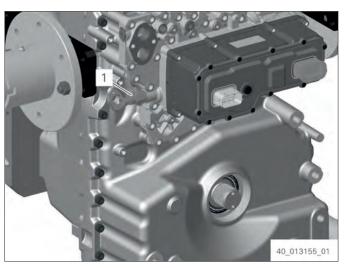


Fig. 385

Installing output flanges

Special tools:

• 5870.048.057 Driver tool

Operating supplies and auxiliary materials:

• 0666.690.191 PHÖNIX SPIRITUS

Installing output flange on gearshift side

 Carry out the following two work steps immediately one after the other.

Apply 0666.690.191 [PHÖNIX SPIRITUS] to outer diameter of the shaft sealing ring.

2. Use 5870.048.057 [Driver tool] to insert shaft seal (1) with seal lip facing the oil chamber.

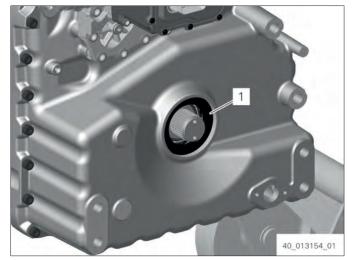


Fig. 386

3. Push the output flange (1) onto the output shaft until contact is obtained.

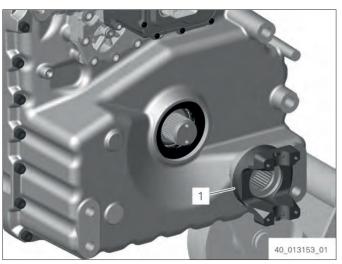


Fig. 387

Fig. 388

4. Insert O-ring (1) in the space between output shaft and output flange.

 Fix output flange with washer (2) and hexagon screws (1). Tightening torque: 40 Nm

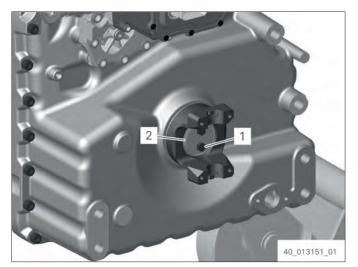


Fig. 389

Installing output flange on input side

6. X Carry out the following two work steps immediately one after the other.

Apply 0666.690.191 [PHÖNIX SPIRITUS] to outer diameter of the shaft sealing ring.

7. Use 5870.048.057 [Driver tool] to insert shaft seal (1) with seal lip facing the oil chamber.

8. Push the output flange (1) onto the output shaft until contact is obtained.

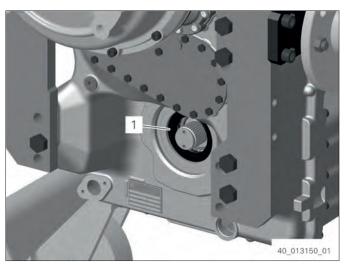


Fig. 390

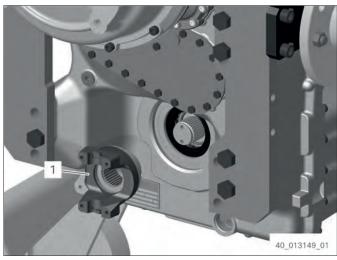


Fig. 391

10.

9. Insert O-ring (1) in the space between output shaft and output flange.

Fix output flange with washer (2) and

hexagon screws (1).

Tightening torque: 40 Nm

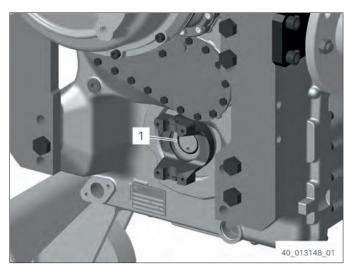


Fig. 392

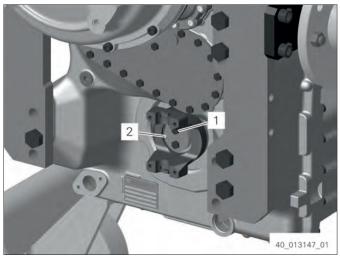


Fig. 393

Installing the temperature sensors and the breather

- Screw in breather (1) and tighten.
 Tightening torque: 12 Nm
- Screw in and tighten temperature sensors with O-ring (2). Tightening torque: 25 Nm

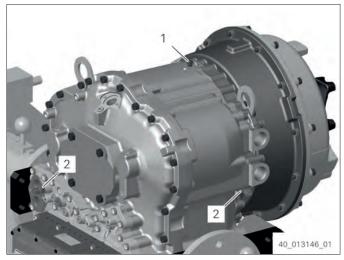


Fig. 394

Installing the speed sensors and pressure controller

- Insert speed sensors with sealing element (1) in housing holes.
- 2. Fix speed sensors with cap screws. Tightening torque: **9.5 Nm**

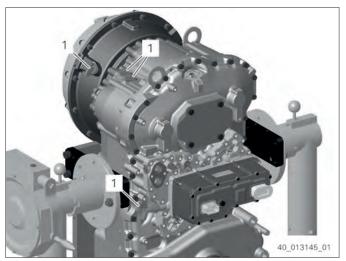


Fig. 395

Fig. 396

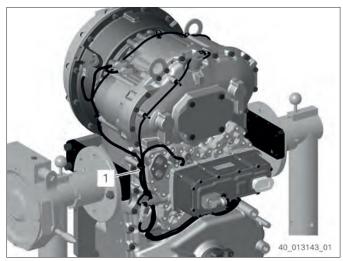


Fig. 397

- Insert the pressure controller with O-rings (1) in the 3 o'clock position in the housing hole.
- Fix pressure controller with cap screws.Tightening torque: 9.5 Nm

Route cable (1) and insert plugs.

Fasten cable to the transmission with cable

5.

6.

ties.

Installing cover plate (filler neck)

- 1. Put on seal and cover plate (1).
- 2. Screw in and tighten hexagon screws. Tightening torque: **23 Nm**

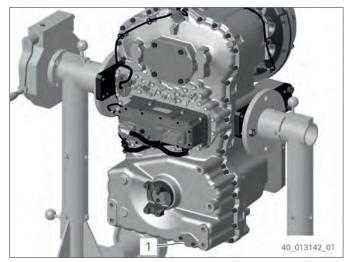


Fig. 398

- 3. Put on seal and cover plate (1).
- 4. Screw in and tighten hexagon screws. Tightening torque: **23 Nm**

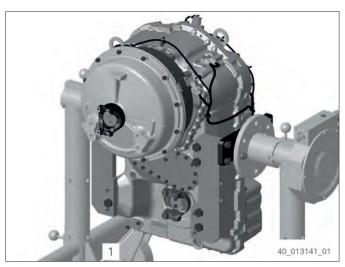


Fig. 399

Installing the pressure filter

1. Oil O-rings (1) and insert them in the radial grooves on the filter head.



Fig. 400

 Fix filter head (1) with internal hexalobular bolts.
 Tightening torque: 34 Nm

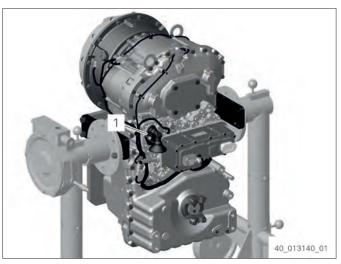


Fig. 401



Fig. 402

- 3. Lightly oil the seal of the pressure filter.
- 4. Screw in pressure filter (1) until contact is obtained with the sealing surface on the filter head.
- 5. Tighten the pressure filter.
 Tightening torque: Contact sealing surface +90° to 180°
 As an alternative use a tool with torque indicator to tighten.
 Tightening torque: 40 Nm

Adding oil

- Bolt in screw plug with O-ring (1) and tighten.
 Tightening torque: 80 Nm
- 2. Prior to initial operation, fill transmission with oil according to Operating Instructions.

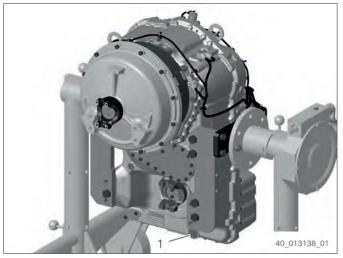


Fig. 403

Group	1	Structure and Function	4-1
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Group	3	Tests and Adjustments	4-38
Group	4	Disassembly and Assembly	4-40

SECTION 4 BRAKE AND FAN SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. OUTLINE

The variable displacement piston pump supplies the hydraulic oil that is required in order to operate the brake and the hydraulic fan system. Oil flows from pump to the cut-off valve.

The cut-off valve controls the flow of oil from the pump to the brake accumulators and also controls the flow of oil to the hydraulic fan motor.

The cut-off valve contains a priority valve. The brake system has priority. The oil flows to the brake accumulators while the accumulators are charged. After the accumulators are fully charged, the oil then flows to the hydraulic fan system.

The accumulator has pre-charged gas and an inlet check valve to maintain a pressurized volume of oil for reserving brake system.

The oil through the accumulator flows to the brake valves. The brake valve is a closed center design, dual circuit operated by a pedal.

The front and rear brakes will operate simultaneously with only one brake pedal depressed.

The hydraulic fan system is used to meet the cooling requirements. The hydraulic fan system controls the fan speed through the pump output pressure. The desired pressure level can be set by varying the solenoid current.

The hydraulic fan system contains directional valve that reverses the direction of fan.

The brake and hydraulic fan system contains the following components :

- · Fan & brake pump
- · Cut-off valve
- · Brake valve
- · Accumulators
- · Pressure sensors and switch
- · Fan motor
- · Directional valve

FULL POWER HYDRAULIC BRAKE SYSTEM

ADVANTAGES - The full power hydraulic brake system has several advantages over traditional brake actuation systems. These systems are capable of supplying fluid to a range of very small and large volume service brakes with actuation that is faster than air brake systems. Figure represents a time comparison between a typical air/ hydraulic and full power hydraulic brake actuation system.

Full power systems can supply significantly higher brake pressures with relatively low reactive pedal forces. The reactive pedal force felt by the operator will be proportional to the brake line pressure being generated.

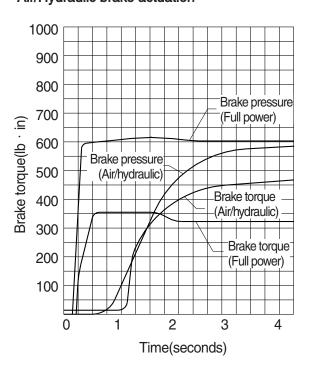
This is referred to as brake pressure modulation.

Another key design feature of full power systems is the ability to control maximum brake line pressure. In addition, because these systems operate with hydraulic oil, filtration can be utilized to provide long component life and low maintenance operation.

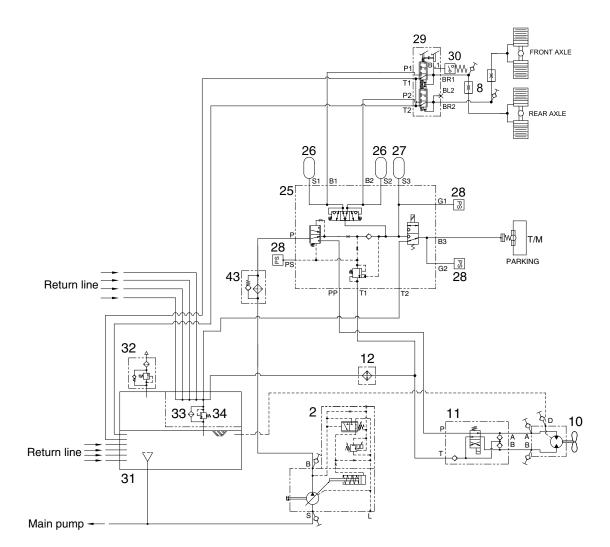
Because these systems are closed center, by using a properly sized accumulator, emergency power-off braking that is identical to power-on braking can be achieved. These systems can be either dedicated, where the brake system pump supplies only the demands of the brake system or non-dedicated, where the pump supplies the demands of the brake system as well as some secondary down stream hydraulic device.

Another important note is that all seals within these system must be compatible with the fluid medium being used.

Response time Full power brake actuation VS Air/Hydraulic brake actuation



2. HYDRAULIC CIRCUIT



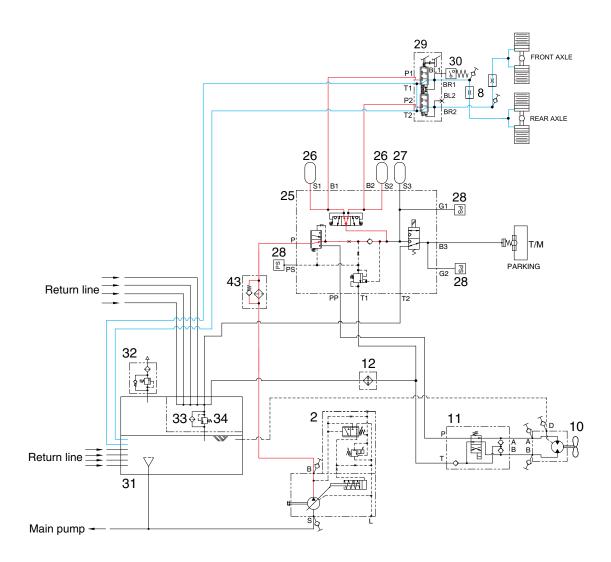
940T34BS01

- 2 Fan & brake pump
- 8 Orifice
- 10 Fan motor
- 11 Directional valve
- 12 Oil cooler
- 25 Cut-off valve

- 26 Accumulator
- 27 Accumulator
- 28 Pressure sensor
- 29 Brake valve
- 30 Pressure switch
- 31 Hydraulic tank

- 32 Air breather
- 33 Return filter
- 34 Bypass valve
- 43 Filter assy

1) SERVICE BRAKE RELEASED



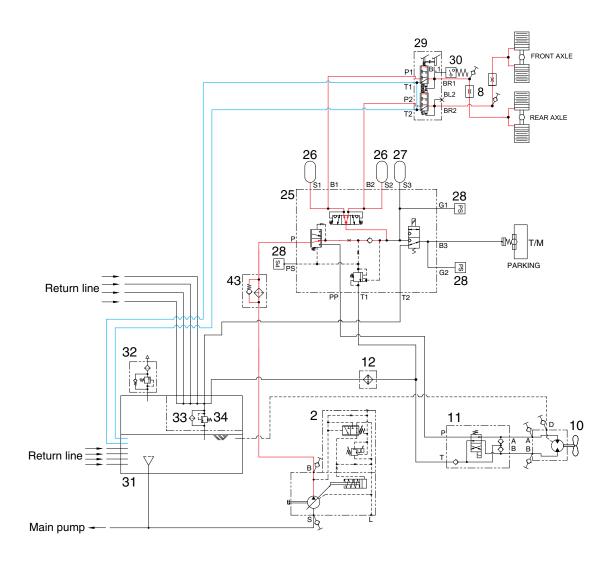
940T34BS02

When the pedal of brake valve (29) is released, the operating force is eliminated by the force of the spring, and the spool is returned.

When the spool removes up, the drain port is opened and the hydraulic oil in the piston of axles return to the tank (31).

Therefore, the service brake is kept released.

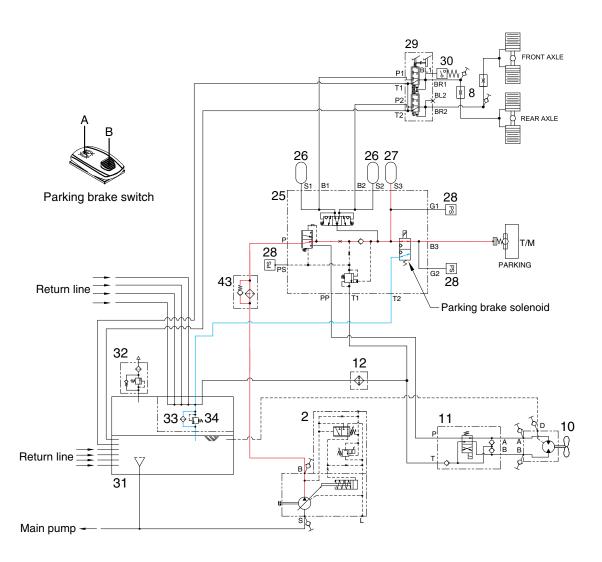
2) SERVICE BRAKE OPERATED



940T34BS03

When the pedal of brake valve (29) is depressed, the operating force overcomes the force of the spring, and is transmitted to the spool. When the spool moves down, the inlet port is opened, and at the same time the hydraulic oil controlled the pressure level by the cut-off valve (25) enters the piston in the front and rear axles. Therefore, the service brake is applied.

3) PARKING BRAKE RELEASED

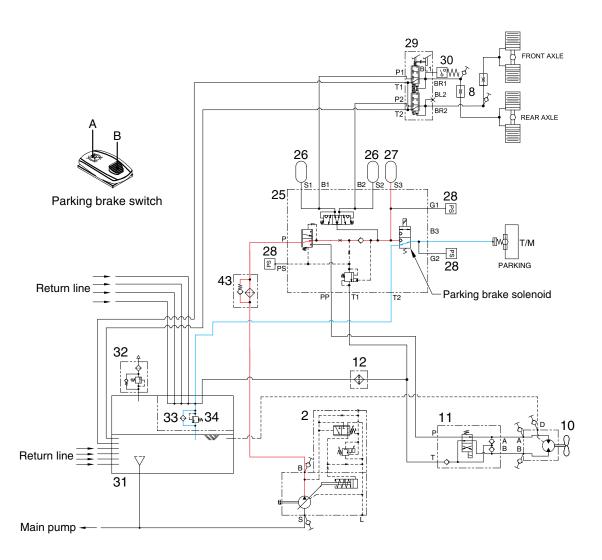


940T34BS04

When the parking brake switch is pressed A position, the solenoid value is energized and the hydraulic oil controlled the pressure level by the cut-off value enters the parking brake. It overcomes the force of the spring and pushes the piston rod. This releases the brake.

Therefore, the hydraulic oil pressure is applied to the parking brake piston through the solenoid valve and the parking brake is kept released.

4) PARKING BRAKE OPERATED

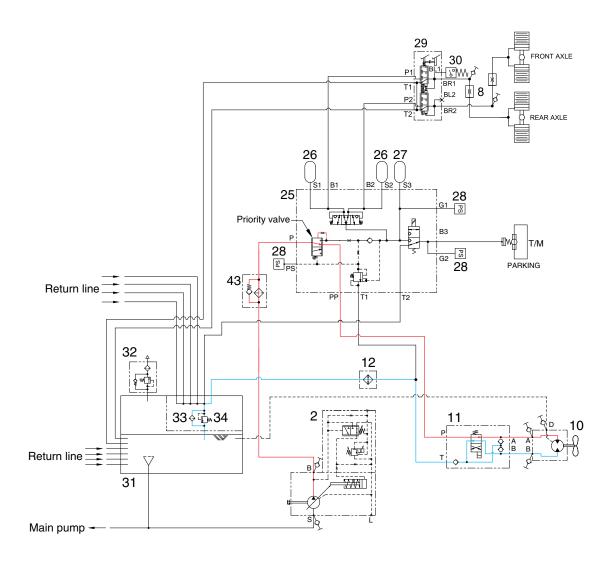


940T34BS05

When the parking brake switch is pressed B position, the solenoid valve is deenergized and the valve open the drain port.

At the same time, the hydraulic oil in the parking brake return to the tank through the solenoid valve. When the piston rod is returned by the force of the spring, the parking brake is applied.

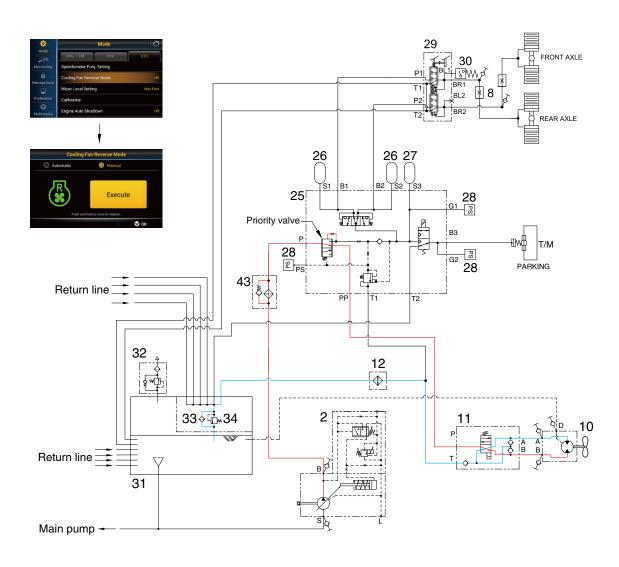
5) FAN MOTOR OPERATED



940T34BS06

When the brake accumulators are fully charged, the priority valve switches position and the oil is directed to hydraulic fan motor through directional valve (11). The flow of the oil causes fan motor (10) to rotate the fan blade. The rotation of the fan forces cool air to flow through the cooler.

6) DIRECTIONAL VALVE OPERATED

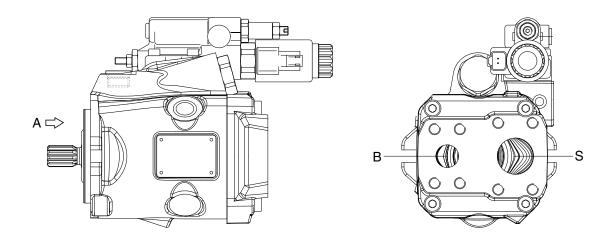


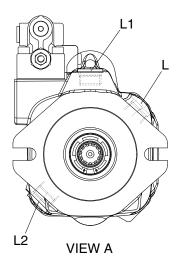
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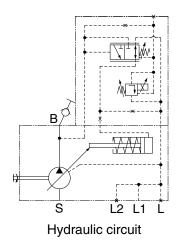
When the fan control switch is pressed A or M position, the solenoid value in the directional value (11) is energized and the flow of the oil is changed. The rotation of the fan is reversed to clear the radiators.

3. FAN AND BRAKE PUMP

1) STRUCTURE

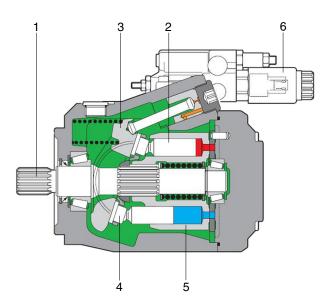






Port	Port name	Port size
В	Delivery port	SAE 3/4"
S	Suction port	SAE 1 1/4"
L, L1, L2	Drain port	3/4-16UNF-2B

2) OPERATION



7609A4BS31

The pump is a variable displacement piston pump. This pump has a maximum delivery pressure of 250 kgf/cm². The axial piston type pump is used to supply oil flow to the cut off valve. The oil is pressurized by the movement of rotary group in the pump.

When the engine is in operation, the drive shaft (1) is driven by the gears in the engine with rotary group. There are nine piston assemblies (2) in rotary group.

Each piston inside cylinder (5) is held against swashplate (3) by piston shoe (4). Swashplate can be any angle between the maximum angle and the neutral angle. The angle of swashplate determines the amount of oil that is pushed out of each cylinder.

The neutral angle is perpendicular with drive shaft (1). When swashplate(3) is at the neutral angle, pistons (2) do not move in and out of rotating cylinder. Therefore, no oil is drawn into the pump and no oil is pushed out of the pump. The pump has zero displacement and zero flow.

When swashplate (3) is at the maximum angle, pistons (2) move in and out of cylinder. The movement of the pistons allows the maximum amount of oil to be drawn into the cylinder. The pump will produce the maximum displacement.

The swashplate (3) angle is controlled by command current signal to control valve solenoid (6). The pump output pressure level can be set by the solenoid current. When the solenoid current signal drops toward a zero value, the pump output pressure level is the maximum.

※ FAN SYSTEM OPERATION

When the brake system pressure is below minimum pressure (125 ± 5 bar), it has the high priority than the fan system. Pump flow to the fan motor is blocked while brake system is charged. However, The fan system has controlled pump when the brake system pressure is charged.

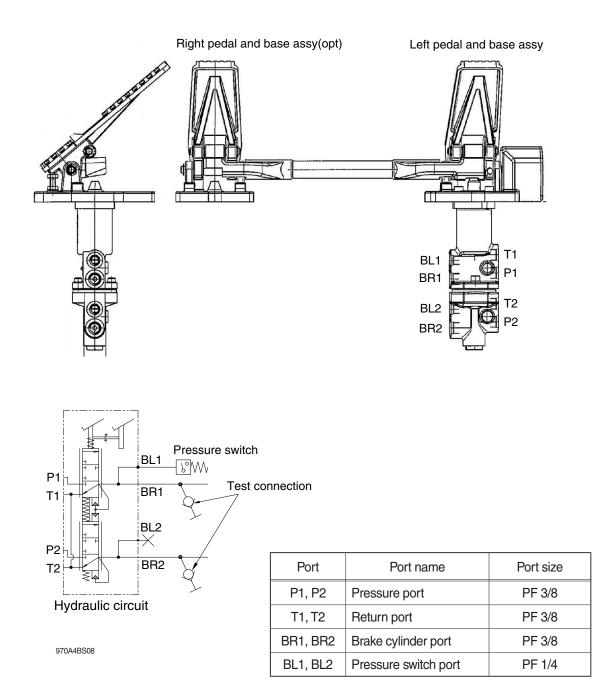
The fan speed solenoid valve (6) controls the pressure (fan speed) of pump when the brake system is fully charged.

The fan speed solenoid valve (6) is a proportional solenoid. As current to the fan speed solenoid increases, pump output pressure decreased, therefore, the fan motor rotates slower.

When the current of the fan speed solenoid valve (6) is reduced, the output pressure is increased. The pump will be stroked and the pump will send maximum flow to the fan motor, thus, the fan motor is turning faster.

4. BRAKE VALVE

1) STRUCTURE



 \cdot Brake pressure specification : 80 \pm 5 bar (1160 \pm 70 psi)

2) OPERATION

(1) Purpose

The purpose of the brake valve is to sensitively increase and decrease the braking pressure when the brake pedal is actuated.

(2) Ready position

When the braking system is ready for operation, its accumulator pressure acts directly on ports (P1, P2) of the brake valve. A connection is established between ports (BR1, BR2) and ports (T1, T2) so that the wheel brakes ports (BR1, BR2) are pressureless via the returns ports (T1, T2).

(3) Partial braking

When the brake valve is actuated, an amount of hydraulic pressure is output as a ratio of the foot force applied.

The spring assembly beneath base is designed in such a way that the braking pressure changes depending on the angle. In the lower braking pressure range, the machine can be slowed sensitively.

When the braking process is commenced, the upper spool is mechanically actuated via spring assembly, and the lower spool is actuated hydraulically by spool. As spools move downward, they will first close returns (T1, T2) via the control edges, thus establishing a connection between accumulator ports (P1, P2) and ports (BR1, BR2) for the wheel brake cylinders. The foot force applied now determines the output braking pressure. The control spools are held in the control position by the force applied (Spring assembly above the spools and the hydraulic pressure below the spool (Balance of forces).

After output of the braking pressure, spools are in a partial braking position, causing ports (P1, P2) and ports (T1, T2) to close and holding the pressure in ports (BR1, BR2).

(4) Full braking position

When pedal is fully actuated, end position of the brakes is reached and a connection established between accumulator ports (P1, P2) and brake cylinder ports (BR1, BR2). Returns (T1, T2) are closed at this point.

When the braking process is ended, a connection is once again established between brake cylinder ports (BR1, BR2) and return ports (T1, T2), closing accumulator ports (P1, P2).

The arrangement of spools in the valve ensures that even if one braking circuit fails the other remains fully operational. This is achieved by means of the mechanical actuation of both spools and requires slightly more pedal travel.

(5) Failure of a circuit

In the event of the lower circuit failing, the upper circuit will remain operational. Spring assembly will mechanically actuate spool.

In the event of the upper circuit failing, the lower circuit will remain operational since the lower spool is mechanically actuated by spring assembly and spool.

(6) Installation requirements

Return lines (T1, T2) must be connected directly to the tank.

The connecting lines must be installed is such a way as to permit proper bleeding.

(7) Maintenance of the brake valve

No special maintenance beyond the legal requirements is necessary.

When using high-pressure cleaners on the machine, please make sure that the water jet is not aimed directly at the brake valve (to prevent damaging the bellows).

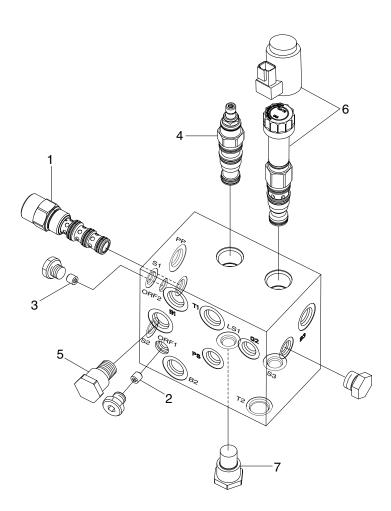
 \triangle For safety reasons the whole of the brake valve must be replaced if parts other than those listed above are damaged.

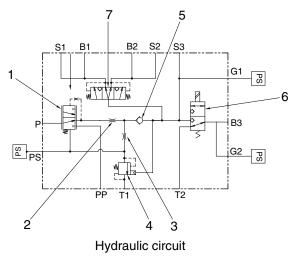
(8) Repair work

- \triangle When working on the braking system, always make sure that there is absolutely no pressure in the system. Even when the engine is switched off there will be some residual pressure in the system.
- When doing repair work, make sure your environment is very clean. Immediately close all open ports on the components and on pipes using plugs.

(9) Replacing the complete actuating mechanism

Carefully clamp the unit vertically in a fixture. The actuating mechanism can be removed by taking out the three bolts. Make sure that spring assembly does not fall out. When installing the new actuating mechanism, make sure that spring assembly is fitted in the right order. Tighten the three bolts.





- 1 Priority valve
- 2 Orifice
- 3 Orifice
- 4 Pressure control valve
- 5 Check valve
- 6 Coil, Solenoid valve
- 7 Directional valve

2) OPERATION

The pressure control valve (4) controls the minimum and maximum pressure of the braking system. When the service brake pressure is below the maximum pressure (125 ± 5 bar), the pressure control valve (4) is blocked and PS pilot pressure (brake priority pressure) increases.

As soon as PS pilot pressure raises up above 15 bar, pump controller current is reduced by MCU (pressure sensor detects brake priority pressure, and pump supply flow and pressure in order to meet the brake system).

The pressure sensor at PS port detect whether brake system needs to be charged.

Priority valve spring and pilot pressure (brake priority pressure) pushed priority spool to the upward.

Therefore, full pump flow directly goes to the brake system in order to satisfy the demand of the brake system.

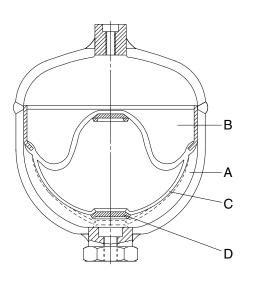
Pump flow goes through the following components : orifice (2), check valve (5), directional valve (7). Brake failure pressure sensor at G1 port detects pressure in the brake accumulators.

When the pressure is lower than 100 bar, the sensor activates warning lamp on the cluster in order to check brake system.

When brake system pressure reaches the maximum brake system pressure (150 bar \pm 5 bar), pressure control valve (4) opens, pilot pressure (brake priority pressure) of priority valve is low by draining the spring side of priority valve (1) to hydraulic tank through valve (4).

6. BRAKE ACCUMULATOR

1) STRUCTURE



Item	31LL-40020 (item 27)	31AC-10030 (item 26)
Diameter	167 mm	136 mm
Mounting height	219 mm	159 mm
Norminal volume	2.0 ℓ	1.0 ℓ
Priming pressure	50 kgf/cm ²	50 kgf/cm ²
Operating medium	Oil	Oil
Operating pressure	Max 210 kgf/cm ²	Max 200 kgf/cm ²
Thread	M22×1.5	M22×1.5
Priming gas	Nitrogen	Nitrogen

A Fluid portionB Gas portion

- C Diaphragm
- D Valve disk

75794BS09

2) OPERATION

(1) Purpose

Fluids are practically incompressible and are thus incapable of accumulating pressure energy. In hydropneumatic accumulators, the compressibility of a gas is utilized to accumulate fluid. The compressible medium used in the accumulators is nitrogen.

In braking systems, the purpose of the accumulators is to store the energy supplied by the hydraulic pump. They are also used as an energy reserve when the pump is not working, as a compensator for any losses through leakage, and as oscillation dampers.

(2) Operation

The accumulator consists of a fluid portion (A) and a gas portion (B) with a diaphragm (C) as a gas-tight dividing element. The fluid portion (A) is connected to the hydraulic circuit, causing the diaphragm accumulator to be filled and the gas volume to be compressed as the pressure rises.

When the pressure falls, the compressed gas volume will expand, thus displacing the accumulated pressure fluid into the circuit.

The diaphragm bottom contains a valve disk (D) which, if the diaphragm accumulator is completely empty, closes the hydraulic outlet, thus preventing damage to the diaphragm.

(3) Installation requirements

The accumulators can be fitted in the hydraulic circuit, directly on a component or in blocks on suitable consoles.

They should be fitted in as cool a location as possible. Installation can be in any position.

(4) Maintenance of the accumulator

No special maintenance beyond the legal requirements is necessary.

The accumulator should be checked annually. It should be replaced if the initial gas pressure has fallen by more than 30% (please refer to Performance testing and checking of the accumulator).

(5) Disposal of the accumulator

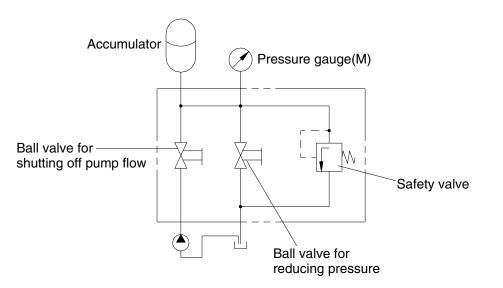
Before the accumulator is scrapped, its gas filling pressure must be reduced. For this purpose, drill a hole through gas chamber (B) using a drill approx. 3mm in diameter. The gas chamber is located on the side opposite the threaded port above the welding seam around the center of the accumulator.

* Wear safety goggles when doing this job.

(6) Performance testing and checking of the accumulator

The accumulator is gradually pressurized via the test pump; until the initial gas pressure is reached, the hydraulic pressure in the accumulator will rise abruptly. This is apparent from gauge **M**. If the initial gas pressure is more than 30% below the prescribed value, the accumulator needs to be replaced. If the measuring process needs to be repeated, wait for intervals of 3 minutes between the individual tests. Any accumulator whose initial gas pressure is insufficient must be scrapped following the instructions under **Disposal of the accumulator**.

The amount of initial gas pressure can also be checked from the vehicle. Start the vehicle's engine. The pump will now supply oil to the accumulators. Until the initial gas pressure is reached, the hydraulic pressure in the accumulator will rise abruptly. This is apparent from the gauge in the cab. If the initial gas pressure is more than 30% below the prescribed value, that initial pressure lies outside the permissible range for **at least one** of the accumulators fitted in the vehicle. This accumulator can be traced only by using the method described above, i.e. all accumulators have to be individually tested. The accumulator whose initial gas pressure is insufficient must be replaced and scrapped following the instruction under **Disposal of the accumulator**.



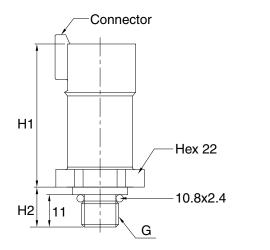
75794BS10

(7) Repair work

- \triangle When working on the braking system, always make sure that there is absolutely no pressure in the system. Even when the engine in switched off there will be some residual pressure in the system.
- When doing repair work, make sure your environment is very clean. Immediately close all open ports on the components and on pipes using plugs.
- \triangle For safety reasons the accumulators need to be replaced as a whole if damaged.

7. PRESSURE SENSOR AND SWITCH

1) STRUCTURE



- Normally open

7609A4BS12

2) TECHNICAL DATA

Item	Туре	Medium	G	H1 mm	H2 mm	Adjusting range kgf/cm ²	Actuating pressure kgf/cm ²	Voltage V
Parking pressure sensor	-	Oil	PF 1/4"	45	12.5	0 ~ 200	100 ± 5	Max 30
Charging pressure sensor	-	Oil	PF 1/4"	45	12.5	0 ~ 200	100 ± 5	Max 30
Brake priority pressure sensor	-	Oil	PF 1/4"	45	12.5	0 ~ 200	100 ± 5	Max 30
Brake stop pressure switch	NO	Oil	PF 1/4"	45	12.5	0 ~ 100	5 ± 1	Max 30

NO : Normally open

3) Tightening torque : 3.5 kgf \cdot m (25.3 lbf \cdot ft)

2) OPERATION

(1) Purpose

The pressure switches are used to visually or audibly warn the driver of the pressure within the system.

(2) Make contact / circuit closer

The pressure switch can be fitted in the braking system or directly on one of its components. The system pressure acts on an absorption area within the switch, making an electrical contact as the pressure on that area is increased. The resulting current is used to activate a warning facility, for instance.

(3) Break contact / circuit breaker

The pressure switch can be fitted in the braking system or directly on one of its components. The system pressure acts on a absorption area within the switch, breaking an electrical contact as the pressure on that area is increased. The current is now broken, e.g. to deactivate a warning facility.

(4) Installation requirements

No special measures need to be taken.

(5) Maintenance of the pressure switch

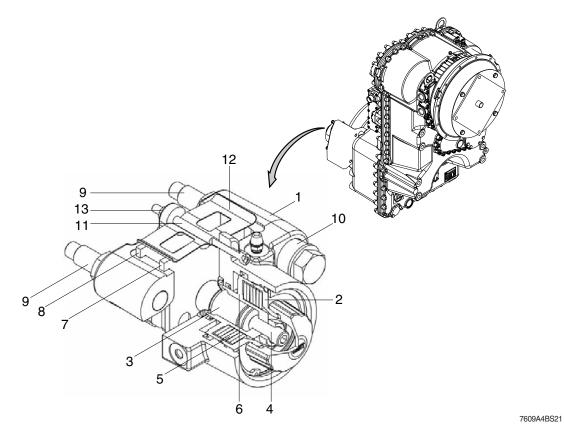
No special maintenance beyond the legal requirements is necessary. When using high-pressure cleaners on the vehicle, please make sure that the water jet is not directed at the pressure switch (corrosion of contacts).

(6) Repair work

- A When working on the braking system, always make sure that there is absolutely no pressure in the system. Even when the engine is switched off there will be some residual pressure in the system.
- * When doing repair work, make sure your environment is very clean.
- Immediately close all open ports on the components and on pipes using plugs.
- st For safety reasons the pressure switch needs to be replaced as a whole if damaged.

8. PARKING BRAKE SYSTEM

1) STRUCTURE



1 Housing

- 6 Piston
- 2 Pressure ring
- 3 Pressure bolt
- 4 Setting screw
- 5 Plate spring pack
- b Piston
- 7 Lining pad
- 8 Lining pad
- 9 Guiding pin
- 10 Rubber buffer

- Adjusting screw
- 12 Lining spring
- 13 Counter nut

11

2) OPERATION

The two identical lining pads (7, 8) slide on the guide surfaces on the top of the housing and are held in position by a lining spring (12). The brake itself is directly fixed on the gearbox with the two guide pins (9).

The brake is positioned axially using the rubber buffers (10) between the brake housing (1) and the guide pins (9), and the setting screw (11).

When the brake is actuated (= closed) a clamping force is created on the lining pads (7, 8) which is transmitted to the brake disc. Under the force of the plate spring pack (5), the piston (6), together with the adjusting screw (4), the pressure bolt (3) and the lining pad (7) are moved towards the brake disc. When the lining pad (7) comes into contact with the brake disc, the reaction force displaces the brake on the guide pins (9), against the spring force of the rubber buffers (10), until the second lining pad (8) is also pressed against the brake disc.

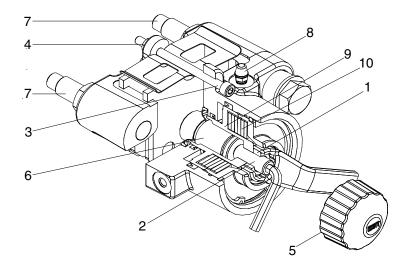
The braking effect (braking torque) is dependent upon the frictional values of the brake linings.

The brake is released by complete pretensioning of the plate spring pack (5). The piston (6) is moved back by the required minimum release pressure to the stop on the pressure ring (2).

During this process the brake positions itself, depending upon the setting, by the two rubber buffers (10) up to contact with the setting screw (11). An equal air gap must be guaranteed on both sides of the brake disc when set correctly.

The clamping force is reduced by wear of the lining pads (7, 8) and the brake disc. The brake must then be readjusted.

3) FITTING AND SETTING INSTRUCTIONS



7609A4BS22

Piston

Spring pack

9

10

1 Lock nut

2

- Screw cap 5
- 6 Pressure bolt
- Setting screw 3 Adjusting screw
- 4 Counter nut
- 7 Guiding bolt
- Bleeding screw 8

* The fitting or adjusting must always be carried out when the brake is cold.

(1) Fitting the brake

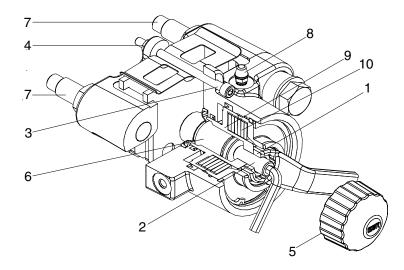
- ① Rotate the screw cap (5) in a counter-clockwise direction and unscrew it.
- 2 Release the lock nut (1) and turn the adjusting screw (2) counter-clockwise until the pressure bolt (6) contacts the piston (9) with the flat surface.
- ③ Slide the brake over the brake disc in this condition.
- ④ Screw the two guide pins (7) into the gearbox.
- 5 Connect the pressure.
- 6 Apply the required release pressure (min. 130 bar) to the brake in order to pre-tension the plate spring pack (10) completely, up to the stop.
- \bigcirc Carry out bleeding of the brake using the bleed value (8).

(2) Clearance adjusting

- ① Insert a setting gauge on both sides between the brake lining carrier and brake disc and hold them in position.
- * The thickness of the setting gauge must be adjusted to the desired air gap.

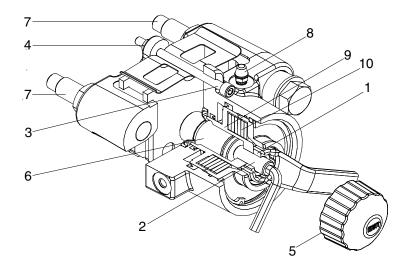
Clearance		Setting gauge
Min.	0.5 mm	0.25 mm
Nominal clearance	1.0 mm	0.50 mm
Max.	1.5 mm	0.75 mm

- ⁽²⁾ Turn the adjusting screw (2) in a clockwise direction until the two setting gauges are clamped between the brake lining carriers and the brake disc.
- ③ Hold the adjusting screw (2) in position and lock using the lock nut (1).
- * The application pressure for clamping the setting gauges must be selected so that both gauges can be removed using a small amount of force after locking in position.
- ④ Release the counter nut (4) and then turn the setting screw (3) in a clockwise direction until the end surface of the setting screw (3) is in contact with the surface provided for setting.
- (5) Hold the setting screw (3) in position and lock using the counter nut (4).
- (6) Remove the setting gauges from both sides of the brake disc.
- * The fitting procedure for the brake and the setting of the desired air gap is now complete. The brake is ready for use.
- 0 Turn the screw cap (5) in a clockwise direction and tighten hand-tight.
- * The brake should be actuated and released several times to check that it is functioning properly.



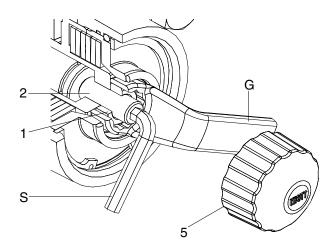
(3) Adjusting instructions

- ① Place the machine on flat ground and secure against rolling away.
- ② Release the parking brake by application of the required release pressure (min. 130 bar).
- ③ Rotate the screw cap (5) in a counter-clockwise direction and unscrew it.
- ④ Release the lock nut (1) of the setting screw (2).
- (5) Insert a setting gauge on both sides between the brake lining carrier and brake disc and hold them in position.
- * The setting gauge must be selected in accordance with the table under (2) "Clearance adjusting".
- (6) Turn the setting screw (2) in a clockwise direction until the two setting gauges are clamped between the brake lining carriers and the brake disc.
- \bigcirc Apply the lock nut (1) to the setting screw (2).
- * The application pressure for clamping the setting gauges must be selected so that both gauges can be removed using a small amount of force after locking in position.
- (8) Release the counter nut (4) and then turn the adjusting screw (3) in a clockwise direction until the end surface of the adjusting screw (3) is in contact with the surface provided for setting.
- (9) Hold the adjusting screw (3) in position and lock using the counter nut (4).
- 1 Remove the setting gauge from both sides of the brake disc.
- * The adjustment of the desired air gap is now complete. The brake is ready for use.
- ① Turn the screw cap (5) in a clockwise direction and tighten hand-tight.
- * Actuate the brake valve several times and check the holding effect of the parking brake on a suitable incline or a suitable gradient.



4) EMERGENCY RELEASE OF THE PARKING BRAKE

In the event of a failure in pressure supply the parking brake can be released mechanically in the following way :



- 1 Lock nut
- 2 Setting screw
- 5 Screw cap

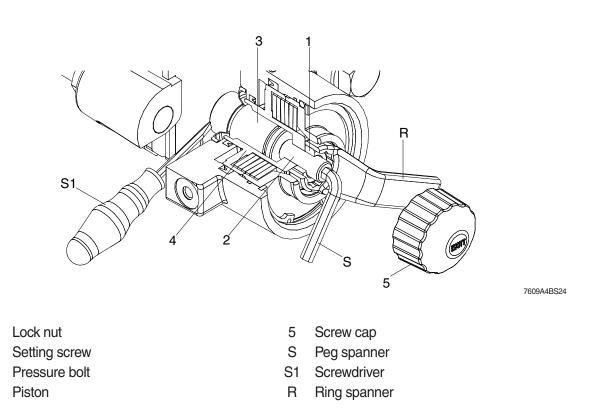
- S Peg spanner
- G Ring spanner
- (1) Secure the machine against rolling away.
- (2) Rotate the screw cap (5) in a counter-clockwise direction and unscrew it.
- (3) Release the lock nut (1) and unscrew it back to the end of the setting screw (2).
- (4) Rotate the setting screw (2) in a clockwise direction until the brake disc is completely free.
- For emergency release a torque of min 7.1 kgf·m (51.6 lbf·ft) is required on the setting screw (2).
- (5) Screw on the lock nut (1) up to contact with the piston and apply a slight locking force to the setting screw (2).
- (6) Screw on the screw cap (5) in a clockwise direction by a few threads. (dirt ingress protection)
- * In this condition the machine has no parking brake facility and thus must be protected from rolling away by different means. The brake must be adjusted before recommissioning.

5) MAINTENANCE AND REPAIR WORK

(1) Maintenance and replacement of the lining pads

The brake, particularly the brake lining carriers, must be visually inspected at regular intervals. If the remaining lining thickness is too thin, these intervals must be reduced accordingly to prevent extensive damage to the brake or the brake disc.

