# CONTENTS

## 1. STRUCTURE

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

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

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

### SECTION 3 POWER TRAIN SYSTEM
This section explains the structure of the drive axle unit.

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

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

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

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

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

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

## 2. HOW TO READ THE SERVICE MANUAL

### Distribution and updating

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

### Filing method

1. See the page number on the bottom of the page.
   File the pages in correct order.
2. Following examples shows how to read the page number.
   Example 1
   2 - 3
   Item number(2. Removal & installation of unit)
   Consecutive page number for each item.
3. Additional pages : Additional pages are indicated by a hyphen(-) and number after the page number. File as in the example.
   7 - 4
   7 - 4 - 1
   7 - 4 - 2 Added pages
   7 - 5

### Revised edition mark(①②③…)

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

### Revisions

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

### Symbols

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

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

## 3. CONVERSION TABLE

Method of using the Conversion Table

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

### Example

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

   Convert 55mm into inches.

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

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

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

2. Convert 550mm 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 55mm.

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

   (3) The original value(550mm) 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 550mm = 21.65 inches.

**Millimeters to inches**

ⓑ

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 |
| ⓐ 50 | 1.969 | 2.008 | 2.047 | 2.087 | 2.126 | ⓒ 2.165 | 2.205 | 2.244 | 2.283 | 2.323 |
| 60 | 2.362 | 2.402 | 2.441 | 2.480 | 2.520 | 2.559 | 2.598 | 2.638 | 2.677 | 2.717 |
| 70 | 2.756 | 2.795 | 2.835 | 2.874 | 2.913 | 2.953 | 2.992 | 3.032 | 3.071 | 3.110 |
| 80 | 3.150 | 3.189 | 3.228 | 3.268 | 3.307 | 3.346 | 3.386 | 3.425 | 3.465 | 3.504 |
| 90 | 3.543 | 3.583 | 3.622 | 3.661 | 3.701 | 3.740 | 3.780 | 3.819 | 3.858 | 3.898 |

## Millimeters to inches

1mm = 0.03937in

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

## Kilogram to Pound

1kg = 2.2046lb

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

## Liter to U.S. Gallon

1 ℓ = 0.2642 U.S.Gal

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

## Liter to U.K. Gallon

1 ℓ = 0.21997 U.K.Gal

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

kgf · m to lbf · ft

1kgf · m = 7.233lbf · 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

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

## TEMPERATURE

Fahrenheit-Centigrade Conversion.

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

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

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

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

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

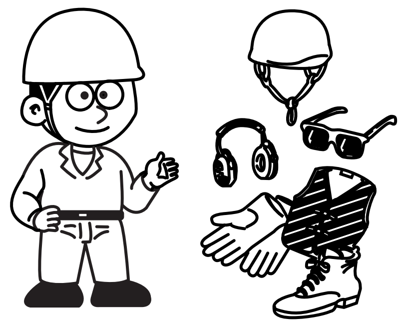
# SECTION 1 GENERAL

## GROUP 1 SAFETY HINTS

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

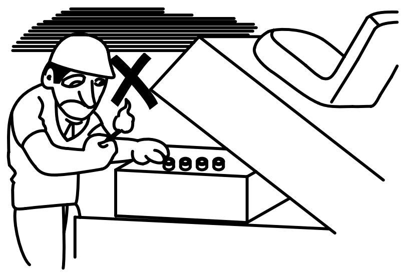
D50ASF01

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



D50ASF02

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



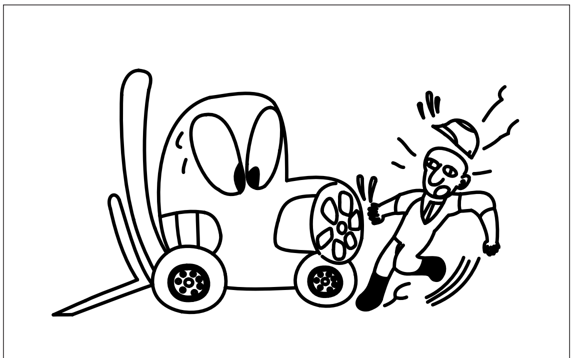
D50ASF03

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

D50ASF06

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

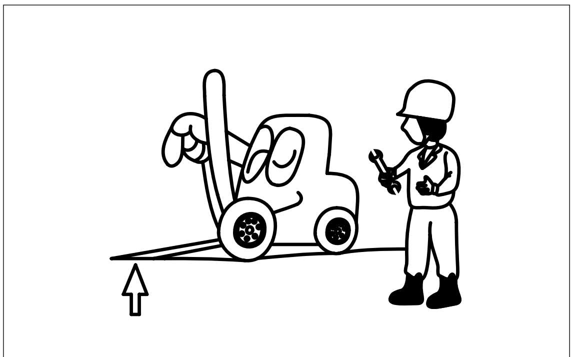
· Hand a caution sign in the operator's compartment (For example Do not start or Maintenance in progress).
This will prevent anyone from starting or moving the machine by mistake.



D50ASF07

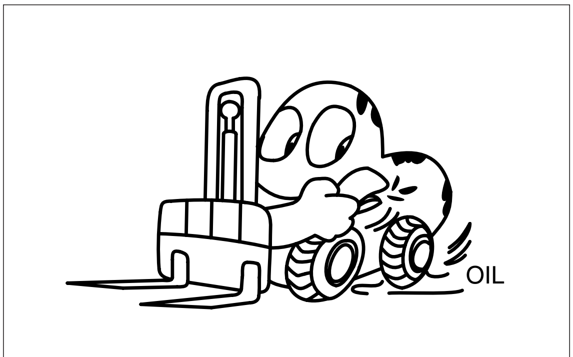
When inspecting running parts or near such parts, always stop the machine first.
Before checking or servicing accumulator or piping, depress brake pedal repeatedly to release pressure.

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



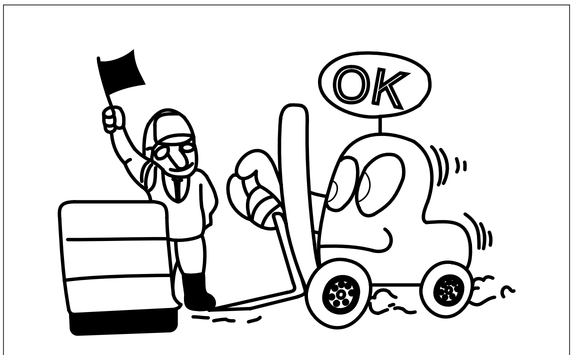
D50ASF08

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




D50ASF09

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




D50ASF10

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

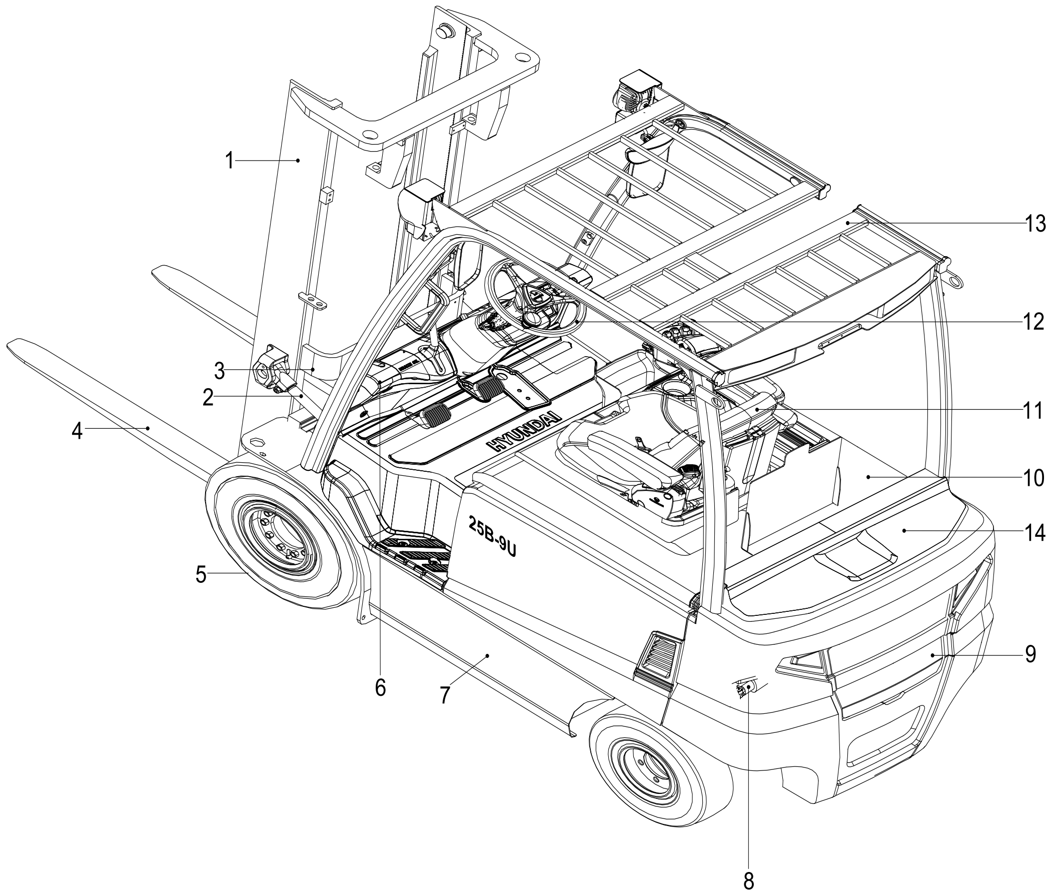

D50ASF11

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

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

# GROUP 2  SPECIFICATIONS

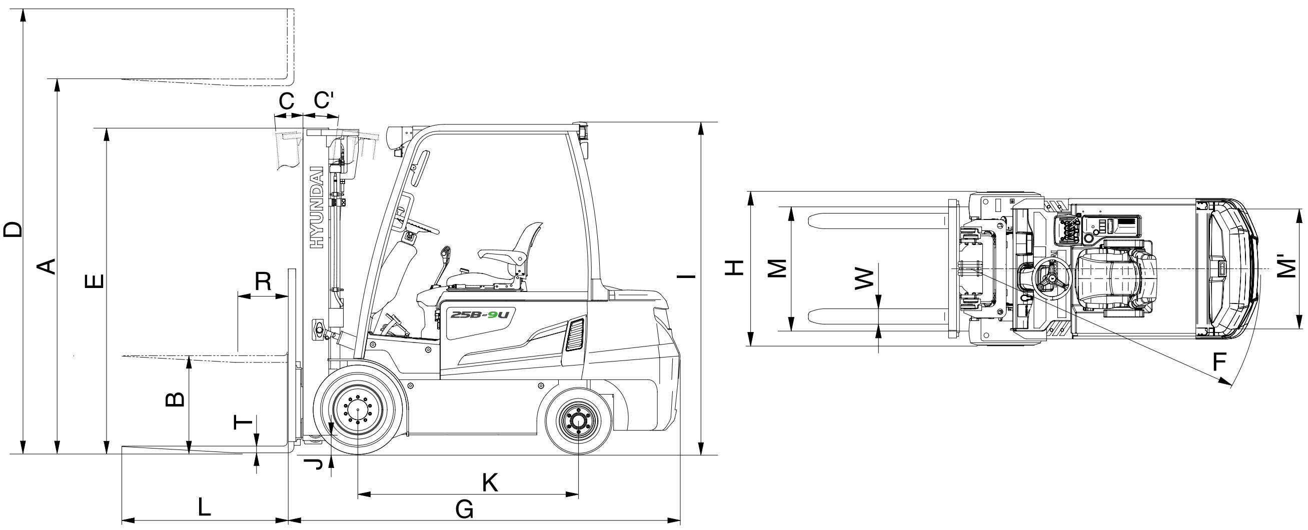
## 1. GENERAL LOCATIONS




25B9UOM0701

| | | | | | |
|---|---|---|---|---|---|
| 1 | Mast | 6 | Dash board | 11 | Seat |
| 2 | Tift cylinder | 7 | Frame | 12 | Steering wheel |
| 3 | Carriage and backrest | 8 | Steering axle | 13 | Overhead guard |
| 4 | Forks | 9 | Counterweight | 14 | Rear cover |
| 5 | Drive unit | 10 | Battery cover | | |

## 2. SPECIFICATIONS




25B9UOM0801

| Model | | | Unit | 25B-9U | 30B-9U | 32B-9U | 35B-9U |
|---|---|---|---|---|---|---|---|
| Capacity | | | kg (lb) | 2500 (5000) | 3000 (6000) | 3200 (6500) | 3500 (7000) |
| Load center | | R | mm (in) | 500 (24") | ← | ← | ← |
| Weight | | | kg (lb) | 4310 (9500) | 4750 (10470) | 4935 (10880) | 5190 (11441) |
| Fork | Lifting height | A | mm (ft-in) | 3300 (10' 10") | ← | ← | ← |
| | Free lift | B | mm (in) | 115 (4.5") | ← | ← | ← |
| | Lifting speed (Load/Unload) | | mm/sec | 420/600 | 340/600 | 330/500 | 300/460 |
| | Lowering speed (Unload/Load) | | mm/sec | 450/500 | ← | ← | ← |
| | L×W×T | L,W,T | mm (inch) | 1050×100×45<br>(41"×4"×1.8") | 1050×122×45<br>(41"×4.8"×1.8") | ← | ← |
| Mast | Tilt angle forward/backward | C/C' | degree | 6/10 | ← | ← | ← |
| | Max height | D | mm (ft-in) | 4485(14' 9") | ← | ← | ← |
| | Min height | E | mm (ft-in) | 2162(7' 1") | ← | 2232 (7' 4") | 2243 (7' 4") |
| Body | Travel speed (Unload) | | km/h | 18.0 | ← | ← | ← |
| | Gradeability (Load) | | % | 24 | 19 | 18 | 16 |
| | Min turning radius (Outside) | F | mm(ft-in) | 1940 (6' 4") | 2150 (7' 1") | 2165 (7' 1") | 2205 (7' 3") |
| ETC | Max hydraulic pressure | | kgf/cm$^2$ | 190 | ← | ← | ← |
| | Hydraulic oil tank | | ℓ (usgal) | 36.7 (8.6) | ← | ← | ← |
| Overall length | | G | mm (ft-in) | 2295 (7' 6") | 2490 (8' 2") | 2500 (8' 2") | 2590 (8' 6") |
| Overall width | | H | mm (ft-in) | 1200 (3' 11") | ← | ← | 1250 (4' 1") |
| Overhead guard height | | I | mm (ft-in) | 2230 (7' 4") | ← | ← | ← |
| Ground clearance (Mast) | | J | mm (in) | 117 (4.6") | ← | ← | 128 (5") |
| Wheel base | | K | mm (ft-in) | 1400 (4' 7") | 1600 (5' 3") | ← | ← |
| Wheel tread (front/rear) | | M/M' | mm (ft-in) | 993/980<br>(3' 3"/3' 3") | ← | ← | 1005/980<br>(3' 4"/3' 3") |

## 3. SPECIFICATION FOR MAJOR COMPONENTS

### 1) CONTROLLER

| Item | Unit | Traction | Pump |
|---|---|---|---|
| Model | - | ZAPI ACE2 X 2 EA | ZAPI ACE3 |
| Type | - | AC | ← |
| Dimension | mm | (200×150×142) X 2 | 200×230×128.6 |
| Current limit | A | 350+350 | 600 |
| Communication | - | CAN | ← |

### 2) MOTOR

| Item | Unit | Traction | Pump |
|---|---|---|---|
| Type | - | AQDG4001 | AMDL4001 |
| Rated voltage | Vac | 30 | 30 |
| Output | kW | 7.0×2 | 17 |
| Insulation | - | Class F | Class F |

### 3) BATTERY

| Item | Unit | 25B-9U | 30/32/35B-9U |
|---|---|---|---|
| Rated voltage | V | 48 | ← |
| Dimension (W×L×H) | mm | 1030×796×537 | 1030×990×537 |
| Min. Battery weight | kg | 970 | 1090 |
| Max. Battery weight | kg | 1300 | 1495 |
| Connector (CE spec) | - | SB 350 or SR 350 (SBE 320 BLUE) | |

### 4) CHARGER

| Item | Unit | Specification |
|---|---|---|
| Type | - | Constant current, constant voltage |
| Battery capacity for charge | V-AH | 48V/660~740 |
| AC input | V | Triple phase 410 |
| | | Single phase 220 |
| | | Triple phase 220/380 |
| | | Triple phase 440 |
| DC output | V | 64±1 |
| Charge time | hr | 6±2 |
| Connector (CE spec) | - | SB 350 or SR 350 (SBE 320 BLUE) |

### 5) GEAR PUMP

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

### 6) MAIN CONTROL VALVE

| Item | Unit | Specification |
|---|---|---|
| Type | - | 3 spool, 4 spool |
| Operating method | - | Mechanical |
| Main relief valve pressure | bar | 190 |
| 2nd relief valve pressure | bar | 130 |

### 7) DRIVE AXLE UNIT

| Item | Unit | Specification |
|---|---|---|
| Max axle load | kg/lb | 4500/9920.8 |
| Max input rpm | rpm | 5000 |
| Gear ratio | – | 24.58 |
| Weight without fluid | kg/lb | 62 kg (137 lb)/EA |
| Oil quantity | ℓ/U.S · qt | 1.0 (1.06) |

### 8) WHEELS

| Item | 25/30/32B-9U | 35B-9U |
|---|---|---|
| Type (front/rear) | SOLID (OPT : NON-MARKING, PNEUMATIC) | |
| Quantity (front/rear) | 2/2 | |
| Front-drive | 23×9-10 (18PR) | 23×10-12 (16PR) |
| Rear-steering | 18×7-8 (16PR) | ← |

### 9) BRAKES & STEERING

| Item | | Specification |
|---|---|---|
| Brakes | Travel | Front wheel, Hydraulic, wet disc brake |
| | Parking | Mechanical |
| Steering | Type | Electronic and Hydraulic Steering |

## 4. TIGHTENING TORQUE FOR MAJOR COMPONENTS

| NO | Items | | Size | kgf · m | lbf · ft |
|---|---|---|---|---|---|
| 1 | Electric system | Hyd pump motor mounting nut | M 8×1.25 | 3.4±0.7 | 24.6±5.0 |
| 2 | | Traction motor mounting bolt | M10×1.5 | 6.9±1.4 | 50±10 |
| 3 | Hydraulic system | Hydraulic pump mounting bolt | M10×1.5 | 6.9±1.4 | 50±10 |
| 4 | | MCV mounting bolt, nut | M10×1.5 | 6.9±1.4 | 50±10 |
| 5 | | Steering pump mounting bolt | M10×1.5 | 1.05±0.2 | 7.6±1.4 |
| 6 | | Brake cylinder mounting bolt | M10×1.5 | 8±0.5 | 57.9±3.6 |
| 7 | Power train system | Drive unit mounting bolt, nut | M20×2.5 | 55.5±2.5 | 401±18.0 |
| 8 | | Steering axle mounting bolt, nut | M20×2.5 | 62±3.0 | 448±21.7 |
| 9 | | Front wheel mounting nut | M14×1.5 | 15.7±2.3 | 114±16.6 |
| 10 | | Rear wheel mounting nut | M14×1.5 | 23±1.0 | 166±7.2 |
| 11 | ETC | Counterweight mounting bolt | M24×3.0 | 199±15 | 1429±108 |
| 12 | | Seat mounting nut | M 8×1.25 | 3.4±0.7 | 24.6±5.0 |
| 13 | | Head guard mounting bolt (front) | M12×1.75 | 12.8±3 | 92.5±21.5 |
| 14 | | Head guard mounting bolt (rear) | M16×2.0 | 29.7±4.5 | 215±32.5 |

## 5. TORQUE CHART

Use following table for unspecified torque.

### 1) BOLT AND NUT

#### (1) Coarse thread

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

#### (2) Fine thread

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

### 2) PIPE AND HOSE (FLARE type)

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

### 3) PIPE AND HOSE (ORFS type)

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

### 4) FITTING

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

## 6. RECOMMENDED LUBRICANTS

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

| Service point | Kind of fluid | Capacity ℓ (U.S. gal) | Ambient temperature °C (°F) -50 (-58), -30 (-22), -20 (-4), -10 (14), 0 (32), 10 (50), 20 (68), 30 (86), 40 (104) |
|---|---|---|---|
| Axle | Gear oil | 1.0 × 2 (0.26) | Mobilfluid 424 (API GL4/SAE 80W) |
| Hydraulic oil tank | Hydraulic oil | 32.8 (8.67) | ★ISO VG 15<br>ISO VG 46<br>ISO VG 68 |
| Steering system | Hydraulic oil | 0.67 (0.17) | |
| Brake system | Brake oil | 0.5 (0.1) | ★HYDRAULIC OIL ISO VG10 (AZOLLA ZS10)<br>HYDRAULIC OIL ISO VG32 (AZOLLA ZS32) |
| Fitting (Grease nipple) | Grease | 0.1 (0.03) | ★NLGI No.1<br>NLGI No.2 |

· API : American Petroleum Institute
· SAE : Society of Automotive Engineers
· ISO : International Organization for Standardization
· NLGI : National Lubricating Grease Institute

★ : Cold region
Russia, CIS, Mongolia

## GROUP 3 PERIODIC REPLACEMENT

For operation safety, never fail to perform periodic maintenance or make periodic replacement of the consumable parts listed in the following.

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

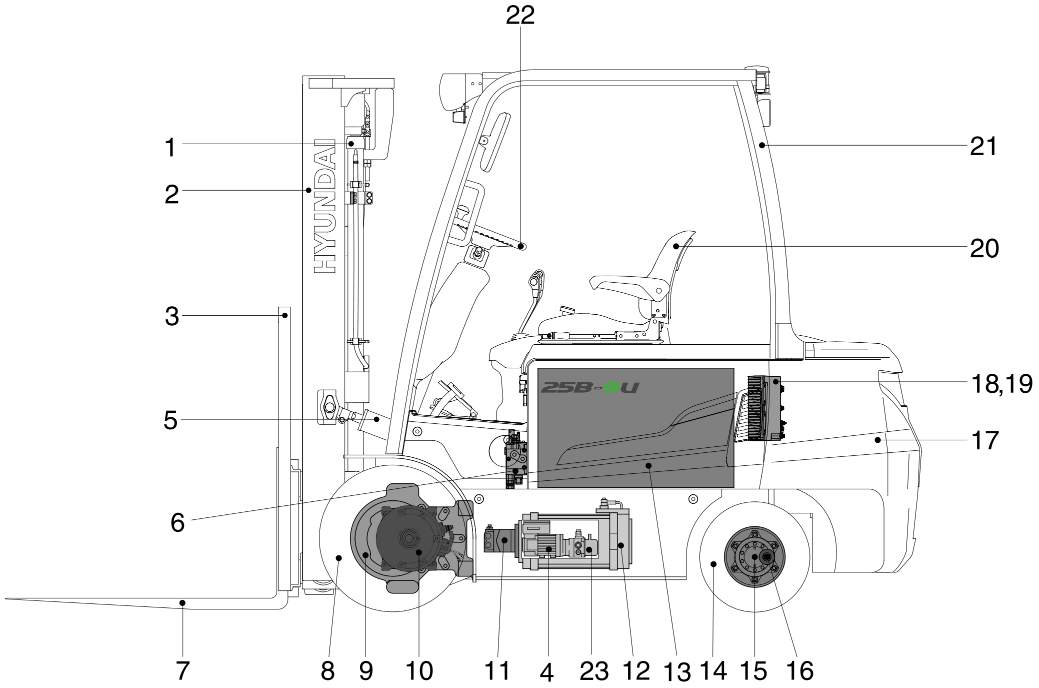
※ **Replacement of consumable service parts is not covered under warranty.**

| No. | Description | Period of replacement |
|---|---|---|
| 1 | Hydraulic oil | Every 1 year |
| 2 | Brake fluid | Every 1 year |
| 3 | Differential oil | Every 1 year |
| 4 | Gear oil | Every 1 year |
| 5 | Wheel bearing grease | Every 1 year |
| 6 | Power steering hose | Every 1 year |
| 7 | Parking, seal and O-ring of steering cylinder | Every 2 year |
| 8 | Parking, seal and O-ring of lift and tilt cylinder | Every 2 year |
| 9 | Reservoir tank tube | Every 1 year |
| 10 | Lift chain | Every 2 year |
| 11 | Hydraulic equipment hose | Every 2 year |
| 12 | Brake hose or tube | Every 2 year |

# SECTION 2 REMOVAL & INSTALLATION OF UNIT

# SECTION 2 REMOVAL & INSTALLATION OF UNIT

## GROUP 1 MAJOR COMPONENTS




25B9URE02

| | | | | | |
|---|---|---|---|---|---|
| 1 | Lift cylinder | 9 | Drive unit | 17 | Counterweight |
| 2 | Mast | 10 | Drive motor | 18 | Traction controller |
| 3 | Backrest | 11 | Hyd gear pump | 19 | Pump controller |
| 4 | EPS motor and controller | 12 | Pump motor | 20 | Seat |
| 5 | Tilt cylinder | 13 | Battery | 21 | Overhead guard |
| 6 | Main control valve | 14 | Rear wheel | 22 | Steering wheel |
| 7 | Forks | 15 | Steering axle | 23 | Bidirectional pump |
| 8 | Front wheel | 16 | Steering cylinder | | |

# GROUP 2 REMOVAL AND INSTALLATION OF UNIT

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

## 1. MAST

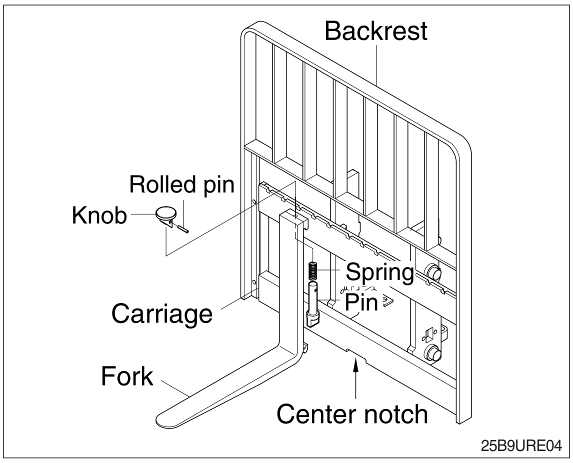
### 1) REMOVAL

Fork — Carriage — Piping — Mast

L15C3RE001

#### (1) Forks

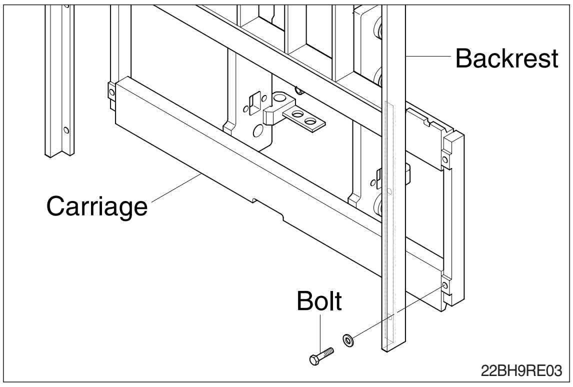
① Lower the fork carriage until the forks are approximately 25 mm (1 in) from the floor.
② Turn knob up and slide one fork at a time toward the center of the carriage where a notch has been cut in the bottom plate for easy removal.
③ Remove only one fork at a time.
※ On larger forks it may be necessary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



25B9URE04

#### (2) Backrest (If necessary)

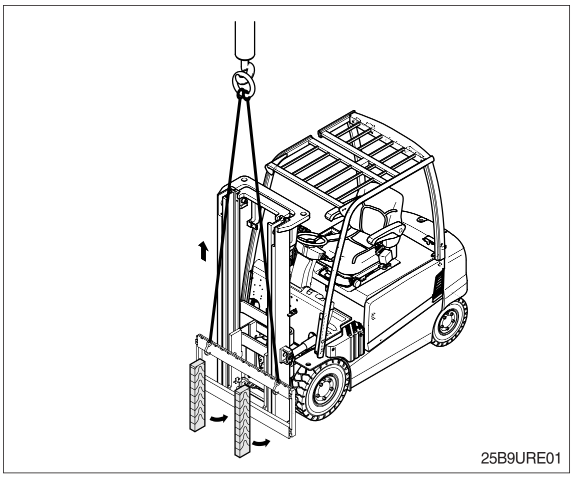
① Remove bolts securing backrest to fork carriage. Disassemble the backrest from the carriage.



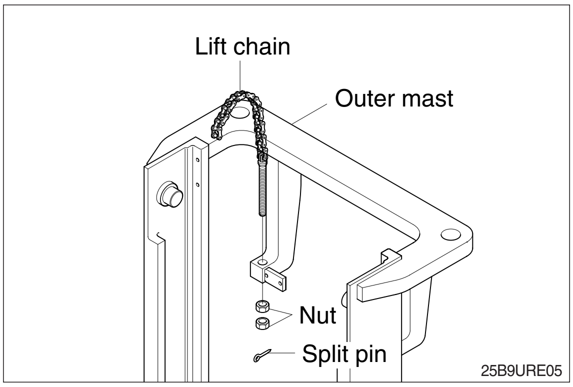
22BH9RE03

#### (3) Carriage

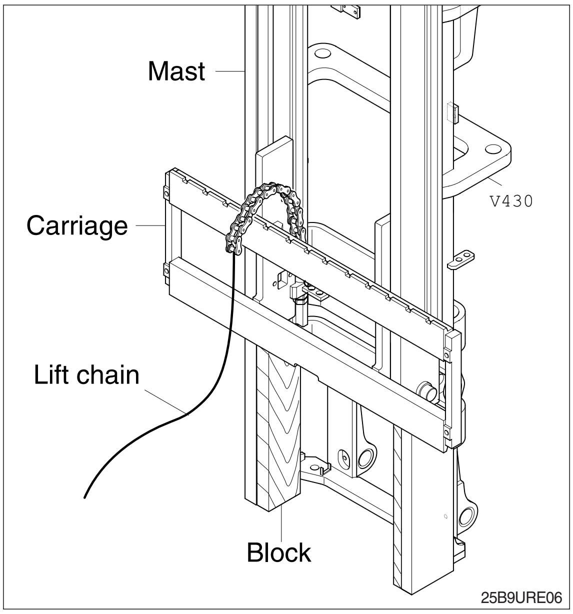
① With the mast vertical, raise the carriage high enough to place blocks under the load forks. This is done to create slack in the load chains when the carriage is lowered. Lower the carriage all the way down to the floor. Make sure the carriage is level, this will prevent any binding when the mast is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


25B9URE01

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



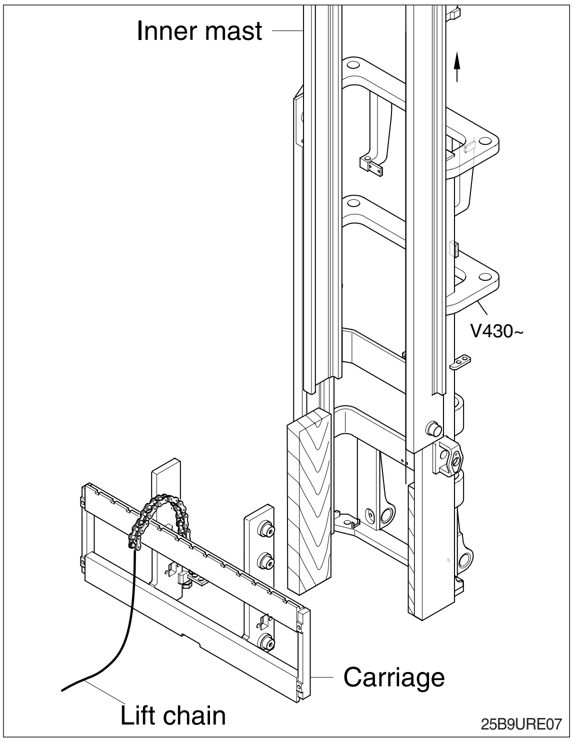

③ Pull the chains out of the sheaves and drape them over the front of the carriage.




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

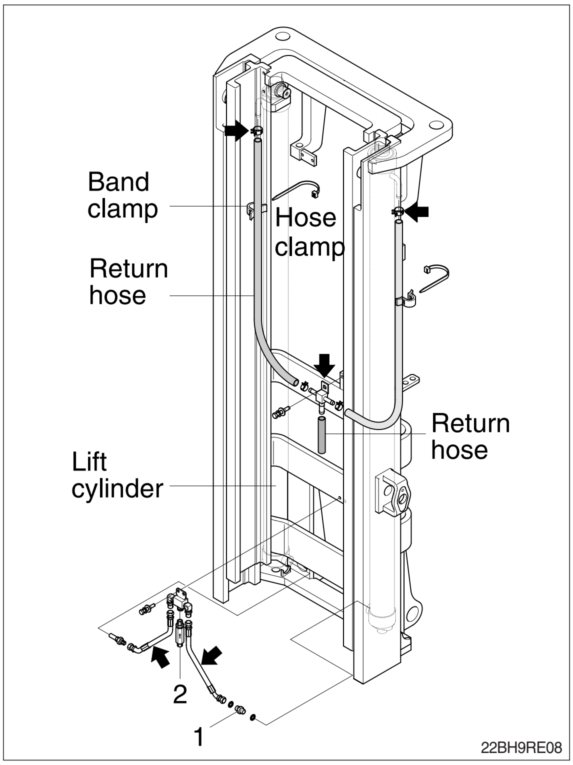
⚠ **Make sure that carriage remains on floor and does not bind while mast is being raised.**

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



(4) Piping

① Remove the return hoses and clamps attached to the cylinder.
② Remove the return hoses from the connector.
③ Remove hose assembly, tee, velocity fuse valve (1) from the lift cylinder.
④ Disconnect hose assembly from the flow regulator (2).
⑤ Disconnect the hoses from the lift cylinders after removing band clamp and hose clamp.
⑥ Remove the return tee and hose clip from the hoses.

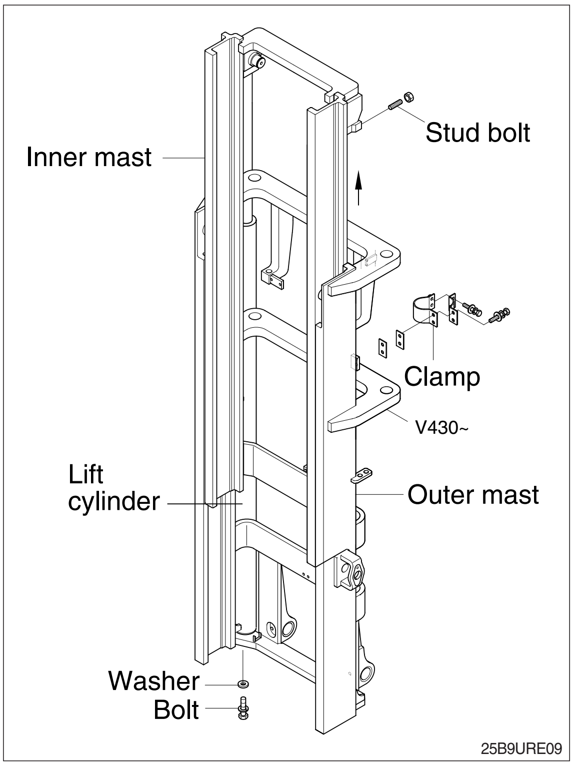



(5) Lift cylinder

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

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

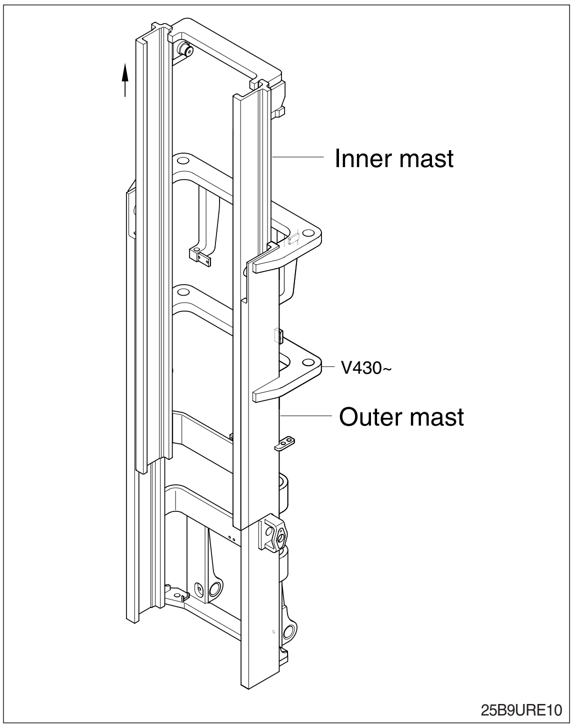
③ Loosen and remove hexagon bolts, shims and clamp securing cylinder.
④ Using an overhead hoist, slowly raise the inner mast high enough to clear lift cylinder.
⑤ Using an overhead hoist, draw out lift cylinder carefully and put down on the work floor.



## (6) Inner mast

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

▲ **Be careful the mast not to swing or fall.**




## (7) Tilt cylinder pin

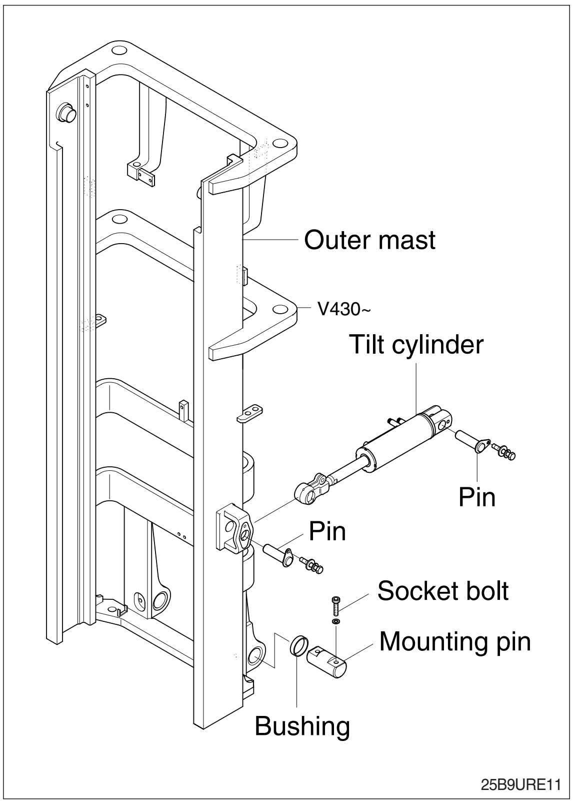
Loosen the bolt and remove the tilt cylinder pin.

## (8) Mast mounting pin

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

※ This operation is carried out from under the machine, so use a pit, or if there is no pit, jack up the machine and loosen with on impact wrench.

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



## 2) INSTALLATION

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

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

### (1) Mast mounting pin

① Check the mast mounting pin, and bushing for wear.

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

③ Tighten mounting socket bolts for the mast mounting pin.

· Tightening torque : 25.2~34.2 kgf · m (182~247 lbf · ft)

### (2) Tilt cylinder pin

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

### (3) Lift cylinder installation and adjustment

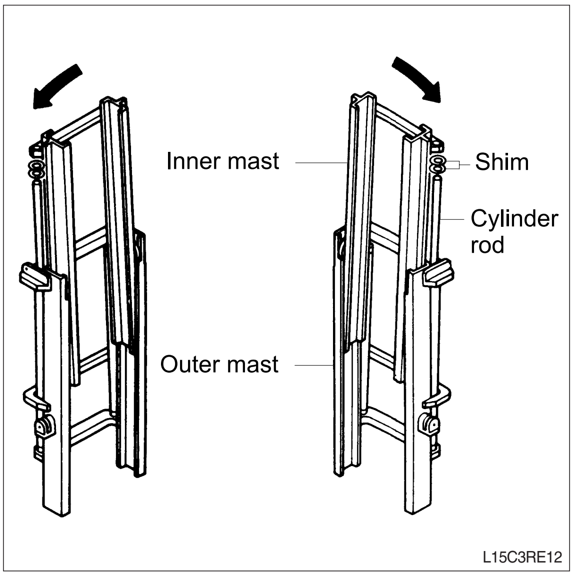
① Assemble the lift cylinder inside the outer mast, then tighten the stopper bolt. If the cylinder assembly has been replaced, adjust as follows so that the left and right cylinders are synchronized at the maximum lifting height.

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

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

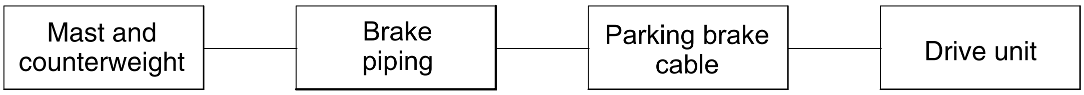
※ If play is to RIGHT, install adjustment shim to RIGHT cylinder.

· Shim thickness : 1.0 mm (0.04 in)



## 2. POWER TRAIN ASSEMBLY

### 1) REMOVAL

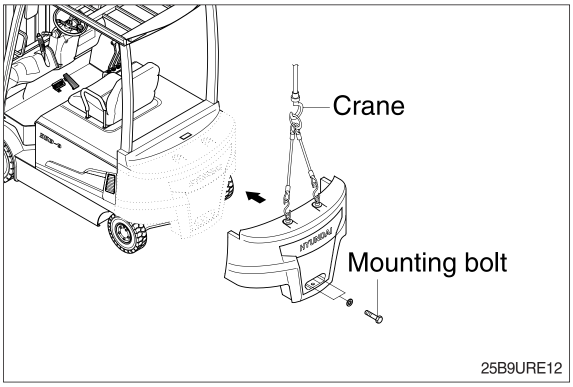



25B9U3RE00

#### (1) Mast and counterweight

Refer to section on mast (page 2-2).

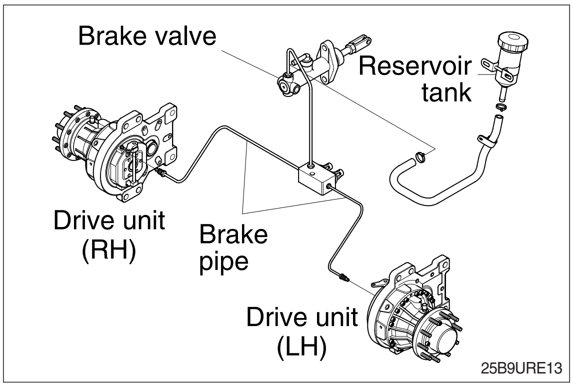
※ After removing mast, remove the counterweight to prevent the truck from turning over. (see page 2-11).




25B9URE12

#### (2) Service brake piping

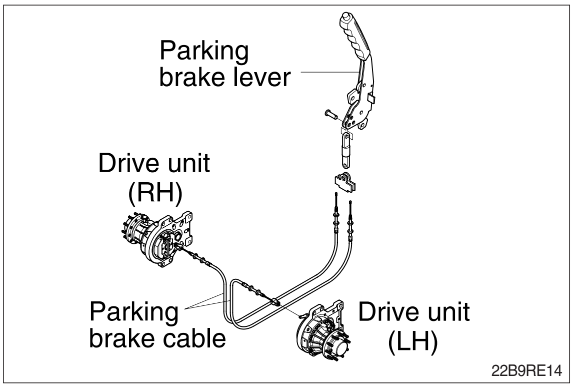
Disconnect the service brake piping from the drive unit.




25B9URE13

#### (3) Parking brake cable

Disconnect parking brake cable from the drive unit.

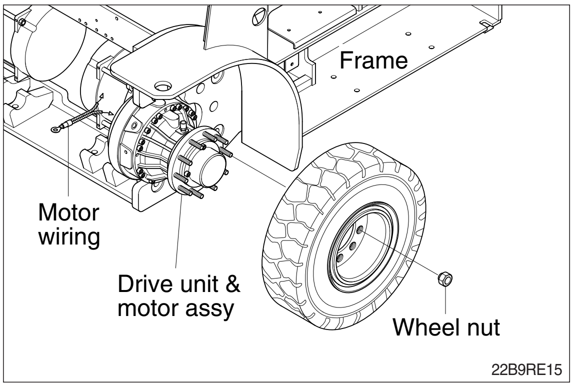



22B9RE14

(4) Drive unit & motor assy

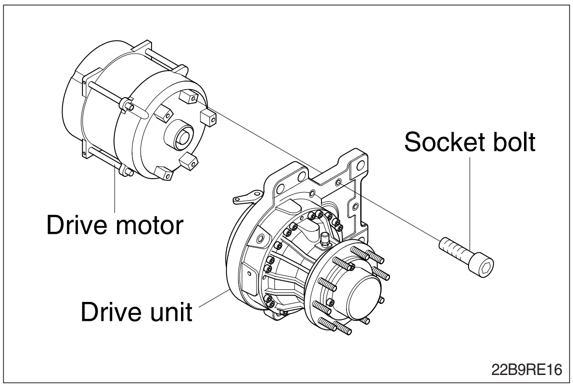
※ Drain the oil before disassembling the drive unit.

① Unscrew ten wheel nuts and remove the wheel.

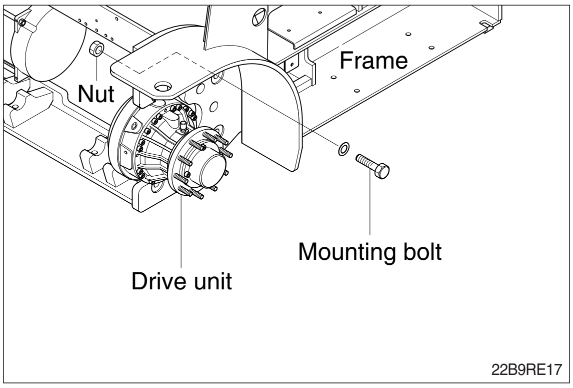



② Remove five socket bolts holding the drive motor in place.

③ Carefully remove the drive motor from the drive unit.




④ Loosen six mounting bolts on the truck frame and carefully take out the drive unit.

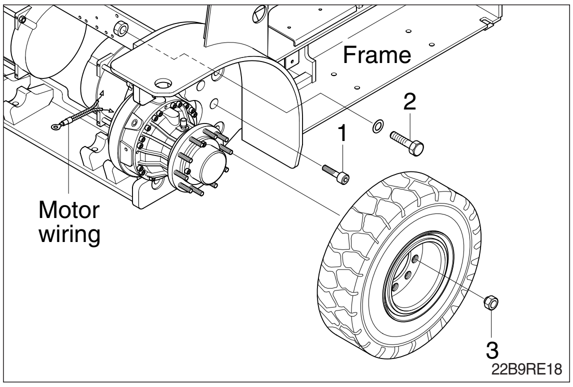



2) INSTALLATION

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

· Tightening torque

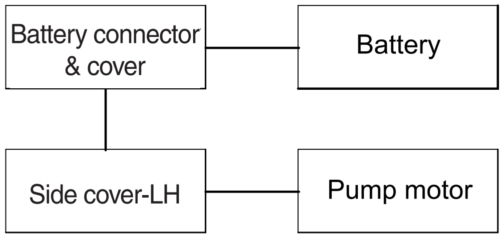
| Item | kgf · m | lbf · ft |
|---|---|---|
| Drive motor (1) | 6 ~ 8 | 43.4 ~ 57.9 |
| Drive unit (2) | 53 ~ 58 | 383 ~ 420 |
| Wheel nut (3) | 13.4 ~ 18 | 96.9 ~ 130 |



## 3. ELECTRICAL COMPONENTS

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

### 1) REMOVAL

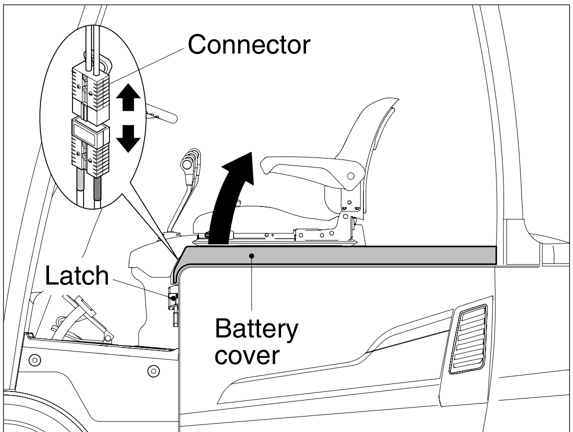



B15T5RE001

#### (1) Battery

⚠ **Before pulling out the battery plug, tilt the mast forward a little, and lower the fork to the lowest position.**
**The batteries weigh from around 1020 ㎏ to 1320 ㎏ so the extreme care must be taken when handling them.**

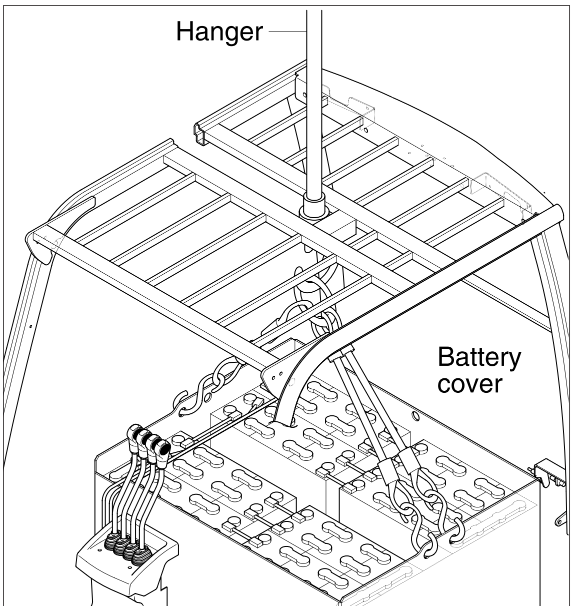
① Disconnect the battery connector.
Release the battery cover latch and open the battery cover.




22B9RE19

② Using a battery hanger, carefully raise the battery assembly.

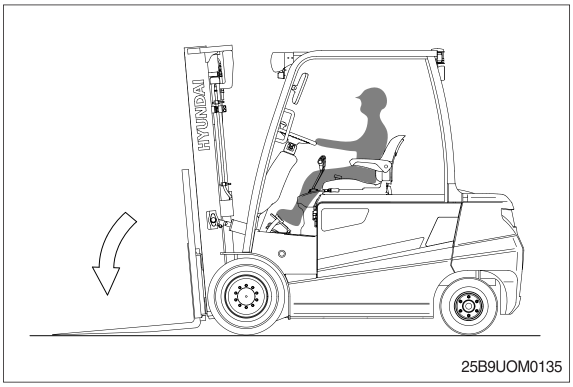
※ Be careful not to damage overhead guard or control system.



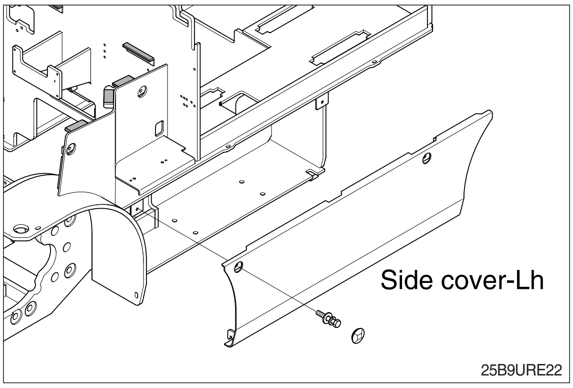

25B9URE20

(2) Pump motor

① Lower the fork to floor.

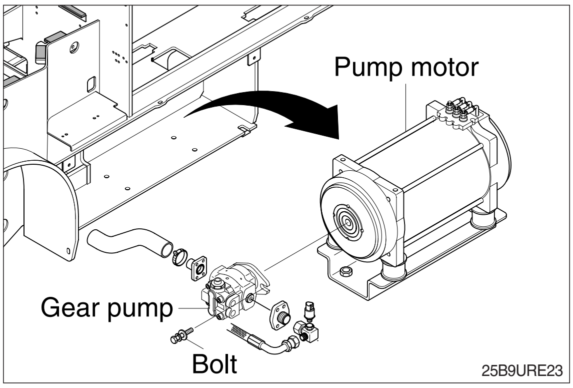



② Remove the LH side cover.



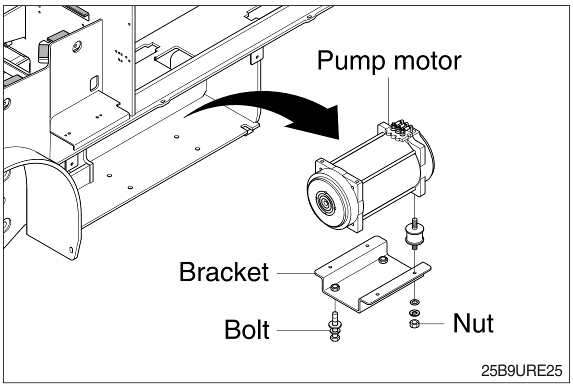

③ Disconnect the wiring of pump motor, the rubber hose, the hydraulic hose.