Once the minimum remaining lining thickness of $1.0 \sim 1.5$ mm per brake lining carrier is reached, the brake lining carrier must be replaced in accordance with the following instructions :



- ① Place the machine on flat ground and secure against rolling away.
- 2 Release the parking brake by application of the required release pressure (min. 130 bar).
- ③ Rotate the screw cap (5) in a counter-clockwise direction and unscrew it.
- ④ Release the lock nut (1) of the setting screw (2).

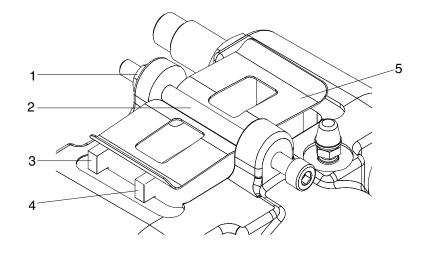
1

2

3

4

- (5) Rotate the setting screw (2) in an counter-clockwise direction until the pressure bolt (3) can be pushed completely into the piston (4).
- 6 Unscrew (lever) the pressure bolt (3) with a suitable screwdriver until it contacts the piston (4).



7609A4BS25

- 1 Counter nut
- 2 Adjusting screw

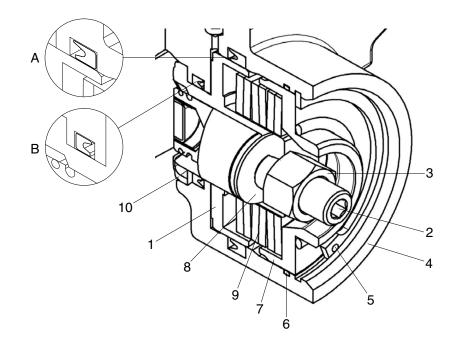
- 4 Lining pad
- 5 Lining spring

- 3 Lining pad
- ⑦ Release the counter nut (1) and unscrew the adjusting screw (2) from the brake housing.
- * The lining spring (5) is pre-tensioned. The lining spring (5) must be held in position with a suitable tool whilst removing the adjusting screw (2).
- 8 Remove the lining spring (5).
- 9 Remove the two lining pads (3, 4) from the lining compartment in the brake housing.
- * If there is no possibility of changing the brake lining carriers (3, 4) as described above (not enough space), the brake must be removed completely.
- * Check the pressure line. A pressure line which is too short must be unscrewed in order to permit removal of the brake.

An emergency release of the parking brake must be carried out before releasing the pressure line.

- 10 Replace the lining pads (3, 4).
- ① The lining spring (5) must be pushed in position with a suitable tool whilst screwing in the adjusting screw (2).
- If you removed the brake completely because of a lack of space you must carry out fitting of the brake.
- * After changing the lining pads (3, 4), or repair to them, the brake must be adjusted in accordance with 3) FITTING AND SETTING INSTRUCTION.

(2) Replacing the seals



7609A4BS26

1 Piston

- 2 Setting screw
- 5 Circlip
- ting screw
- 6 Sealring

- 3 Lock nut
- 4 Housing

- 7 Pressure ring
- 8 Pressure bolt
- 9 Plate spring pack
- 10 Dust protection cap
- A Detail sealring
- B Detail sealring

Leaking seals must be replaced in accordance with the following instructions :

- 1 Place the machine on flat ground and secure against rolling away.
- ② Release the parking brake by application of the required release pressure (min. 130 bar).
- If the brake cannot be pressurised with the required release pressure (min. 130 bar) because of excessive leaks, the parking brake MUST be released using the emergency procedure. See 4) Emergency release of the parking brake.
- ③ Rotate the screw cap in a counter-clockwise direction and unscrew it.
- 4 Release the lock nut (3) of the setting screw (2).
- (5) Rotate the setting screw (2) in an counter-clockwise direction until the pressure bolt (8) can be pushed completely into the piston (1).
- 6 Unscrew (lever) the pressure bolt (8) with a suitable screwdriver until it contacts the piston (1).
- \bigcirc Actuate the brake valve and dissipate the existing release pressure down to 0 bar.

* The plate spring pack (9) is now fully de-tensioned.

- ⑧ Unscrew the pressure line and remove the brake completely.
- (9) Remove the circlip (5) and remove the pressure ring (7) from the housing (4).
- 10 Remove the plate spring pack (9) and the piston (1).
- ① Always replace both the seals (A, B).

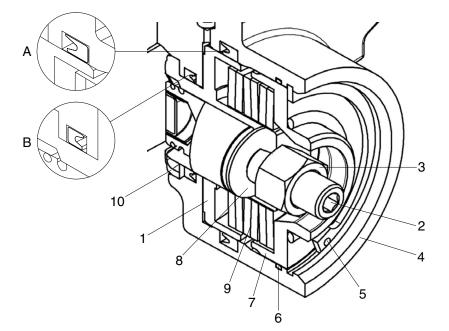
- * Observe the fitting direction of the grooved rings and use a suitable fitting needle with rounded edges to fit the new grooved rings. Take care there is a danger of injury.
- * Carry out re-fitting of the individual parts into the brake in reverse order. Apply a light coat of fitting fluid lubricant to the sliding and sealing surfaces of the piston when fitting.
- 2 If necessary, also replace the dust protection cap (10).
- * The dust protection cap (10) has a vulcanised-in steel ring which is used to press it into the opening in the brake housing (4).

In order to replace this you will need to "lever it out" with a suitable tool and then replace with a fitting fixture by pressing it into the housing (4).

⁽³⁾ Fit the brake onto gearbox in accordance with the fitting instructions.

(3) General instructions

Any faults or damage detected on parts not listed here must, of course, be rectified or replaced by genuine parts.



GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

This procedure is designed so the mechanic can make a quick check of the system using a minimum amount of diagnostic equipment. If you need additional information, read **structure and function**, Group 1.

A location will be required which is level and has adequate space to complete the checks.

The engine and all other major components must be at operating temperature for some checks.

Locate system check in the left column and read completely, following the sequence from left to right. Read each check completely before performing.

At the end of each check, if no problem is found (OK), that check is complete or an additional check is needed. If problem is indicated (NOT OK), you will be given repair required and group location. If verification is needed, you will be given next best source of information:

Chapter 2 : Troubleshooting Group 3 : Tests and adjustments * Hydraulic oil must be at operating temperature for these checks (refer to page 6-49).

Item		Description	Service action
Parking brake capacity check	11111111111111111111111111111111111111	Start engine. Fasten seat belt.	OK Check completed.
Seat belt must be worn while doing this check to prevent possible injury	10 mph 40	Release parking brake and put transmission in 2nd gear forward.	NOT OK Inspect parking brake. Go to group 3.
when machine stops suddenly.		Drive machine at 8 km/hr and switch parking brake ON.	to group o.
	Release	LOOK/FEEL : Machine must come to a stop within 2 meters (6 feet) when parking brake is engaged at 8 km/hr.	
		Transmission must shift to neutral.	
Parking brake transmission lockout check Engine running.	Release ON	Turn parking brake to ON. Place transmission in 1st forward. Slowly increase engine speed to high idle. LOOK : Machine must not move.	OK Check completed. NOT OK Go to transmission control circuit in section 3.

Item		Description	Service action
Service brake pump flow check			OK Check completed.
 Hydraulic oil must be at operating temperature for the check. 	DD T.	Operate brake pedal approximately 20 times. Start engine and run at low idle.	NOT OK Check for brake circuit
Engine OFF.		Record number of seconds required for low brake pressure	leakage. Go to next page.
	*(()) 	indicator lamp to go out. LOOK : Indicator lamp must go out in less than 4 seconds from time engine starts. NOTE : Indicator will not come on	· · ·
		approximately 1 second after starting engine.	If time does not decrease, check for worn brake pump.
Service brake capacity check	OFF	Select clutch cut-off mode to OFF.	OK Check completed.
Engine running.		Apply service brakes, release park brake and put transmission in 2nd forward.	NOT OK Check brake pressure.
	Release	Increase engine speed to high idle.	IF OK
		LOOK : Machine may not move or move at a very slow speed.	Inspect brake disk.
		Repeat check three times to ensure accurate results.	

ltem		Description	Service action
Brake accumulator precharge check	、八、	Start and run engine for 30 seconds.	OK Check completed.
The axles and hydraulic oil must be at operating temperature for this	707		Make sure brake pedal is
check.		NOTE : Engine oil pressure lamp will be on due to no engine oil	not binding and keeping brakes partially engaged.
		pressure.	Bleed brakes in group 3.
		Count the number of times the brake pedal can be fully depressed	
		before the low brake pressure warning lamp comes ON.	NOT OK If light comes ON with
		LOOK : Warning lamp should not come ON in 1~5 applications.	engine running, accumulator has lost it's
		Start engine and operate at low idle.	charge. Inspect and recharge accumulator.
		Observe cluster while applying brake pedal with maximum force.	
		LOOK/LISTEN : Brake pressure indicator must not come ON.	
Brake system leakage		Start engine and wait 30 seconds.	OK
check		Stop engine.	Check completed.
		Wait 2 minutes.	NOT OK If brake leakage is
		Turn start switch to ON and wait 5 seconds.	indicated with brakes released, check leakage at
		LOOK : Brake oil pressure warning lamp must not come ON within 2 minutes after stopping engine.	accumulator inlet check valve and brake valve. If brake leakage is indicated with brakes applied, check for leakage at brake valve and brake pistons.
			Check individual component leakage.

Item		Description	Service action
Service brake pedal check		Slowly depress brake pedal. Listen for a hissing noise that indicates oil is flowing to brake pistons. LISTEN/FEEL : A hissing noise must be heard when pedal is depressed.	OK Check completed. NOT OK Inspect for debris under brake pedal.
Service and parking brake system drag checks Engine running	Release	Position machine on gradual slope. Lower bucket approximately 50 mm (2 in) from ground. Release parking and service brakes. LOOK : Machine must move or coast. NOTE : If machine does not move, check brake pedals to be sure they fully release when feet are removed from pedals. Drive machine at high speed for about 5 minutes. Brake drag is indicated if brake areas in differential case are hot. NOTE : Observe parking brake. If disk is hot, parking brake drag is indicated.	OK Check completed. NOT OK Adjust park brake. NOT OK Check floor mat interfer- ence to pedal or debris build-up. IF OK Check for brake pressure when brake is released. Go to brake pressure test.
Clutch cut-off check	L mode	Select clutch cut-off mode to L mode. Release parking brake. Run engine at half speed in 1st forward. Firmly depress brake pedal. FEEL : Transmission must disengage when brake pedal is depressed at 30% of pedal stroke. NOTE : Clutch cut-off mode can be selected to operator preference to match your loading needs.	OK Check completed. NOT OK Adjust clutch cut-off mode.

2. TROUBLESHOOTING

1) SERVICE BRAKE

Diagnose malfunction charts are arranged from most probable and simplest to verify, to least likely, more difficult to verify. Remember the following steps when troubleshooting a problem :

Step 1. Operational check out procedure (see section 1)

Step 2. Operational checks (in this group)

Step 3. Troubleshooting

Step 4. Tests and adjustments (see group 3)

Problem	Cause	Remedy
Poor or no brakes	Brake accumulator charge low.	Do brake accumulator check.
	Brake pump standby pressure low.	Do brake pump standby pressure test.
	Brake pressure low.	Do brake valve pressure test.
	Air in system.	Bleed brakes.
	Worn brake surface material.	Inspect brake surface material.
	Leakage in brake valve.	Do brake valve leakage test.
	Leakage in brake piston seal.	Check for an over filled differential. Apply brakes and check for leakage from check plug.
Aggressive brakes	Internal restriction in circuit.	Remove lines and components.
	Brake valve malfunction.	Disassemble and inspect.
	Low oil level.	Check oil level.
Brakes drag	Brake pedal not returning properly.	Inspect floor mat and pedal.
	Debris holding valve partially open in brake valve.	Do brake valve pressure test.
	Warped brake disk.	Inspect brake disk.
	Stuck brake piston.	Repair.
Brakes lock up	Brake valve malfunction.	Clean or replace brake valve.

Problem	Cause	Remedy
Brakes chatter	Air in brake system.	Do brake bleed procedure.
	Worn brake surface material.	Inspect brake surface material.
	Wrong oil in differential.	Drain.Refill.
Hissing noise when brake pedal is held with engine stopped	Leakage in brake valve, or brake piston.	Do brake system leakage test.
light will not go out or	Malfunction in brake low pressure warning switch.	Replace switch.
stays on excessively long after start-up	Brake accumulator pressure too low.	Recharge accumulator.
	Low brake pump standby pressure setting.	Do brake pump standby pressure test.
	Leakage in pressure reducing manifold block.	Do pressure reducing valve manifold leakage test.
	Leakage in brake system.	Do brake system components leakage tests.
	Worn brake pump.	Do brake pump flow test.
	Leakage in parking brake solenoid.	Do parking brake pressure test.

2) PARKING BRAKE MALFUNCTIONS

Problem	Cause	Remedy
Brake will not hold	Pads not adjusted correctly.	Adjust parking brake.
	Malfunctioning parking brake solenoid.	Inspect and replace.
	Worn brake disk and / or brake pads.	Disassemble, inspect, repair.
	Brake piston hangs up in bore.	Remove and inspect. Repair.
Brake disk overheats	Pads out of adjustment.	Adjust parking brake.
	Brake not released.	Release parking brake. Disassemble, inspect brake. Repair if necessary. Inspect for loosen or broken lines between brake pressure switch and indicator on dash.
Parking brake indicator in monitor does not come on when brake applied	Faulty wiring or switch.	Inspect for loose or broken lines between brake pressure switch and indicator on dash. Inspect for a faulty indicator on dash. Replace if necessary.
Brake will not apply	Pads out of adjustment.	Adjust parking brake.
	Malfunctioning wiring, switch, or solenoid.	Check electric circuit.
	Restriction between brake valve and brake.	Remove hose and inspect. Replace.

GROUP 3 TESTS AND ADJUSTMENTS

1. PARKING BRAKE PERFORMANCE

1) MEASUREMENT CONDITION

- (1) Tire inflation pressure : Specified pressure
- (2) Road surface : Flat, dry, paved surface with 1/5 (11°20') gradient.
- (3) Machine : In operating condition

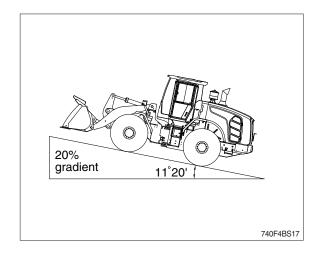
Item	Standard valve
Parking brake performance	Keep machine on 20% (11°20') gradient

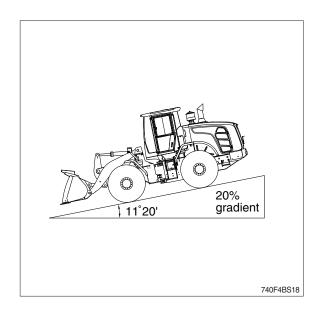
2) MEASURING PROCEDURE

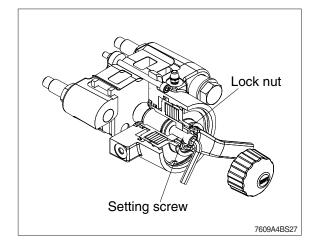
- Start the engine and drive the machine straight up a 1/5 gradient with the bucket unloaded.
- (2) Depress the service brake, place the gear selector lever in neutral, then stop the engine.
- (3) Turn the parking brake switch ON, then slowly release the service brake pedal and the machine must be kept stopped.
- * The measurement must be made with the machine facing either up or down the slope.

2. ADJUSTMENT OF PARKING BRAKE

- (1) External brake inspection · Inspect for wear of brake pad
- (2) Refer to the PARKING BRAKE SYSTEM on the page 4-21.







3. HYDRAULIC BRAKE BLEEDING PROCEDURE

▲ Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.

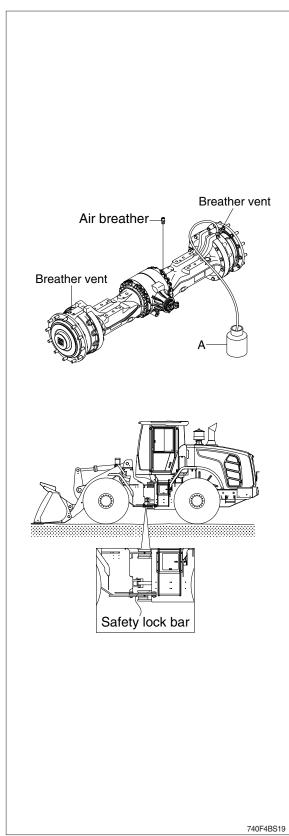
Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result.

Doctors unfamiliar with this type of injury should reference a knowledgeable medical source.

Two people are required to bleed brake system oil, one to operate brake valve and other to open and close bleed screws.

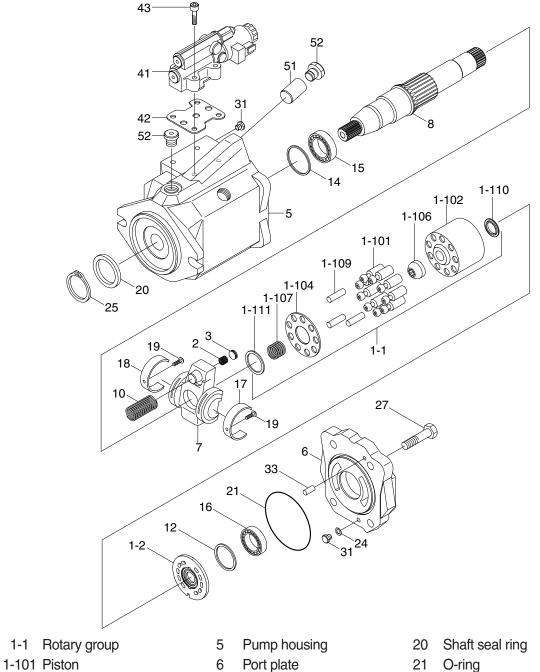
- 1) Install frame locking bar. Engage parking brake.
- Put a clear plastic tube on bleed screw to route low to hydraulic oil tank filler tube or container (A).
- 3) Start engine and run at low idle.
- 4) Push and hold brake pedal down until brake bleeding procedure is complete.
- If bubbles continue for more than 2 minutes, stop bleeding procedure. Check for and correct problem, then continue.
- Open on bleed screw on differential and axle assembly until hydraulic oil starts to flow. Close bleed screw when oil is free of air. Release brake pedal.
- 6) Repeat steps 1)~5) for each bleed screw.
- 7) Push either brake pedal and hold down.
- 8) Check hydraulic oil level.



GROUP 4 DISASSEMBLY AND ASSEMBLY

1. FAN AND BRAKE PUMP

1) STRUCTURE



- 1-102 Cylinder
- 1-104 Retaining plate
- 1-106 Retaining ball
- 1-107 Spring
- 1-109 Pressure pin
- 1-110 V-ring
- 1-111 Back-up plate
 - 1-2 Control plate
 - 2 Pressure spring
 - Stop 3

- 7 Swash plate
- 8 Drive shaft
- 10 Spring
- 12 Adjustment shim
- 14 Stop ring
- 15 Tapered roller bearing
- 16 Tapered roller bearing
- 17 Liner bearing
- 18 Liner bearing
- 19 Flat screw

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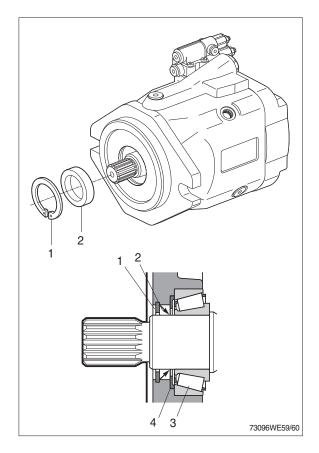
- O-ring
- 24 Kantseal ring
- 25 Retaining ring
- 27 Socket screw
 - 31 Plug
- 33 Cylinder pin
- 41 Control valve
- 42 Gasket
- 43 Socket screw
- 51 Control piston
- 52 Locking screw

2) GENERAL REPAIR GUIDELINES

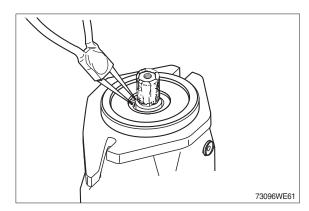
- ※ Observe the following guidelines when carrying out repairs on hydraulic pumps.
- (1) Close off all openings of the hydraulic unit.
- (2) Replace all of the seals.Use only original spare parts.
- (3) Check all sealing and sliding surfaces for wear.
- Re-work of the sliding surfaces by using, for example abrasive paper, can damage the surface.
- (4) Fill the hydraulic pump with hydraulic oil before commissioning.

3) SEALING THE DRIVE SHAFT

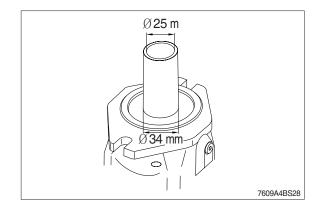
- 1 Retaining ring 2 Shaft seal
- 3 Bearing 4 Stop ring



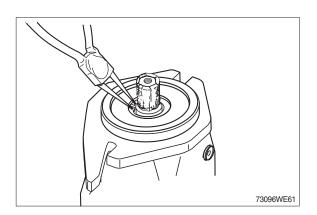
(1) Protect the drive shaft.Wrap the drive shaft with tape.Remove the retaining ring.Remove shaft seal to front.



- Change the shaft seal and check its sliding surface (drive shaft) and housing, grease the sealing ring.
 Visual check shaft seal and housing.
- 73096WE62
- (2) Assembling of the sealing ring carefully down to the stop ring.

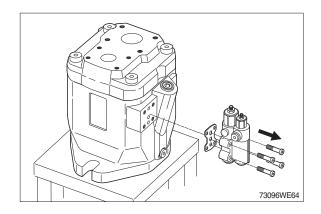


- (3) Assemble the retaining ring (circlip).
- * Visual check to ensure that the circlip is correctly located in the groove.

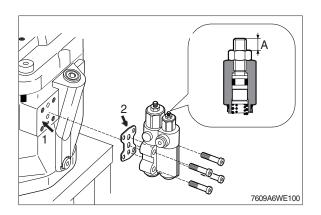


4) SEALING THE CONTROL VALVE

(1) Remove the control valve.



(2) Measure dimension A and note down.Check sealing surface (1).Replace gasket (2).

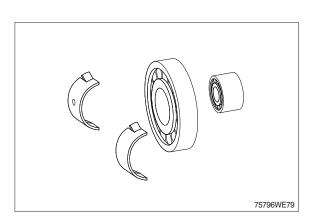


(3) Assemble control valve.

Tighten the bolts.

(4) Check dimension A.

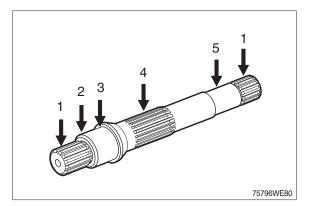
- Tightening torque : 1.58 kgf · m (11.4 lbf · ft)
- T609A6WE101



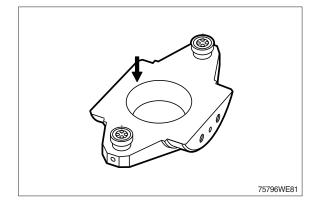
- 5) INSPECT HINTS
- (1) Renew all bearings.

(2) Check :

- 1 Wear on splines, rust
- 2 Drive shaft seal wear grooves
- 3 Bearing seat
- 4 Splines for cylinder drive
- 5 Bearing seat

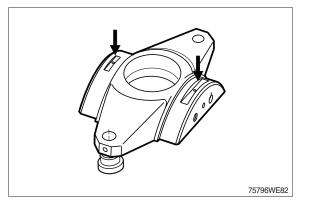


(3) Check : Sliding surface free of grooves.



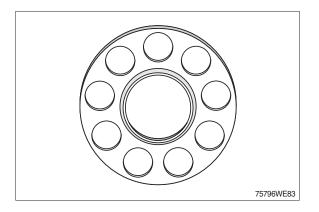
(4) Check :

Bearing surfaces.



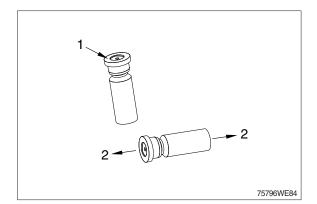
(5) Check :

That the retaining plate is free of grooves and that there is no wear in the slipper pad area.



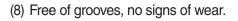
(6) Check :

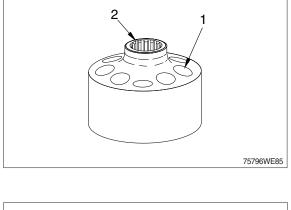
Check to see that there are no scratches or metal deposits on the sliding surface (1) and that there is no axial play (2) (Pistons must only be replaced as a set).

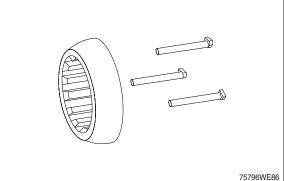


(7) Check :

- 1 Cylinder bores
- 2 Splines

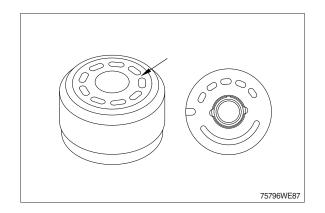






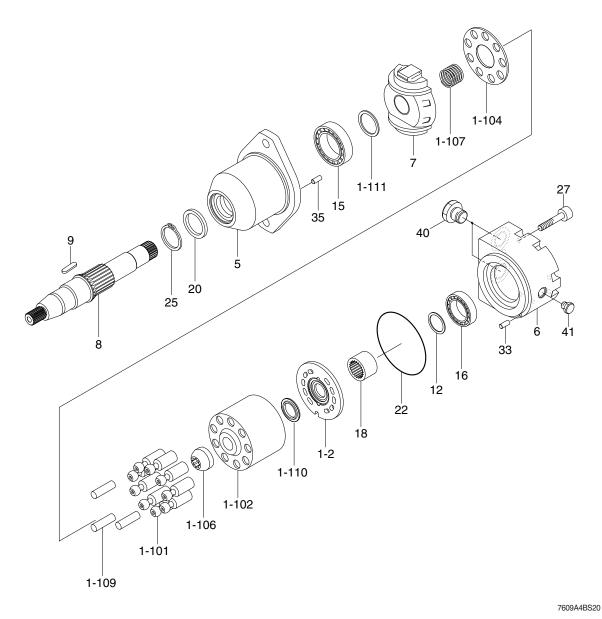
(9) Check :

Cylinder sliding surface free of grooves, no wear, no embedded foreign particles. That there are no scratches on the control plate. (Only replace them as a set).



2. FAN MOTOR

1) STRUCTURE



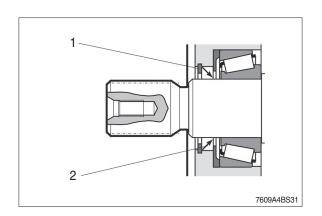
- 1-1 Rotary group
- 1-101 Piston
- 1-102 Cylinder
- 1-104 Retaining plate
- 1-106 Retaining ball
- 1-107 Spring
- 1-109 Pressure pin
- 1-110 V-ring
- 1-111 Back-up plate

- 1-2 Control plate
- 5 Motor housing
- 6 Port plate
- 7 Cam plate (swash plate)
- 8 Drive shaft
- 9 Shaft key
- 12 Adjustment shim
- 15 Tapered roller bearing
- 16 Tapered roller bearing

- 18 Bearing bushing
- 20 Shaft seal
- 22 O-ring
- 25 Retaining ring (circlip)
- 27 Socket bolt
- 33 Cylinder pin
- 35 Cylinder pin
- 40 Screw
- 41 Screw

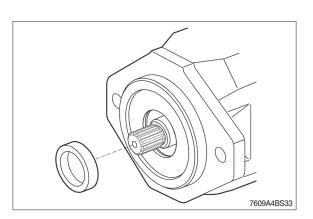
2) SEALING THE DRIVE SHAFT

- (1) 1 Circlip
 - 2 Shaft seal



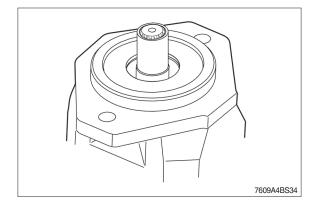
(2) Remove key.Protect the drive shaft.Remove the circlip.

(3) Change the shaft seal and check its sliding surface (drive shaft) and housing, grease the sealing ring.



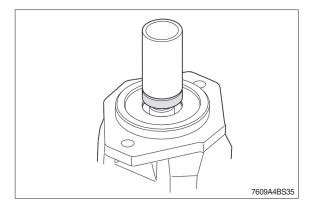
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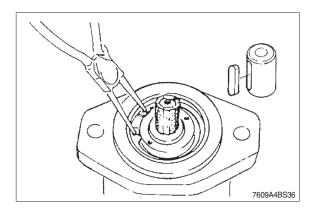
(4) Use installation tool or plastic strip for assembling seal.



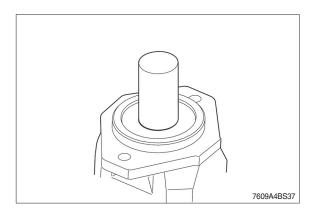
(5) Use a suitable pipe to mount the shaft seal, but don't push it too deep. If the shaft ring touches the bearing ring you will damage the seal ring.

(6) Assemble the circlip.





(7) Assemble the circlip in the correct position.

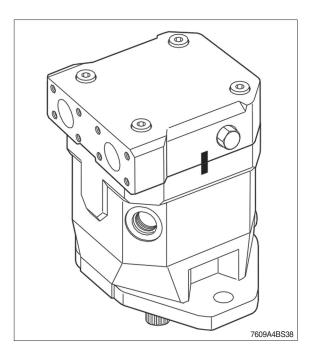


* This discription showes how th change the drive shaft seal but it isn't the way of serial assembly.

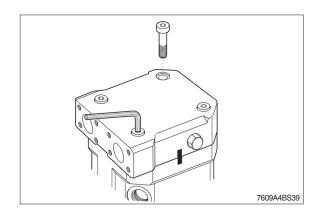
The seal is assembled together with the taper roller bearing from inside the motor housing normally to get a secure sealing condition. If you decide to repair the motor in the shown way be very careful while handling so that the drive shaft wouldn't be damaged during disassembly of the shaft seal.

3) DISASSEMBLE THE MOTOR

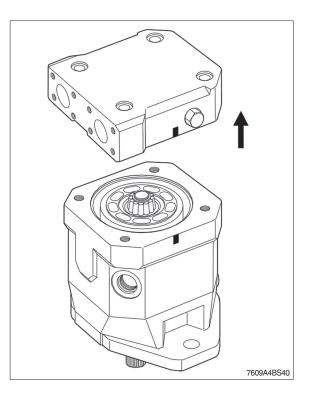
Disassembly position.
 Mark the location of the port plate on the housing.



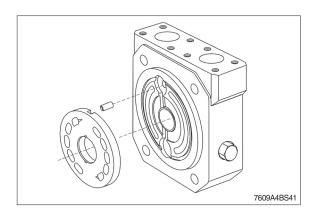
(2) Remove the port plate fixing bolts crosswise.



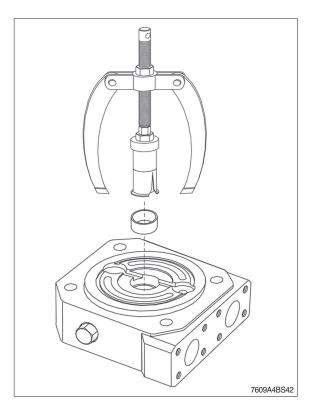
- (3) Remove the port plate.
- * Control plate can drop down-hold tight.



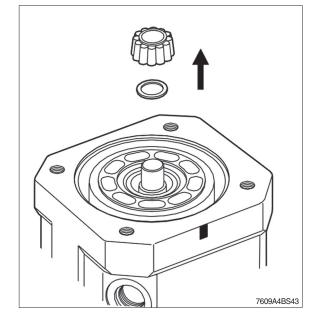
(4) Remove control plate.



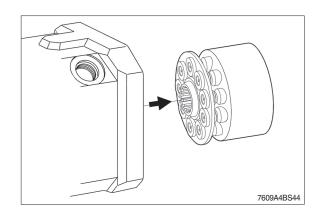
(5) Remove bearing outer ring with withdrawal tool.Do not damage the sealing surface.



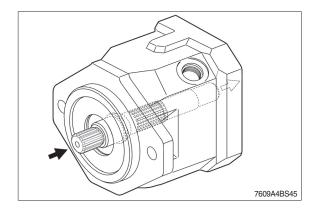
(6) Disassemble the taper roller bearing (near by port plate).Remove the adjustment shim.



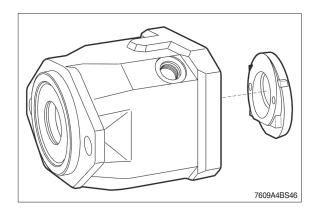
(7) Remove the rotary group in a horizontal position.



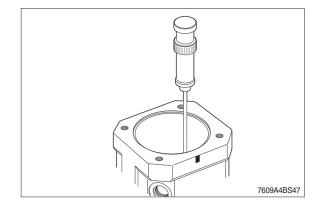
(8) Remove the drive shaft to rear side.



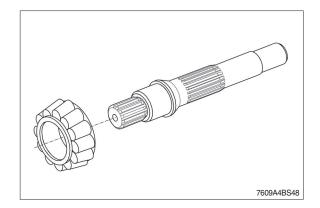
(9) Remove swash plate with special tool (see the next figure).



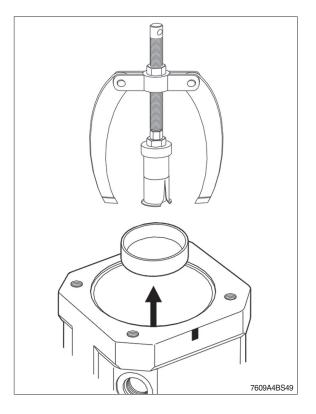
(10) Loosen the swash plate with a slide hammer (a small hook - diameter 6 mm catches the end of the swash plate at the bottom).



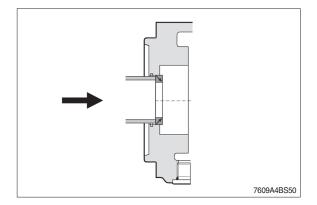
(11) Press down bearing.



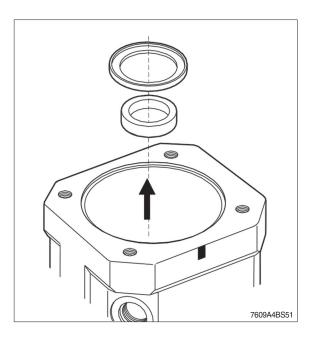
(12) The external front bearing ring is pulled out of the pump housing.



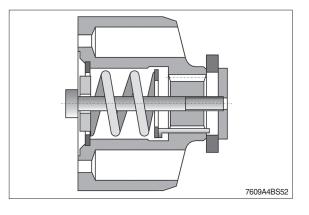
(13) Disassemble circlip and shaft seal.



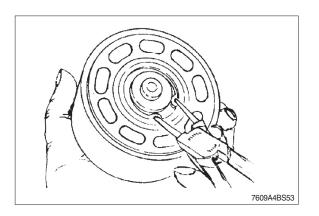
(14) Remove shaft seal and shim.



(15) Pre-tension the spring using a suitable device.

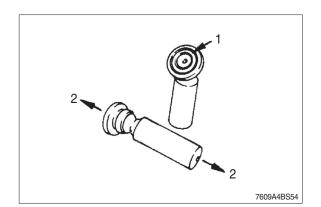


(16) Remove circlip. Remove spring and pressure pins.

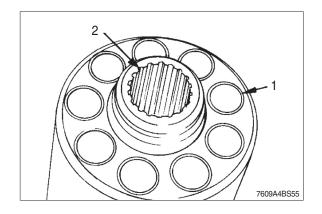


4) INSPECTION HINTS

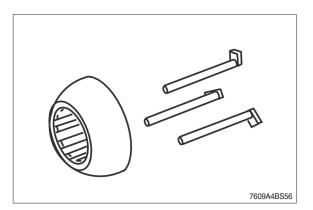
(1) Check to see that there are no scratches or metal deposits on the sliding surface (1), and that there is no axial play (2), (pistons must only be replaced as a set).



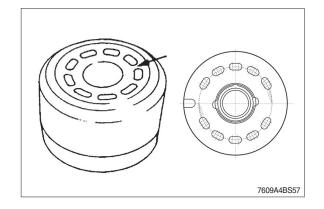
(2) Check cylinder bores (1) and splines (2).



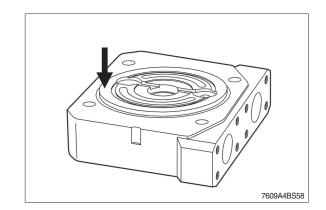
(3) Free of grooves, no signs of wear.



(4) Cylinder sliding surface free of grooves, no wear, no embedded foreign particles. That there are no scratches on the control plate. (Only replace them as a set).

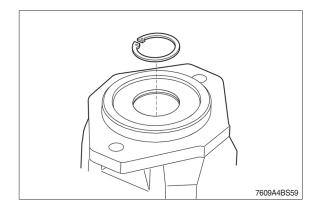


(5) Mounting surface - control plate undamaged.

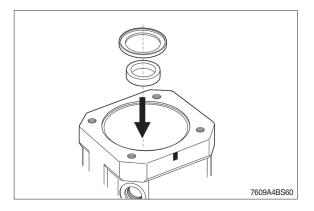


5) MOTOR ASSEMBLY

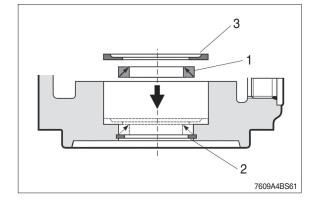
(1) Fit the circlip into the housing.



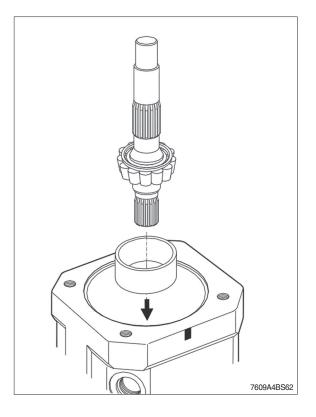
(2) Assemble shaft seal and shim against circlip.



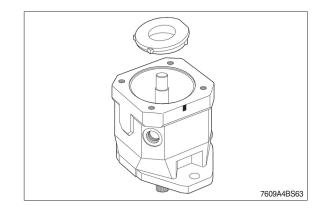
(3) Assembly of the shaft seal (1) against the safety ring (2) back up the shim (3) down to the seal ring.



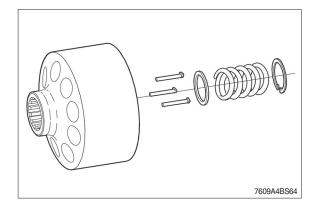
- (4) Press outer bearing ring into housing.Shaft seal with pre-assembled bearing into housing.
- * Protect splines of the shaft with plastic strip against damage of the seal lip.



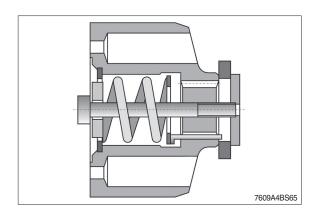
(5) Assemble swash plate.

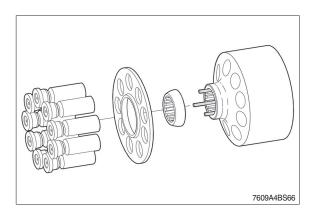


(6) Fit pressure pins using an assembly aid.

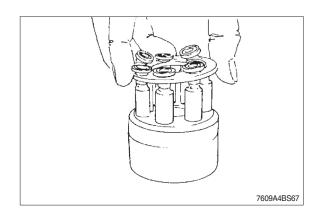


(7) Pre-tension the spring using a suitable device.

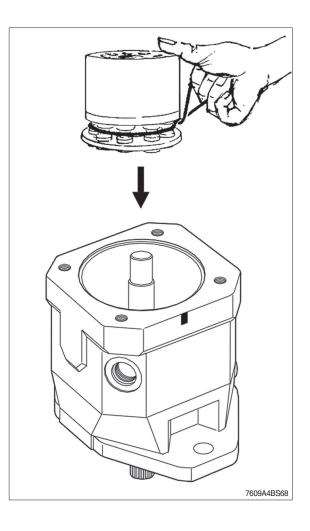




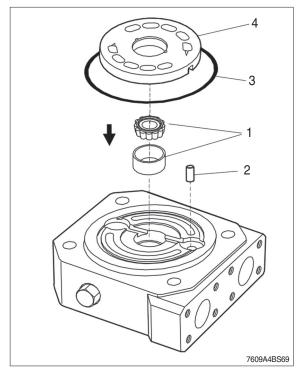
- (8) Assemble piston with retaining plate.
- * Oil piston and slipper pad.



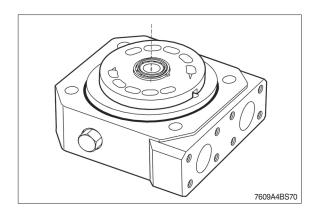
- (9) Fit rotary group.
- Assembly aid : Hold the pistons by using an O-ring.



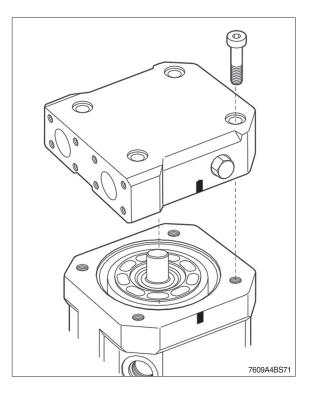
- (10) Fit bearing (1) in port plate.Fit cyilindrical pin (2).Fit O-ring (3).Fit control plate (4).
- * Assembly : Hold the components in place with grease.



(11) Fit control plate. Assembly aid : Grease



(12) Fit the port plate and fix it with the bolts crosswise.



Group	1	Structure and Function	5-1
Group	2	Operational Checks and Troubleshooting	5-8
Group	3	Tests and Adjustments	5-14
Group	4	Disassembly and Assembly	5-19

GROUP 1 STRUCTURE AND FUNCTION

1. OUTLINE

The steering system of this machine consists of a variable piston pump supplying a load sensing steering system and an closed center loader system.

The components of the steering system are :

- · Main pump
- · Steering unit
- · Accumulator
- · Steering cylinders

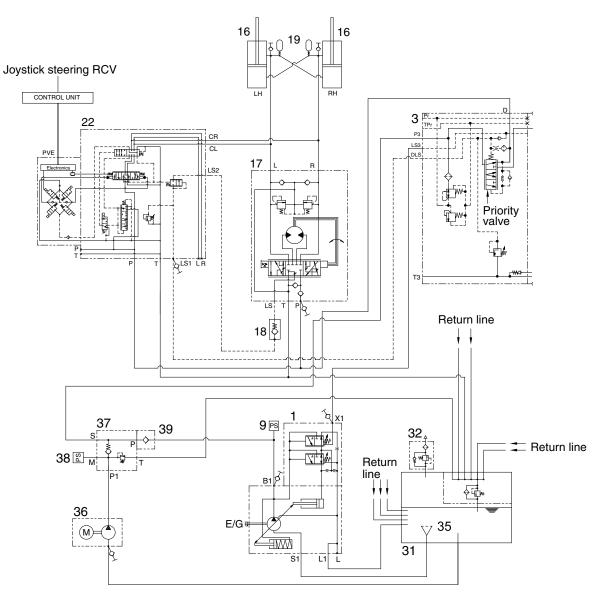
The main pump draws hydraulic oil from the hydraulic tank.

Outlet flow from the pump flows to the priority valve in main control valve. The priority valve in main control valve preferentially supplies flow, on demand, to the steering unit. When the machine is steered, the steering unit routes flow to the steering cylinders to articulate the machine.

When the machine is not being steered, or if pump flow is greater than steering flow, the priority valve supplies flow to the loader system.

That is, output flow from the pump enters into the main control valve for the operation of the attachment.

2. HYDRAULIC CIRCUIT

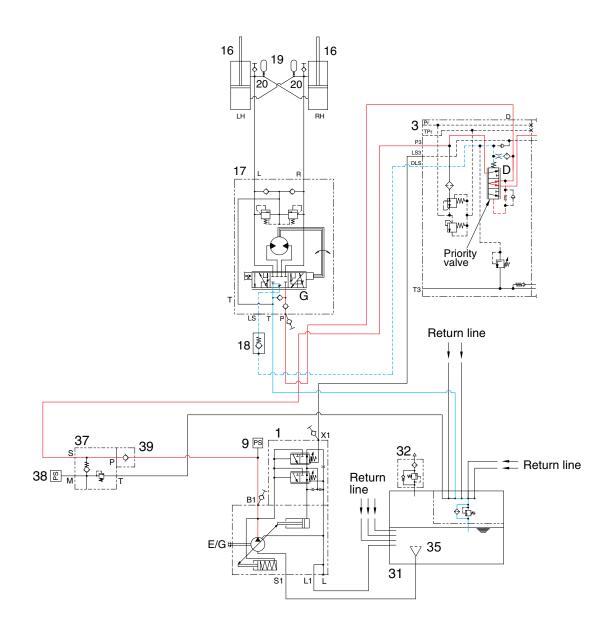


940T35SE01

- 1 Main pump
- 3 Main control vavle
- 9 Pressure sensor
- 16 Steering cylinder
- 17 Steering unit
- 18 Line check valve
- 19 Accumulator
- 22 Joystick steering vlave(opt)
- 31 Hydraulic tank
- 32 Air breather

- 35 Strainer
- 36 Motor pump (option)
- 37 Check block (option)
- 38 Pressure sensor (option)
- 39 Check valve (option)

1) NEUTRAL

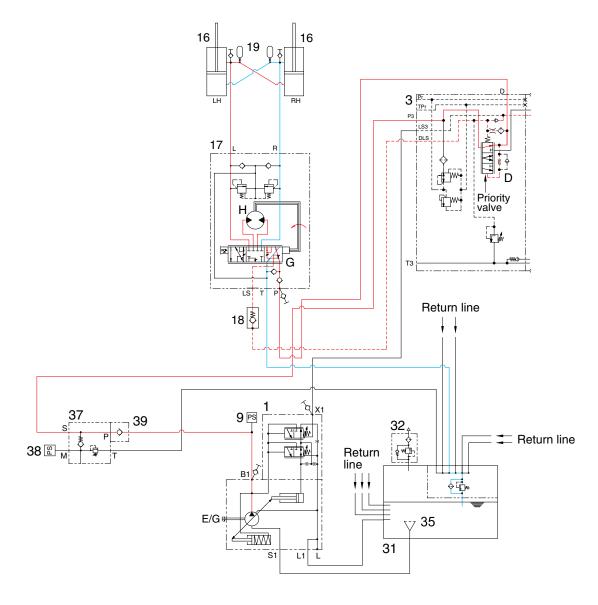


940T35SE02

The steering wheel is not being operated so control spool (G) does not move.

The oil from the pump enters the priority valve in main control valve and the inlet pressure oil moves the spool (D).

Almost all of pump flow goes to the loader system and partly flows into the hydraulic tank (31) through the spool (G).



940T35SE03

When the steering wheel is turned to the left, the spool (G) within the steering unit (17) connected with steering column turns in left hand direction.

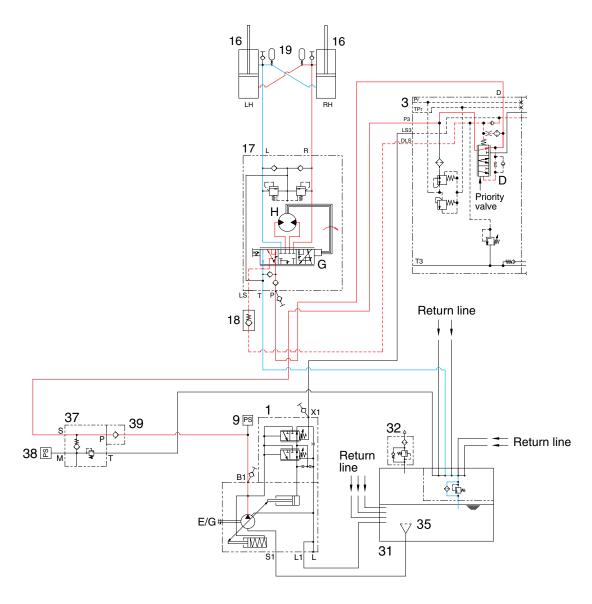
At this time, the oil discharged from the pump flows into the spool (G) of the steering unit (17) through the spool (D) of priority valve in main control valve and flows into the gerotor (H).

Oil flow from the gerotor flows back into the spool (G) where it is directed out the left work port (L) to the respective chamber of the steering cylinders (19).

Oil returned from left and right cylinder returns to hydraulic tank through the spool (G) of the steering unit.

When the above operation is completed, the machine turns to the left.

3) RIGHT TURN



940t35SE04

When the steering wheel is turned to the right, the spool (G) within the steering unit (17) connected with steering column turns in right hand direction.

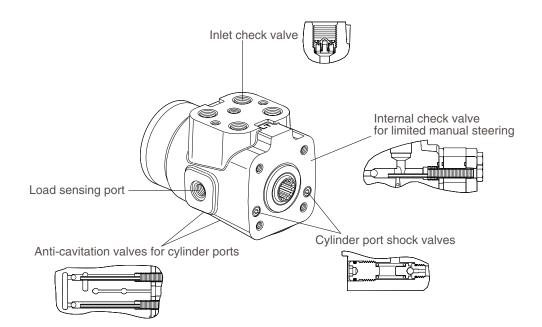
At this time, the oil discharged from the pump flows into the spool (G) of the steering unit (17) through the spool (D) of priority valve in main control valve and flows into the gerotor (H).

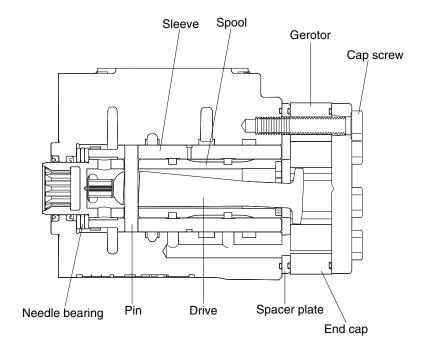
Oil flow from the gerotor flows back into the spool (G) where it is directed out the right workport to the respective chamber of the steering cylinders (19).

Oil returned from left and right cylinder returns to hydraulic tank through the spool (G) of the steering unit.

When the above operation is completed, the machine turns to the right.

3. STEERING UNIT

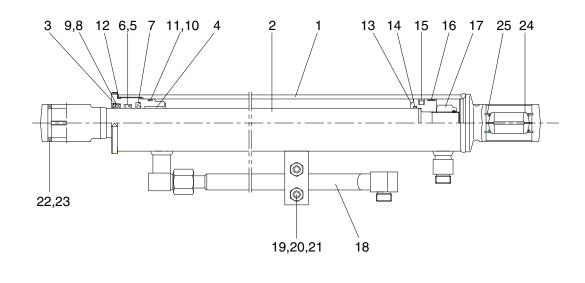




940A5SE10

4. STEERING CYLINDER

1) STRUCTURE



- 1 Tube assy
- 2 Rod assy
- 3 Gland
- 4 Du bushing
- 5 Rod seal
- 6 Back up ring

Dust wiper

Snap ring

7 Buffer ring

8

9

15 Piston seal

11

12

13

16 Wear ring

14 O-ring

10 O-ring

Back up ring

O-ring

Piston

- 17 Nylon nut
- 18 Pipe assy

- 19 U-bolt
- 20 Hexagon nut
- 21 Spring washer

7407SE07

- 22 Bushing
- 23 Dust seal
- 24 Spherical bearing
- 25 Retaining ring

2) OPERATION

This machine use to cross connected cylinder for steering operation.

The steering cylinder use a gland (3) to remove piston and sealed seals. Dust wiper (8) located on the in side of the gland protects cylinder inner parts from dust. The piston (13) is fastened to the rod (2) by a nut (17).

The piston uses a single wear ring (16) with a piston seal (15) to seal between the piston and tube. The gland seals against the tube with two O-rings. The rod is sealed against the gland with a rod seal (5).

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

This procedure is designed so the service man can make a quick check of the steering system using a minimum amount of diagnostic equipment. If you need additional information, prefer to structure and function in group 1.

A location will be required which is level and has adequate space to complete the checks.

The engine and all other major components must be at operating temperature for some checks.

Locate system check in the left column and read completely, following this sequence from left to right.

Read each check completely before performing.

At the end of each check, if no problem is found(OK), that check is complete or an additional check is needed. If problem is indicated(NOT OK), you will be given repair required and group location.

If verification is needed, you will be given next best source of information :

Chapter 2 : Troubleshooting Group 3 : Tests and adjustments

ltem		Description	Service action	
Steering unit check		Run engine at low idle.	OK Chack completed	
		Turn steering wheel until frames are at maximum right (A) and then left (B) positions.		
	У <i>У</i>	LOOK : Frames must move smoothly in both directions.		
		When steering wheel is stopped, frames must stop.		
		FEEL : Excessive effort must not be required to turn steering wheel.		
		NOTE : It is normal for steering to drift from stops when steering wheel is released.		
Steering system leakage check		Turn steering wheel rapidly until frames are against stops.	OK Check completed.	
Heat hydraulic oil to oper- ating temperature. Run engine at high idle.	Left Right	Hold approximately 2 kgf on steering wheel.	NOT OK Do steering system lea	
0 0		Count steering wheel revolutions for 1 minute.	U	
		Repeat test in opposite direction.		
		LOOK : Steering wheel should rotate less than 5 rpm.		
		NOTE : Use good judgment; Excessive steering wheel rpm does not mean steering will be affected.		
Priority valve low press-		Park machine on a hard surface.	OK Ohaala aanualata d	
ure check		Hold brake pedal down.	Check completed.	
		Run engine at high idle.	NOT OK Do priority valve in main	
		Steer machine to the right and left as far as possible.	control valve pressure test.	
		LOOK : Machine must turn at least half way to the right and left stops.		
Priority valve high pres- sure check		Steer to steering stop and release steering wheel.	OK Check completed.	
Run engine at high idle.		Roll bucket back and hold over relief and observe engine rpm.	NOT OK Priority pressure is set too	
		Turn steering wheel to steering stop and hold, observe engine rpm.	high. Do priority valve	
		LOOK : Steering stall engine rpm must be higher than hydraulic stall rpm.		

* Hydraulic oil must be at operating temperature for these checks (refer to page 6-49).

2. TROUBLESHOOTING

* Diagnose malfunction charts are arranged from most probable and simplest to verify, to least likely, more difficult to verify. Remember the following steps when troubleshooting a problem :

Step 1. Operational check out procedure (see group 3 in section 1)

Step 2. Operational checks (in this group)

Step 3. Troubleshooting

Step 4. Tests and adjustments (see group 3)

Problem	Cause	Remedy
No steering	Low oil level.	Add recommended oil.
	Restricted suction line.	Check.
	Failed hydraulic pump.	Remove and inspect return filter for metal pump particles.
	Failed main hydraulic pump drive.	Do main pump flow test.
	Stuck priority valve spool in MCV.	Remove and inspect priority valve spool in MCV.
	Broken priority valve spring in MCV.	Remove and inspect spring.
	Failed hydraulic lines.	Check.
Slow or hard steering	Too much friction in the mechanical parts of the machine.	Lubricate bearings and joints of frame or cylinders or repair if necessary. Check steering column installation.
	Cold oil.	Warm the hydraulic oil.
	Low priority valve pressure setting.	Do priority valve pressure test.
	Worn hydraulic pump.	Do hydraulic pump performance check.
	Sticking priority valve spool in MCV.	Remove and inspect.
	Broken priority valve spring in MCV.	Remove and inspect.
	Pinched or restricted LS line.	Inspect line.
	Low system relief valve setting.	Test and adjust if necessary.
	Low overload relief valves setting.	Test and adjust if necessary.

Problem	Cause	Remedy
Constant steering to	Air in system.	Check for foamy oil.
maintain straight travel	Leakage in steering system.	Do steering system leakage check.
	Worn steering unit.	Do steering unit neutral leakage test in group 3.
	Leaf spring without spring force or broken.	Replace leaf springs.
	Spring in overload relief valve broken.	Replace overload relief valve.
	Gear wheel set worn.	Replace gear wheel set.
	Cylinder seized or piston seals worn.	Replace defects parts.
Slow steering wheel	Leakage in steering system.	Do steering system leakage check.
movement will not cause any frame movement	Worn steering unit gerotor.	Do steering unit leakage check.
Steering wheel can be turned with frames against steering stop	Leakage in steering system.	Do steering system leakage check.
no resistance and causes	Broken steering column or splined of steering unit.	Remove and inspect.
no frame movement	Lack of oil in steering unit.	Start engine and check steering operation.
	Leakage in steering system.	Do steering system leakage test in group 3.
Erratic steering	Air in oil.	Check for foamy oil.
	Low oil level.	Add recommended oil.
	Sticking priority valve spool in MCV.	Remove and inspect spool.
	Loose cylinder piston.	Remove rod to inspect piston.
	Damaged steering unit.	Remove and inspect.
Spongy or soft steering	Air in oil.	Check for foamy oil.
	Low oil level.	Add recommended oil.
Free play at steering	Loose steering wheel nut.	Tighten.
wheel	Worn or damaged splines on steering column or valve.	Inspect.
Steering unit binding or steering wheel does not		Inspect.
immediately return to neutral when released	High return pressure.	Check for a pinched or damaged return line.
	Contamination in steering unit.	Inspect hydraulic filter for contamination. Repair cause of contamination. Flush hydraulic system.

Problem	Cause	Remedy
Steering unit locks up	Large particles of contamination in steering unit.	Inspect hydraulic filter for contamination. Repair cause of contamination. Flush hydraulic system.
	★ Thermal shock	Do of MCV DLS port flow test. This oil flow provides a warm-up flow to steering unit when not using the steering.
	Worn or damaged steering unit.	Repair or replace steering unit.
Abrupt steering wheel oscillation	Improperly timed gerotor gear in steering unit.	Time gerotor gear.
Steering wheel turns by	Lines connected to wrong port.	Reconnect lines.
itself	Worn or damaged steering unit.	Repair or replace steering unit.
Vibration in steering system or hoses jump	High priority valve setting.	Do priority valve pressure test.
steering wheel cannot	Steering column and steering unit out of line.	Align the steering column with steering unit.
be obtained, i.e. there is a tendency towards "motoring"	Too little or no play between steering column and steering unit input shaft.	Adjust the play and, if necessary, shorten the splines journal.
	Pinching between inner and outer spools.	Contact the nearest service shop.
"Motoring" effect. The steering wheel can	Leaf springs are stuck or broken and have therefore reduced spring force.	Replace leaf springs.
turn on its own	Inner and outer spools pinch, possibly due to dirt.	Clean steering unit or contact the nearest service shop.
	Return pressure in connection with the reaction between differential cylinder and steering unit too high.	Reduce return pressure.
Backlash	Cardan shaft fork worn or broken.	Replace cardan shaft.
	Leaf springs without spring force or broken.	Replace leaf springs.
	Worn splines on the steering column.	Replace steering column.
Jerky steering	Priority spool orifice in MCV missing.	Inspect orifice.
	Sticking spool in cushion valve.	Inspect cushion valve. Flush the spool in cushion valve.

★ Thermal shock is caused by a large temperature differential (approx 30°C, 50°F) between the steering unit and hydraulic oil. If the steering is not operated for a long period of time and the orifice in the bottom of the priority spool is plugged, the steering unit may bind up when the steering is operated if the hydraulic oil is hot enough.

Problem	Cause	Remedy
"Shimmy" effect The steered wheels vibrate	Air in the steering cylinder.	Bleed cylinder. Find and remove the reason for air collection.
(Rough tread on tires gives vibrations.)	Mechanical connections or wheel bearings worn.	Replace worn parts.
	High priority valve setting pressure.	Set pressure as regular value.
Steering wheel can be	Oil is needed in the tank.	Fill with clean oil and bleed the system.
turned the whole time without the steered	Steering cylinder worn.	Replace or repair cylinder.
wheels moving	Gear wheel set worn.	Replace gear wheel set.
	Spacer across cardan shaft forgotten.	Install spacer.
Steering wheel can be turned slowly in one or both directions without	leaky or are missing in overload relief	Clean or replace defect or missing valves.
the steered wheels turning	One or both overload relief valves are leaky.	Clean or replace.
Steering is too slow and heavy when trying to turn quickly	Insufficient oil supply to steering unit, pump defective or number of revolutions too low.	Replace pump or increase number of revolutions.
	Relief valve setting too low.	Adjust valve to correct setting.
	Relief valve sticking owing to dirt.	Clean the valve.
	Spool in priority valve sticking owing to dirt.	Clean the valve, check that spool moves easily without spring.
	Too weak spring in priority valve.	Replace spring by a stronger.
"Kick back" in steering wheel from system Kicks from wheels	Fault in the system.	Contact authorized man or shop.
Heavy kick-back in steering wheel in both directions	Wrong setting of cardan shaft and gear-wheel set.	Correct setting as shown in group 4.
Turning the steering wheel activates the steered wheels opposite		Connect lines to correct ports.
Hard point when starting	Spring force in priority valve too weak.	Replace spring by a stronger.
to turn the steering wheel	Air in LS line.	Bleed LS line.
	Clogged orifices in priority valve.	Clean orifices in spool and in connecting plugs for LS.
	Oil is too thick (cold).	Let machine run until oil is warm.
Too little steering force	Pump pressure too low.	Correct pump pressure.

GROUP 3 TESTS AND ADJUSTMENTS

1. HYDRAULIC OIL CLEAN UP PROCEDURE USING PORTABLE FILTER CADDY

- Service equipment and tool
 Portable filter caddy
 Two 4000 mm × 1" 100R1 Hoses
 Quick disconnect fittings
 Discharge wand
 Connectors
- Steering system use oil from hydraulic oil tank. Flush all lines in the steering system.
 Disassemble and clean major compon-ents for steering system.

Steering components may fail if steering system is not cleaned after hydraulic oil tank contamination.

- If hydraulic system is contaminated due to a major component failure, remove and disassemble steering cylinders to clean debris from cylinders.
- 2) Install a new return filter element. Inspect filter before installing new element.
- * For a failure that creates a lot of debris, remove access cover from hydraulic oil tank. Drain and clean hydraulic oil tank of fill the specified oil to hydraulic oil tank through upper cover.
- To minimize oil loss, pull a vacuum in hydraulic oil tank using a vacuum pump. Connect filter caddy suction line to drain port at bottom of hydraulic oil tank using connector. Check to be sure debris has not closed drain port.
- Put filter caddy discharge line into hydraulic oil tank filler hole so end is as far away from drain port as possible to obtain a thorough cleaning of oil.

 Start the filter caddy. Check to be sure oil is flowing through the filters.
 Operate filter caddy approximately 10 minutes so oil in hydraulic oil tank is circulated

through filter a minimum of four times.

* Hydraulic tank capacity : 130 ℓ (34.3 U.S. gal)

Leave filter caddy operating for the next steps.

- 6) Start the engine and run it at high idle.
- * For the most effective results, cleaning procedure must start with the smallest capacity circuit then proceed to the next largest capacity circuit.
- 7) Operate all functions, one at a time, through a complete cycle in the following order: Clam, steering, bucket, and boom. Also include all auxiliary hydraulic functions.

Repeat procedure until the total system capacity has circulated through filter caddy seven times, approximately 30 minutes. Each function must go through a minimum of three complete cycles for a through cleaning for oil.

- Filtering time for machines with auxiliary hydraulic functions must be increased because system capacity is larger.
- 8) Stop the engine. Remove the filter caddy.
- 9) Install a new return filter element.
- 10) Check oil level in hydraulic oil tank ; Add oil if necessary.

2. TEST TOOLS

1) CLAMP-ON ELECTRONIC TACHOMET-ER INSTALLATION

Service equipment and tools Tachometer

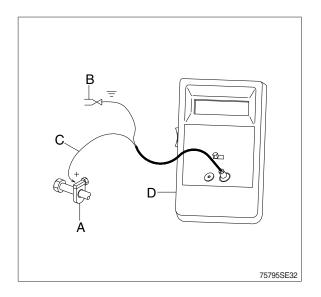
A : Clamp on tachometer.

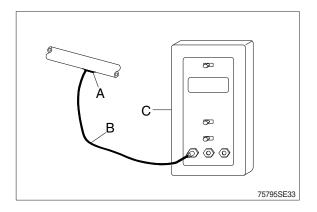
Remove paint using emery cloth and connect to a straight section of injection line within 100 mm (4in) of pump. Finger tighten only-do not over tighten. B : Black clip (-). Connect to main frame.

- C : Red clip (+). Connect to transducer.
- D : Tachometer readout. Install cable.

2) DIGITAL THERMOMETER INSTALLATION

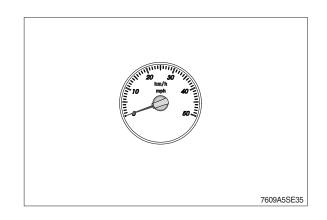
- Service equipment and tools Digital thermometer
 - A : Temperature probe. Fasten to a bare metal line using a tie band. Wrap with shop towel.
 - B : Cable.
 - C : Digital thermometer.





3) DISPLAY MONITOR TACHOMETER

The display monitor tachometer is accurate enough for test work.



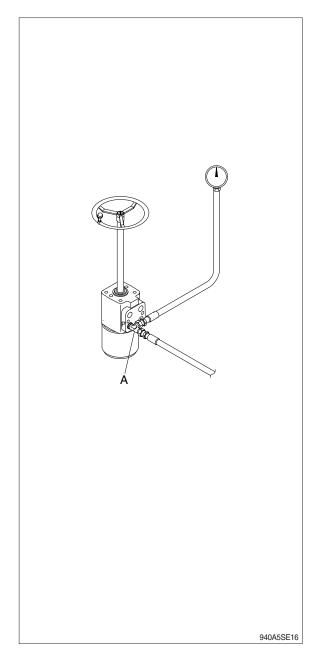
3. STEERING SYSTEM RESTRICTION TEST

· SPECIFICATION

Oil temperature $45\pm5^{\circ}C (113\pm9^{\circ}F)$ Engine speedHigh idleMaximum pressure210 bar (3045 psi)at steering unit

- GAUGE AND TOOL Gauge 0~7 MPa (0~70 bar, 0~1000 psi) 2EA
- This test will check for restrictions in the steering system which can cause overheating of hydraulic oil.
- Install temperature reader. (see temperature reader installation procedure in this group).
- Heat hydraulic oil to specifications. (see hydraulic oil warm up procedure at page 6-49).
- 3) Connect fitting (A) and install gauge.
- ▲ Do not operate steering or loader functions or test gauge may be damaged.
- 4) Run engine at specification and read pressure gauges.

If pressure is more than specification at the steering unit, inspect priority spool in MCV for a stuck spool. Make sure orifice plugs are installed in ends of priority spool. Check for plugged orifice in priority spool of MCV.

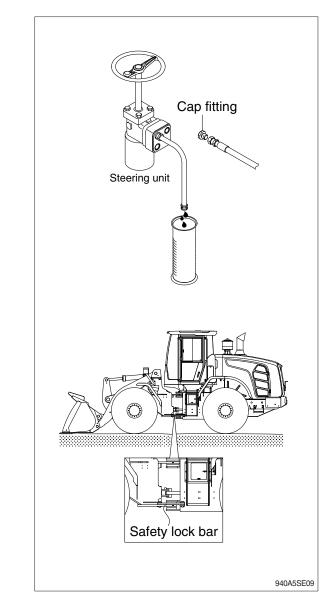


4. STEERING UNIT LEAKAGE TEST

· SPECIFICATION

Oil temperature $45\pm5^{\circ}C (113\pm9^{\circ}F)$ Engine speedHigh idleMaximum leakage10 ℓ /min

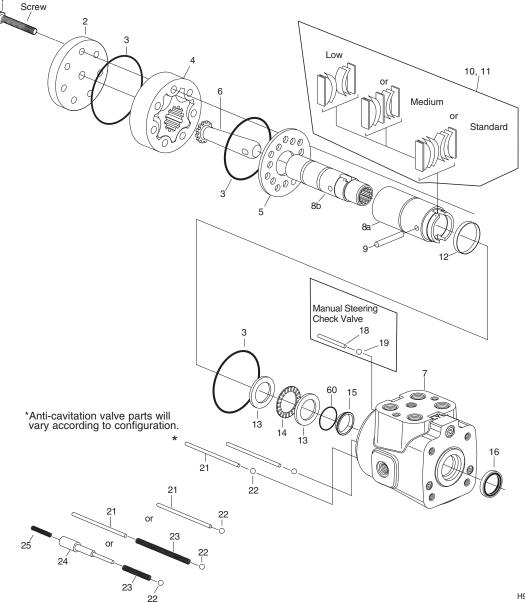
- GAUGE AND TOOL
 Temperature reader
 Measuring container (approx 20 ℓ)
 Stop watch
- 1) Install frame locking bar to prevent machine from turning.
- Install temperature reader. (see temperature reader installation procedure in this group).
- Heat hydraulic oil to specifications. (see hydraulic oil warm up procedure at page 6-49).
- 4) Disconnect return hose from fitting. Install cap fitting.
- Run engine at specifications.
 Rotate steering wheel against locking bar using approximately 1.2 kgf · m of force.
 Measure oil flow from return hose for 1 minute.
- 6) Leakage is greater than specifications, repair or replace steering unit.



GROUP 4 DISASSEMBLY AND ASSEMBLY

1. STEERING UNIT

1) STRUCTURE



H940AC5SE01

- 1 Cap screw
- 2 End cap
- 3 Seal
- 4 Gerotor subassembly
- 5 Spacer plate
- 6 Drive
- 7 Valve housing
- 8 Spool / sleeve

- 9 Centering pin
- 10 Spacer spring
- 11 Centering spring
- 12 Retainer spring
- 13 Bearing race
- 14 Needle thrust bearing
- 15 Seal
- 16 Dust seal

- 18 Roll pin
- 19 Ball
- 21 Roll pin
- 22 Check ball
- 23 Compression spring
- 24 Anti-cavitation plug retainer
- 25 Compression spring
- 60 O-ring

2) INTRODUCTION

- (1) Most repairs require the removal of the control unit from the vehicle.
- (2) Cleanliness is extremely important.
- (3) Clean the port areas thoroughly before disconnecting the hydraulic lines.
- (4) Plug the control unit ports and cover open hydraulic lines immediately after they have been disconnected.
- (5) Drain the oil and clean the exterior of the control unit before making repairs.
- (6) Wash all metal parts in clean solvent.
- (7) Use filtered, moisture-free compressed air to dry the parts.Do not wipe them dry with paper towels or cloth lint in a hydraulic system will cause damage.
- (8) Always use new seals when reassembling hydraulic control units.
- (9) Lubricate new rubber seals with a petroleum jelly before installation.
- (10)Torque all bolts over gasketed joints, then repeat the torquing sequence to make up for gasket compression.

After all repairs are complete it is essential to verify the accuracy of control unit repairs on an authorized test stand.

3) TOOLS

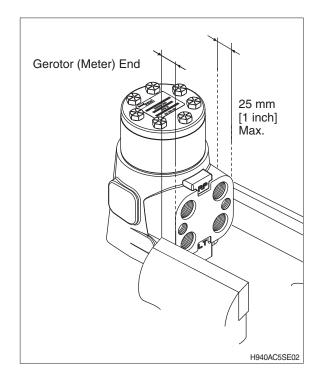
- (1) Screwdriver (102~152 mm [4~6"] long, ×3 mm [118"] wide flat blade)
- (2) 1/2 inch socket for current hex head cap screws.
- (3) Breaker bar wrench.
- (4) Torque wrench (30 Nm [300 lb-in] capacity).

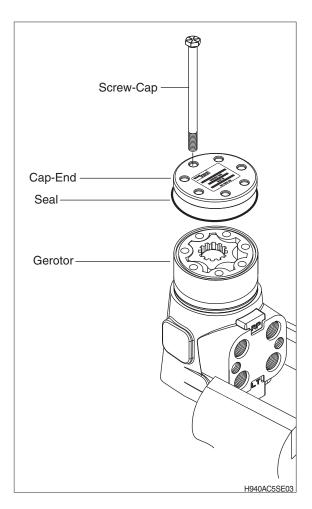
4) DISASSEMBLY

Cleanliness is extremely important when repairing a steering control unit. Work in a clean area. Before disconnecting lines, clean port area of unit thoroughly. Use a wire brush to remove foreign material and debris from around exterior joints of the unit.

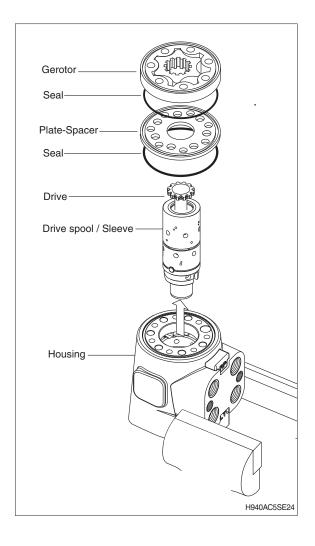
We recommend that you keep the unit in a vise during disassembly. Follow the clamping procedures explained throughout the manual.

- Clamp unit in vice, meter end up. Clamp lightly on edges of port face sides. Use protective material on vice jaws. Housing distortion could result if jaws are overtightened.
- (2) Remove (5/16") cap screws.
- (3) Remove end cap.
- (4) Remove seal from gerotor.

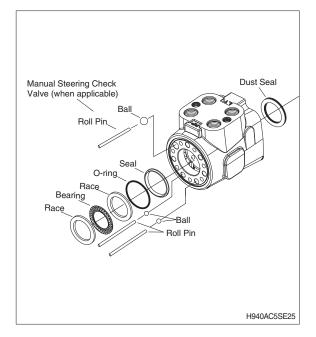




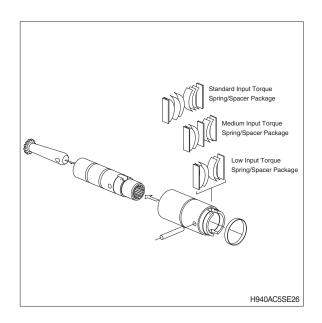
- (5) Remove gerotor. Be careful not to drop star.
- (6) Remove seal from spacer plate.
- (7) Remove spacer plate.
- (8) Remove seal from housing.
- (9) Pull drive and twist to remove drive assembly from housing.
- (10) Remove housing from vise.
- Do not bindspool and sleeve in housing. Rotate spool and sleeve assembly slowly when removing it from housing. Remove spacer plate.



- (11) Carefully remove bearing and races, anticavitation valves and manual steering check valve (roll pin and ball) from bolt holes by tipping housing gerotor side down.
- (12) Do not remove any valves other than manual steering check valve assembly and anti-cavitation valve assembly. All other valves are factory preset and are non-serviceable.
- (13) Carefully Remove seal with a thin-blade screw driver. Do not scratch seal groove with screw driver.
- (14) Use thin bladed screwdriver to pry dust seal from housing. Do not damage housing.



- (15) Push pin from spool and sleeve assembly.
- (16) Remove Drive
- (17) Push spool partially from control end of sleeve, then carefully remove centering springs and retaining ring from spool by hand.
- Standard input torque unit uses six centering springs and two spacers. Medium input torque unit uses four centering springs and three spacers. Low input torque unit uses four centering springs and two spacers.

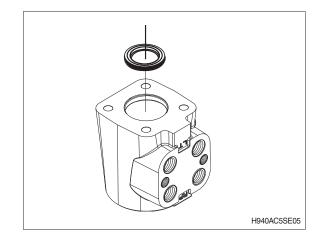


5) ASSEMBLY

* Assembly cleanliness

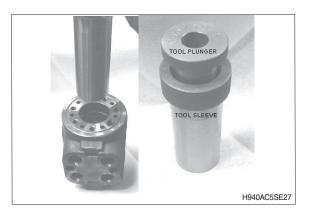
Check all mating surfaces. Replace any parts that have scratches or burrs that could cause leakage. Clean all metal parts in clean solvent. Blow dry with air. Do not wipe dry with cloth or paper towel because lint or other matter can get into the hydraulic system and cause damage. Do not use grit paper or file or grind these parts.

- * Lubricate all seals with clean petroleum jelly. A good service policy is to replace all old seals with new seals. Do not use excessive lubricant on seals for meter section.
- (1) Refer to parts lists covering your steering control unit when ordering replacement parts.
- (2) Place housing on a flat work area on a clean lint free cloth.Install press-fit 24.9 mm (0.98") ID seal in housing with metal surface of seal facing toward housing.

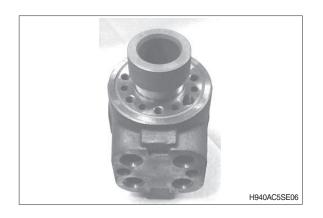


2-Piece shaft seal installation

- (3) For installation of O-ring and seal.
- ① Place housing on a flat work area as shown in the right figure.
- ⁽²⁾ Lubricate seal and O-ring with hydraulic oil before installation.
- ③ Align sleeve with housing bore as shown in the right figure.



④ Insert sleeve into housing bore.



5 Place o-ring on plunger.



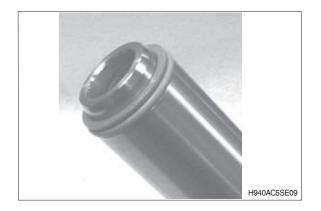
 6 Align seal with plunger.
 Cross section "L" shape of seal should be upside down.



O Push seal onto plunger.

Lip of seal should be between O-ring and plunger.

No gap should exist between O-ring and seal.



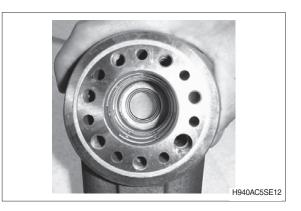
(8) Align plunger with sleeve.



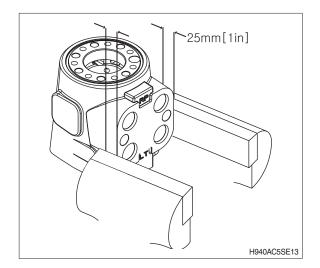
- 9 Push plunger into sleeve until it bottoms out, rotate 1/4 turn.
- While holding sleeve in housing, withdraw plunger.
- 1 Withdraw sleeve.



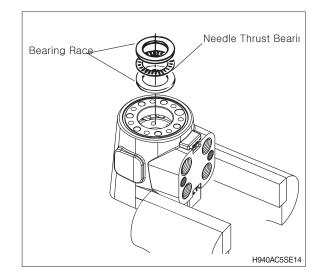
 Inspect seal installation.
 Seal and O-ring must both be within shaft seal counterbore of housing.



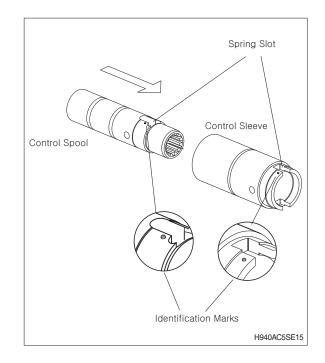
(4) Clamp housing in vice.



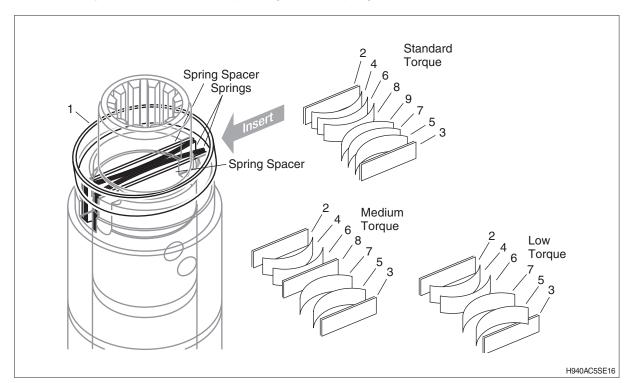
(5) Install two bearing races and thrust bearing as shown in right figure.



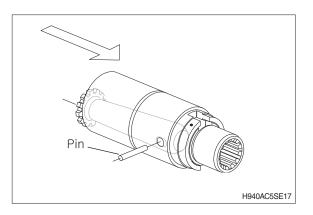
(6) Assemble spool and sleeve carefully so that spring slots line up at the same end. Rotate spool while sliding parts together. Test for free rotation. Spool should rotate smoothly in sleeve with fingertip force applied at splined end.
Align spring slots and identification marks in spool and sleeve and stand parts on end of bench.



(7) Installation of spring spacers and springs, hold spring retainer at an angle as shown (see 1), insert spring spacers and springs one at a time in sequence noted by reference numbers 2~9,(standard torque), 2~8(medium torque), 2~7 (lowtorque), then position spring retainer correctly over all these parts. Adjust alignment of spring parts with a small screwdriver.

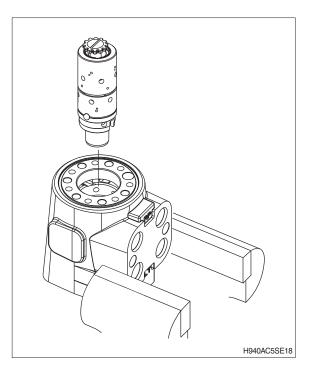


- (8) Assemble drive and spool/sleeve.
- (9) Insert pin through spool and sleeve assembly through hole in drive, until pin is flush at both sides of sleeve.



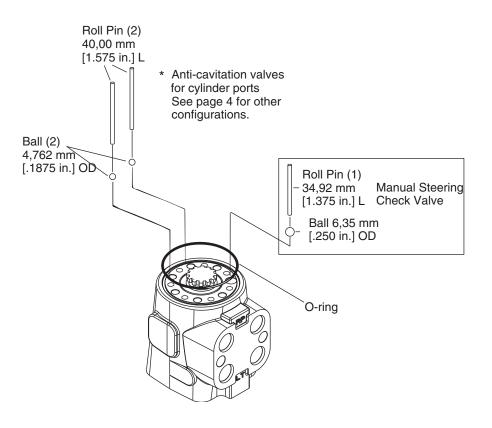
- (10) Position spool and sleeve assembly so that splined end of spool enters 14 hole end of housing first.
- While inserting spool and sleeve assembly into housing, make sure parts do not tilt out of position.
 Push assembly gently into place with slight rotating action. Bring spool assembly entirely within housing bore until parts are flush at 14 hole end of housing.

With spool assembly in this flush position, check for free rotation within housing by turning assembly with fingertip force at splined end.



(11) Install 72.6 mm (2.86") ID O-ring in housing.

(12) Install anti-cavitation valves and manual steering check valve (if used) in holes. After installing balls, inspect holes to make sure they are properly seated.

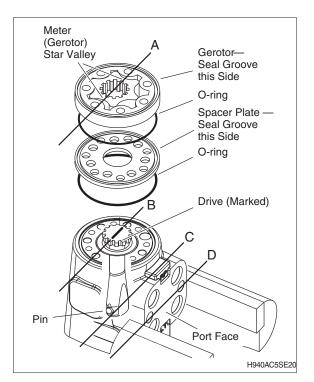


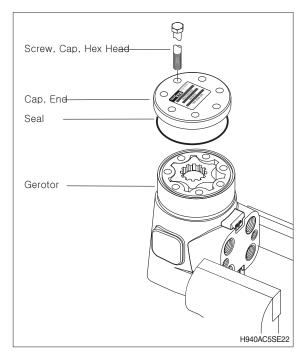
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* Timing reference data

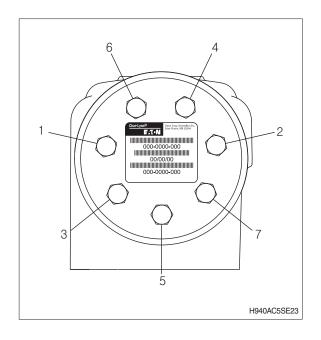
Align star valleys (reference A) with marked drive 1 and drive 2 (reference B). Valleys must align with pin. Note parallel relationship of reference lines A, B, C, and D in figure. Align bolt holes without disengaging gerotor from drive.

- (13) Install spacer plate. Align bolt holes in spacer plate with tapped holes in housing.
- (14) Lubricate and install 72.6 mm (2.86 in) ID seal in spacer plate.
- (15) Install gerotor (meter) seal groove up, note position of star valleys in relation to marked drive.
- (16) Lubricate and install 72,6 mm [2.86 in.] ID seal in gerotor ring.
- (17) Lubricate and install 72,6 mm [2.86 in.] ID seal in gerotor.
- (18) Install end cap on gerotor, aligning holes.
- Check to insure thatspool and sleeve are flush orslightly below 14 hole surface of housing.
- Clean upper surfaceof housing by wiping with palmof clean hand. Clean each of the flat surfaces of meter sec-tion parts in a similar way justbefore reassembly. Do not usecloth or paper to clean surfaces.



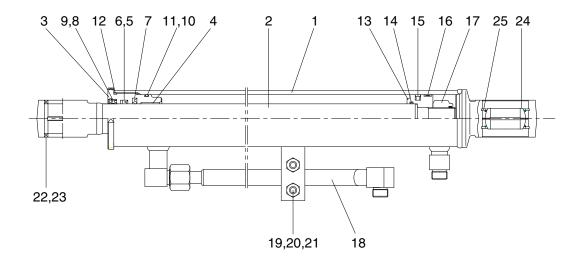


(19)Install 7 dry cap screws in end cap. Pretighten cap screws to 17Nm [150 Ib-in], then torque screws to 28-34 Nm [250-300 lb-in] in sequence shown in the right figure.



2. STEERING CYLINDER

1) STRUCTURE



- 1 Tube assy
- 2 Rod assy
- 3 Gland
- 4 Du bushing
- 5 Rod seal
- 6 Back up ring
- 7 Buffer ring
- 8 Dust wiper
- 9 Snap ring

10 O-ring

- 11 Back up ring
- 12 O-ring
- 13 Piston
- 14 O-ring
- 15 Piston seal
- 16 Wear ring
- 17 Nylon nut

- 18 Pipe assy
- 19 U-bolt
- 20 Hexagon nut
- 21 Washer spring

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- 22 Bushing
- 23 Dust seal
- 24 Spherical bearing
- 25 Retaining ring

2) TOOLS AND TIGHTENING TORQUE

(1) Tools

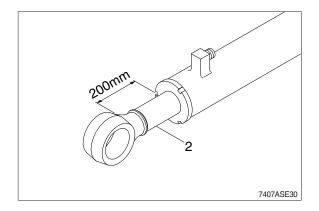
Tool name	Remark		
Spanner	17 32 41		
Steel bar	For gland		
(-) Driver	Small and large sizes		
Torque wrench	Capable of tightening with the specified torques		

(2) Tightening torque

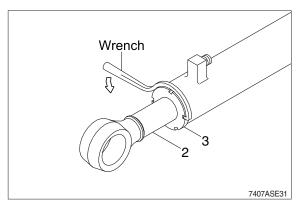
Part name	Item	Size	Torque	
			kgf ∙ m	lbf · ft
Gland	3	M70 $ imes$ 2.0	70 ± 7	506 ± 51
Piston	13	M27 $ imes$ 2.0	75 ± 8	542 ± 58
Nut(Pipe assy)	18	M22 $ imes$ 1.5	30 ± 3	217 ±21.7
Nut	20	M10 $ imes$ 1.0	3.2 ± 0.3	23.1±2.2

3) DISASSEMBLY

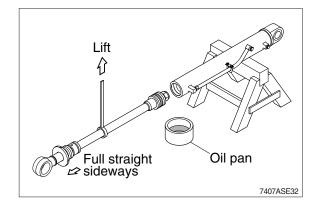
- (1) Remove cylinder head and piston rod
- ① Hold the clevis section of the tube in a vise.
- * Use mouth pieces so as not to damage the machined surface of the cylinder tube. Do not make use of the outside piping as a locking means.
- ② Pull out piston rod (2) about 200 mm (7.1 in). Because the piston rod is rather heavy, finish extending it with air pressure after the oil draining operation.



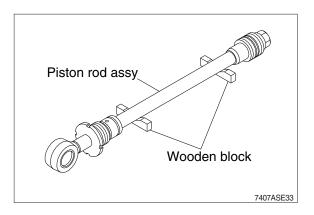
- 3 Loosen and remove the gland (3).
- * Cover the extracted piston rod (2) with rag to prevent it from being accidentally damaged during operation.



- ④ Draw out gland (3) and piston rod (2) assembly together from cylinder tube (1).
- Since the piston rod assembly is heavy in this case, lift the tip of the piston rod (2) with a crane or some means and draw it out. However, when piston rod (2) has been drawn out to approximately two thirds of its length, lift it in its center to draw it completely.

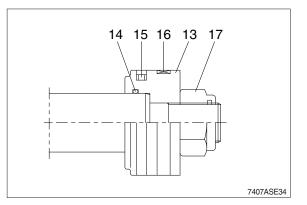


- Note that the plated surface of piston rod (2) is to be lifted. For this reason, do not use a wire sling and others that may damage it, but use a strong cloth belt or a rope.
- ⁽⁵⁾ Place the removed piston rod assembly on a wooden V-block that is set level.
- % Cover a V-block with soft rag.

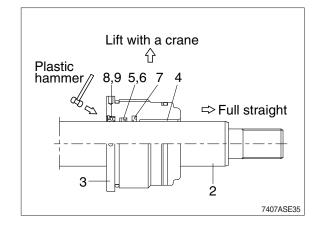


(2) Remove piston and gland assembly

- 1 Remove the nylon nut (17).
- 2 Remove piston assembly (13), and O-ring (14).

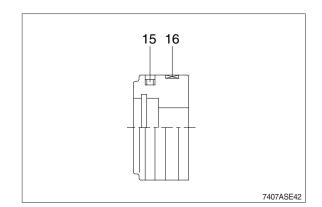


- ④ Remove the gland (3) assembly from piston rod (2).
- If it is too heavy to move, move it by striking the flanged part of gland (3) with a plastic hammer.
- Pull it straight with cylinder head assembly lifted with a crane.
 Exercise care so as not to damage the lip of rod bushing (4) and packing (5,6,7,8,9) by the threads of piston rod (2).



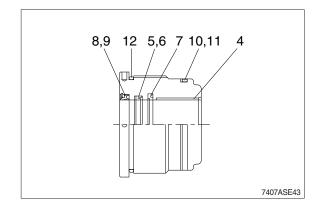
(3) Disassemble the piston assembly

- Remove wear ring (16) and piston seal (15).
- Exercise care in this operation not to damage the grooves.



(4) Disassemble gland assembly

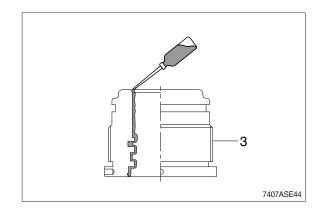
- Remove back up ring (11), and O-ring (10).
- 2 Remove O-ring (12).
- ③ Remove snap ring (9) and dust wiper (8).
- 4 Remove back up ring (6), rod seal (5).
- \bigcirc Remove buffer ring (7).
- Exercise care in this operation not to damage the grooves.
- * Do not remove seal and ring, if does not damaged.



4) ASSEMBLY

(1) Assemble gland assembly

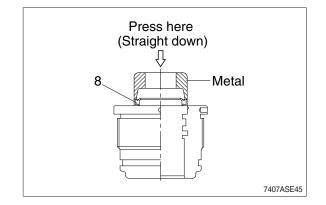
- * Check for scratches or rough surfaces if found smooth with an oil stone.
- ① Coat the inner face of gland (3) with hydraulic oil.



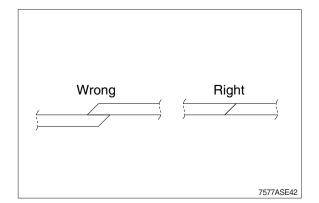
② Coat dust wiper (8) with grease and fit dust wiper (8) to the bottom of the hole of dust wiper.

At this time, press a pad metal to the metal ring of dust seal.

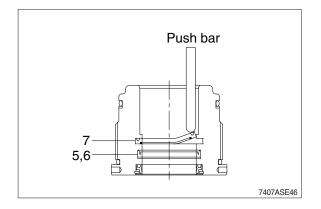
3 Fit snap ring (9) to the stop face.



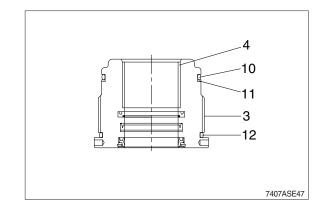
- ④ Fit back up ring (6) and rod seal (5) to corresponding grooves, in that order.
- 5 Fit buffer ring (7).
- * Coat each packing with hydraulic oil before fitting it.
- Insert the backup ring until onside of it is inserted into groove.



- Rod seal (5) has its own fitting direction. Therefore, confirm it before fitting them.
- Fitting rod seal (5) and buffer ring (7) up side down may damage its lip. Therefore check the correct direction that is shown in fig.

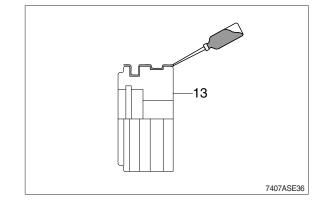


- \bigcirc Fit back up ring (11) to gland (3).
- % Put the backup ring in the warm water of 30~50°C.
- 0 Fit O-ring (10) to gland (3).
- (8) Fit bushing (4) to gland (3).

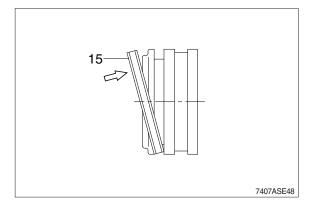


(2) Assemble piston assembly

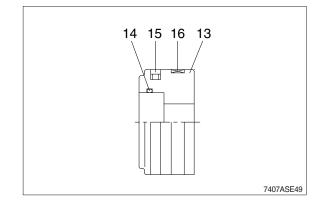
- Check for scratches or rough surfaces.If found smooth with an oil stone.
- ① Coat the outer face of piston (13) with hydraulic oil.



- ② Fit piston seal (15) to piston
- * Put the piston seal in the warm water of 60~100°C for more than 5 minutes.
- * After assembling the piston seal, press its outer diameter to fit in.

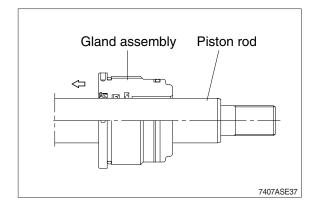


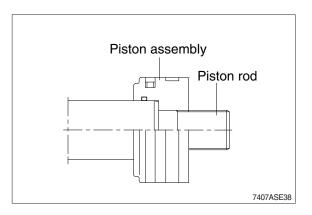
- $\ensuremath{\textcircled{3}}$ Fit wear ring (16) to piston (13).
- 4 Fit O-ring (14) to piston (13).