④ Loosen the mounting bolts and remove the gear pump from pump motor.
· Tightening torque
5.5~8.3 kgf·m (39.8~60 lbf·ft)




⑤ Remove the tightening bolts of the pump motor mounting bracket.

⑥ Loosen the nuts and remove the motor from mounting bracket.
· Tightening torque
Bolt : 5.5~8.3 kgf·m (39.8~60 lbf·ft)
Nut : 2.0~3.0 kgf·m (14.5~21.7 lbf·ft)

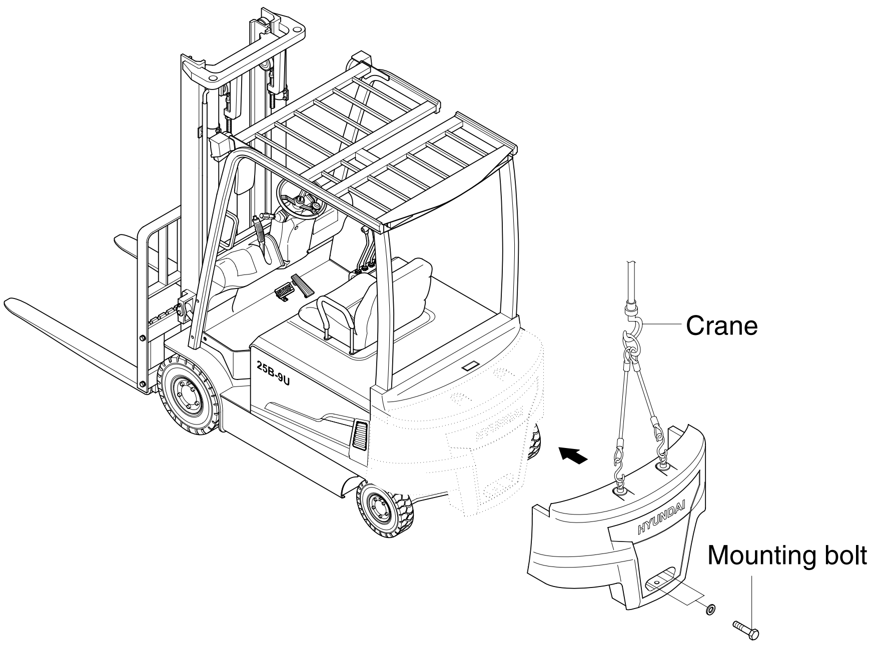


## 4. STEERING AXLE

### 1) REMOVAL

Counterweight — Rear wheel — Hose — Mounting bolt

D35ARE37




25B9URE25

#### (1) Counterweight

Install a lifting tool in the counterweight, and raise with a crane.

Remove the mounting bolts, raise slightly and move to the rear.

· Weight of counterweight (standard)

| | | | |
|---|---|---|---|
| 25B-9U | 890 kg (1960 lb) | 32B-9U | 1194 kg (2630 lb) |
| 30B-9U | 1037 kg (2290 lb) | 35B-9U | 1371 kg (3020 lb) |

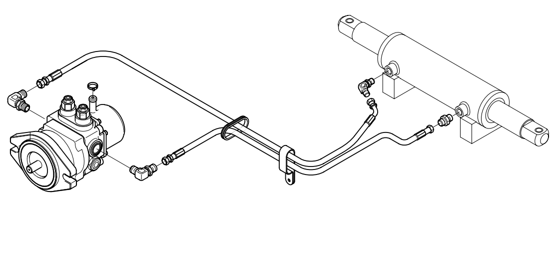
· Tightening torque : 184~214 kgf · m (1330~1545 lbf · ft)

#### (2) Rear wheel

Refer to the page 5-17.

#### (3) Hose

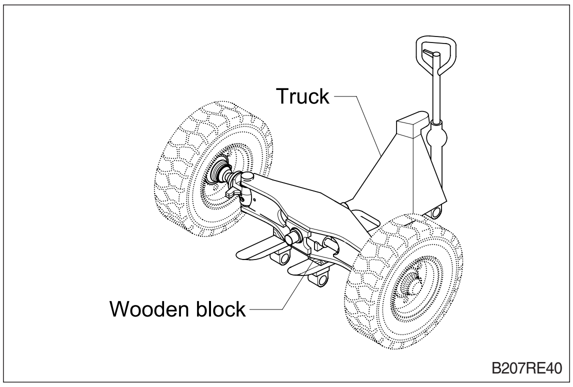
Remove the hoses from the steering cylinder.



25B9URE37

(4) Mounting bolt

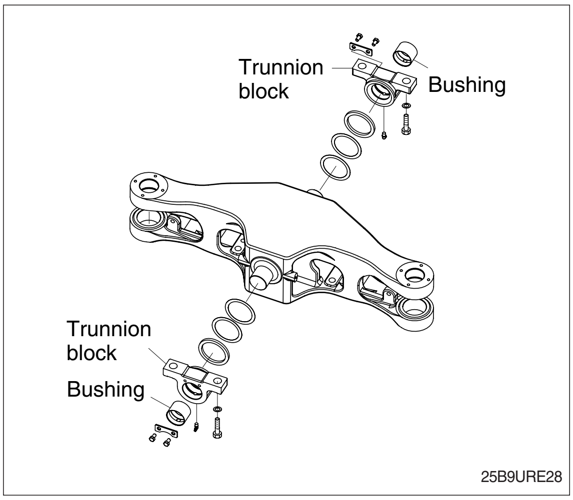
Put a block under the steering axle, support on a truck, and raise the frame with a crane. Remove the mounting bolts installed to the frame, and pull out to the rear. There are shims and spacer between the trunnion block and steering axle to prevent play.




2) INSTALLATION

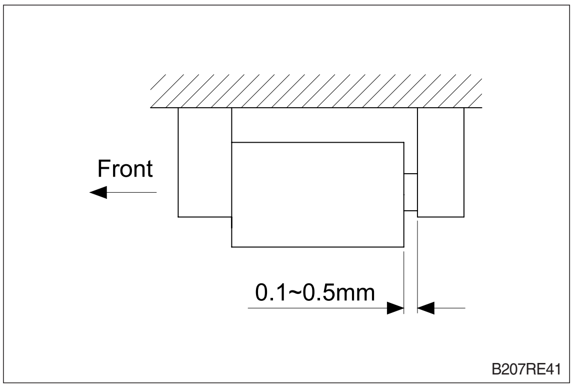
Installation is in the reverse order to removal, but be careful of the following points.

(1) When replacing the bushing at the trunnion block, install so that the hole in the bushing faces down.




(2) Install the trunnion block so that the clearance is under 0.5mm when the trunnion block is pushed fully to the rear.
Tightening torque of mounting bolt for trunnion block. Apply loctite #277.

· 59~65 kgf · m (427~470 lbf · ft)




(3) When installing the rear wheel, coat the hub bolt and tighten the nut to 22~24 kgf · m (159~174 lbf · ft).

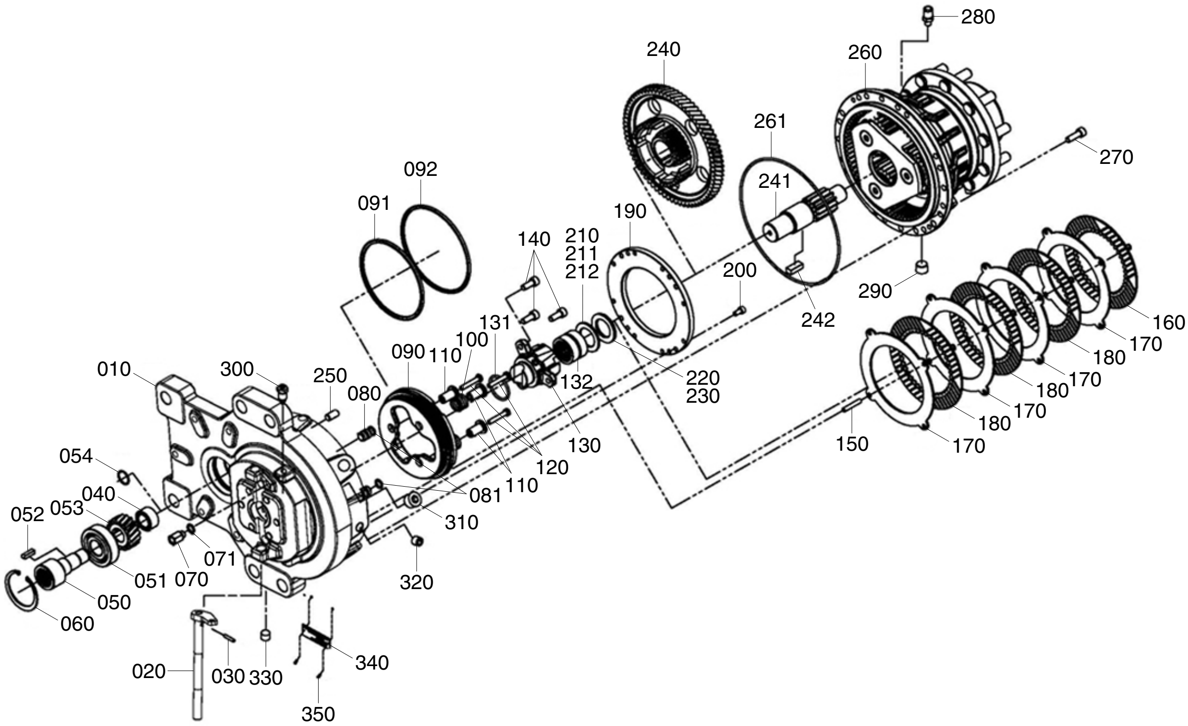
(4) When installing the counterweight, align with the center of frame. Coat the mounting bolt with molybdenum disulphide and tighten.

# SECTION 3 POWER TRAIN SYSTEM

## GROUP 1 STRUCTURE AND OPERATION

### 1. STRUCTURE

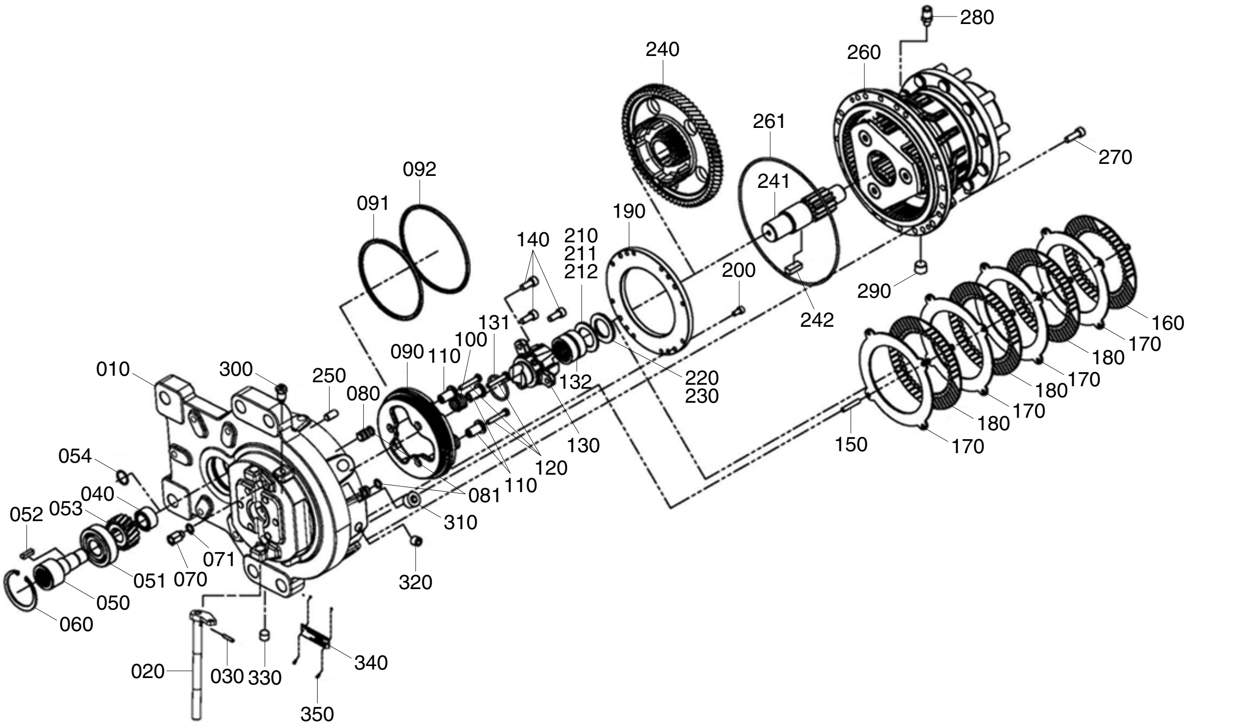
#### 1) DRIVE AXLE (1/2)




22B9PT01

| | | | | | |
|---|---|---|---|---|---|
| 010 | Housing (LH, RH) | 070 | Fitting (brake) | 120 | Bolt (piston brake) |
| 020 | Parking lever (LH, RH) | 071 | O-ring (fit-brake) | 130 | Bearing boss (drive) |
| 030 | Spring pin | 080 | Parking pin | 131 | O-ring (bearing boss) |
| 040 | Needle roller bearing (drive) | 081 | O-ring (parking pin) | 132 | Needle bearing roller (drive) |
| 050 | Drive gear shaft | 090 | Brake piston | 140 | Hex socket bolt (bearing boss) |
| 051 | Ball bearing (drive) | 091 | D-ring (small) | 150 | Guide pin |
| 052 | Key (drive) | 092 | D-ring (large) | 160 | Spring brake disc |
| 053 | Drive gear | 100 | Return spring | 170 | Reaction plate |
| 054 | Snap ring (drive) | 110 | Spacer | 180 | Friction plate |
| 060 | Snap ring (drive) | | | | |

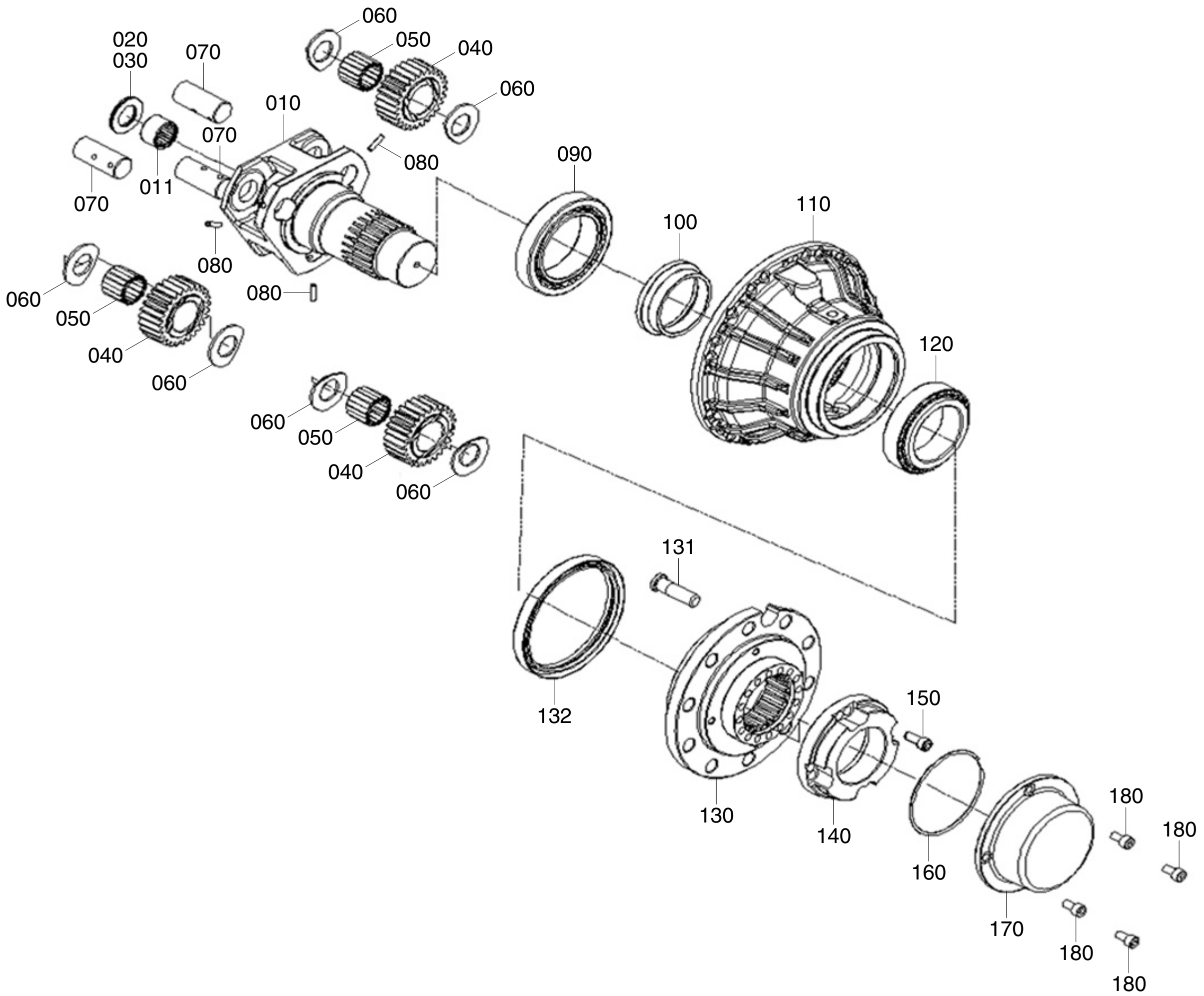
## DRIVE AXLE (2/2)




22B9PT01

| | |
|---|---|
| 190 | Disc plate stopper |
| 200 | Hex socket bolt (brake cover) |
| 210 | Spacer (bearing boss), 3.0t) |
| 211 | Spacer (bearing boss), 3.1t) |
| 212 | Spacer (bearing boss), 3.2t) |
| 220 | Thrust needle bearing (bearing boss) |
| 230 | Thrust needle washer (bearing boss) |
| 240 | Driven gear |
| 241 | Sun gear shaft |
| 242 | Key (driven) |
| 250 | Dowel pin (plate housing) |
| 260 | Wheel assy |
| 261 | O-ring (final housing) |
| 270 | Hex socket bolt (housing) |
| 280 | Air breather |
| 290 | Magnetic plug (drain) |
| 300 | Air breather (brake) |
| 310 | Socket plug (fill oil) |
| 320 | Socket plug (level) |
| 330 | Socket plug (drain) |
| 340 | Name plate (LH, RH) |
| 350 | Rivet |

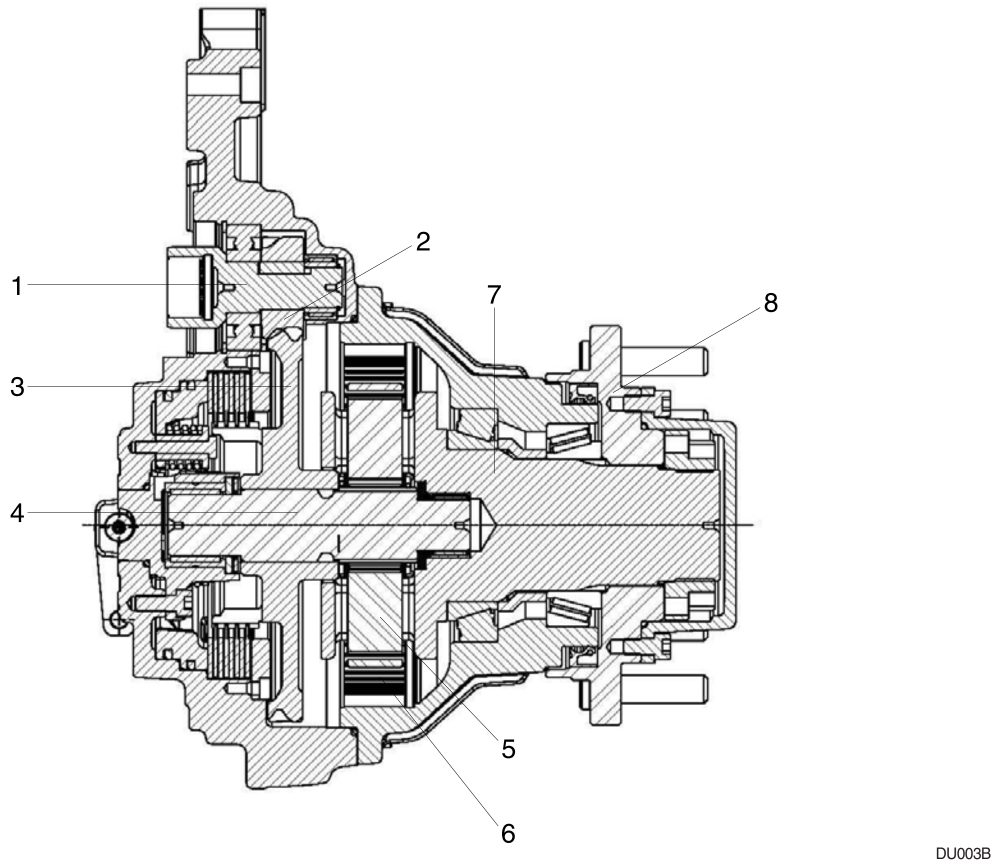
## 2) WHEEL




22B9PT02

| | | | | | |
|---|---|---|---|---|---|
| 010 | Carrier shaft | 070 | Planetary gear shaft | 131 | Stud bolt |
| 011 | Needle roller bearing | 080 | Spring pin | 132 | Oil seal |
| 020 | Thrust needle bearing | 090 | Taper roller bearing | 140 | Lock nut |
| 030 | Thrust needle washer | 100 | Spacer | 150 | Hex socket bolt |
| 040 | Planetary gear | 110 | Final housing | 160 | O-ring |
| 050 | Needle roller bearing | 120 | Taper roller bearing | 170 | Wheel cap |
| 060 | Thrust washer | 130 | Adapter | 180 | Hex socket bolt |

### 3) OPERATION PRINCPLE




| | | | | | |
|---|---|---|---|---|---|
| 1 | Drive shaft | 4 | Sun gear shaft | 7 | Carrier shaft |
| 2 | Drive gear | 5 | Planetary gear | 8 | Wheel adapter |
| 3 | Driven gear | 6 | Ring gear | | |

The drive axle include service brake and parking brake as a power transfer components which are assembled to drive wheels of the battery fork lift.

The rotation power from the drive motor transmits to the drive shaft (1).

The driven gear (3) engages with the drive gear (2) which is fixed by key to the drive shaft.

The driven gear (3) is fixed by key to the sun gear shaft (4).

The planetary gears (5) which are fixed by key to the sun gear shaft (4) engage with the ring gear (6).

Finally reduced rotation power is transmitted to the wheel adapter (8) which is fixed with the carrier shaft (7) and the wheel is rotated.

## 3. SPECIFICATION

| Item | Unit | Specification |
|---|---|---|
| Max wheel load | kg/lb | 4500/9921 |
| Gear ratio | – | 24.58 |
| Weight without fluid | kg/lb (EA) | 62/137 |
| Oil quantity (Mobilfluid 424) | ℓ /U.S. · gal | 1.0/0.26 |

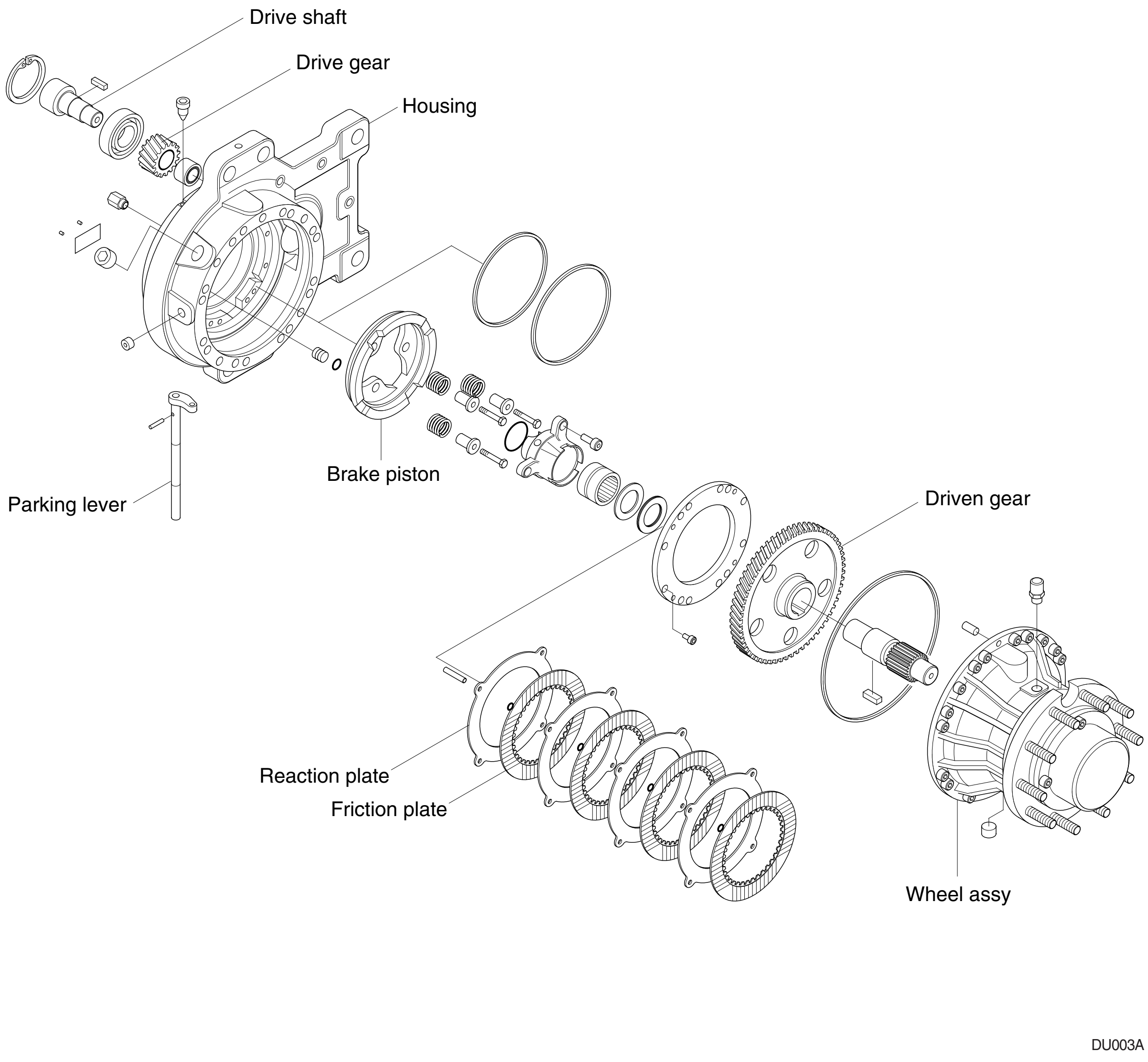
## GROUP 2 TROUBLESHOOTING

| Problem | Cause | Remedy |
|---|---|---|
| **1. Noise** | | |
| 1) Knock ing conditional on speed | · Gearing of helical gear steep has been damaged when mounting motor. | - Dismount electric motor.<br>Check drive pinion and helical gear for damage. |
| 2) Singing noise | · Motor connection is not correct. | - Check motor connection. |
| | · Motor bearing is faulty. | - Check motor bearing. |
| 3) Muffled grinding noise | · Wheel bearings faulty.<br>- Due to insufficient gear oil level.<br>- Inadmissibly high prestress of bearings. | - Have bearings checked in a workshop. |
| | · Gearing of planetary step is damaged<br>- Due to insufficient gear oil level.<br>- Due to excessive bearing clearance of wheel. | - Have gear set of planetary step and wheel bearings checked in a workshop. |
| **2. Leakage** | | |
| 1) Breather valve | · Excessive gear oil level. | - Check gear oil level. |
| 2) Motor | · O-ring seal faulty. | - Dismount electric motor, check O-ring and sealing surfaces for damages. |
| 3) Wheel shaft | · Sealing ring of wheel shaft faulty. | - Check sealing ring and wheel shaft for damages in the sealing area. |
| 4) Brake lever | · Sealing ring of brake lever faulty. | - Check sealing ring and straight pin for damages in the sealing area.<br>Consult workshop. |
| 5) Drive line overheat | · Gear oil level is either too high or too low. | - Check gear oil level. |
| | · Wheel bearings with an excessive pretension. | - Check clearance of wheel shaft. |

# GROUP 3 DISASSEMBLY AND ASSEMBLY

## 1. THE DRIVE AXLE ASSY

### 1) STRUCTURE

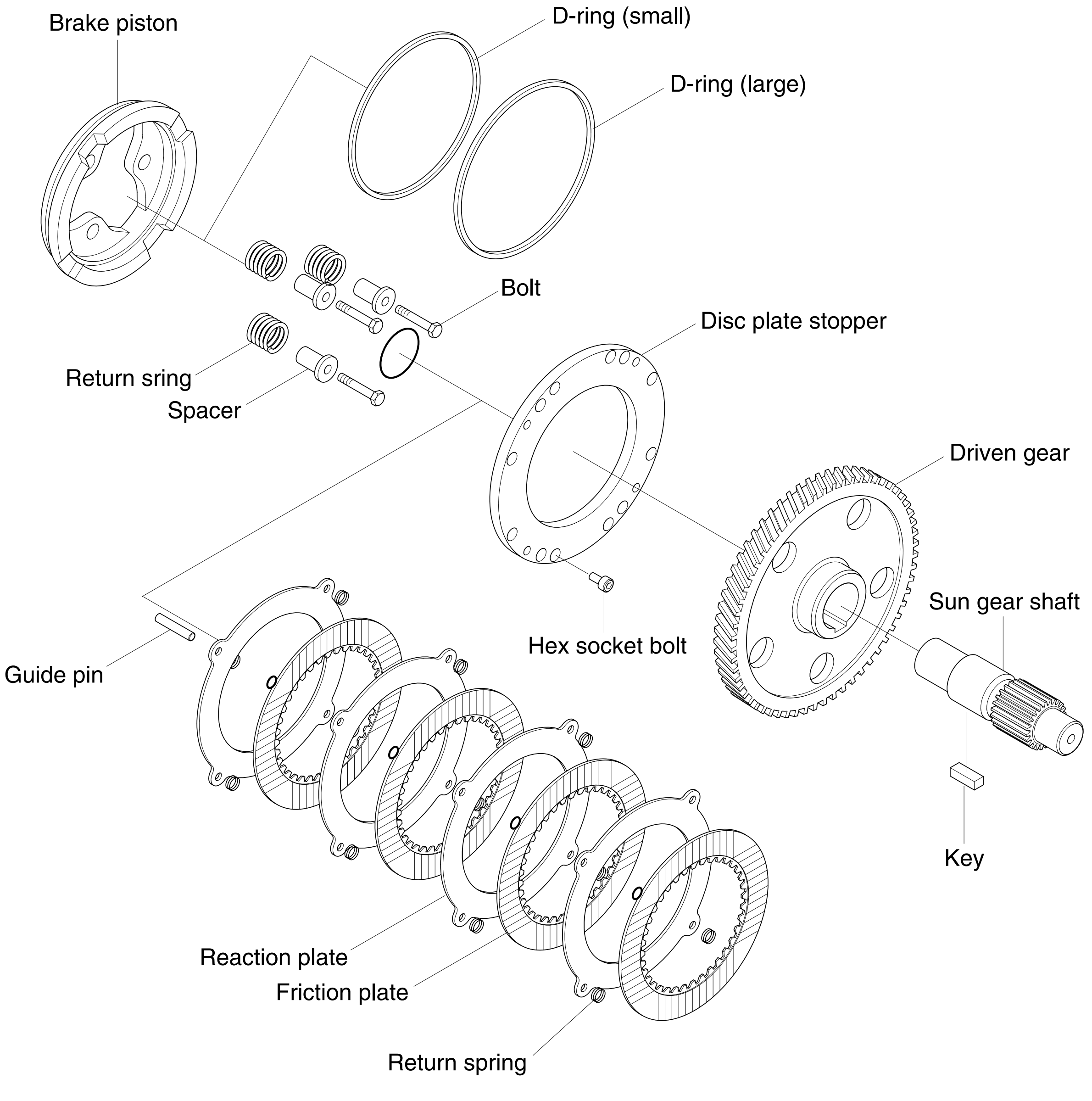



※ Arrange all the components according to disassembled sequence when disassembling the drive axle assy.

※ Record using the felt-tip pen if necessary and provide the components to discriminate easily.

※ Store the disassembled components to clean place for cleaness of it.

2) DISASSEMBLY OF SERVICE BRAKE




(1) Disassemble the sun gear shaft and the driven gear from the bearing boss.

(2) Loosen and remove the socket bolts (14 EA) to fix the stopper using the special tool.

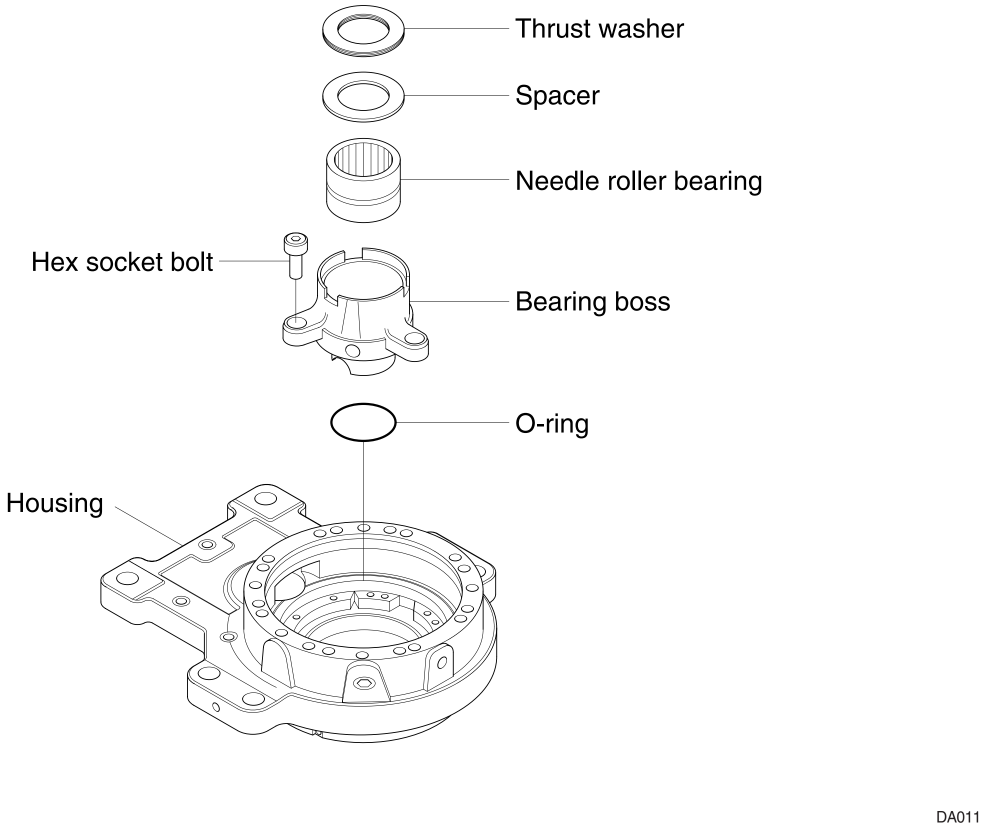
(3) Disassemble the reaction plates (4 pcs) and the friction plates (4 pcs) from the housing.

※ When disassembling the reaction plates and the friction plate, take care to damage or loss of the return springs (16EA).

(4) Remove the bolts to fix the piston from the housing using the spaner or wrench.

※ When disassembling the piston, let air pressure into the brake port.

### 3) DISASSEMBLY OF BEARING BOSS




(1) Remove the thrust washer and spacer from the bearing boss.

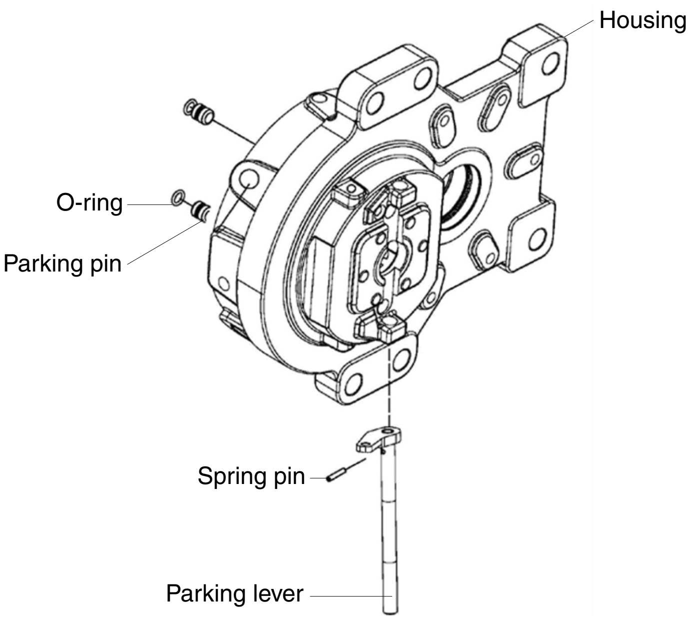
(2) Disassemble the hex socket bolts (3EA) to fix the bearing boss from the housing using the special tool.

(3) Take care to the damage and the break away of the O-ring for the bearing boss.

※ When disassembling the bearing boss, always renew the O-ring.

4) DISASSEMBLY OF PARKING LEVER AND DRIVE SHAFT ASSY

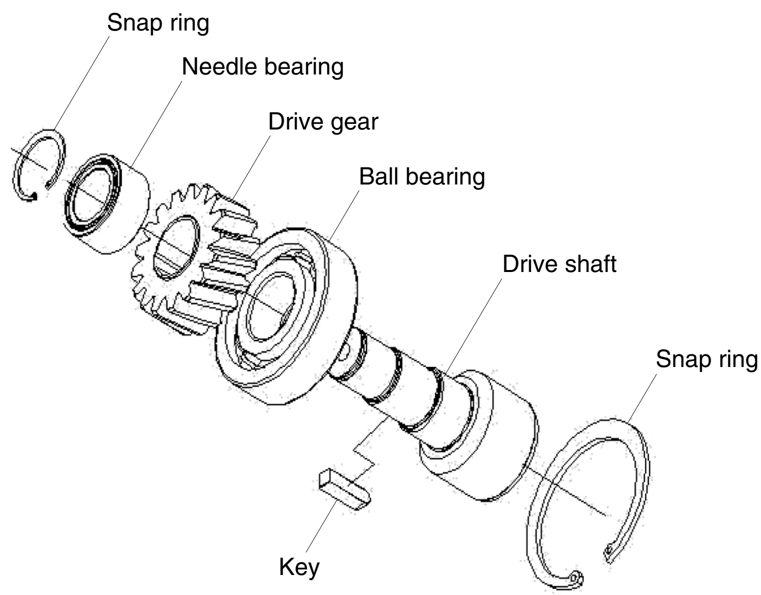
(1) The parking lever and pin




DA012A

① Remove the spring pin using the pryer.
② Remove the parking pin and the O-ring from the housing using the rubber mallet and driver.
※ Take tare to do not damage for the O-ring of the parking pin.
③ Remove the parking lever from the housing.

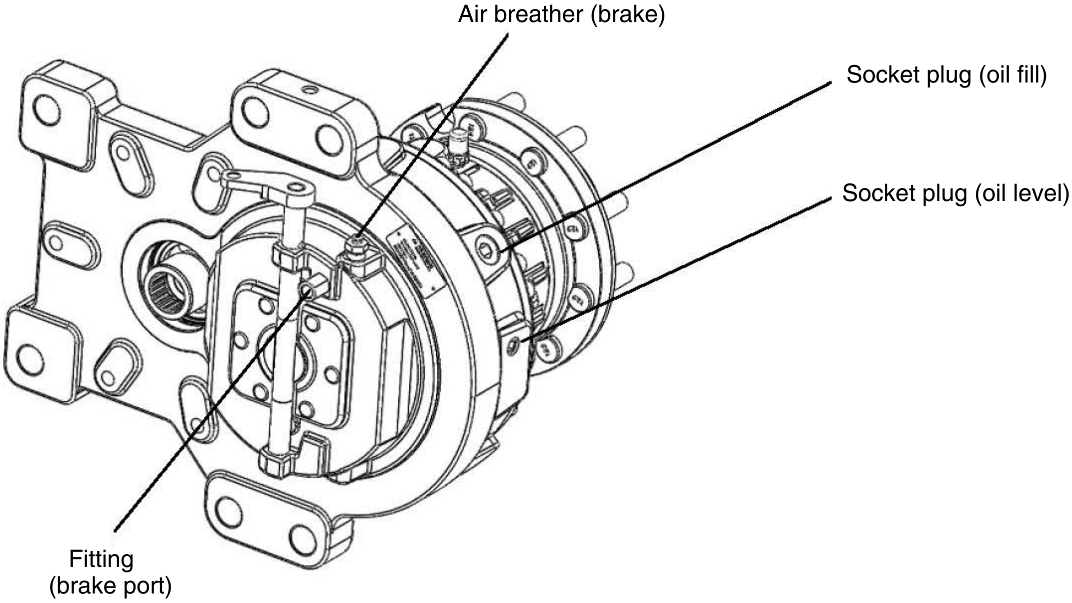
(2) The drive shaft assy

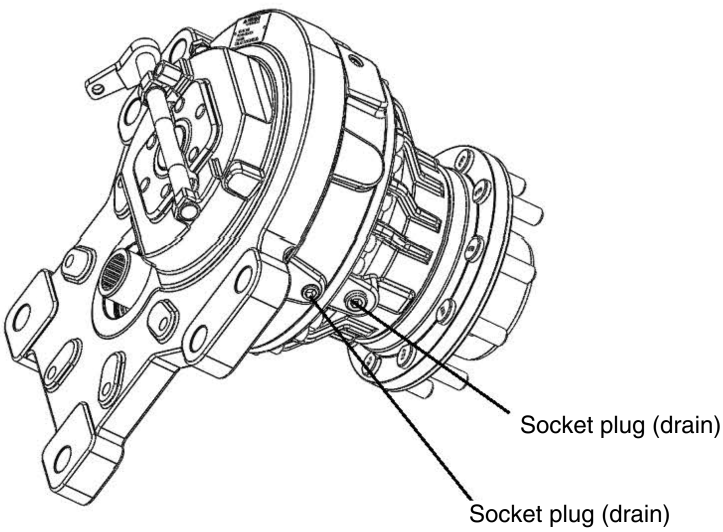



DA012B

① Remove snap ring from the drive shaft.
② Disassemble the drive gear and the key from the drive shaft.
③ Disassemble the ball bearing from the drive shaft using the gear puller.
※ When disassembling the ball bearing, fix the gear to the inner race of the ball bearing.

## 5) DISASSEMBLY OF THE BRAKE FITTING AND PLUG




DA013

(1) Remove the fitting of the brake port and the air breather.

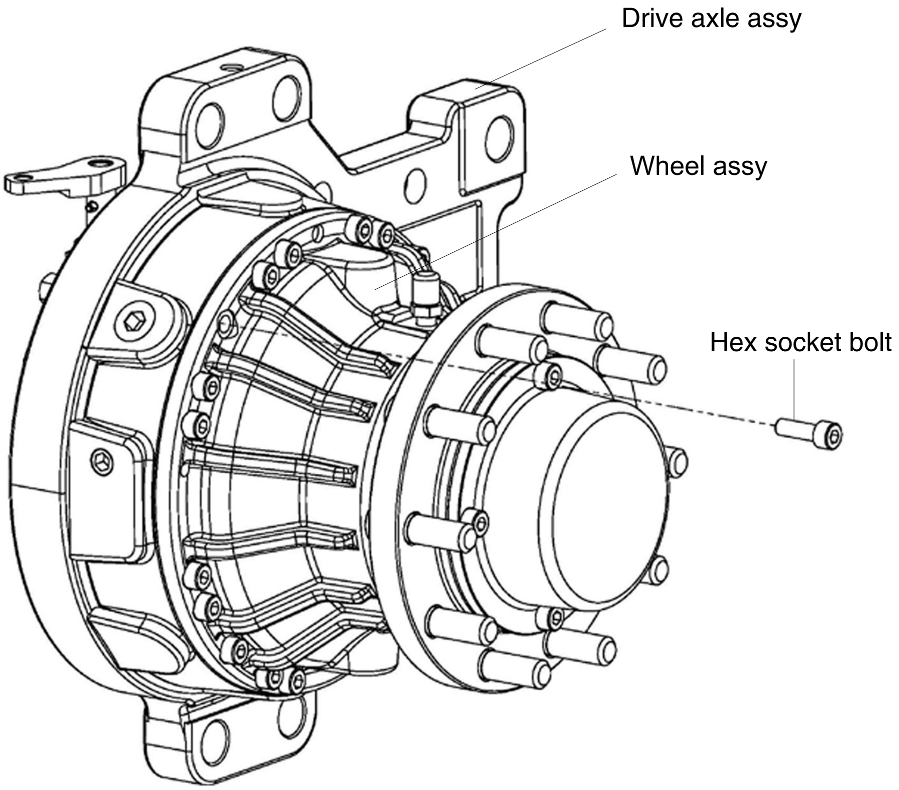
(2) Remove the socket plug (oil level and filling).

(3) Remove the socket plug (drain 2EA).

## 2. DISASSEMBLY OF THE WHEEL ASSY

### 1) REMOVE THE WHEEL ASSY

Loosen the hex socket bolts using the special tool and remove the wheel assy from the drive axle assy.



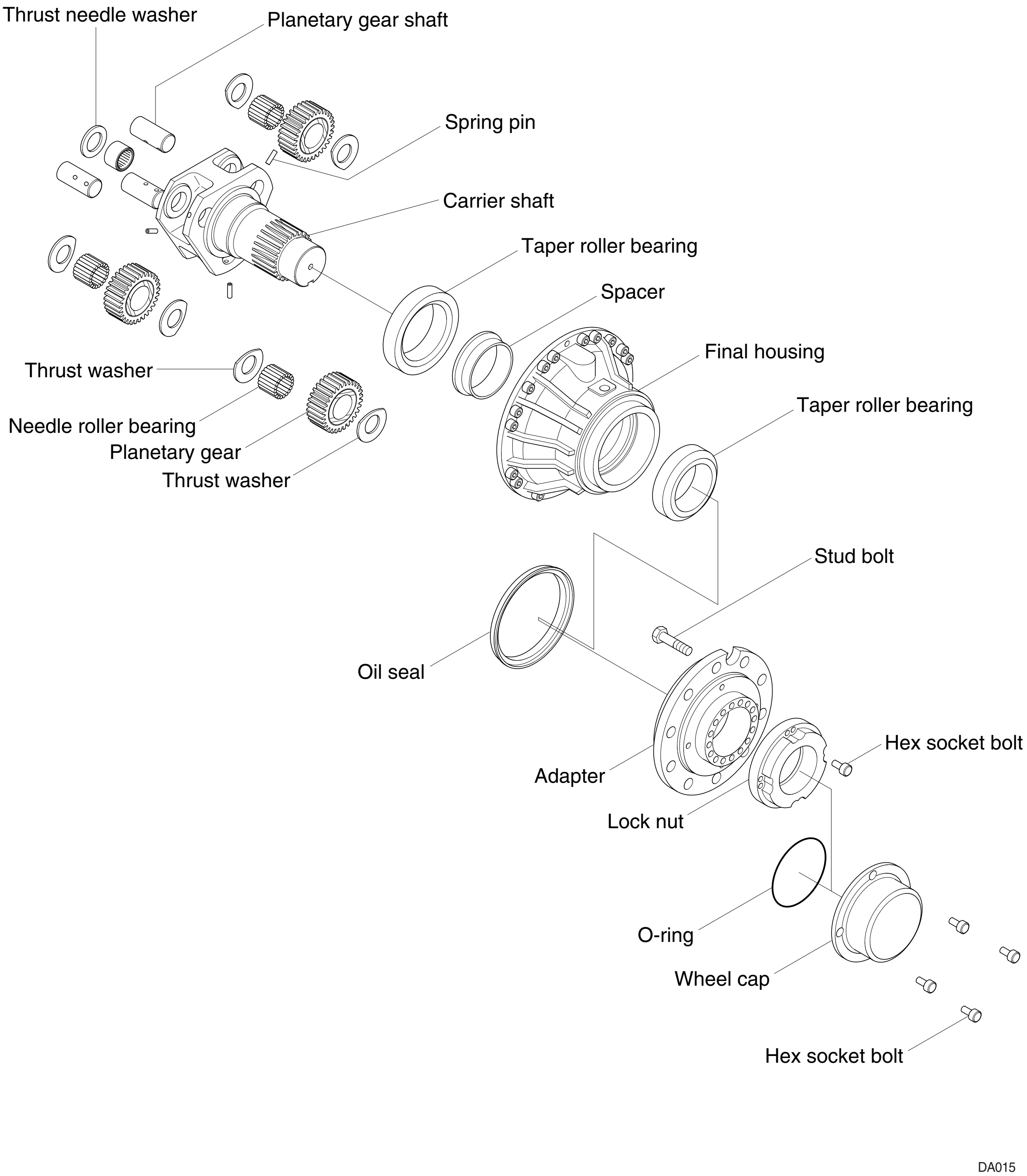

DA014

※ When disassembling the wheel assy, arrange the all components in regular sequence for dissassembling.

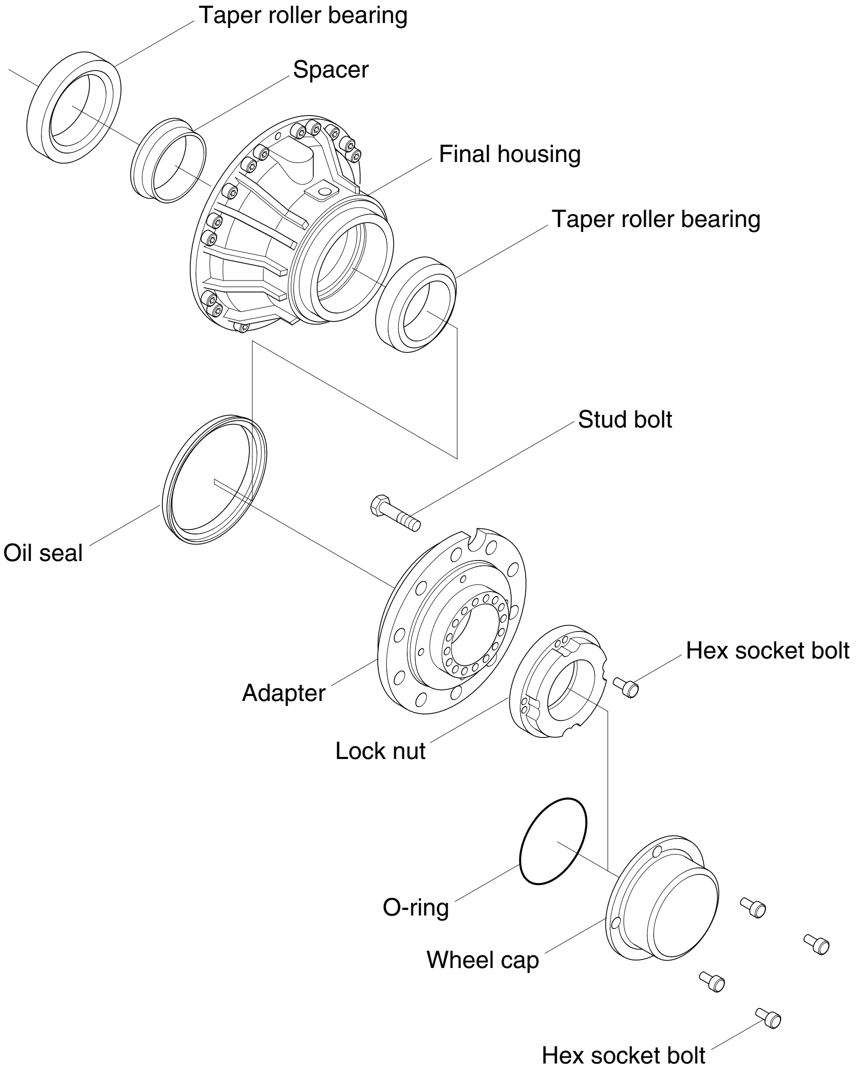
※ Disassemble according to regular sequence for all components.

※ Record using the felt-tip pen if necessary and provide the components to discriminate easily.