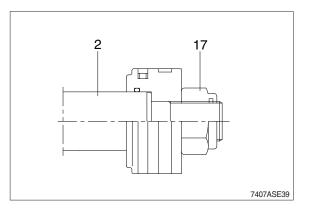
(3) Install piston and gland assembly

- 1 Fix the piston rod assembly to the work bench.
- ② Apply hydraulic oil to the outer surface of piston rod (2), the inner surface of piston and gland.
- ③ Insert gland assembly to piston rod (2).
 - \cdot Tightening torque : 70 \pm 7kgf \cdot m (506 \pm 51lbf \cdot ft)
- (4) Fit piston assembly to piston rod. \cdot Tightening torque : 75 \pm 8kgf \cdot m (542 \pm 58lbf \cdot ft)



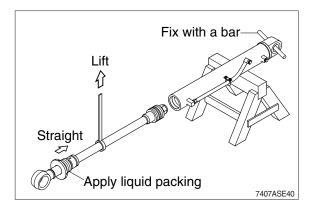


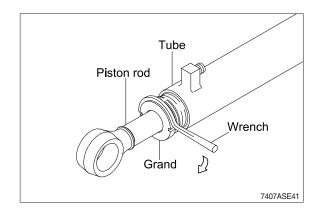
5 Tighten nylon nut(17) to piston rod(2).



(4) Overall assemble

- Place a V-block on a rigid work bench. Mount the cylinder tube assembly (1) on it and fix the assembly by passing a bar through the clevis pin hole to lock the assembly.
- ⁽²⁾ Insert the piston rod assembly in to the cylinder tube assembly, while lifting and moving the piston rod assembly with a crane.
- * Be careful not to damage piston seal by thread of cylinder tube.
- ③ Match the bolts holes in the cylinder head flange to the tapped holes in the cylinder tube assembly and tighten socket bolts to a specified torque.
- * Refer to the table of tightening torque.

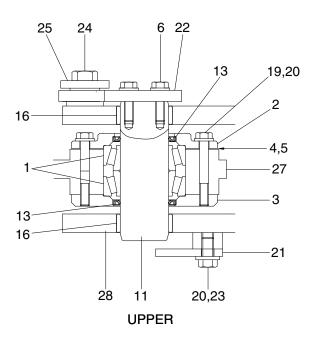


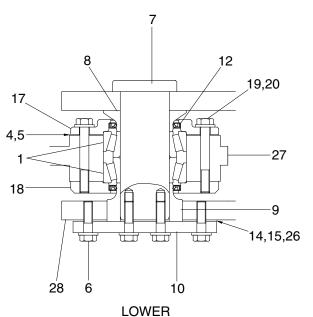


2. CENTER PIVOT PIN

1) CONSTRUCTION

Figure shows the construction of the center pivot pin assembly. This assembly serves to connect the front frame with the rear frame; two sets of assemblies are provided, one each for the upper and lower parts. The numbers in parentheses following the parts name denote the item numbers shown in the figure in the disassembly and assembly procedures.





74095SE13

- 1 Bearing
- 2 Cover
- 3 Cover
- 4 Shim (0.1 t)
- 5 Shim (0.5 t)
- 6 Bolt-w/washer
- 7 Pin
- 8 Collar
- 9 Collar
- 10 Plate

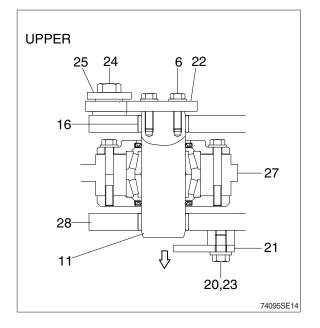
- 11 Pin
- 12 Dust seal
- 13 Dust seal
- 14 Shim (0.1 t)
- 15 Shim (0.5 t)
- 16 Bushing
- 17 Cover
- 18 Cover
- 19 Hexagon bolt
- 20 Hardened washer

- 21 Plate
- 22 Plate
- 23 Hexagon bolt
- 24 Hexagon bolt
- 25 Hardened washer
- 26 Shim (2.0 t)
- 27 Front frame
- 28 Rear frame

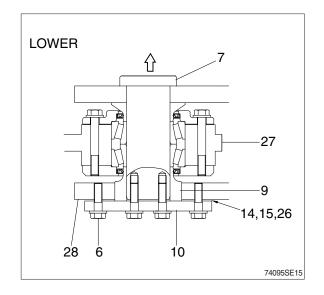
2) DISASSEMBLY

After supporting the front frame and the rear frame as horizontally as possible using wood blocks and jacks, disassemble as follows: In order to facilitate the disassembly/assembly of the center pivot pins, remove the drive shaft, hydraulic line and steering cylinder first.

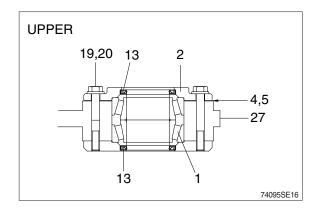
- Maintain the horizontal level of front frame (27) and rear frame (28), and then remove hexagon bolt (6, 23, 24), washer (20, 25) and plate (21, 22).
- (2) Take out upper pin (11) to the downside using a metal punch.



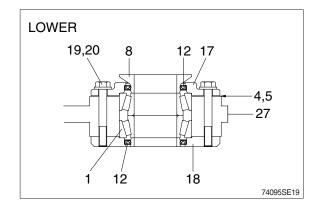
- (3) Maintain the front frame horizontal level, remove hexagon bolts (6) and then remove the plate (10) and shims (14, 15, 26).
- (4) Take out lower pin (7) to the upside using a metal punch carefully.
- (5) Jack up or lifting the front frame (27) slightly, the collar (9) protrudes over the rear frame.Remove the collar (9).
- (6) Lift the frame by passing the slinging wire rope at four positions of front frame, in order to separate it from the rear frame.
- (7) Support the front frame safely.



- (8) Remove bolt (19), washer (20) and then take out cover (2) and shims (4, 5).
- (9) Take out dust seal (13) from the cover (2).
- (10) Remove the bearing (1), and dust seal (13).



- (11) Remove bolt (19), washer (20) and then take out cover (17, 18) and shims (4, 5).
- (12) Take out the dust seal (12) from the cover (17, 18).
- (13) Remove the bearing (1) and collar (8).



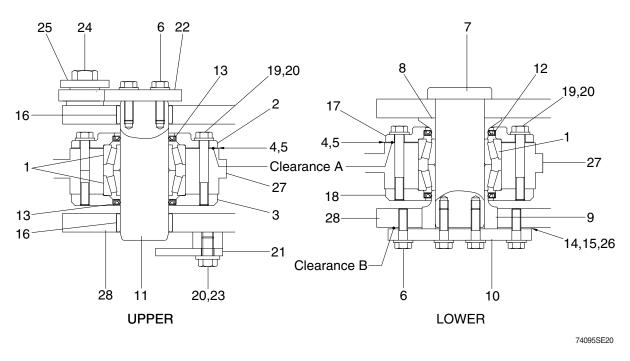
3) INSPECTION

- (1) Check the bearing sliding surface for excessive wear, scorching or scratches; replace if necessary.
- (2) Replace all dust seals (12,13) with new ones.
- (3) Grind any pins (7, 11) dented with an oilstone or replace any pins abrasive excessively.
- (4) Check inside cover (2, 3, 17, 18) and collar (8, 9) for dents or scratches; if any damage is found, correct with a grinder or replace.
- (5) The serviceable limit of pins and bushings is shown in the table below.

Unit : mm

Item No.	Name	Std dimension	Serviceable limit			Domodu
			Outer dia	Inner dia	Clearance	Remedy
7, 11	Pin		64.5			
1	Tapered roller bearing	65		65.5	0.8	Replace
8, 9	Collar			65.5		
12, 13	Dust seal	When removed		Replace		

4) ASSEMBLY



Assemble the center pivot group by reversing the order of disassembly while paying close attention to the following.

- (1) Put the dust seal (12,13) into cover (2, 3, 17, 18).
- * Apply grease to the lip of the dust seal. Insert the dust seal so that the dust seal lip faces out and punch four places on the outer circumference of the seal to lock it.
- (2) Lower the temperature of the lower bearing cup to $-75\pm5^{\circ}$ C ($-103\pm9^{\circ}$ F) and install it to front frame until it contacts the bottom of the frame.
- (3) Place the cover (3, 18).
- (4) Coat lightly with oil and install lower bearing in bore in front frame. Coat lightly with oil and install upper bearing in bore in upper front frame.
- (5) Place the cover (2, 17) and hold in place with bolt (19). At this time, adjust shims (4, 5) to press the shoulder of bearing (1) against retainer.

· Adjustment method of clearance A

Install bearing (1) and cover (2, 17) without shim (4, 5)

Install four of bolt (19) so that each bolt is separated by 90 degrees.

Tightening torque : 0.8~1.0 kgf · m (5.8~7.2 lbf · ft)

- 0 Adjust shims (4, 5) in order to control the clearance A.
 - · Clearance A : Below 0.1 mm
 - Shim thickness : 0.1 mm, 0.5 mm

- (5) Apply grease to lower collar (8) and insert it to the lower of roller bearing.
- (6) After setting the bearing so that its upper surface is horizontal, tighten the all the bolt (19). After tightening, confirm that tapered roller bearing moves lightly. (bearing preload : 0.6 ~ 0.9 kgf ⋅ m) ; if does not move smoothly, add shims (4, 5).
 - Tightening Torque : $9.8 \sim 15.8 \text{ kgf} \cdot \text{m} (70.9 \sim 114 \text{ lbf} \cdot \text{ft})$
 - · Apply loctite #243.
- (7) Move the front frame and join it to the rear frame so that match the pin hole at the center.
- (8) Apply grease to pin (11), bushing (16) and insert it into tapered roller bearing (1).
- (9) Apply grease to lower collar (9) and insert it to the lower of roller bearing through rear frame (28).
- (10) Apply grease to pin (7) and insert it into tapered roller bearing (1).
- (11) Before tightening bolt (6), adjust shims (14, 15) in order to control the clearance between the plate (21) and rear frame (28).
 - · Adjustment method of clearance B
 - Install pin (7) and plate (21) without shim (14,15, 26).
 Install four of bolt (6) so that each bolt is separated by 90 degrees.
 - Tighting torque : $0.8 \sim 1.0$ kgf m ($5.8 \sim 7.2$ lbf ft)
 - ② Adjust shims in order to control the clearance B.
 - · Clearance B : 0.1~0.2 mm
 - Shim thickness : 0.1 mm, 0.5 mm, 2.0 mm
- (12) Tighten the all the bolts (6).
 - Tightening Torque : 9.8~15.8 kgf m (70.9~114 lbf ft)
 - · Apply loctite #243.

Trouble Probable cause		Remed
	Capscrew for fixing steering valve is loose	Retighten
Shock is felt when steering	Faulty center pivot pin mounting bolts	Retighten
	Center pivot pins have worn out	Readjust or replace
	Faulty hydraulic system	See hydraulic system
	Fault fixing of connecting capscrews	Retighten
	Center pins have worn out	Readjust or replace
Shock is felt when moving backward or forward	Bearings of support unit have worn out	Retighten
	Drive shaft damaged	See drive system
	Faulty transmission	See transmission system

5) TROUBLESHOOTING

Group	1	Structure and Function	6-1
Group	2	Operational Checks and Troubleshooting	6-35
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GROUP 1 STRUCTURE AND FUNCTION

1. HYDRAULIC SYSTEM OUTLINE

The loader hydraulic system is a pilot operated, closed center system which is supplied with flow from the variable displacement piston main hydraulic pump.

The loader system components are :

- · Main pump
- · Main control valve
- · Bucket cylinder
- · Boom cylinders
- $\cdot \text{ EH}$ remote control valve
- · Safety valve

The main control valve is load pressure independent flow distribution system which routes flow to the boom, bucket or auxiliary cylinders (not shown) when the respective spools are shifted.

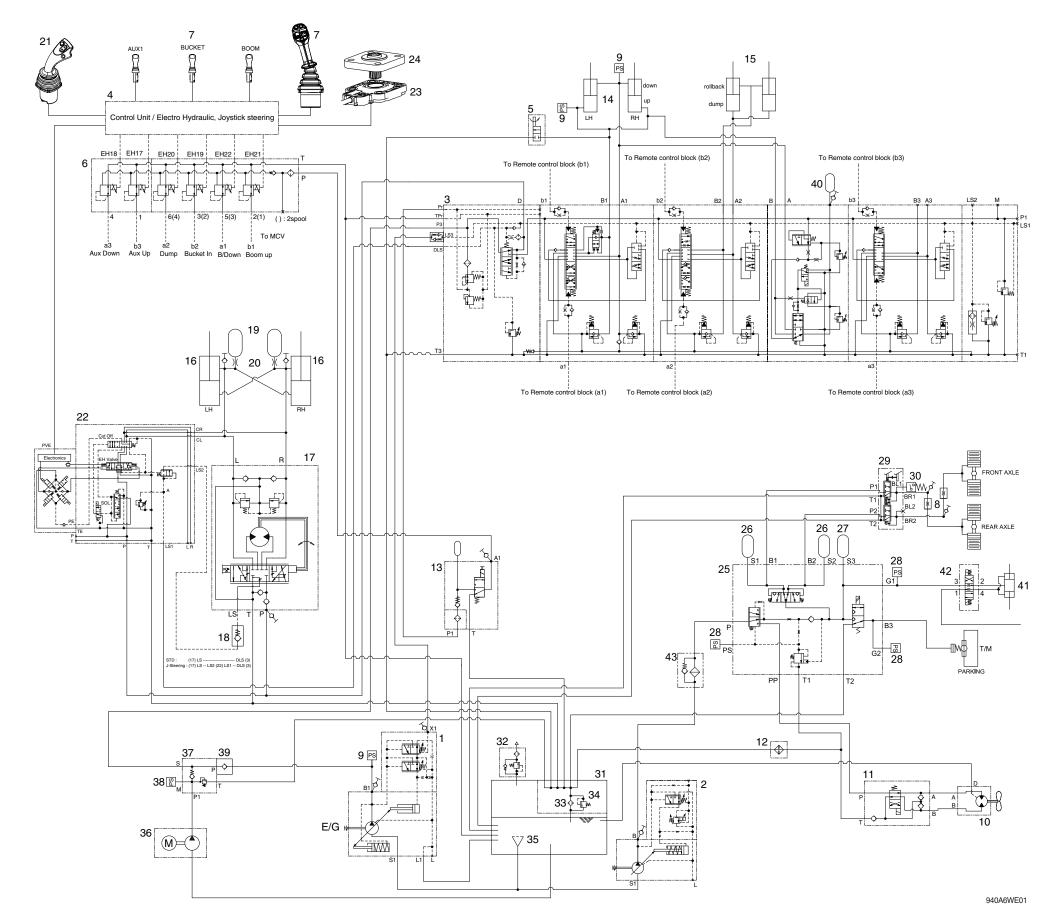
Flow from the main pump is routed to the main control valve where pump outlet pressure is reduced to pilot circuit pressure. The main control valve flow to the remote control valve.

The remote control valve routed flow to either end of each spool valve section in the main control valve to control spool stroke.

A accumulator mounted on safety valve supplies a secondary pressure source to operated remote control valve so the boom can be lowered if the engine is off.

The return circuit for the main hydraulic system have return filter inside the hydraulic tank. The return filter uses a filter element and a bypass valve. The bypass valve is located in the upside of filter.

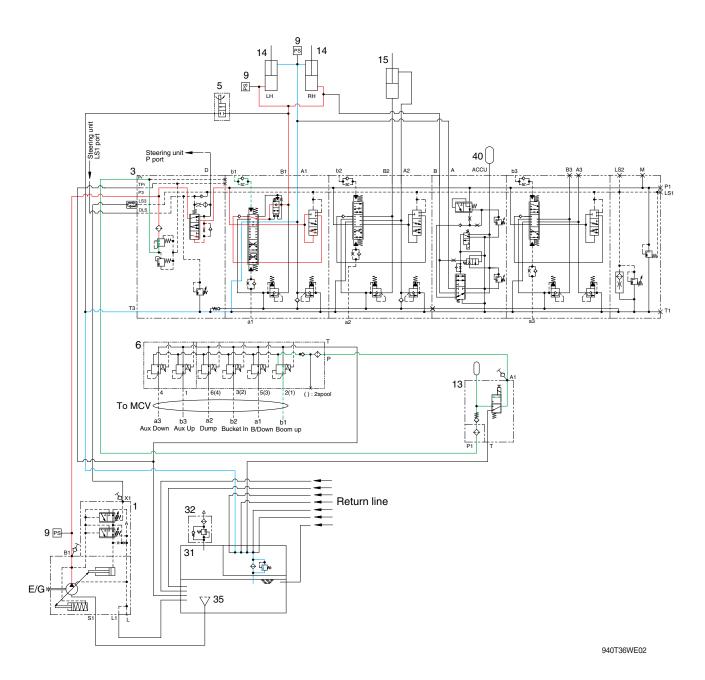
2. HYDRAULIC CIRCUIT (HL940 T3, HL940XT T3)



- 1 Main pump
- 2 Fan & brake pump
- 3 Main control valve
- 4 Control unit
- 5 Boom lowering valve
- 6 Control block
- 7 Remote control lever(EH)
- 8 Orifice
- 9 Pressure sensor
- 10 Fan motor
- 11 Directional valve
- 12 Hyd oil cooler
- 13 Safety valve
- 14 Boom cylinder
- 15 Bucket cylinder
- 16 Steering cylinder
- 17 Steering unit
- 18 Line check valve
- 19 Accumulator
- 20 Orifice
- 21 Joystick steering lever (opt)
- 22 Joystick steering valve (opt)
- 23 Steering sensor(opt)
- 24 Adapter(opt)
- 25 Cut off valve
- 26,27 Accumulator
- 28 Pressure sensor
- 29 Brake valve
- 30 Pressure switch
- 31 Hydraulic tank
- 32 Air breather
- 33 Return filter
- 34 Bypass valve
- 35 Strainer assy
- 36 Motor pump (opt)
- 37 Check block (opt)
- 38 Pressure sensor (opt)
- 39 Check valve (opt)
- 40 Accumulator (opt)
- 41 Quick coupler cylinder (opt)
- 42 Solenoid valve (opt)
- 43 Line filter

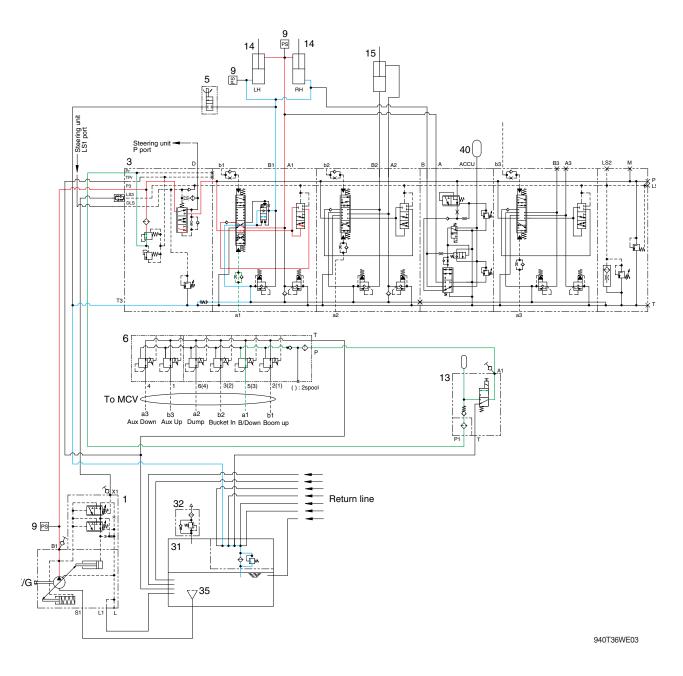
3. WORK EQUIPMENT HYDRAULIC CIRCUIT

1) WHEN THE RCV LEVER IS IN THE RAISE POSITION



- When the EH RCV lever (7, boom) is pulled back, the boom spool is moved to raise position by pilot oil pressure from EH control block (6).
- The oil from main pump (1) flows into main control valve (3) and then goes to the large chamber of boom cylinder (14) by pushing the load check valve of the boom spool.
- The oil from the small chamber of boom cylinder (14) returns to hydraulic oil tank (31) through the boom spool at the same time.
- When this happens, the boom goes up.

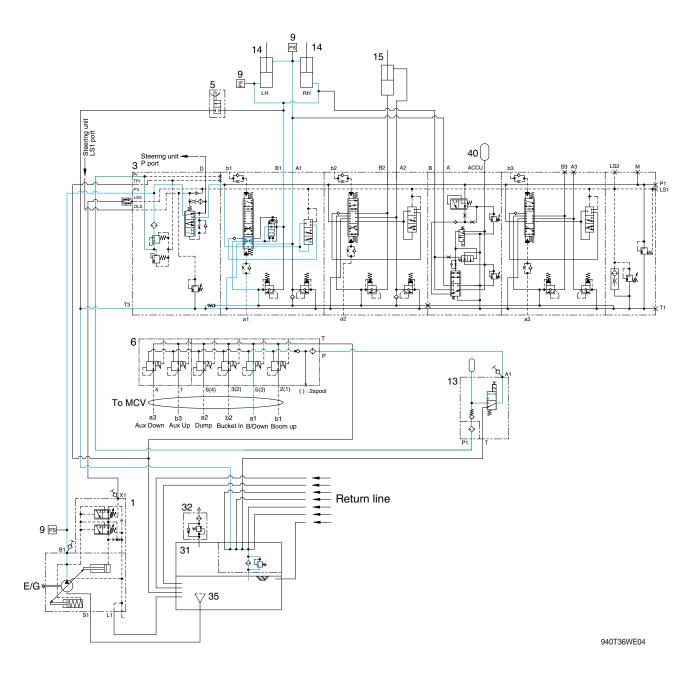
2) WHEN THE RCV LEVER IS IN THE LOWER POSITION



- When the EH RCV lever (7, boom) is pushed forward, the boom spool is moved to lower position by pilot pressure from EH control block (6).
- The oil from main pump (1) flows into main control valve (3) and then goes to small chamber of boom cylinder (14) by pushing the load check valve of the boom spool.
- The oil returned from large chamber of boom cylinder (14) returns to hydraulic tank (31) through the boom spool at the same time.
- When the lowering speed of boom is faster, the return oil from the large chamber of boom cylinder combines with the oil from the pump through the regeneration check valve, and flows into the small chamber of the cylinder.

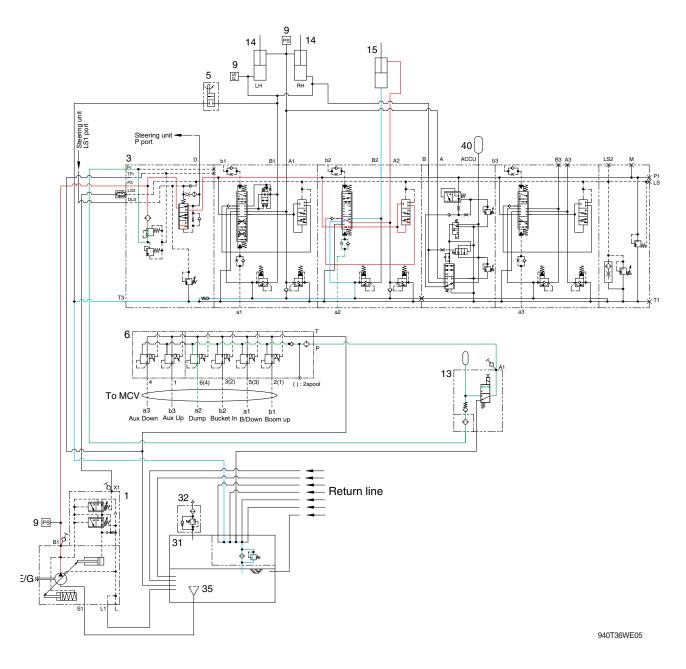
This prevents cylinder cavitation by the negative pressure when the pump flow cannot match the boom down speed.

3) WHEN THE RCV LEVER IS IN THE FLOAT POSITION



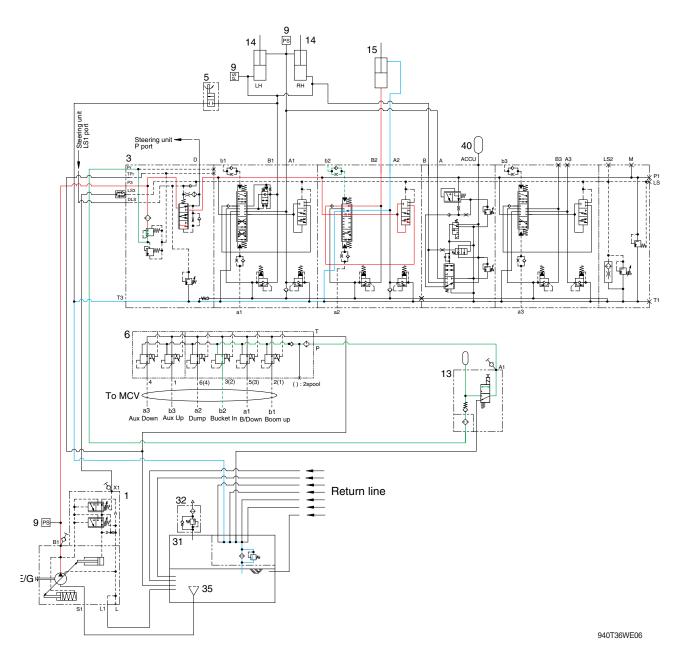
- When the EH RCV lever (7, boom) is pushed further forward from the lower position, the pilot pressure reaches to 30bar, then the boom spool is moved to floating position.
- The work ports (A1), (B1) and the small chamber and the large chamber are connected to the return passage, so the boom will be lowered due to it's own weight.
- In this condition, when the bucket is in contact with the ground, it can be move up and down in accordance with the shape of the ground.

4) WHEN THE RCV LEVER IS IN THE DUMP POSITION



- If the EH RCV lever (7, bucket) is pushed right, the bucket spool is moved to dump position by pilot oil pressuer from EH control block (6).
- The oil from main pump (1) flows into main control valve (3) and then goes to the small chamber of bucket cylinder (15) by pushing the load check valve of the bucket spool.
- The oil at the large chamber of bucket cylinder (15) returns to hydraulic tank (31).
- · When this happens, the bucket is dumped.
- When the dumping speed of bucket is faster, the oil returned from the large chamber of bucket cylinder combines with the oil from the pump, and flows into the small chamber of the cylinder. This prevents cylinder cavitation by the negative pressure when the pump flow cannot match the bucket dump speed.

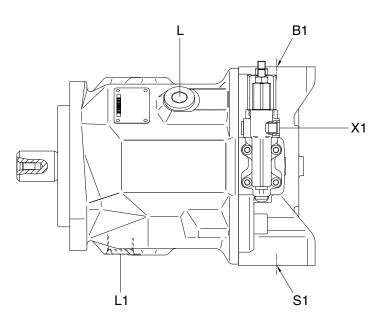
5) WHEN THE RCV LEVER IS IN THE ROLL BACK (retract) POSITION

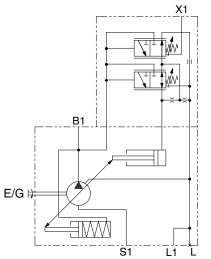


- If the EH RCV lever (7, bucket) is pulled left, the bucket spool is moved to roll back position by pilot oil pressuer from EH control block (6).
- The oil from main pump (1) flows into main control valve (3) and then goes to the large chamber of bucket cylinder by pushing the load check valve of the bucket spool.
- The oil at the chamber of bucket cylinder (15) returns to hydraulic tank (31).
- When this happens, the bucket roll back.
- When the rolling speed of bucket is faster, the return oil from the small chamber of bucket cylinder combines with the oil from the pump, and flows into the large chamber of the cylinder.
 - This prevents cylinder cavitation by the negative pressure when the pump flow cannot match the bucket rolling speed.

4. MAIN PUMP

1) STRUCTURE (1/2)

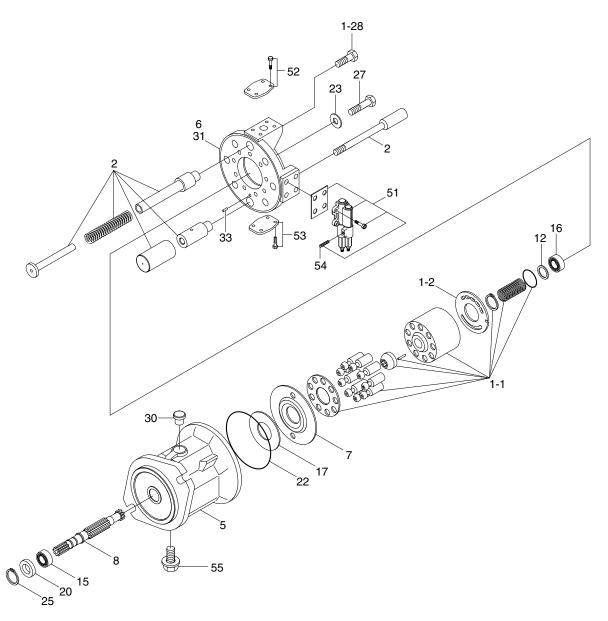




74096WE12

Port	Port name	Port size
B1	Pressure port	SAE 1"
S1	Suction port	SAE 2"
L, L1	Case drain port	1 1/16-12UN
X1	Pilot pressure port	7/16-20UNF

STRUCTURE (2/2)



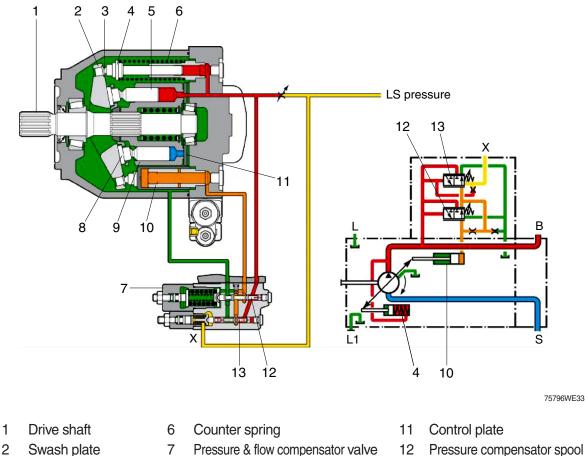
74096WE11

- 1 Rotary group
- 1-1 High speed rotary group
- 1-2 Control plate
- 2 Adjusting piece
- 5 Pump housing
- 6 Port plate
- 7 Swash plate
- 8 Drive shaft
- 12 Adjustment shim

- 15 Taper roller bearing
- 16 Taper roller bearing
- 17 Bearing liner
- 20 Shaft seal ring
- 22 O-ring
- 23 O-ring
- 25 Retaining ring
- 27 Socket screw
- 28 Locking screw

- 30 Locking screw
- 31 Double break-off pin
- 33 Cylinder pin
- 51 Control valve
- 52 Flange cover
- 53 Flange cover
- 54 Seal screw
- 55 Seal screw

2) FUNCTION



- 2 Swash plate
- 3 Shoe plate

Piston

5

- 4 Counter piston
- 8 Piston shoe
- 9 Cylinder
- 10 Control piston

- 12 Pressure compensator spool
- 13 Flow compensator spool

The steering pump and loader pump are variable displacement piston pump. The steering pump and loader pump are flow controlled by LS signal. When the steering and loader are not being used, the pumps are at low pressure standby.

The load sensing pressure that is sensed from steering and loader hydraulic systems flows to flow compensator spool (13). This spool keeps the pump output at a level that is necessary to fulfill the requirements for the system flow and for the pressure.

The pressure compensator spool (12) also limits maximum system pressure. The pressure compensator spool (12) prevents damage to the steering and loader hydraulic components from excessive pressure.

The swivel angle of the pumps is controlled by counter piston (4) and control piston (10). Counter spring (6) cause swash plate (2) to move at maximum displacement or causes swash plate (2) to upstroke.

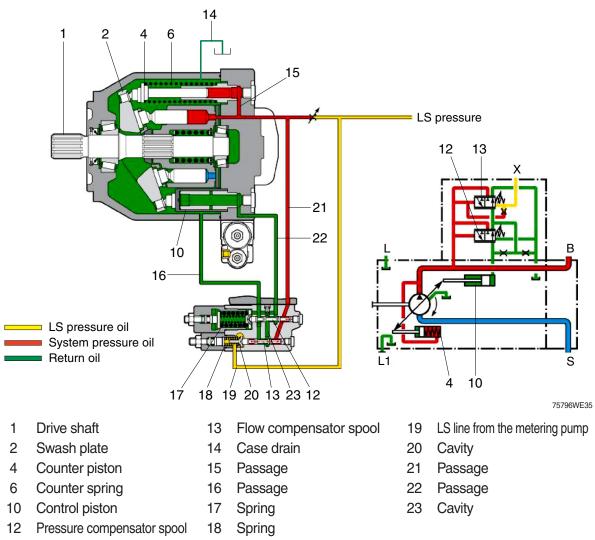
Control piston (10) has a larger area (diameter) than counter piston (4). Control piston (10) causes swash plate (2) to destroke the pump.

Flow compensator spool (13) and/or pressure compensator spool (12) changes pump output by regulating the pump discharge pressure that is acting on control piston (10).

Control piston (10) diameter is larger than counter piston (4) diameter, the oil pressure that is acting against control piston (10) overcomes the force of counter spring (6). The oil pressure than causes the pump to destoke.

Pressure and flow compensator valve (7) also controls the maximum output of pump pressure. When steering and loader pressure rises above pressure compensator setting, pressure compensator spool (12) overrides flow compensator spool (13). This causes the pump to destroke.

(1) Upstroking



Upstroking of the pump occurs as flow demand from loader and steering system.

The increased flow demand causes a LS pressure in LS line (19). The LS pressure in LS line (19) combines with the force of spring (18) in cavity (20).

The force of spring (18) causes pump pressure to be higher than the LS pressure (19).

If the combination of LS pressure and of spring force is greater than the pump discharge pressure, this difference pressure causes spool (13) to move right. As spool (13) moves right, the spool (13) blocks the flow of supply oil to control piston (10). Pump swash plate (2) is controlled by pressure and flow as much as hydraulic system requests.

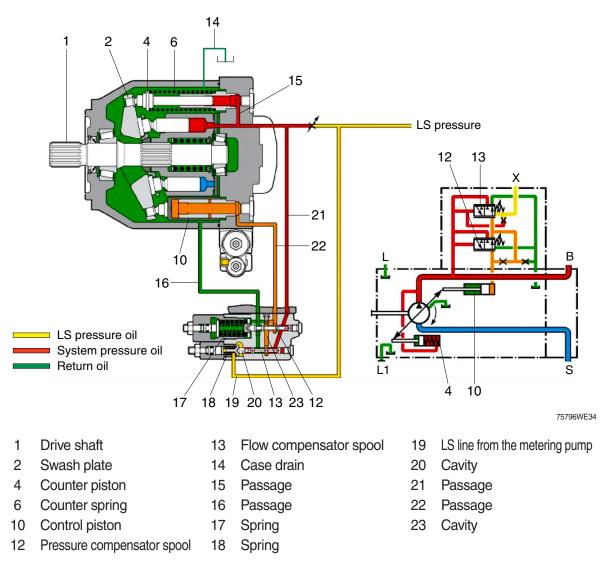
When the oil flow to control piston (10) is blocked, the pilot oil in passage (22) drains to passage (23). The oil then flows past pressure compensator spool (12) and through passage (16) into the housing and via the drain line (14) to tank.

Supply oil flows through passage (15) to counter piston (4). The oil acts against counter piston (4). The oil combines with the force of counter spring (6). This causes swash plate (2) to upstroke.

This also causes the pump flow to increase. As flow requirements are satisfied, the pump output pressure increase. The pressure increases until the pressure in passage (15) moves flow compensator spool (13) up to be satisfied with system requirement for pressure and flow.

 \cdot Pump discharge pressure = force of spring (18) + LS pressure (19)

(2) Destroking



The decreased flow demand causes a LS pressure in line (19). The LS pressure in line (19) combines with the force of spring (18) in cavity (20).

This combination of LS pressure and of spring force is less than the pump pressure in passage (21). This causes flow compensator spool (13) to move left.

Pump oil now flows through passage (15). The oil then flows past flow compensator spool (13), through passage (22), and then to control piston (10).

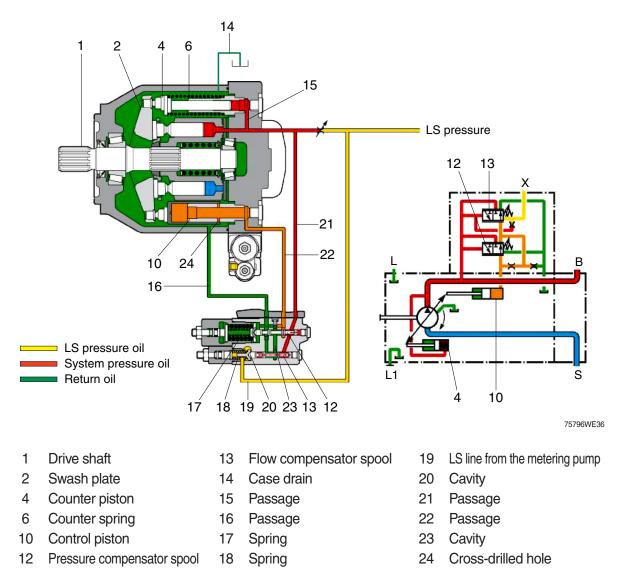
The pump pressure behind control piston (10) is now greater than the combined force of counter piston(4) and of counter spring (6). The angle of swash plate (2) decreases. This decreases the pump output and the system pressure.

When the lower flow requirements are met, flow compensator spool (13) moves right up to the balanced position. Swash plate (2) maintains an angle that is sufficient to provide the lower required pressure. If the operator does not turn the steering wheel and does not move RCV, then the pump will return to low pressure standby.

 $\$ Control piston \rightarrow Changes pump displacement ; influenced by controller.

Counter piston \rightarrow Helps to change pump displacement but no possible to control this piston.

(3) Low pressure standby



Low pressure standby constitutes the following condition: a running engine and inactive steering and loader. There are no flow demands on the pump or pressure demands on the pump. Therefore, there is no LS pressure in line (19).

Before you start the engine, counter spring (6) holds swash plate (2) at the maximum angle. As the pump begins to turn, oil begins to flow and pressure increases in the system.

Because of close centered steering control valve and close centered loader hydraulic system.

As this pressure increase, the pressure pushes flow compensator spool (13) against spring (18). This causes flow compensator spool (13) to move left. This opens passage (23) in order to allow pressure oil to flow to control piston (10).

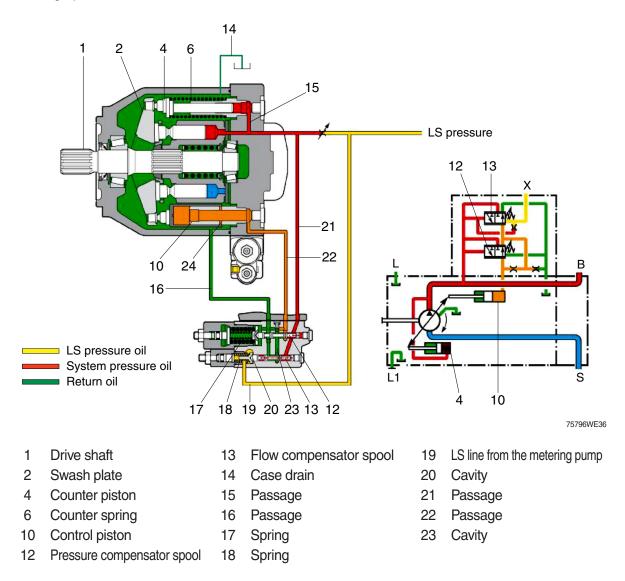
The oil acts against control piston (10) in order to overcome the force of counter spring (6). The oil causes control piston (10) to move to the left.

When control piston (10) moves to the left, the piston moves swash plate (2) toward the minimum angle. Control piston (10) continues to move to the left until cross-drilled hole (24) allows the oil to drain to the case.

Cross-drilled hole (24) limits the maximum travel of control piston (10) to the left. The pump supplies a sufficient amount of flow that compensates for system leakage. The pump also supplies a sufficient of flow that compensates for leakage to the pump case. The leakage to the pump case is a result of the cross-drilled hole. The pump maintains low pressure standby. Low pressure standby pressure should not exceed 40 bar (580 psi).

* Low pressure standby will vary in the same pump as the system leakage or the pump leakage increases. The pump will upstroke slightly in order to compensate for the increasing leakage. Control piston (10) will cover more of the cross-drilled hole.

(4) High pressure stall



When the hydraulic system stalls under load or when the cylinders reach the end of the stroke, the main system pressure increases. But LS pressure (19) is regulated by LS relief valve on steering system and loader system. The pressure difference between discharged pump and LS pressure equal to spring (18). It means no flow is necessary. Therefore, discharged pressure push flow compensator spool (13) left . Supply oil now flows past flow compensator spool (13) and through passage (23). The oil flows past flow compensator spool (13) and into passage (22). The oil then flows to control piston (10).

Pump swash plate (2) will be minimum displacement if the operator does not turn the steering wheel and RCV, then the pump will return to low pressure standby.

(5) Adjustment of flow control

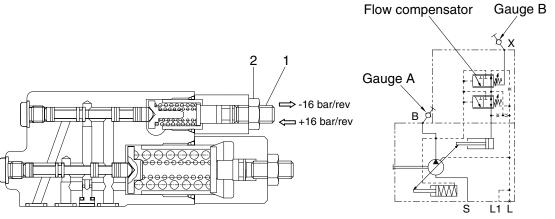
Flow compensator setting must be carried out following procedures and conditions.

① Conditions

- Engine is running (at high or low idle).
- RCV is operated slowly (example : Boom up).
- Pressure gauges are installed.
- * Discharge pump flow should be less than max pump flow.

2 Procedures

- Loosening the hexagon nut (2).
- Adjusting screw (1) of flow controller by tightening or loosing the screw (1).
 - · Flow setting : $\triangle P$ = Gauge A Gauge B
 - · Specification : 30 bar



75796WE37

(6) Adjustment of pressure control

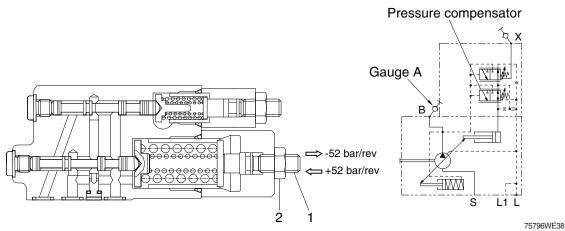
Pressure compensator setting must be carried out following procedures and conditions.

1 Conditions

- Engine is running.
- System is at relief condition.

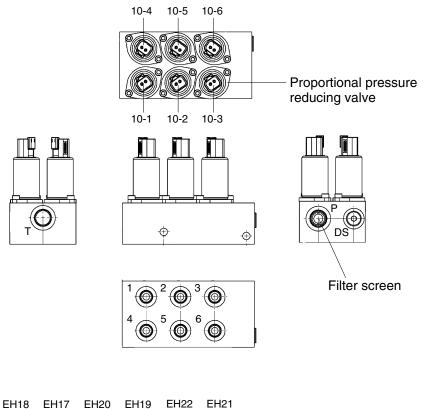
2 Procedures

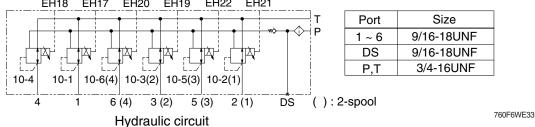
- Loosening the hexagon nut (2).
- Adjusting screw (1) of pressure controller by tightening or loosing the screw (1).
- · Maximum pressure setting = Gauge A
- · Specification : 300 bar



5. EH (electro hydraulic) CONTROL BLOCK

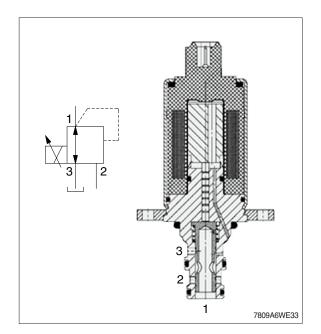
1) STRUCTURE





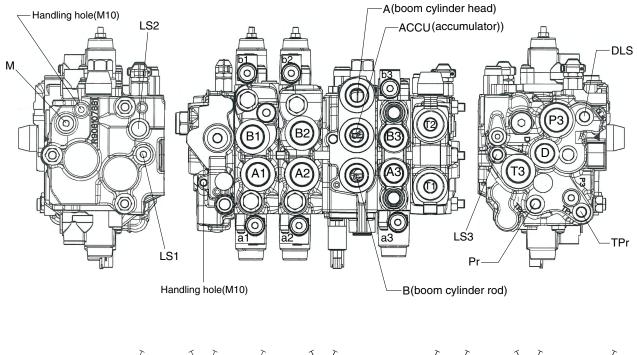
2) OPERATION

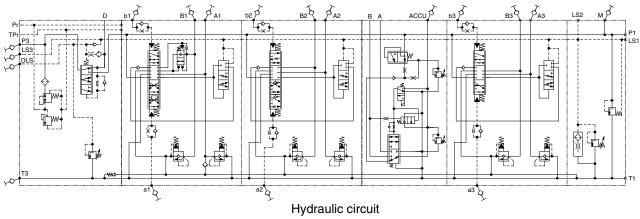
The proportional pressure reducing valve (10-1~6) is a direct-acting spool-type valve. When de-energized, port 2 is closed and port 1 (delivery) is connected to port 3 (tank). When the inlet pressure fluctuates it provides an almost constant outlet pressure-depending on the energization of the coil. When the control current increases, the coil solenoid exerts a force on the control piston which is proportional to the control current and thereby defines the regulated pressure at port 1. This setting is proportional to the control current. Pressures at tank port 3 are additive to the set pressure. If, as a result of external factors, the pressure at port 1 rises above the preset pressure, the valve opens from port 1 to tank port 3.



6. MAIN CONTROL VALVE

1) STRUCTURE



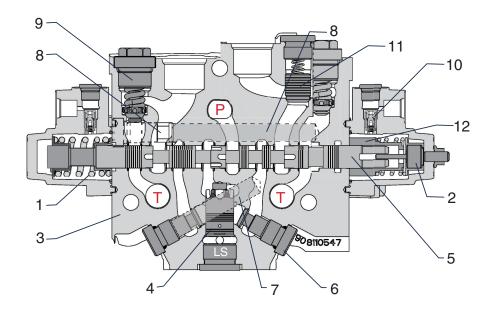


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Port	Port name	Port size	Port	Port name	Port size
P3	From main pump	1 5/16-12UNF	a3, b3	Auxiliary pilot port	9/16-18UNF
Т3	To hydraulic tank	1 5/16-12UNF	LS3	Load sensing port	9/16-18UNF
A1, B1	To bucket cylinder port	1 5/16-12UNF	Pr	To RCV P port	-
A2, B2	To boom cylinder port	1 5/16-12UNF	DLS	To steering unit LS port	9/16-18UNF
A3, B3	To aux cylinder port	1 1/16-12UNF	D	To steering unit P port	1 1/16-12UNF
a1, b1	Bucket pilot port	9/16-18UNF	A, B, ACCU	-	1 5/16-12UNF
a2, b2	Boom pilot port	9/16-18UNF	LS1,2, M	-	Plugged

2) BOOM SECTION OPERATION

(1) Component description

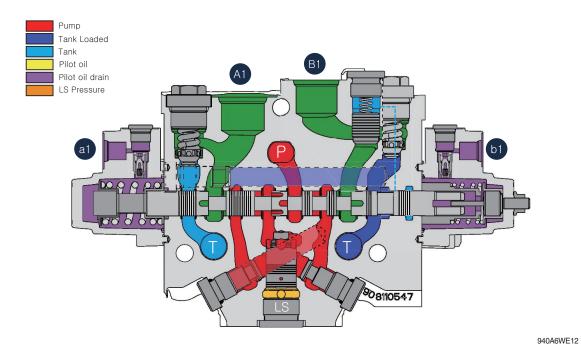


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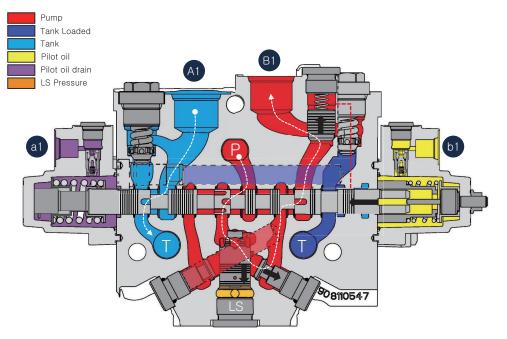
- 1 Spring pack
- 2 Anti-rotation device (opt)
- 3 Housing
- 4 Pressure compensator
- 5 Spool
- 6 Check valve

- 7 Bridge
- 8 Tankregen channel
- 9 Relief valve
- 10 Snubber
- 11 Low Leak poppet
- 12 4th position device

(2) Boom neutral position



The spool is in neutral position, pump is in low pressure stand-by. The A and B ports are not connected to the pumps nor the tank.

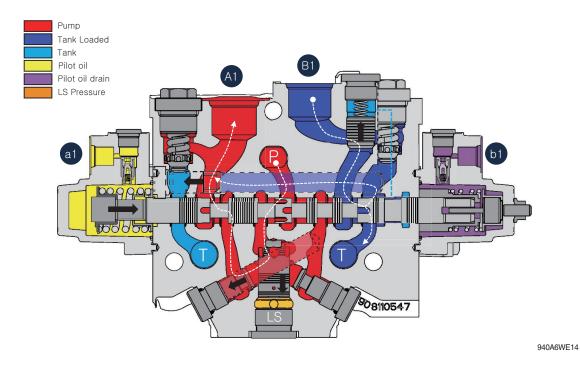


(3) Boom raise position

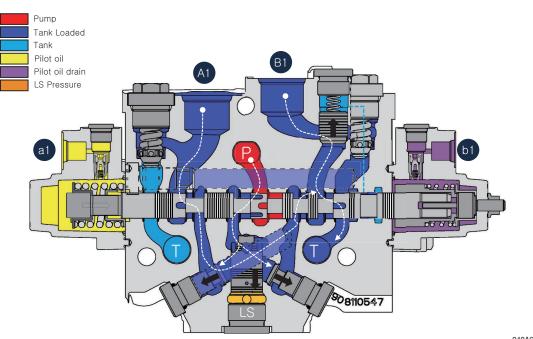
940A6WE12

When the pilot pressure is led to the port b1, the oil from the pump flows to the cylinder port B1 and oil from the cylinder flows into the tank through the cylinder port A1.

(4) Boom lower position



When the pilot pressure is led to the port a1, the oil from the pump flows to the cylinder port A1 and oil from the cylinder flows into the tank through the cylinder port B1. If pressure in A1 becomes too low, flow from the tank avoid fullfiled A1 through tank regen channel.



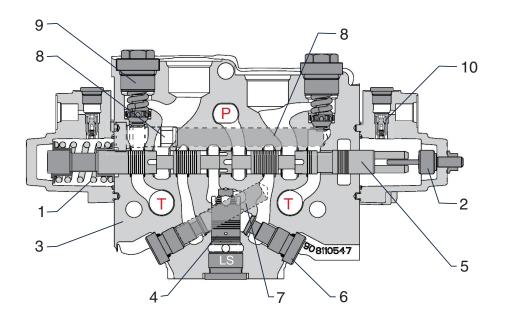
(5) Boom float position

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When the pilot pressure is led to the port a1 in 4th position, the oil from the pump flows to the cylinder port A1 & A1 and oil from the cylinder flows into the tank through the cylinder port B1 & A1 to let cylinder free of movement.

3) BUCKET SECTION OPERATION

(1) Component description

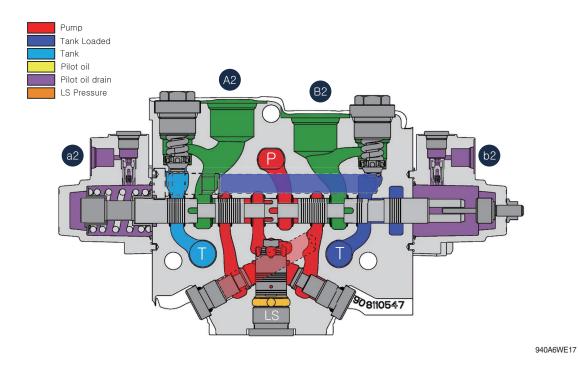


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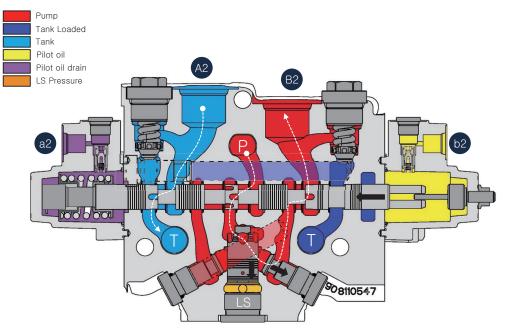
- 1 Spring pack
- 2 Anti-rotation device (opt)
- 3 Housing
- 4 Pressure compensator
- 5 Spool
- 6 Check valve

- 7 Bridge
- 8 Tankregen channel
- 9 Relief valve
- 10 Snubber

(2) Bucket neutral position



The spool is in neutral position, pump is in low pressure stand-by. The A and B ports are not connected to the pumps nor the tank.

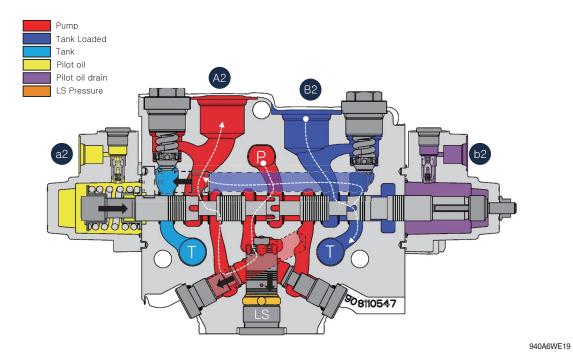


(3) Bucket roll back (retract) position

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When the pilot pressure is led to the port b2, the oil from the pump flows to the cylinder port B2 and oil from the cylinder flows into the tank through the cylinder port A2.

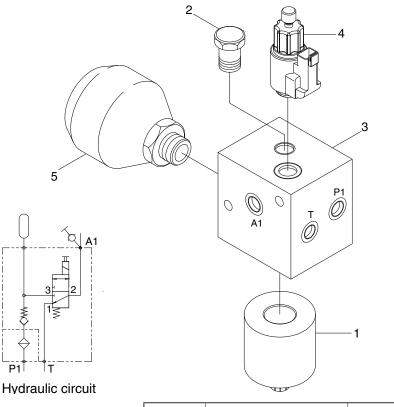
(4) Bucket dump position



When the pilot pressure is led to the port a2, the oil from the pump flows to the cylinder port A2 and oil from the cylinder flows into the tank through the cylinder port B2. If pressure in A2 becomes too low, flow from the tank fullfiled A2 through tank regen channel.

7. SAFETY VALVE

1) STRUCTURE



Port	Port name	Port size
P1	From MCU	PF 3/8"
A1	Supply to RCV lever	PF 1/4"
Т	To hydraulic tank	PF 1/4"

75796WE16

- 1 Bowl and element assy
- 2 Check valve Cartridge

- Solenoid valve 4
- 5 Accumulator

3

2) OPERATION

This valve is used to cut off the pilot circuit.

When the pilot cut off switch in the cab is pressed to ON position, the solenoid valve is activated and then the pilot oil flow into the pilot circuit.

The accumulator satisfied short term peak power demands and is a source of emergency power in case of main circuit pressure failures.

8. BOOM AND BUCKET CYLINDER

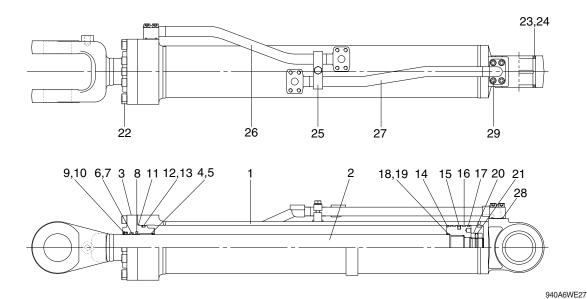
The boom cylinders are two unit and the bucket cylinder is one unit. They use a bolt on rod guide.

The piston (14) threads on to the rod (2) and is retained by a nut (20) and set screw (21).

The piston seals against the tube (1) with piston seal (15). Two wear rings (16) are located on each side of the piston seal.

The gland (3, the rod guide) seals against the tube with an O-ring (12). The cylinder thread seals against the rod with a lip type buffer ring (8) and a rod seal (5). A dust wiper (9) cleans the rod when it is retracted.

1) BOOM CYLINDER

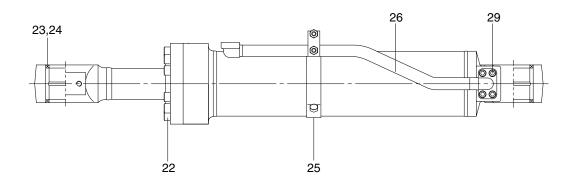


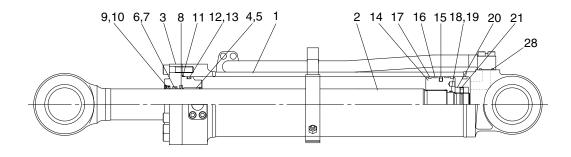
- 1 Tube assembly
- 2 Rod assembly
- 3 Gland
- 4 Bushing
- 5 Snap ring
- 6 Rod seal
- 7 Back up ring
- 8 Buffer ring
- 9 Dust wiper
- 10 Snap ring

- 11 O-ring
- 12 O-ring
- 13 Back up ring
- 14 Piston
- 15 Piston seal
- 16 Wear ring
- 17 Dust ring
- 18 O-ring
- 10 Dealeura
- 19 Back up ring
- 20 Lock nut

- 21 Set screw
- 22 Bolt
- 23 Bushing
- 24 Dust seal
- 25 Band assembly
- 26 Pipe assembly
- 27 Pipe assembly
- 28 O-ring
- 29 Bolt

2) BUCKET CYLINDER





940A6WE22

- 1 Tube assembly
- 2 Rod assembly
- 3 Gland
- 4 Bushing
- 5 Snap ring
- 6 Rod seal
- 7 Back up ring
- 8 Buffer ring
- 9 Dust wiper
- 10 Snap ring

- 11 O-ring
- 12 O-ring
- 13 Back up ring
- 14 Piston
- 15 Piston seal
- 16 Wear ring
- 17 Dust ring
- 18 O-ring
- 19 Back up ring
- 20 Lock nut

- 21 Set screw
- 22 Bolt
- 23 Bushing
- 24 Dust seal
- 25 Band assembly
- 26 Pipe assembly
- 27 Pipe assembly
- 28 O-ring
- 29 Bolt

9. HYDRAULIC OIL TANK

1) STRUCTURE

1

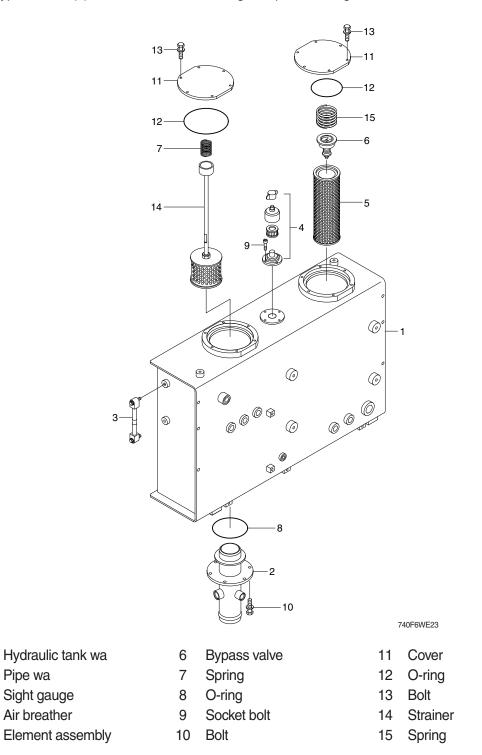
2

3

4

5

- The oil from the hydraulic tank is sent from the pump through main control valve to the cylinders. In the return circuit, the oil from various parts merges.
- A part of oil is cooled in the oil cooler, passes through the hydraulic filter and returns to the hydraulic tank (1).
- If the hydraulic return oil filter becomes clogged, return filter bypass valve (6) acts to allow the oil to return directly to the hydraulic tank (1). This prevents damage to the hydraulic filter (5). The bypass valve (6) is also actuated when negative pressure is generated in the circuit.

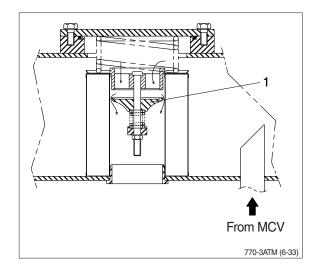


2) RETURN OIL FILTER BYPASS VALVE

(1) When the filter is clogged

Bypass valve (1) is opened and the oil returns directly to the tank without passing through the filter.

• Bypass valve set pressure : 1.36 kg/cm² (19.3 psi)



3) AIR BREATHER

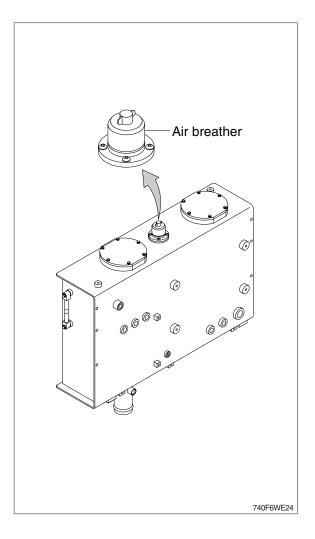
The air breather is equipped with the capacity to perform three functions simultaneously-as an air filter, breathing valve, and as a lubrication opening.

(1) Preventing negative pressure inside the tank

The tank is a pressurized sealed type, so negative pressure is formed inside the hydraulic tank when the oil level drops during operations. When this happens, the difference in pressure between the tank and the outside atmospheric pressure opens the poppet in the breather, and air from the outside is let into the tank or prevent negative pressure.

(2) Preventing excessive pressure inside the tank

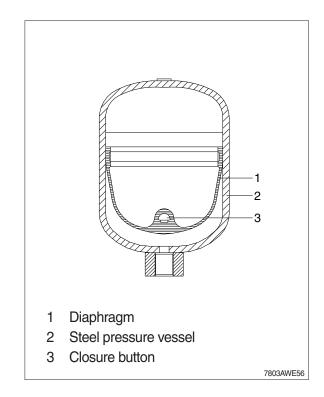
When the hydraulic cylinder is being used, the oil level in the hydraulic system increases and as temperature rises. If the hydraulic pressure rises above the set pressure, breather is actuated to release the hydraulic pressure inside the tank.



10. ACCUMULATOR

The accumulator is installed at the safety valve. When the boom is left the raised position, and the control levers are operated with the engine stopped the pressure of the compressed nitrogen gas inside the accumulator sends pilot pressure to the control valve to actuate it and allow the boom and bucket to come down under their own weight.

Type of gas	Nitrogen gas (N2)	
Volume of gas	0.75 ℓ (0.2 U.S.gal)	
Charging pressure of gas	16 kg/cm ² (228 psi)	
Max actuating pressure	128 kg/m² (1820 psi)	



11. RIDE CONTROL SYSTEM (option)

1) ACCUMULATORS

(1) Pre-charging

Use an inert gas such as nitrogen for pre-charging accumulator.

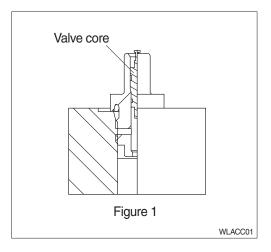
- * Do not use oxygen or shop air.
- Nitrogen source and all components must be rated for a pressure at least as high as the nitrogen source.

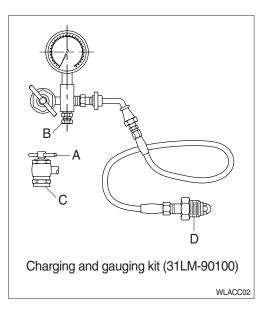
Accumulator having gas valve as per figure 1.

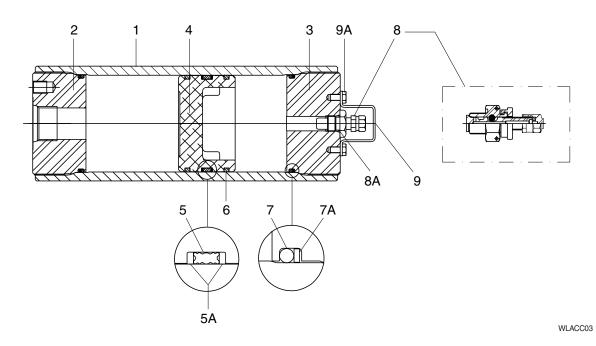
- 1 Remove gas valve guard and gas valve cap.
- ② Back gas chuck "T" handle (A) all the way out (counter clockwise) before attaching charging & gauging kit to accumulator gas valve.
- ③ Close bleed valve (B).
- ④ Making sure not to loop or twist the hose, attach swivel nut (C) to gas valve and tighten 11.5~17 kgf·cm (10~15 lbf·ft).
- (5) Turn gas chuck "T" handle (A) until the gauge starts showing the pressure in the accumulator. Do not turn the "T" handle all the way down, as it will damage the valve core.
- 6 Crack open nitrogen bottle valve (D) and **slowly** fill accumulator. Shut off when gauge indicates desired pre-charge.
- This will allow the gas temperature to stabilize.
 If the desired pre-charge is exceeded, close nitrogen bottle valve (D), then slowly open bleed valve (B). Do not reduce pre-charge by depressing valve core with a foreign object.
 High pressure may rupture rubber valve seat.
- ⑧ When finished pre-charging accumulator, turn "T" handle (A) all the way out on gas chuck, then open bleed valve (B).
- ④ Hold gas valve to keep from turning, loosen swivel nut (C), remove assembly. Check for pre -charge leak using a common leak reactant.
- ① Replace gas valve cap 11.5~17 kgf·cm (10~15 lbf·ft) and valve guard. (Gas valve cap serves as a secondary seal.)

(2) Pre-charge checking procedure

Using appropriate valve in the hydraulic system, discharge all oil from accumulator and allow piston to bottom against hydraulic end cap.







1 Body

4

5

- 5A V-O-ring back-up washers
- 2 Hydraulic cap3 Gas cap

Piston

V-O-ring

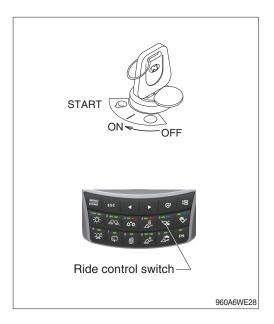
- 6 Piston ring (piston)
- 7 O-ring
- 7A O-ring back-up washer
- 8 Gas valve

- 8A Gas valve O-ring
- 9 Gas valve guard
- 9A Screw

2) REMOVE FROM HYDRAULIC SYSTEM

Attention

- 1) Before carrying out any maintenance work the accumulators must be unloaded (zero pressure).
- 2) Bucket should be lade on the ground.
- 3) Turn the starting switch to ON position and press the ride control switch on monitor to operate ride control function.
- 4) Lower the boom to the postion of down or floating to release the charged oil in accumulators.



GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

This procedure is designed so the mechanic can make a quick check of the system using a minimum amount of diagnostic equipment. If you need additional information, read structure and function, Group 1.

A location will be required which is level and has adequate space to complete the checks.

The engine and all other major components must be at operating temperature for some checks.

Locate system check in the left column and read completely, following the sequence from left to right. Read each check completely before performing.

At the end of each check, if no problem is found (OK), that check is complete or an additional check is needed. If problem is indicated (NOT OK), you will be given repair required and group location. If verification is needed, you will be given next best source of information:

- · Chapter 2 : Troubleshooting
- · Group 3 : Tests and adjustments

* Hydraulic oil must be at operating temperature for these checks (refer to page 6-49).

ltem	Description	Service action
Hydraulic system warm-up procedure Run engine at high idle.	Hold a hydraulic function over relief to heat oil. (don't keep relief condition over 5 seconds at a time)	
Refer to page 6-51.	Periodically cycle all hydraulic functions to distribute warm oil.	
	Repeat procedure until oil is at operating temperature.	
	FEEL : Hydraulic reservoir must be uncomfortable to hold your hand against. (approximately 40 ~50°C)	
Hydraulic pump performance check Heat hydraulic oil to	With bucket flat on ground, actuate boom raise. Time how long it takes to raise boom to full height.	
operating temperature. Run engine at high idle.	LOOK : Boom must raise to full height in less than 7 seconds.	
		IF OK Do steering system leakage check at page 5-18.
		IF OK Do main hydraulic pump flow test at page 6-50.
Control valve lift check Run machine at low idle.	With bucket partially dumped, lower boom to raise front of machine.	
	Slowly move boom control lever (RCV lever) to boom lower position.	Repair lift checks in loade
	Slowly move bucket control lever to bucket dump position.	
	LOOK : Boom must not raise before moving down.	
	Bucket must not rollback before dumping.	

Item	Description		Service action
Bucket rollback circuit relief valve check	¢.	Position bucket at a 45° angle against an immovable object.	OK Check complete.
		Engage transmission in 3rd speed forward.	Replace boom lower
		LOOK : Bucket angle must not change.	check valve.
Bucket dump circuit relief valve low pressure check	/ The st	Raise front of machine which bucket at 45° angle.	OK Go to next check.
		Backdrag with bucket while observing bucket angle.	Do loader system and
		LOOK : Bucket must not rollback	circuit relief valve test at page 6-53.
Pilot control valve float check		With the bucket partially dumped, lower boom to raise front of	OK Check complete.
Run engine at low idle.		machine. Push control lever to the float detent position and release lever.	NOT OK Do pilot control valve pressure test in group 3.
		LOOK : Front of machine lower to the ground and valve must remain in float position when lever is released.	, <u>3</u>
Boom cylinder and bucket cylinder drift		Set the boom and bucket horizontal, then stop the engine.	OK Check complete.
check Heat hydraulic oil to		Stop the engine, wait for 5 minutes, then start measuring.	NOT OK Go to next check.
operating temperature.		Measure the amount the lift and dump cylinder rods retract during 15 minutes. (unloaded bucket)	
		A : Retraction of boom cylinder rodB : Retraction of bucket cylinder rod	
		Boom cylinder must drift less than 10 mm	
		Bucket cylinder must drift less than 36mm	

Item	Description		Service action
Boom cylinder leakage check Heat hydraulic oil to operating temperature.	and the second s	Dump bucket until teeth or cutting edge is perpendicular to the ground. Raise boom until cutting edge is about 1 m (3 ft) above ground. Stop engine. Measure drift from tooth or cutting edge to ground for 1 minute. Wait 10 minutes. Measure drift from tooth or cutting edge to ground for 1 minute. LOOK : Compare the drift rate between the first measurement and the second measurement.	Drift is approximately the same between first and second measurement. Repair loader control valve or circuit relief valve. NOT OK If drift is considerably less on second measurement, repair cylinder.
Bucket cylinder leakage check Heat hydraulic oil to operating temperature.		 Raise bucket about 1 m (3 ft) off ground with bucket level. Stop engine. Place a support under boom. Measure drift from tooth or cutting edge to ground for 1 minute. Wait 10 minutes. Measure drift from tooth or cutting edge to ground for 1 minute. LOOK : Compare the drift rates between the first measurement and the second measurement. 	Drift is approximately the same between first and second measurement. Repair loader control valve or circuit relief valve at page 6-53. NOT OK Drift is considerably less on second measurement.
Check valve of safety valve leakage check Heat hydraulic oil to operating temperature.	Surger Street Stre	Put bucket level and position about 1.2 m (4 ft) above ground. Place a piece of tape on cylinder rod at least 51 mm (2 in) from rod guide. Run engine at low idle in safety- release position. LOOK : Bucket must not drift up.	Check complete.

Item		Description	Service action
Bucket leveler (positioner) check	Position bucket fully dumped just above ground level.		OK Check complete.
Run engine at low idle.		Move control lever to bucket leveler detent position and release.	NOT OK Do bucket leveler checks.
		LOOK : Bucket must rollback to the level position and control lever must return to neutral. If bucket is in a rolled back position when key is turned ON, control lever must be returned to neutral manually if placed in the bucket leveler detent position.	
		After bucket is dumped once, bucket leveler will work normally.	
Boom height kickout		Position bucket flat on ground.	ОК
check		Move control lever to boom raise	Check complete. NOT OK Do boom height kickout check.
Run engine at low idle.		detent position and release.	
		LOOK : Boom must raise to the set height and stop.	
		Control lever must return to neutral.	
Cycle time check	Function	Operating condition.	Maximum cycle time
Heat hydraulic oil to	Boom raise	Bucket flat on ground to full height.	5.5 sec
operating temperature. Run engine at high idle.	Boom lower	Full height to level ground.	3.7 sec
	Bucket dump	Boom at full height.	2.3 sec
	Bucket rollback	Boom at full height.	1.8 sec
	Steering [No. of	Frame stop to frame stop.	3.9 turns
	turns]		OK Check complete.
			NOT OK Go to slow hydraulic functions in group 2.

*** MEASURING BOOM AND BUCKET CYCLE TIME**

1) MEASUREMENT CONDITION

- \cdot Coolant temperature $$: Inside operating range
- · Steering position : Neutral
- · Hydraulic temperature : 40~50°C
- · Bucket : Unloaded
- · Engine speed : High idling

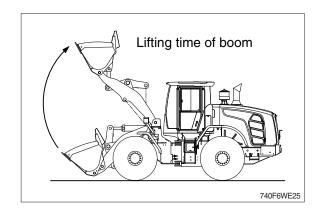
2) MEASURING TOOL

· Stop watch (1EA)

3) MEASURING PROCEDURE

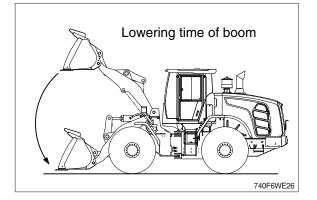
(1) LIFTING TIME OF BOOM

Set the bucket near the maximum tilt back position and at the lowest position on the ground. Raise the bucket and measure the time taken for bucket to reach the maximum height of the boom.



(2) LOWERING TIME OF BOOM

Set the bucket horizontal with the boom at the maximum height, lower the bucket and measure the taken for the bucket to reach the lowest position on the ground.

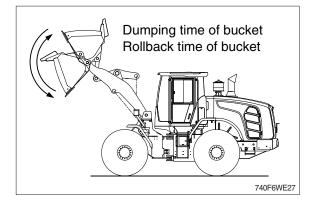


(3) DUMPING TIME OF BUCKET

Raise the boom to the maximum height and measure the time taken for the bucket to move from the maximum tilt back position to the maximum dump position

(4) ROLL BACK TIME OF BUCKET

Raise the boom to the maximum height and measure the time taken for the bucket to reach the maximum tilt back position.



2. TROUBLESHOOTING

Diagnose malfunction charts are arranged from most probable and simplest to verify, to least likely, more difficult to verify. Remember the following steps when troubleshooting a problem :

Step 1. Operational check out procedure (see section 1)Step 2. Operational checks (see group 2)Step 3. TroubleshootingStep 4. Tests and adjustments (see group 3)

Problem	Cause	Remedy
Noisy hydraulic pump	Low oil supply or wrong viscosity.	Fill reservoir with recommended oil.
	Plugged or pinched suction line.	Clean or replace line.
	Air in oil.	Check for foamy oil. Tighten connections.
	Plugged suction strainer. Loose or missing hydraulic line clamps. Hydraulic lines in contract with frame. Worn or damaged pump.	Replace O-rings and or lines. Inspect and clean strainer in reservoir. Tighten or replace clamps. Inspect and repair. Do hydraulic pump performance check in group 2.
No or Slow bydraulio	Failed or worn hydrualic pump.	Do hydraulic pump flow test in group 3. Do performance check.
No or Slow hydraulic functions	Cold oil.	Warm oil up.
	Slow engine speed.	Adjust engine speed. Check high idle speed.
	Suction line air leak.	Check for foamy oil.
	Low oil supply.	Add recommended oil.
	Wrong oil viscosity.	Use recommended oil.
	Oil leaking past cylinders or control valve.	Check cylinder drift in group 2.
	Blocked or damaged line.	Inspect lines.
	Binding loader control valve (MCV) spool.	Inspect valve.
	Faulty steering unit.	Check steering unit specification.

Problem	Cause	Remedy
No steering or hydraulic function	Low oil level.	Add recommended oil.
	Failed hydraulic pump.	Remove and inspect return filter for metal pump particles.
No hydraulic functions steering normal	Failed hydraulic pump.	Remove and inspect return filter for metal pump particles, or replace the pump.
	Failed line filter.	Remove and inspect line filter for RCV.
	Faulty safety valve.	Safety valve leakage test or ON, OFF function test.
	Stuck open port relief valve.	Replace relief valve.
Boom float function	Faulty pilot control valve (RCV).	Replace relief valve.
does not work	Loader control valve (MCV) spool binding in bore.	Do pressure reducing valve pressure test in group 3.
One hydraulic function does not work.	Faulty pilot control valve (RCV).	Do pilot control valve pressure test. Inspect and repair valve.
	Stuck open port relief valve.	Replace relief valve.
	Oil leaking past cylinder packings.	Do boom and bucket cylinder leakage test in group 3.
	Blockage in oil lines or valve.	Inspect lines for damage. Disconnect and inspect lines for internal blockage.
	Loader control valve (MCV) spool stuck in bore.	Inspect and repair valve.
Low hydraulic power	Leakage within work circuit.	Do cylinder drift check in group 2.
	Low system relief valve (main relief valve) setting.	Do loader system and port relief valve pressure test in group 3.
	Low port relief valve setting.	Do loader system and port relief valve pressure test in group 3.
	Leaking system relief valve.	Remove and inspect valve.
	Worn hydraulic pump.	Do hydraulic pump performance check in group 2.

Problem	Cause	Remedy
Function drifts down	Leaking cylinders.	Do cylinder leakage checks in group 3.
	Leaking seals in circuit relief valve (port relief valve) or valve stuck open.	Inspect seals. Replace relief valve.
	Leaking loader control valve (MCV).	Repair or replace valve section.
Boom drifts up	Leakage in boom down spool.	Remove and inspect boom down spool.
Boom down does not	Safety valve not operated.	Operate valve.
work (engine off)	Stuck pilot control valve.	Inspect.
	Faulty line filter.	Remove and inspect filter.
	Accumulation not operated.	Inspect.
	MCV spool stuck.	Inspect and repair valve.
Oil overheats	Low oil viscosity in hot weather.	Use recommended oil.
	Excessive load.	Reduce load.
	Holding hydraulic system over relief.	Reduce load.
	Leakage in work circuit.	Do boom and bucket cylinder leakage test in group 3.
	Plugged fins in oil cooler.	Inspect and clean oil cooler.
	Internally plugged oil cooler.	Do hydraulic oil cooler restriction test.
	Incorrect system or circuit relief valve setting.	Do loader system and circuit relief valve pressure test in group 3.
	Restriction in oil lines or loader control valve (MCV).	Inspect for dented or kinked lines.
	Malfunctioning steering valve.	Do hydraulic system restriction test in group 3.
	Leaking system main relief valve.	Do hydraulic system restriction test in group 3. Remove and inspect valve and seals.
	Worn hydraulic pump (internal leakage).	Do hydraulic pump performance check in group 2.
Function drops before raising when valve is activated	Stuck open lift check valve.	Do control valve lift check in group 2.
Hydraulic oil foams	Low oil level.	Add recommended oil.
	Wrong oil.	Change to recommended oil.
	Water in oil.	Change oil.
	Loose or faulty suction lines (air leak in system).	Tighten or install new lines.
Remote control valve (RCV) leaking	Leaking plunger seals.	Remove, inspect and replace plunger seals.

- * Followings are general precautions for the hydraulic system and equipment.
- Every structure has its limit of strength and durability. The relief valve is installed to limit the pressure on the hydraulic equipment and protect various parts of the wheel loader from possible damage. Therefore, never change the preset pressure of the relief valve unless absolutely necessary.
- 2) Since the hydraulic equipment is built with precision, the presence of only the slightest amount of dust and / or other particles in the hydraulic circuit might cause wear and/or damage, resulting in unstable functions and/or damage, resulting in unstable functions and/or unexpected accidents. Therefore, always keep hydraulic oil clean. Periodically, check the filter in the return circuit and replace the element as necessary.
- 3) Extract about 200cc of hydraulic oil from the tank as a sample every 6 months. If possible, have it analyzed by a specialist to confirm that the oil can still be used. Never extract the oil for sampling until the oil temperature has become the normal operating temperature. Since the replacement period varies depending on operating conditions, refer to **Operator's Manual** and change oil.
- 4) Should the equipment get damaged due to the presence of metal particles and/or foreign matter in the circuit drain out the hydraulic oil and carry out flushing. Also, replace the filter element and clean the hydraulic tank. Change the hydraulic oil entirely.
- 5) When checking the filter, if found metal particles in the element, drain out the hydraulic oil entirely, flush the whole circuit, and then fill with new oil. The presence of metal particles may indicate internal damage to the equipment. In such a case, check carefully before flushing, and repair or replace as required.
- 6) To add and/or change the hydraulic oil, always use recommended oil. (Refer to the list of recommended oils and lubricants at Section 1/Group 2, Recommended lubricants.) Never mix oil of different makes of kinds.
- 7) To change the hydraulic oil, use a clean vessel and funnel for pouring it into the tank. Never use cloth because it might cause the presence of lint in the circuit.
- 8) When removing the hydraulic equipment, be sure to put plugs or caps on hoses, tube lines and ports. Also, enter mating marks for later identification.
- 9) Disassemble and/or assemble the hydraulic equipment only in a clean place free of dust. When disassembling, be careful about the interchangeability of parts, and clean the disassembled parts with pure and clean mineral cleansing oil. Clean the internal passages as well. After the parts have dried, wipe them off with a clean lint-free cloth.
- 10) When overhauling the hydraulic equipment replace all O-rings, backup rings, etc. with new ones. Assemble O-rings with grease or vaseline applied.
- 11) After installing the equipment, add more hydraulic oil to make up for that lost during disassembly.
- 12) Tighten joints correctly. Loose joints will cause the hydraulic oil to leak. If the oil leaks, the tank oil level drops and air gets sucked in, so the pump will break down. Also loose joints in suction lines will take air in and might cause abnormal noise, malfunction or damage to pumps.

GROUP 3 TESTS AND ADJUSTMENTS

1. HYDRAULIC OIL CLEAN UP PROCEDURE USING PORTABLE FILTER CADDY

- * Service equipment and tool
 - · Portable filter caddy
 - \cdot Two 4000 mm \times 1in 100R1 Hoses
 - · Quick disconnect fittings.
 - · Discharge wand
 - · Various size fittings.
- Brake system uses oil from hydraulic oil tank. Flush all lines in the brake, pilot, steering system and cut off system.
 Disassemble and clean major components for brake and steering system. Remove and clean pilot caps from main control valve.

Brake and steering components may fail if brake and steering system is not cleaned after hydraulic oil tank contamination.

- If hydraulic system is contaminated due to a major component failure, remove and disassemble steering cylinders to clean debris from cylinders.
- 2) Install a new return filter element. Inspect filter housing before installing new element.
- * For a failure that creates a lot of debris, remove access cover from hydraulic oil tank. Drain and clean hydraulic oil tank of fill the specified oil to hydraulic oil tank through upper cover.
- To minimize oil loss, pull a vacuum in hydraulic oil tank using a vacuum pump. Connect filter caddy suction line to drain port at bottom of hydraulic oil tank using connector. Check to be sure debris has not closed drain port.
- Put filter caddy discharge line into hydraulic oil tank filler hole so end is as far away from drain port as possible to obtain a thorough cleaning of oil.

5) Start the filter caddy. Check to be sure oil is flowing through the filters.

Operate filter caddy approximately 10 minutes so oil in hydraulic oil tank is circulated through filter a minimum of four times.

※ Hydraulic oil tank capacity : 130 ℓ (34.3 U.S. gal)

Leave filter caddy operation for the next steps.

- 6) Start the engine and run it at high idle.
- * For the most effective results, cleaning procedure must start with the smallest capacity circuit then proceed to the next largest capacity circuit.
- 7) Operate all functions, one at a time, through a complete cycle in the following order: Clam, steering, bucket, and boom. Also include all auxiliary hydraulic functions. Repeat procedure until the total system capacity has circulated through filter caddy seven times, approximately 30 minutes. Each function must go through a minimum of three complete cycles for a through cleaning for oil.
- Filtering time for machines with auxiliary hydraulic functions must be increased because system capacity is larger.
- 8) Stop the engine. Remove the filter caddy.
- 9) Install a new return filter element.
- 10) Check oil level in reservoir; Add oil if necessary.

2. BOOM HEIGHT KICKOUT ADJUSTMENT

The bucket can be adjusted to a height desired by using the boom kick-out device.

- A Park the machine on level ground and block the tires to prevent sudden movement of the machine.
- A Press the parking brake switch.
- ▲ Fix the front and rear frames by using the safety lock bar.
- Do not work underneath the work equipment.

1) ADJUSTMENT OF THE BOOM KICKOUT AND BUCKET LEVELER

(1) Lift kickout position

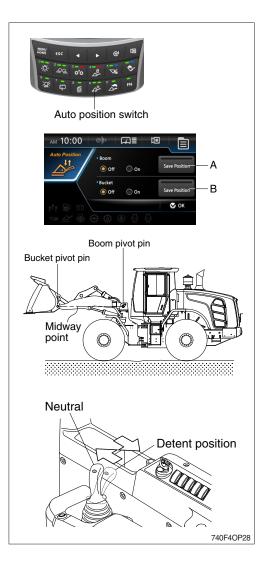
To set the lift kickout, raise the bucket to the desired position above the midway point. Then push icon (, A) for 2~3 seconds. The boom will return to the programmed position when the raise detent is activated and the boom is below the kickout position.

(2) Lower kickout position

To set the lower kickout, lower the bucket to the desired position below the midway point. Then push icon (, A) for 2~3 seconds. The boom will return to the programmed position when the float detent is activated and the boom is at least a foot above the kickout position.

(3) Bucket leveler position

To set the bucket leveler, roll back the bucket to the desired position. Then push icon (, B) for 2~3 seconds. The bucket will return to the programmed position when the roll back detent is activated and the bucket is below the leveler position.



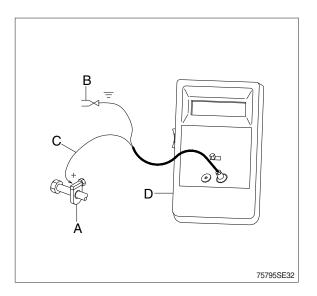
3. TEST TOOLS

1) CLAMP-ON ELECTRONIC TACHOMETER INSTALLATION

- · Service equipment and tools Tachometer
- A : Clamp on tachometer.

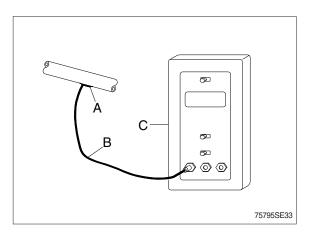
Remove paint using emery cloth and connect to a straight section of injection line within 100 mm (4 in) of pump. Finger Tighten only-do not over tighten.

- B : Black clip (-). Connect to main frame.
- C : Red clip (+). Connect to transducer.
- D: Tachometer readout. Install cable.



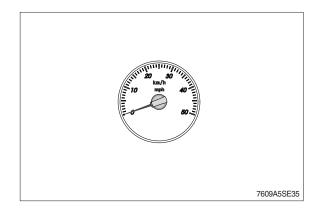
2) DIGITAL THERMOMETER INSTALLATION

- · Service equipment and tools Digital thermometer
- A : Temperature probe. Fasten to a bare metal line using a tie band. Wrap with shop towel.
- B : Cable.
- C : Digital thermometer.



3) DISPLAY MONITOR TACHOMETER

The display monitor tachometer is accurate enough for test work.



4. HYDRAULIC OIL WARM UP PROCEDURE

- 1) Install temperature reader (see temperature reader installation procedure in this group).
- 2) Run engine at high idle.
- 3) Hold a hydraulic function over relief to heat the oil.
- Periodically cycle all hydraulic functions to distribute warm oil.
- 5) Heat oil to test specification (approx. 45°C).

* Ride control system (option)

Attention

- 1) Before carrying out any maintenance work the accumulators must be unloaded (zero pressure).
- 2) Bucket should be lade on the ground.
- Turn the starting switch to ON position and press the ride control switch on monitor to operate ride control function.
- Lower the boom to the postion of down or floating to release the charged oil in accumulators.

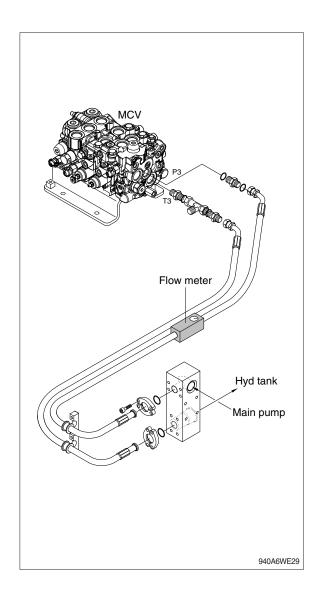


5. MAIN HYDRAULIC PUMP FLOW TEST

· SPECIFICATION

Oil temperature $45\pm5^{\circ}C (113\pm9^{\circ}F)$ Engine speed2230 rpmTest pressure 280 ± 5 bar (3980 psi)Maximum pump flow $160 \ell / min (42.3 gpm)$

- FLOW METER GAUGE AND TOOL Gauge 0~35 MPa (0~350 bar, 0~5000 psi) Temperature reader
- 1) Make test connections.
- Install temperature reader.
 (see temperature reader installation procedure in this group)
- Heat hydraulic oil to specifications.
 (see hydraulic oil warm up procedure in this group)
- 4) Run engine at test specifications.
- 5) Close flow meter loading valve to increase pressure to test specifications.
- 6) Read flow meter.
- If flow is below specifications, check suction line and suction pressure for abnormality before removing pump.



6. LOADER SYSTEM AND PORT RELIEF VALVE PRESSURE TEST

· SPECIFICATION

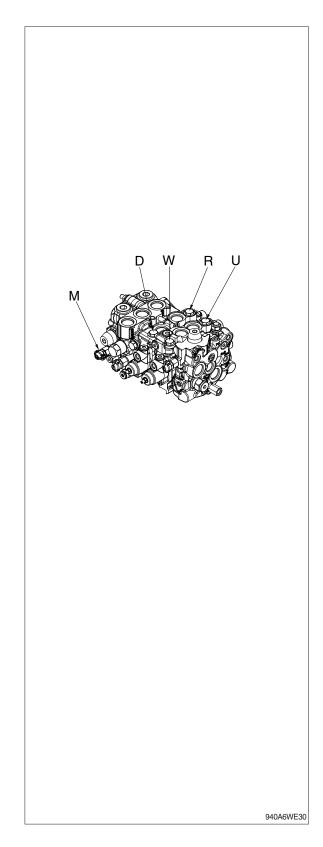
Oil temperature (40~50°C)

Relief valve	Engine speed	Relief pressure
System (M)	High	280±5 kg/cm² (3980±70 psi)
Boom raise (U) Boom down (W) Bucket rollback (R)	Low	340±10 kg/cm² (4840±140 psi)
Bucket dump (D)	Low	340±10 kg/cm² (4840±140 psi)

- Gauge and tool
 Gauge 0~35 MPa (0~350 bar, 0~5000 psi)
 M : System (main) relief valve
 R : Bucket rollback relief
 - D : Bucket dump relief
 - U/W : Boom raise/down relief
- 1) Install fitting and pressure gauge to test port in pump delivery line.
- Install temperature reader.
 (see temperature reader installation procedure in this group)
- Heat hydraulic oil to specifications.
 (see hydraulic oil warm up procedure in this group)
- To check the system relief (M), run engine at high idle. Lower boom to bottomed position.

Slowly activate boom down function while watching pressure gauge. If pressure is not to specification, loosen lock nut on system relief valve (M) and adjust to specification.

Do not adjust the system relief valve above 280 kg/cm² (3980 psi). Damage to the pump will result from excessive pressure settings.



7. HYDRAULIC SYSTEM RESTRICTION TEST

· SPECIFICATION

Oil temperature 45±5°C(113±9°F) Engine speed High idle Maximum pressure 1 MPa (10 bar, 145 psi) at steering unit. Maximum pressure at main control valve 1 MPa (10 bar, 145 psi)

GAUGE AND TOOL

Gauge 0~7 MPa (0~70 bar, 0~1000 psi) 2EA This test will check for restrictions in the hydraulic system which can cause overheating of hydraulic oil.

- 1) Install temperature reader.
 - Steering unit : T port (return line)
 Main control valve : T port (return line)
 (see temperature reader installation procedure in this group)
- Heat hydraulic oil to specifications. (see hydraulic oil warm up procedure in this group)
- 3) Connect fitting and gauge to steering valve.
- 4) Connect fitting and gauge to main control valve.
- ▲ Do not operate steering or loader funct-ions or test gauge may be damaged.
- 5) Run engine at specification and read pressure gauges.

If pressure is more than specification at the loader control valve, check for a kinked, dented or obstructed hydraulic line. Check loader control valve for a binding spool.

If pressure is more than specification at the steering unit, inspect neutral condition of the steering unit for a stuck spool. Make sure orifice plugs are installed in ends of priority spool in MCV.

Check for plugged orifice in priority valve in MCV.

8. LOADER CYLINDER DRIFT TEST

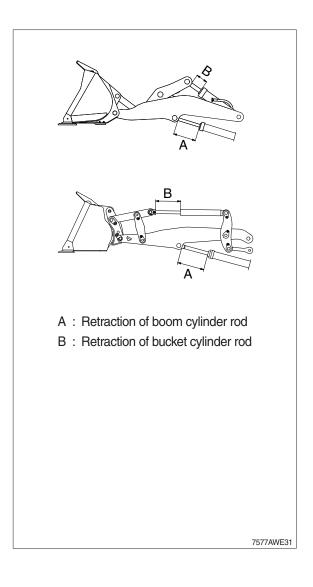
· SPECIFICATION

Oil temperature 45±5°C(113±9°F) Boom horizontal Bucket horizontal Bucket unloaded

ltem	Standard value
Retraction of boom cylinder rod	10 mm
Retraction of bucket cylinder rod	36 mm

GAUGE AND TOOL

- Stop watch
 Temperature reader
- A Put the safety lock lever in the lock position.
- **A** Do not go under the work equipment.
- 1) Set the boom and bucket horizontal, then stop the engine.
- 2) Stop the engine, wait for 15 minutes, then start measuring.
- 3) Measure the amount the boom and bucket cylinder rods retract during 5 minutes.