(1) Disassembly of the carrier and the hub bearing

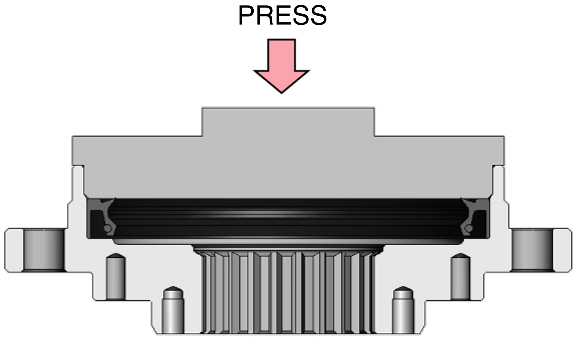


(2) Disassembly of the wheel sub assy




DA016A

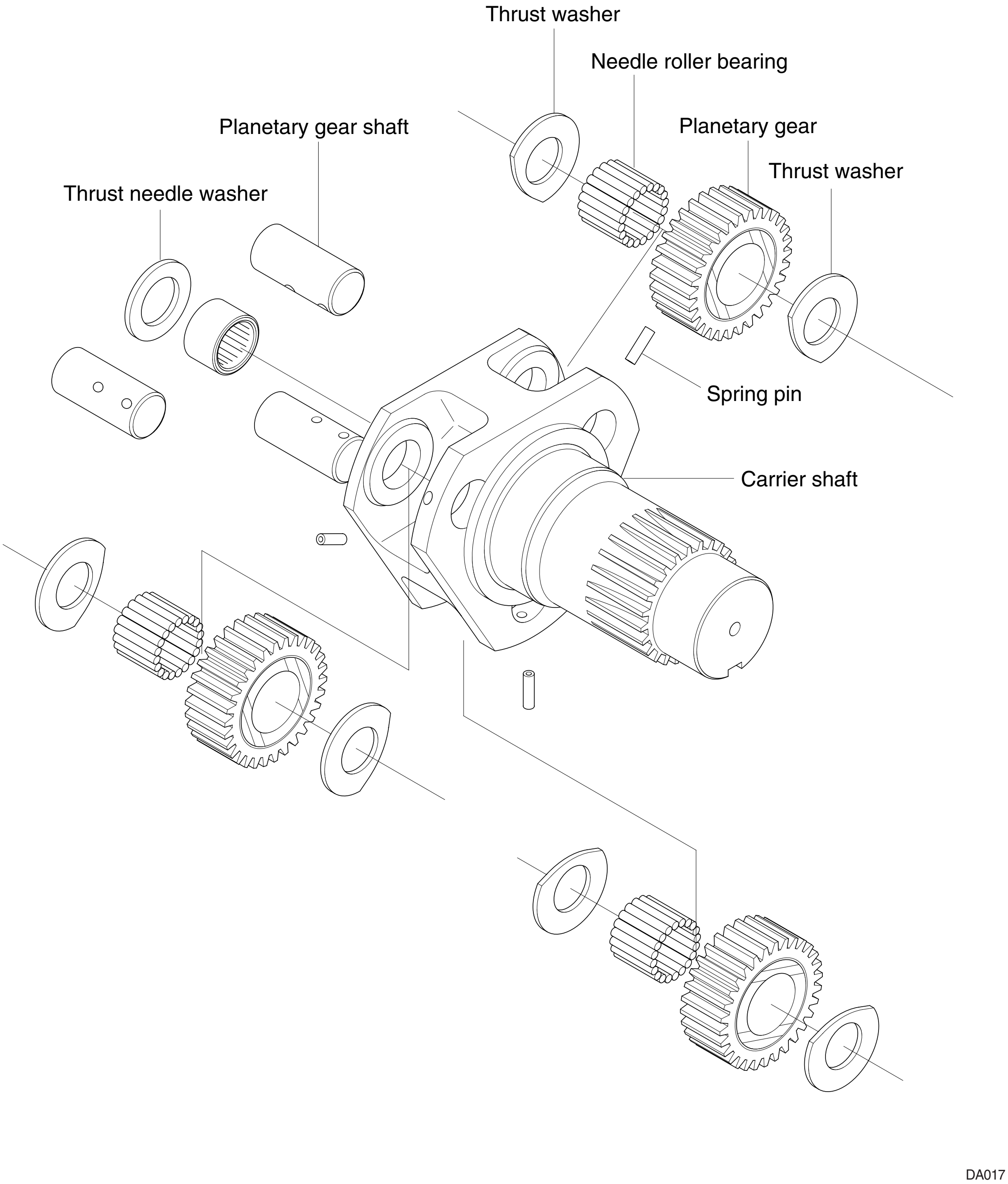
① Loosen the hex socket bolts (4EA) to fix the wheel cap using the special tool and disassemble the wheel cap from the wheel adapter.
② Remove the hex socket bolts to fix the lock nut.
③ Disassemble the lock nut to fix the adapter from the carrier shaft.
④ Disassemble the wheel adapter from the carrier shaft.
※ Take care not to damage the oil seal which is inserted in the wheel adapter.
⑤ Disassemble the taper roller bearing after putting on the wheel assy to the press.




DA016B

Assembly method of the oil seal using the jig

(3) Disassembly of the carrier shaft assy




① Set up straightly the carrier shaft assy on the flat place.
② Remove the spring pin to fix the planetary gear shaft using pliers or tool.
③ Disassemble the planetary gear shaft tapping smoothly using the mallet or tool in two or three times.

– Repeat the disassembly for the planetary gear shaft assys (3EA).

**⚠ When reassembling the planetary gear shaft, take care not to lose the spring pins. Always make sure that the spring pins are assembled to the planetary gear shaft after assembling.**

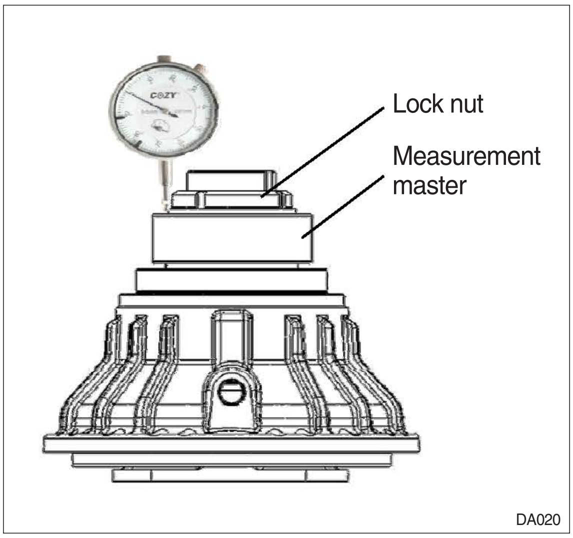
## 3. ADJUSTMENT

### 1) PRELOAD AND ADJUSTMENT OF THE HUB TAPER ROLLER BEARING

#### (1) Tools for assemble and disassemble

① Adapter for lock nut
② Torque wrench : set 20 kgf · m
③ Minus (-) driver
④ Rubber hammer

#### (2) Measuring the spacer



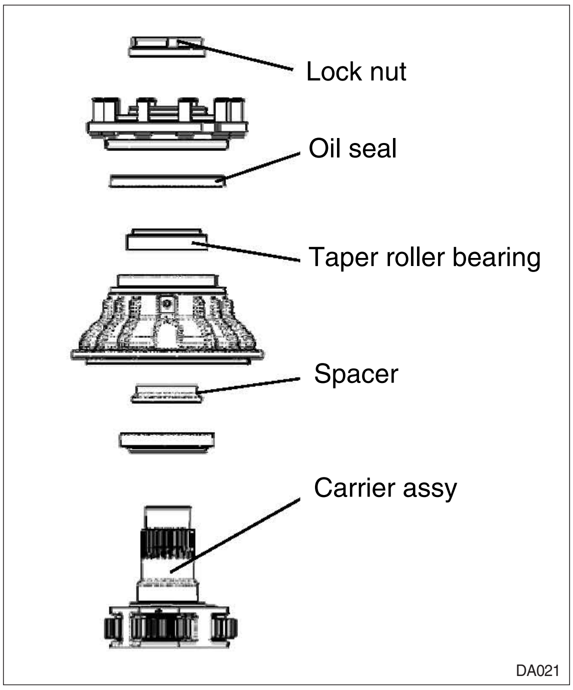

① Before the spacer assembling
- Measure the spacer by using a measurement master.
- Press in the outer race of the bearing into the housing.
- First, combine the taper roller bearing into carrier shaft and tighten and set the pre-load adjustment nut to 20 kgf · m and record the reading value of the dial gauge.

② After the spacer assembled.
- Assemble the spacer which is selected as above method and apply the pre-load.
- Measure the pre-load on the assembled parts using the dial gauge.

③ Compare the values which are measured by above ① and ②.
① > ② : Add the spacer
① < ② : Reduce the spacer

※ Use the correct spacer according to measuring value.

#### (3) Pre-load adjustment order

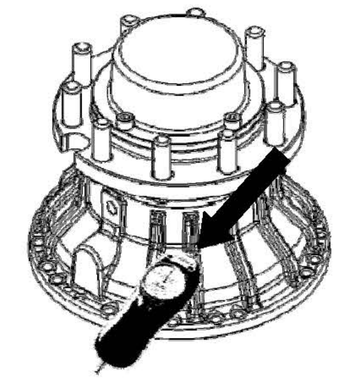



① Put the bearing cup into the final housing and press in by using a assembling jig.
② Locate the correct spacer as right figure.
③ Locate the taper roller bearing as right figure.
④ Press in the bearing by a press and a press in jig.
Tap a plastic hammer on the bearing and rotate the wheel adapter 2 or 3 times.
⑤ Tighten the pre-load adjustment nut and set the torque value.
(Torque wrench torque setting : 20 kgf·m)
⑥ Prevent loosening by tighten the bolt.

⑦ Measure the pre-load value using a push pull gauge as right figure.

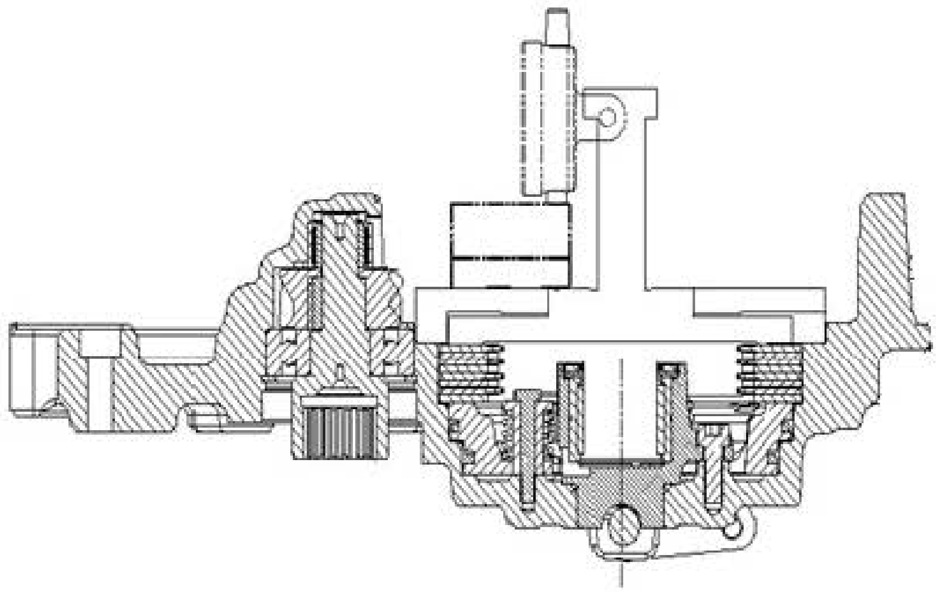
- Torque spec of push pull gauge :

12~15 kgf·m



DA022

## 2) CLEARANCE ADJUSTMENT OF THE BRAKE DISC



DA023

### (1) Tools for setting

① Measurement jig
② Dial gauge

### (2) Pre-load adjustment order

① Assemble the friction plates and reaction plates into the housing normally.
② Install the measuring jig each on the housing surface and brake disc surface until contact correctly.
③ Put a dial gauge on the jig.
④ Measure the difference of height from jig face to jig face.
※ When measuring, apply the pre-load (150 kgf · m) on the brake disc.
⑤ If the deviation value of the dial gauge is zero (0), the measured clearance is set correctly as 0.9 mm.
⑥ The clearance adjustment according to measuring value is decided by the thickness of the disc plate stopper.
The setting stroke is decided according to the specifications. (Refer to spec.)
⑦ Measured clearance > 0.9 mm : Use a large-thickness stopper
⑧ Measured clearance < 0.9 mm : Use a small-thickness stopper

**Measure value and stroke specifications**

| Measure value | Setting stroke (mm) |
|---|---|
| -0.15 | 0.95 |
| -0.10 | 0.9 |
| -0.05 | 0.85 |
| 0 | 0.8 |
| 0.05 | 0.75 |
| 0.1 | 0.7 |
| 0.15 | 0.62 |

Spec : 0.85~0.9 mm

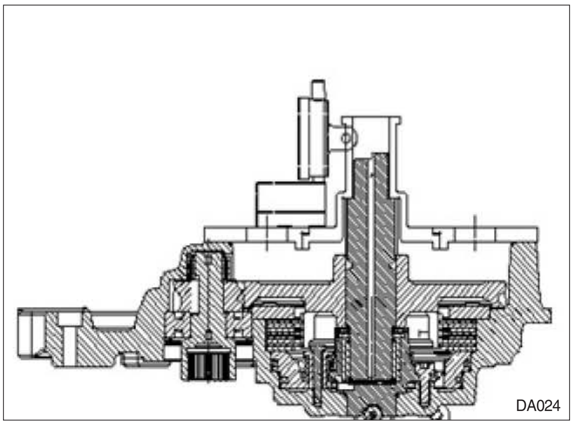
## 3) CLEARANCE ADJUSTMENT OF THRUST NEEDLE BEARING

### (1) Tools for setting

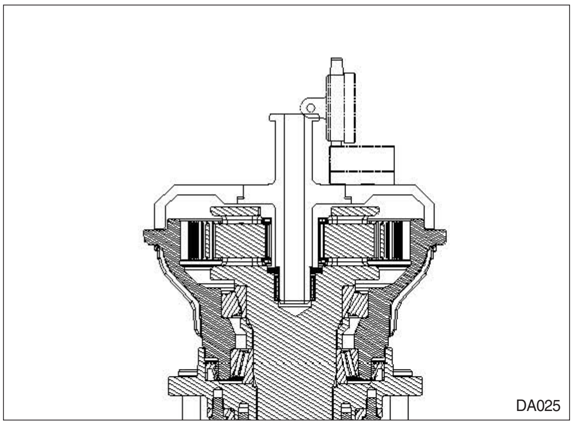
① Measurement jig
② Dial gauge

### (2) Clearance measuring method

① Place the assembled drive shaft on a special jig or a flat surface.
② Set a measuring jig as right figure.
③ Put a dial gauge on the measuring jig and measure the height difference of the measuring jig.
④ Record the reading value of the dial gauge.
⑤ Place the assembled wheel assy on a special jig or a flat surface.
⑥ Set a measuring jig on the wheel assy as right figure.
⑦ Record the reading value of the dial gauge.
⑧ Calculate the height difference between the drive shaft side and wheel assy side and set the clearance of the axial direction.
⑨ Set the specification according to the clearance specification of the thrust needle bearing.
· Specification : 0.05~0.1 mm



DA024



DA025

### (3) The measurement value calculation and shim adjustment

① Add the reading values of the wheel assy and drive shaft.
② Standard shim thickness (3 mm) - ① = Adjustment shim thickness
③ If the add value (①) is zero (0), the setting clearance is 0.1 mm.
Prepare a correct spacer according to measured value.
④ Example : 3 mm, 3.1 mm, 3.2 mm

# SECTION 4 BRAKE SYSTEM

## GROUP 1 STRUCTURE AND FUNCTION

### 1. OUTLINE

There are two brake systems, the service brake system and the parking brake system.

In the service brake system, oil pressure is generated in the master cylinder by treading on the brake pedal. This pressure causes the brake lever to press the pressure pin which gives braking pressure to the disk carrier.

In the parking brake system, the brake lever is operated by cable. Therefore the pressure pin makes braking pressure onto the disk carrier.

### 2. SPECIFICATION

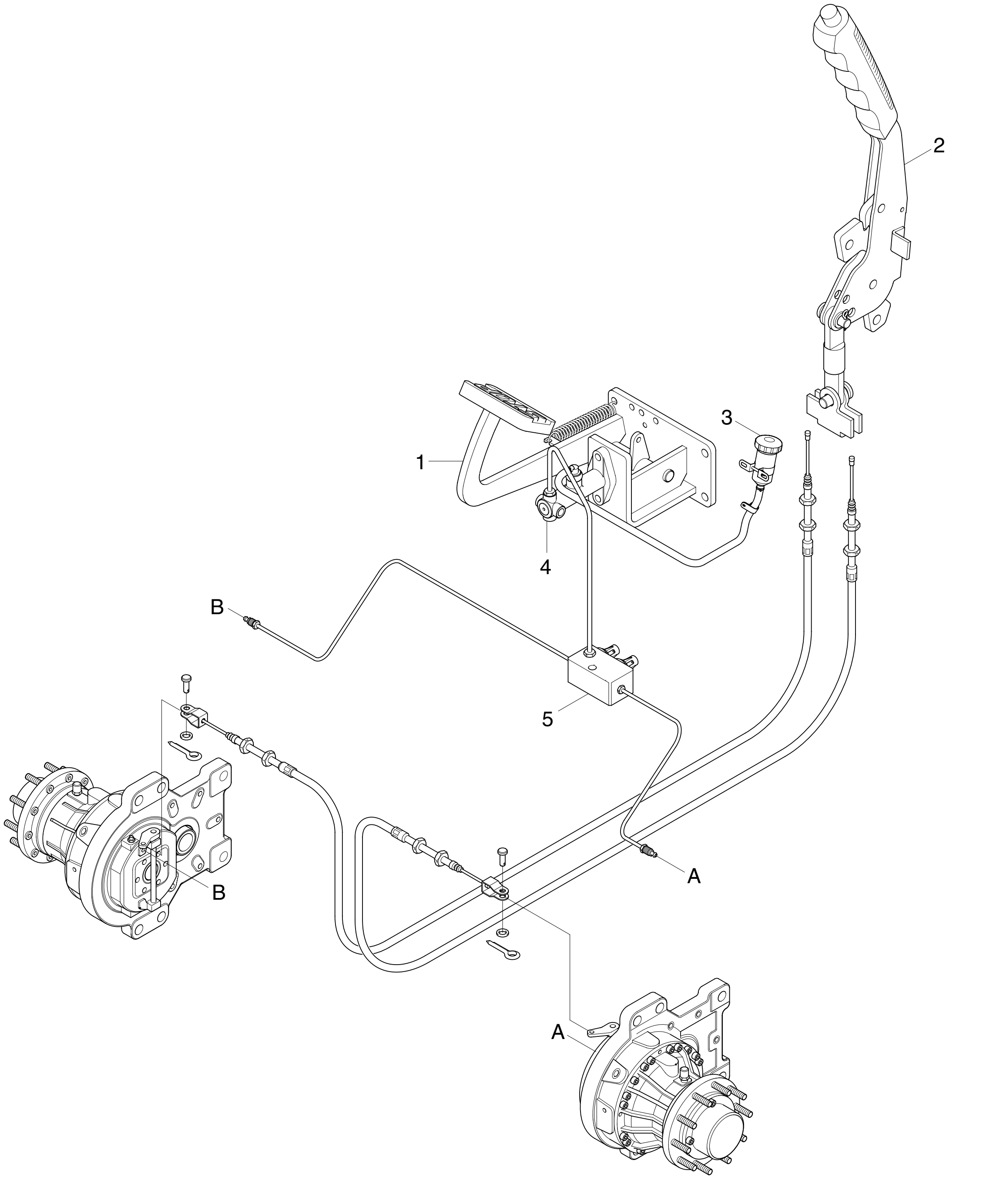
#### 1) SERVICE BRAKE

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

#### 2) PARKING BRAKE

| Item | Specification |
|---|---|
| Type | Ratchet, internal expanding mechanical type |
| Parking lever stroke | 13.5 degree |
| Parking cable stroke | 60 mm |

## 3. BRAKE PEDAL AND PIPING




| | | | | | |
|---|---|---|---|---|---|
| 1 | Brake pedal assy | 3 | Reservoir tank assy | 5 | 5-way block |
| 2 | Parking lever assy | 4 | Brake valve assy | | |

## 4. CONNECTING THE BRAKE

We recommend to use a two-stage output cylinder for the service brake. Advantage compared to a single stage cylinder : the pedal stroke can be as small as possible.

Three connections M10×1 are provided for connecting the hydraulic brake system and the brake cable.

### 1) CONNECTING THE HYDRAULIC BRAKE SYSTEM

Connect the bleeder and the brake hose (hydraulic line) according to the assembly position.

· Tightening torque : 1.2~1.6 kgf · m (9~12 lbf · ft)

When placing the hydraulic lines, the bending radii should be kept as large as possible to keep the resistance against the restoring forces for lifting the break as small as possible.

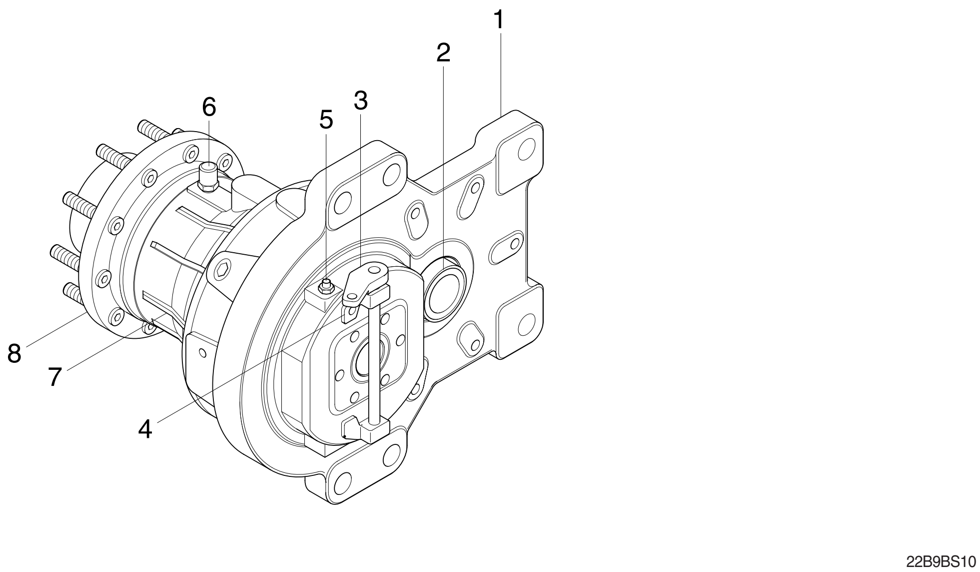
### 2) CONNECTING THE PARKING BRAKE CABLE

Screw the parking brake cable into the lever.

Check and maintain the installation dimensions when the installation has been finished.

When placing the brake cable, the bending radii should be kept as large as possible to keep the resistance against restoring forces of the brake as small as possible.

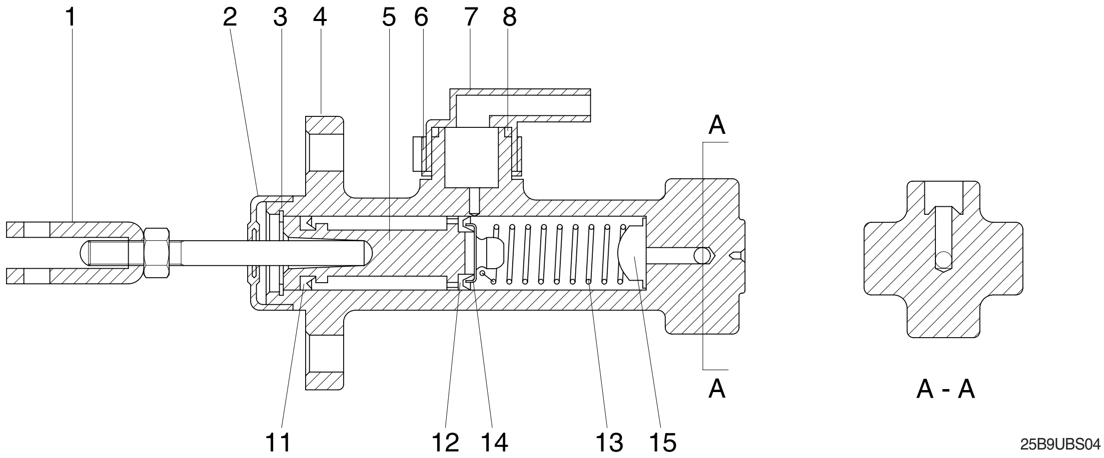
**⚠ Bleed the brake system after filling of brake fluid.** **Refer to page 4-7.**




| | | | | | |
|---|---|---|---|---|---|
| 1 | Housing | 4 | Brake port | 7 | Final housing |
| 2 | Gear drive shaft | 5 | Bleeding valve | 8 | Wheel hub |
| 3 | Parking lever | 6 | Air breather | | |

## 5. BRAKE VALVE

### 1) STRUCTURE




| | | | | | |
|---|---|---|---|---|---|
| 1 | Rod assy | 6 | Union | 13 | Spring |
| 2 | Boot | 7 | Elbow | 14 | Spring seat |
| 3 | Snap ring | 8 | O-ring | 15 | Spring seat |
| 4 | Body | 11 | Secondary cup | | |
| 5 | Piston | 12 | Primary cup | | |

### 2) DISASSEMBLY

(1) Remove the boot (2) and remove the rod assy (1).

(2) Remove the snap ring (3) and take out the piston (5), the secondary cup (11), primary cup (12), spring (13) and spring seat (14, 15).

(3) Specification of brake valve.

· Cylinder bore diameter : 19.05 mm

· Piston stroke : 23.0 mm

### 3) INSPECTION

(1) Clean and check these components.

※ Use isopropyl alcohol or brake fluid for washing the components. Do not use gasoline, kerosene or any other mineral oils. When using alcohol, do not leave rubber parts in the liquid for more than 30 seconds.

(2) Inspect the inside wall of the body, and if any faults are found, replace the brake valve assembly.

(3) Replace the boot (2), the secondary cup (11), primary cup (12) and piston (5), if deformation or any other defect is found.

### 4) ASSEMBLY

※ Prior to assembly make sure again of no contaminant of the components. Apply a thin coat of brake oil to the components.

· Assembly is in opposite order to disassembly.

## GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

### 1. OPERATIONAL CHECKS

#### 1) BRAKE PIPING

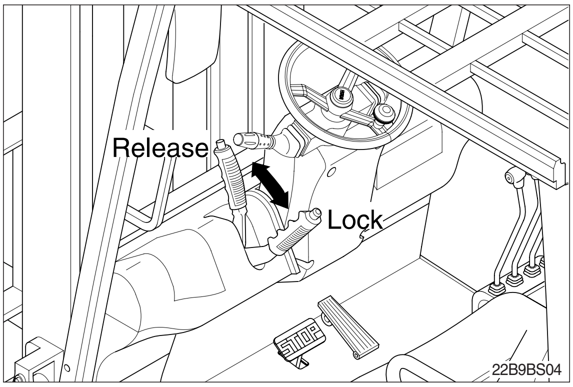
(1) Check pipes, hoses and joints for damage, oil leakage or interference.
(2) Operate brake pedal and check operating force when pedal in depressed. Check also change in operating force, and change in position of pedal when pedal is kept depressed.

#### 2) BRAKING FORCE

(1) Select a dry, flat, paved surface and, drive truck at maximum speed. When signal is given, stop truck immediately and measure distance from point where signal was given to point where truck stopped (unloaded)
  · Stopping distance : Within 5 m (16' 5")
(2) Check that there is no pulling of steering wheel, pulling by brakes to one side or abnormal noise when making emergency stops.

#### 3) PARKING BRAKE

(1) Operating force of parking lever is 20~30 kgf · m (144~217 lbf · ft).
(2) Check that parking brake can hold machine in position when loaded on 15% slope. If there is no slope available, travel at low speed and check braking effect of parking brake.



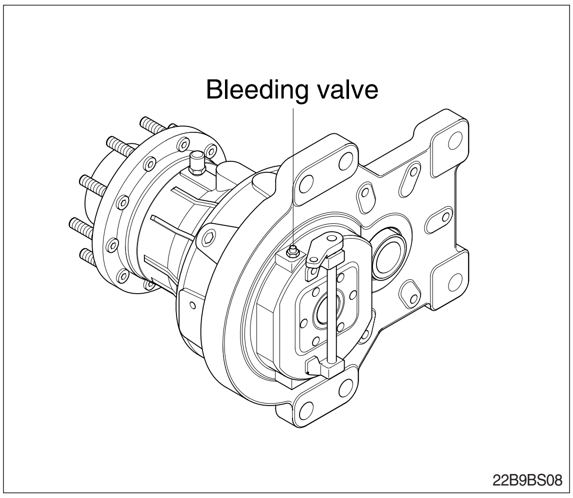
22B9BS04

## 2. TROUBLESHOOTING

| Problem | Cause | Remedy |
|---|---|---|
| Brakes do not work | · Oil leakage in the system or oil to low in tank.<br>· Air trapped in the system.<br>· Worn out of deteriorated piston cup in body resulting in oil leakage | · Repair oil leakage. After bleeding fill oil tank of brake valve to specified level with brake oil.<br>· Bleed air completely from the brake lever.<br>· Inspect body and piston for degree of wear.<br>On satisfactory, replace cup. |
| Brake pedal travel too large | · Air trapped in the system. | · Bleed air completely out.<br>· Inspect oil tube joints & connections and replace leaking parts. |
| Wheel feel heavy | · Return port in brake valve closed by piston cup.<br>· Return spring | · Inspect brake valve.<br>· Repair or replace pedal return spring. |

## GROUP 3 TESTS AND ADJUSTMENTS

### 1. BLEED THE BRAKE SYSTEM




The brake system must be bleeded after replenishing with brake fluid.

1) Remove cap from bleeding valve and fit proper hose to collect escaping brake fluid in a vessel.
2) Apply pressure by operating the brake pedal.
3) Open bleeding valve approx. half a turn with a spanner and press the brake pedal simultaneously to bleed the system.

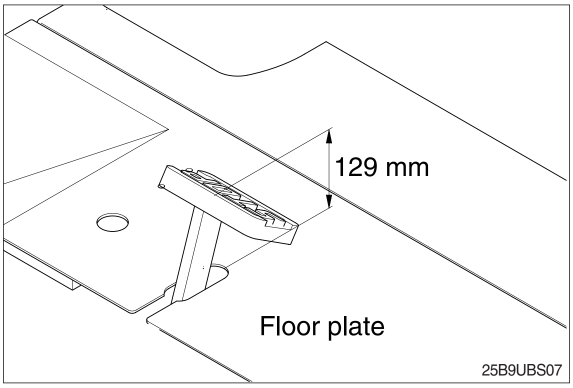
※ Collect escaping brake fluid into a suitable vessel.
Do not drain brake fluid into the soil or the gutters.

⚠ **Close the bleeding valve before releasing the brake pedal.**

※ Repeat this procedure until the brake fluid escapes without bubbles.
Check the brake fluid container for sufficient fluid and refill if necessary.

4) When brake fluid escapes without bubbles tighten bleeding valve, remove hose and put dust protector onto the bleeding valve.
   · Tightening torque : 5 kgf · m (37 lbf · ft)

### 2. ADJUSTMENT OF PEDAL

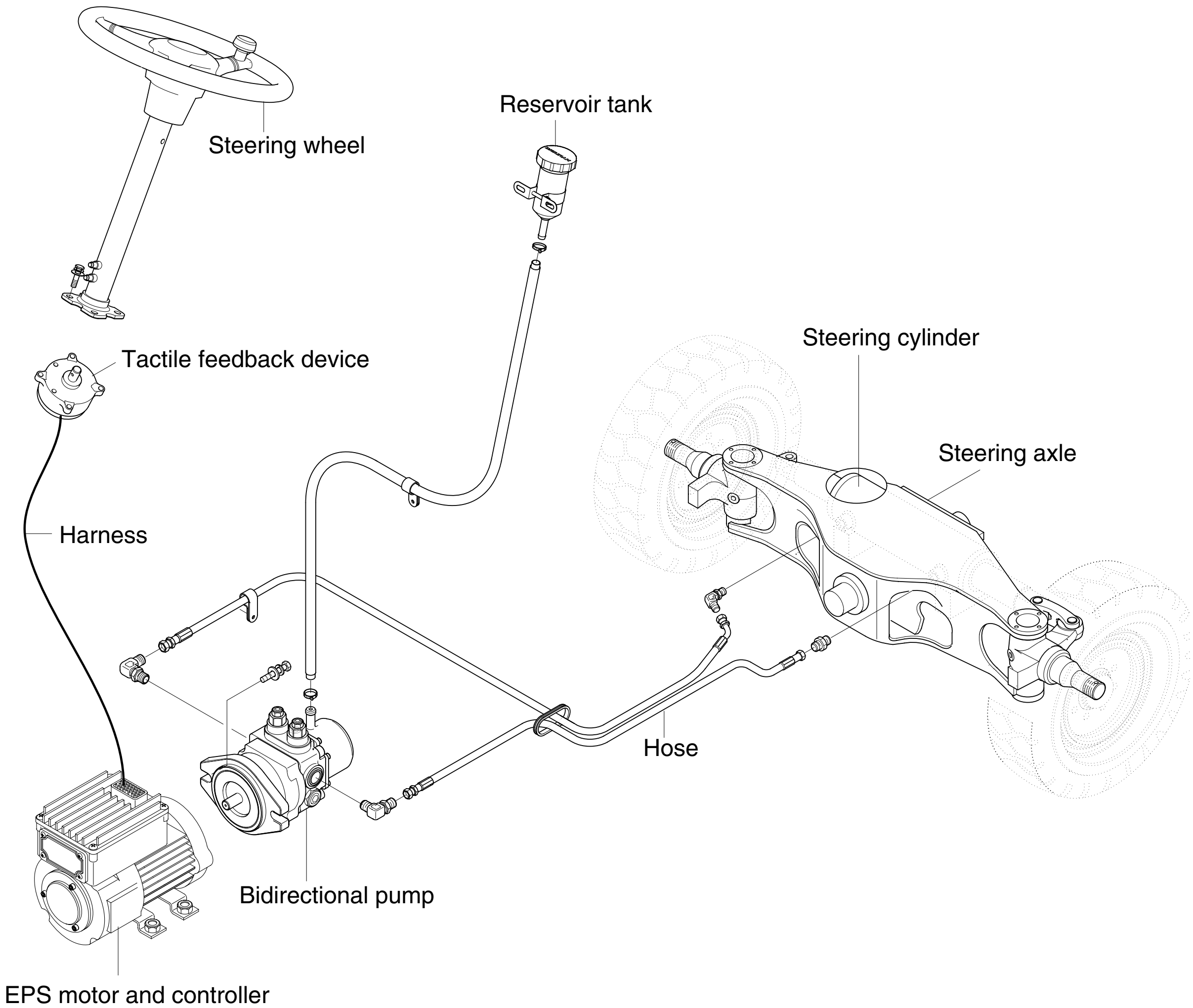



1) BRAKE PEDAL
   (1) Pedal height from floor plate adjust with stopper bolt.
   · Pedal height : 129 mm (5.1 in)
   (2) Play
   Adjust with rod of mast cylinder.
   · Pedal play : 4~6 mm (0.15~0.23 in)

# SECTION 5 STEERING SYSTEM

## GROUP 1 STRUCTURE AND FUNCTION

### 1. OUTLINE

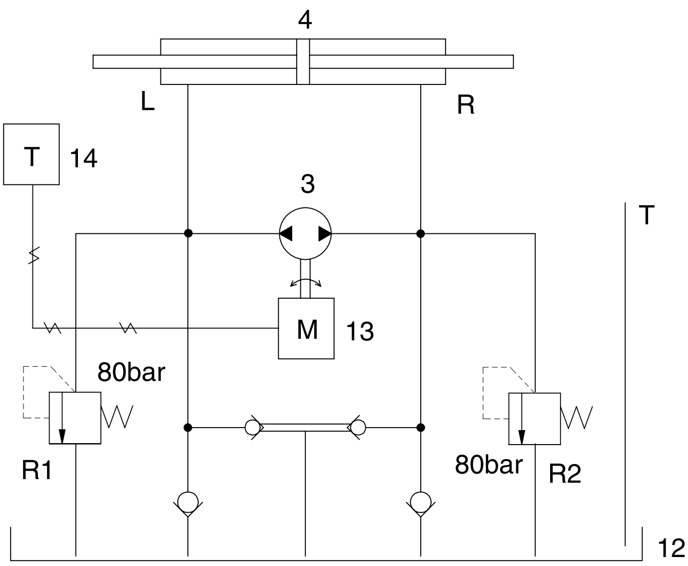



25B9USS01

The steering system for this machine is composed of steering wheel assembly, Tactile feedback device, EPS motor and controller, bidirectional pump, steering sensor, steering cylinder, steering axle and pipings. As the operator turns the steering wheel, the tactile feedback device detects and transmits the steering position to the EPS controller and the motor rotates. The bidirectional pump is rotated with the EPS motor and delivered pressurized oil to the steering cylinder. The force produced by the steering cylinder moves the knuckle of steering tires through the intermediate link.

The axle body is unit structure having steering knuckles installed to its both ends by means of king pins. Hub and wheel are mounted through bearing to spindle of knuckle.

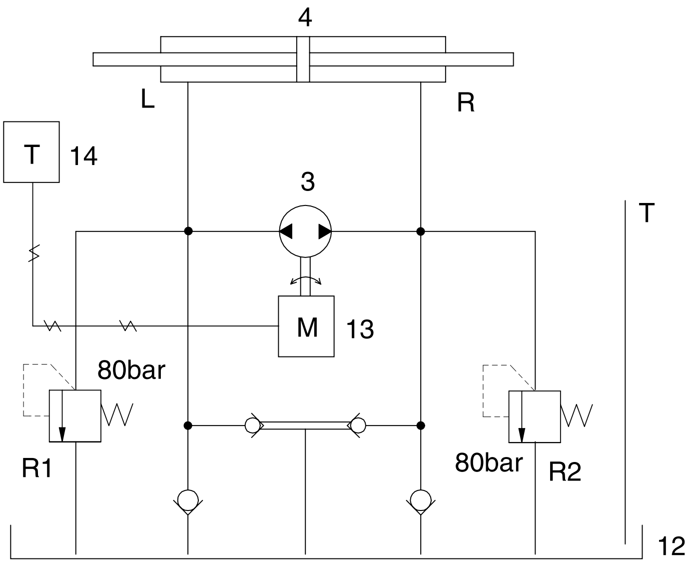
## 2. HYDRAULIC CIRCUIT




22B9SS02

| | | | | | |
|---|---|---|---|---|---|
| 3 | Bidirectional pump | 12 | Reservoir tank | 14 | Tactile feedback device |
| 4 | Steering cylinder | 13 | EPS motor and controller | | |

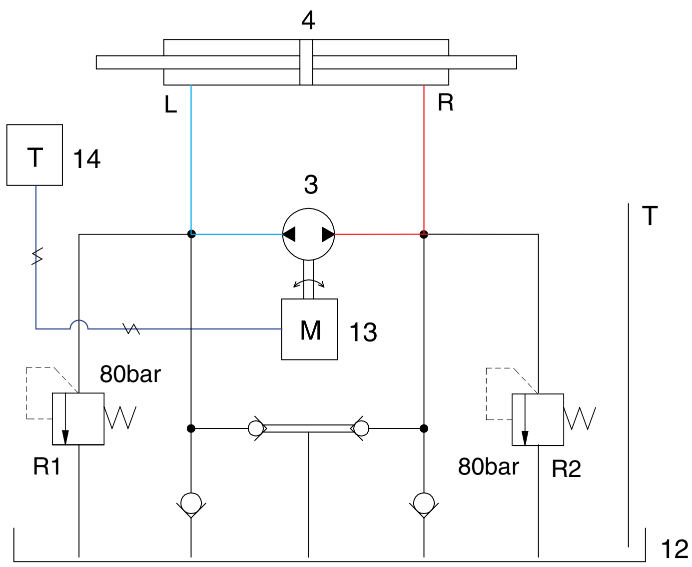
1) NEUTRAL




25B9USS02

The steering wheel is not being operated and the tactile feedback device does not sense any signal. The forklift keeps neutral position.

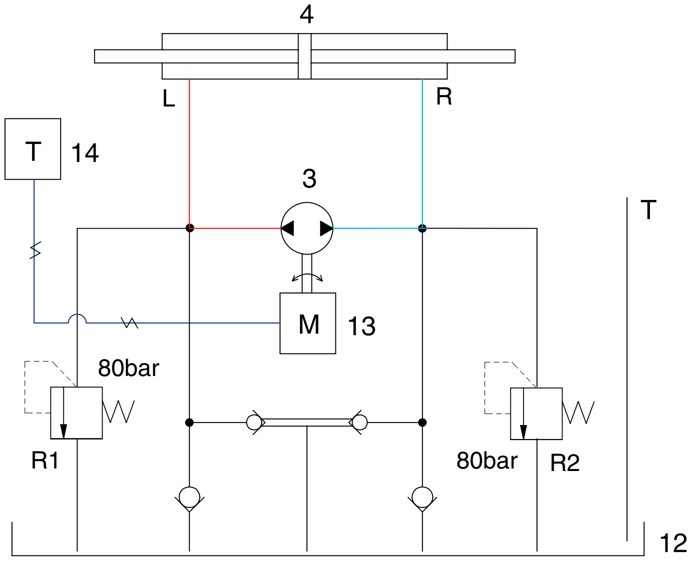
2) LEFT TURN




25B9USS03

When the steering wheel is turned to the left, the tactile feedback device senses left rotating signal and transmits to the EPS controller. The EPS motor and bidirectional pump is rotated and delivered pressurized oil to the port R of the steering cylinder and then the forklift turns to the left.

### 3) RIGHT TURN

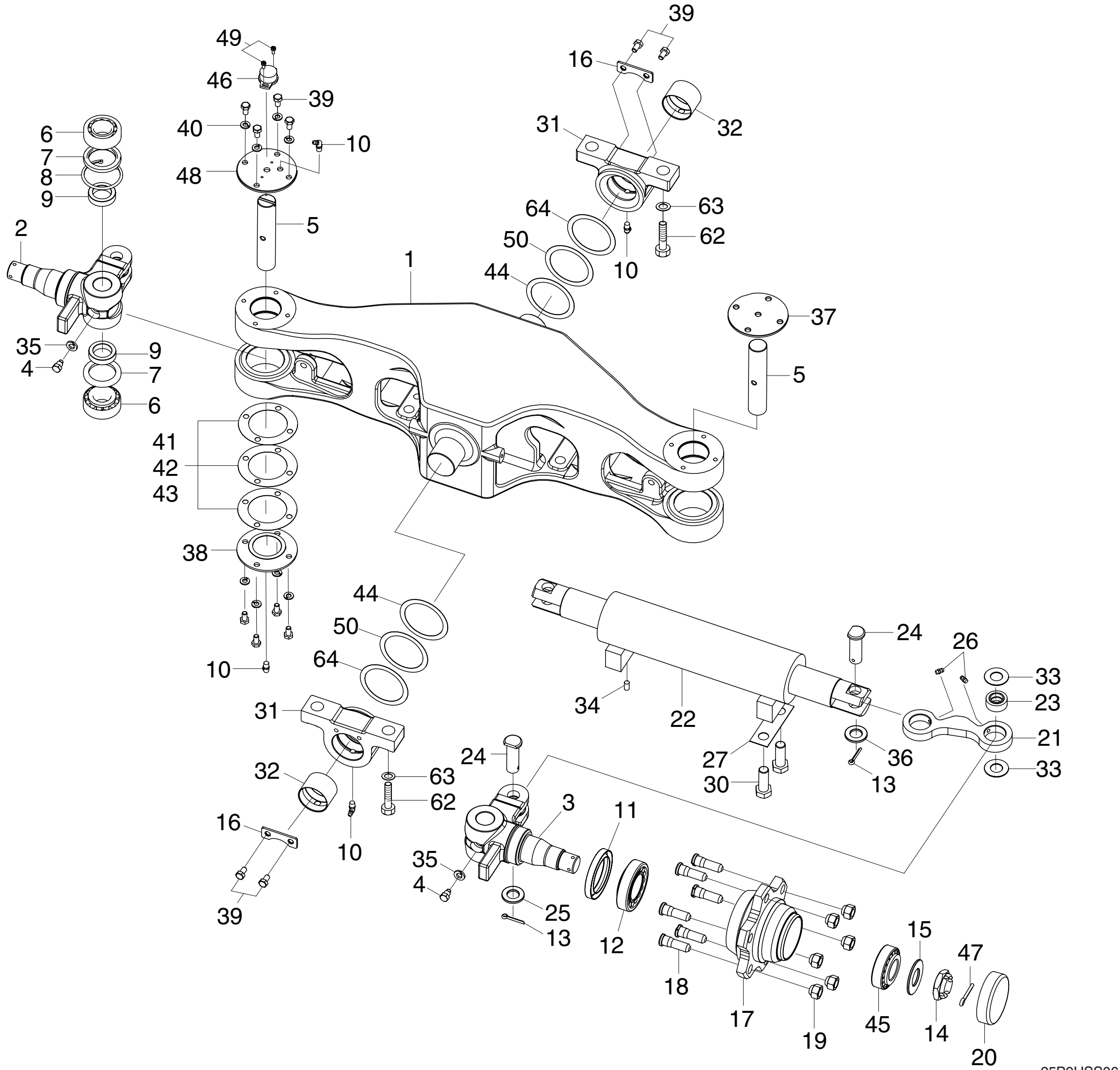



25B9USS04

When the steering wheel is turned to the right, the tactile feedback a senses right rotating signal and transmits to the EPS controller. The EPS motor and bidirectional pump is rotated and delivered pressurized oil to the port L of the steering cylinder and then the forklift turns to the right.

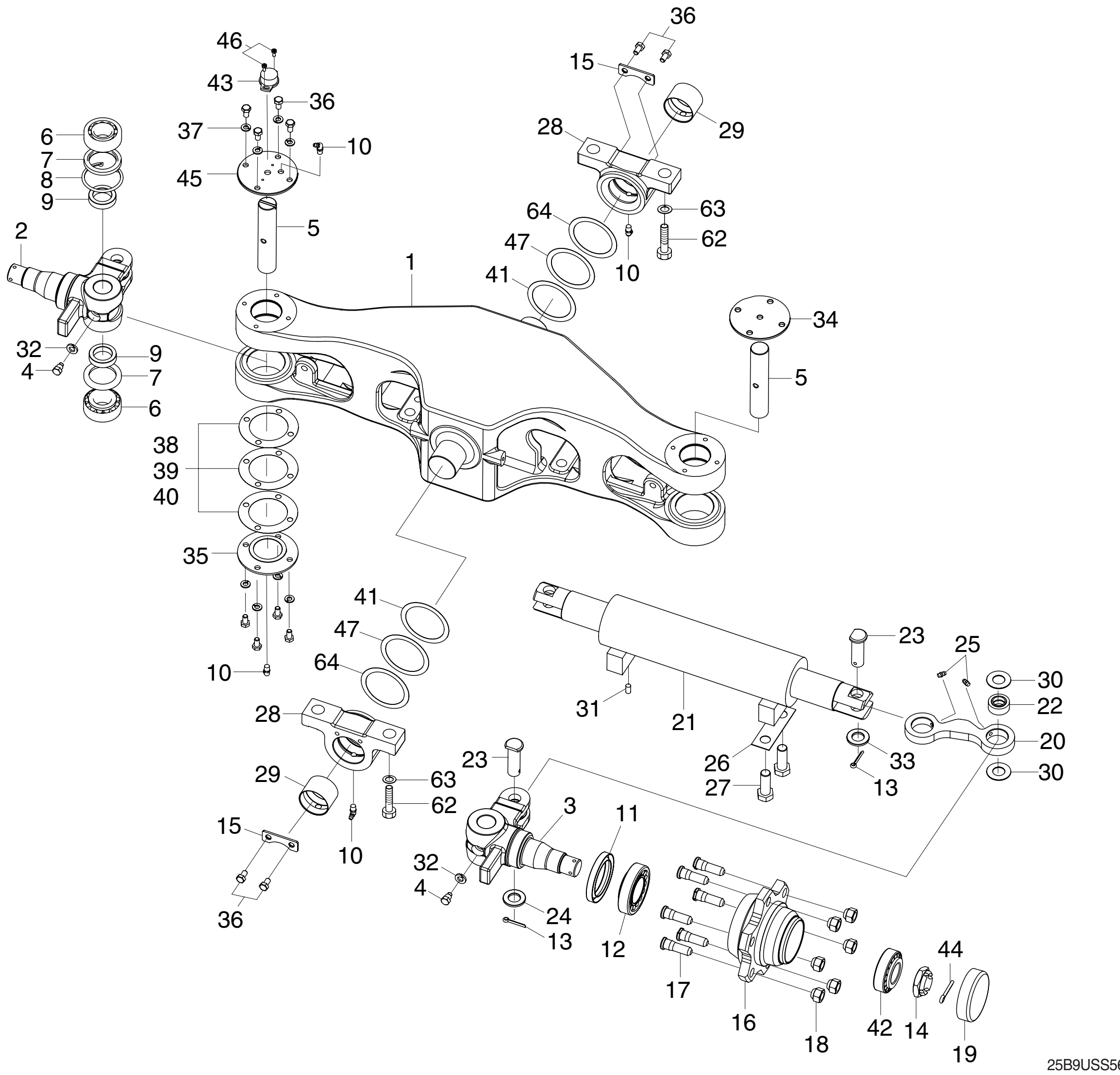
## 3. STEERING AXLE

### 1) STRUCTURE




| | | | | | |
|---|---|---|---|---|---|
| 1 | Steering axle body | 19 | Hub nut | 39 | Hex bolt |
| 2 | Knuckle-RH | 20 | Hub cap | 40 | Spring washer |
| 3 | Knuckle-LH | 21 | Steering link | 41 | Shim (0.1t) |
| 4 | Special bolt | 22 | Steering cylinder assy | 42 | Shim (0.15t) |
| 5 | King pin | 23 | Spherical plain bearing | 43 | Shim (0.3t) |
| 6 | Taper roller bearing | 24 | Steering link pin | 44 | Shim |
| 7 | Oil seal | 25 | Plain washer | 45 | Taper roller bearing |
| 8 | Snap ring | 26 | Grease nipple | 46 | Steering sensor |
| 9 | Collar | 27 | Lock plate | 47 | Split pin |
| 10 | Grease nipple | 30 | Hex bolt | 48 | Cover |
| 11 | Oil seal | 31 | Trunnion block | 49 | W/Washer bolt |
| 12 | Taper roller bearing | 32 | Bushing | 50 | Shim (1.0t) |
| 13 | Split pin | 33 | Thrust washer | 51 | Protector (not shown) |
| 14 | Slotted nut | 34 | Pin | 52 | Hex bolt |
| 15 | Washer | 35 | Spring washer | 53 | Spring washer |
| 16 | Plate | 36 | Hardened washer | 62 | Hex bolt |
| 17 | Hub | 37 | Upper cover | 63 | Hardened washer |
| 18 | Hub bolt | 38 | Lower cover | | |

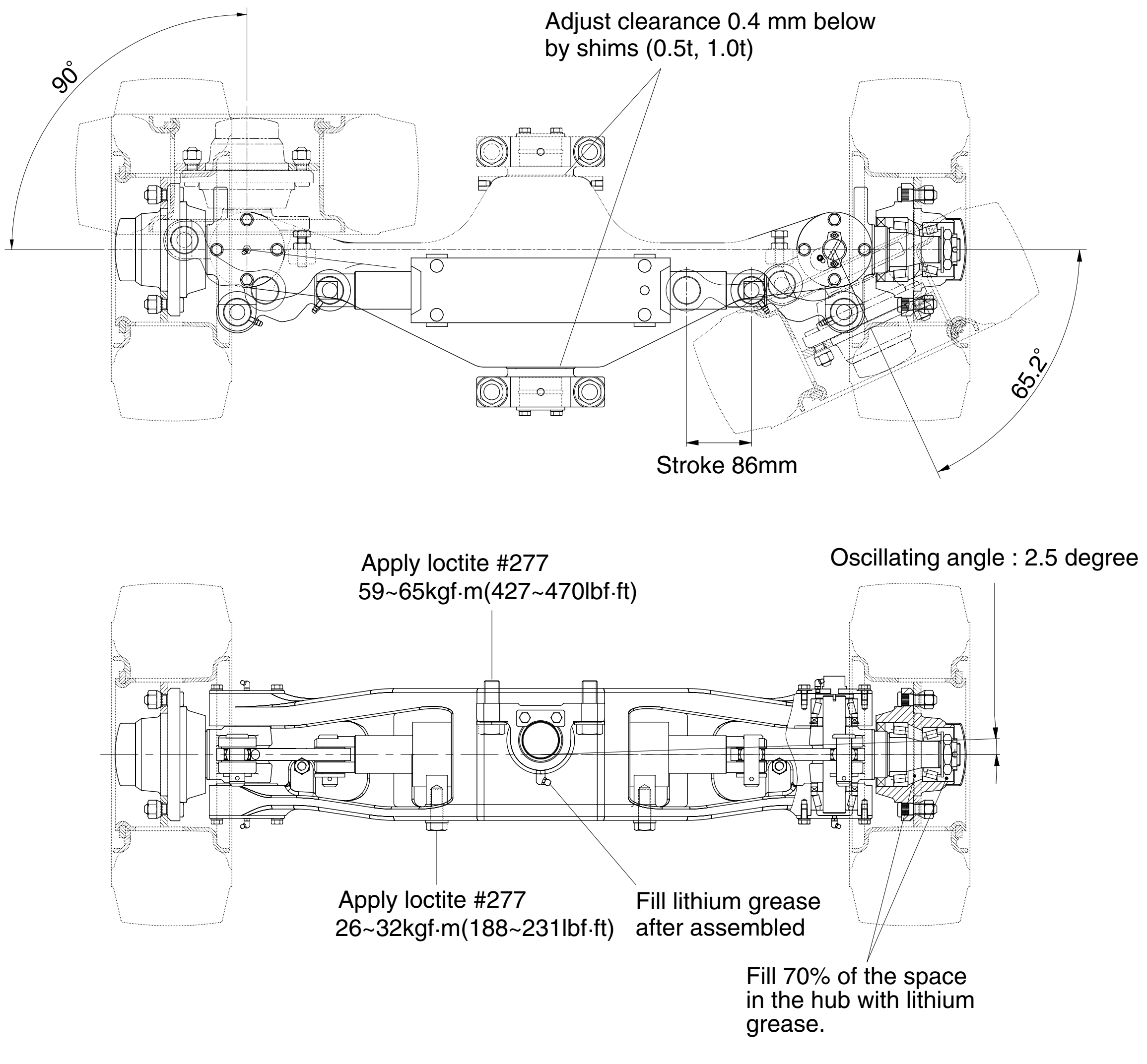
## STRUCTURE (KIA OPTION)




25B9USS56

| | | | | | |
|---|---|---|---|---|---|
| 1 | Steering axle body | 18 | Hub nut | 35 | Lower cover |
| 2 | Knuckle-RH | 29 | Hub cap | 36 | Hex bolt |
| 3 | Knuckle-LH | 20 | Steering link | 37 | Spring washer |
| 4 | Special bolt | 21 | Steering cylinder assy | 38 | Shim (0.1t) |
| 5 | King pin | 22 | Spherical plain bearing | 39 | Shim (0.15t) |
| 6 | Taper roller bearing | 23 | Steering link pin | 40 | Shim (0.3t) |
| 7 | Oil seal | 24 | Plain washer | 41 | Shim |
| 8 | Snap ring | 25 | Grease nipple | 42 | Taper roller bearing |
| 9 | Collar | 26 | Lock plate | 43 | Potentiometer assy |
| 10 | Grease nipple | 27 | Hex bolt | 44 | Split pin |
| 11 | Oil seal | 28 | Trunnion block | 45 | Cover |
| 12 | Taper roller bearing | 29 | Bushing | 46 | W/Washer bolt |
| 13 | Split pin | 30 | Thrust washer | 47 | Shim (1.0t) |
| 14 | Slotted nut | 31 | Pin | 62 | Hex bolt |
| 15 | Plate | 32 | Spring washer | 63 | Hardened washer |
| 16 | Hub | 33 | Hardened washer | 64 | Spacer |
| 17 | Hub bolt | 34 | Upper cover | | |

2) TIGHTENING TORQUE AND SPECIFICATION




25B9USS07

| Item | Unit | Center pin support single shaft |
|---|---|---|
| Max steering angle of wheels (Inside/Outside) | degree | 90/65.2 |
| Tread (Front/Rear) | mm (in) | 993 (39.1)/980 (38.6) |

# GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

## 1. OPERATIONAL CHECKS

| Check item | Checking procedure |
|---|---|
| Knuckle | · Check knuckle visually or use crack detection method. If the knuckle is bent, the tire wear is uneven, so check tire wear. |
| Steering axle | · Ask assistant to drive machine at minimum turning radius.<br>· Fit bar and a piece of chalk at outside edge of counterweight to mark line of turning radius.<br>· Min turning radius (Outside) : Refer to page 1-5 (Specifications) |
| Hydraulic pressure of power steering | · Install oil pressure gauge at the bidirectional pump.<br>· Turn steering wheel fully and check oil pressure.<br>※ Oil pressure : 80 $kgf/cm^2$ (1138 psi) |

## 2. TROUBLESHOOTING

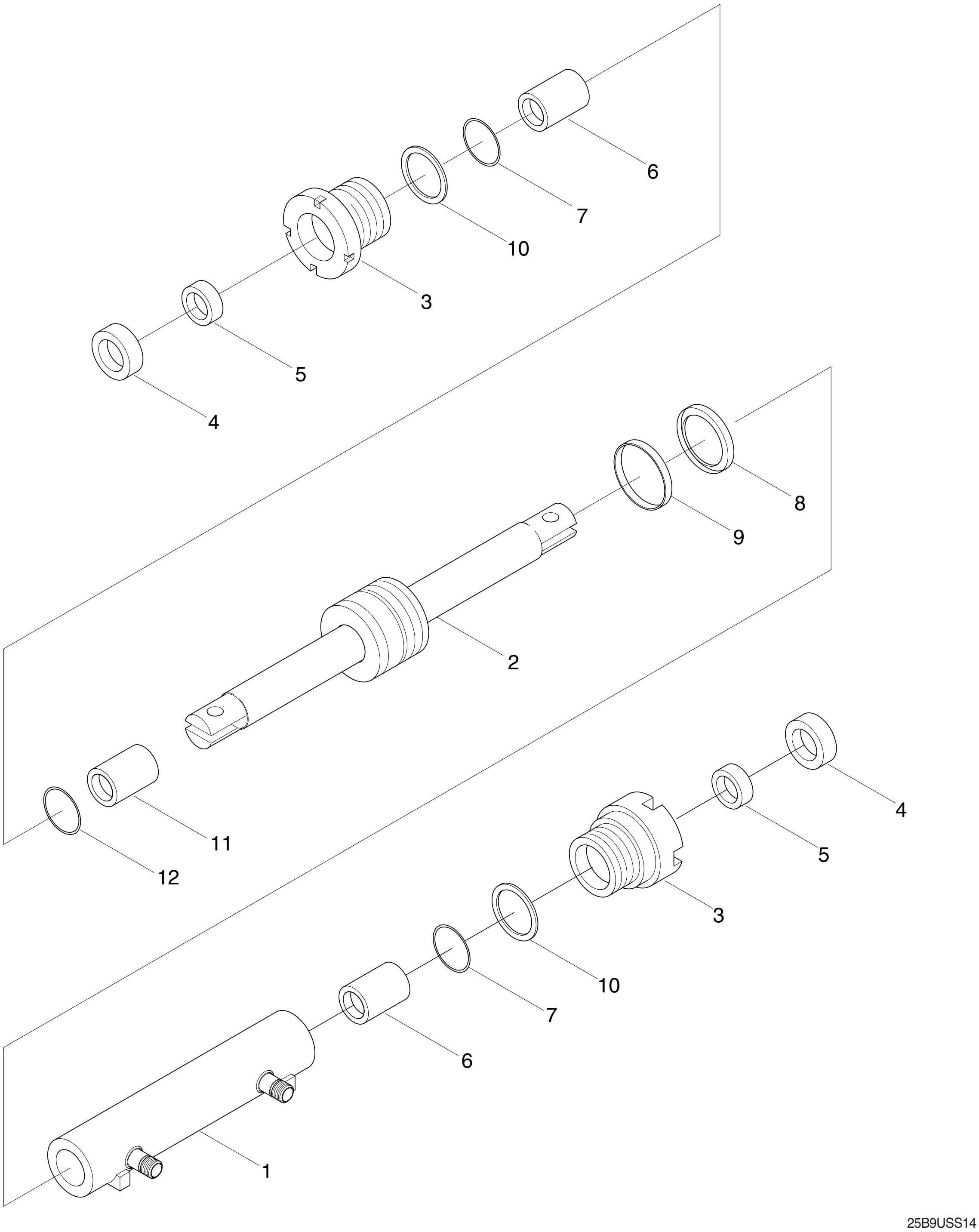
| Problem | Cause | Remedy |
|---|---|---|
| Steering wheel drags. | · Low oil pressure.<br>· Bearing faulty.<br>· Gears poorly meshing. | · Check lockout. Repair.<br>· Clean or replace.<br>· Check and correct meshing. |
| Steering wheel fails to return smoothly. | · Bearing faulty.<br>· Gears poorly meshing. | · Clean or replace.<br>· Check and correct meshing. |
| Steering wheel turns unsteadily.<br>Steering system makes abnormal sound or vibration. | · Lockout loosening.<br>· Lockout loosening.<br>· Air in oil circuit. | · Retighten.<br>· Retighten.<br>· Bleed air. |
| Abnormal sound heard when steering wheel is turned fully | Bidirectional pump<br>· Faulty. (Valve fails to open.)<br>Piping<br>· Pipe(from pump to power steering cylinder) dented or clogged. | · Adjust valve set pressure and check for specified oil pressure.<br>· Repair or replace. |
| Piping makes abnormal sounds. | Bidirectional pump<br>· Lack of oil.<br>· Oil inlet pipe sucks air.<br>· Insufficient air bleeding. | · Add oil.<br>· Repair.<br>· Bleed air completely. |
| Valve or valve unit makes abnormal sounds. | Bidirectional pump<br>· Oil inlet pipe sucks air.<br>· Faulty. (Unbalance oil pressure)<br>Piping<br>· Pipe(from pump to power steering) dented or clogged.<br>· Insufficient air bleeding. | · Repair or replace.<br>· Adjust valve set pressure and check specified oil pressure.<br>· Repair or replace.<br>· Bleed air completely. |

| Problem | Cause | Remedy |
| --- | --- | --- |
| Steering cylinder head leakage (Piston rod) | · Packing foreign material.<br>· Piston rod damage.<br>· Rod seal damage and distortion.<br>· Chrome gilding damage. | · Replace<br>· Grind surface with oil stone.<br>· Replace<br>· Grind |
| Steering cylinder head thread (A little bit leak is no problem) | · O-ring damage. | · O-ring damage. |
| Welding leakage | · Tube inside damage.<br>· Piston seal damage and distortion | · Grind surface with oil store.<br>· Replace |
| Rod | · Tube inside damage.<br>· Piston seal damage and distortion | · Grind surface with oil store.<br>· Replace |
| Piston rod bushing inner diameter excessive gap | · Bushing wear. | · Replace |

## GROUP 3 DISASSEMBLY AND ASSEMBLY

### 1. STEERING CYLINDER

#### 1) STRUCTURE




| | | | | | |
|---|---|---|---|---|---|
| 1 | Tube assembly | 5 | Rod seal | 9 | Wear ring |
| 2 | Rod assembly | 6 | DD bushing | 10 | Lock washer |
| 3 | Rod cover | 7 | O-ring | 11 | Spacer |
| 4 | Dust wiper | 8 | Piston seal | 12 | O-ring |

## 2) DISASSEMBLY

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

(1) Put wooden blocks against the cylinder tube, then hold in a vice.

(2) Remove the gland by hook a wrench in the notch of cylinder head and turn counter-clockwise.

(3) Remove the cylinder rod and piston from the tube.

(4) Check wear condition of the sealing parts. If there are some damage, replace with new parts.

## 3) CHECK AND INSPECTION

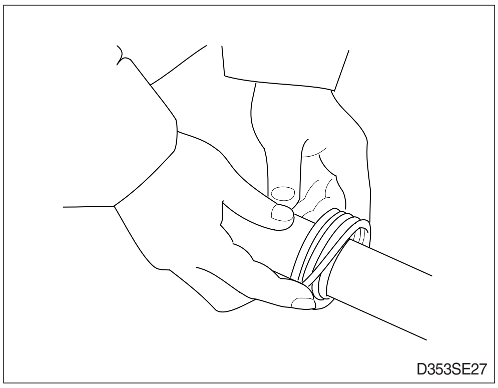
mm(in)

| Check item | Criteria | | Remedy |
|---|---|---|---|
| | Standard size | Repair limit | |
| Clearance between piston & cylinder tube | 0.064~0.137 (0.0025~0.0054) | 0.180 (0.0070) | Replace piston seal |
| Clearance between cylinder rod & bushing | 0.024~0.112 (0.0009~0.0044) | 0.120 (0.0049) | Replace bushing |
| Seals, O-ring | Damage | | Replace |
| Cylinder rod | Dents | | Replace |
| Cylinder tube | Biting | | Replace |

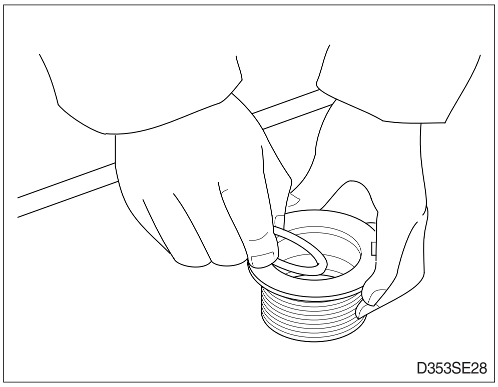
## 4) ASSEMBLY

(1) Install a new piston seal the groove on the piston.

※ Be careful not to scratch the seal too much during installation or it will not seat properly.

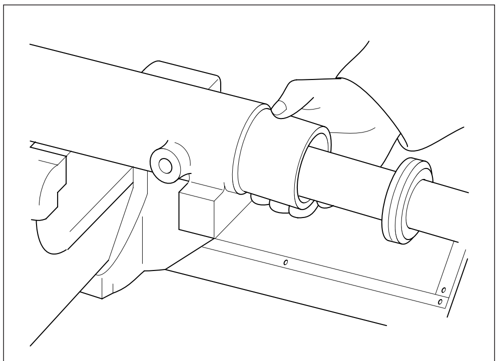



(2) Install the rod seal to the position in the gland applying a slight coat with grease prior to install.



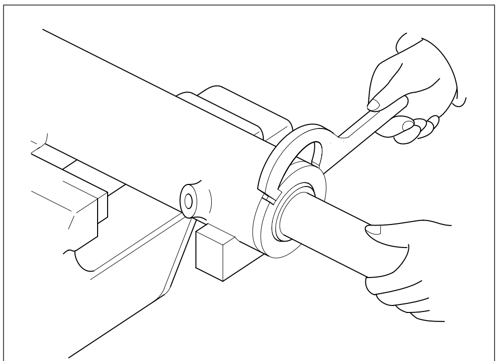
(3) Install the dust wiper to the gland using a special installing tool. Coat the dust wiper with grease slightly before installing.

(4) Set a special tool the cylinder, gland assembly into the cylinder tube.



D353SE29

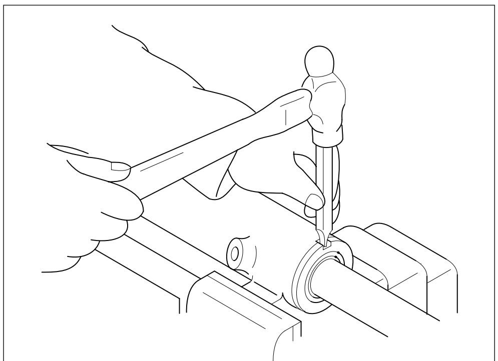
(5) Using a hook spanner, install the gland assembly, and tighten it with torque 40±4kgf · m (289±29lbf · ft).



D353SE30

(6) After the gland assembly was installed to the cylinder tube, calk at the tube end into the groove on the gland to prevent screw loosening.

※ If it need calking again, never using previous calking position.



D353SE31

(7) Move the piston rod back and forth several times for the full distance of its stroke. This helps to seat the ring and seals before applying full hydraulic pressure to the cylinder.

(8) Install cylinder into trail axle.

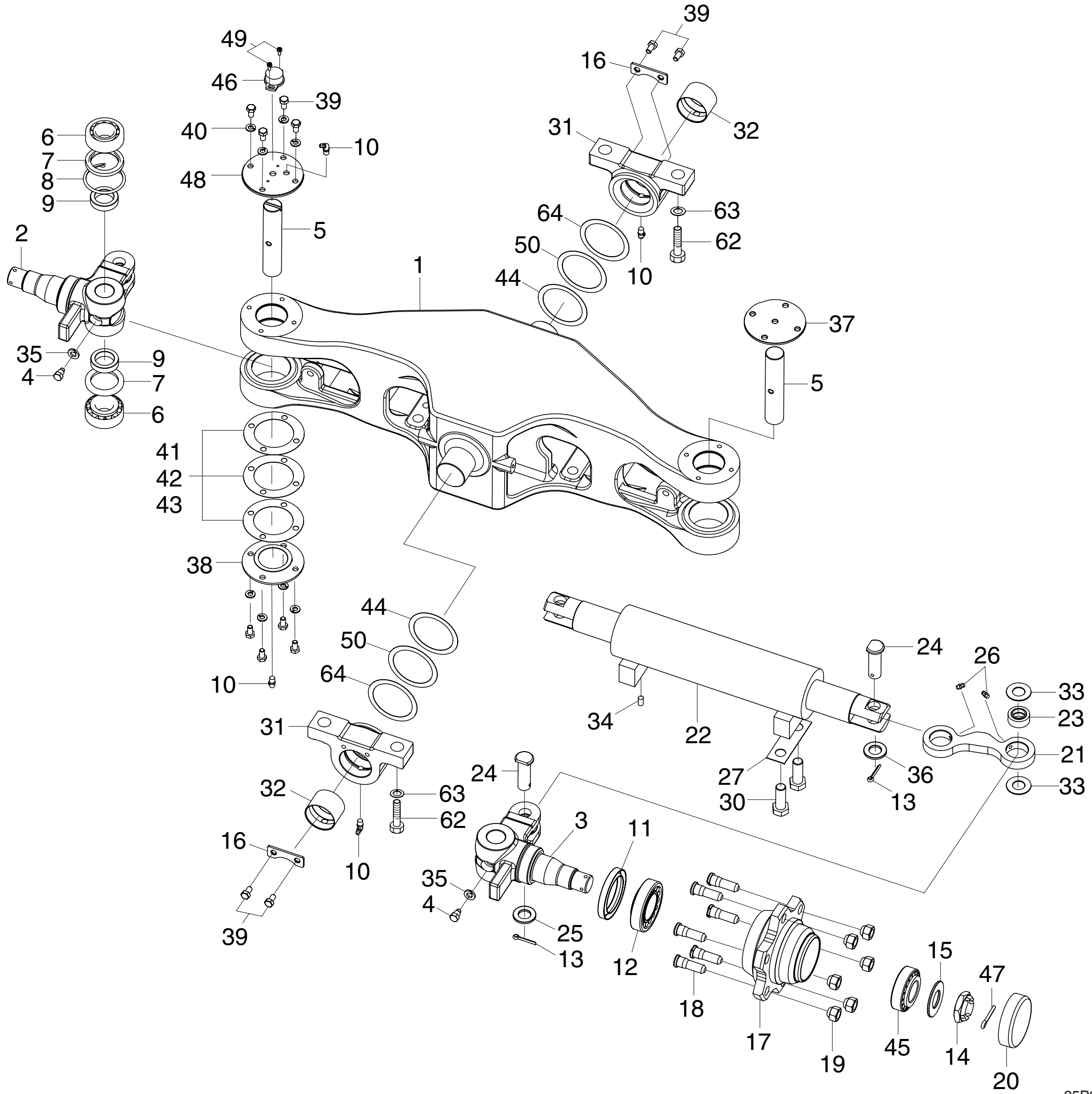
(9) While idling the engine with the rear wheels off the ground, operate the steering wheel left and right alternately.

※ Then, repeat the above operation at gradually increasing engine rpm. This releases air from the system and completes preparation for operation.

(10) Stop the engine, lower the floating rear wheels, and check pump joints for oil leaks and looseness and retighten, them as required.

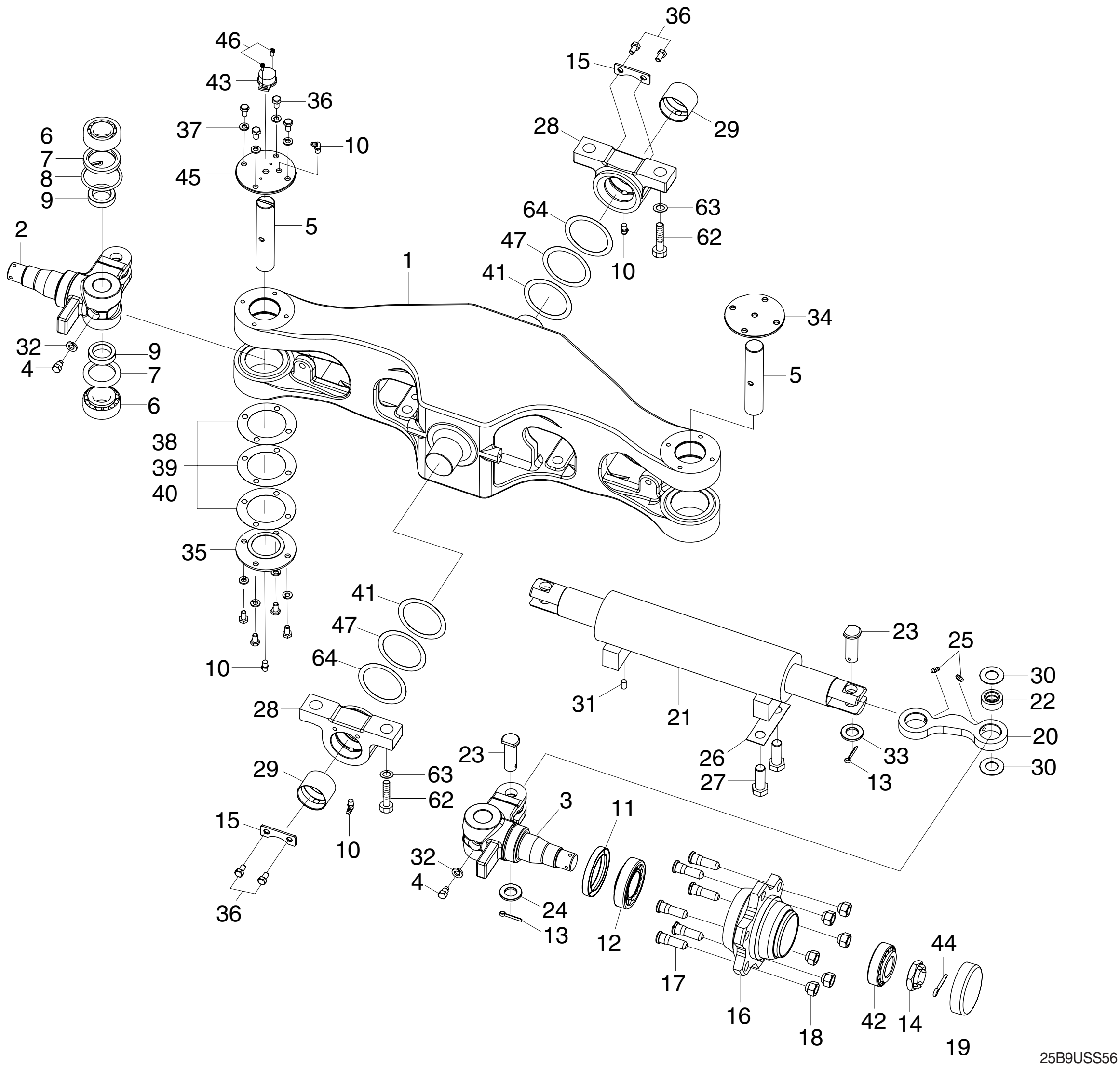
## 2. STEERING AXLE

### 1) STRUCTURE



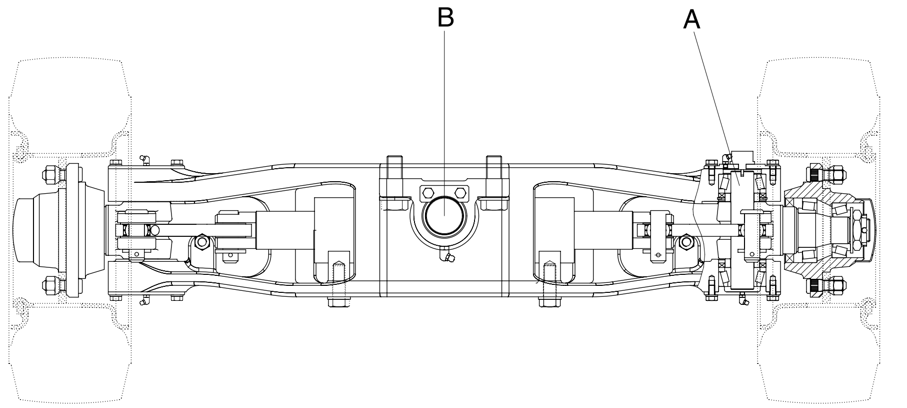

| | | | | | |
|---|---|---|---|---|---|
| 1 | Steering axle body | 19 | Hub nut | 39 | Hex bolt |
| 2 | Knuckle-RH | 20 | Hub cap | 40 | Spring washer |
| 3 | Knuckle-LH | 21 | Steering link | 41 | Shim (0.1t) |
| 4 | Special bolt | 22 | Steering cylinder assy | 42 | Shim (0.15t) |
| 5 | King pin | 23 | Spherical plain bearing | 43 | Shim (0.3t) |
| 6 | Taper roller bearing | 24 | Steering link pin | 44 | Shim |
| 7 | Oil seal | 25 | Plain washer | 45 | Taper roller bearing |
| 8 | Snap ring | 26 | Grease nipple | 46 | Steering sensor |
| 9 | Collar | 27 | Lock plate | 47 | Split pin |
| 10 | Grease nipple | 30 | Hex bolt | 48 | Cover |
| 11 | Oil seal | 31 | Trunnion block | 49 | W/Washer bolt |
| 12 | Taper roller bearing | 32 | Bushing | 50 | Shim (1.0t) |
| 13 | Split pin | 33 | Thrust washer | 51 | Protector (not shown) |
| 14 | Slotted nut | 34 | Pin | 52 | Hex bolt |
| 15 | Washer | 35 | Spring washer | 53 | Spring washer |
| 16 | Plate | 36 | Hardened washer | 62 | Hex bolt |
| 17 | Hub | 37 | Upper cover | 63 | Hardened washer |
| 18 | Hub bolt | 38 | Lower cover | | |

## STRUCTURE (KIA OPTION)




| | | | | | |
|---|---|---|---|---|---|
| 1 | Steering axle body | 18 | Hub nut | 35 | Lower cover |
| 2 | Knuckle-RH | 29 | Hub cap | 36 | Hex bolt |
| 3 | Knuckle-LH | 20 | Steering link | 37 | Spring washer |
| 4 | Special bolt | 21 | Steering cylinder assy | 48 | Shim (0.1t) |
| 5 | King pin | 22 | Spherical plain bearing | 39 | Shim (0.15t) |
| 6 | Taper roller bearing | 23 | Steering link pin | 40 | Shim (0.3t) |
| 7 | Oil seal | 24 | Plain washer | 41 | Shim |
| 8 | Snap ring | 25 | Grease nipple | 42 | Taper roller bearing |
| 9 | Collar | 26 | Lock plate | 43 | Potentiometer assy |
| 10 | Grease nipple | 27 | Hex bolt | 44 | Split pin |
| 11 | Oil seal | 28 | Trunnion block | 45 | Cover |
| 12 | Taper roller bearing | 29 | Bushing | 46 | W/Washer bolt |
| 13 | Split pin | 30 | Thrust washer | 47 | Shim (1.0t) |
| 14 | Slotted nut | 31 | Pin | 62 | Hex bolt |
| 15 | Plate | 32 | Spring washer | 63 | Hardened washer |
| 16 | Hub | 33 | Hardened washer | 64 | Spacer |
| 17 | Hub bolt | 34 | Upper cover | | |

## 2) CHECK AND INSPECTION




22B7SS12

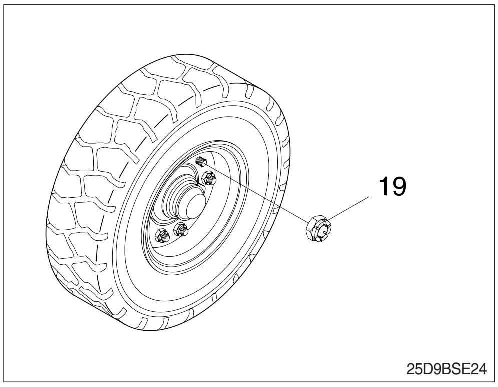
mm (in)

| No. | Check item | Criteria | | Remedy |
|---|---|---|---|---|
| | | Standard size | Repair limit | |
| A | Diameter of king pin | 30 (1.18) | 29.8 (1.17) | Replace |
| B | Diameter of center pin | 50 (2.0) | 49.5 (1.9) | Replace |
| - | Rear axle, hub, knuckle, bearing | · Damage, wear<br>· Seizure, abnormal noise, defective rotation | | Replace |

### 3) DISASSEMBLY

※ Servicing work on the knuckle part can be carried out without removing the axle assy from chassis.
The work can be done by jacking up the balance weight part of the truck.

(1) Loosen the hub nut (19) and take off the steering wheel tire.




(2) Remove hub cap (20).

(3) Pull out split pin (47) before removing slotted nut (14) and washer (15).

(4) Using the puller, take off the wheel hub (17) together with the taper roller bearing (12, 45).

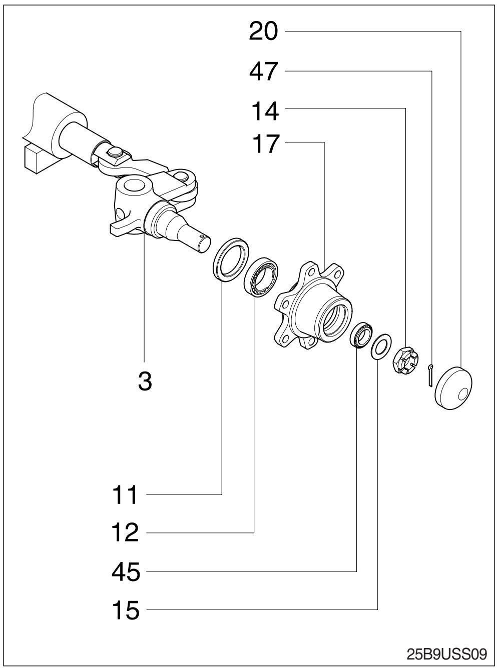
※ Be very careful because just before the hub (17) comes off, taper roller bearing (12, 45) will fall out.

(5) After wheel hub (17) is removed take off the inner race of bearing (12, 45).

(6) Pull out oil seal (11).

※ Don't use same oil seal twice.

(7) Repeat the same procedure for the other side. Moreover, when disassembling is completed, part the slotted nut (14) in the knuckle (3) to protect the threaded portion.




(8) Loosen special bolt (4) and spring washer (35).

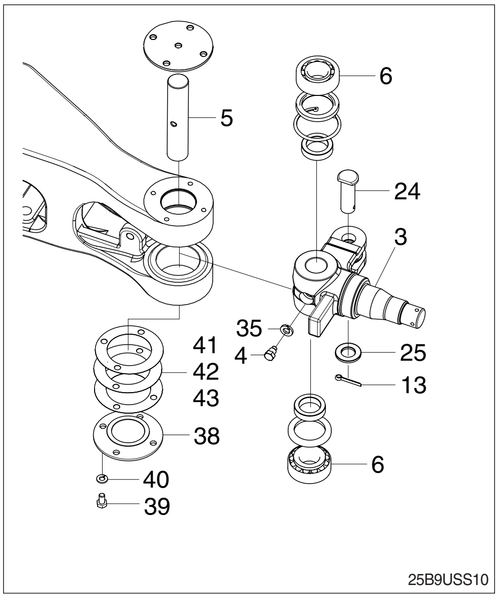
(9) Remove bolt (39), washer (40), lower cover (38) and shims (41, 42, 43).

(10) Push out the king pin (5) without damaging the knuckle (3).

(11) Pull out the taper roller bearing (6).

(12) Remove spilt pin (13), plain washer (25) and then pull out link pin (24).

(13) Remove knuckle (3).



4) ASSEMBLY

※ In reassembling, have all parts washed, grease applied to lubricating parts, and all expendable items such as oil seal and spring washers replaced by new ones.

Perform the disassembly in reverse order.

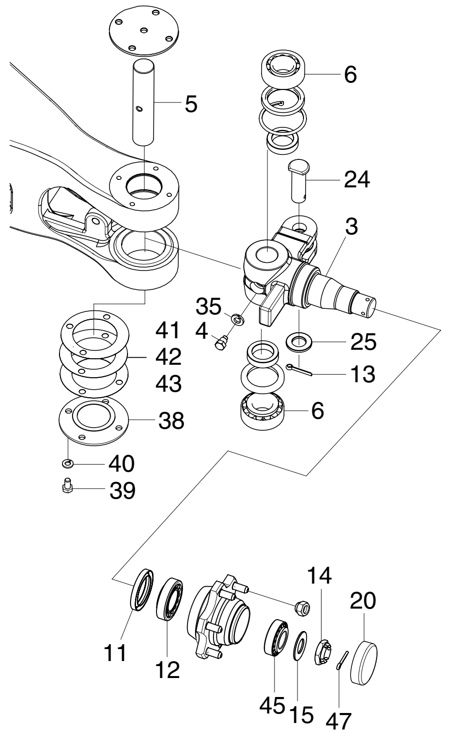
(1) Tighten the special bolt (4) and spring washer (35) of king pin (5).

※ There is a notch in the middle of the king pin (5), make sure that this notch is on the special bolt (4) side.

(2) Always use drive-in tool. In assembling the taper roller bearing (6), be sure that the fixed ring of the bearing is placed in position facing the knuckle (3).

(3) Wheel hub

- Mount oil seal (11) and inner race of taper roller bearing (12) on the knuckle (3). The bearing should be well greased before assembling.
- Install the outer race of the taper roller bearing (45) in the wheel center and assemble to the knuckle (3).
- Tighten slotted nut (14) with washer (15) and lock with split pin (47). In locking with split pin, locate the hole for the split pin by turning the nut back 1/6 of a turn. Adjust the preload of bearing.
- Mount the hub cap (20).
  Bearing should be well greased before assembling.



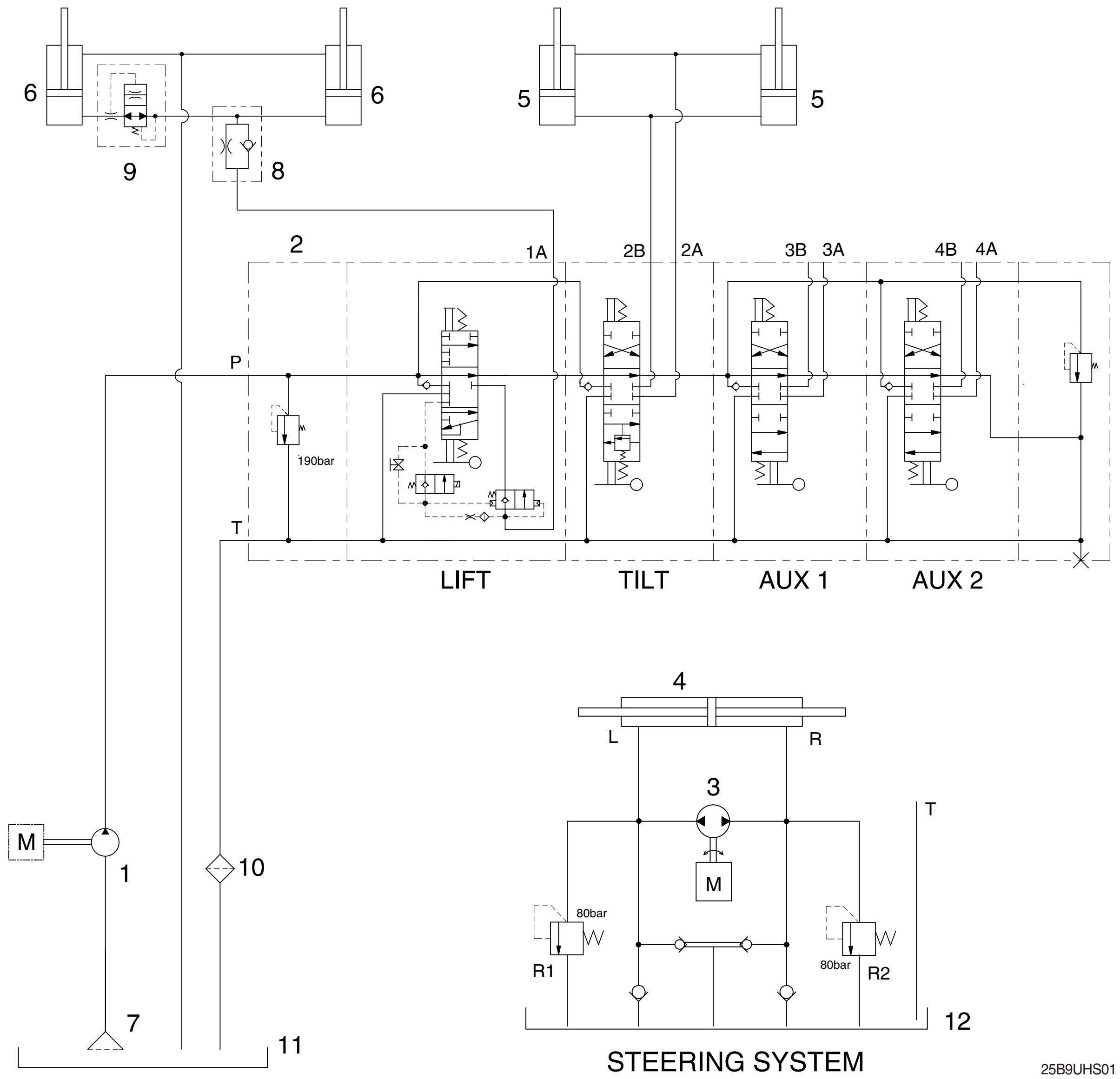

25B9USS11

# SECTION 6 HYDRAULIC SYSTEM

## GROUP 1 STRUCTURE AND FUNCTION

### 1. HYDRAULIC CIRCUIT

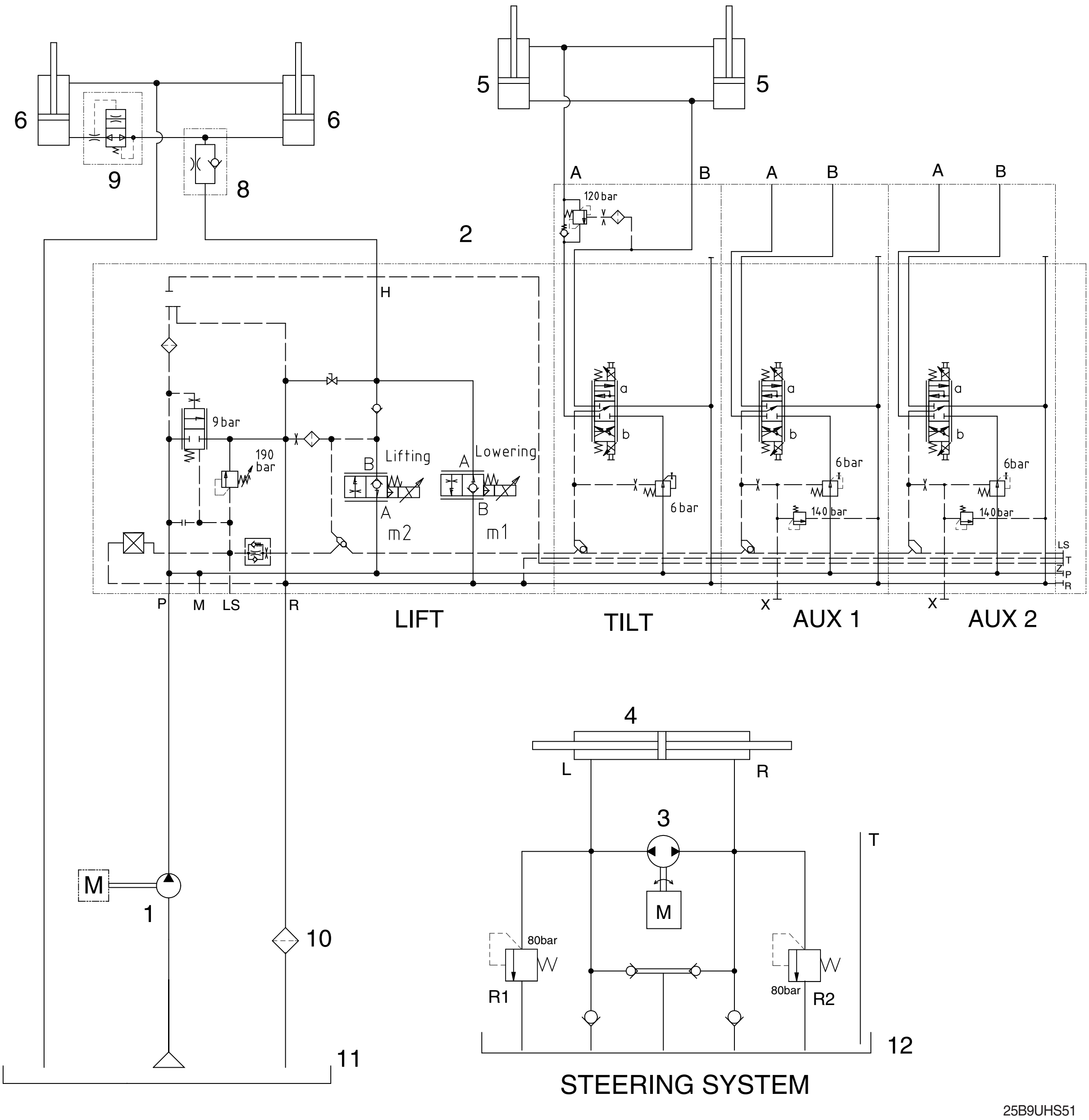
· MANUAL TYPE




| | | | | | |
|---|---|---|---|---|---|
| 1 | Hydraulic gear pump | 5 | Tilt cylinder | 9 | Down safety valve |
| 2 | Main control valve | 6 | Lift cylinder | 10 | Return filter |
| 3 | Bidirectional pump | 7 | Suction strainer | 11 | Hydraulic oil tank |
| 4 | Steering cylinder | 8 | Down control valve | 12 | Reservoir tank |

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

· FINGERTIP TYPE

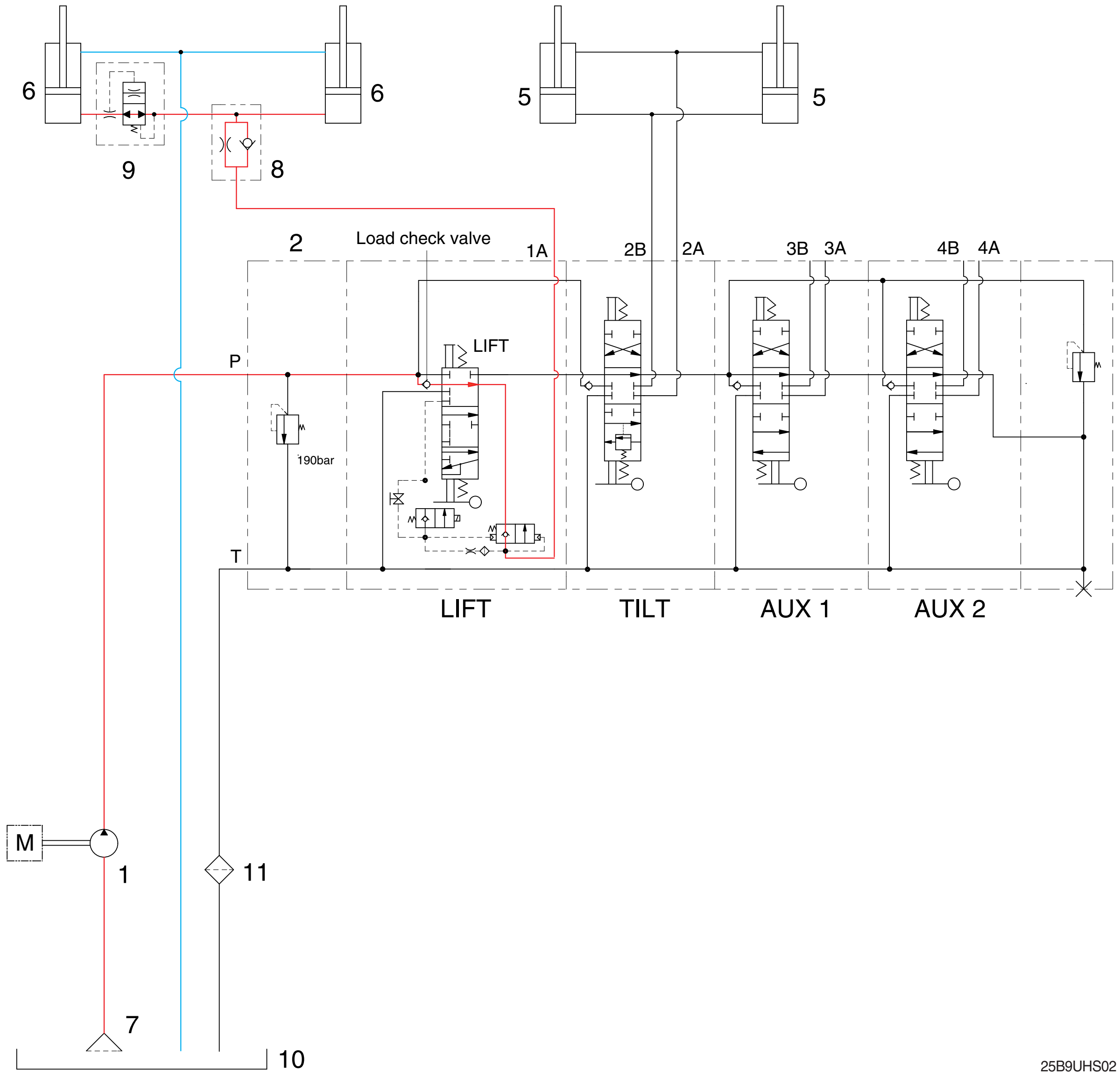



| | | | | | |
|---|---|---|---|---|---|
| 1 | Hydraulic gear pump | 5 | Tilt cylinder | 9 | Down safety valve |
| 2 | Main control valve | 6 | Lift cylinder | 10 | Return filter |
| 3 | Steering unit | 7 | Suction strainer | 11 | Hydraulic oil tank |
| 4 | Steering cylinder | 8 | Down control valve | 12 | Reservoir tank |

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

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

※ Descriptions are based on the manual type.




When the lift control lever is pulled back, the spool on the first block is moves to lift position.

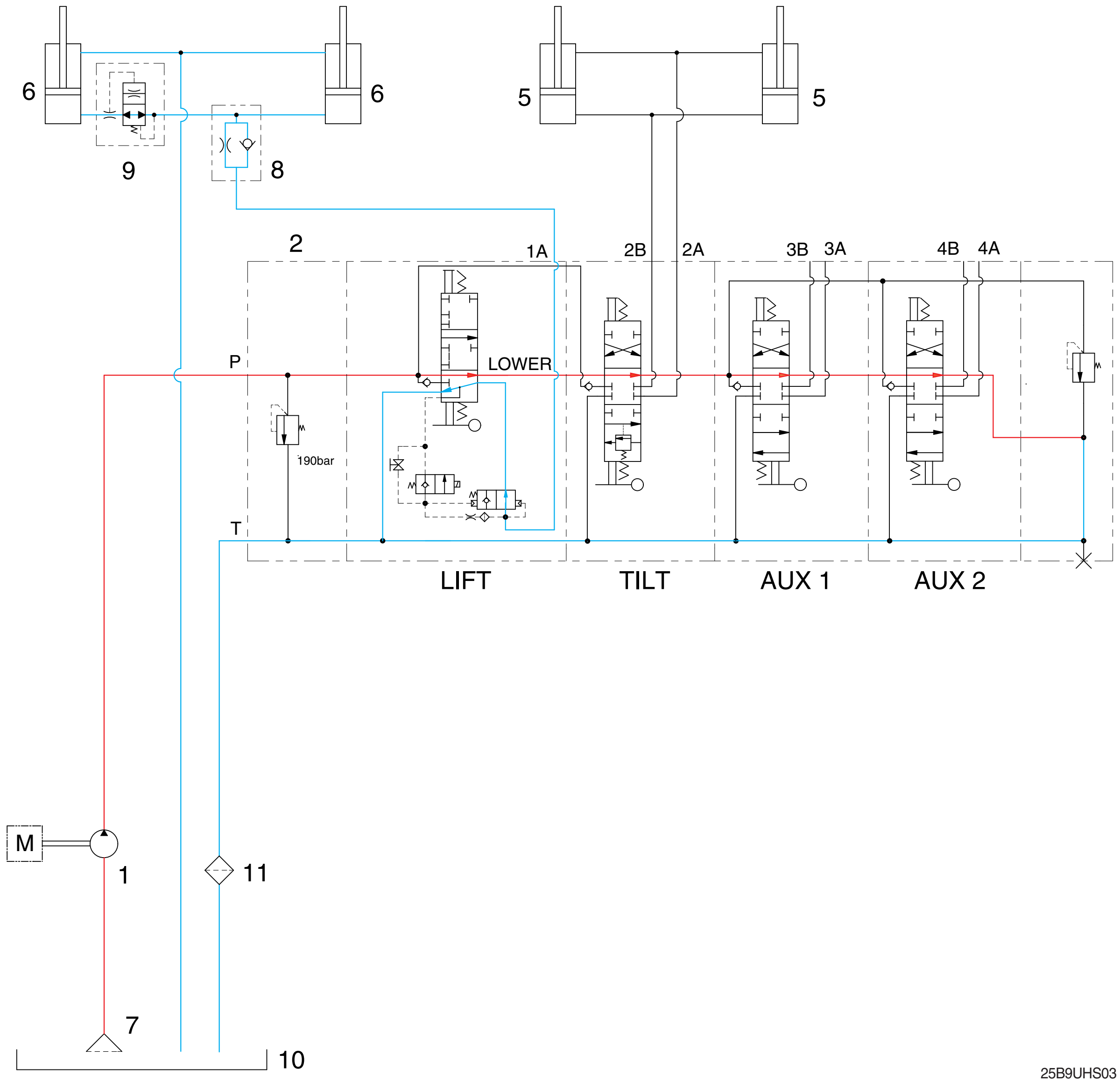
The oil from hydraulic gear pump (1) flows into main control valve (2) and then goes to the large chamber of lift cylinder (6) by pushing the load check valve of the spool.

The oil from the small chamber of lift cylinder (6) returns to hydraulic oil tank (11) at the same time.

When this happens, the forks go up.