9. BOOM AND BUCKET CYLINDER LEAKAGE TEST

· SPECIFICATION

 Oil temperature
 45±5°C(113±9°F)

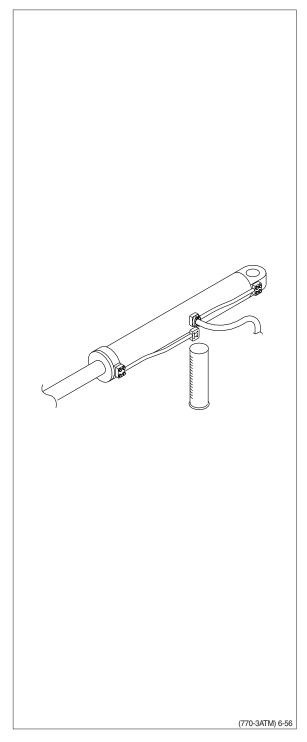
 Engine speed
 Low idle

 Maximum leakage
 15 m ℓ /min (1/2 oz/min)

GAUGE AND TOOL Temperature reader Stop watch Measuring container

- 1) Fasten temperature sensor to head end port of cylinder to be tested. Cover sensor with a shop towel.
- Heat hydraulic oil to specifications (see hydraulic oil warm up procedure in this group).
- A Never work under raised equipment unless it is supported with a hoist or support stands.
- Full extend the cylinder to be tested. If testing the boom cylinders, restrain boom in the fully raised position using a hoist or a stand.
- * Check cylinders for leakage in the fully extended position only. In the retracted position contacts the end of the cylinder and seals off piston seal leakage.
- 4) Remove and plug cylinder rod end hose or line.
- Run engine at slow idle. Activate control lever to extend cylinder for 1 minute over relief while measuring leakage for open port.

If leakage is within specification, excessive cylinder drift is caused by leakage in the loader control valve or circuit relief valve.



10. CYCLE TIME TEST

· SPECIFICATION

Oil temperature $--45\pm5^{\circ}C(113\pm9^{\circ}F)$

Engine speed —— High idle

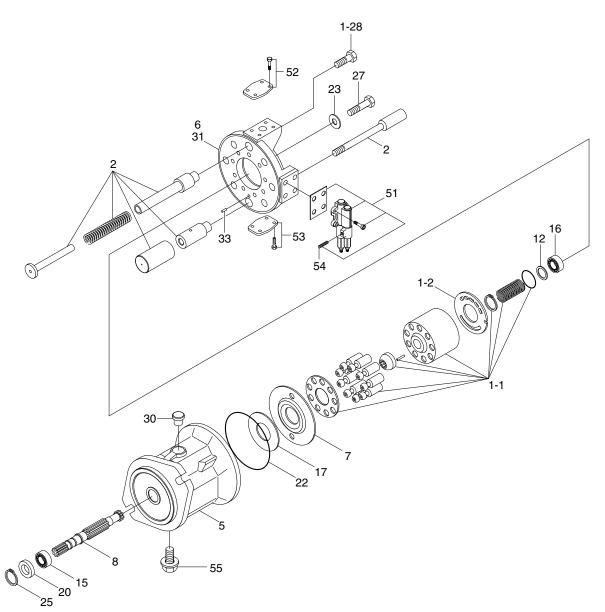
Function	Operating conditions	Maximum cycle time (seconds)
Boom raise	Bucket flat on ground to full height	5.5
Boom lower (float)	Full height to ground level	3.7
Bucket dump	Boom at full height	2.3
Bucket rollback	Boom at full height	1.8
Steering (number of turns)	Frame stop to stop	3.9 turns

11. HYDRAULIC OIL FILTER INSPECTION PROCEDURE

- Lower the bucket to the ground, stop the engine, move the control lever back and forth several times, and clean all over the upper surface of the hydraulic oil tank.
- 2) Remove the bolts and take out the filter case cover and O-ring.
- 3) Remove the spring and bypass valve.
- 4) Remove the filter element from the tank.
- 5) Check the element and the filter case bottom for debris. Excessive amounts of brass and steel particles can indicate a failed hydraulic pump or a pump failure in process. A rubber type of material can indicated cylinder packing or other packing failure.
- * The hydraulic oil filter in the filter case of the hydraulic oil tank should be replaced every 250 operating hours or more often. When the filter element is replaced, please keep as follows.
- (1) Clean the inside of the filter case.
- (2) Place new element in the proper positions inside the filter case.
- (3) Install the bypass valve and spring. Make sure the element stand upright, and check for complete contact of the element bottom with the filter case bottom.
- (4) Install the O-ring and filter case covers. Tighten them with bolt. Replace the O-ring with new one if damaged.sa

1. MAIN PUMP

1) STRUCTURE (1/2)



74096WE11

- 1 Rotary group
- 1-1 High speed rotary group
- 1-2 Control plate
- 2 Adjusting piece
- 5 Pump housing
- 6 Port plate
- 7 Swash plate
- 8 Drive shaft
- 12 Adjustment shim

- 15 Taper roller bearing
- 16 Taper roller bearing
- 17 Bearing liner
- 20 Shaft seal ring
- 22 O-ring
- 23 O-ring
- 25 Retaining ring
- 27 Socket screw
- 28 Locking screw

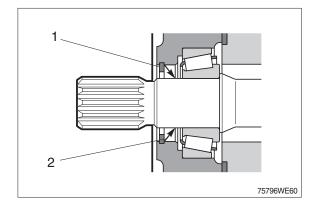
- 30 Locking screw
- 31 Double break-off pin
- 33 Cylinder pin
- 51 Control valve
- 52 Flange cover
- 53 Flange cover
- 54 Seal screw
- 55 Seal screw

2) GENERAL REPAIR GUIDELINES

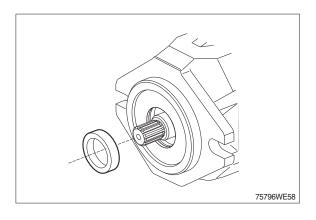
- * Observe the following guidelines when carrying out repairs on hydraulic pumps.
- (1) Close off all openings of the hydraulic unit.
- (2) Replace all of the seals.Use only original spare parts.
- (3) Check all sealing and sliding surfaces for wear.
- Re-work of the sliding surfaces by using, for example abrasive paper, can damage the surface.
- (4) Fill the hydraulic pump with hydraulic oil before commissioning.

3) SEALING THE DRIVE SHAFT

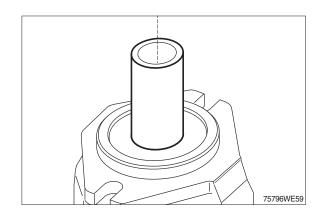
- Protect the drive shaft. Remove the circlip. Remove the shaft seal.
 - 1 Circlip 2 Shaft seal



(2) Change the shaft seal and check its sliding surface (drive shaft) and housing, grease the sealing ring.

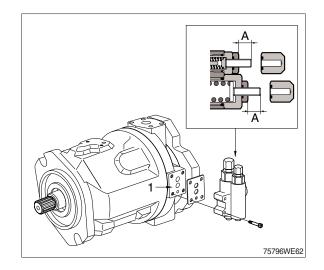


(3) Assemble the sealing ring, fitting tool holds the correct position of the sealing ring in the pump housing. Assemble the circlip in the correct position.



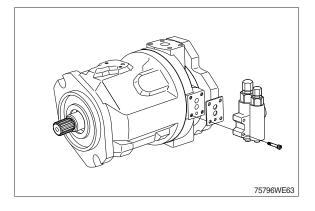
4) SEALING/CLEANING THE CONTROL VALVE

- (1) Disassemble the control valve.
- Measure dimension A and note down.
 Check sealing surface (1).

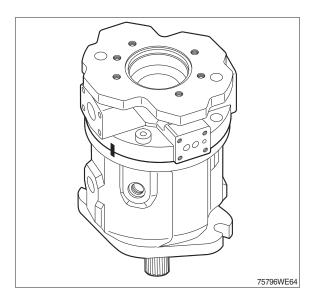


5) DISASSEMBLE THE PUMP

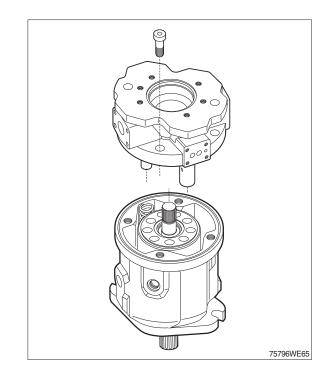
(1) Remove the control valve.



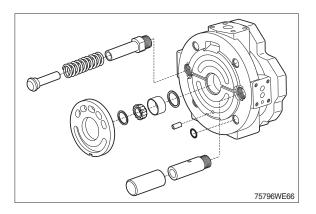
(2) Mark the location of the connection plate on the housing.



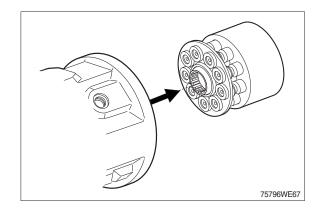
- (3) Remove the connection plate fixing bolts and the connection plate.
- Distributor plate and adjustment piston can drop down.



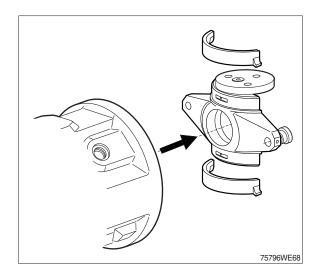
- (4) Remove distributor plate.Take note of the orientation.
- Remove bearing with withdrawal tool.Do not damage the sealing surface.



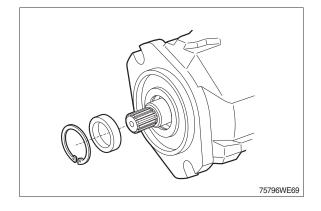
(5) Remove the rotary group in a horizontal position.



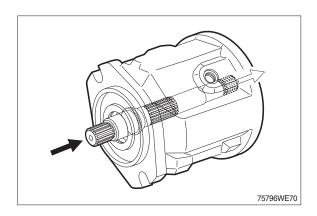
(6) Remove swash plate and bearing shells.



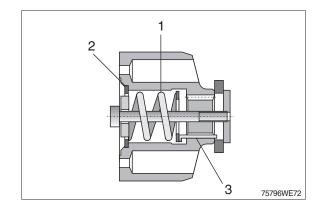
(7) Remove the circlip and the shaft seal.



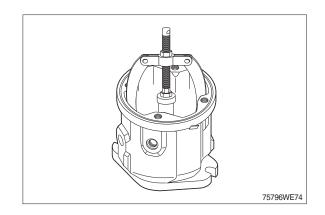
(8) Remove the drive shaft through rear side.



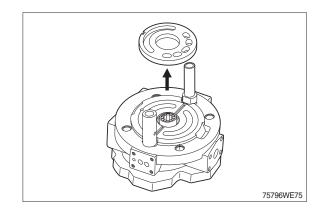
(9) Pre-tension the spring (1) using a suitable device.Remove circlip (2).Remove spring (1) and pressure pins (3).



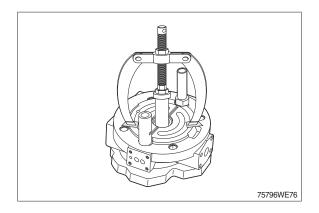
(10) Use bearing puller to remove outer bearing race of front bearing out of housing press seat.



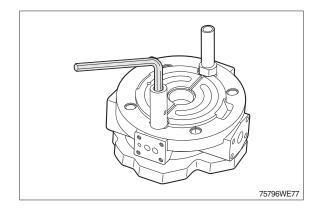
(11) Remove the control plate.



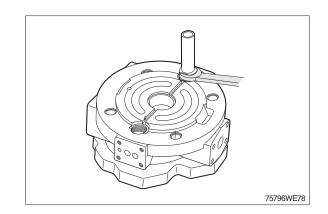
(12) Use bearing puller to remove outer bearing race of rear bearing - press seat.



(13) Disassemble the guide of control piston (Mounting position: pilot valve side).

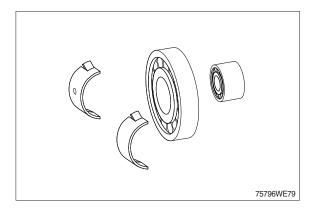


(14) Disassemble the guide of the opposite piston.



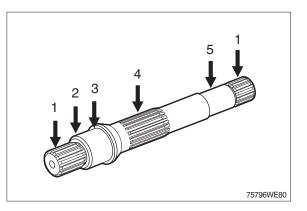
6) INSPECT HINTS

(1) Renew all bearings.

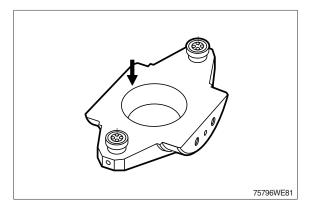


(2) Check :

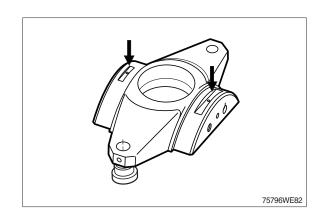
- 1 Wear on splines, rust
- 2 Drive shaft seal wear grooves
- 3 Bearing seat
- 4 Splines for cylinder drive
- 5 Bearing seat



(3) Check : Sliding surface free of grooves.

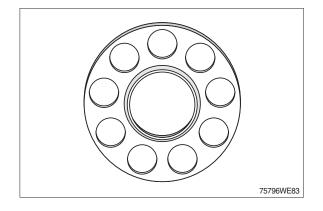


(4) Check : Bearing surfaces.



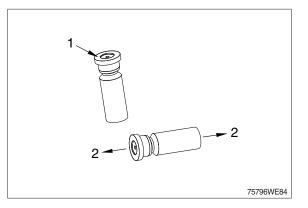
(5) Check :

That the retaining plate is free of grooves and that there is no wear in the slipper pad area.



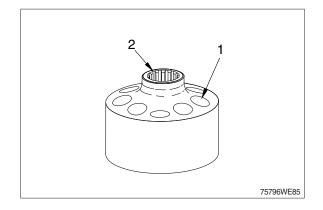
(6) Check :

Check to see that there are no scratches or metal deposits on the sliding surface (1) and that there is no axial play (2) (Pistons must only be replaced as a set).

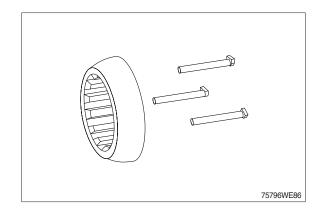


(7) Check :

- 1 Cylinder bores
- 2 Splines

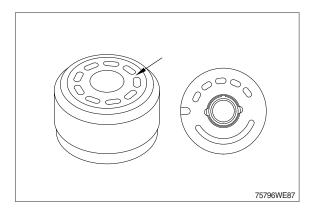


(8) Free of grooves, no signs of wear.



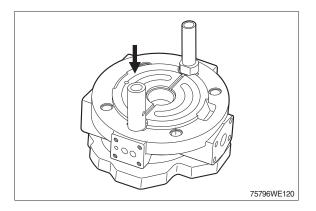
(9) Check :

Cylinder sliding surface free of grooves, no wear, no embedded foreign particles. That there are no scratches on the control plate. (Only replace them as a set).



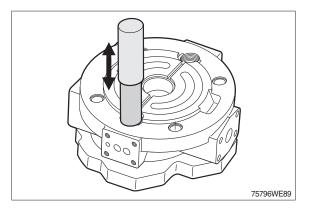
(10) Check :

Mounting surface - control plate undamaged.



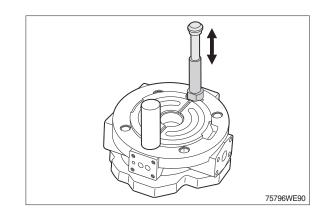
(11) Check :

Check running conditions of the control piston.



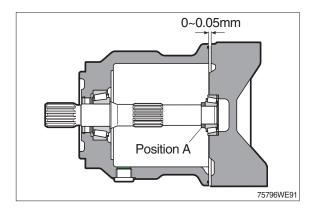
(12) Check :

Check running conditions of the opposite piston.



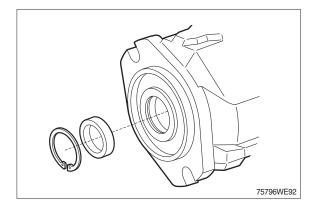
7) ADJUSTMENT OF TAPER ROLLER BEARING SET

 Cast iron housing must have initial tension of the bearings: 0~0,05 mm, grind position A if necessary.

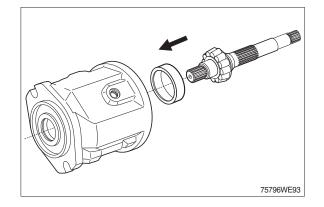


8) PUMP ASSEMBLY

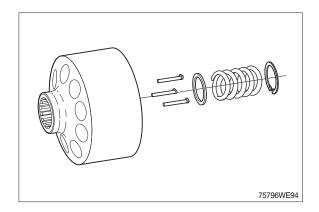
(1) Fit the seal into the housing. Fit the circlip.



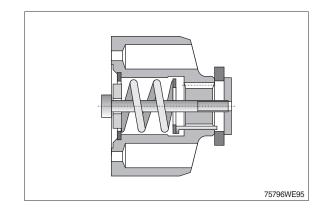
- (2) Fit the drive with bearing from rear end.
- ※ Do not touch seal lip with edge of keyway or spline.



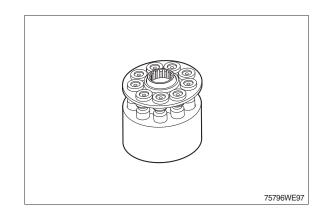
(3) Fit pressure pins using an assembly aid.



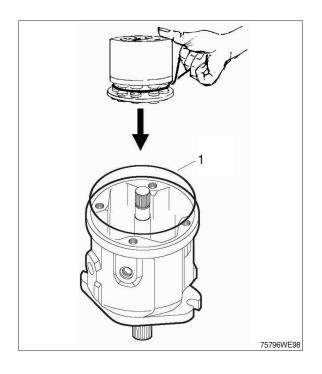
(4) Pre-tension the spring using a suitable device.



- (5) Assemble piston with retaining plate.
- * Oil piston and slipper pad.



- (6) Fit rotary group.
- Hold the piston by using an O-ring.Fit O-ring (1).

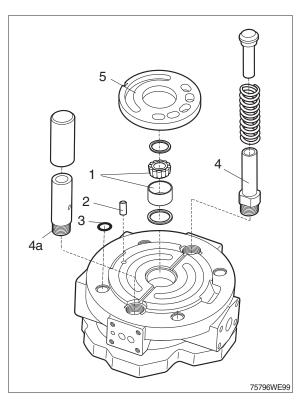


(7) Fit bearing (1) in connection plate.
Fit cyilindrical pin (2).
Fit O-rings (3) 4 pieces.
Fit adjustment spool (4) and guide piston (4a).

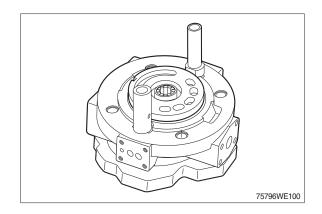
Fit distributor plate (5) (direction of rotation dependent)

* Assembly.

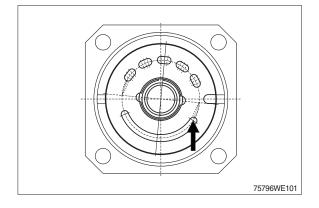
Hold the components in place with grease.



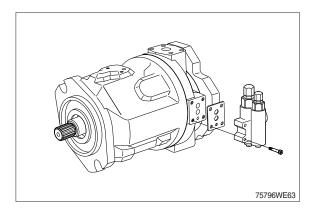
- (8) Fit distributor plate.
- * Assembly aid : Grease



(9) For clockwise rotation pumps the distributor plate is off-set by 4° to the right from the centre position.
(Clockwise and anti-clockwise rotation distributor plates are not identical).

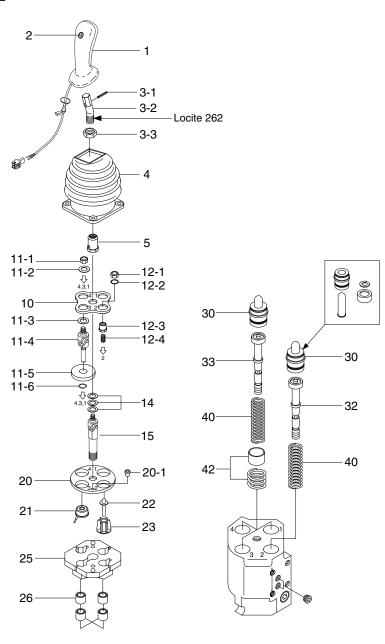


(10) Fit connection plate and control valve.



2. REMOTE CONTROL VALVE

1) STRUCTURE



7707WE64

- 1 Handle
- 2 Push button
- 3-1 Locking pin
- 3-2 Bent lever
- 3-3 Nut
- 4 Rubber boot
- 5 Locking nut
- 10 Cardan bracket
- 11-1 Self-locking nut
- 11-2 Washer
- 11-3 Washer

- 11-4 Cardan
- 11-5 Armature
- 11-6 Spring ring
- 12-1 Counter nut
- 12-2 Spring ring
- 12-3 Switch plate screw
- 12-4 Press screw
- 14 Shims (0.1, 0.2, 0.5 mm)
- 15 Cardan
- 20 Flange
- 21 Solenoid

- 22 Intermediary plunger kit
- 23 Intermediary plunger guide
- 25 Electric bracket
- 26 Bushing
- 30 Plunger kit
- 32 Regulation unit
- 33 Regulation unit
- 40 Return spring
- 42 Prefeeling point kit

2) DISASSEMBLY AND ASSEMBLY

(1) PUSH BUTTON

* The remote control valve does not need to be removed from the machine to perform this operation.

Remove worn pushbutton using a small screwdriver.

The installation of new elements is performed without any special tools; the parts are simply pressed into place.

(2) RUBBER BOOT

- ① Remove the remote control valve from the machine or free the valve by unscrewing the 4 screws fixing the plate in order to release the electrical cable.
 - · Assembly

Torque : 1.02 kgf \cdot m (7.4 lbf \cdot ft)

Hold the remote control valve using a vice or a vice-grip wrench (clamp onto the body).

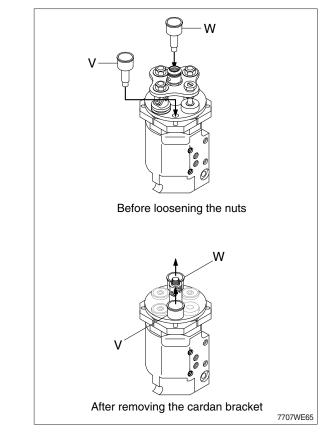
- * The pilot unit does not need to be removed from the machine to release the cable. However, it is recommended to lift the control unit by undoing the 4 fixing screws on the arm rest.
- * It is unnecessary to remove the units with no electrical functions.
- ② Lift and turn the boot inside out.
- 3 Remove the grommet (7) from its emplacement to free the cable.
- 4 Loosen the handle mounting nut (3-3) using a 19 mm open-end wrench.
 - · Assembly : torque 4.08 kgf · m (29.5 lbf · ft)
- \bigcirc Unscrew and remove the handle (1).
 - Assembly
 - Add loctite 262 onto the lever thread
 - Torque : 4.08 kgf · m (29.5 lbf · ft)
- 6 Replace the faulty rubber boot (4) with a new one.
- \bigcirc Replace the handle (1) following the disassembly instructions in reverse order.

(3) HANDLE

- 1 Clamp the threaded section of the lever (3-2) in a vice fitted with V-shaped vice clamp.
- 2 Remove the pin (3-1) using a 5mm pin driver.
- ③ Replace the lever (3-2) onto the new handle (1) and secure it with the pin (3-1) using a 5mm pin driver.
- * Respect the position of the curved lever to ensure that the handle is correctly oriented as indicated by the machine's technical specifications.
- 4 Replace the nut (3-3) on the threaded section and replace the boot (4).

(4) DETENT CARDAN BRACKET KIT

- Remove the 2 grommets (20-1) from the flange (20).
- * Place centering sleeves V & W to avoid damaging the cardan knuckles while loosening the nuts.
- * Unscrew the locking nut (5) using a 23mm open-end wrench.
 - \cdot Assembly : Torque 4.08 \pm 0.4 kgf \cdot m (29.5 \pm 2.9 lbf ft)
- ① Unscrew the self-locking nut (11-1) using a 13mm open-end wrench.
 - · Assembly
 - Torque 1.02 kgf \cdot m (7.4 lbf \cdot ft)
 - Place centering sleeves (V-W) to avoid damaging the cardan knuckles while screwing the nuts.
- ² Remove : Friction washer (11-2)
 - Friction washer (11-3)
 - Cardan/armature assembly
 - (11-4 ~ 11-6)



(5) NON-DETENT PLUNGER KIT

- ① Unscrew the self-locking nut (12-1) using a 13 mm open-end wrench.
 - · Reassembly : Torque 1.02 kgf · m (7.4 lbf · ft)
 - Place centering sleeves (V-W) to avoid damaging the cardan knuckles while screwing the nuts.
- 2 Undo the snap ring (12-2) using a flat-end screwdriver.
- ③ Remove the screw assembly (12-3, 12-4)

(6) CARDAN

- 1 Remove the centering sleeves V & W.
- 2 Remove the cardan bracket (10) and the shims (14).
- 3 Unscrew the cardan (15) using a 17 mm open-end wrench.
 - · Reassembly : Ungrease the cardan threads
 - Add loctite 262 onto the cardan threads (both end)
 - Torque 4.08 kgf · m (29.5lbf · ft)

(7) SOLENOID AND CONNECTOR

- It is advised to mount the connector onto the solenoid cable once the remote control valve is assembled.
- ① Remove the flange (20) and the electrical bracket (25),
- 2 Remove the protecting bushes (26) from the electrical bracket (25).
- ③ Undo the solenoid (21) from the electric bracket (25).
- ④ Replace the solenoid.
- * Clean the polar face using a piece of cloth and pay attention not to hit them.
- (5) Assembly : Place the solenoid cable in its emplacement on the electric bracket before fitting the protection bushes.

(8) INTERMEDIARY PLUNGER KIT

- 1 Undo the intermediary plunger guide (23).
- 2 Remove and replace the intermediary plunger kit assembly (22).

(9) GUIDE / PLUNGER AND REGULATION UNIT

- * Beware of the plungers that might jump out due to the spring return.
- 1 Remove : Guide/plunger assembly (30).
 - Regulation unit (32/33).
 - Return spring (40).
 - Pre-feeling point kit (42).
- ② The remote control valve is now totally disassembled. Assemble in reverse order following the torque specification.

3. MAIN CONTROL VALVE

1) STARTING, MAXIMAL PRESSURE SET UP

(1) Break the locking cover with a pair of pliers.

Decalibrate the LS pressure relief valve (19 mm open end spanner on counternut ; 5 mm socket wrench) before starting the machine.

Maintain one of the control block spool valve in action before the linked hydraulic receiver is at the end of stroke.

- On the spool valve, the value of the secondary valve pressure must be greater than that of the LS pressure relief valve to adjust.
- (2) Adjust the maximum pressure measured in M using the LS pressure relief valve (19 mm open end spanner on counternut ; 5 mm socket wrench.

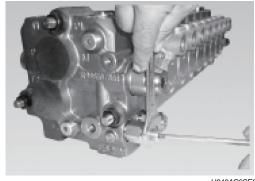
Tighten the counternut of the adjusting screw to the torque :

- 2.55 ± 0.25 kgf \cdot m (18.4 \pm 1.8 lbf·ft)

Protect the setting by putting a new locking cover. Fit together two half covers.



H940AC6SE01



H940AC6SE02

2) LS PRESSURE RELIEF VALVE REPLACEMENT

The control block does not need to be removed from the machine to perform this operation.

▲ Place all of the machine's actuators connected to the control block in neutral position. Release stored pressure by operating all the spools.

- (1) On the inlet element, unscrew the LS pressure relief valve (24 mm open end spanner).
- * Reassembly Install the LS pressure relief valve on the inlet element.
 - Torque : 4.59±0.46 kgf · m (33.2±3.3 lbf·ft)

Set the LS pressure relief valve to the specified value

Fit a new appropriate locking cover

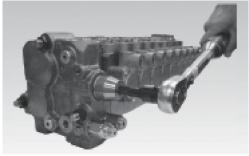




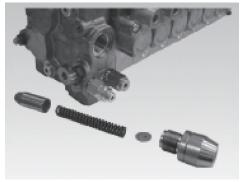
H940AC6SE03

3) REGULATING UNIT REPLACEMENT

- (1) Unscrew the plug (12 mm socket wrench).
- (2) Remove using a magnet to extact it from its bore : shims, spring, piston.
- Clean parts to remove any attracted metal particle.
 Do not use magnet for reassembly.
- Reassembly Reassemble parts in reverse order.
 - Torque : 10.2±1.02 kgf · m (73.8±7.38 lbf·ft)



H940AC6SE04



H940AC6SE05

4) FLOW REGULATOR REPLACEMENT

- (1) Unscrew the flow regulator (22 mm open end spanner).
- * Reassembly reassemble parts in reverse order.
 - Torque : 2.04±0.20 kgf · m (14.8±1.48 lbf·ft)



H940AC6SE06



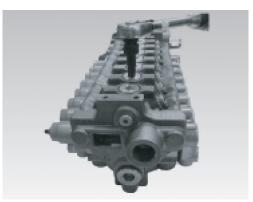
H940AC6SE07

5) PRESSURE COMPENSATOR REPLACEMENT

- (1) Unscrew the compensator plug (12 mm socket wrench).
- (2) Remove the compensator piston using a magnet to extract it from its bore.
- Clean parts to remove any attracted metal particle.
 Do not use magnet for reassembly.
- * Reassembly reassemble parts in reverse order.
 - Torque : 12.2±1.22 kgf · m (88.5±8.85 lbf.ft)







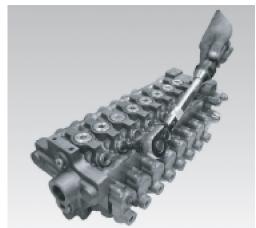
H940AC6SE10



H940AC6SE11

6) CHECK VALVE REPLACEMENT

- (1) Unscrew one of the check valves (6 mm socket wrench).
- * Reassembly Install the check valve on the distribution element.
 - Torque : 7.14±0.71 kgf · m (51.6±5.16 lbf·ft)



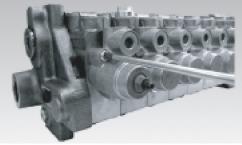
H940AC6SE13



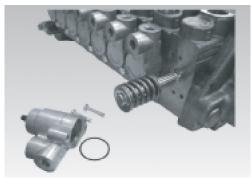
H940AC6SE14

7) REMOVAL OF THE HYDRAULIC COVER

- (1) Remove the 2 mounting screws.
- (2) Remove the cover and O-ring.
- Reassembly Replace the cover O-ring.
 Reassemble parts in reverse order.
 Torque for the 2 mounting screws.
 - Torque :
 - 0.61 ± 0.06 kgf \cdot m (4.43 \pm 0.44 lbf·ft)



H940AC6SE15



H940AC6SE16

8) COMPLET CONTROL BLOCK DISASSEMBLY/ASSEMBLY

(1) Remove the control block from the machine.Remove the 3 nuts (19 mm ring wrench).



H940AC6SE18

(2) Remove the final element.Separate the distribution elements.



H940AC6SE19

- (3) Reassembly
 - Replace the O-rings between distribution elements, initial element and final element.
 - Check the cleanliness of the element faces.
 - In case of tie rods reassembly, check their orientation : the shortest thread goes into the final element.
 - Torque for the 3 tie rods :
 - 6.12 ± 0.25 kgf \cdot m (44.3 \pm 4.43 lbf·ft)
 - Reassemble elements in reverse order

Place the control block horizontally on an even support area to tight the nuts.

Torque for the 3 nuts :

 $6.12 \pm 0.25 \text{ kgf} \cdot \text{m} (44.3 \pm 4.43 \text{ lbf·ft})$

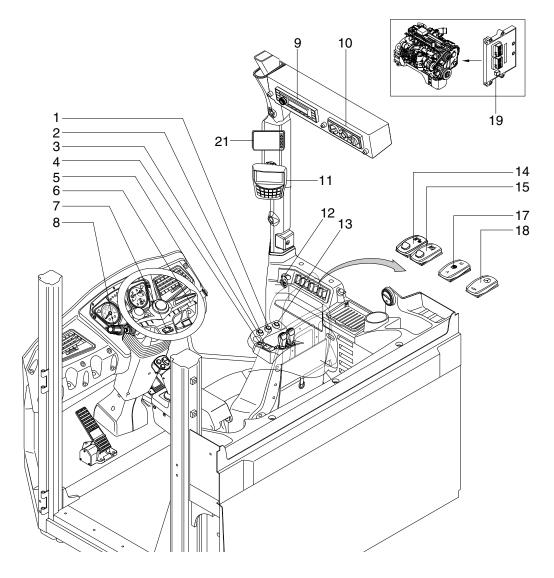


H940AC6SE20

Group	1 Component Location	7-1
Group	2 Electrical Circuit	7-3
Group	3 Electrical Component Specification	7-22
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Group	5 Troubleshooting	7-52

GROUP 1 COMPONENT LOCATION

1. LOCATION 1



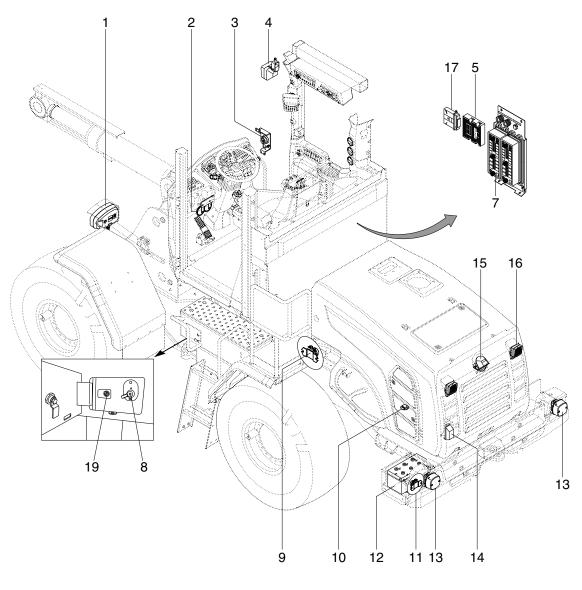
970SA7EL20

- 1 Kick down button
- 2 Horn button
- 3 FNR switch
- 4 FNR select button
- 5 Hone button
- 6 Multi function switch
- 7 Hazard switch

- 8 Gear select lever
- 9 Radio & USB player
- 10 Aircon & heater switch
- 11 Monitor
- 12 Starting switch Starting button (opt)
- 13 Work load button

- 14 Pilot cut off switch
- 15 Parking brake switch
- 17 Differential lock switch (opt)
- 18 Emergency test switch
- 19 Engine control unit (ECU)
- 21 Camera monitor

2. LOCATION 2



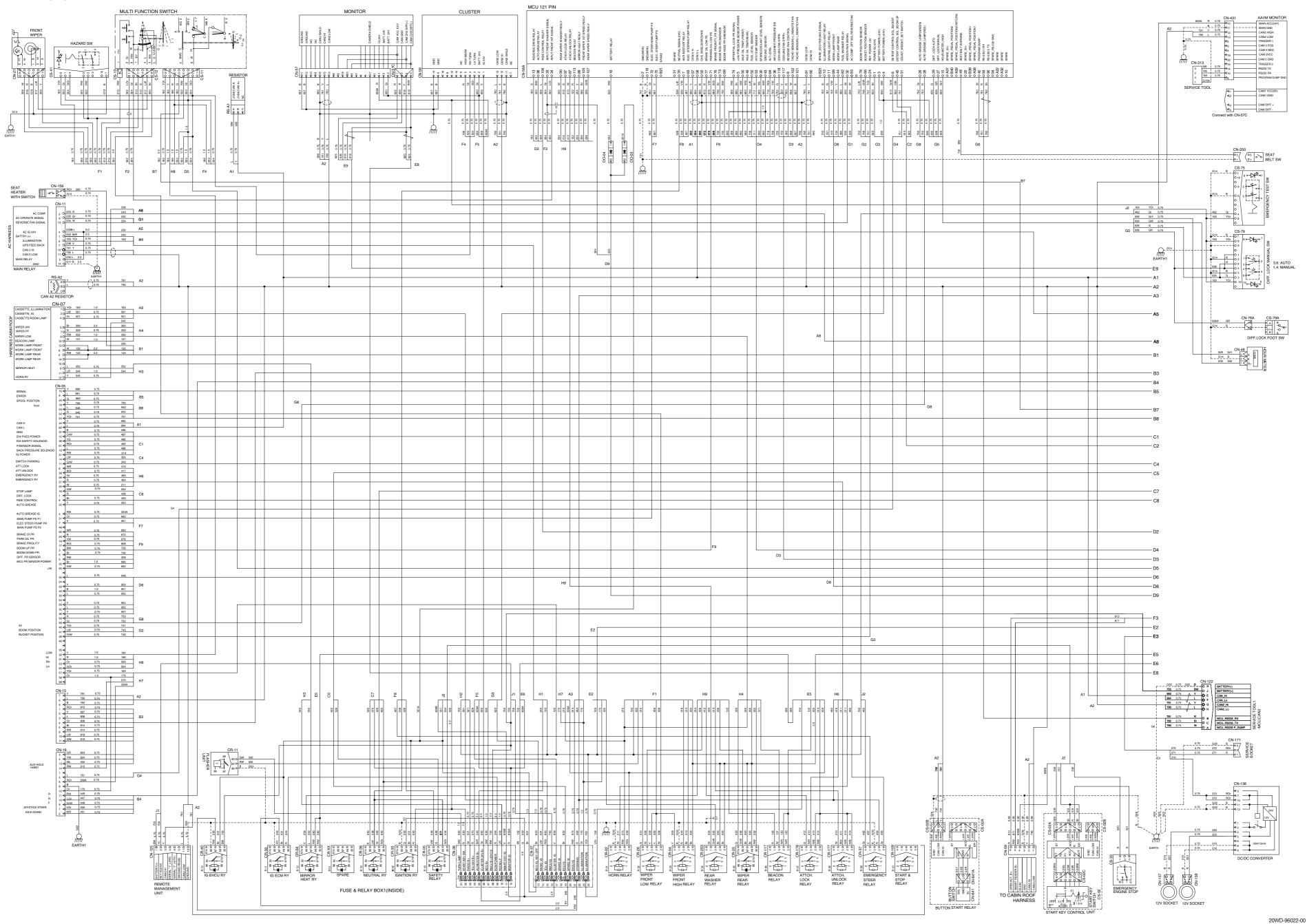
960A7EL21

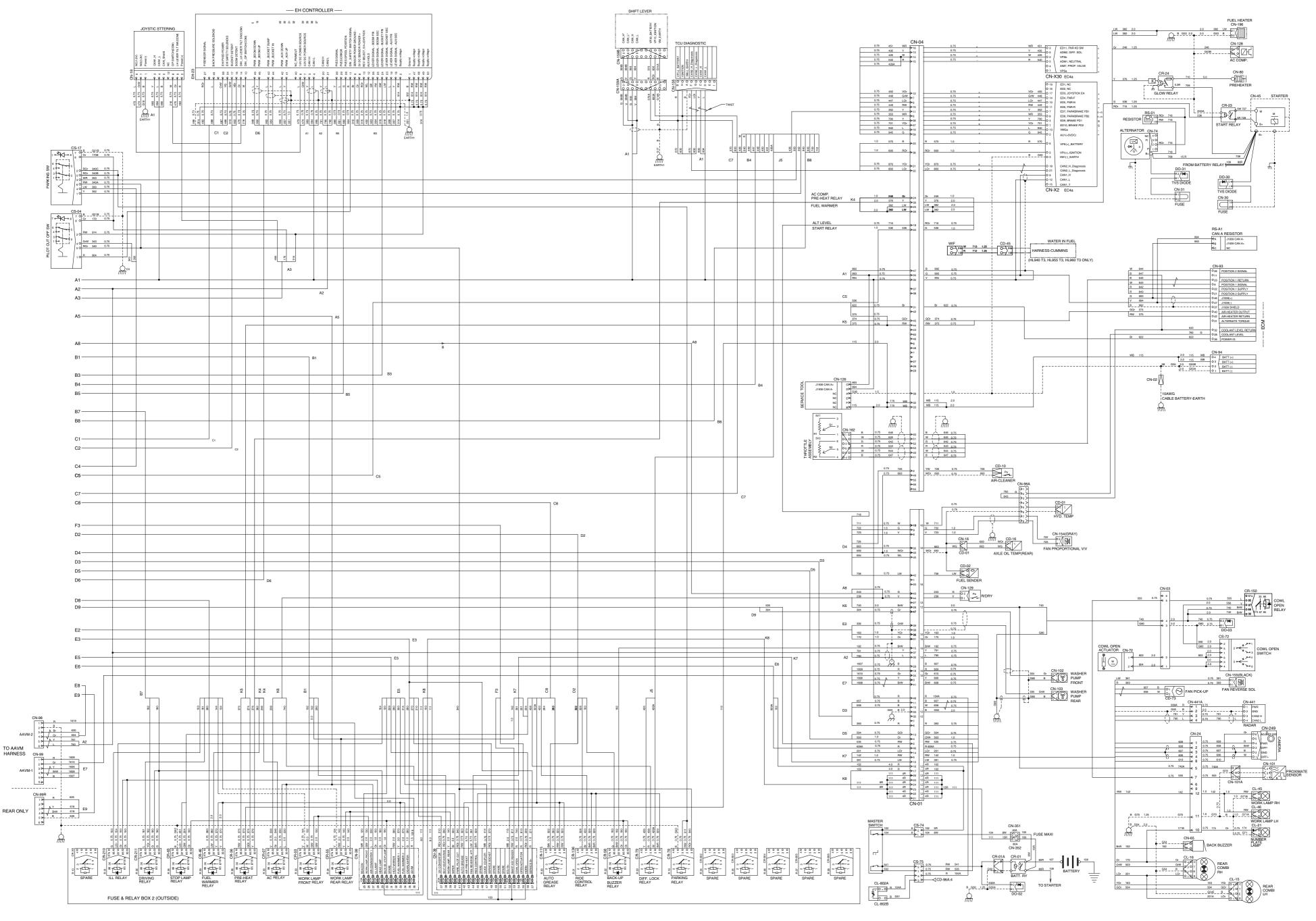
- 1 Head lamp
- 2 Horn
- 3 Angle sensor
- 4 Work lamp
- 5 Machine control unit (MCU)
- 7 Fuse and relay box

- 8 Master switch
- 9 Start relay
- 10 Fuel sender
- 11 Battery relay
- 12 Battery
- 13 Rear combi lamp
- 14 Number plate lamp
- 15 Camera (opt)
- 16 Work lamp
- 17 Control unit (electro hydraulic & joystick steering)
- 19 Engine hood open switch

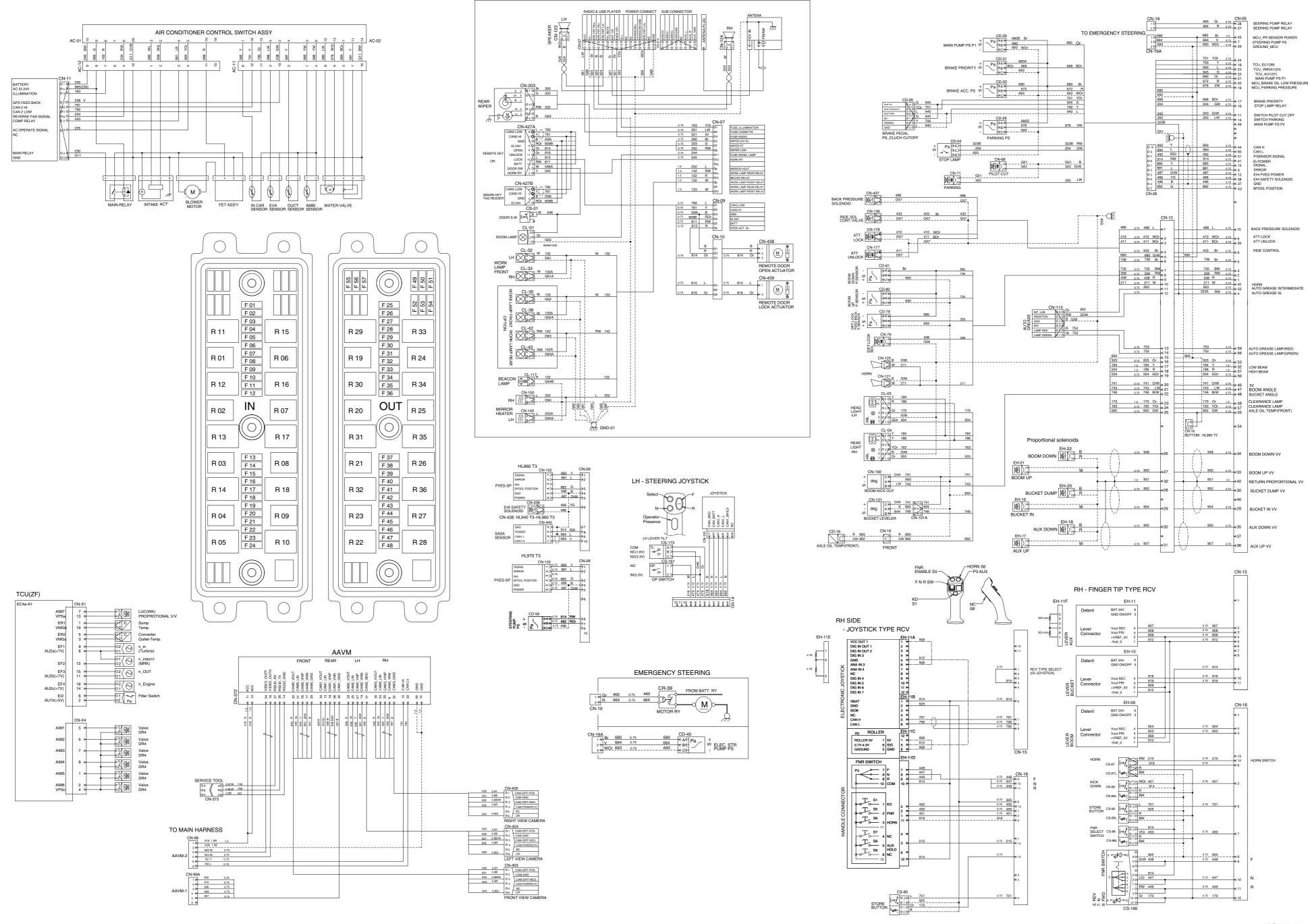
GROUP 2 ELECTRICAL CIRCUIT

• ELECTRICAL CIRCUIT (1/3)