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

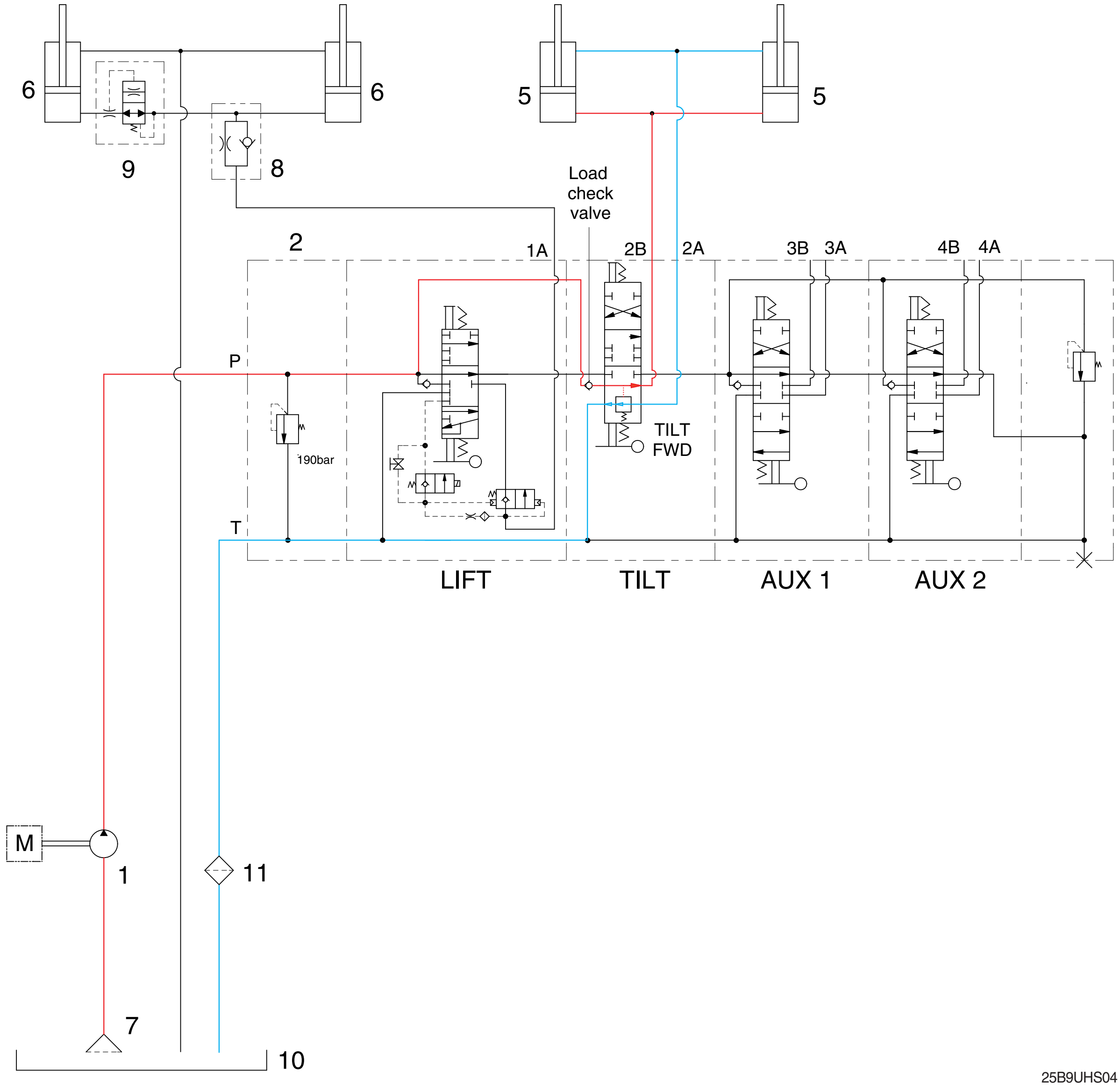
2) WHEN THE LIFT CONTROL LEVER IS IN THE LOWER POSITION




When the lift control lever is pushed forward, the spool on the first block is moved to lower position. The small chamber and the large chamber are connected to the hydraulic oil tank (11), so the forks will be lowered due to its own weight.

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

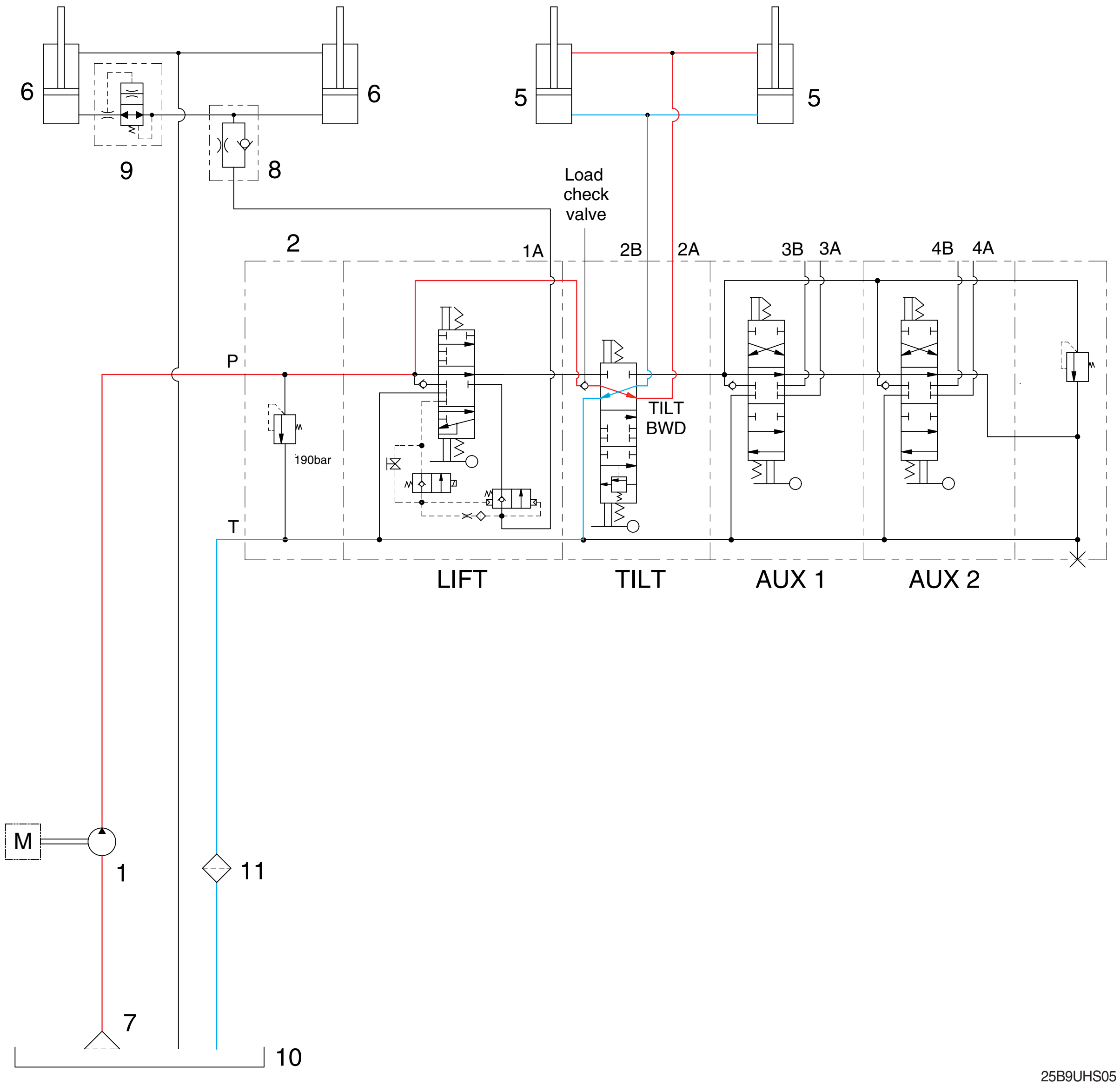
3) WHEN THE TILT CONTROL LEVER IS IN THE FORWARD POSITION




When the tilt control lever is pushed forward, the spool on the second block is moved to tilt forward position.
The oil from hydraulic gear pump (1) flows into main control valve (2) and then goes to the large chamber of tilt cylinder (5) by pushing the load check valve of the spool.
The oil at the small chamber of tilt cylinder (5) returns to hydraulic tank (11) at the same time.
When this happens, the mast tilt forward.

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

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

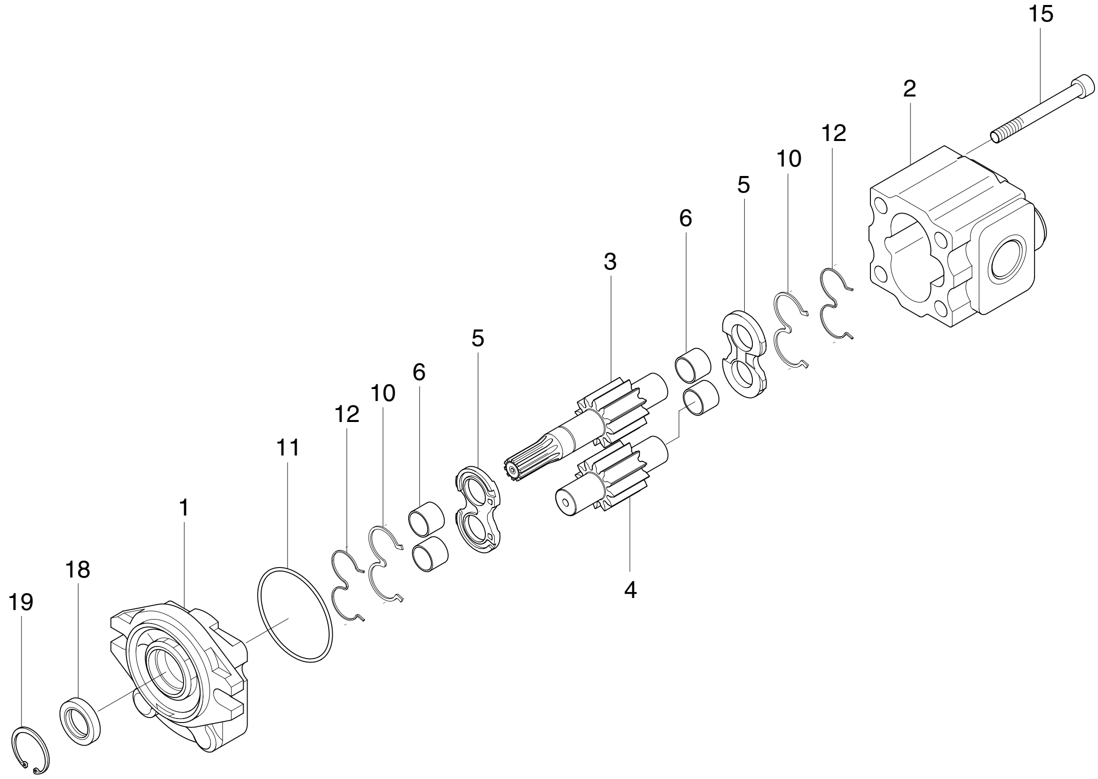



When the tilt control lever is pulled back, the spool on the second block is moved to tilt backward position.
The oil from hydraulic gear pump (1) flows into main control valve (2) and then goes to the small chamber of tilt cylinder (5) by pushing the load check valve of spool.
The oil at the large chamber of tilt cylinder (5) returns to hydraulic tank (11) at the same time.
When this happens, the mast tilt backward.

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

## 2. HYDRAULIC GEAR PUMP

### 1) STRUCTURE

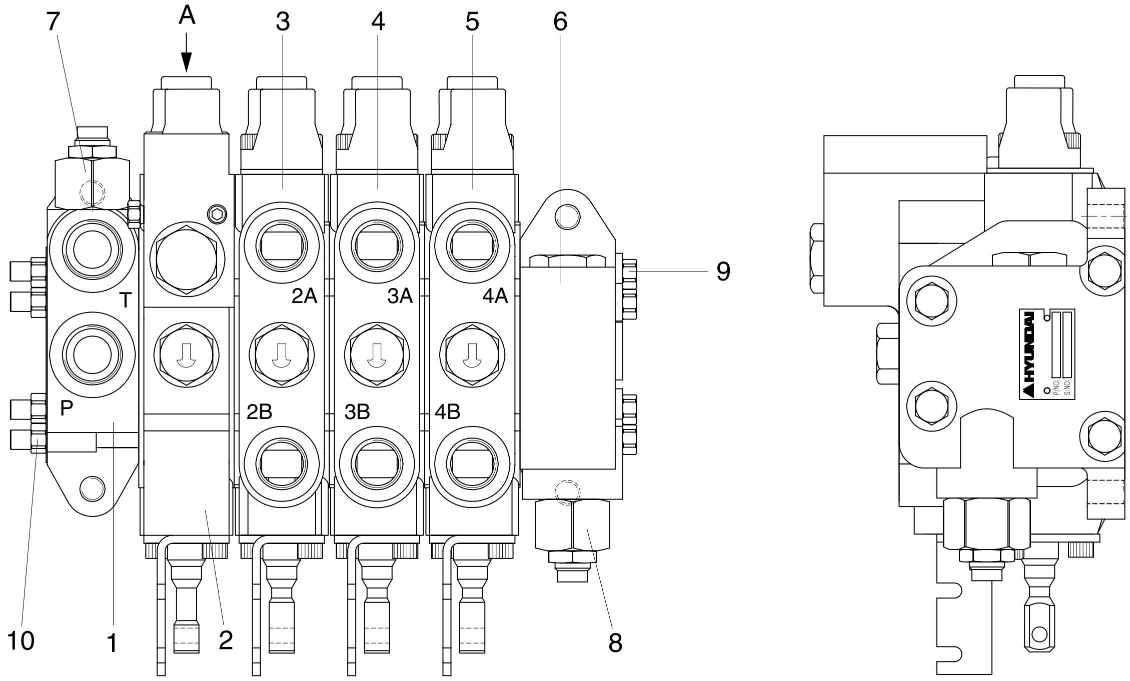


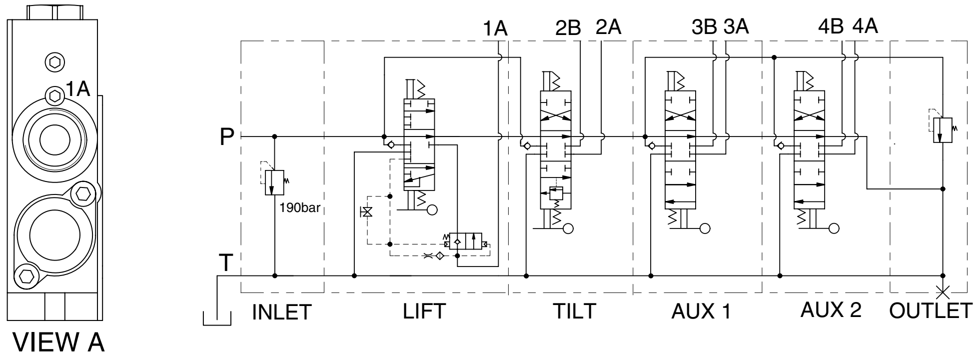

31HA-01530

| | | | | | |
|---|---|---|---|---|---|
| 1 | Front cover | 5 | Side plate | 12 | Back up ring |
| 2 | Body | 6 | Bushing | 15 | Socket bolt |
| 3 | Drive gear | 10 | Gasket | 18 | Oil seal |
| 4 | Driven gear | 11 | Gasket | 19 | Retaining ring |

## 3. MAIN CONTROL VALVE (MANUAL TYPE)

### 1) STRUCTURE (4 Spool, without OPSS)



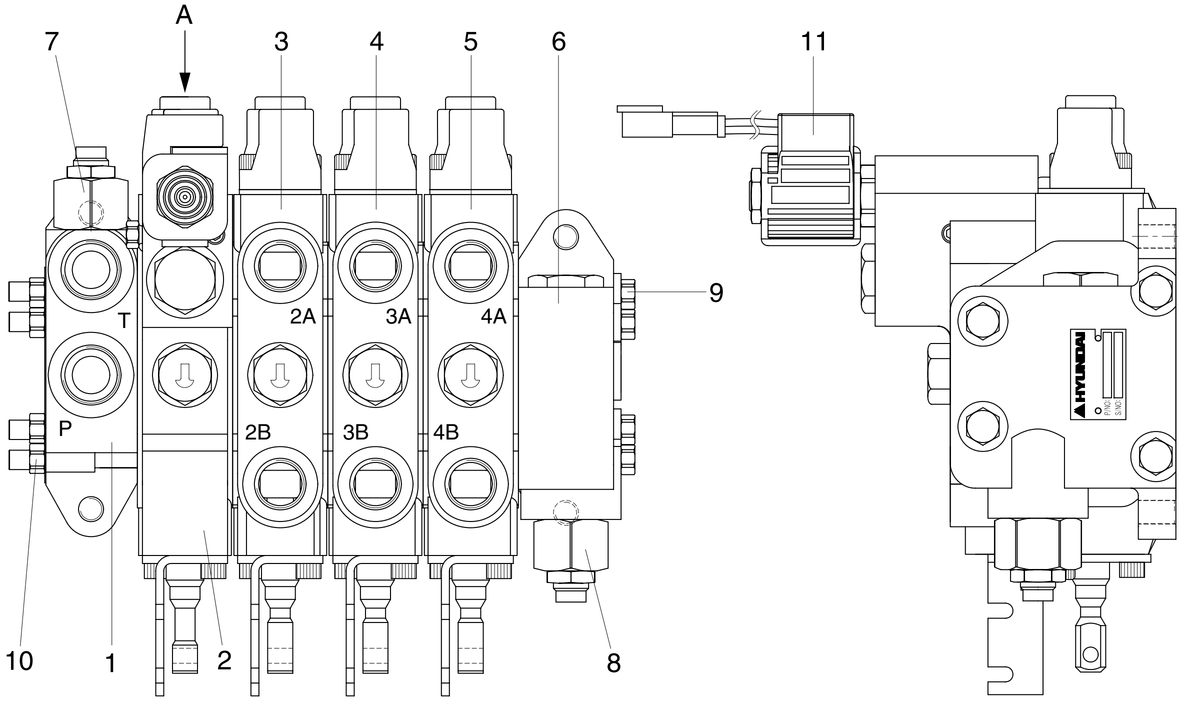



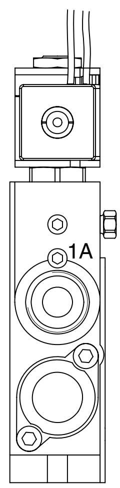

| Port name | Size | Port |
|---|---|---|
| Inlet port | 7/8-14UNF | P |
| Outlet port | 7/8-14UNF | T |
| Work port | 7/8-14UNF | 1A |
| Work port | 3/4-16UNF | 2A, 2B, 3A, 3B, 4A, 4B |

25B9UHS06

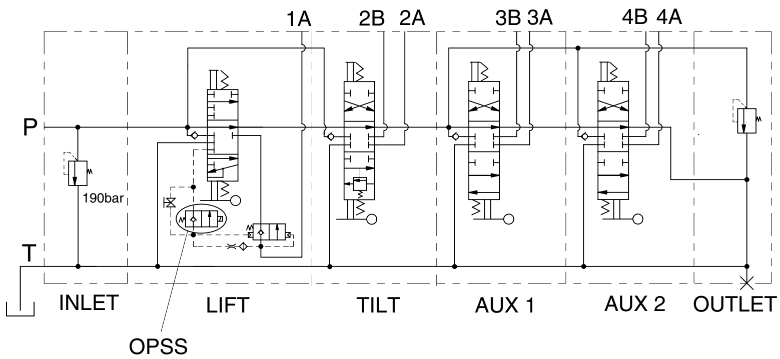
1 Inlet block assy
2 Lift block assy
3 Tilt block assy
4 Aux 1 block assy
5 Aux 2 block assy
6 Outlet block assy
7 Main relief valve assy
8 Auxiliary relief valve assy
9 Long bolt
10 Nut

STRUCTURE (4 Spool, with OPSS)



VIEW A




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

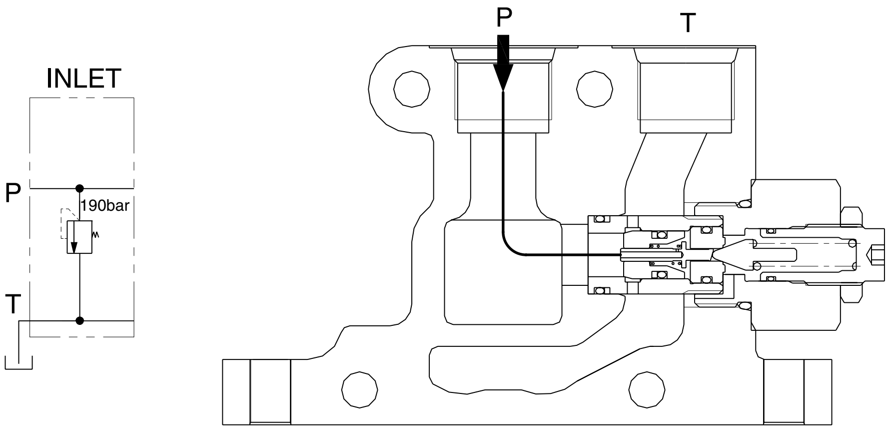
25B9UHS07

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

2) INLET SECTION

(1) Operation

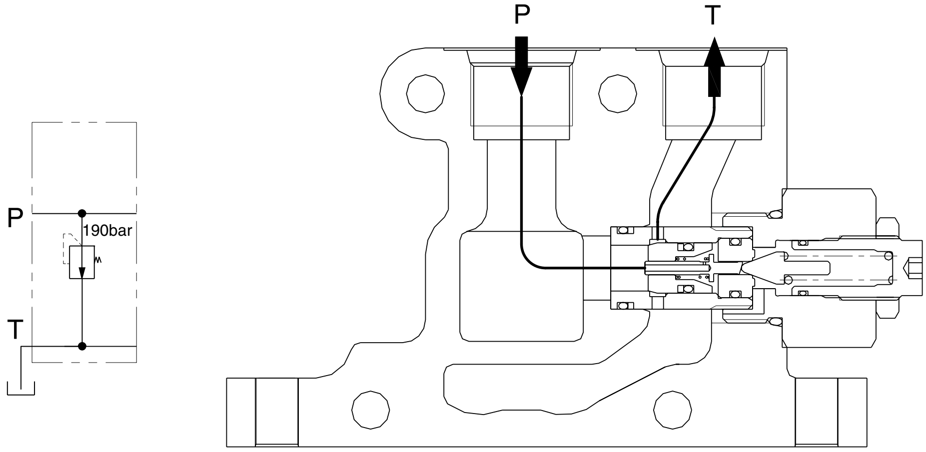
The inlet section contains the pump inlet connection and main relief valve.




22B7HS09

(2) Operation of relief valve at setting pressure

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




22B7HS10

3) LIFT SECTION (WITHOUT OPSS)

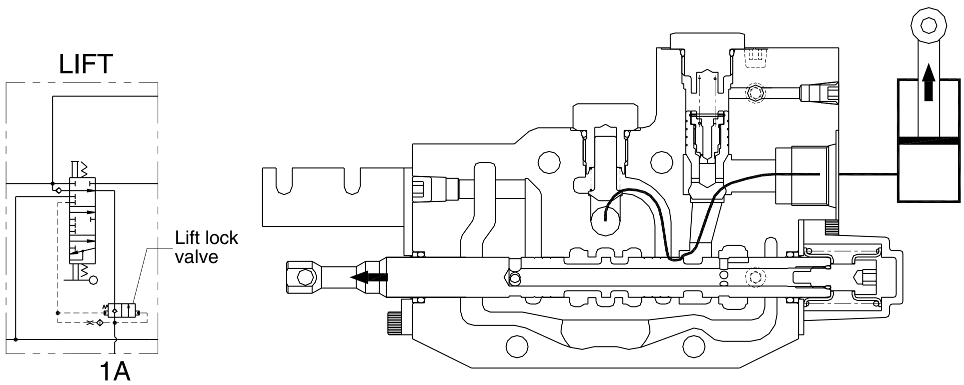
(1) Operation

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

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

① Lifting

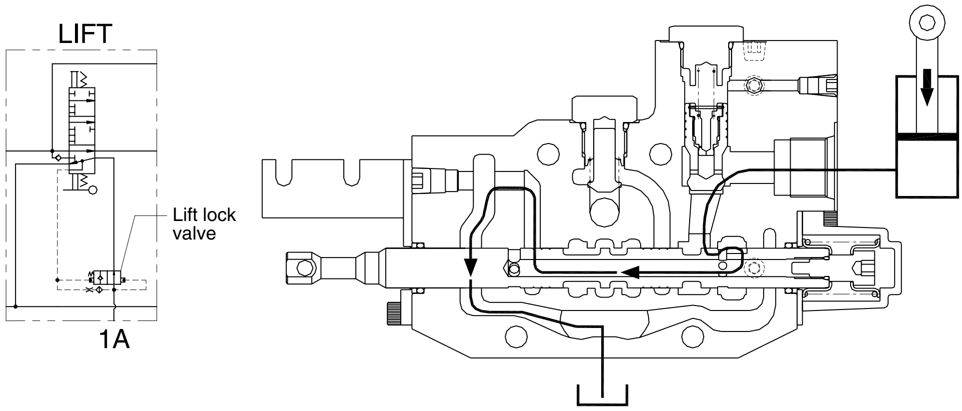
When the operator shifts the lever backwards, the spool is extended out of the valve, and this opens the internal fluid passages that lift the mast. Oil flows through the high pressure parallel cavity, past the load check valve, through the spool metering notches, past the lift lock check valve, and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




22B7HS11

② Lowering

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




22B7HS12

Pressure is limited by the main relief valve.

## LIFT SECTION (WITH OPSS)

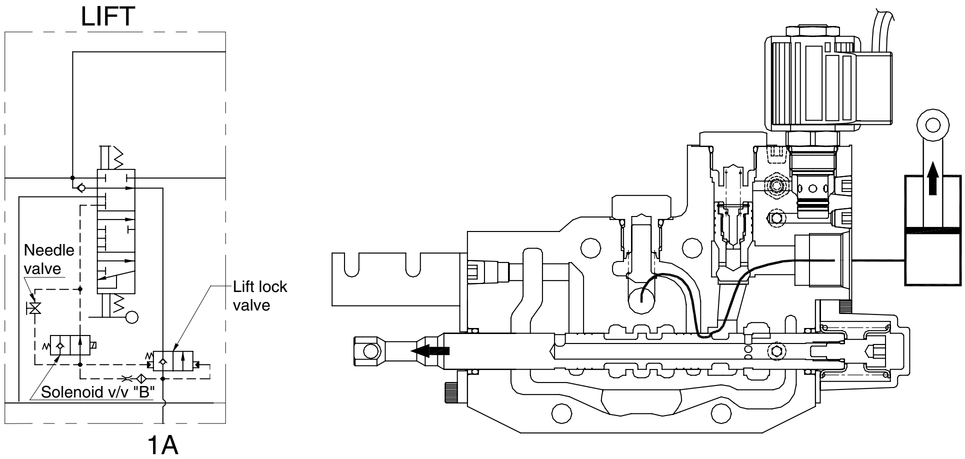
### (1) Operation

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

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

① Lifting

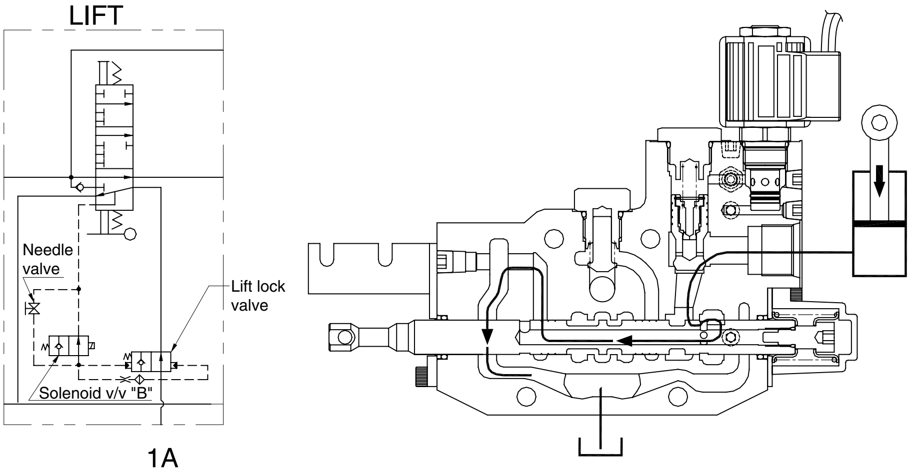
When the operator shifts the lever backwards, the spool is extended out of the valve, and this opens the internal fluid passages that lift the mast. Oil flows through the high pressure parallel cavity, past the load check valve, through the spool metering notches, past the lift lock check valve, and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




22B7HS11S

② Lowering

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




22B7HS12S

Pressure is limited by the main relief valve.

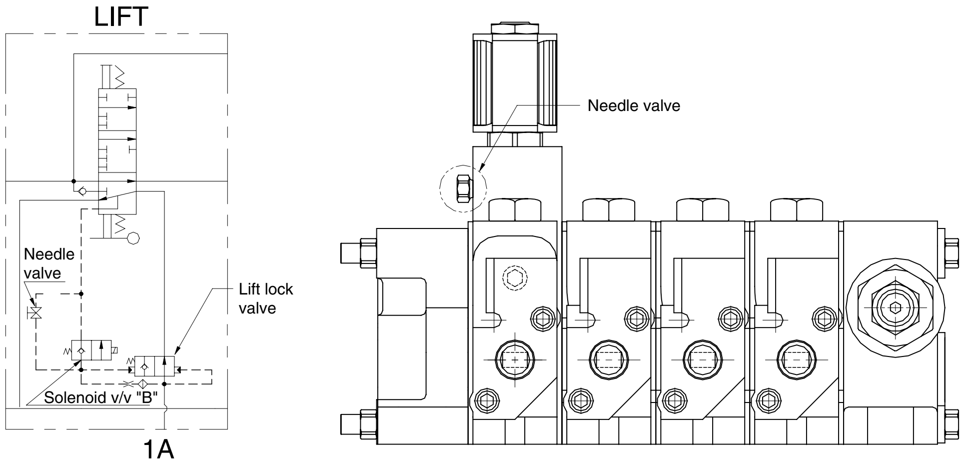
③ Secondary lowering method

A secondary lowering method is available in the event of the loss of battery power that is needed to energize the normally closed solenoid valve.

Important note : Before opening the secondary needle valve, make sure personnel and equipment are safely positioned to avoid accidents. Be careful to operate this secondary valve slowly, as heavy loads may be suspended.

A manual valve (needle valve) is located on the lift section, and it can be operated by opening the vehicle cowling and rotating the manual valve (needle valve ) counterclockwise with a wrench.

Open the manual valve (needle valve) approximately 2~3 turns (do not rotate more than 4 turns). Then shift the lift spool slowly for controlled lowering. This should be just enough for slow, controlled movement of the mast.




22B7HS12AS

Pressure is limited by the main relief valve.

## 4) TILT SECTION

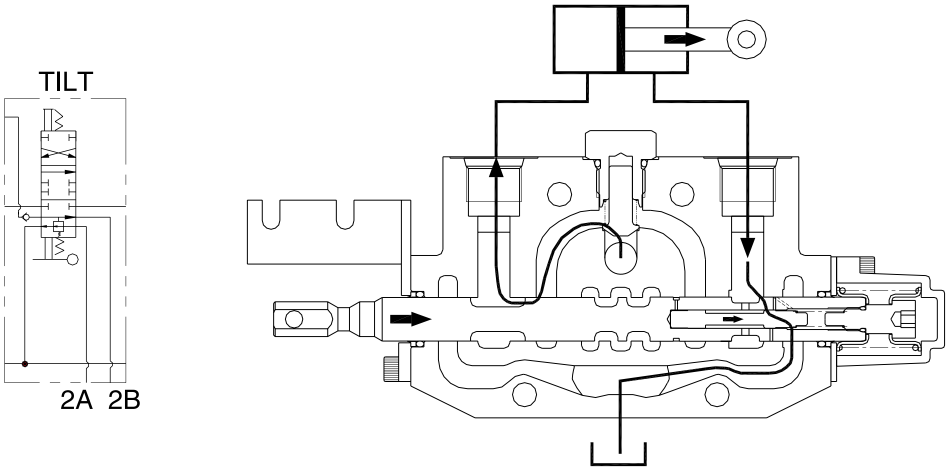
### (1) Operation

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

① Tilt forward

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

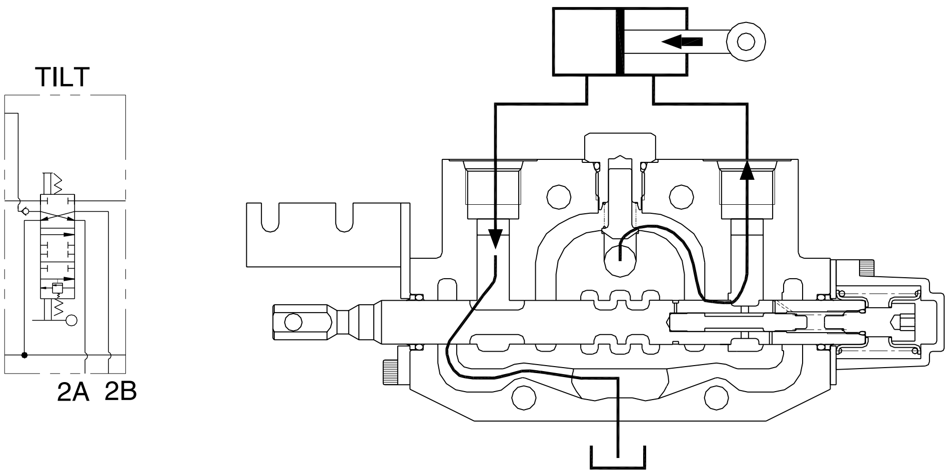
Simultaneously, the high pressure acts upon the end of the tilt lock plunger to move it towards the spring end of the spool. This plunger movement opens additional spool metering notches which control oil flow from the rod end of the cylinder to the tank return line.




22B7HS13

② Tilt Back

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



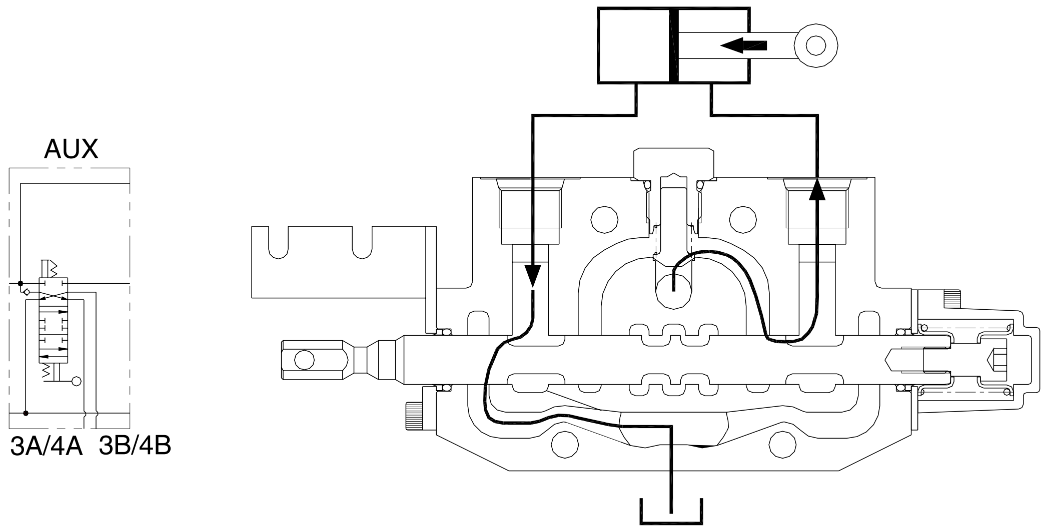

22B7HS14

Pressure is limited by the main relief valve.

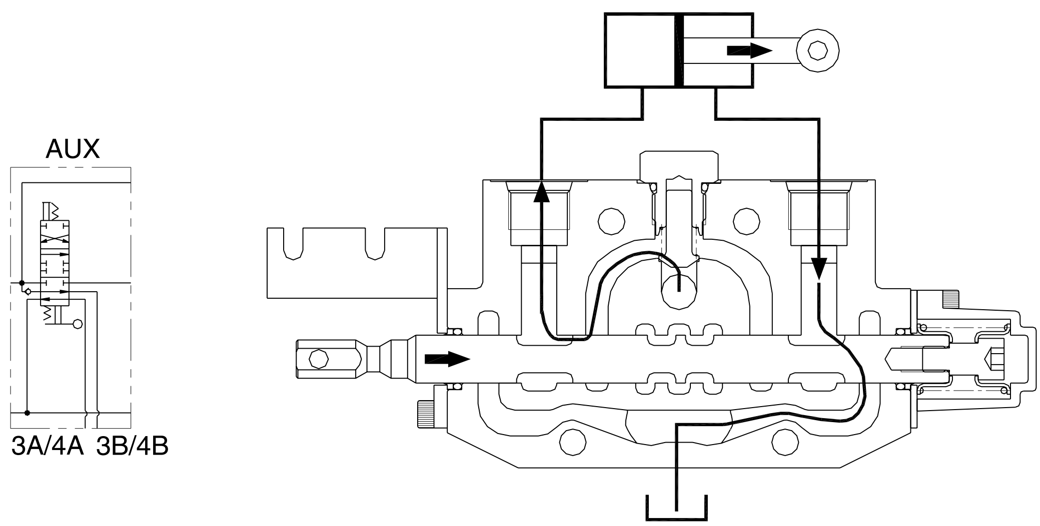
5) AUXILIARY SECTIONS

(1) Operation

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




22B7HS15



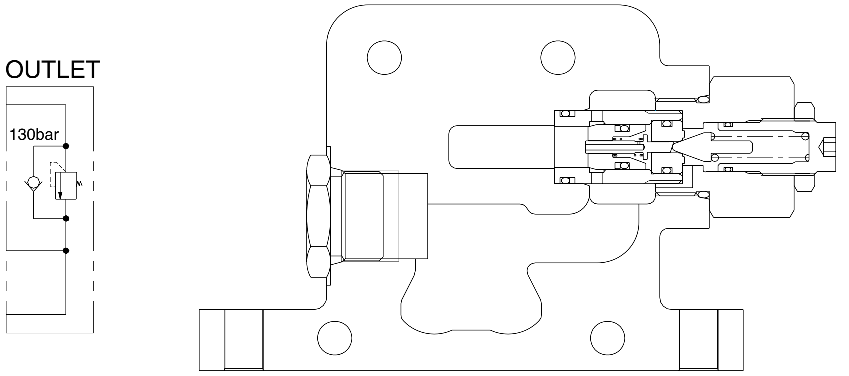

22B7HS16

Pressure is limited by the secondary main relief valve.

## 6) OUTLET SECTION

### (1) Operation

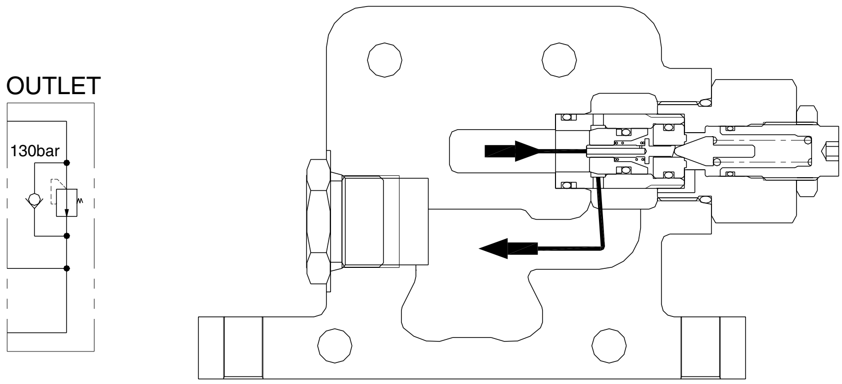
The outlet section contains the tank port and the secondary relief valve (with built-in anti-cavitation feature).




22B7HS17

### (2) Operation of relief valve at setting pressure

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

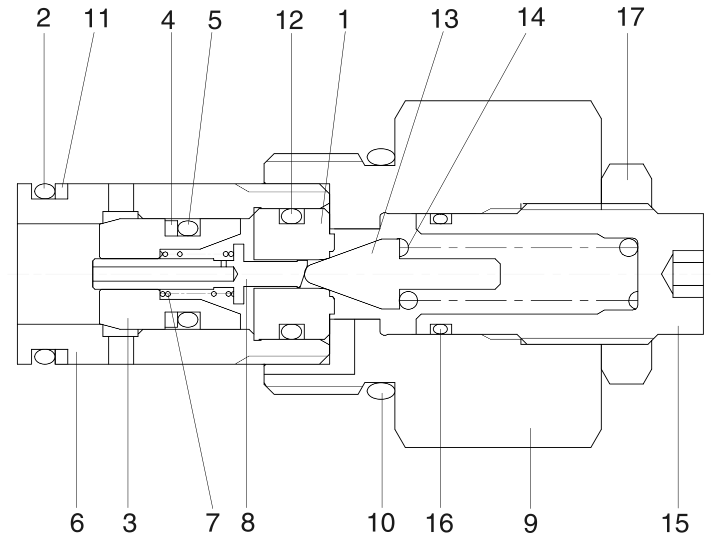


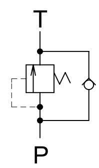

22B7HS18

### 7) MAIN RELIEF VALVE

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

Relief valve pressure varies by 130 $kgf/cm^2$ in accordance with 1 revolution of adjust bolt.




· Main relief valve : 190 $kgf/cm^2$

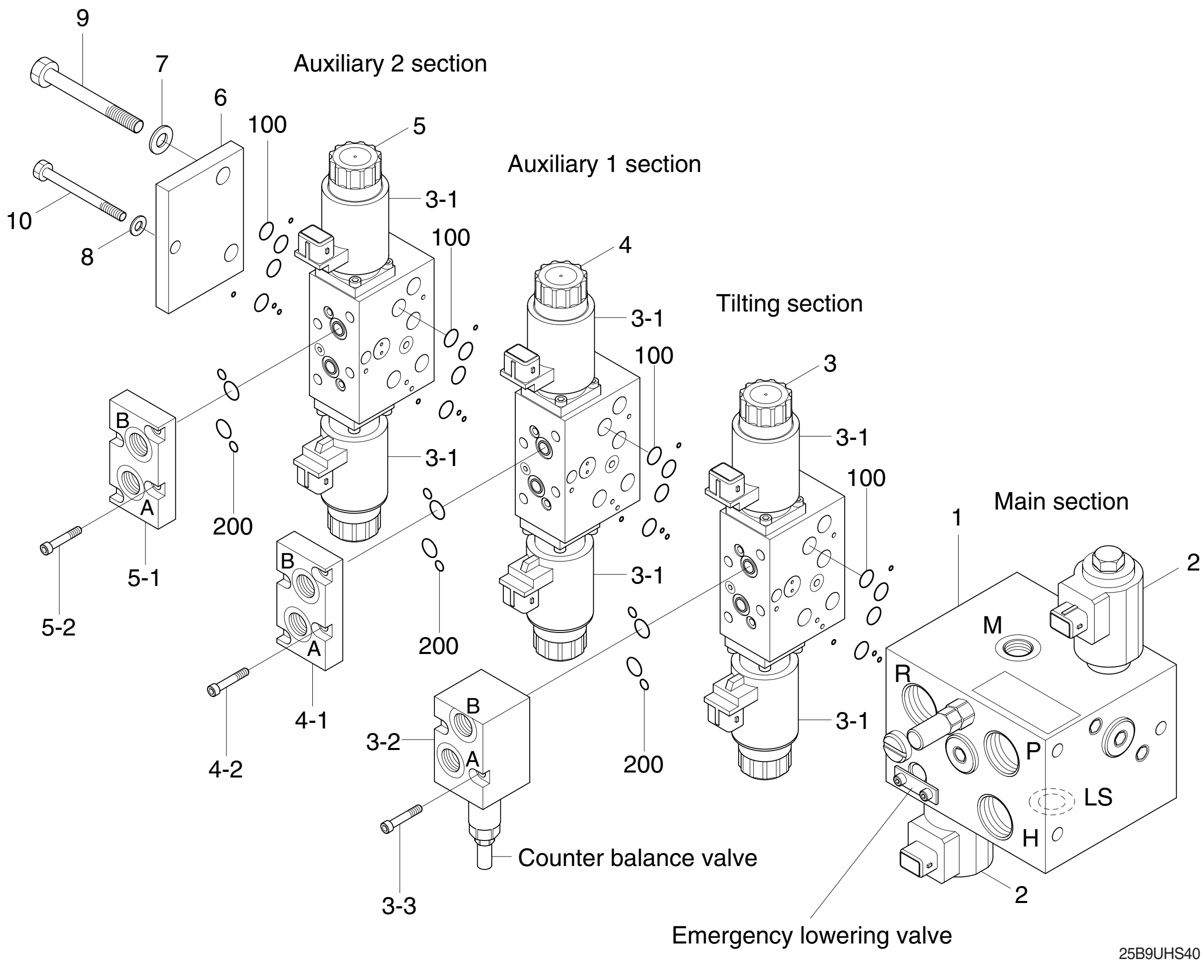
· Secondary main relief valve : 130 $kgf/cm^2$ (For 3,4 spool only)

22B7HS20

| | | | | | |
|---|---|---|---|---|---|
| 1 | Pilot seat | 7 | Main spring | 13 | Pilot poppet |
| 2 | O-ring | 8 | Piston | 14 | Pilot spring |
| 3 | Main poppet | 9 | Body | 15 | Adjust screw |
| 4 | Back up ring | 10 | O-ring | 16 | O-ring |
| 5 | O-ring | 11 | Back up ring | 17 | Lock nut |
| 6 | Socket | 12 | O-ring | | |

# 4. MAIN CONTROL VALVE (FINGERTIP TYPE)

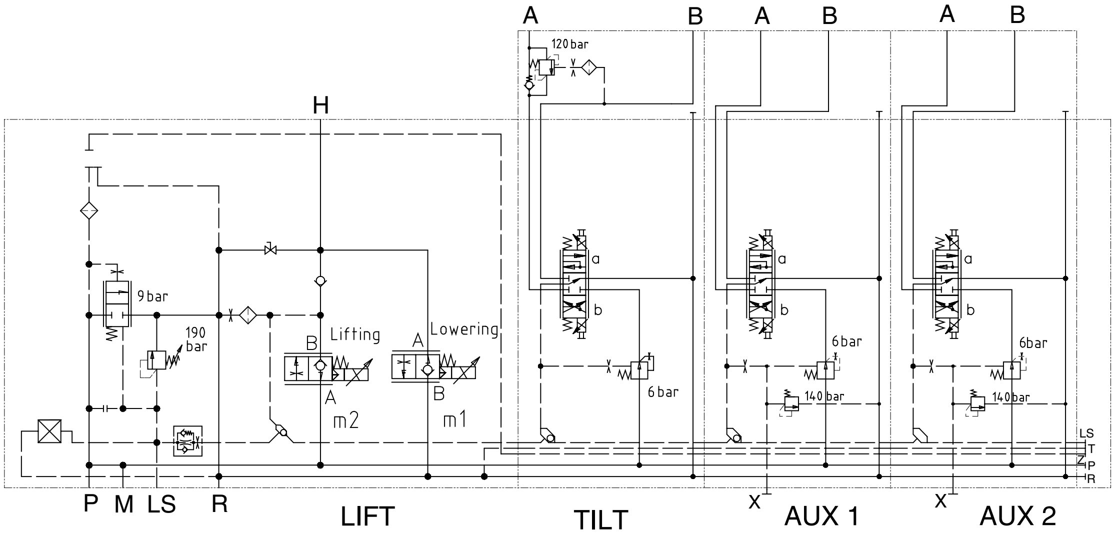
## 1) STRUCTURE




| Port name | Size | Port |
|---|---|---|
| Inlet port | 1 1/16-12UNF | P |
| Outlet port | 1 1/16-12UNF | R |
| Work port | 1 1/16-12UNF | H |
| Work port | 3/4-16 UNF | A, B |
| - | 7/16-20UNF | M, LS |

1 Main block
2 Solenoid valve (lift)
3 Solenoid valve (tilt)
3-1 Coil amp
3-2 Block
3-3 Socket head screw
4 Solenoid valve (auxiliary 1)
4-1 Ancillary block
4-2 Socket head screw
5 Solenoid valve (auxiliary 2)
5-1 Ancillary block
5-2 Socket head screw
6 End plate
7 Washer
8 Washer
9 Socket head screw
10 Socket head screw
100 Section seal kit
200 Ancillary block seal kit

## 2) HYDRAULIC CIRCUIT




25B9UHS41

| Port name | Size | Port |
|---|---|---|
| Inlet port | 1 1/16-12UNF | P |
| Outlet port | 1 1/16-12UNF | R |
| Work port | 1 1/16-12UNF | H |
| Work port | 3/4-16 UNF | A, B |
| - | 7/16-20UNF | M, LS |

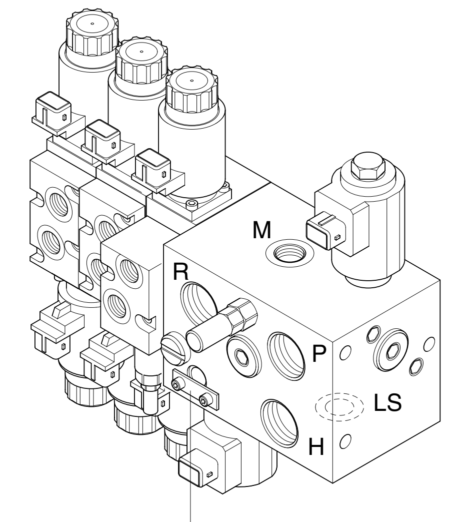
## 3) EMERGENCY LOWERING

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

(1) Turn off the emergency switch.