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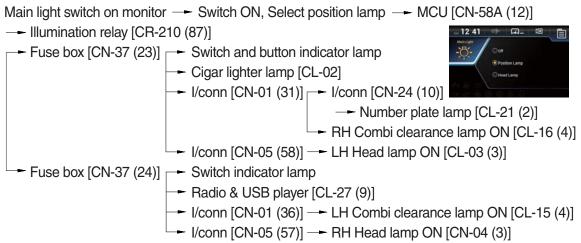


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MEMORANDUM

1. ILLUMINATION CIRCUIT

1) OPERATING FLOW

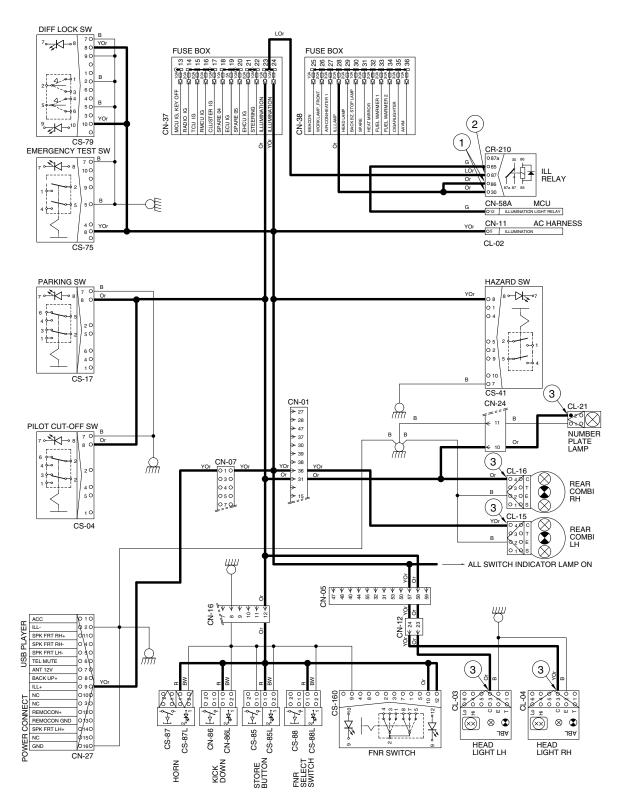


2) CHECK POINT

Engine	Key switch	Check point	Voltage
		① - GND (relay input)	
OFF	ON	② - GND (relay output)	20~25V
		3 - GND (to light)	

* GND : Ground

ILLUMINATION CIRCUIT



960SA7EL04

2. HEAD LIGHT CIRCUIT

1) OPERATING FLOW

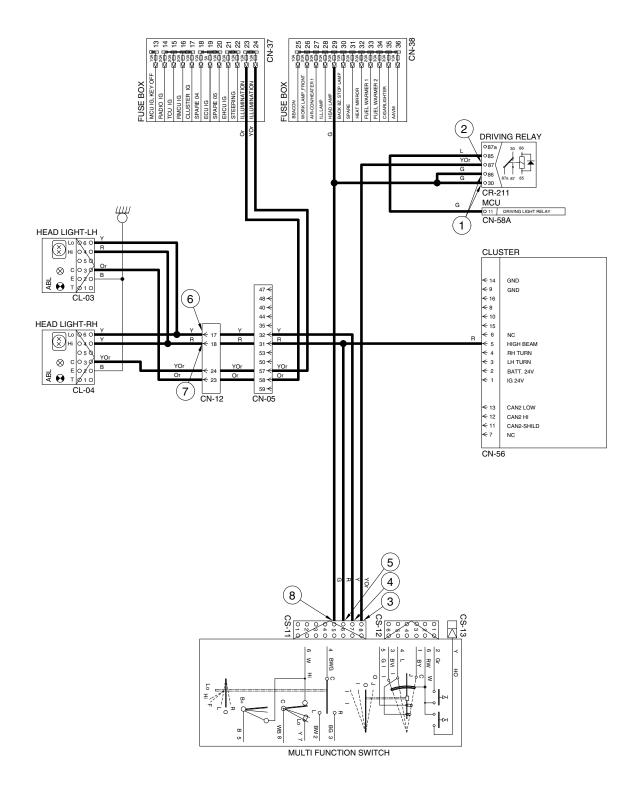
Main light switch on monitor --- Switch ON, Select head lamp --- MCU [CN-58A (11)]

- --- Driving relay [CR-211 (87)] --- Multi function switch [CS-11(8)]
- Multi function switch MIDDLE [CS-11(7)]
 I/conn [CN-05 (32)]
 I/conn [CN-12 (17)]
 LH Head light low beam ON [CL-03 (6)]
 RH Head light low beam ON [CL-04 (6)]
 I/conn [CN-05 (31)]
 I/conn [CN-12 (18)]
 I/conn [CN-05 (31)]
 I/conn [CN-12 (18)]
 RH Head light high beam ON [CL-03 (4)]
 RH Head light high beam ON [CL-04 (4)]
 Cluster high beam pilot lamp ON [CN-56 (5)]

2) CHECK POINT

Engine	Key switch	Check point	Voltage
		① - GND (relay input)	
		② - GND (relay output)	
		③ - GND (multi function input)	
OFF		4 - GND (multi function output)	20~25V
OFF	ON	5 - GND (multi function output)	20~23V
		⑥ - GND (low beam)	
		${ar {\mathbb T}}$ - GND (high beam)	
		⑧ - GND (passing B ⁺)	

* GND : Ground



⁹⁶⁰SA7EL05

3. WORK LIGHT SWITCH

1) OPERATING FLOW

- % Main light switch on monitor : Select position lamp.
- (1) Work lamp switch (select Front)

MCU [CN-58A (88)] -- Front work lamp relay [CR-03 (87)] -- I/conn [CN-07 (06)]

- --- LH Front work lamp ON [CL-32 (1)]
- RH Front work lamp ON [CL-33 (1)]

(2) Work lamp switch (select Rear)

MCU [CN-58A (44)] -- Rear work lamp relay [CR-55 (87)] -- I/conn [CN-01 (05)]

→ I/conn [CN-24 (12)] → LH Rear work lamp ON [CL-46 (1)]

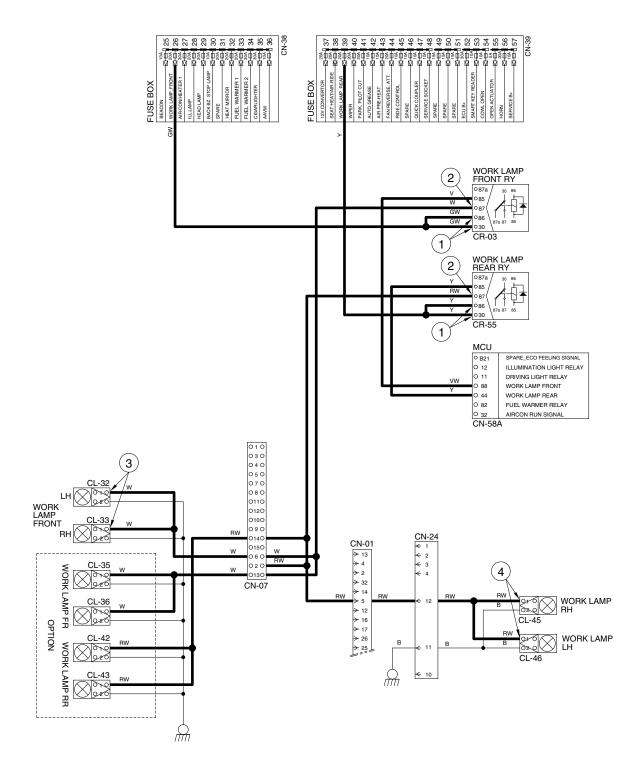


2) CHECK POINT

Engine	Engine Key switch Check point		Voltage
		① - GND (work lamp power input)	
OFF		2 - GND (work lamp power output)	20~25V
OFF	ON	③ - GND (front work lamp)	20~250
		4 - GND (rear work lamp)	

* GND : Ground

RH Rear work lamp ON [CL-45 (1)]



960SA7EL06

4. STARTING CIRCUIT

1) OPERATING FLOW

Battery(+) terminal \rightarrow Fusible link [CN-351 (40A)] \rightarrow Master switch [CS-74 (1) \rightarrow (2)] \rightarrow I/conn [CN-01 (16, 17)] \rightarrow Fuse box [CN-36] \rightarrow Start switch [CS-02A (1)] \rightarrow ECM power relay [CR-30 (30)] \rightarrow Power relay [CR-35 (30)]

* The gear selector lever is neutral position. It is necessary condition before the starting. The gear selector has an output signal which is activated whenever the shift lever is in the neutral position. This signal can be used to control a relay and prevent engine from starting whenever the shift lever is not in the neutral position.

(1) When start key switch is in ON position

Start switch ON [CS-02C (2, 3)]
$$\rightarrow$$
 I/conn [CN-01(2)] \rightarrow Master switch [CS-75 (1) \rightarrow (2)]
 \rightarrow Battery relay [CR-1]
 \rightarrow Battery relay operating (All power is supplied with the electric component)

- → ECM power relay [CR-30 (30) → (87)] → Fuse box [CN-37 (19)]
- → I/conn [CN-04 (31)] → ECM [CN-93 (39)]
- ← Fuse box [CN-37 (13)] ← MCU [CN-58A (A03)]
 - Power relay [CR-35 (30) \rightarrow (87)] Fuse box [CN-37 (15)]
 - -- TCU DIAGNOSTIC [CN-135 (H)]
- (2) When start key switch is in START position

Start switch START [CS-2C (6)] \rightarrow Start safety relay [CR-05 (30) \rightarrow (87)] \rightarrow I/conn [CN-04 (20)] \rightarrow Start relay [CR-23] \rightarrow Starter (terminal B⁺ and M connector of start motor)

2) CHECK POINT

Engine	Key switch	Check point	Voltage
		① - GND (battery B ⁺)	
		② - GND (fusible link)	
		③ - GND (start key B terminal)	
Running	ON	4 - GND (start key BR terminal)	20~25 V
		⑤ - GND (i/conn CN-01 (16))	20 20 1
		⑥ - GND (start key C terminal)	
		$\overline{\mathbb{C}}$ - GND (start safety relay output)	
		8 - GND (start key ACC terminal)	

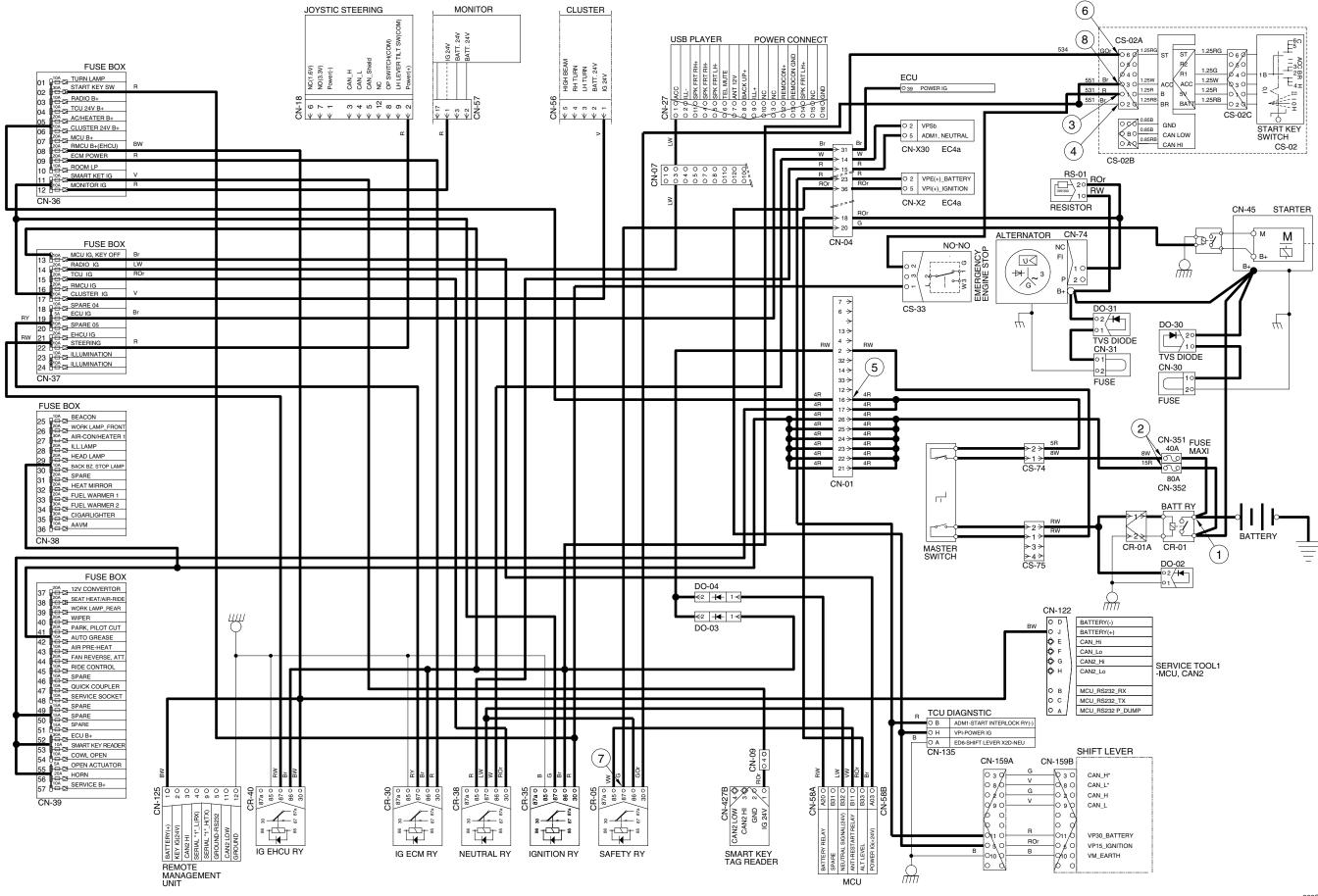
* GND : Ground

* ECM : Electronic control module

* MCU : Machine control unit

* TCU : Transmission control unit

STARTING CIRCUIT



5. CHARGING CIRCUIT

When the starter is activated and the engine is started, the operator releases the key switch to the ON position.

Charging current generated by operating alternator flows into the battery through the battery relay (CR-01).

The current also flows from alternator to each electrical component and controller through the fuse box.

1) OPERATING FLOW

(1) Warning flow

- Altermator [CN-74 (1)] -- I/conn [CN-04 (18)] -- MCU [CN-58A (64)]
- -- Cluster charge warning lamp ON

(2) Charging flow

- Alternator --- Starter [CN-45 (B⁺)] --- Battery relay [CR-01]
- Battery (+) terminal -- Charging
- Fusible link [CN-351 (40A)] → Master switch [CS-74 (1)→(2)] → I/conn [CN-01 (16, 17)]
 Fuse box [CN-36, 39]
- └─► Fusible link [CN-352 (80A)] ─► I/conn [CN-01 (21~26)] ─► Fuse box [CN-38, 39]

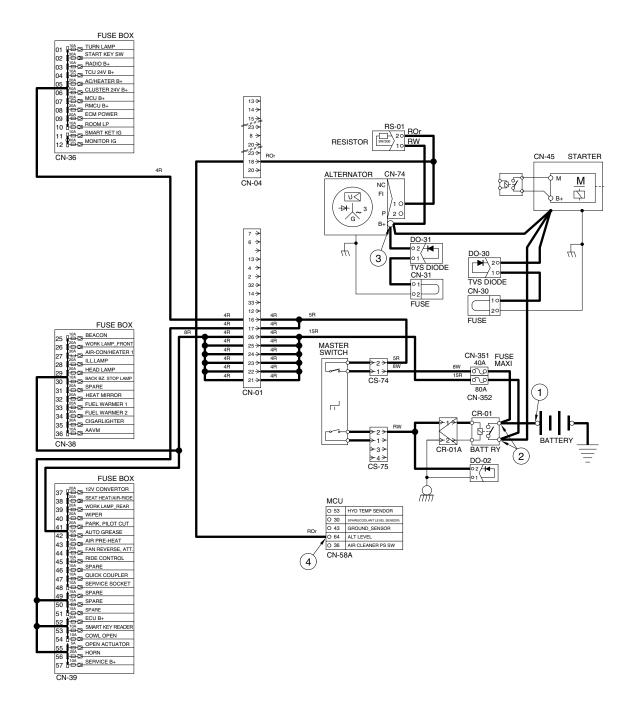
2) CHECK POINT

Engine	Key switch	Check point	Voltage
		① - GND (battery)	
OFF		② - GND (battery relay)	00,001/
	ON	③ - GND (alternator B ⁺)	20~28V
		④ - GND (MCU)	

% GND : Ground

* MCU : Machine control unit

CHARGING CIRCUIT



960SA7EL08

6. ELECTRIC PARKING, PILOT CUT OFF CIRCUIT

1) OPERATING FLOW

(1) Parking OFF

Fuse box [CN-39 (41)] → Parking switch OFF → [CS-17 (5)→(4)] → I/conn [CN-05 (14)]



--- Parking solenoid ON (activated)

--- Parking brake released (by hydraulic pressure)

→ [CS-17 (2)→(1)] → T/M control unit [CN-157 (21)]

(2) Parking ON

Fuse box [CN-39 (41)] — Parking switch ON — Parking solenoid [CN-71] OFF — Parking brake applied [By spring force]

(3) Pilot cut off ON

Fuse box [CN-39 (41)] → Pilot cut off switch ON → Pilot cut off switch [CS-4 (5)→(4)]

--- I/conn [CN-05 (11)] --- I/conn [CN-12 (12)] --- Pilot cut off solenoid ON [CN-68] (activate)

Pilot cut off released

(4) Pilot cut off OFF

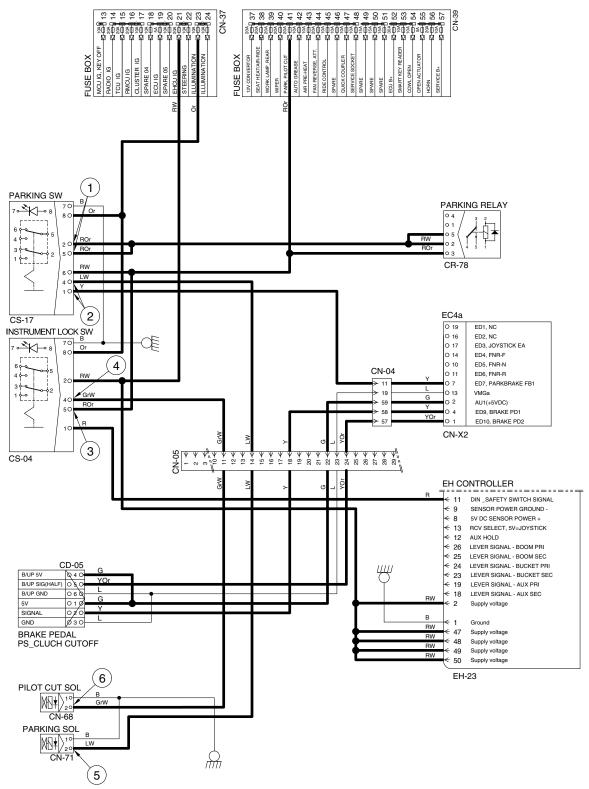
Fuse box [CN-39 (41)] — Pilot cut off switch OFF — Pilot cut off solenoid [CN-68] OFF — Pilot cut off applied

2) CHECK POINT

Engine	Key switch	Check point	Voltage
		① - GND (parking switch input)	
		2 - GND (parking switch output)	
Rupping	ON	③ - GND (pilot cut off switch input)	20~25V
Running	ON	4 - GND (pilot cut off switch output)	20~230
		⑤ - GND (parking solenoid)	
		6 - GND (pilot cut off solenoid)	

* GND : Ground

ELECTRIC PARKING, PILOT CUT OFF CIRCUIT



960SA7EL09

7. WIPER AND WASHER CIRCUIT

1) OPERATING FLOW

Fuse box [CN-39 (40)] → Wiper relay Hi [CR-4 (3)→(4)] → Front wiper motor [CN-21 (1)] → Wiper relay Lo [CR-26 (5), (2)] — Multi function switch [CS-12 (6)] Rear washer relay [CR-203 (2, 3)] Rear wiper relay [CS-25 (2, 5)] I/conn [CN-07 (5)] — Rear wiper motor [CN-203 (1)] (1) Front washer switch ON MCU [CN-58A (A39)→(B17)] → Front wiper relay Lo $[CR-26 (5) \rightarrow (3)] \longrightarrow$ Front wiper motor $[CN-21 (5)] \longrightarrow$ Wiper motor operating (low) (2) Front wiper switch ON ① INT position Wiper switch ON [CS-12 (6)→(1)] → MCU [CN-58A (A40)→(B17)] → Wiper relay Lo [CR-26 (5)→(3)] → Front wiper motor [CN-21(5)] → Front wiper motor intermittently operating 2 Lo position Wiper switch ON [CS-12 (6) \rightarrow (4)] \rightarrow Wiper relay Lo [CR-26 (4) \rightarrow (3)] \rightarrow Front wiper motor [CN-21 (5)] -- Front wiper motor operating (low) 3 Hi position Wiper switch ON [CS-12 (6) \rightarrow (3)] \rightarrow Wiper relay Hi [CR-4(3) \rightarrow (5)] \rightarrow Front wiper motor [CN-21(4)] - Front wiper motor operating (high) (3) Auto-parking (when switch OFF) Switch OFF → Fuse box [CN-39 (40)] → Wiper relay Hi [CR-4 (3)→(4)] → Front wiper motor [CN-21 (1) \rightarrow (2)] \rightarrow Multi function switch [CS-12 (5) \rightarrow (4)] \rightarrow Wiper relay Lo [CR-26 (4)→(3)] → Front wiper motor [CN-21 (5)] → Wiper motor stop (4) Rear wiper and washer switch Rear wiper switch on monitor → MCU [CN-58B (B16)] → Rear wiper relay [CR-25 (5)→(3)] → I/conn [CN-07 (8)] → Rear wiper motor [CN-203 (5)] --- Rear wiper motor operating MCU [CN-58B (B05)] → Rear washer relay [CR-203 (3)→(5)]

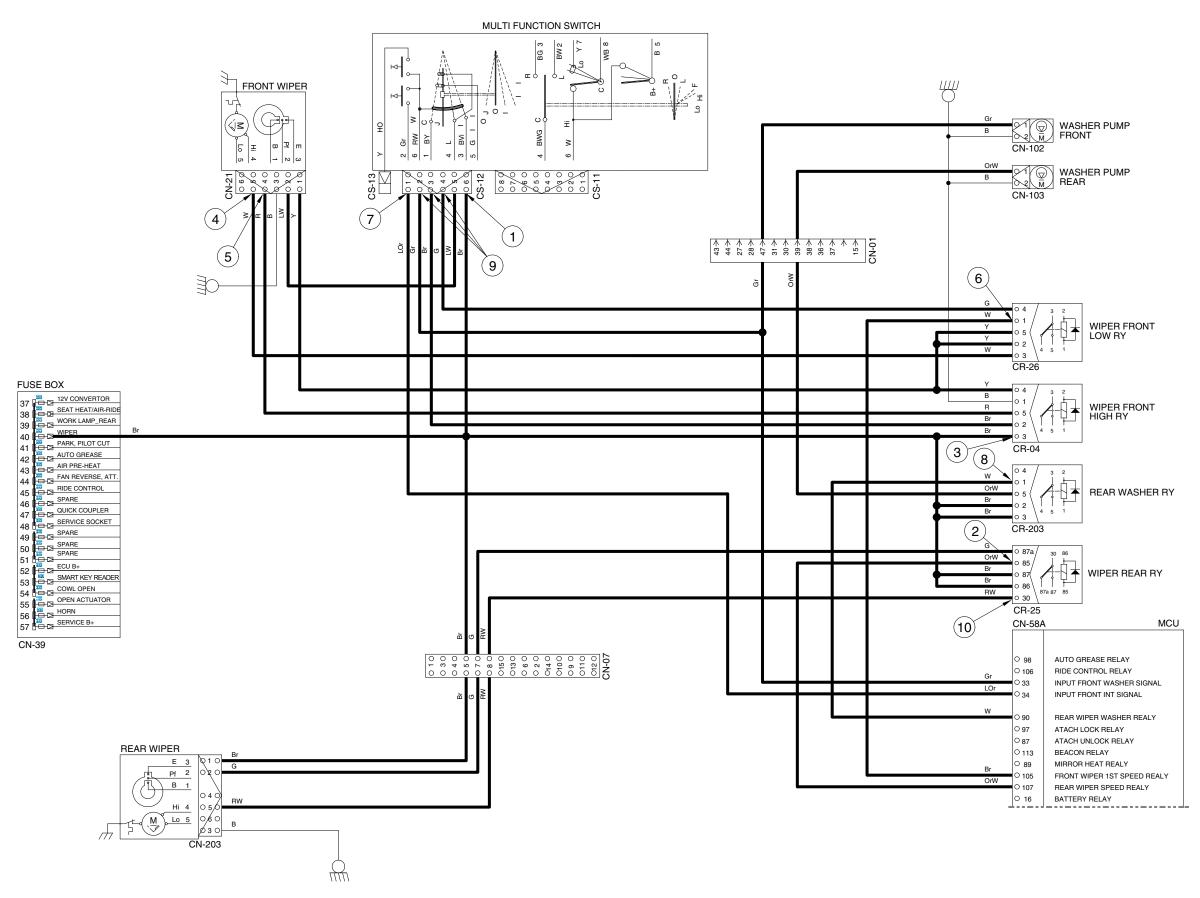
→ I/conn [CN-01 (39)] → Rear washer pump [CN-103 (1)]

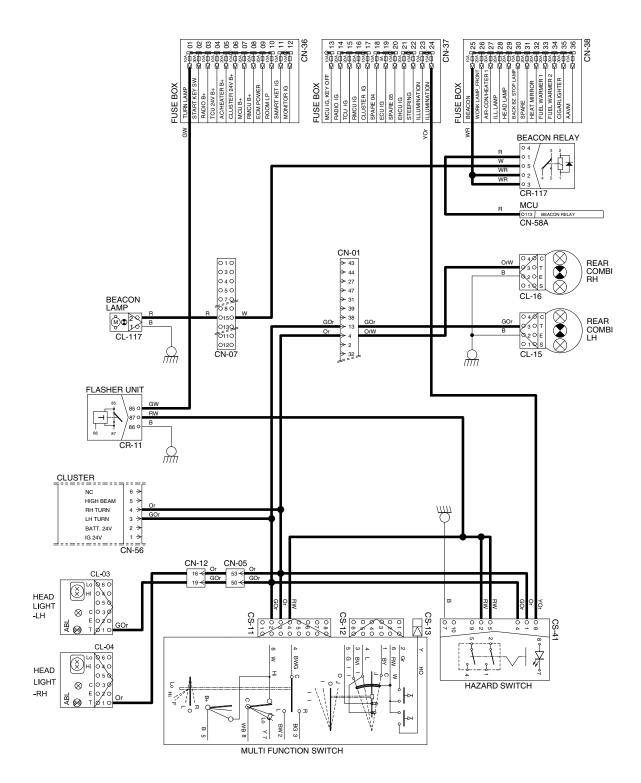
--- Washer operating

2) CHECK POINT

Condition	Check point		
	① - GND (front wiper switch power input)	6 - GND (wiper relay power input)	
Engine : Stop	2 - GND (rear wiper relay power input)	0 - GND (front washer power output)	
Key switch : ON	$\ensuremath{\Im}$ - GND (wiper relay power input)	8 - GND (rear washer power output)	
Voltage : 20~25V	4 - GND (front wiper motor Lo power input)	${\small \textcircled{9}}$ - GND (front wiper motor power output)	
	5 - GND (front wiper motor High power input)	10 - GND (rear wiper motor power output)	

% GND : Ground





960SA7EL11

GROUP 3 ELECTRICAL COMPONENT SPECIFICATION

Part name	Symbol	Specifications	Check item
Battery		12V × 150Ah (2EA)	Gravity 1.280 over : over charged 1.280 ~ 1.250 : normal 1.250 below : discharged
Battery relay	CR-1	Rated load : 24V 100A (continuity) 1000A (30seconds)	Coil resistance breaked : approx 50 Ω connected : $\infty \Omega$
Fusible link	CN-351 (40A), CN-352 (80A)	24V	Resistance between ring termi- nal and each connector pin 0 \Omega : normal
Start key	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	B-BR : 24V 1A B-ACC : 24V 10A B-ST : 20V 40A	Resistance between each pin Key off : $\infty \Omega$ (for each pin) Key on : 0Ω (for pin 1-2 & 1-3) Start : 0Ω (for pin 1-5)
Pressure switch	$\begin{array}{c c} A & \begin{array}{c} Pa \\ B & \begin{array}{c} \\ C \end{array} \end{array} \begin{array}{c} Pa \\ 0 \\ \hline \end{array} \\ \end{array}$	N.C Туре	Resistance 0Ω: normal (close)
Pressure switch	○ 1 ○ 2 Pa CD-48 CD-129	N.O Туре	Resistance $\infty \Omega$: normal (open)

Part name	Symbol	Specifications	Check item
Pilot cut off, parking brake, diff lock, attach lock, unlock solenoid	CN-68 CN-177 CN-71 CN-178 CN-79	24V 1A	Resistance normal : 15~25 Ω
Air cleaner pressure switch	Pa CD-10	Max load : 6W N.O Type	Resistance $\infty \Omega$: normal (open)
Lock-up, Ride control valve / Fan sole- noid	○ 2 ○ 1 CN-43 CN-136 CN-154 CN-155	24V 1.2A	 ※ Check LED lamp ※ Check resistance about 24 Ω
Fuel sender	010 020 CD-2	-	Resistance at fuel levels full level : 200Ω 9/12 level : 500Ω 6/12 level : 800Ω 3/12 level : 1100Ω empty : 1300Ω
Room lamp	$ \begin{array}{c c} & 3 \\ & 2 \\ & 1 \\ \end{array} $ CL-1	24V 10W	Resistance normal : 1.2Ω
Relay (5pin)	CR-3 CR-5 CR-7 CR-30 CR-35 CR-36 CR-38 CR-40 CR-46 CR-55 CR-56 CR-63 CR-210 CR-211 CR-381	24V 20A	Resistance normal : about 160 Ω (for pin 85~86) 0 Ω (for pin 30~87) ∞ Ω (for pin 30~87)

Part name	Symbol	Specifications	Check item
Relay (5 pin)	CR-2 CR-4 CR-25 CR-26 CR-37 CR-58 CR-79 CR-115 CR-117 CR-136 CR-302 CR-303	24V 20A	Resistance normal : about 160Ω (for pin 1~2) 0Ω (for pin 3~4) $\infty \Omega$ (for pin 3~5)
Hydraulic, transmission temperature	CD-1 CD-49	_	Resistance normal : $\infty \Omega$ 105. C over : 0Ω
Speaker	010 20 CN-123 (LH) CN-124 (RH)	4Ω 20W	Resistance normal : 4Ω
Switch (Locking type)	CS-4 CS-17 CS-75	24V 8A	Resistance at switch off position $\infty \Omega$ between pin 1-5 and 2-6 0Ω between pin 5-7 and 6-8
Work lamp, Number plate lamp	CL-21 CL-32 CL-33 CL-35 CL-36 CL-42 CL-43 CL-45 CL-46	Work lamp 24V 70W Number plate lamp 24V 10W	Resistance normal : 1.2 Ω
Beacon lamp	CL-117	24V 70W (H1 TYPE)	Resistance normal : 1.1 Ω

Part name	Symbol	Specifications	Check item
DC/DC Converter	* 3 7 10 12 12 12 12 12 12 12 12 12 12	12V 3A	Resistance 8.8 Ω (for pin A-B) 7.7 Ω (for pin B-C)
Horn	CN-120 CN-121	24V 2A	Operation by external power source - conncet 24V power to (+) terminal - ground the (-) terminal
Receiver dryer	20 PA 10-0-0- CN-29	24V 2.5A	Resistance 0Ω : 2.1 \pm 0.3~27 \pm 2kgf/cm ² $\infty \Omega$: ~2.1 \pm 0.3, 27 \pm 2~kgf/cm ²
Radio & USB player	CN-52	24V 20W+20W	Resistance Power ON : 4Ω+4Ω (for pin 1-6, 4-8)
Back up buzzer	CN-65	24V 0.5A 110dB	Resistance normal : 5.2Ω
Washer pump	M 20 CN-102 (FR) CN-103 (RR)	24V 2.5A	Resistance normal : 26.4 ଯ (for pin1-2)

Part name	Symbol	Specifications	Check item
Wiper motor	E 3 PF 2 PF 2 B 1 Hi 4 So So So So So So So So So So So So So	24V 1.5A 2-speed Auto parking	-
Cigar lighter	CL-2	24V 5A 1.4W	Coil resistance normal : about 1MΩ
Alternator	CN-74	24V 70A	Voltage normal : 24~28V
Starter	M B+ CN-45	24V-4.8kW	Operating or not
Aircon compressor	CN-28	24V 79W	Resistance normal : 13.4Ω
Start relay	CR-23	24V 300A	Coil resistance normal : $1-2\Omega$ Switch connection $\infty \Omega$ at normal open position 0Ω when engaged

Part name	Symbol	Specifications	Check item
Blower motor		24V 9.5A	Resistance at each switch posi- tion normal : 0.5-2 Ω
Door switch	CS-1 CS-55	24V 2W	Resistance normal : about 5MΩ
Flasher unit	B5 0 B7 0 B6 0 CR-11	24V 85 ~ 190 C/M 50dB	-
Head lamp	$\begin{array}{c c} & 6 & \downarrow L_0 \\ & 4 & 0 & H_1 \\ & 5 & 5 \\ & 5 & 5 \\ & 3 & 0 \\ & 3 & 0 \\ & 3 & 0 \\ & 3 & 0 \\ & 0 & 0 \\ & 0 \\ & 0 \\ & 0 \\ & 1 \\ & T \\ \hline \end{array} \xrightarrow{H}_{evel}$ $\begin{array}{c} & \\ & \\ & \\ & \\ & \\ & \\ & \\ & \\ & \\ & $	24V 75W/70W (H4 TYPE) 24V 4W (T4W)	Resistance normal : a few Ω
Combi lamp (rear)	$ \begin{array}{c} \circ 4 \otimes C \\ \circ 3 \circ T \\ \circ 2 \circ E \\ \circ 1 \otimes S \end{array} $ CL-15 CL-16	24V 5W (R5W) 2×24V 21W (P21W)	-
Master switch	CS-74 CS-75	Continuous capaci- ty : 180Amp Push in capacity : 1000Amp	-

Part name	Symbol	Specifications	Check item
Warning buzzer	020 00 CN-26	24V 200mA 90±5dB (ℓm)	-
Preheater	CN-80	24V 200A	Resistance 0.25~0.12 Ω
Resistor	$ \begin{array}{c c} $	4W	Resistance A - B : 120 Ω

GROUP 4 CONNECTORS

1. CONNECTOR DESTINATION

Connector	Туре	No. of	Destination	Connecto	or part No.
number	nber pin Destination	Female	Male		
CN-1	DEUTSCH	48	I/conn (Frame harness-Main harness)	DRB16-48SAE-L018	DRB12-48PAE-L018
CN-2	DEUTSCH	60	I/conn (Front harness-Main harness)	DRB12-60SBE-L018	DRB12-60PBE-L018
CN-4	DEUTSCH	60	I/conn (Engine harness-Main harness)	DRB16-60SAE-L018	DRB12-60PAE-L018
CN-5	DEUTSCH	60	I/conn (Bottom harness-Main harness)	DRB16-60SBE-L018	DRB12-60PBE-L018
CN-7	AMP	15	I/conn (Main harness-Cab harness)	2-85262-1	368301-1
CN-9	AMP	6	I/conn (Main harness-Cab harness)	174264-2	174262-2
CN-11	AMP	15	I/conn (Main harness-Aircon harness)	HDP26-24-35SN	HDP24-24-35PN
CN-12	DEUTSCH	35	I/conn (Front harness-Bottom harness)	2-85262-1	368301-1
CN-14	DEUTSCH	12	I/conn (Frame harness-Grill harness)	DT06-12S	DT04-12P
CN-15	KET	11	I/conn (RH console harness-Main harness)	MG651350	MG641353
CN-16	KET	14	I/conn (RH console harness-Main harness)	MG651110	MG641113
CN-18	DEUTSCH	12	LH seat console	DT06-12S	DT04-12P
CN-19	DEUTSCH	2	I/conn (Emer steer harness-Bottom harness)	DT04-2S	DT04-2P
CN-21	AMP	6	Front wiper motor	936257-1	-
CN-22	DEUTSCH	2	Compressor	DTP06-2S	
CN-24	DEUTSCH	12	Grill harness	DT06-12S	-
CN-26	TYCO	10	EHI unit	174655-2	174657-2
CN-26A	AMP	10	Joystick steering	-	174657-2
CN-27	MK II	16	Radio and USB player	PK145-16017	-
CN-27A	MK II	8	USB connector	174984-2	-
CN-31	DEUTSCH	3	Brake priority	DT06-3S	-
CN-36~39	-	-	Fuse box	21WB-16031	-
CN-43	AMP	2	Lock-up	282028	-
CN-45	Ring term	-	Starter	R14-12	ST 710246-2
CN-48	AMP	1	Hour meter	2-520193-2	-
CN-51	AMP	34	MCU	4-1437290-1	-
CN-52	AMP	34	MCU	2-1437285-3	-
CN-53	AMP	26	MCU	1473416-1	
CN-54	AMP	34	MCU	4-1437290-1	
CN-56	KUM	16	Cluster	KPK145-16017	-
CN-57	AMP	20	Monitor	174047-2	-
CN-64	MOLEX	4	Smart key	39012040	-
CN-65	DEUTSCH	2	Back up buzzer	DT06-2S	-
CN-68	DEUTSCH	2	Pilot cut off	DT06-2S	-
CN-71	DEUTSCH	2	Parking solenoid	DT06-2S	-
CN-72	DEUTSCH	2	Cowl open activator	DT06-2S	-

Connector	Туре	No. of	Destination	Connecto	or part No.
number	1300	pin		Female	Male
CN-74	PACKARD	4	Alternator	1218-6568	-
CN-79	DEUTSCH	2	Differential lock solenoid	DT06-2S	-
CN-79A	DEUTSCH	2	Differential lock solenoid	DT06-2S	DT04-2D-E005
CN-93	DEUTSCH	50	ECM (engine control module)	DRC26-505-04	-
CN-94	DEUTSCH	4	ECM power	DT06-4S	-
CN-101,101	DEUTSCH	3	Boom kick out, Bucket leveler	DT06-3S	-
CN-102	KET	2	Front washer tank	MG640605	-
CN-103	KET	2	Rear washer tank	MG640605	-
CN-112	-	16	Gear box	21L7-60290	-
CN-115	DEUTSCH	6	Auto grease	DT06-6S	DT04-6P
CN-120,121	DEUTSCH	2	Horn	DT06-2S	-
CN-122	DEUTSCH	9	Machine service tool	HD10-9-96P	-
CN-123	KET	2	Speaker (LH)	7123-1520	-
CN-124	KET	2	Speaker (RH)	7123-1520	-
CN-125	DEUTSCH	12	RMCU(remote management control unit)	DT06-12S	DT04-12P
CN-126	DEUTSCH	9	Engine service tool	HD10-9-96P	-
CN-128	NMWP	1	Aircon compressor	PB625-01027	-
CN-129	KET	2	Receiver drier	MG640795	-
CN-134	DEUTSCH	9	Diagnostic (TCU)	HD10-9-96P	-
CN-136	DEUTSCH	2	Ride control solenoid	DT06-2	-
CN-136A	Econoseal J	2	I/conn (Ride control harness-Front harness)	S816-002002	S816-102002
CN-137	AMP	1	12V socket	172434-2	-
CN-138	AMP	12	DC/DC Converter	1-967622-1	-
CN-139	AMP	2	12V socket	172434-2	-
CN-149	DEUTSCH	2	Mirror heat (LH)	DT06-2S	DT04-2P
CN-150	DEUTSCH	2	Mirror heat (RH)	DT06-2S	DT04-2P
CN-152	AMP	4	Proportional valve	2-967059-1	-
CN-154	DEUTSCH	2	Fan speed solenoid	DT06-2S	-
CN-155	DEUTSCH	2	Fan reverse solenoid	DT06-2S	-
CN-156	DEUTSCH	2	Seat heat (with switch)	-	DT04-2P-E005
CN-157	AMP	68	T/M control unit	963598-1	-
CN-158	PACKARD	4	Gear shift lever	1201-0974	-
CN-159A	DEUTSCH	12	Gear shift lever	DT06-12S	-
CN-160	CARLING	12	FNR joystick lever	LC3-01	-
CN-162	AMP	6	Pedal	174262-2	-
CN-163	AMP	2	ECO feeling switch	174352-2	-
CN-171	AMP	1	Service socket	172434-2	-
CN-177	DEUTSCH	2	Quick coupler unlock solenoid	DT06-2S	-

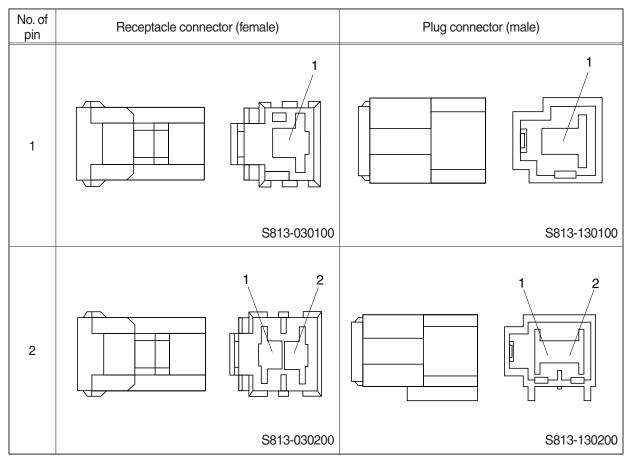
Connector	Turco	No. of	Destination	Connecto	or part No.
number	Туре	pin	Destination	Female	Male
CN-177A	Econoseal J	3	I/conn (Front harness-Quick coupler harness)	S816-003002	S816-103002
CN-178	DEUTSCH	2	Quick coupler lock solenoid	DT06-2S	-
CN-196	PACKARD	4	Fuel heater	2-967325-3	-
CN-203	AMP	6	Rear wiper motor	936257-1	-
CN-246	KET	1	PTC power	-	MG620659-5
CN-249	DEUTSCH	6	Camera	DT06-4S	DT04-6P
CN-250	DEUTSCH	2	Seat belt alarm	DT06-2S-EP06	-
CN-252	TYCO	6	Differential lock	S816-006602	S816-106602
CN-313	DEUTSCH	6	AAVM monitor service tool	DT06-4S-EP06	DT06-4S-EP06
CN-399	AMP	4	DEF sensor	1-967325-1	-
CN-431	KET	20	AAVM monitor	MG635026	-
CN-437	DEUTSCH	2	Back pressure solenoid	DT06-3S-EP06	-
CN-X30	TYCO	6	TCU (transmission control unit)	1-1418469-1	-
CN-X2	TYCO	21	TCU (transmission control unit)	3-1534127-1	-
Relay					
CR-1	Ring term	-	Battery relay	S820-104002	-
CR-2	AMP	5	Horn relay	VCFM-1002	-
CR-3	AMP	5	Front work lamp relay	VCFM-1002	-
CR-4	AMP	5	Wiper relay (Hi)	VCFM-1002	-
CR-5	HELLA	5	Safety relay	8JA003526-001	-
CR-7	AMP	5	Aircon relay	VCFM-1002	-
CR-11	250	-	Flasher unit	S810-003702	-
CR-23	Ring term	-	Start relay	ST 710289-2	ST 710384-2
CR-24	Shur	1	Preheater relay	S822-014000	-
CR-25	AMP	5	Rear wiper relay	VCFM-1002	-
CR-26	AMP	5	Wiper relay (low)	VCFM-1002	-
CR-30	HELLA	5	ECM power relay	8JA003526-001	-
CR-36	AMP	5	Preheater relay	VCFM-1002	-
CR-39	-	2	Emergency steering pump relay	S820-104000	-
CR-40	KET	5	EHCU power relay	MG610047-1	-
CR-46	HELLA	5	Fuel warmer relay	8JA003526-001	-
CR-55	AMP	5	Rear work lamp relay	VCFM-1002	-
CR-56	KET	5	Mirror heat relay	MG610047-1	-
CR-58	AMP	5	Back up relay	VCFM-1002	-
CR-63	AMP	5	Stop lamp relay	VCFM-1002	-

Connector	Turce	No. of	Destination	Connecto	r part No.		
number	Туре	pin	Destination	Female	Male		
Switch	Switch						
CS-1	AMP	1	Door switch	ST730018-3	-		
CS-2	KET	6	Start key switch	MG610335-5	-		
CS-4	CARLING	10	Pilot cut off switch	VC2-01	-		
CS-11	KET	8	Multi function switch	MG610339-5	-		
CS-12	KET	6	Multi function switch	MG610339-5	-		
CS-13	KET	1	Multi function switch	ST730018-3	-		
CS-17	CARLING	10	Parking switch	VC2-01	-		
CS-33	AMP	6	Engine stop switch	174262-2	-		
CS-41	CARLING	10	Hazard switch	VC2-01	-		
CS-74	DEUTSCH	2	Master switch	DT06-2S	-		
CS-75	CARLING	10	Emergency steering test switch	VC2-01	-		
CS-79	CARLING	10	Differential lock switch	VC2-01	-		
CS-85, 85L	KET	2	Workload switch	MG610070	MG620074		
CS-86, 86L	KET	2	Kick down switch	MG610070	MG620074		
CS-87, 87L	KET	2	Horn switch	MG610070	MG620074		
CS-88, 88L	KET	2	FNR select switch	MG610070	MG620074		
CS-105	CARLING	10	SCR switch	VC2-01	-		
Light							
CL-1	KET	3	Room lamp	MG651032	-		
CL-3	DEUTSCH	6	Head light (LH)	DT06-6S-EP06	-		
CL-4	DEUTSCH	6	Head light (RH)	DT06-6S-EP06	-		
CL-15	YAZAKI	4	Combi lamp (RR, LH)	7232-7444	-		
CL-16	YAZAKI	4	Combi lamp (RR, RH)	7232-7444	-		
CL-21	SWP	2	Number plate lamp	S814-002000	-		
CL-22	DEUTSCH	2	Work light (LH)	DT06-2S	-		
CL-23	DEUTSCH	2	Work light (RH)	DT06-2S	-		
CL-32	DEUTSCH	2	Rear work light (RH)	DT06-2S	DT04-2P		
CL-33	DEUTSCH	2	Rear work light (LH)	DT06-2S	DT04-2P		
CL-42	DEUTSCH	2	Rear work light (opt)	DT06-2S	DT04-2P		
CL-45	DEUTSCH	2	Work light (RH)	DT06-2S-EP06	-		
CL-46	DEUTSCH	2	Work light (LH)	DT06-2S-EP06	-		
CL-117	AMP	2	Beacon lamp	174198-2	-		