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

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

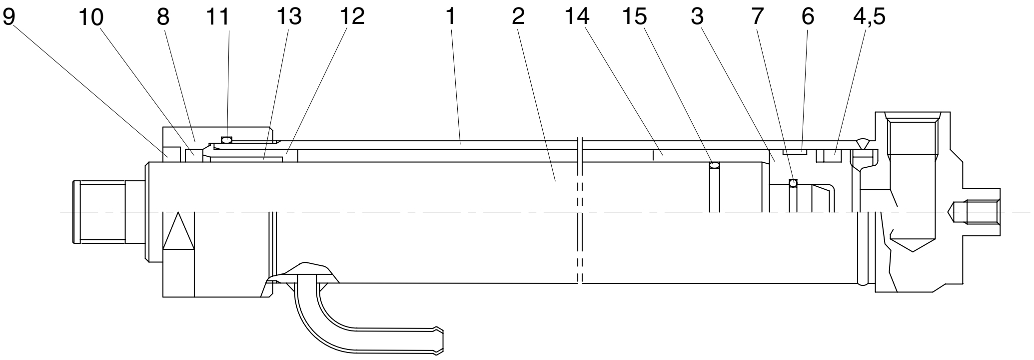



Emergency lowering valve

25B9UHS42

## 5. LIFT CYLINDER

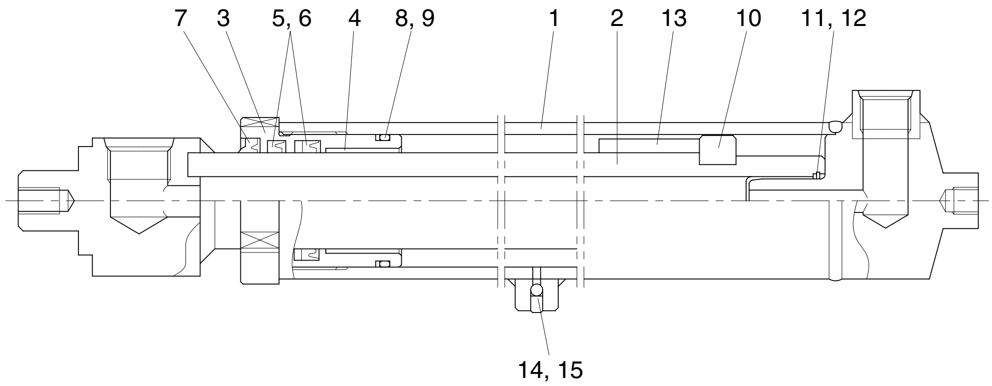
### 1) V MAST




D255HS18

| | | | | | |
|---|---|---|---|---|---|
| 1 | Tube assembly | 6 | Wear ring | 11 | O-ring |
| 2 | Rod | 7 | Retaining ring | 12 | Guide |
| 3 | Piston | 8 | Gland | 13 | DU bushing |
| 4 | Piston seal | 9 | Dust wiper | 14 | Spacer |
| 5 | Back up ring | 10 | Rod seal | 15 | O-ring |

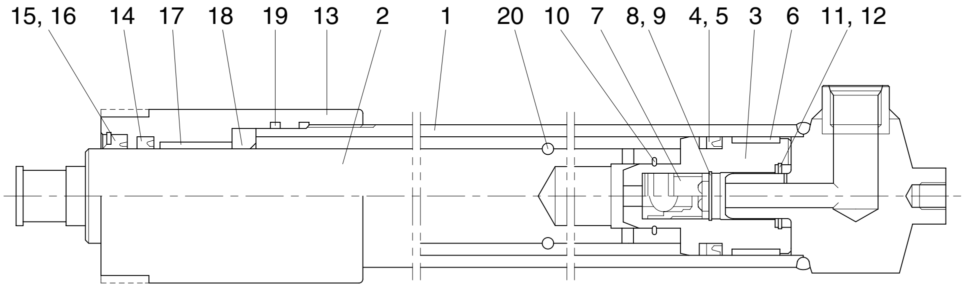
### 2) VF MAST




22B9FHS20

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

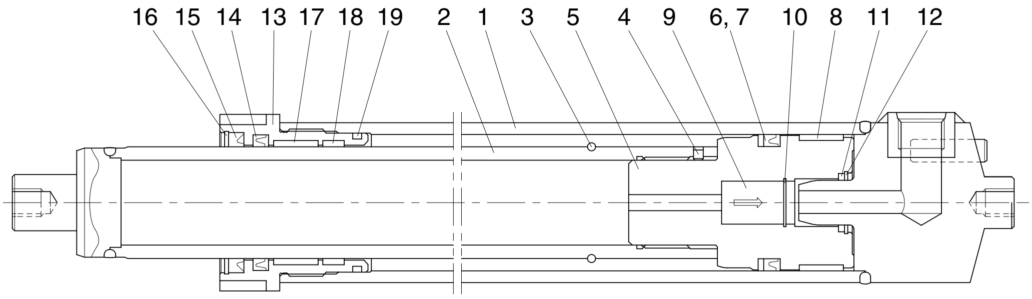
### 3) TF AND TS-MAST




22B9FHS21

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

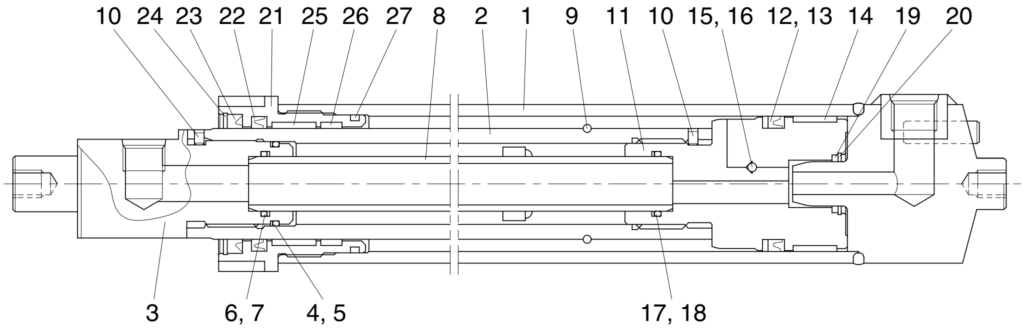
### 4) QF-MAST (LH)




22B9FHS22

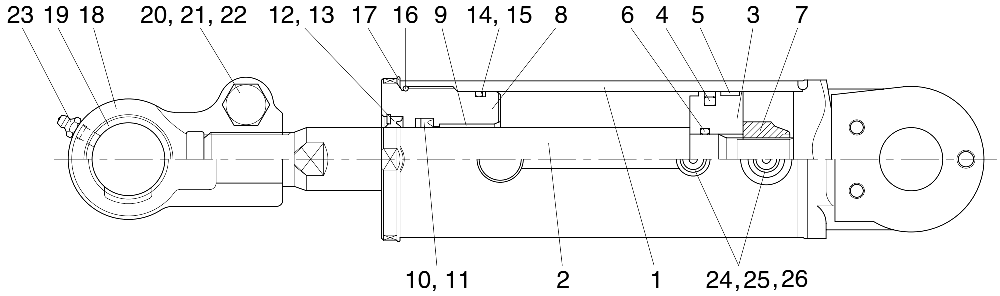
| | | | | | |
|---|---|---|---|---|---|
| 1 | Tube assembly | 8 | Wear ring | 15 | Dust wiper |
| 2 | Rod assembly | 9 | Check valve | 16 | Retaining ring |
| 3 | Stop ring | 10 | Retaining ring | 17 | Wear ring |
| 4 | Set screw | 11 | Cushion seal | 18 | Dust ring |
| 5 | Piston | 12 | Retaining ring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

5) TF AND TS-MAST




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

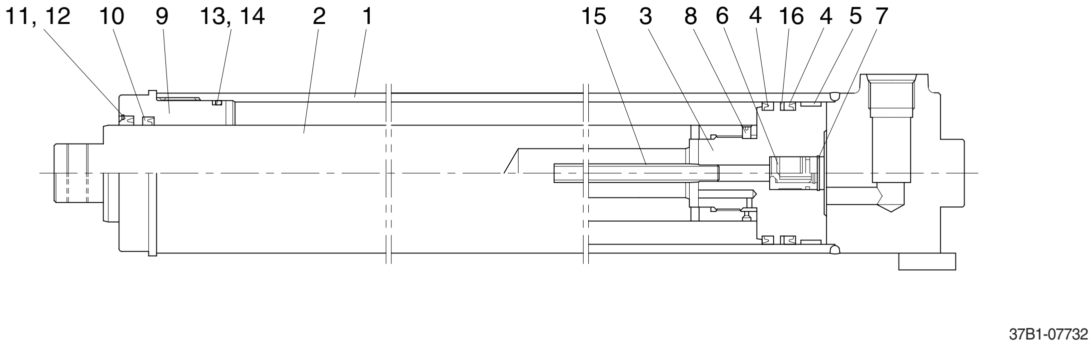
## 6. TILT CYLINDER




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

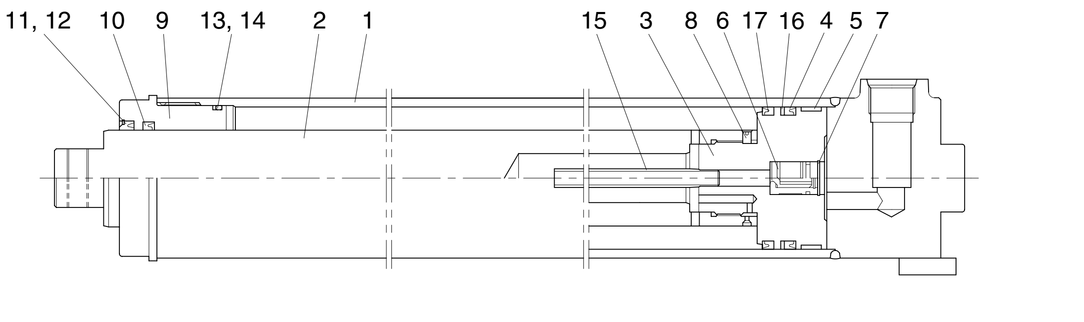
## 7. FREE LIFT CYLINDER

### 1) VF-MAST AND TF MAST (30/32/35B-9U)



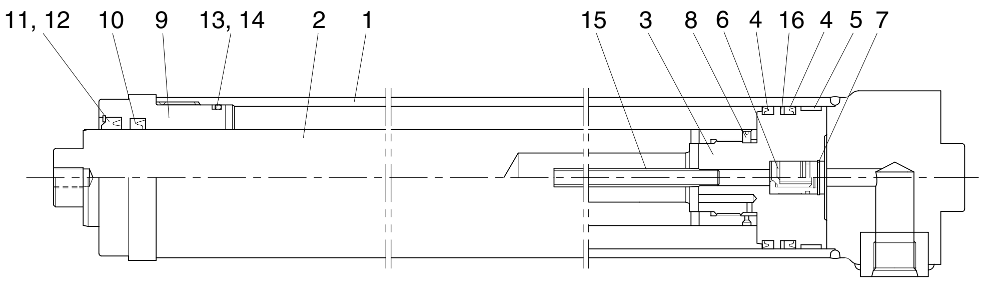

| | | | | | |
|---|---|---|---|---|---|
| 1 | Tube assembly | 7 | Retaining ring | 13 | O-ring |
| 2 | Rod | 8 | Set screw | 14 | Back up ring |
| 3 | Piston | 9 | Rod cover | 15 | Pipe |
| 4 | U-packing | 10 | U-packing | 16 | Back up ring |
| 5 | Wear ring | 11 | Dust wiper | | |
| 6 | Check valve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

### 2) TF-MAST (25B-9U)




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

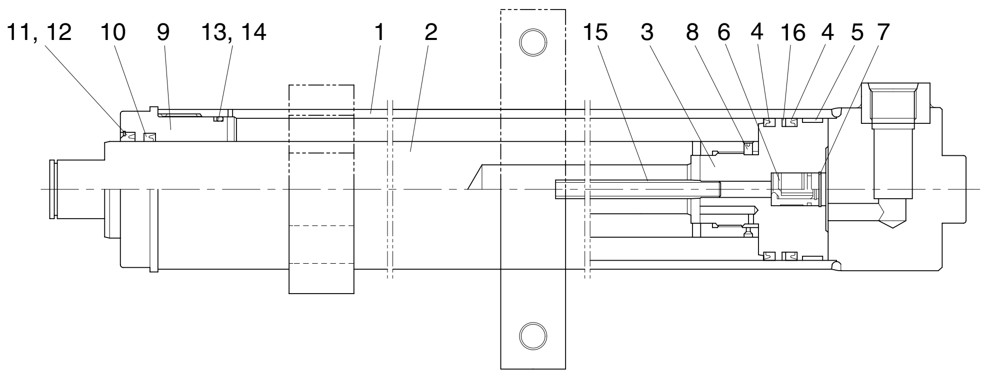
3) TS-MAST




3AHN-80202

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

4) QF-MAST




3CHN-07503

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

# GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

## 1. OPERATIONAL CHECKS

### 1) CHECK ITEM

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

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

· **Check condition**

- Hydraulic oil : Normal operating temp (50 °C)
- Mast substantially vertical.
- Rated capacity load.

· **Hydraulic drift**

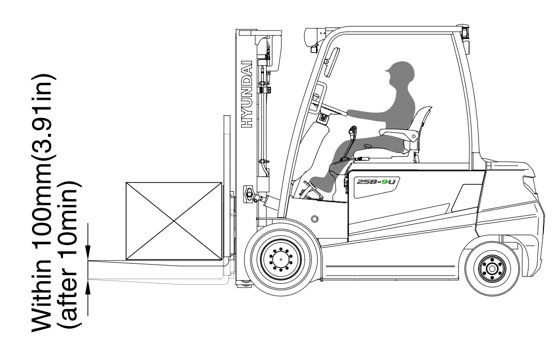
- Down (Downward movement of forks) : Within 100 mm (3.9 in)
- Forward (Extension of tilt cylinder) : Within 5°

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

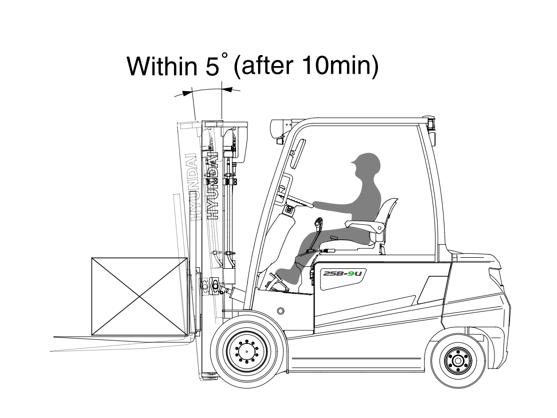
Check that clearance between tilt cylinder bushing and mounting pin is within standard range.

mm (in)

| | |
|---|---|
| Standard | Under 0.6 (0.02) |




25B9UHS16

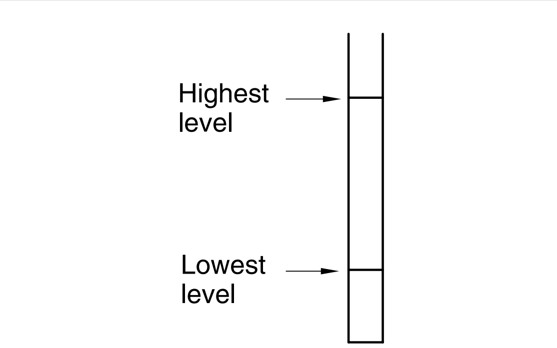



25B9UHS17

### 2) HYDRAULIC OIL

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

(2) When changing hydraulic oil, clean suction strainer(screwed into outlet port pipe)




B15AOM116

### 3) MAIN CONTROL VALVE

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

Check that oil pressure is 190 kgf/cm$^2$ (2700 psi).

## 2. TROUBLESHOOTING

### 1) SYSTEM

| Problem | Cause | Remedy |
|---|---|---|
| Large fork lowering speed | · Seal inside control valve defective.<br>· Oil leaks from joint or hose.<br>· Seal inside cylinder defective. | · Replace spool or valve body.<br>· Replace.<br>· Replace packing. |
| Large spontaneous tilt of mast | · Tilting backward : Check valve defective.<br>· Tilting forward : tilt lock valve defective.<br>· Oil leaks from joint or hose.<br>· Seal inside cylinder defective. | · Clean or replace.<br>· Clean or replace.<br>· Replace.<br>· Replace seal. |
| Slow fork lifting or slow mast tilting | · Lack of hydraulic oil.<br>· Hydraulic oil mixed with air.<br>· Oil leaks from joint or hose.<br>· Excessive restriction of oil flow on pump suction side.<br>· Relief valve fails to keep specified pressure.<br>· Poor sealing inside cylinder.<br>· High hydraulic oil viscosity.<br>· Mast fails to move smoothly.<br>· Oil leaks from lift control valve spool.<br>· Oil leaks from tilt control valve spool. | · Add oil.<br>· Bleed air.<br>· Replace.<br>· Clean filter.<br>· Adjust relief valve.<br>· Replace packing.<br>· Change to ISO VG46.<br>· Adjust roll to rail clearance.<br>· Replace spool or valve body.<br>· Replace spool or valve body. |
| Hydraulic system makes abnormal sounds | · Excessive restriction of oil flow pump suction side.<br>· Gear or bearing in hydraulic pump defective. | · Clean filter.<br>· Replace gear or bearing. |
| Control valve lever is locked | · Foreign matter jammed between spool and valve body.<br>· Valve body defective. | · Clean.<br>· Tighten body mounting bolts uniformly. |
| High oil temperature | · Lack of hydraulic oil.<br>· High oil viscosity.<br>· Oil filter clogged. | · Add oil.<br>· Change to ISO VG46.<br>· Clean filter. |

### 2) HYDRAULIC GEAR PUMP

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

### 3) MAIN RELIEF VALVE

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

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

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

### 4) LIFT CYLINDER

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

## GROUP 3 DISASSEMBLY AND ASSEMBLY

Check immediately that any spare parts you receive have not been damaged in shipment.
Always work in a clean environment.
Wash all components in solvent and blow dry with compressed air before refitting.
Take care not to damage rubber seals.
Avoid damaging precision machined surfaces.
Components should fit into their housings without excessive force. If force is necessary, this normally means that the component does not have the correct dimensional tolerances of is aligned incorrectly.
When hand pressure is insufficient, only use press or rubber hammer to fit components.
Never strike components with steel hammers.
Steel bush must be fitted only with a suitable press.
Do not use hammers to fit bearings.
Always respect the direction of rotation when assembling components.

## 1. HYDRAULIC GEAR PUMP

※ Tools required

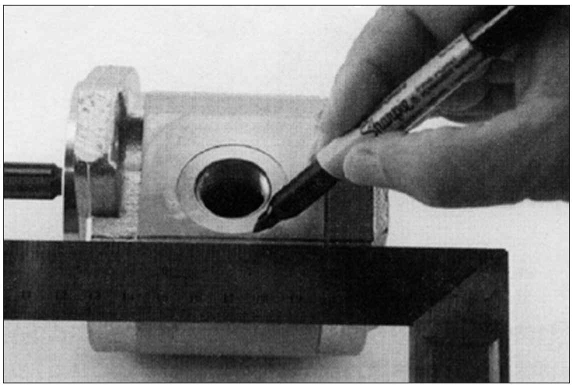
· Metric socket set
· Internal snap ring pliers
· Shaft seal sleeve
· Torque wrench

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

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

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

(4) Remove key from drive shaft if applicable.

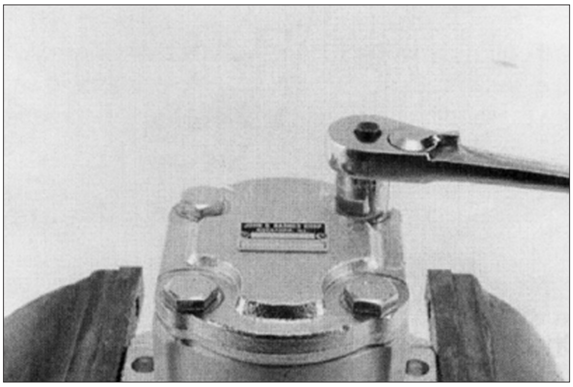


PUMP 01

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

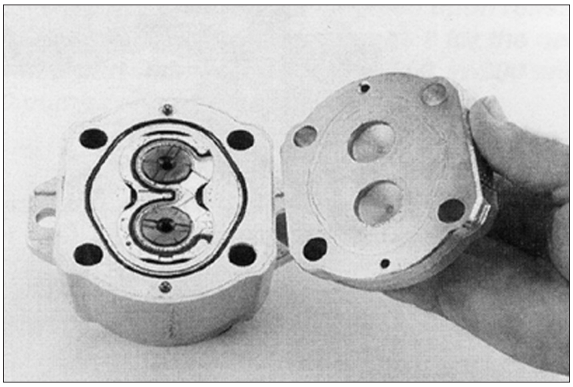
(6) Loosen the four metric hexagon head bolts.

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



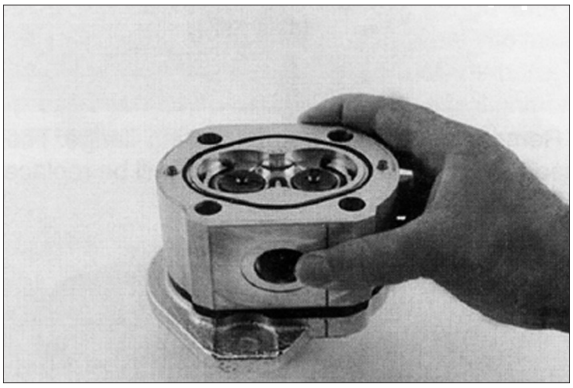
PUMP 02

(8) Lift and remove end cover.



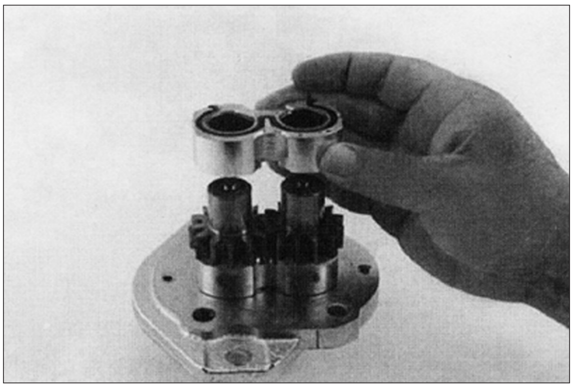
PUMP 03

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



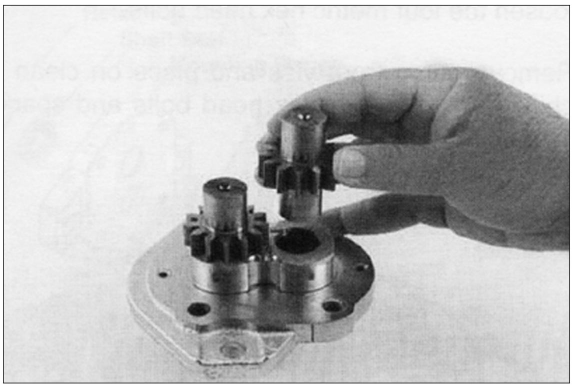
PUMP 04

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



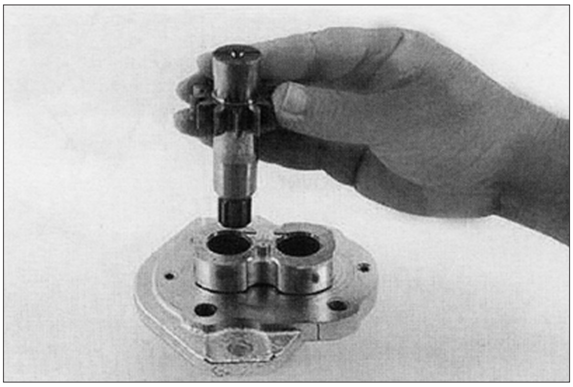
PUMP 05

(11) Remove idler shaft from bearing block.



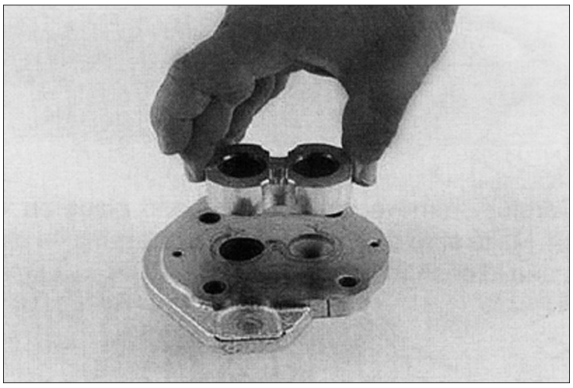
PUMP 06

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



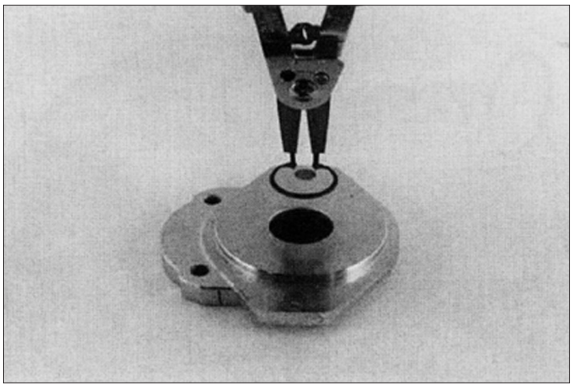
PUMP 07

(13) Remove the front bearing block.



PUMP 08

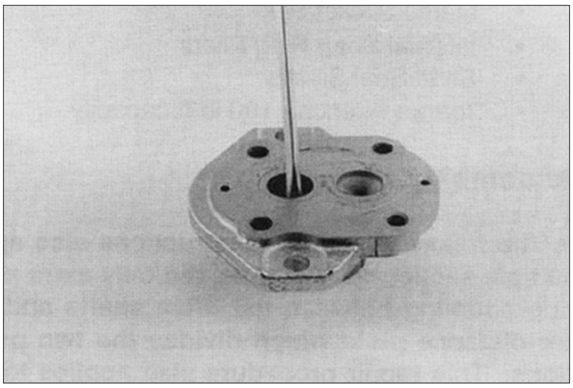
(14) Turn mounting flange over, with shaft seal up, and remove the retaining ring with proper snap ring pliers.



PUMP 09

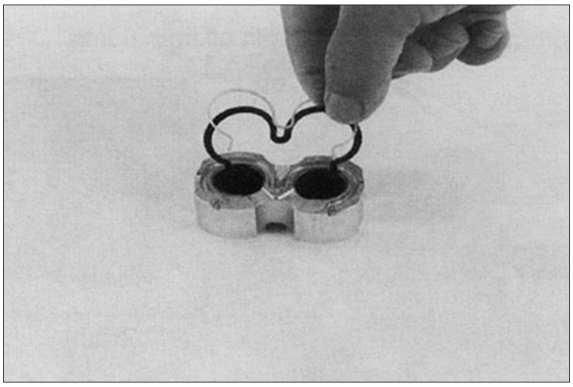
(15) Remove the oil seal from mounting flange, be careful not to mar or scratch the seal bore.

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



PUMP 10

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

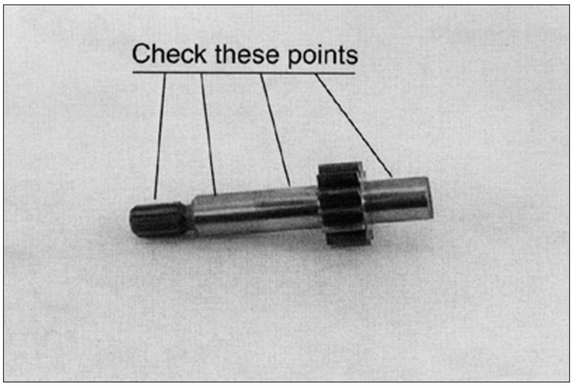

PUMP 11

## 2) INSPECT PARTS FOR WEAR

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

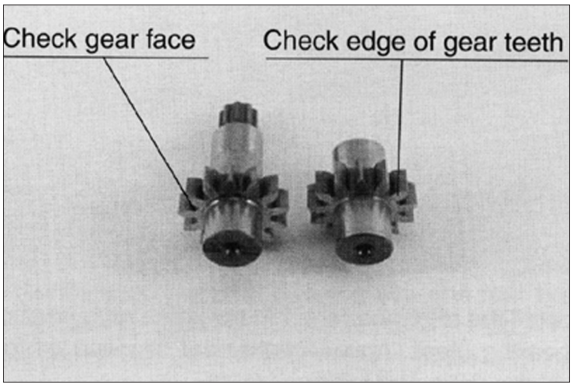
(2) Check drive shaft spline for twisted or broken teeth, check keyed drive shaft for broken or chipped keyway. No marks or grooves on shaft in seal area, some discoloration of shaft is allowable.

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



PUMP 12

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



PUMP 13

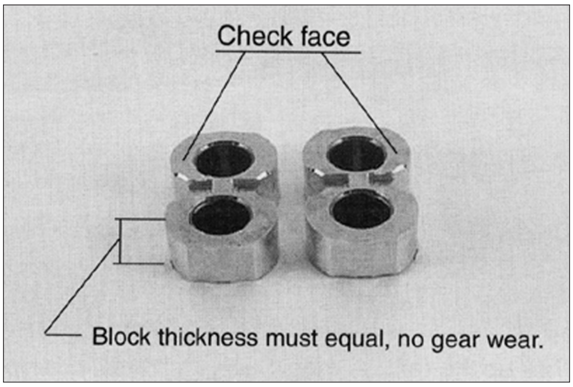
(5) Inspect bearing blocks for excessive wear or scoring on the surfaces which are in contact with the gears. Also inspect the bearings for excessive wear or scoring.

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

※ General information

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

※ This pump is not bi-rotational.

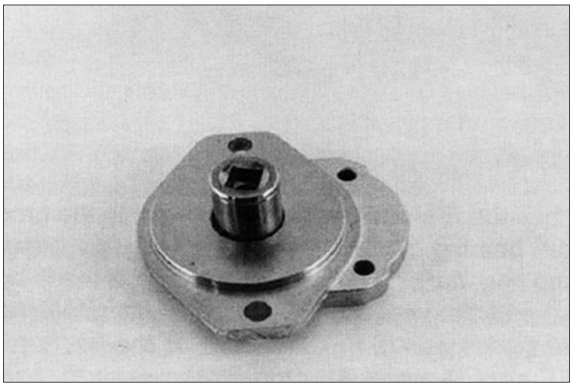



PUMP 14

### 3) ASSEMBLY

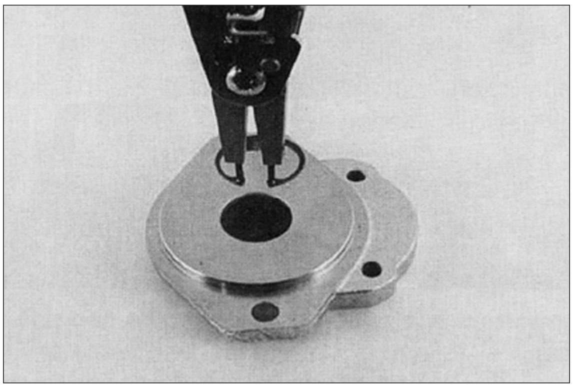
※ New seals should be installed upon reassembly of pump.

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



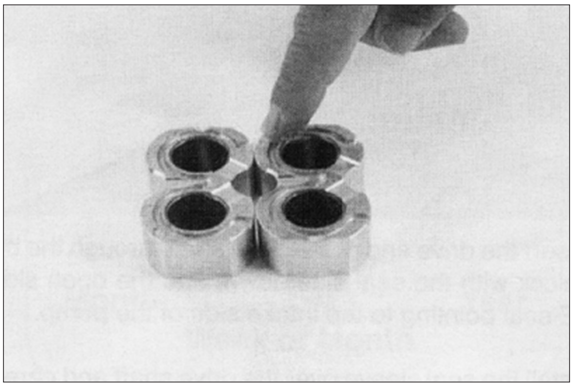
PUMP 15

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



PUMP 16

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

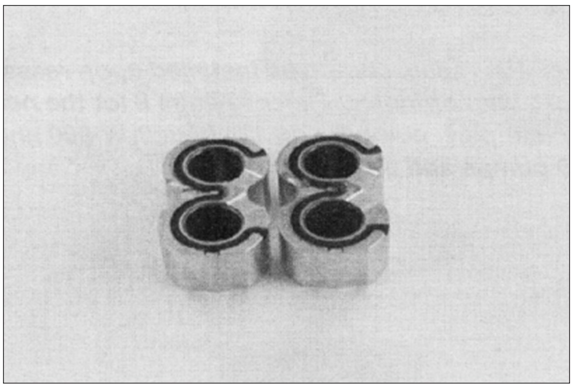


PUMP 17

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

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

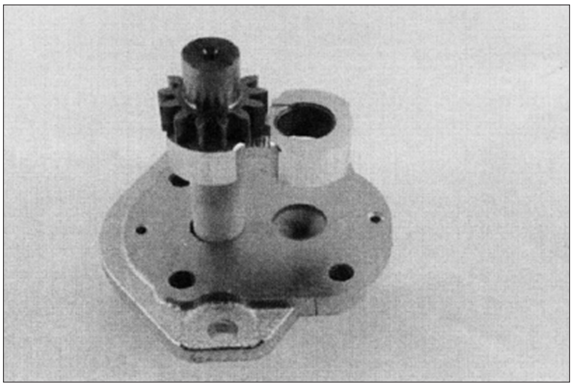
(6) Apply a light coating of petroleum jelly to the exposed face of the front bearing block.



PUMP 18

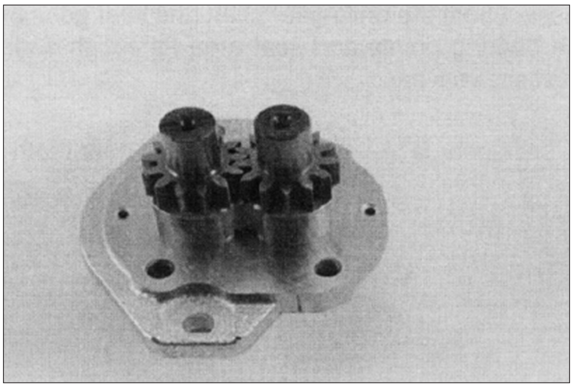
(7) Insert the drive end of the drive shaft through the bearing block with the seal side down, and the open side of the E-seal pointing to the intake side of the pump.

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



PUMP 19

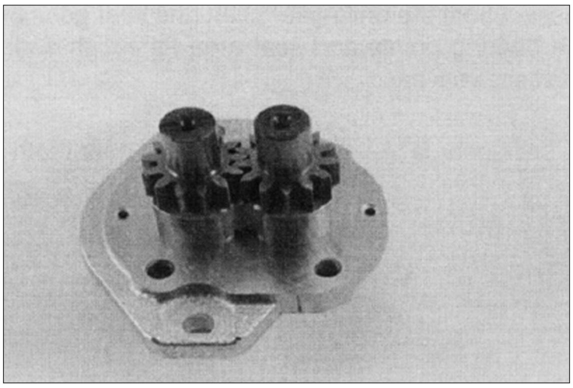
(9) Install the idler gear shaft in the remaining position in the bearing block. Apply a light coat of clean oil to the face of the drive and idler gears.



PUMP 20

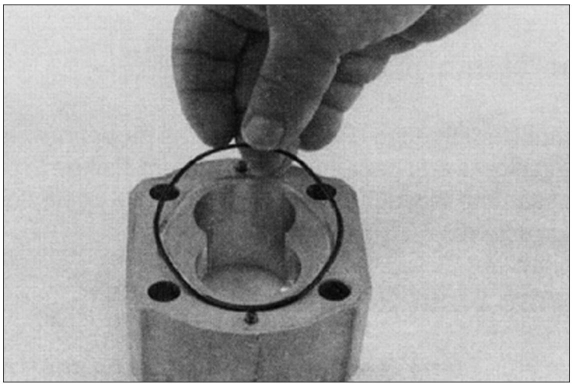
(10) Pick up the rear bearing block, with seal side up and with open end of the E-seal facing the intake side of the pump, place over the drive and idler gear shafts.

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



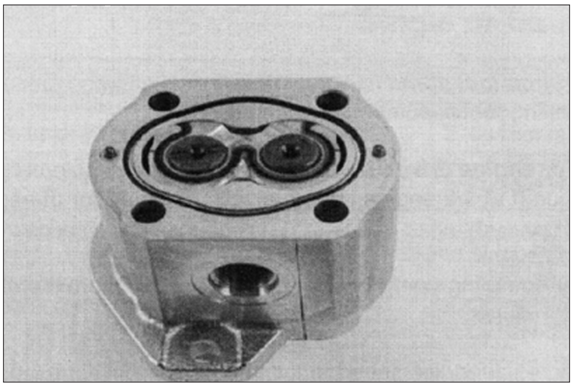
PUMP 21

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



PUMP 22

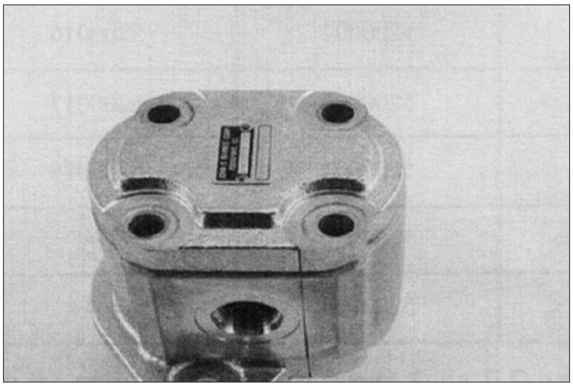
(13) Gently slide the gear housing over the rear bearing block assembly, slide housing down until the housing engages the dowel pins. Press firmly in place with hands, do not force or use any tool.
Check to make sure the intake port in the housing in on the same side as the open end of the E-seal and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



PUMP 23

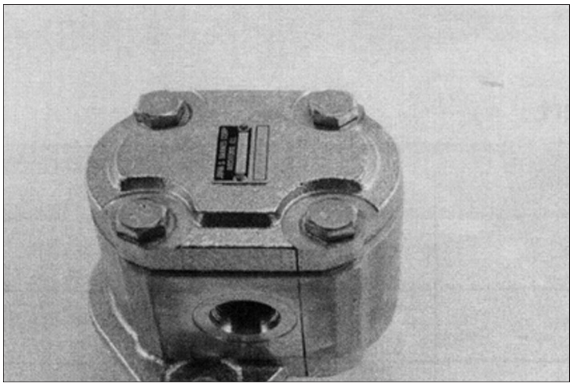
(14) The surface of the rear bearing block should be slightly below the face of the gear housing. If the bearing block sits higher then the rear face of the gear housing then the E-seal or O-ring have shifted out of the groove. If this is the case, remove the gear housing and check for proper seal installation.

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



PUMP 24

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



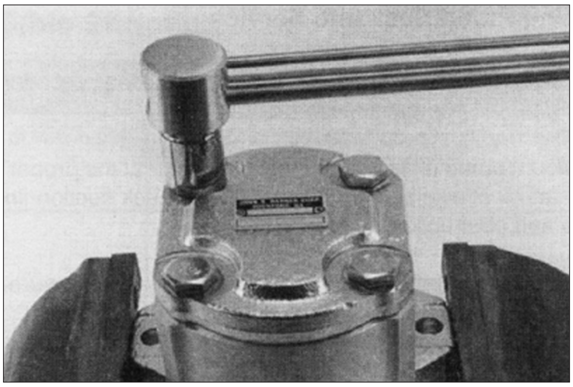
PUMP 25

(17) Place mounting flange of the pump back in the protected jawed vise and alternately torque the bolts.

· Tighten torque : 3.0~4.0 kgf · m (22~29 lbf · ft)

(18) Remove pump from vise.

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



PUMP 26

## 2. MAIN CONTROL VALVE (MANUAL TYPE)

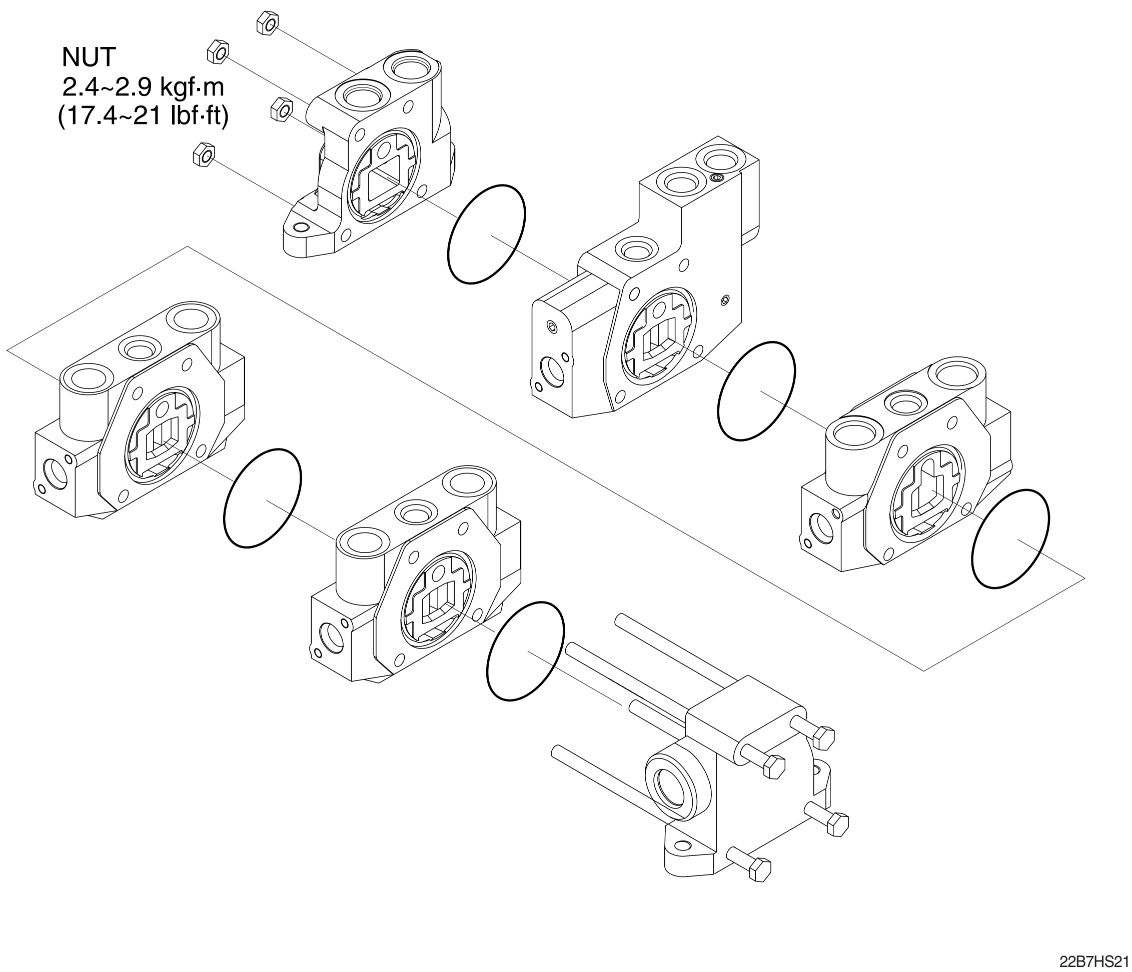
※ Descriptions are based on the OPSS type.

### 1) ASSEMBLY

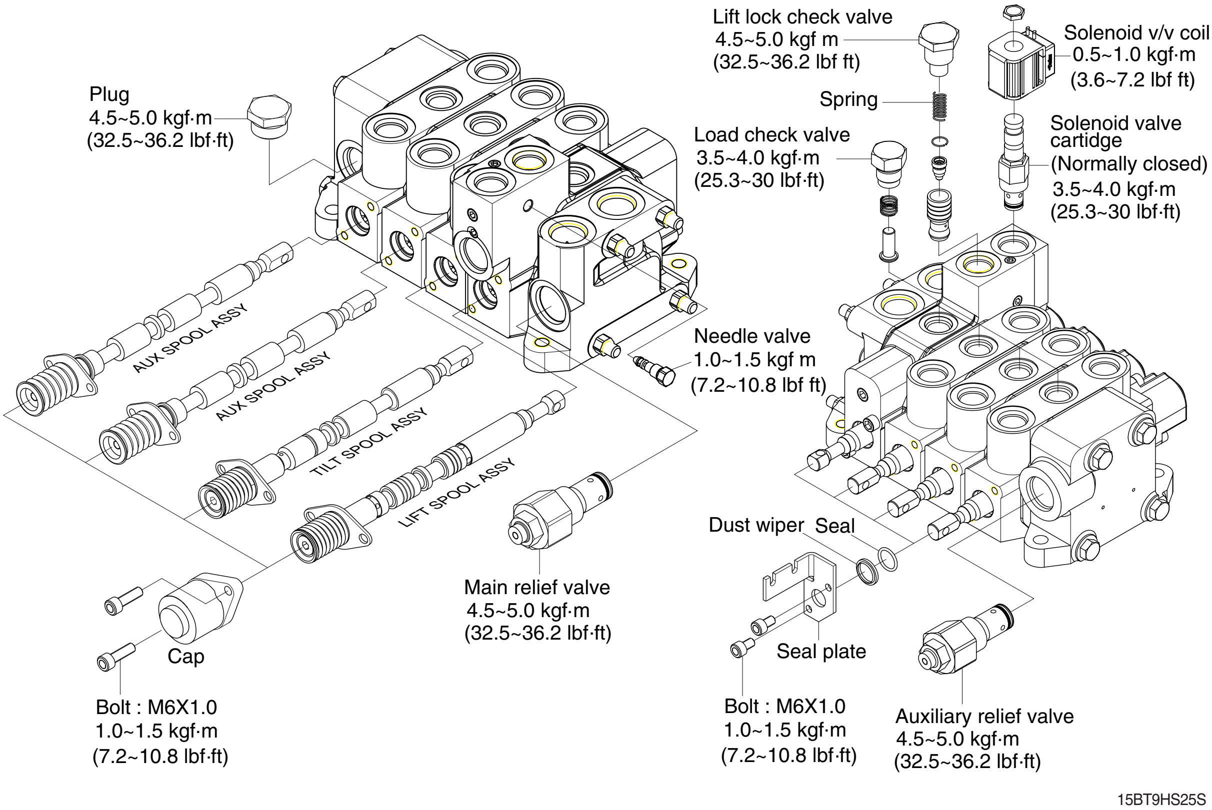
#### (1) General

① Ensure that the assembly area will be clean and free of contamination.
② Use a flat (within 0.2 ㎜) work surface when bolting the valve sections together.
③ Use calibrated torque wrenches and instrumentation.
④ Additional auxiliary valve sections may be added to the main control valve in a similar manner as indicated below.

#### (2) Block sub assembly




① Attach all the O-rings to the appropriate grooves between the spool sections.
② Stack the valve sections such that all the work ports are facing up, the spool ends are all in the
③ same direction, and they are resting on a flat (within 0.2 ㎜), uniform surface.
④ Insert all the tie rods through the drilled holes in each of the housings.
Press the sections together, being carefully not to damage sealing surfaces or seals.
⑤ Install nuts to both ends of all tie rods and progressively torque in a circular pattern until reaching a torque of 2.4~2.9 kgf · m (17.4~21 lbf · ft) on all tie rods. Periodically, make sure that the valve remains flat while applying torque.




### (3) Inlet section

① Install the main relief valve assembly into the lower side cavity of the inlet section, as illustrated. Torque to 4.5~5.0 kgf · m (32.5~36.2 lbf · ft).

② Install the plug assembly in the tank port of the inlet section. Torque to 4.5~5.0 kgf · m (32.5~36.2 lbf · ft)

### (4) Lift section

① The spool assembly should already consist of the lift spool, the return spring, one spring seat on either end of the spring, the seal plate, a spool seal, and a dust wiper. All of these are assembled on the end of the spool opposite the clevis.

② Insert the clevis end of the spool into the right-hand side of the spool bore(the tallest end of the housing). Place the spool cap over the spool and spring assembly and connect the cap to the housing using two bolts. Torque both bolts alternatively until a torque of 1.0~1.5 kgf · m (7.2~10.8 lbf · ft) is reached on both bolts.

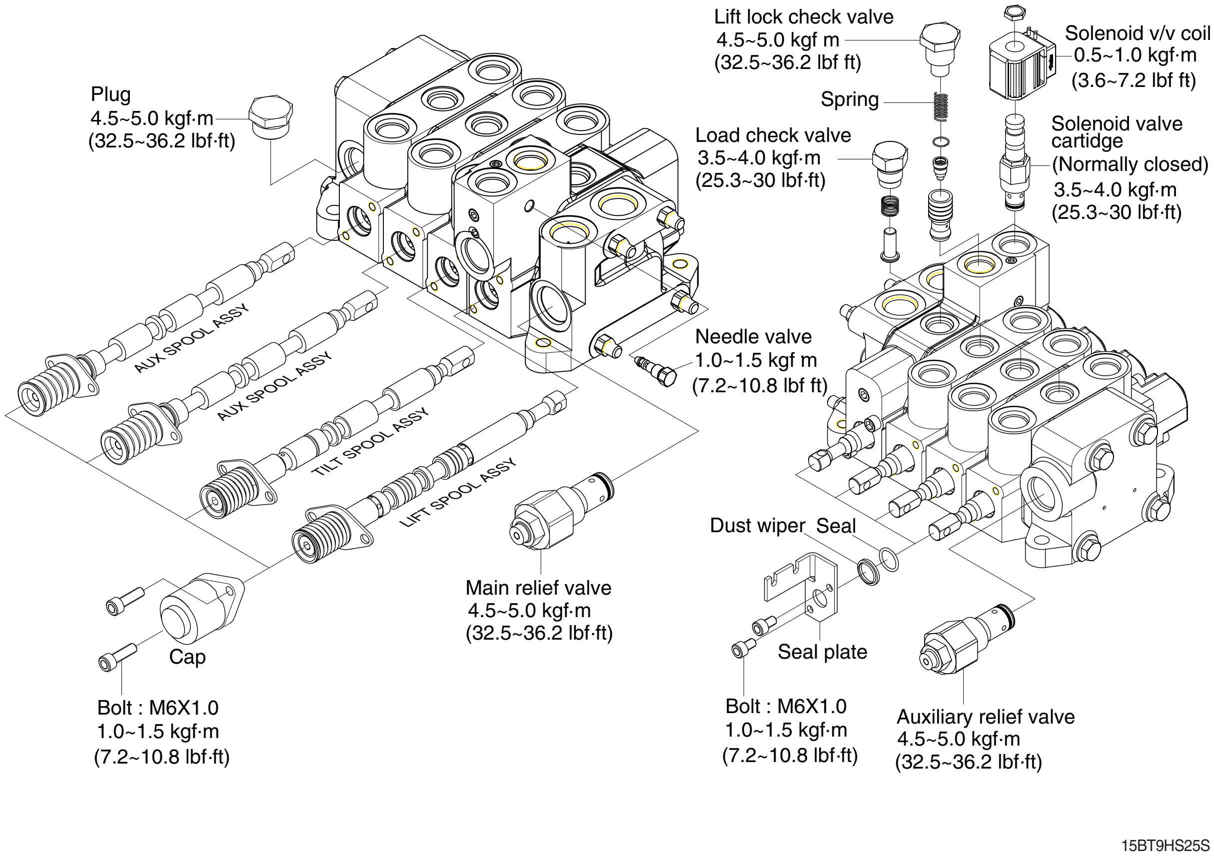
③ Install the second spool seal and dust wiper over the clevis end of the spool and retain with a seal plate and two bolts. Torque both bolts alternatively until a torque of 1.0~1.5 kgf · m (7.2~10.8 lbf · ft) is reached on both bolts.

④ The load check assembly is inserted into the top center cavity. Torque to 3.5~4.0 kgf · m (25.3~30 lbf · ft)

⑤ The normally closed solenoid is installed in the rightmost cavity on the top of the section. Torque to 3.5~4.0 kgf · m (25.3~30 lbf · ft)

⑥ Install the lift lock check valve assembly in the remaining open cavity in the top of the housing. Torque to 4.5~5.0 kgf · m(32.5~36.2 lbf · ft)

⑦ Install the needle valve subassembly in the cavity on the inlet-facing surface of the housing. Torque to 1.0~1.5 kgf · m (7.2~10.8 lbf · ft)




(5) Tilt section

① The spool assembly should already consist of the tilt spool(with tilt plunger and spring inserted into the bore on the spring end), the return spring, one spring seat on either end of the spring, the seal plate, a spool seal, and a dust wiper. All of these are assembled on the end of the spool opposite the clevis.

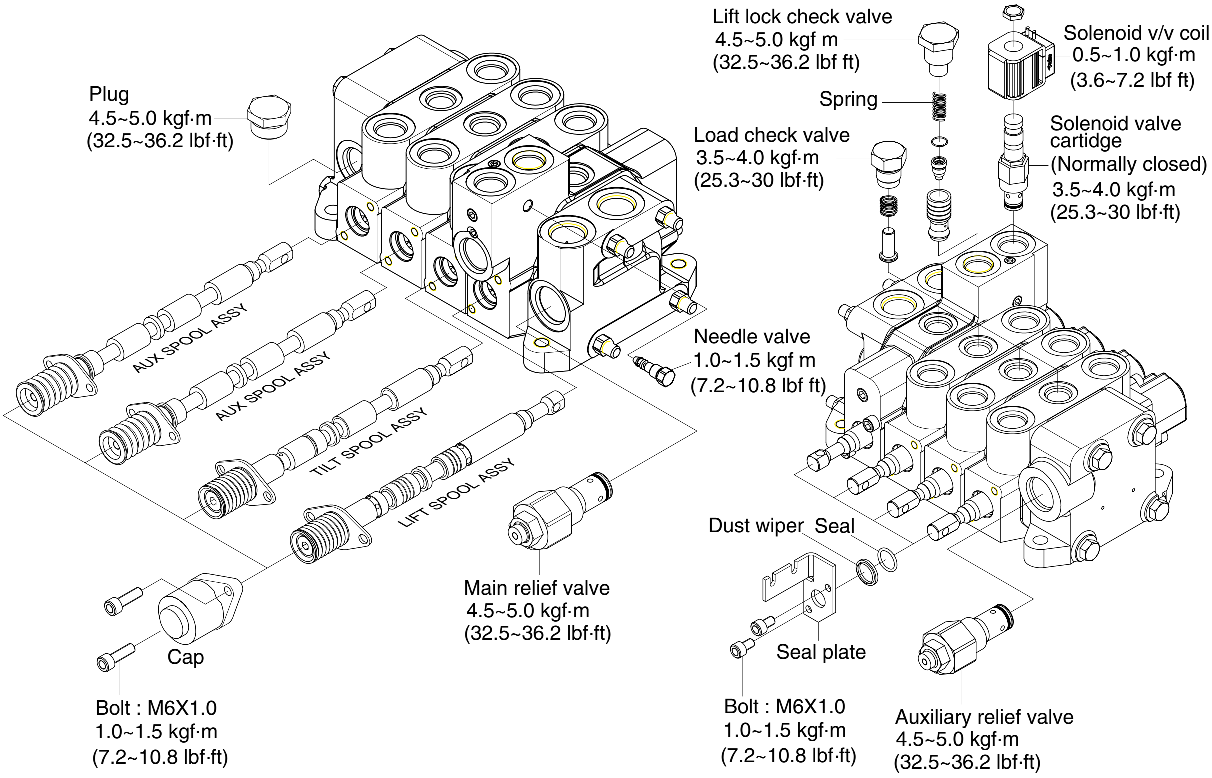
② Insert the clevis end of the spool into the right-hand side of the spool bore(the tallest end of the housing). Place the spool cap over the spool and spring assembly and connect the cap to the housing using two bolts. Torque both bolts alternatively until a torque of 1.0~1.5 kgf · m (7.2~10.8 lbf · ft) is reached on both bolts.

③ Install the second spool seal and dust wiper over the clevis end of the spool and retain with a seal plate and two bolts. Torque both bolts alternatively until a torque of 1.0~1.5kgf · m(7.2~10.8lbf · ft) is reached on both bolts.

④ The load check assembly is inserted into the top center cavity. Torque to 3.5~4.0 kgf · m (25.3~30 lbf · ft).

⑤ Install the anti-cavitation check valve in the housing cavity on the clevis end directly above the spool assembly. Torque to 4.5~5.0 kgf · m (32.5~36.2 lbf · ft).

⑥ Install the plug in the housing cavity above the spool assembly. Torque to 3.5~4.0 kgf · m (25.3~30 lbf · ft).




(6) Auxiliary section

※ Same procedure for all aux sections, but spool assembly components may vary.

① The spool assembly should already consist of the proper aux spool, the return spring, one spring seat on either end of the spring, the seal plate, a spool seal, and a dust wiper. All of these are assembled on the end of the spool opposite the clevis.

② Insert the clevis end of the spool into the right-hand side of the spool bore (the tallest end of the housing). Place the spool cap over the spool and spring assembly and connect the cap to the housing using two bolts. Torque both bolts alternatively until a torque of 1.0~1.5 kgf · m (7.2~10.8 lbf · ft) is reached on both bolts.

③ Install the second spool seal and dust wiper over the clevis end of the spool and retain with a seal plate and two bolts. Torque both bolts alternatively until a torque of 1.0~1.5 kgf · m(7.2~10.8 lbf · ft) is reached on both bolts.

④ The load check assembly is inserted into the top center cavity. Torque to 3.5~4.0 kgf · m (25.3~30 lbf · ft).

(7) Outlet section

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

## 2) DISASSEMBLY

### (1) General

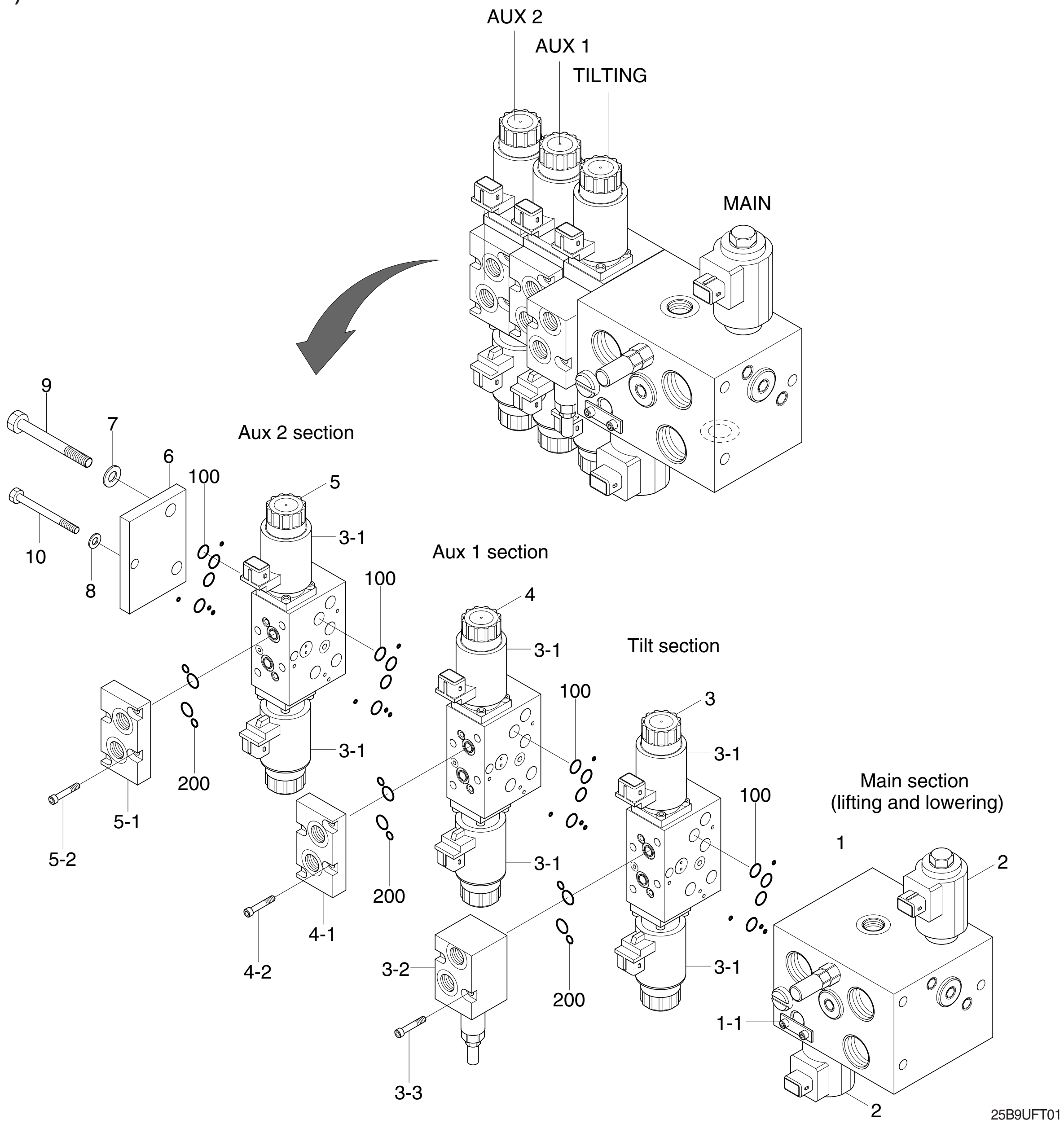
① Subassemblies (such as relief valves, check valves, and spools) may be removed without having to loosen the tie rods and disassembling the entire valve.
② Disassemble the valve sections on a flat working surface.
③ Ensure that the disassembly area will be clean and free of contamination.
④ Keep the disassembly area neat to avoid loss or damage of parts.

### (2) Disassembly

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

## 3. MAIN CONTROL VALVE (FINGERTIP, OPT)

### 1) STRUCTURE

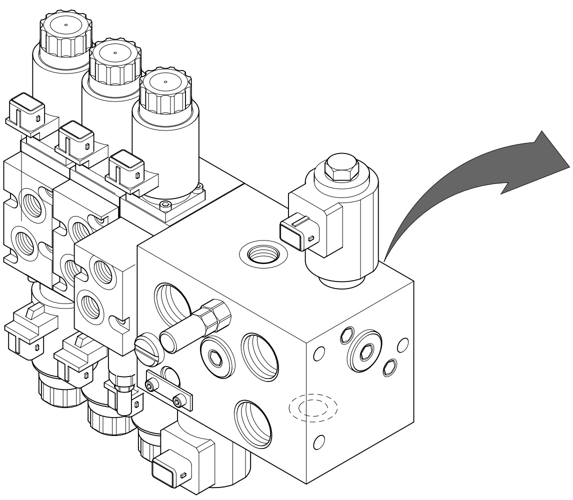



※ Tightening torque

- Item (3-3, 4-2, 5-2) : 0.61 kgf·m (4.4 lbf.ft)
- Item (9) : 2.3 kgf·m (17.0 lbf.ft)
- Item (10) : 0.97 kgf·m (7.0 lbf.ft)

| | | | | | |
|---|---|---|---|---|---|
| 1 | Main block | 4-1 | Ancillary block | 8 | Washer |
| 2 | Solenoid valve (lift) | 4-2 | Socket head screw | 9 | Socket head screw |
| 3 | Solenoid valve (tilt) | 5 | Solenoid valve (auxiliary 2) | 10 | Socket head screw |
| 3-1 | Coil amp | 5-1 | Ancillary block | 100 | Section seal kit |
| 3-2 | Block | 5-2 | Socket head screw | 200 | Ancillary block |
| 3-3 | Socket head screw | 6 | End plate | | |
| 4 | Solenoid valve (auxiliary 1) | 7 | Washer | | |

2) MAIN SECTION



25B9UFT02

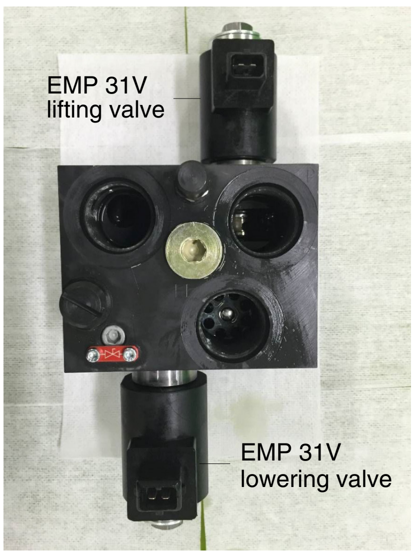
※ Flow rate : 80 lpm

※ Maximum pressure : 250 bar

※ Setting pressure : 190 bar

(1) Lifting and lowering valve

① Main section



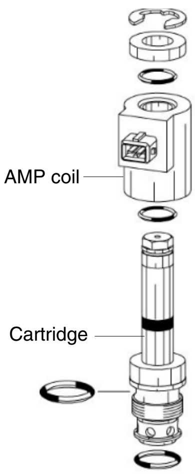

25B9UFT03

※ When it can't control lifting & lowering, need to check EMP valve. Because of contamination material EMP valve often can't operate properly that means valve poppet and seat opened.

② EMP solenoid valve

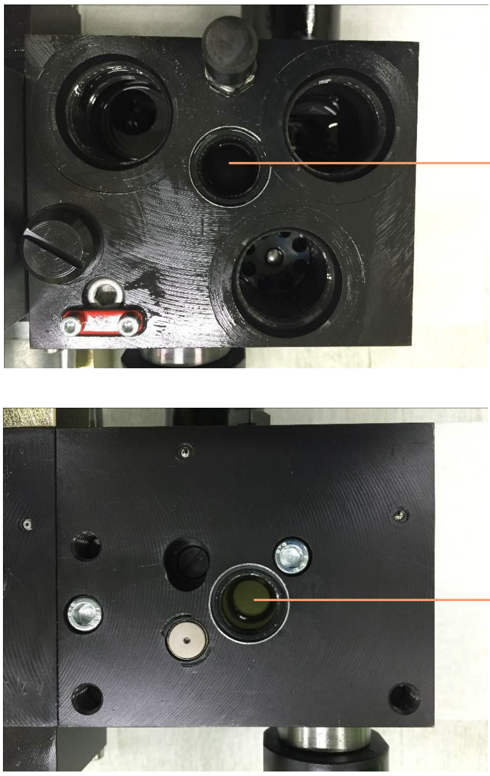
25L7AFT04

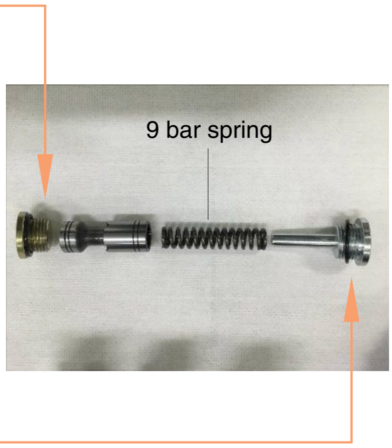
※ Tightening torque
6.1 kgf·m (44.3 lbf·ft)




25L7AFT05

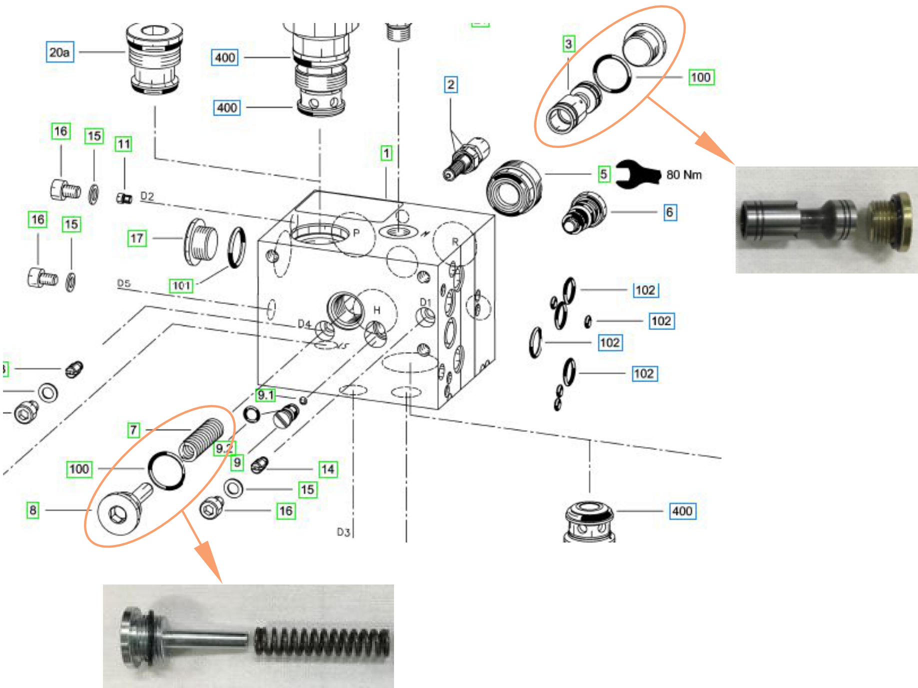
(2) 3-way controller





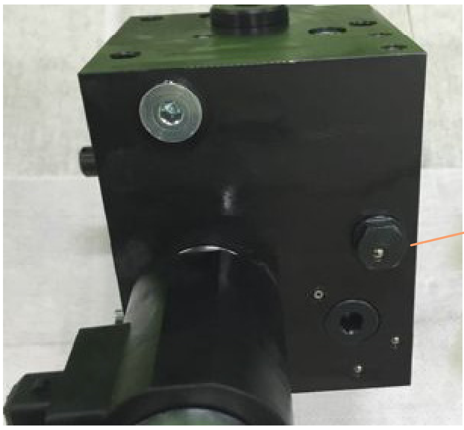

25L7AFT06

※ During unloading, supplied oil by the pump return to tank keeping 9 bar of system pressure.



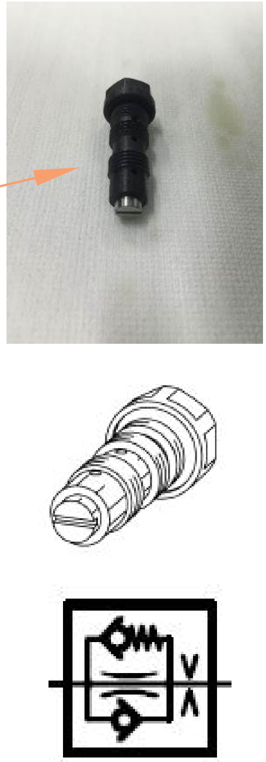

25L7AFT07

(3) S damping screw



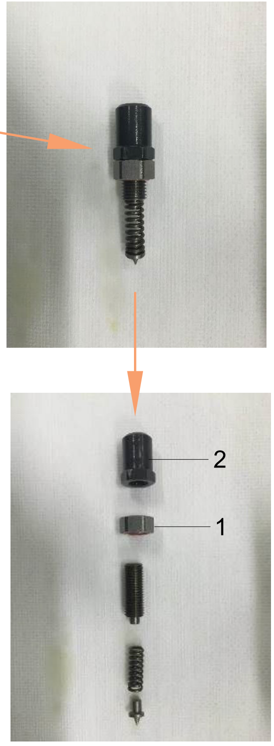
※ S damping
Integrated combination of orifice, check valve, pre-load valve (approx. 25 bar).

※ Tightening torque
1.02 kgf·m (7.4 lbf·ft)



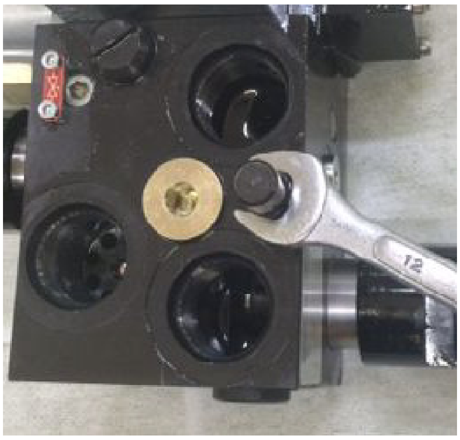
25L7AFT09

(4) Pressure relief valve



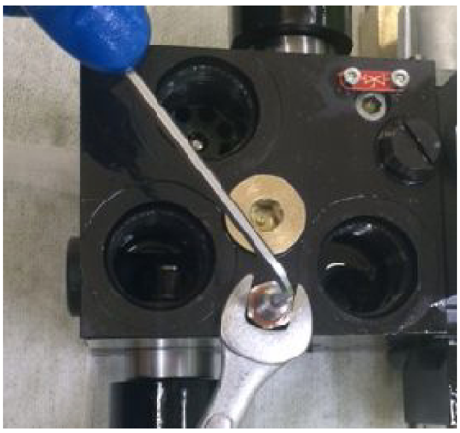

※ Relief valve
Control the main system pressure.

25L7AFT10



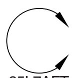
25L7AFT11

※ Use with a 12 mm spanner.
※ Tightening torque (1)
1.43 kgf·m (10.3 lbf·ft)



25L7AFT12

※ Use with a 3 mm wrench.
※ Tightening torque (2)
1.43 kgf·m (10.3 lbf·ft)

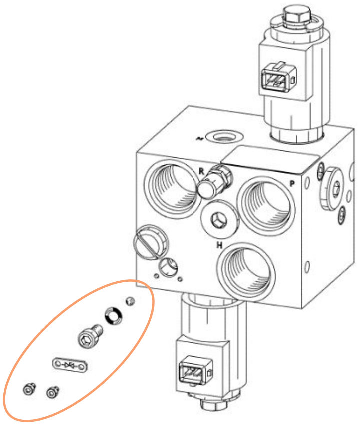

= Pressure increases
= Pressure decreases

25L7AFT13

※ Rotating clockwise to increase setting pressure with a wrench.
※ 80 bar increase and decrease per 1 turn.

### (5) Emergency lowering valve and shuttle valve

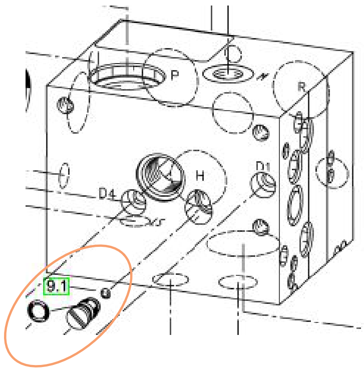
① Emergency lowering valve



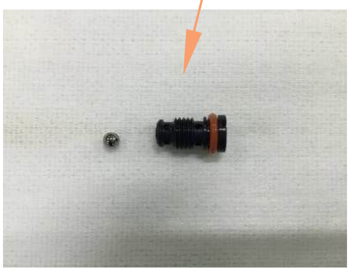
25B9UFT14

※ When need to force lowering, rotate counter clockwise increasingly with emergency lowering valve.

② Shuttle valve

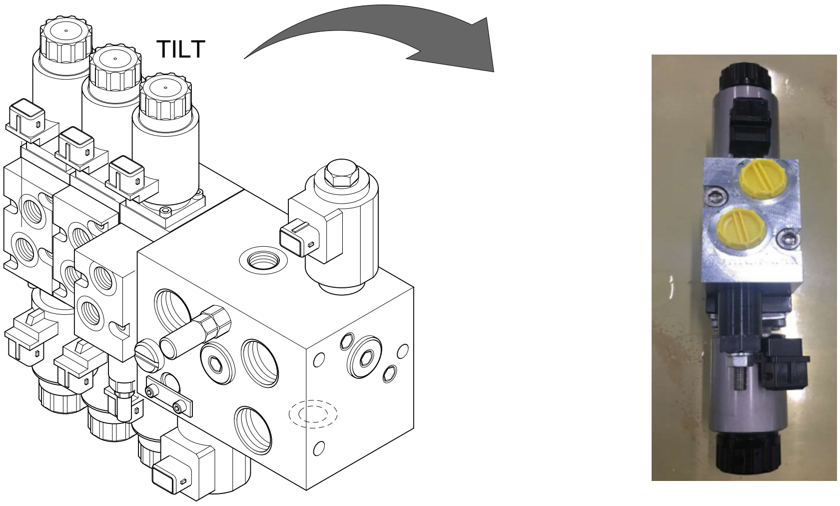



25L7AFT15



※ Transfer bigger load pressure through shuttle valve.
※ Use a flat screw driver.

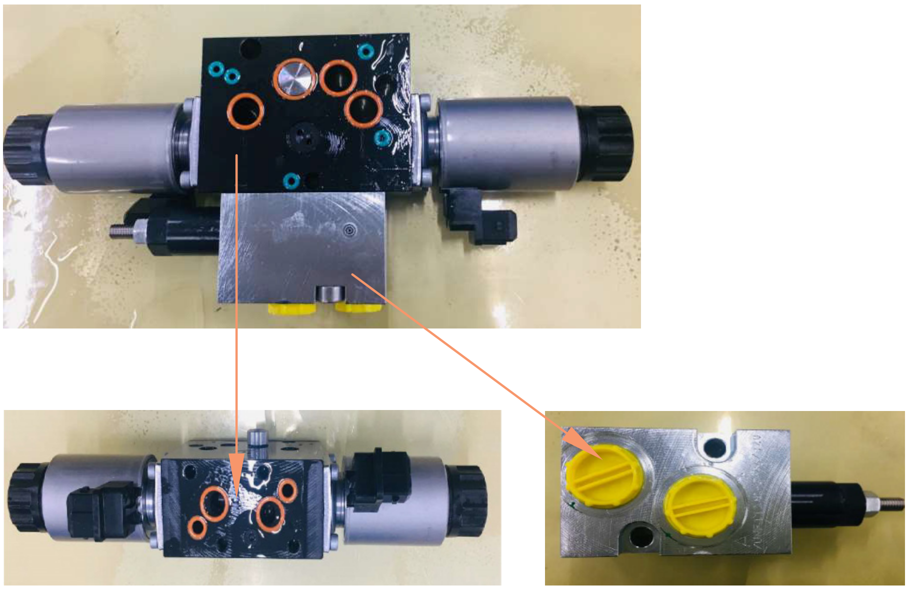
## 3) TILT SECTION




25B9UFT16

※ Flow rate : 16 lpm
※ Load holding pressure : 120 bar

### (1) Proportional directional valve



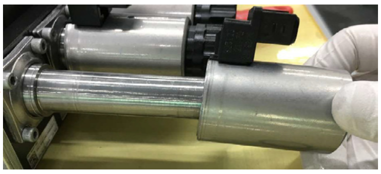
25B9UFT17

① Valve section block ② Counter balance valve block

## (2) Disassembly valve section

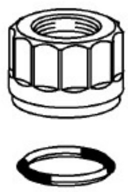
① Disassemble spool

② Disassemble coil



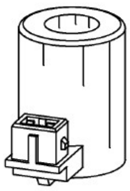
25B9UFT18

③ Disassembling process



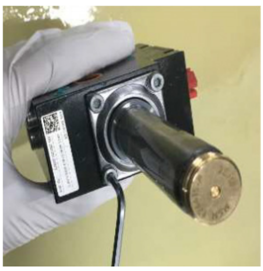
25B9UFT19

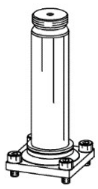
a. Release cap.



25B9UFT20

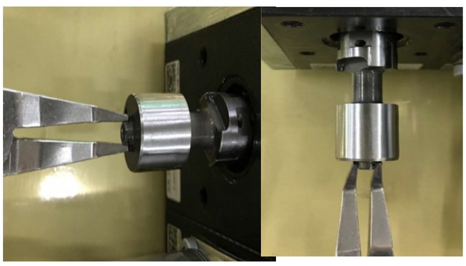
b. Release oil part.

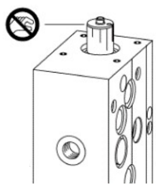




25B9UFT21

c. Release actuation system.



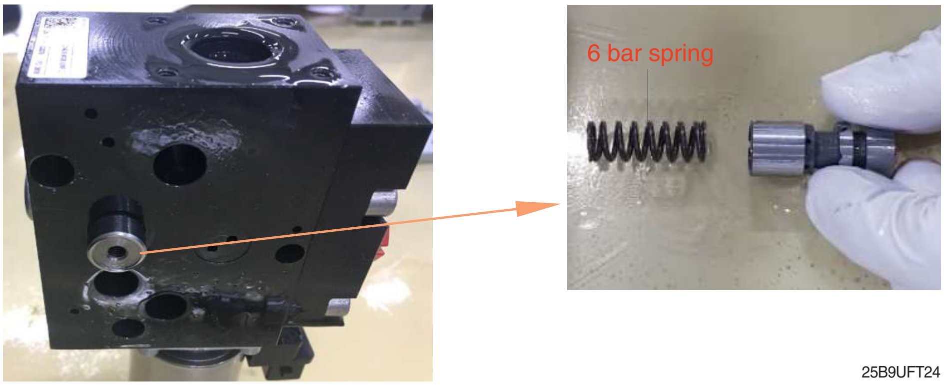


25B9UFT22

d. Pull out spool.
※ Do not use finger.
※ Use tool like picture (long nose plier).

(3) 2 way controller and shuttle valve

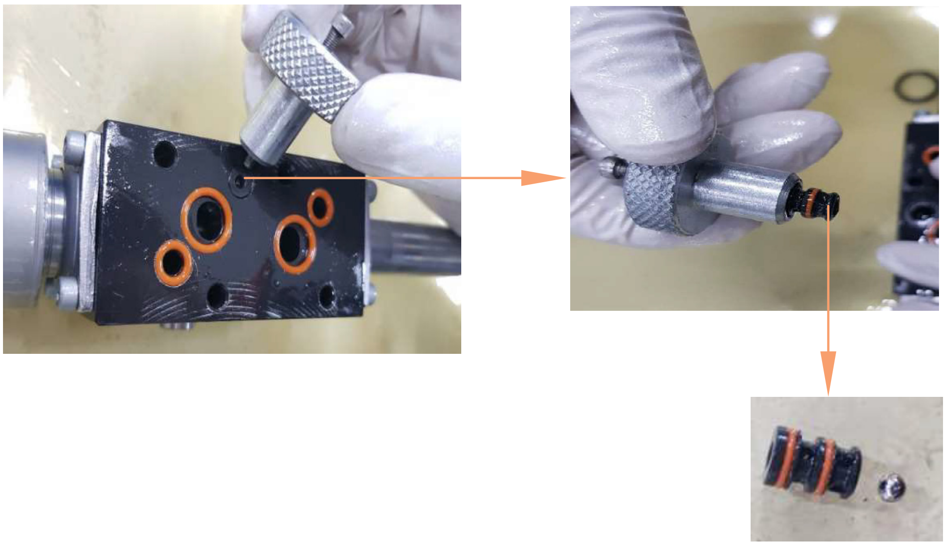
① 2 way controller (6 bar)




25B9UFT24

※ Pull out 2 way controller by fingers directly
※ 2 way controller make it keep 6 bar regardless of load change between in and out of spool.

② Shuttle valve

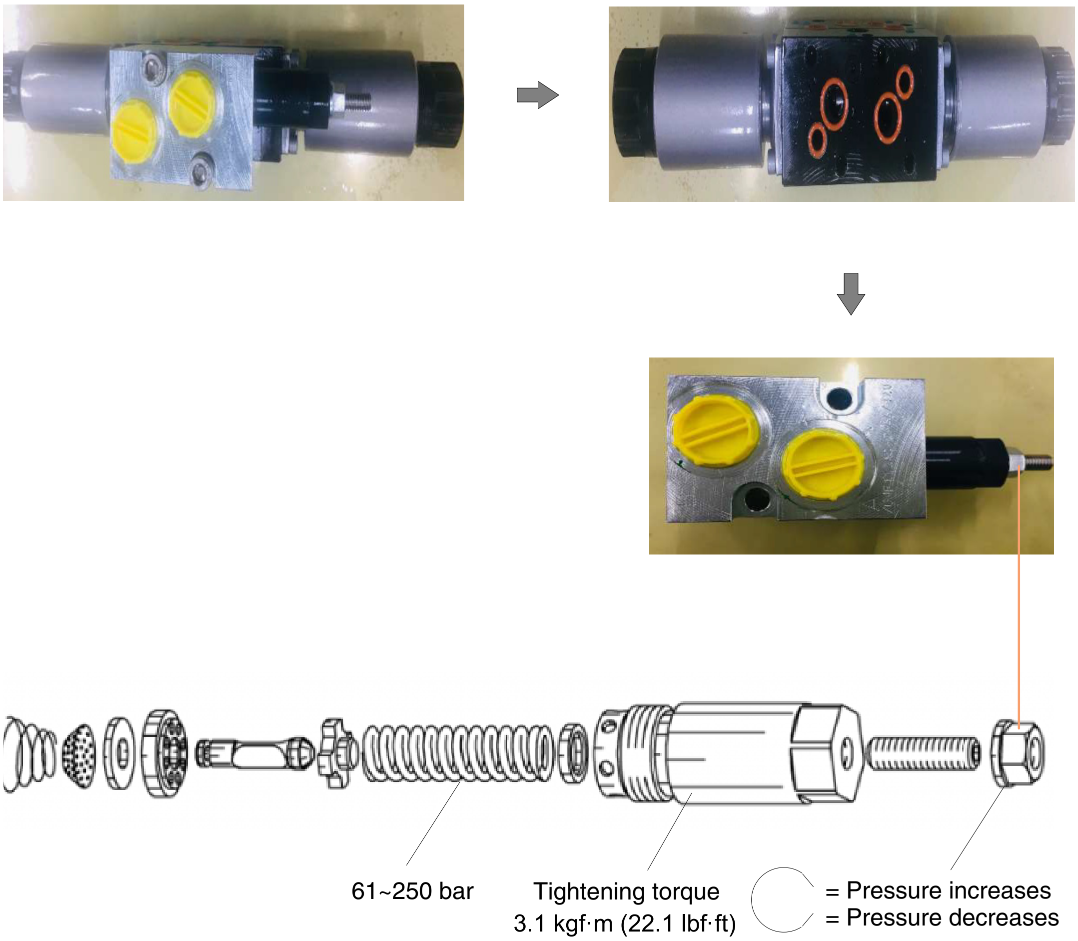


25B9UFT25

※ Transfer bigger load pressure through shuttle valve.
※ Fix 3 mm bolt and pull out.

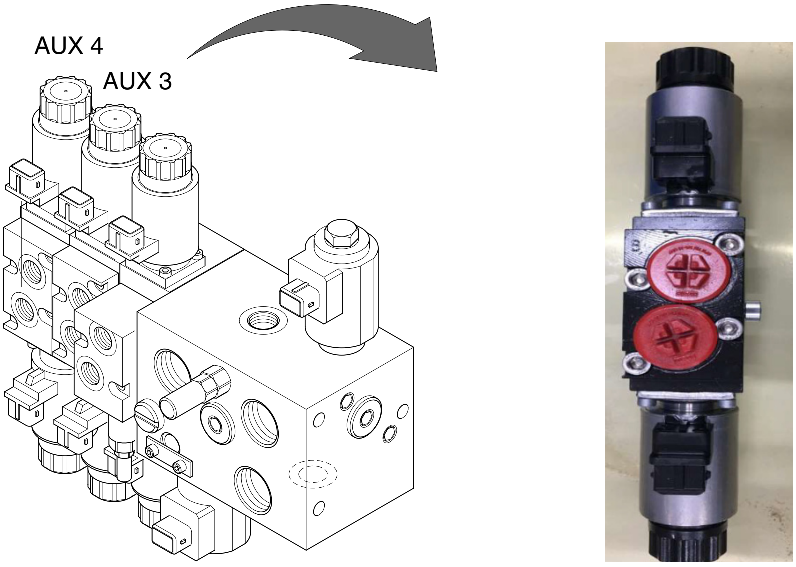
### (4) Counter balance valve

※ Counter balance valve needs during tilting out operation.




25B9UFT28

## 4) AUXILIARY SECTION




25B9UFT29

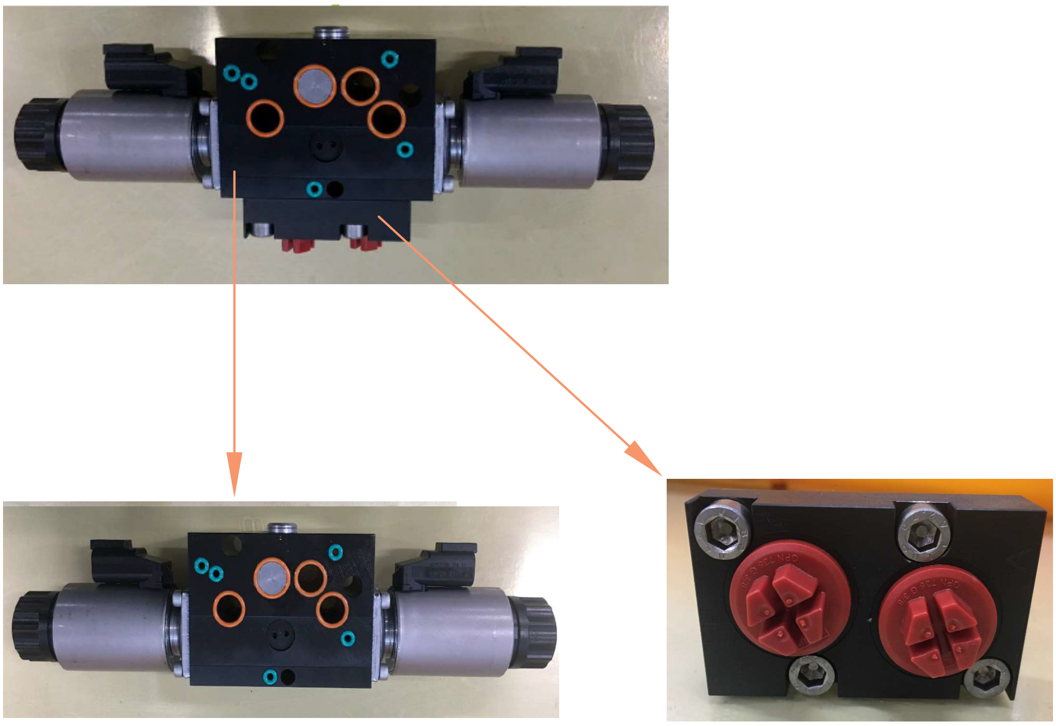
※ Flow rate

AUX 1 : 10 lpm, AUX  2 : 25 lpm

※ Pressure limit

AUX 1 : 140 bar, AUX 2 : 140 bar

### (1) Proportional directional valve



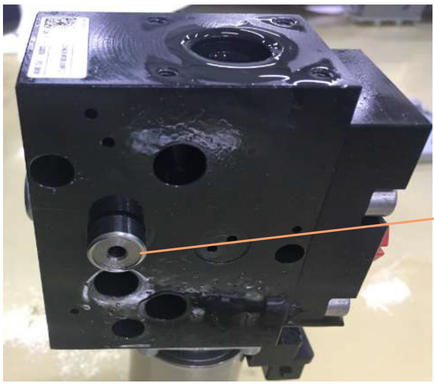
25B9UFT30

① Valve section block

② Ancillary block

(2) 2 way controller and shuttle valve

① 2 way controller (6 bar)

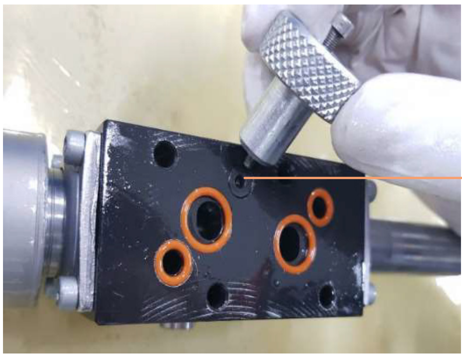


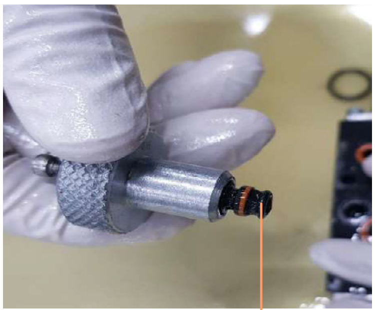

25B9UFT24

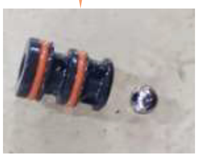
※ Pull out 2 way controller by fingers directly.

※ 2 way controller make it keep 6 bar regardless of load change between in and out of spool.

② Shuttle valve







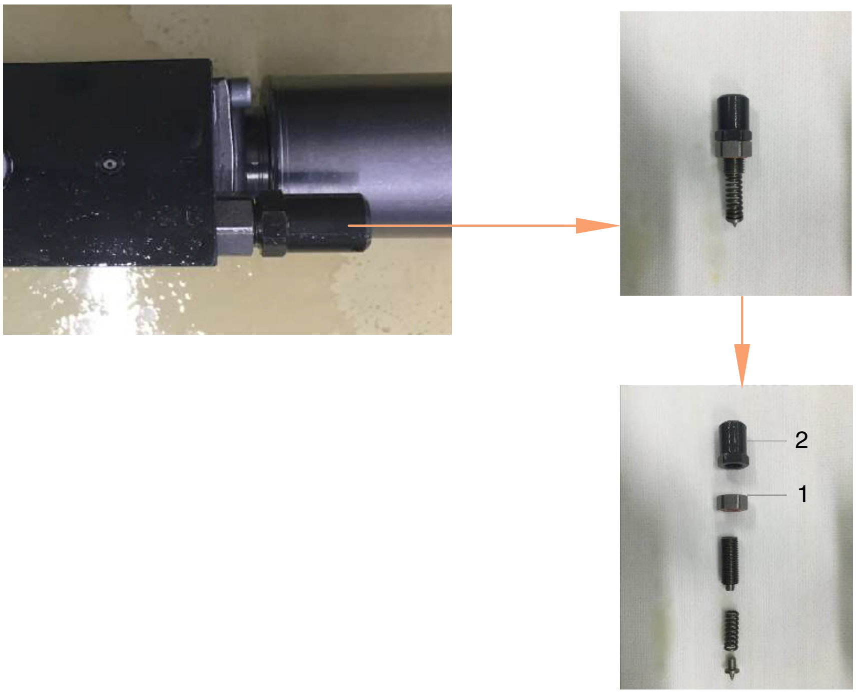
25B9UFT25

※ Transfer bigger load pressure through shuttle valve.

※ Fix 3 mm bolt and pull out.

(3) Second relief valve

※ Controlling individual section pressure, rotating clockwise to increase setting pressure with wrench.
※ 80 bar increase and decrease per 1 turn.

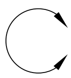



25B9UFT26

25B9UFT27

※ Use with a 12 mm spanner.
※ Tightening torque (1)
1.43 kgf·m (10.3 lbf·ft)

※ Use with a 3 mm wrench.
※ Tightening torque (2)
1.43 kgf·m (10.3 lbf·ft)

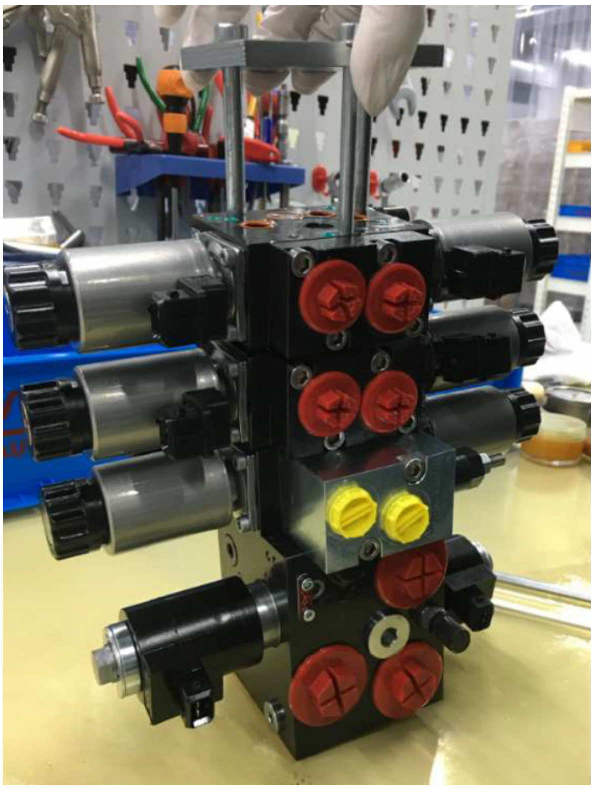


= Pressure increases
= Pressure decreases

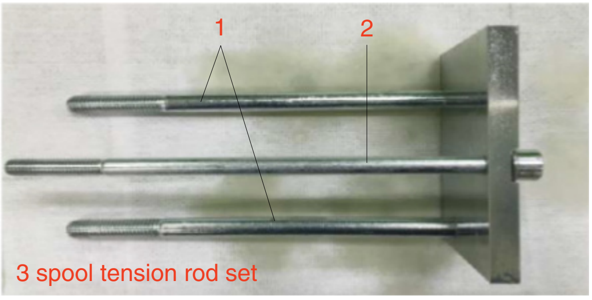
25L7AFT13

## 5) ADD SECTION PART

### (1) Disassembly

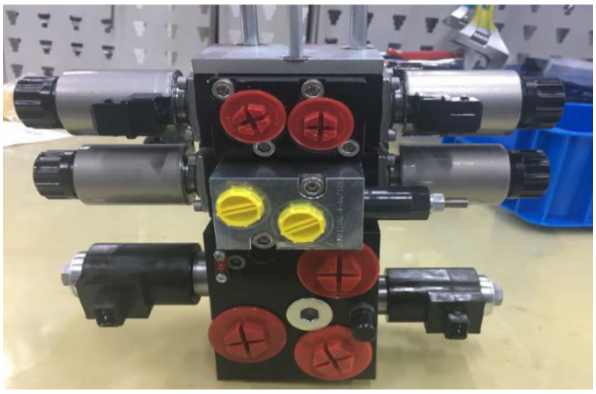


25B9UFT31




25B9UFT32

※ Tightening torque
- Item 1 (2 EA) : 2.3 kgf·m (17.0 lbf·ft)
- Item 2 (1 EA) : 0.97 kgf·m (7.0 lbf·ft)



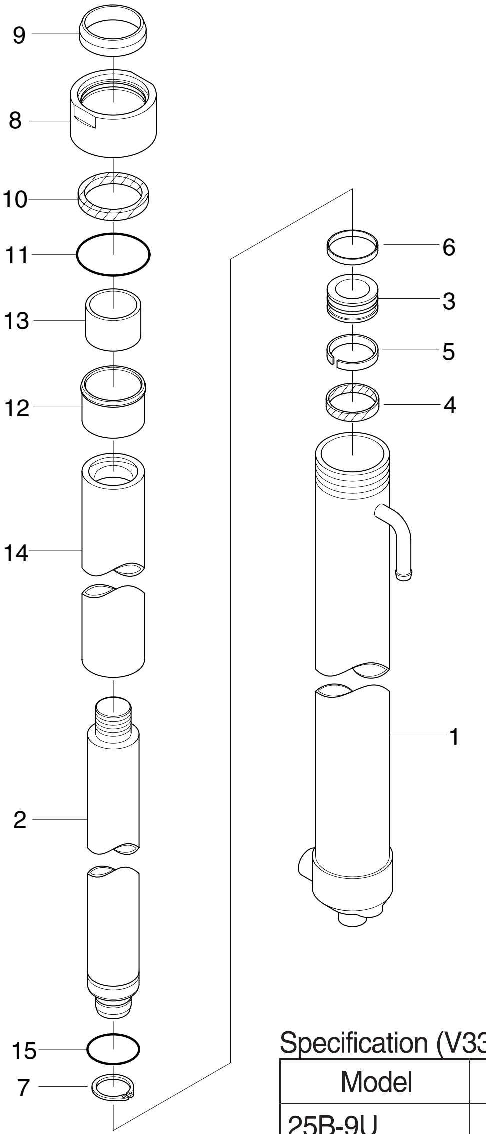
25B9UFT33

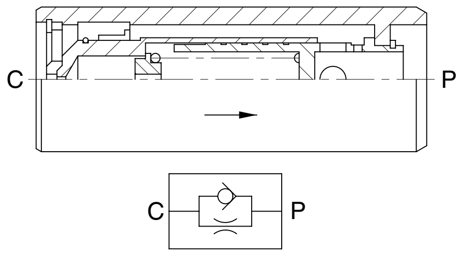
※ From 4 spool to 3 spool.

※ When it needs to disassemble section valve, it's possible to release tension rod sets.

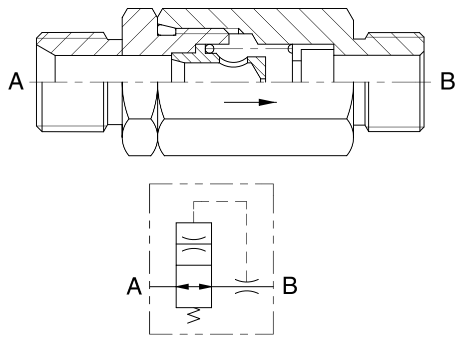
## 4. LIFT CYLINDER

### 1) STRUCTURE




Down control valve




Down safety valve

Specification (V330, std) Unit (in)

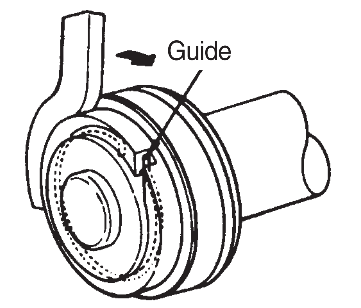
| Model | Inner dia | Outer dia | stroke | Rod o/dia |
|---|---|---|---|---|
| 25B-9U | 50 | 58 | 1630 | 40 |
| 30/32/35B-9U | 55 | 63 | 1630 | 45 |

25B9UHS26

| | | | | | |
|---|---|---|---|---|---|
| 1 | Tube assy | 6 | Wear ring | 11 | O-ring |
| 2 | Rod | 7 | Retaining ring | 12 | Guide |
| 3 | Piston | 8 | Gland | 13 | DU bushing |
| 4 | Piston seal | 9 | Dust wiper | 14 | Spacer |
| 5 | Back up ring | 10 | Rod seal | 15 | O-ring |

2) DISASSEMBLY

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




D35ACO168

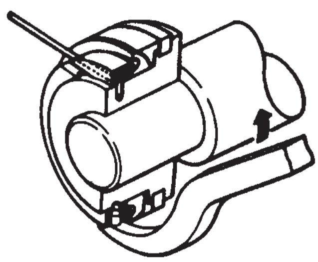
3) CHECK AND INSPECTION

mm (in)

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

4) ASSEMBLY

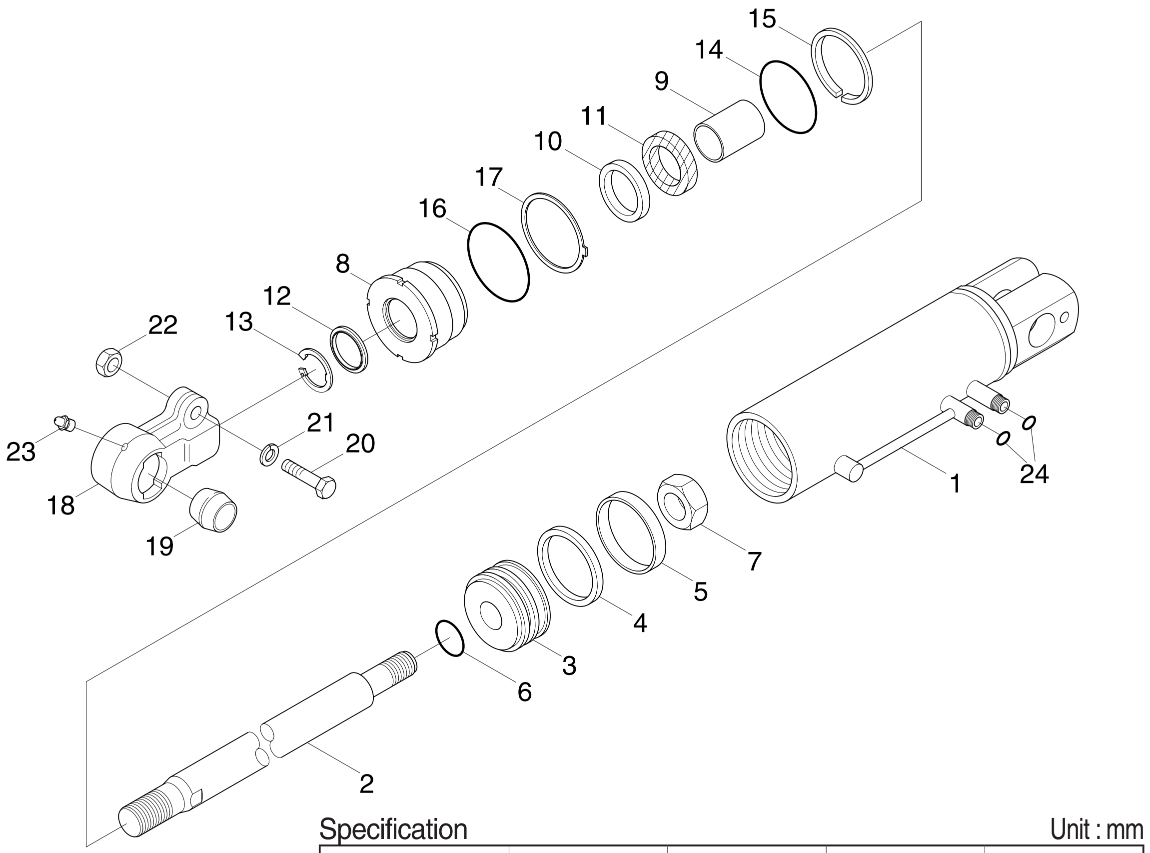
(1) Soak the piston ring in hydraulic oil at a temperature of 40 to 50°C, expand the inside diameter and assemble on the piston. Install a piston seal.
Bend the edge of the guide and rotate it to install the guide completely.