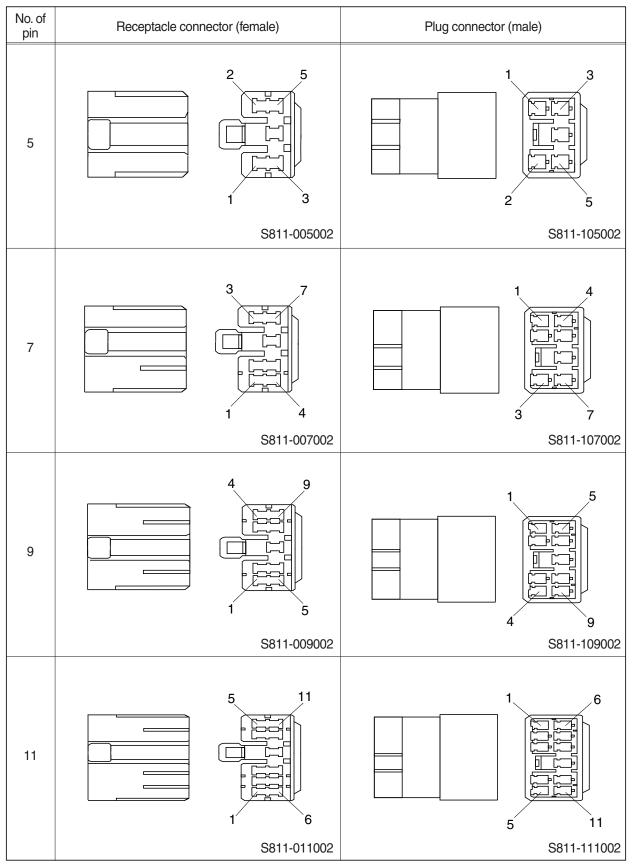
Connector	Turne	No. of	Destination	Connector part No.				
number	Туре	pin		Female	Male			
Sensor, se	Sensor, sender							
CD-1	AMP	2	Hyduaulic oil temp sendor	85202-1	-			
CD-2	YAZAKI	2	Fuel sendor	7123-7424	-			
CD-3	DEUTSCH	3	Brake fail pressure switch	DT06-3S	-			
CD-4	DEUTSCH	3	Stop lamp pressure switch	DT06-3S	-			
CD-5	PACKARD	3	Clutch cut off pressure switch	-	1215793			
CD-10	AMP	2	Air cleaner switch	85202-1	-			
CD-17	AMP	2	Engine pick-up sensor	85202-1	-			
CD-26	DEUTSCH	3	Parking pressure switch	DT06-3S	-			
CD-27	AMP	2	Turbin pick up sensor	85202-1	-			
CD-31	DEUTSCH	3	Brake priority pressure switch	DT06-3S	-			
CD-39	DEUTSCH	3	Main pump pressure switch	DT06-3S	-			
CD-40	DEUTSCH	3	Steering pump pressure switch	DT06-3S	-			
CD-43	AMP	2	Lock up proportional valve	282027	-			
CD-45	DEUTSCH	2	WIF sensor	DT06-2S-EP06	-			
CD-46	AMP	3	Output speed sensor	282087	-			
CD-47	AMP	2	Gear chain sensor	85202-5	-			
CD-48	AMP	2	Oil filter restriction sensor	282080	-			
CD-49	AMP	2	Converter temp sensor	85202-1	-			
CD-73	AMP	2	Speed sendsor	174352-2	-			
CD-79	DEUTSCH	3	Diff lock feed back sensor	DT06-3S	-			
CD-80	DEUTSCH	3	Boom positioner sensor	DT06-3S	-			
CD-81	DEUTSCH	3	Bucket positioner sensor	DT06-3S	-			
CD-96	PACKARD	3	Coolant level sensor	12110293	-			
CD-101	SUMITOMO	4	TBAP sensor	6098-0144	-			

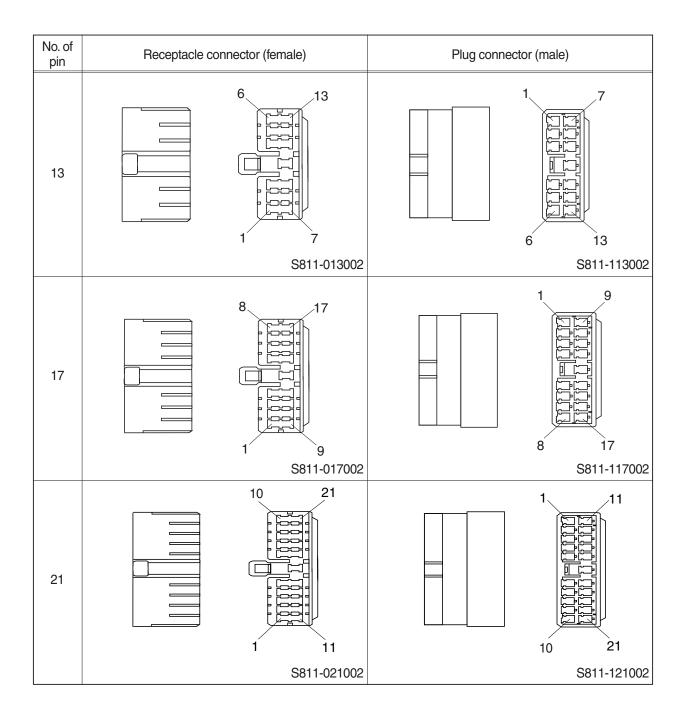
2. CONNECTION TABLE FOR CONNECTORS

1) 58-L TYPE CONNECTOR

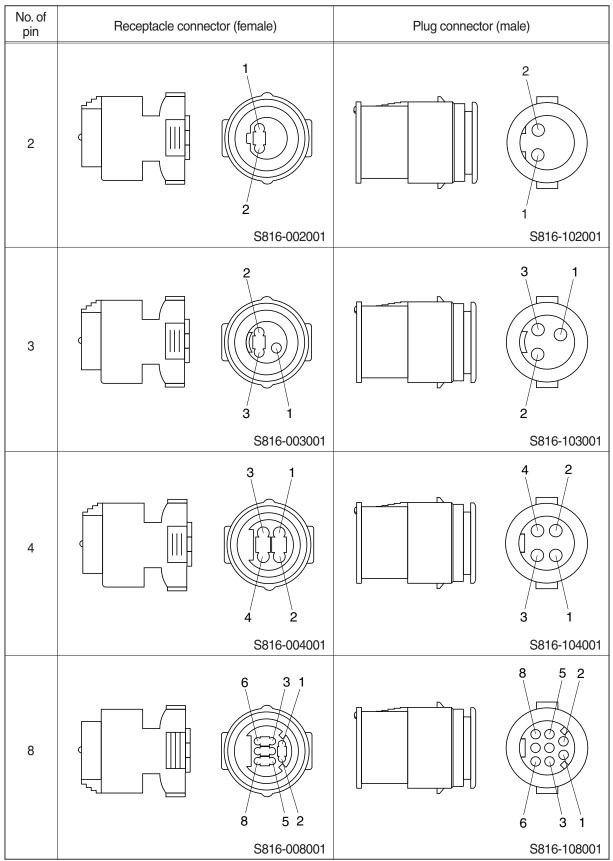


2) PA TYPE CONNECTOR

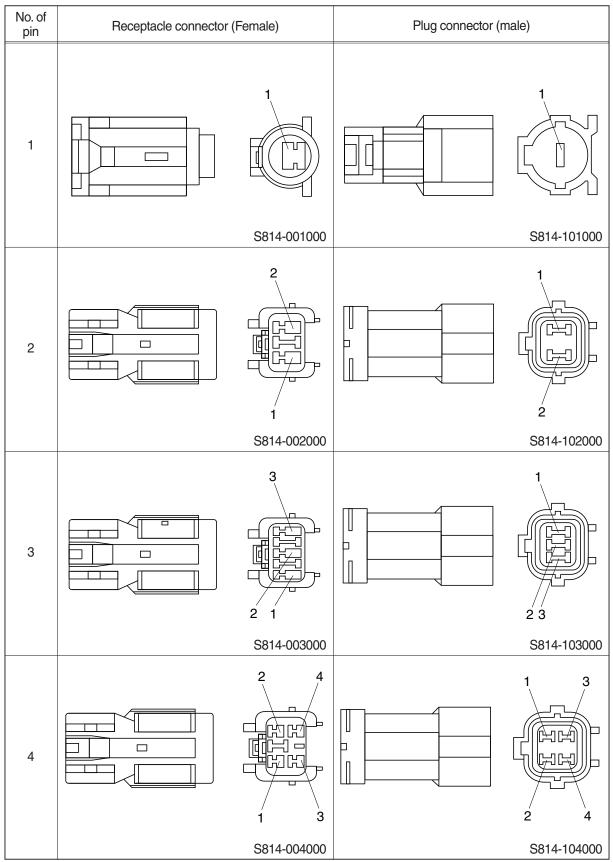


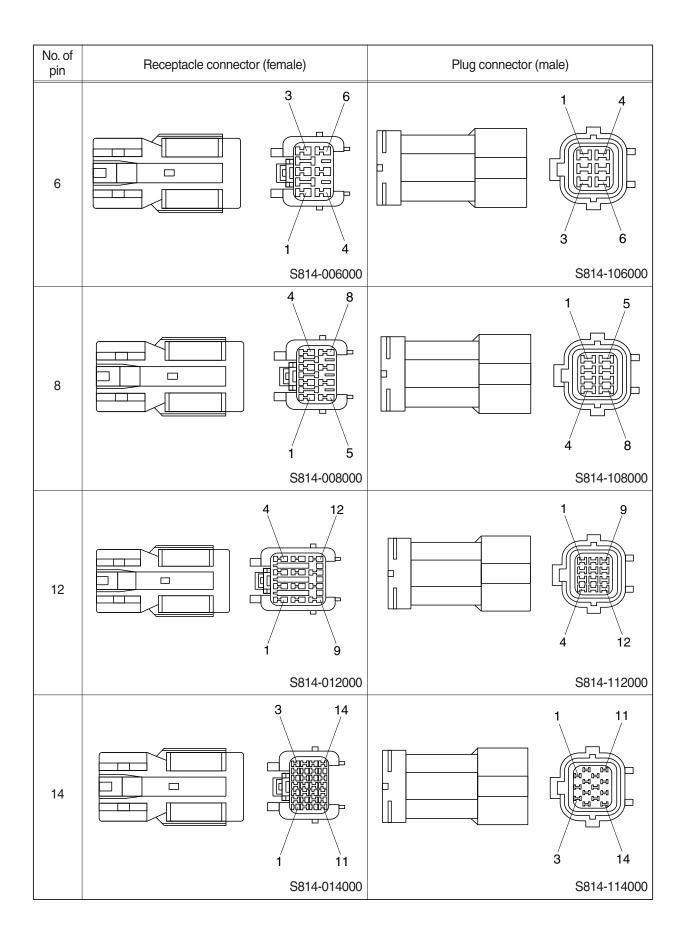


3) J TYPE CONNECTOR

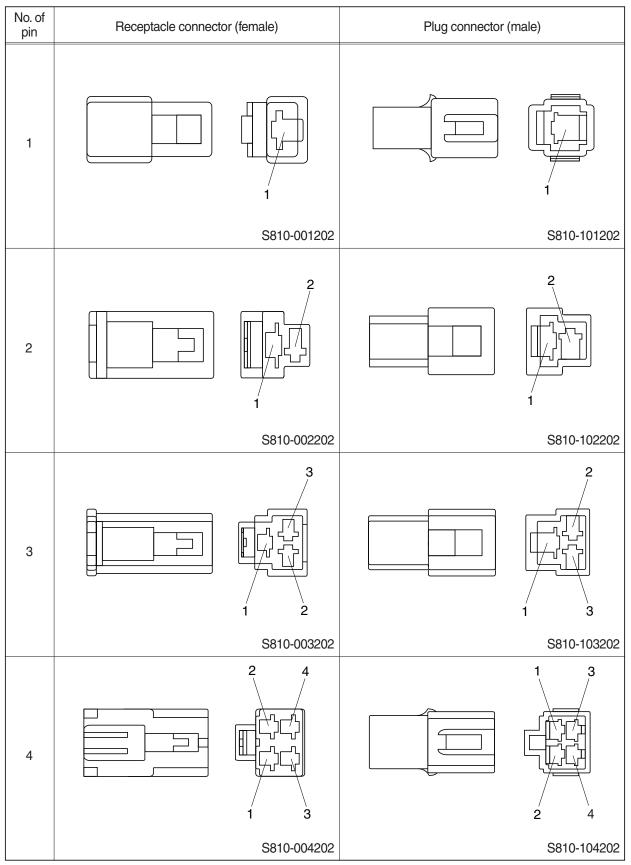


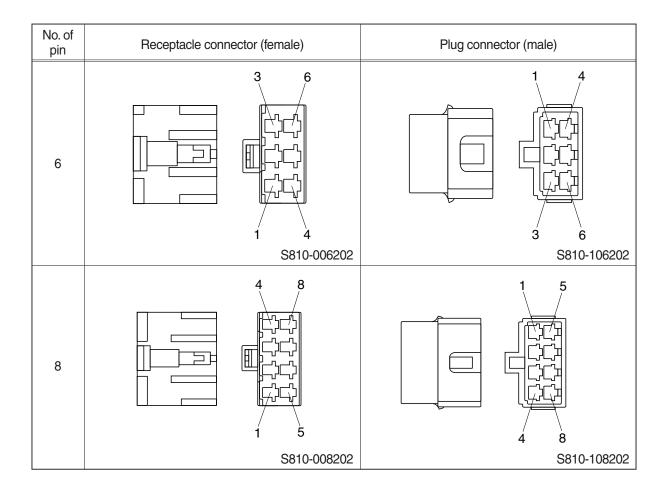
4) SWP TYPE CONNECTOR





5) CN TYPE CONNECTOR

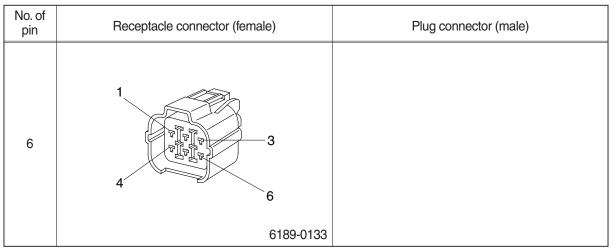




6) ITT SWF CONNECTOR

No. of pin	Receptacle connector (female)	Plug connector (male)
10	2 1 1 1 1 1 1 1 1 2 12 12 5WF589790	
	SWI 509790	

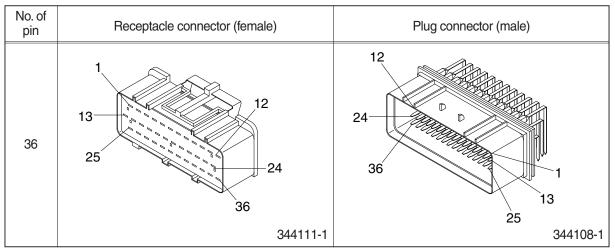
7) HW090 SEALED CONNECTOR



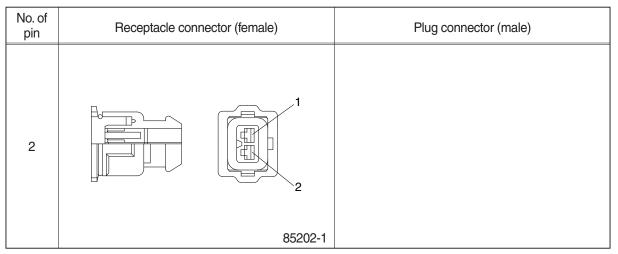
8) MWP02F-B CONNECTOR

No. of pin	Receptacle connector (female)	Plug connector (male)
2	1 2	
	PH805-02028	

9) AMP ECONOSEAL CONNECTOR



10) AMP TIMER CONNECTOR



11) AMP 040 MULTILOCK CONNECTOR

No. of pin	Receptacle connector (female)	Plug connector (male)
12	1 6 +++++ 12	
	174045-2	

12) KET 090 WP CONNECTORS

No. of pin	Receptacle connector (female)	Plug connector (male)
2		
	MG640795	

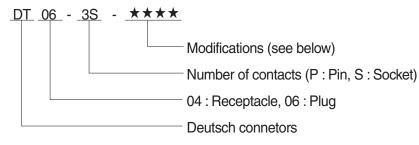
13) ITT SWF CONNECTOR

No. of pin	Receptacle connector (female)	Plug connector (male)
10		
	SWF593757	

14) MWP NMWP CONNECTOR

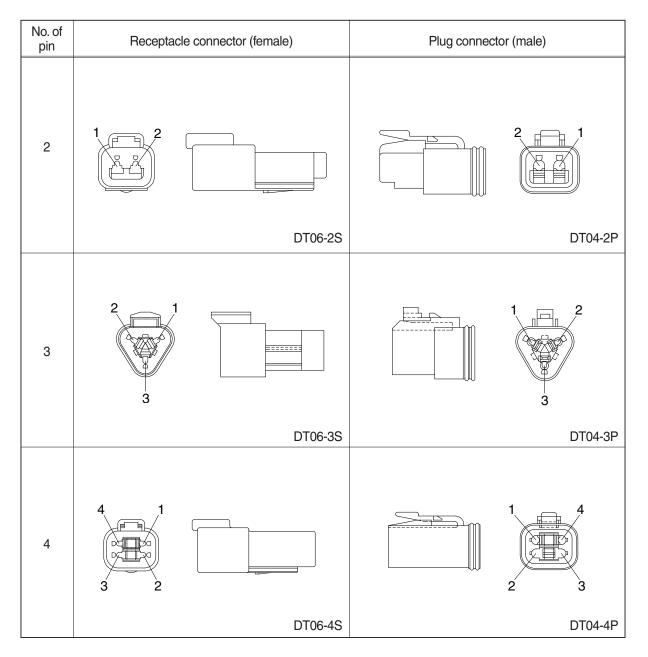
No. of pin	Receptacle connector (female)	Plug connector (male)
1	1	
	NMWP01F-B	

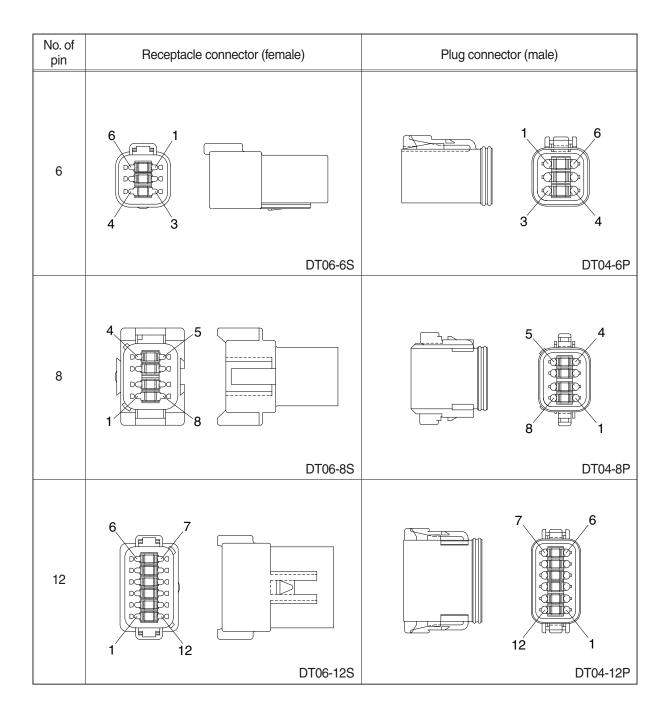
15) DEUTSCH DT CONNECTORS



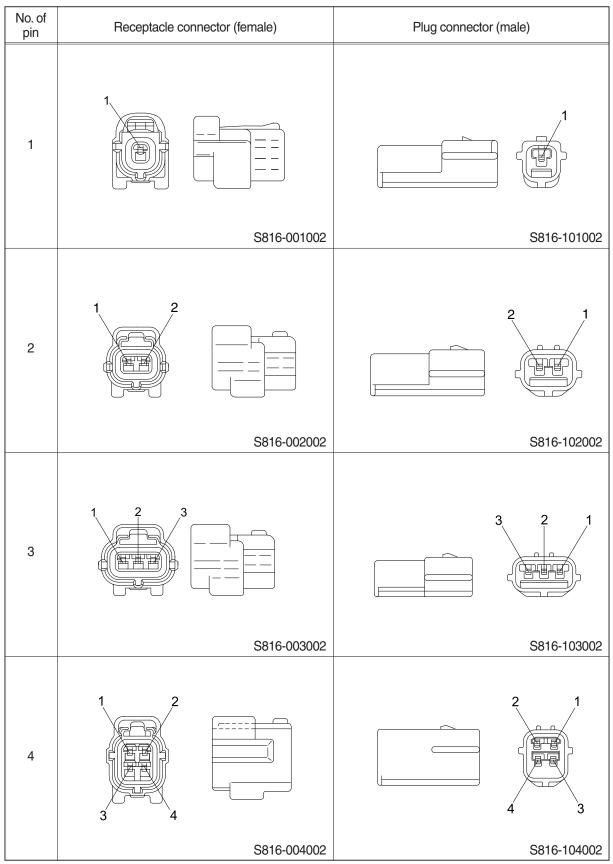
- Modification
 - E003 : Standard end cap gray
 - E004 : Color of connector to be black
 - E005 : Combination E004 & E003
 - EP04 : End cap
 - EP06 : Combination P012 & EP04

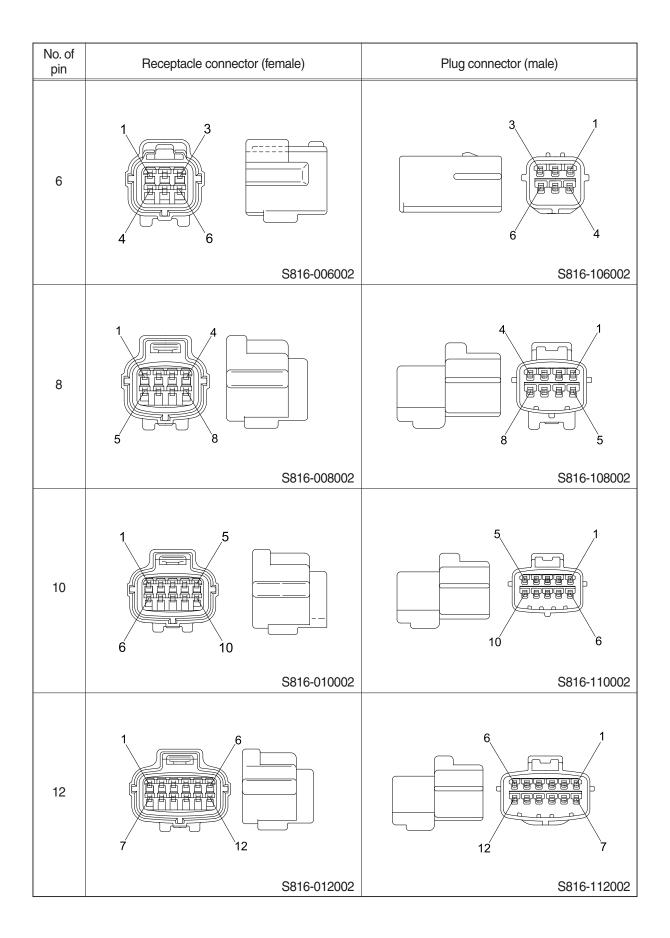
P012 : Front seal enhancement - connectors color to black for 2, 3, 4 & 6pin

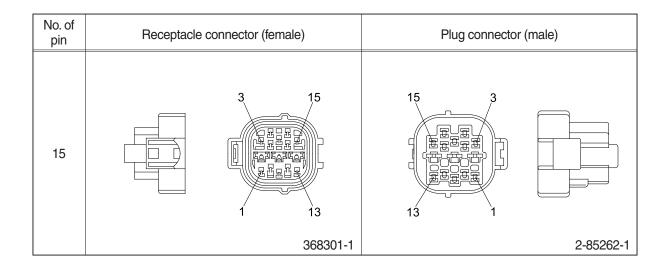




16) ECONOSEAL J TYPE CONNECTORS



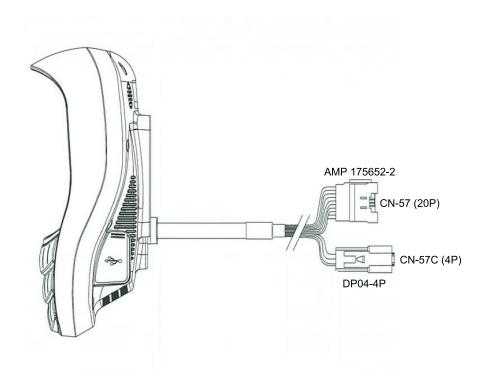




17) METRI-PACK TYPE CONNECTOR

No. of pin	Receptacle connector (female)	Plug connector (male)
2		
	12040753	

18) MONITOR CONNECTOR (21WD-11400)

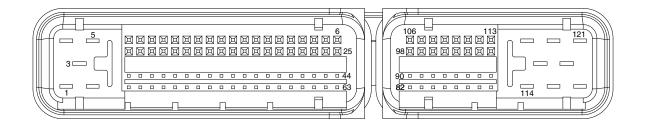


		RT NO.	: AMP 175652-2
NO	PIN NAME	NO	PIN NAME
1	IG 24V	11	GND
2	BATTERY 24V	12	GND
3	BATTERY 24V	13	N.C
4	CAMERA CH1 (SINGLE)	14	CAN2 L
5	CAMERA CH3 DIFF-	15	CAN2 H
6	CAMERA VCC (8V OUTPUT)	16	CAN2 SHIELD
7	N.C	17	CAMERA SHIELD
8	N.C	18	N.C
9	CAMERA CH2 DIFF-(OPTIONAL)	19	N.C
10	CAMERA CH2 DIFF+(OPTIONAL)	20	CAMERA CH3 DIFF+

	A CEPIED 3 PART N	0. : DT04	- 4 P
_		Luis	
NO	PIN NAME	NO	PIN NAME
NO 1	PIN NAME CAM VCC (8V OUTPUT)	<u>NO</u> 3	CAM CH3 DIFF+

19) MCU

CN-58A



011 00/1			
		O 61	CAN2 LOW
013	REVERSE DRIVE RELAY	0 60	CAN2 HI
0 98	AUTO GREASE RELAY		
O 106	RIDE CONTROL RELAY	O B21	SPARE_ECO FEELING SIGNAL
0 33	INPUT FRONT WASHER SIGNAL	0 12	ILLUMINATION LIGHT RELAY
O 34	INPUT FRONT INT SIGNAL	0 11	DRIVING LIGHT RELAY
		0 88	WORK LAMP FRONT
0 90	REAR WIPER WASHER REALY	0 44	WORK LAMP REAR
O 97	ATACH LOCK RELAY	0 82	FUEL WARMER RELAY
0 87	ATACH UNLOCK RELAY	0 32	AIRCON RUN SIGNAL
O 113	BEACON RELAY	0 83	AC COMP. OFF SIG_REVERSE FAN
0 89	MIRROR HEAT REALY	0	_
O 105	FRONT WIPER 1ST SPEED REALY	0 78	BOOM POSITION SENSOR
O 107	REAR WIPER SPEED REALY	0 66	BUCKET POSITION SENSOR
		0 24	REF. POWER +5V
		01	POWER IG(+24V)
		03	BATTERY POWER(+24V)
		04	BATTERY POWER(+24V)
O 16	BATTERY RELAY	04	BATTERT FOWER(+24V)
		06	DETENT CONTROL SOL_BUCKET
		0 45	DETENT CONTROL SOL_BOOM UP
		0 51	COUNT_WEIGHT_SET SWITCH
02	GND(MAIN)	0 29	AUTO GREASE LAMP(GREEN)
O 116	GND(MAIN)	0 28	AUTO GREASE LAMP(RED)
0 72	ELEC. STEER MAIN PUMP PS		
O 75	ELEC. STEER PUMP PS	0 26	DIFF, LOCK AUTO
O B21	SPARE	0 27	DIFF. LOCK MANUAL
		0 15	HOUR METER_HIGH
		O A07	SPARE 5V+
O 31	SPARE	O B40	SPARE_PEDAL POSITION2
O 35	NEUTRAL SIGNAL(24V)	O A09	SPARE PEDAL POSITION2 RETURN
07	ANTI-RESTART RELAY	0 48	SEAT BELT WARNING
O 63	ELEC. STEERING PUMP RELAY	0 40	SPARE 5V+
0 57	CAN(1)-H	O B39	SPARE PEDAL POSITION1
O 58	CAN(1)-L	O A08	SPARE_PEDAL POSITION1
O 55	CAN_SHIELD(GROUND)	0 408 0 42	PROGRAM DUMP
0 77	BRAKE OIL LOW PS	0 42	RS-232(1) RX
071	PARKING OIL LOW PS	0 93	
0 76	BRAKE PRIORITY_PR SIGNAL	0 92	RS-232(1) TX SPARE RS-232 GND
0 73	BOOM ROD PR SNENSOR		SPARE_RS-232 GND
0 68	BOOM HEAD PR SNENSOR	O A22	
		O A32	SPARE
0 74	DIFFERTIAL LOCK PR SIGNAL	O 10	SPARE
05	+24V PRESSURE SENSOR POWER		
O 50	AXLE OIL TEMP (FRONT)		
0 49	AXLE OIL TEMP(REAR)		
0 52	FUEL LEVEL SENSOR		
O 53	HYD TEMP SENDER		
O 30	SPARE(COOLANT LEVEL SENSOR)		
0 43	GROUND_SENSOR		
0 64	ALT LEVEL		
0 36	AIR CLEANER PRESSURE SW		
0 118	COOLING FAN EPPR-		
1	1	1	

C 118 OOLING FAN EPPR-0 117 COOLING FAN EPPR+

08 REVERSE FAN CONTROL

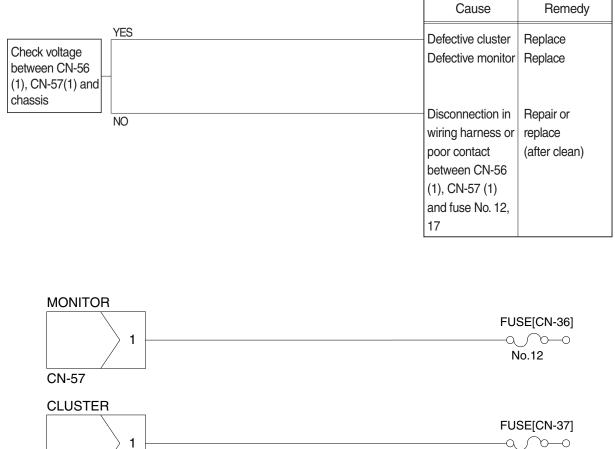
- 0 102 TACHO SENSOR(+)_REMOTE FAN 0 101
 - TACHO SENSOR(-)_REMOTE FAN

7-51

GROUP 5 TROUBLESHOOTING

1. WHEN STARTING SWITCH IS TURNED ON, CLUSTER AND MONITOR LAMP DOES NOT LIGHT UP

- Before carrying out below procedure, check all the related connectors are properly inserted and the fuse No.12, 17 are not blown out and ON/OFF of bulb.
- · After checking, connect the disconnected connectors again immediately unless otherwise specified.



o_____ No.17

960A7EL24

Check voltage

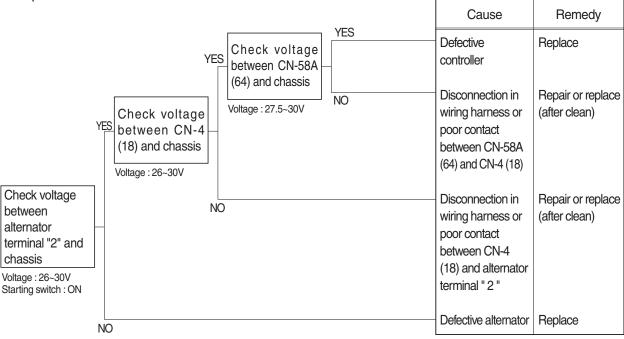
CN-56

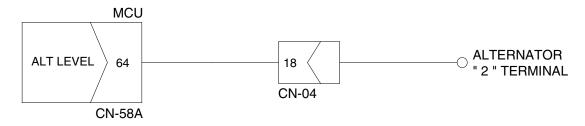
YES	20 ~ 30 V
NO	0 V

2. **WHEN BATTERY LAMP LIGHTS UP** (engine is started)

· Before carrying out below procedure, check all the related connectors are properly inserted.

· After checking, connect the disconnected connectors again immediately unless otherwise specified.





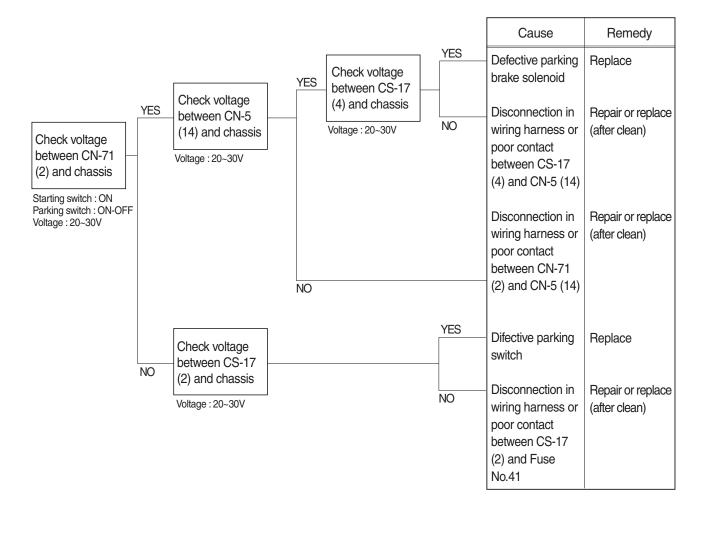
960SA7EL38

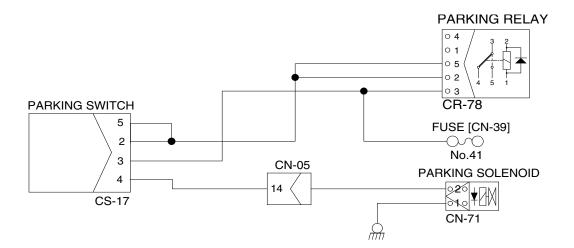
Check valtage

YES	20 ~ 30 V
NO	0 V

3. WHEN PARKING SOLENOID DOES NOT WORK

- Before carrying out below procedure, check all the related connectors are properly inserted and the fuse No.41 is not blown out.
- · After checking, connect the disconnected connectors again immediately unless otherwise specified.

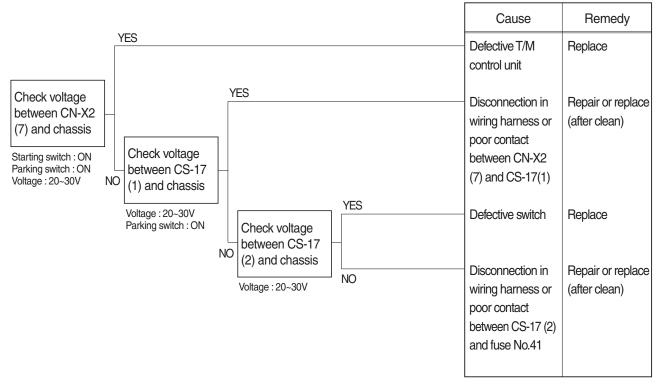


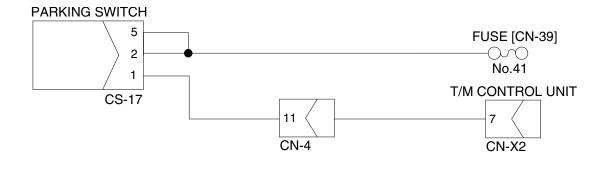


960SA7EL39

4. TRANSMISSION IS NOT RETURNED TO NEUTRAL WHEN PARKING BRAKE IS APPLIED

- Before carrying out below procedure, check all the related connectors are properly inserted and the fuse No.15 (transmission control unit) and No.41 are not blown out.
- · After checking, connect the disconnected connectors again immediately unless otherwise specified.





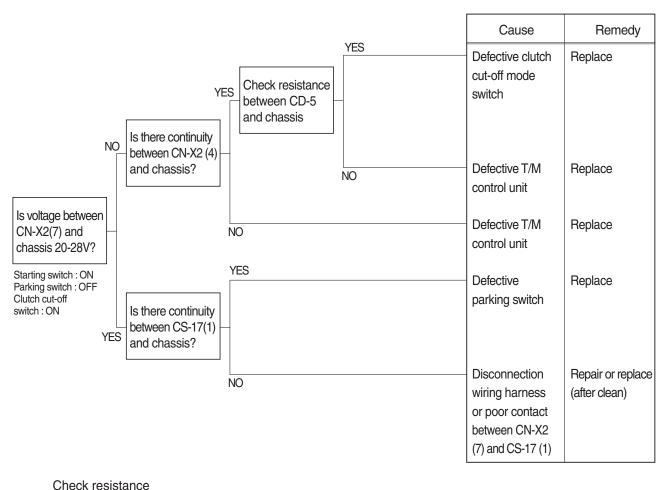
960SA7EL40

Check resistance

YES	MAX 1 Ω
NO	MIN 1MΩ

5. MACHINE DOES NOT TRAVEL

- Before carrying out below procedure, check all the related connectors are properly inserted and the fuse No.15 (transmission control unit) is not blown out.
- · After checking, connect the disconnected connectors again immediately unless otherwise specified.
- · Wiring diagram : See page 7-18.

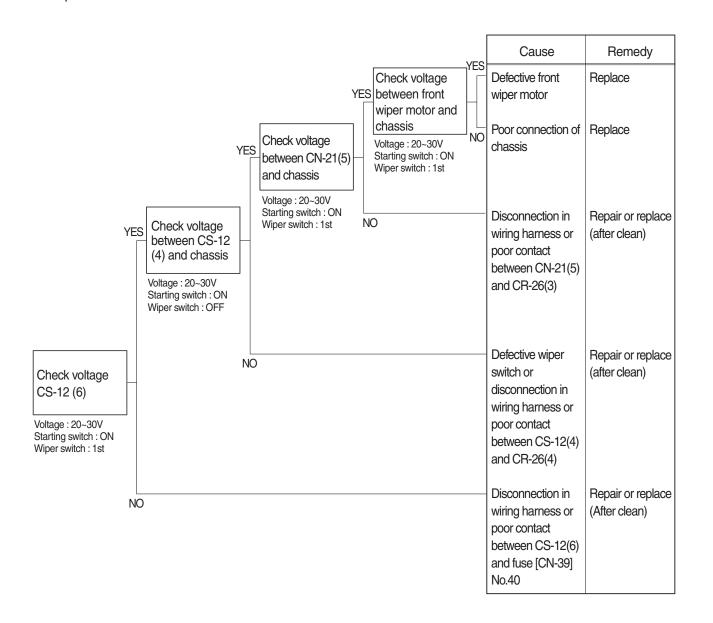


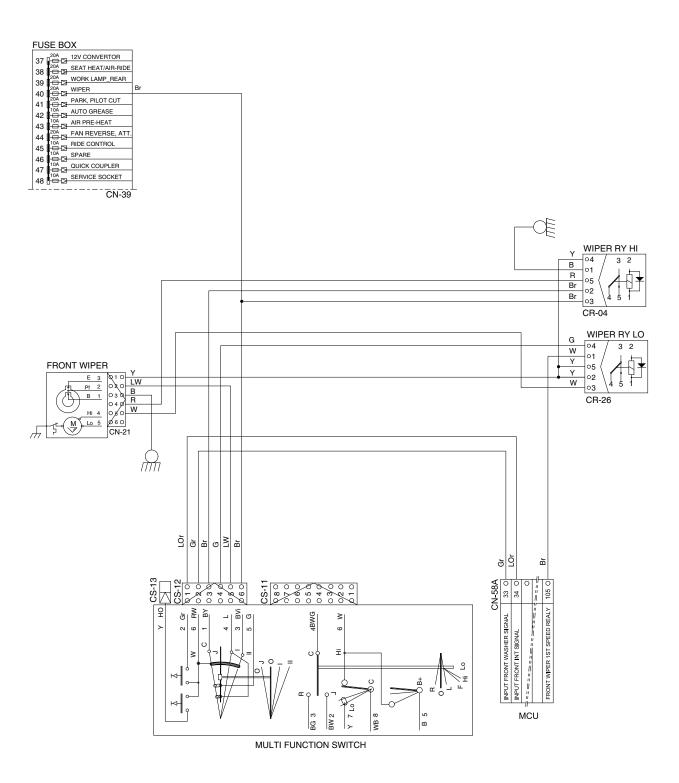
YES	MAX 1 Ω
NO	ΜΙΝ 1Μ Ω

6. WHEN STARTING SWITCH IS TURNED ON, WIPER MOTOR DOES NOT OPERATE

• Before carrying out below procedure, check all the related connectors are properly inserted and the fuse No.40 is not blown out.

· After checking, connect the disconnected connectors again immediately unless otherwise specified.

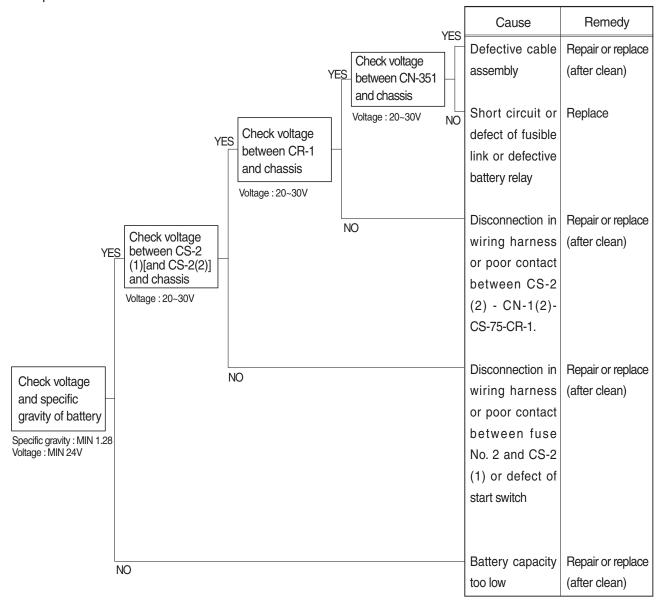


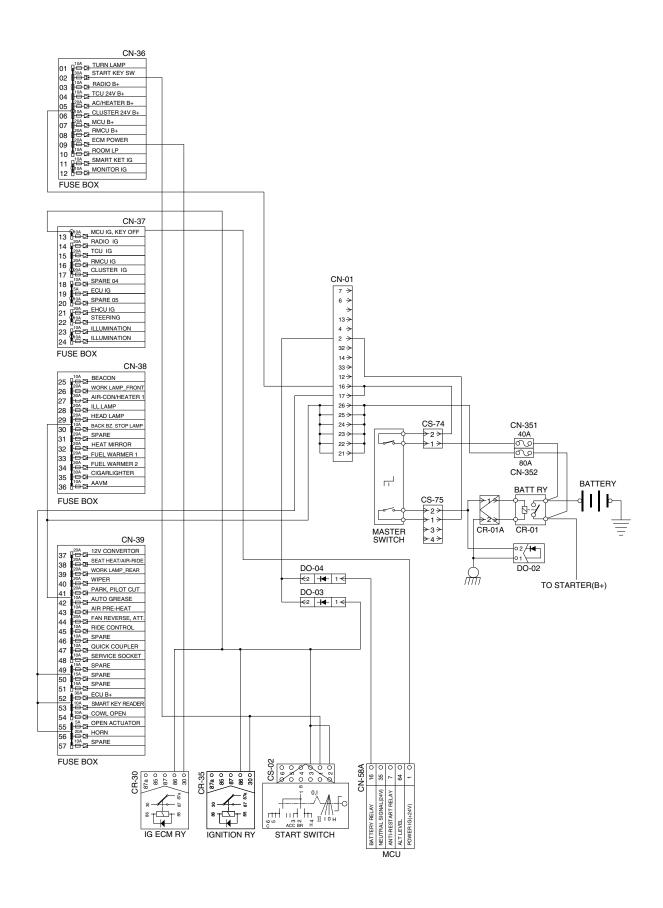


7. WHEN STARTING SWITCH "ON" DOES NOT OPERATE

• Before carrying out below procedure, check all the related connectors are properly inserted the fuse No.2 is not blown out.

· After checking, connect the disconnected connectors again immediately unless otherwise specified.



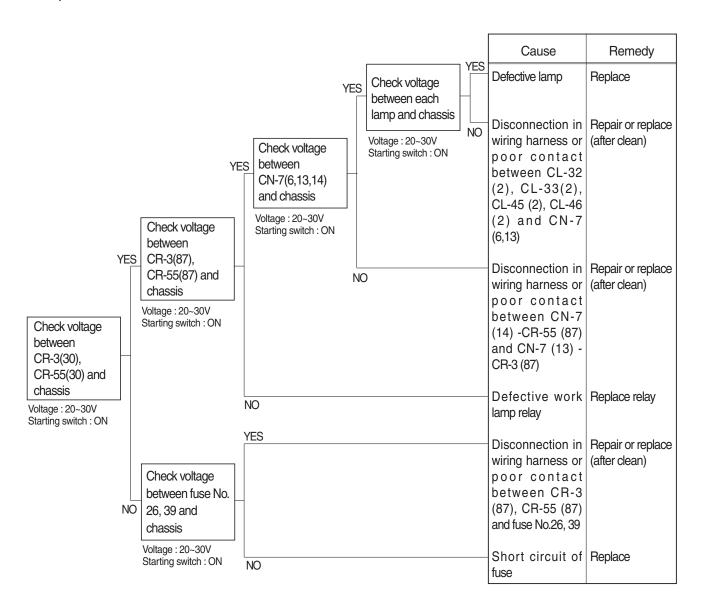


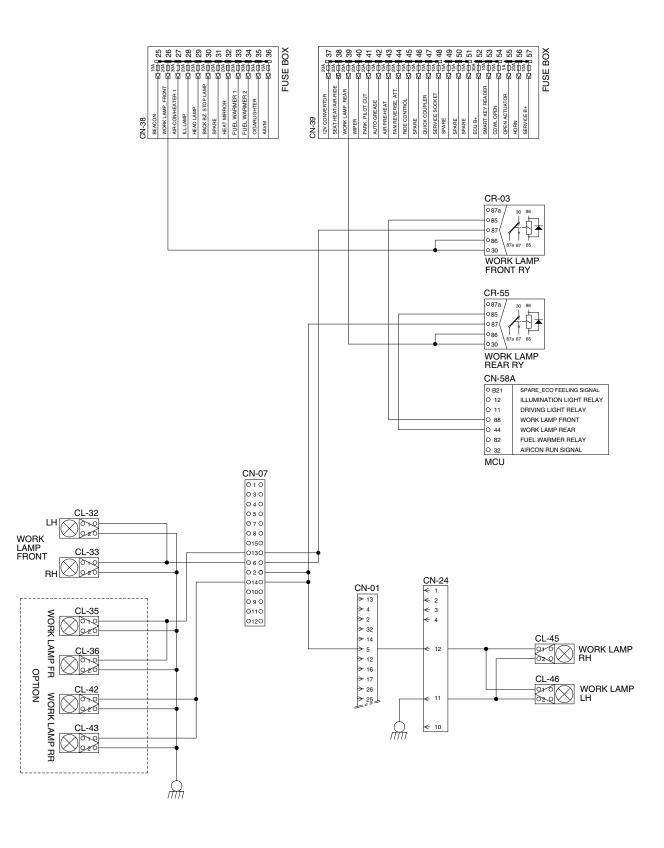
960SA7EL42

8. WHEN STARTING SWITCH IS TURNED ON, WORK LAMP DOES NOT LIGHTS UP

• Before carrying out below procedure, check all the related connectors are properly inserted, and the fuse No.26, 39 is not blown out.

· After checking, connect the disconnected connectors again immediately unless otherwise specified.





960SA7EL43