D35ACO169

# 5. TILT CYLINDER

## 1) STRUCTURE

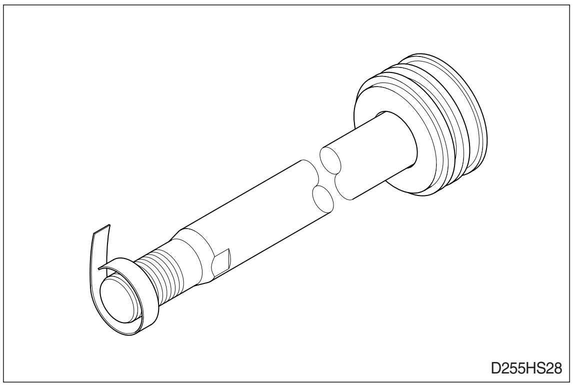



Specification Unit : mm

| Model | Inner dia | Outer dia | Stroke | Rod o/dia |
|---|---|---|---|---|
| All | 75 | 88 | 148 | 35 |

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

## 2) DISASSEMBLY


D255HS28

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

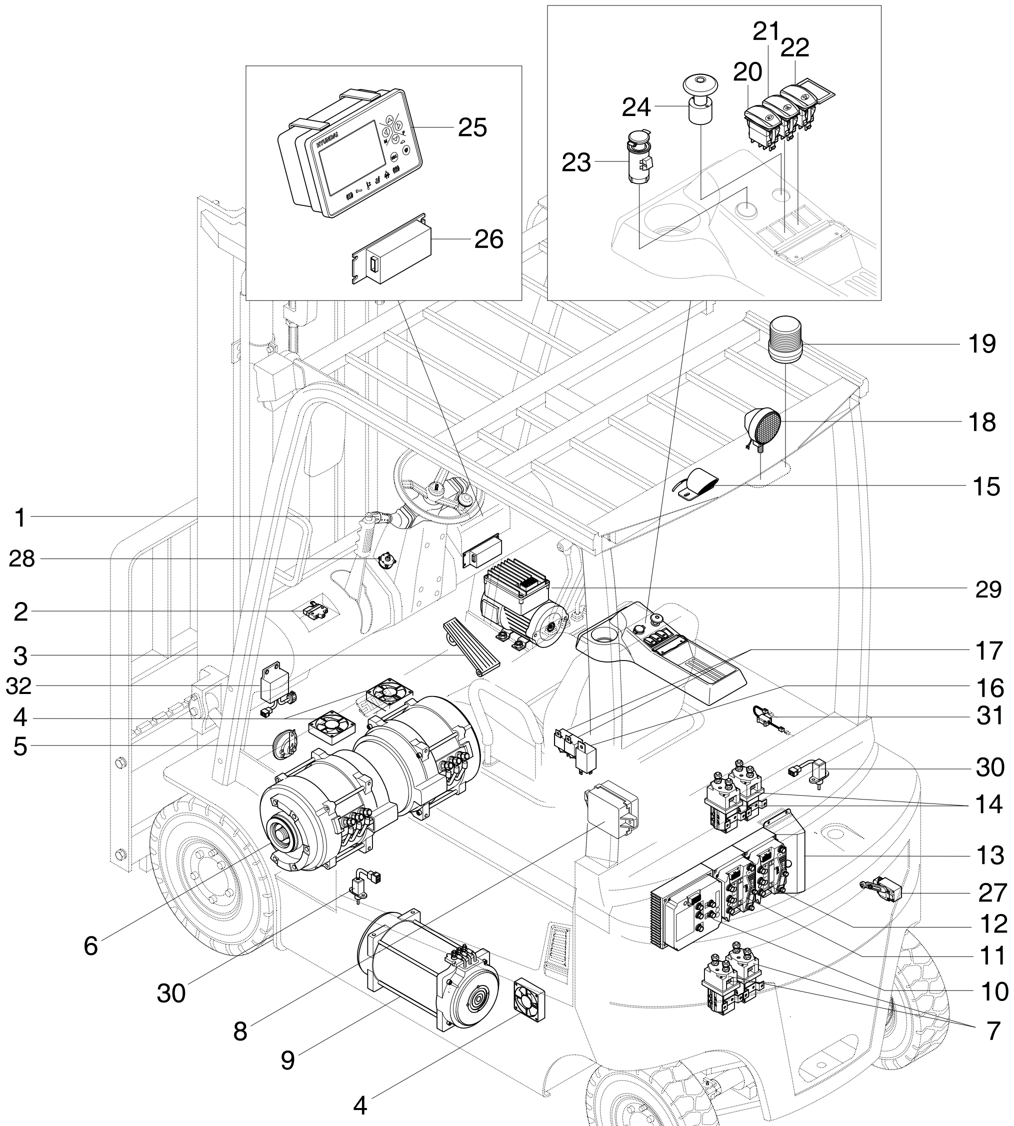
## 3) CHECK AND INSPECTION

mm (in)

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

# SECTION 7 ELECTRICAL SYSTEM

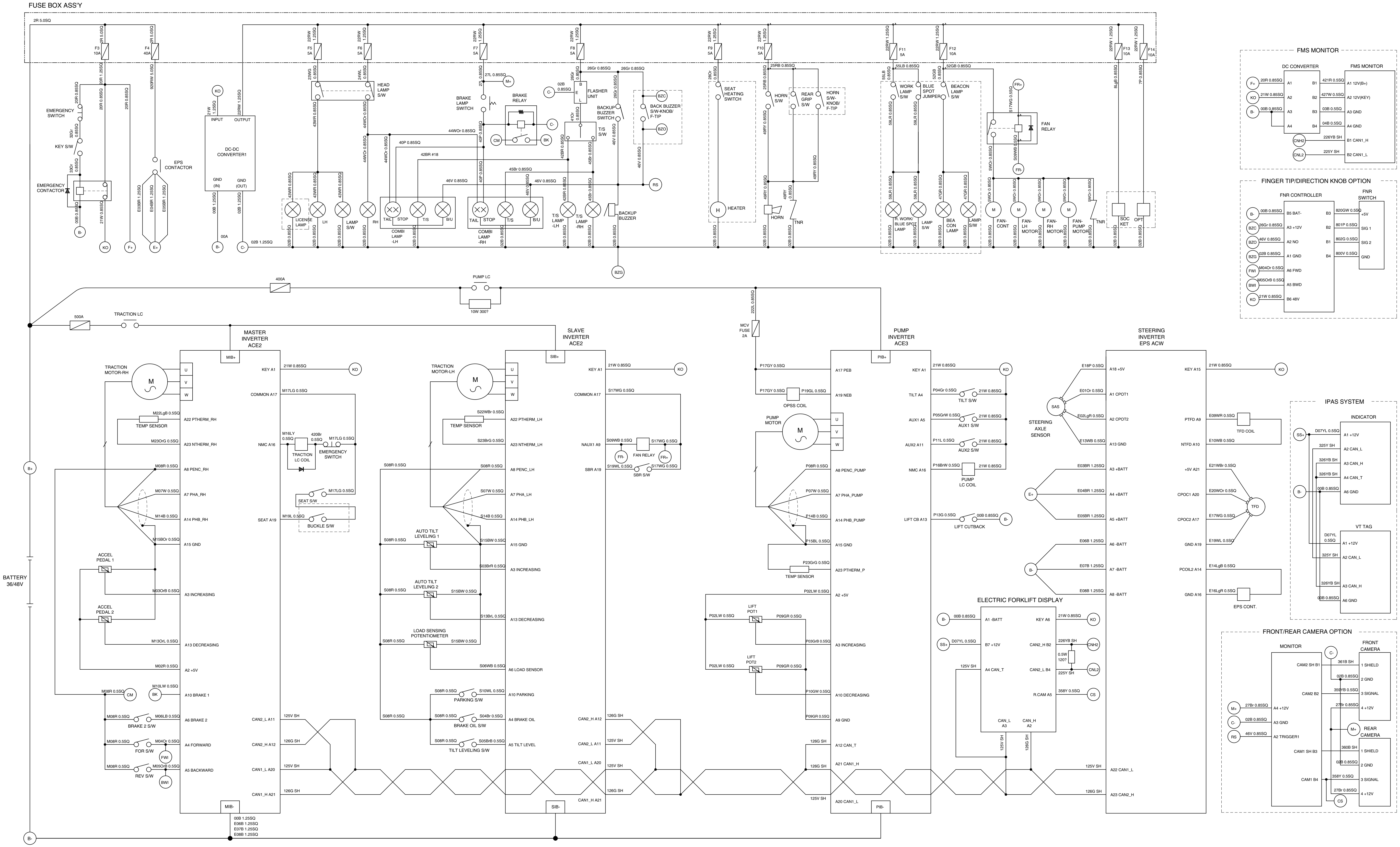
## GROUP 1 COMPONENT LOCATION




25B9UEL01

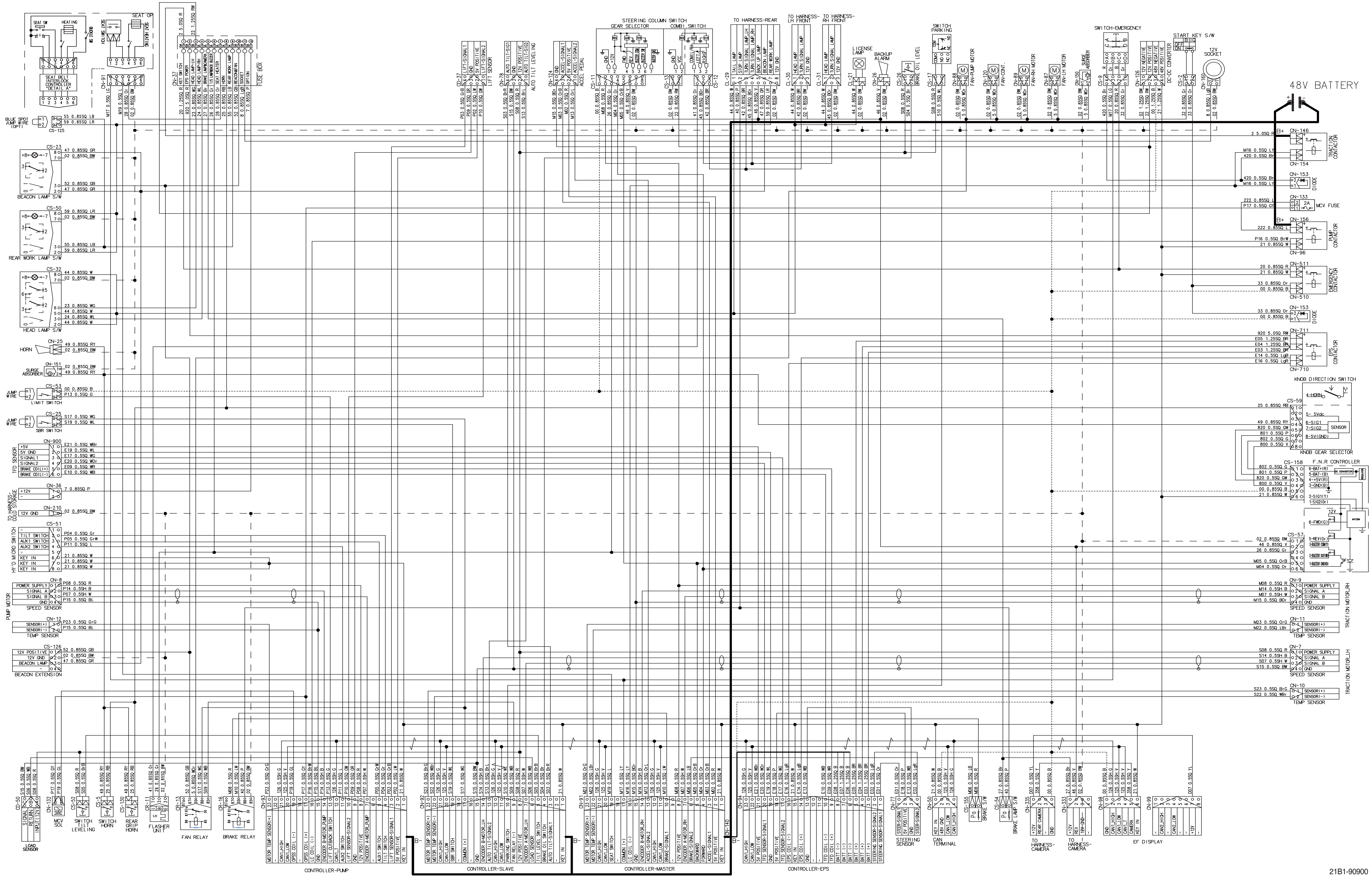
| | | | | | |
|---|---|---|---|---|---|
| 1 | Combination switch | 12 | Traction controller - master | 23 | Socket assy |
| 2 | Parking micro switch | 13 | Fan assy | 24 | Emergency switch assy |
| 3 | Accelerator assy | 14 | Contactor | 25 | Display |
| 4 | Fan assy | 15 | Back up alarm | 26 | DC-DC converter |
| 5 | High horn | 16 | Flasher unit assy | 27 | SBR switch assy (opt) |
| 6 | Drive motor | 17 | Relay | 28 | Tactile feedback device |
| 7 | Contactor | 18 | Working lamp (opt) | 29 | EPS controller with motor |
| 8 | Fuse box assy | 19 | Beacon lamp (opt) | 30 | Linear sensor |
| 9 | Pump motor | 20 | Head lamp switch (opt) | 31 | Interlock controller (opt) |
| 10 | Pump controller | 21 | Rear working lamp switch (opt) | 32 | FNR controller (opt) |
| 11 | Traction controller - slave | 22 | Beacon lamp switch (opt) | | |

## · ELECTRICAL CIRCUIT (1/15, NON-UL, MANUAL, 25B-9U : ~#800, 30B-9U : ~#390, 32B-9U : ~#152, 35B-9U : ~#205)

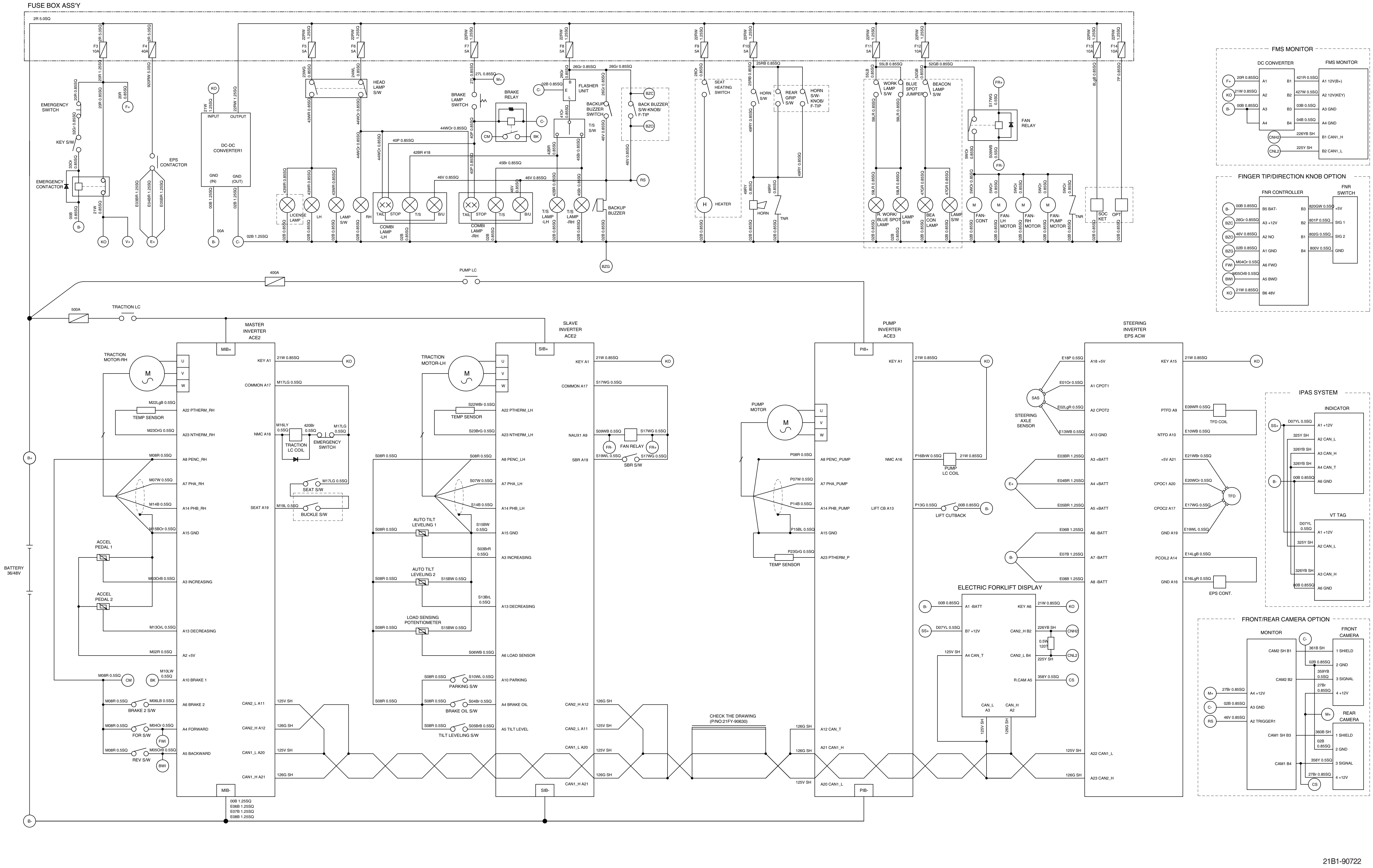



21B1-90712

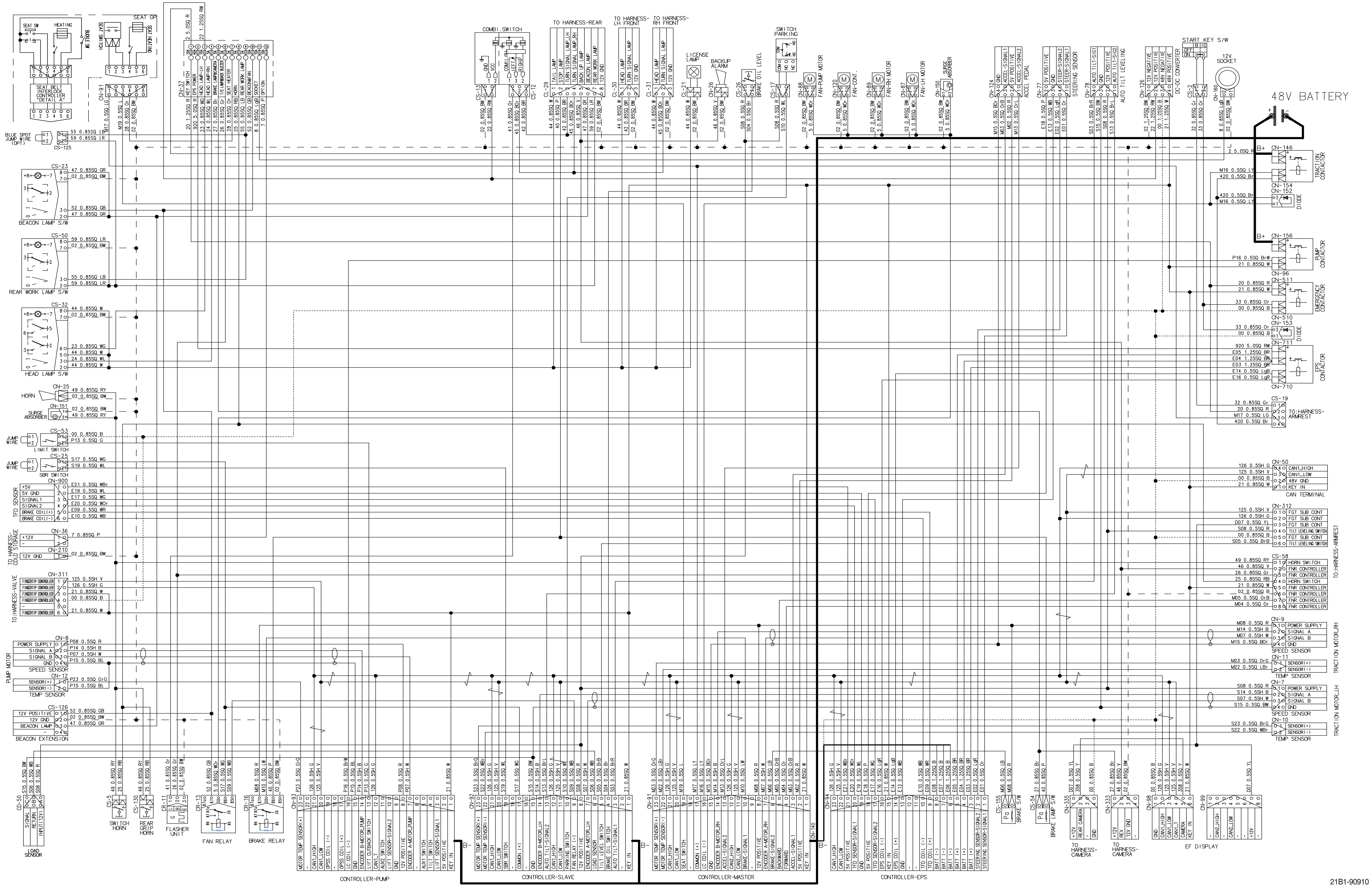
· ELECTRICAL CIRCUIT (2/15, NON-UL, MANUAL, 25B-9U : #801~, 30B-9U : #391~, 32B-9U : #153~, 35B-9U : #206~)



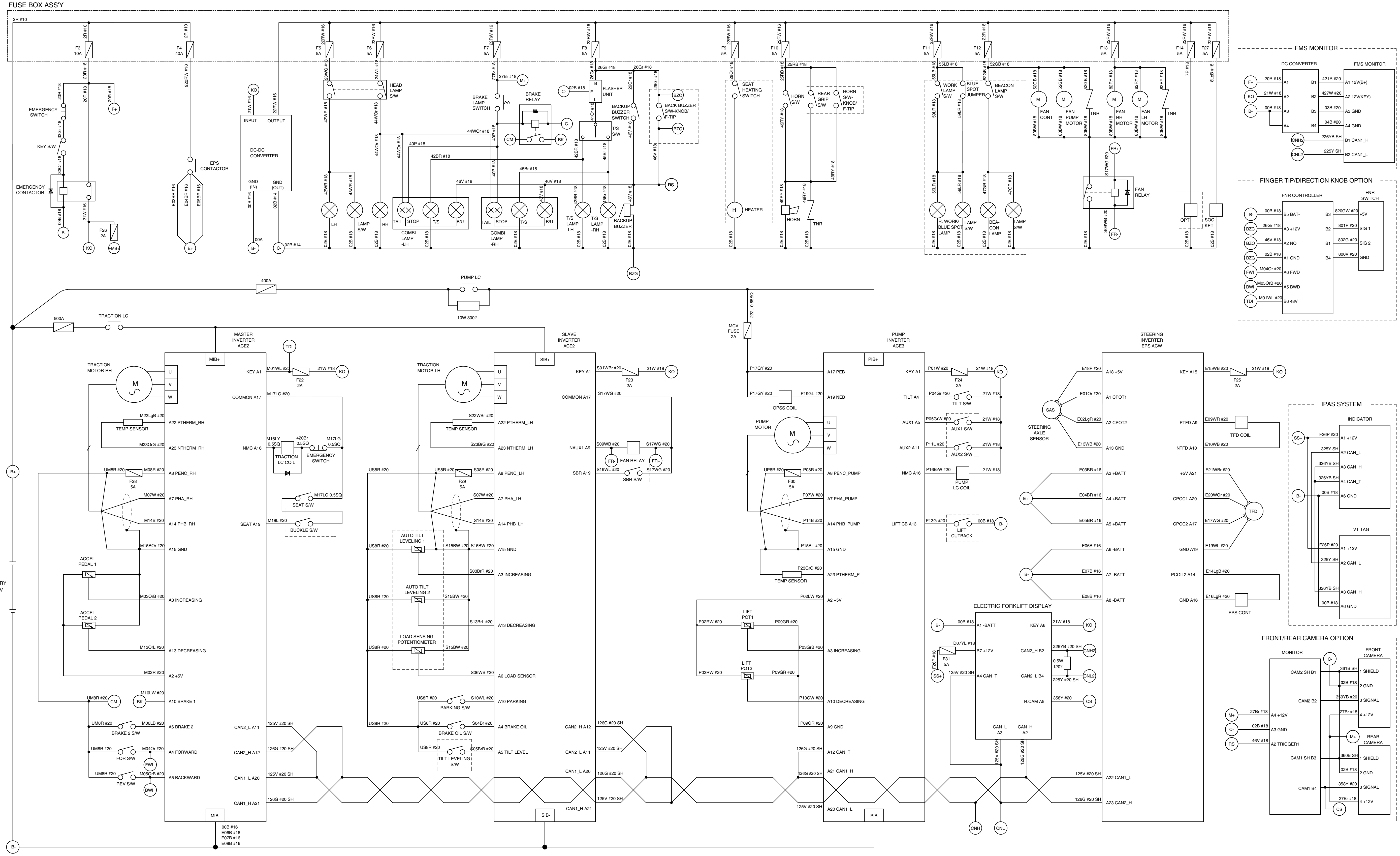
· ELECTRICAL CIRCUIT (3/15, NON-UL, FINGERTIP, 25B-9U : ~#800, 30B-9U : ~#390, 32B-9U : ~#152, 35B-9U : ~#205)



· ELECTRICAL CIRCUIT (4/15, NON-UL, FINGERTIP, 25B-9U : #801~, 30B-9U : #391~, 32B-9U : #153~, 35B-9U : #206~)

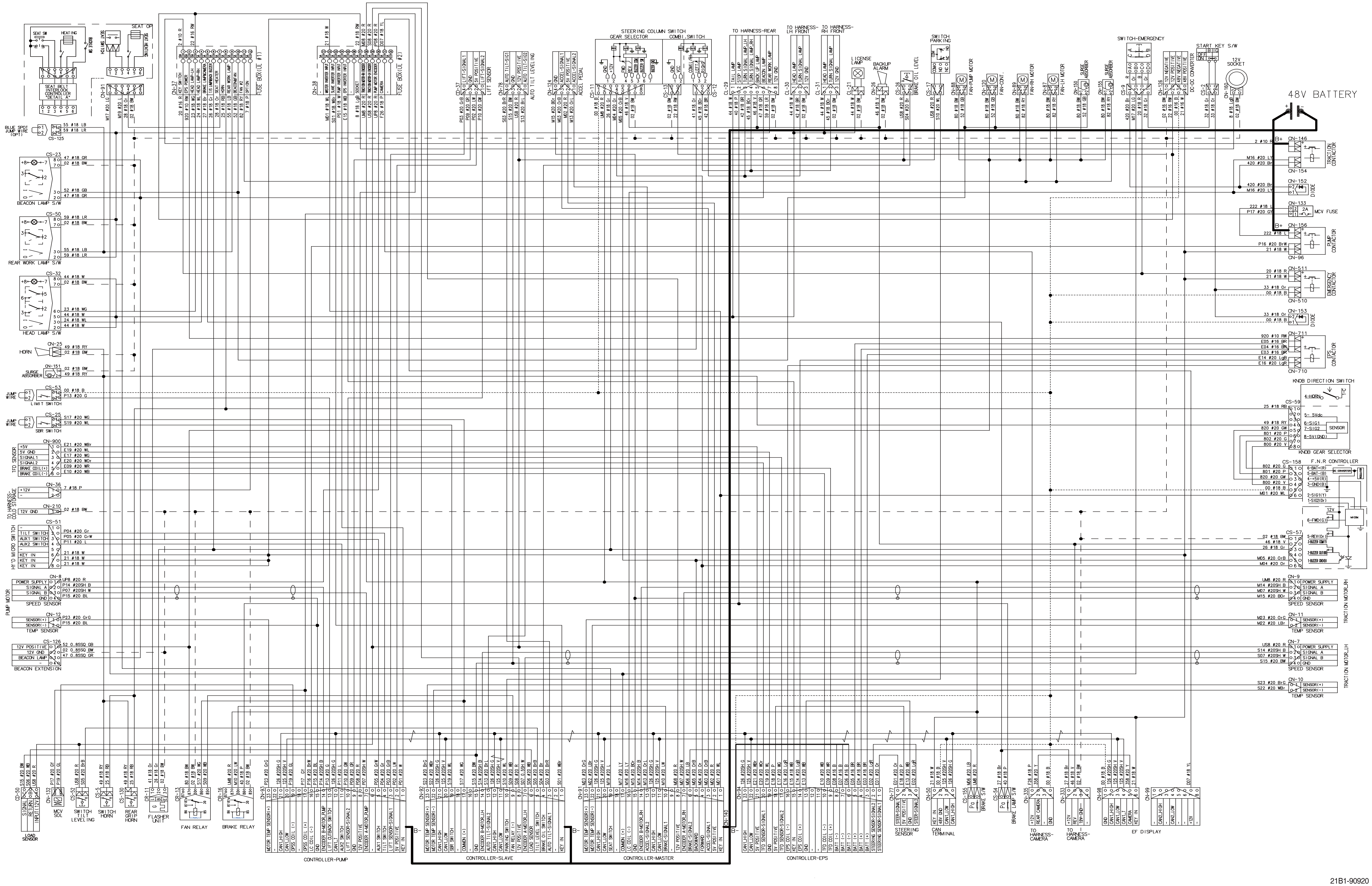


· ELECTRICAL CIRCUIT (5/15, UL, MANUAL, 25B-9U : ~#800, 30B-9U : ~#390, 32B-9U : ~#152, 35B-9U : ~#205)

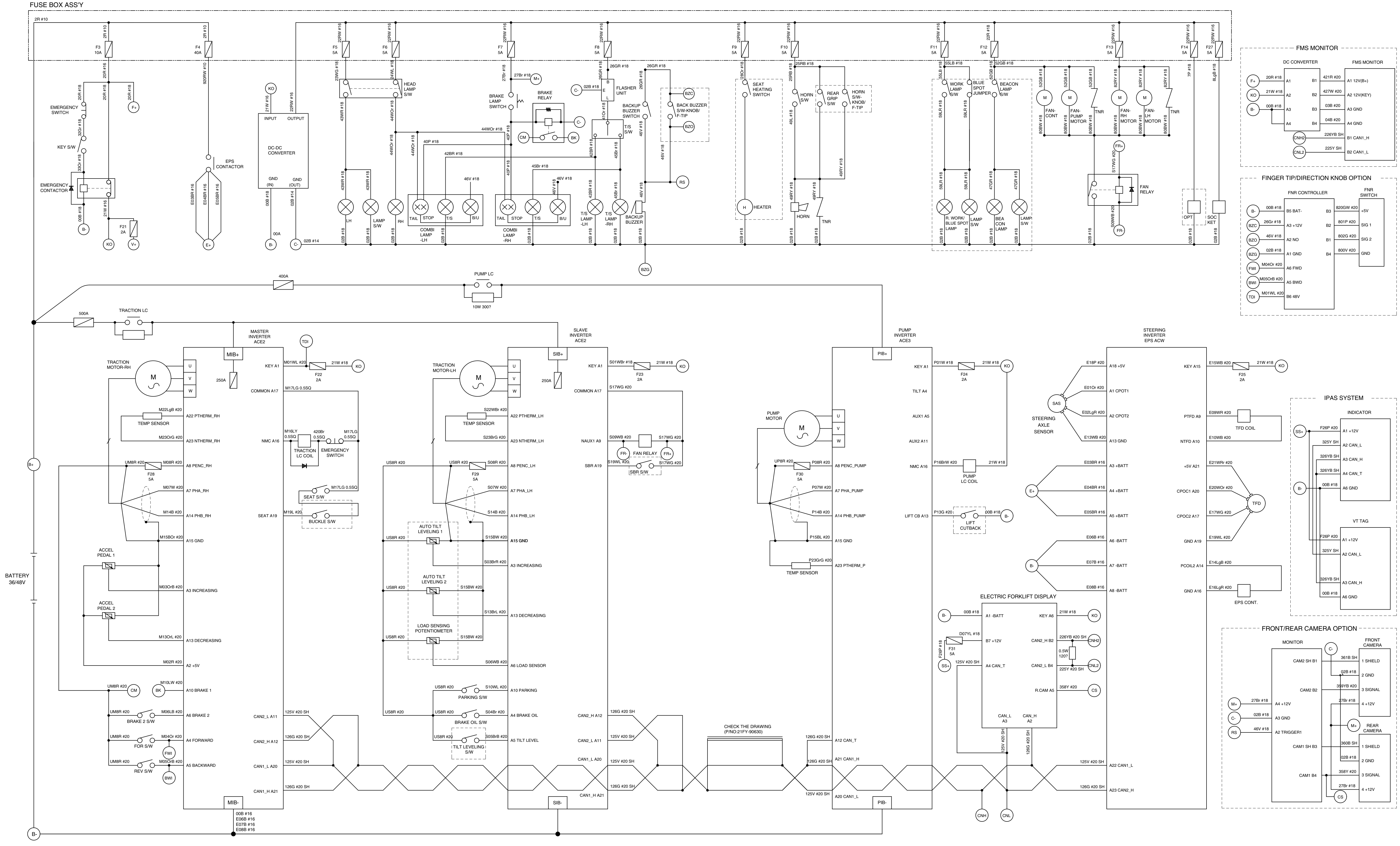



21B1-90732

· ELECTRICAL CIRCUIT (6/15, UL, MANUAL, 25B-9U : #801~, 30B-9U : #391~, 32B-9U : #153~, 35B-9U : #206~)

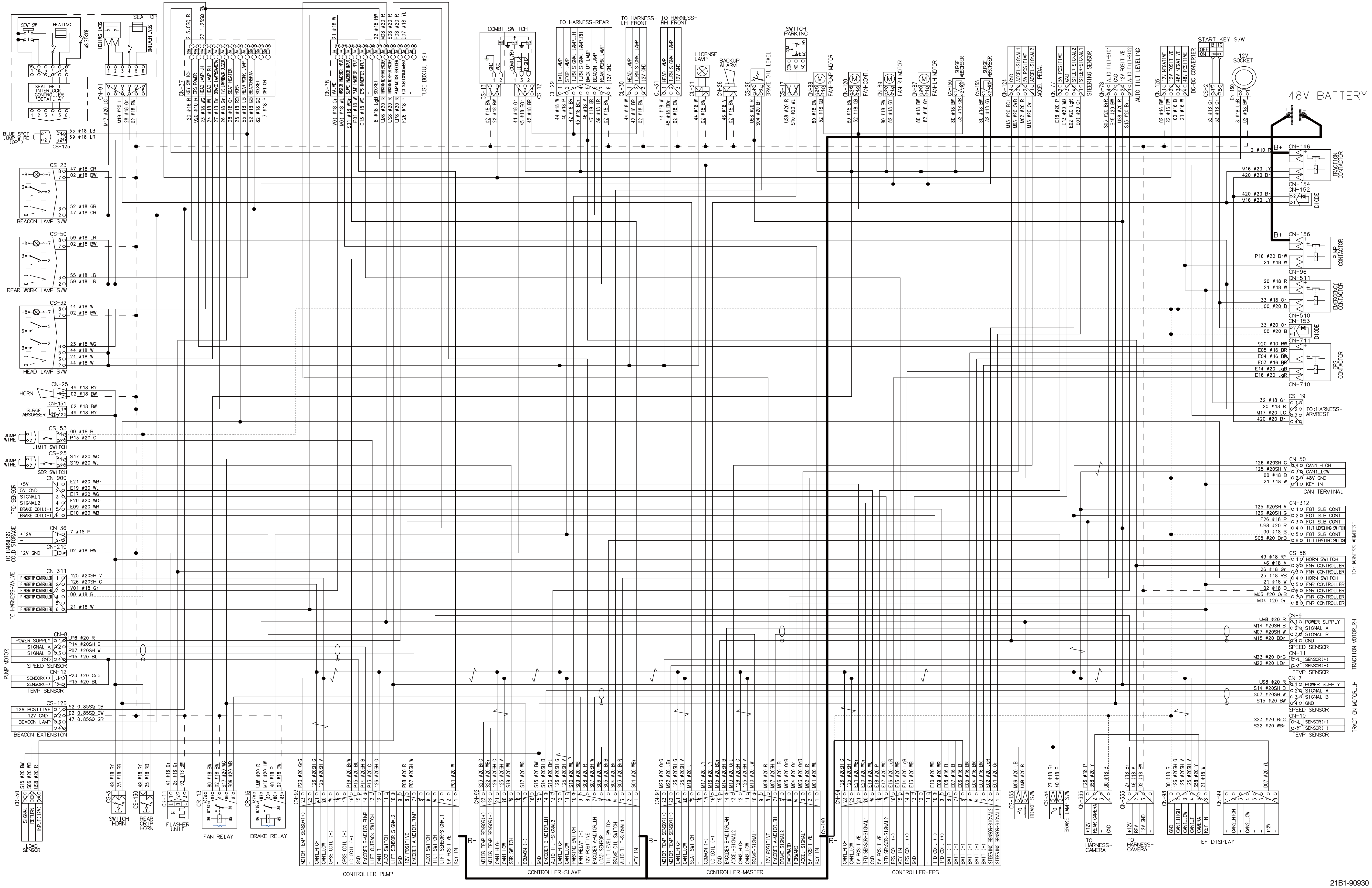


· ELECTRICAL CIRCUIT (7/15, UL, FINGERTIP, 25B-9U : ~#800, 30B-9U : ~#390, 32B-9U : ~#152, 35B-9U : ~#205)

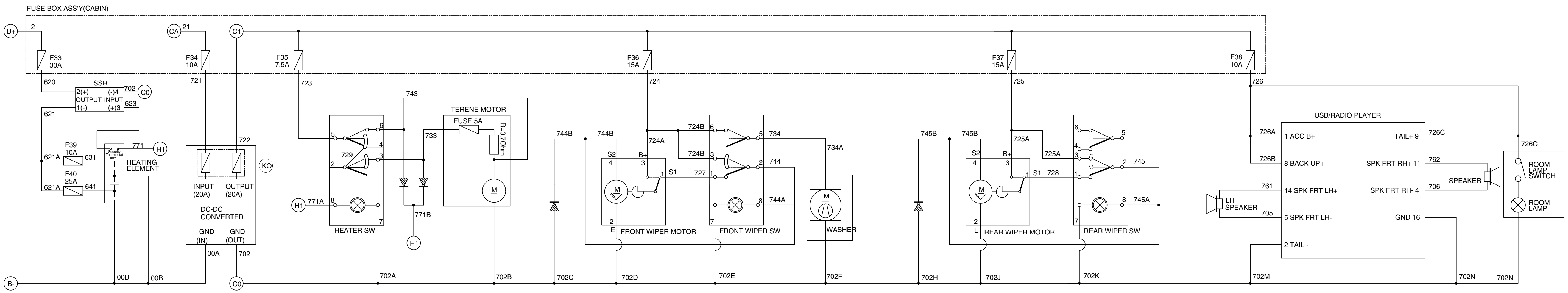


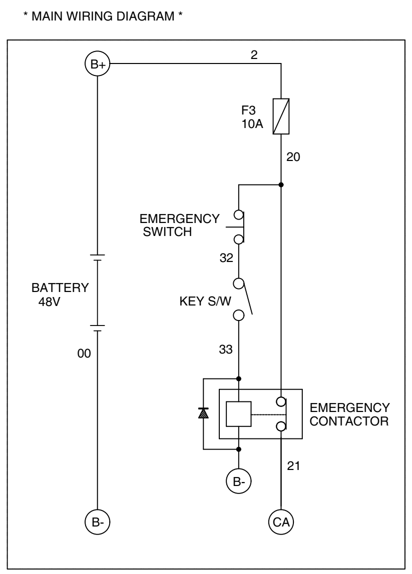

21B1-90742

· ELECTRICAL CIRCUIT (8/15, UL, FINGERTIP, 25B-9U : #801~, 30B-9U : #391~, 32B-9U : #153~, 35B-9U : #206~)



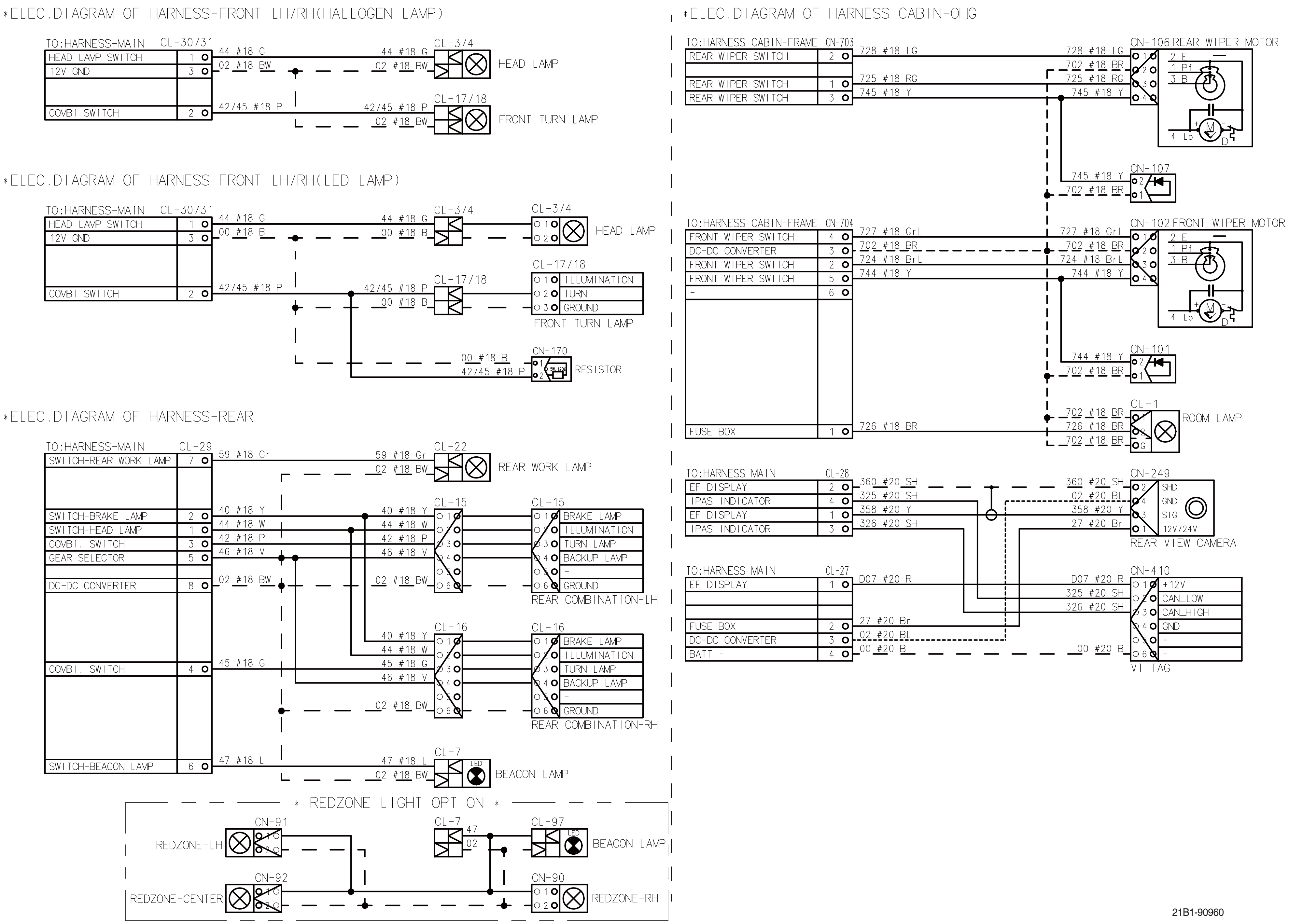
## · ELECTRICAL CIRCUIT (9/15, CABIN, 25B-9U : ~#800, 30B-9U : ~#390, 32B-9U : ~#152, 35B-9U : ~#205)



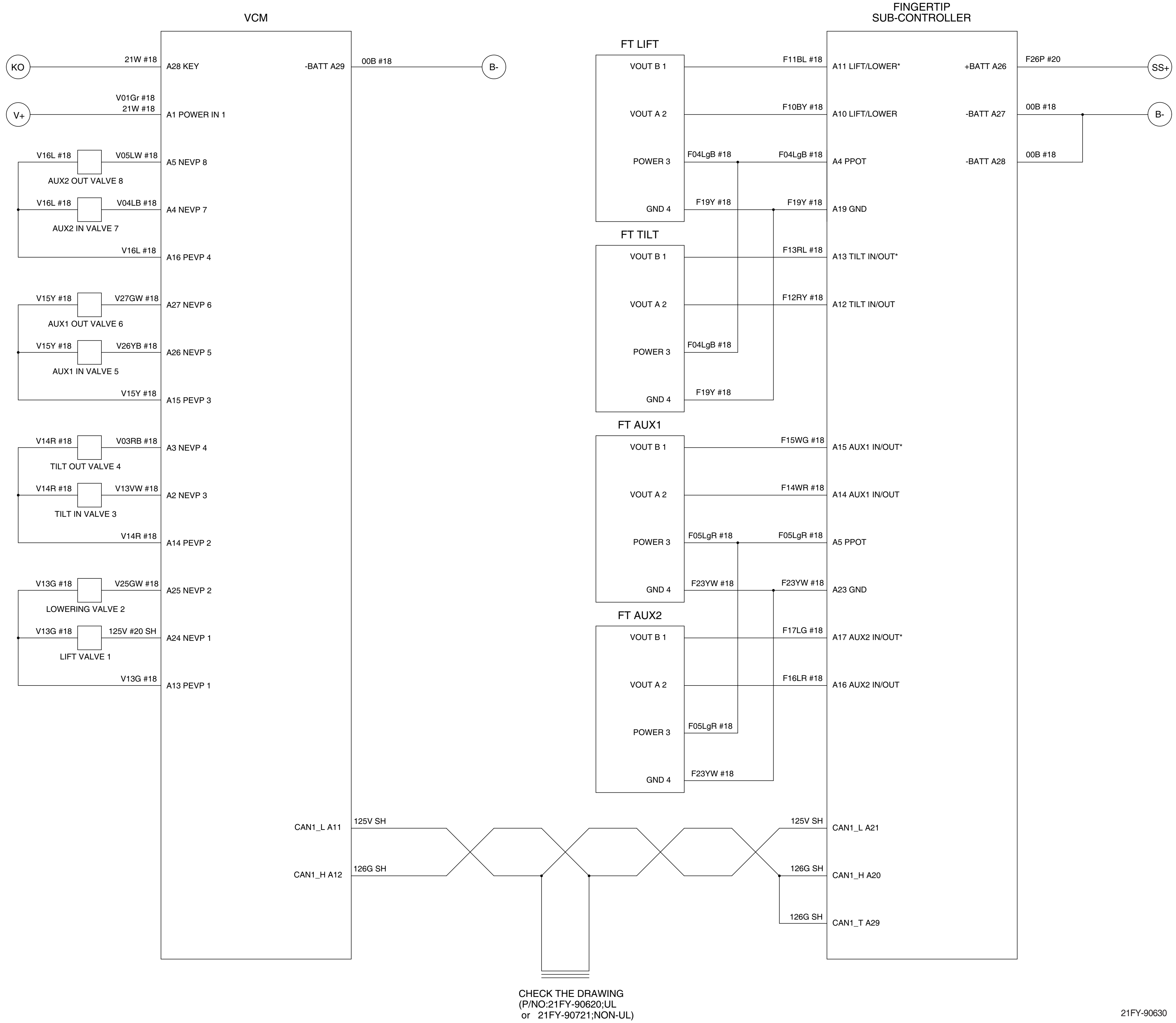




21FY-90770

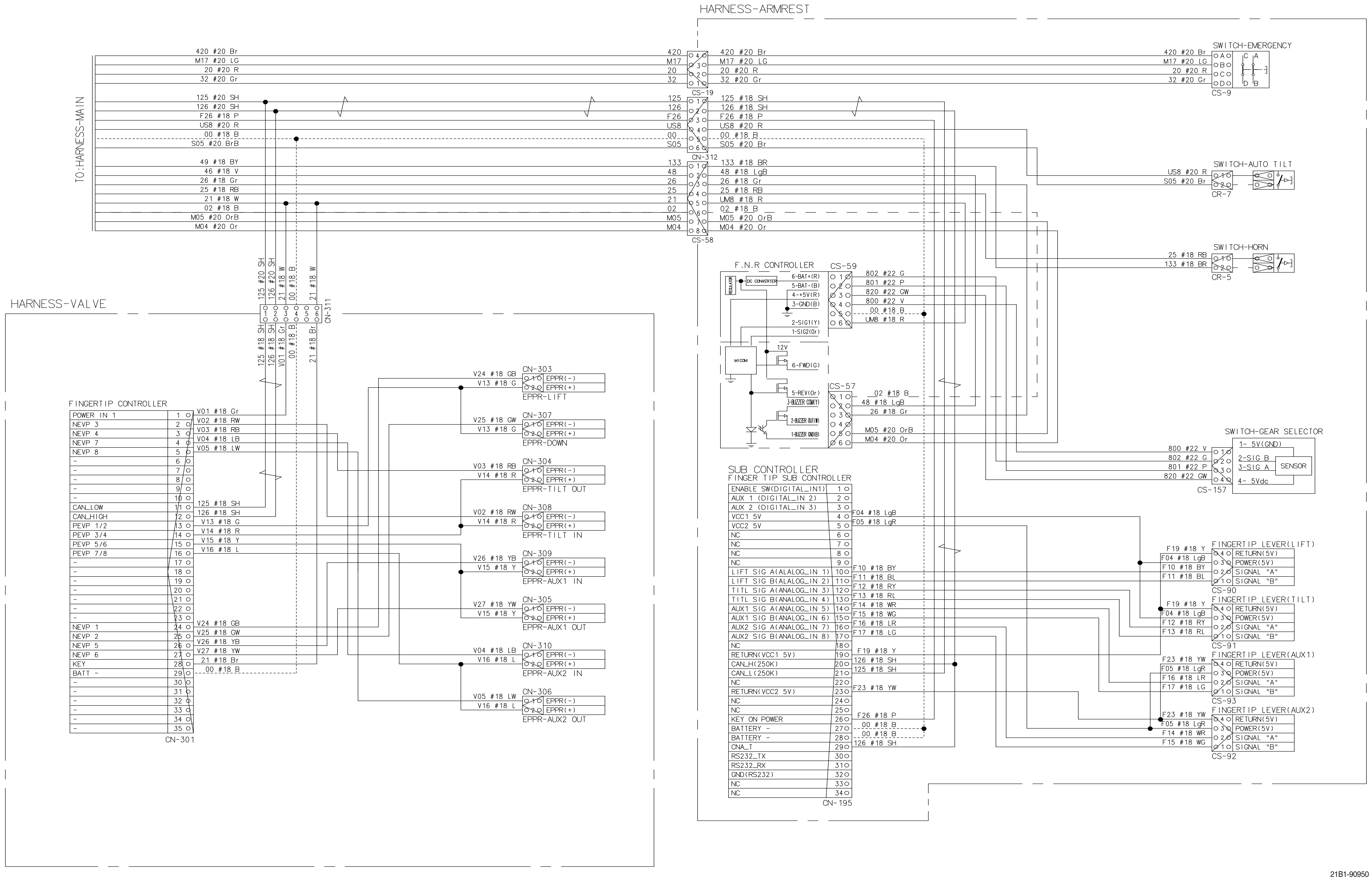
· ELECTRICAL CIRCUIT (10/15, CABIN, 25B-9U : #801~, 30B-9U : #391~, 32B-9U : #153~, 35B-9U : #206~)



· ELECTRICAL CIRCUIT (11/15, FINGERTIP, 25B-9U : ~#800, 30B-9U : ~#390, 32B-9U : ~#152, 35B-9U : ~#205)

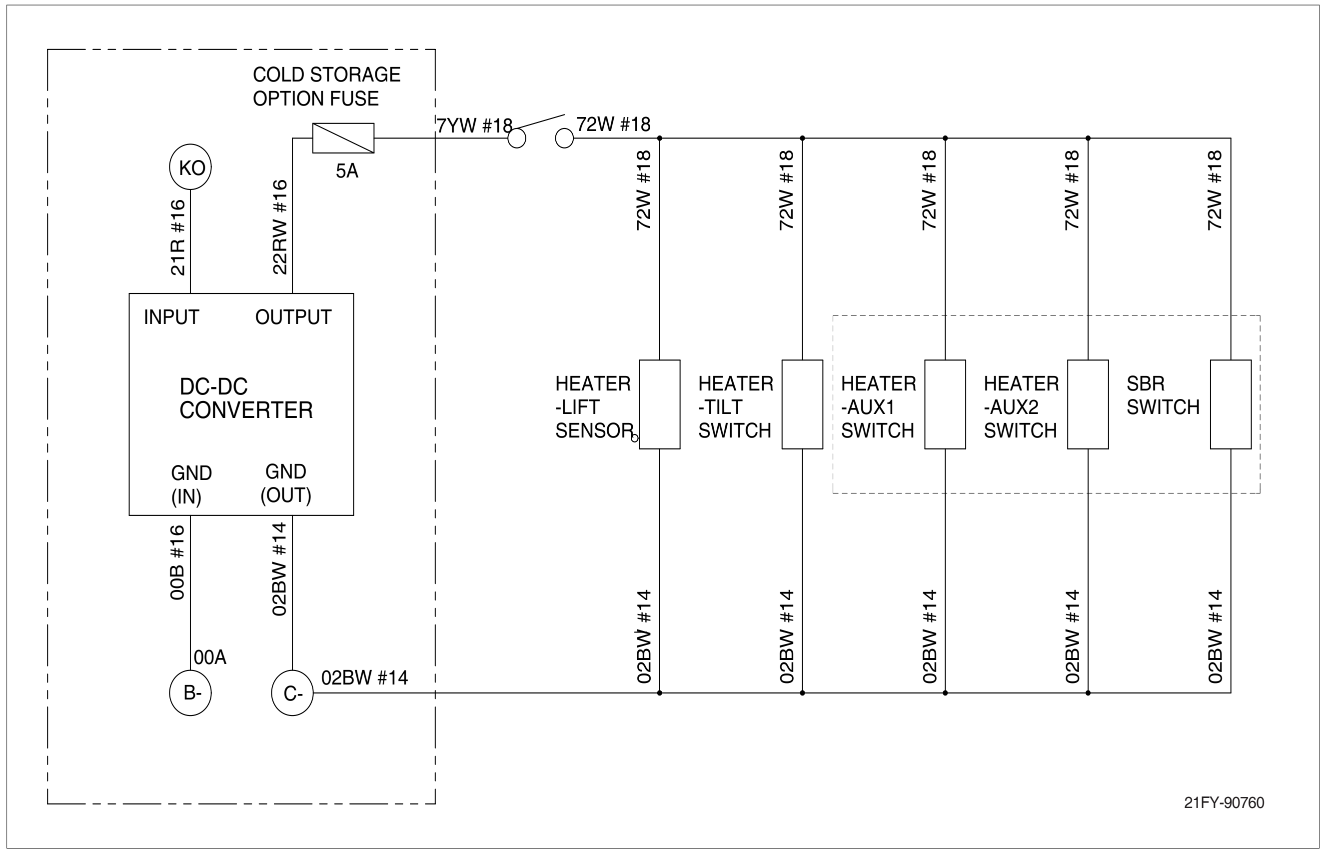


· ELECTRICAL CIRCUIT (12/15, FINGERTIP, 25B-9U : #801~, 30B-9U : #391~, 32B-9U : #153~, 35B-9U : #206~)

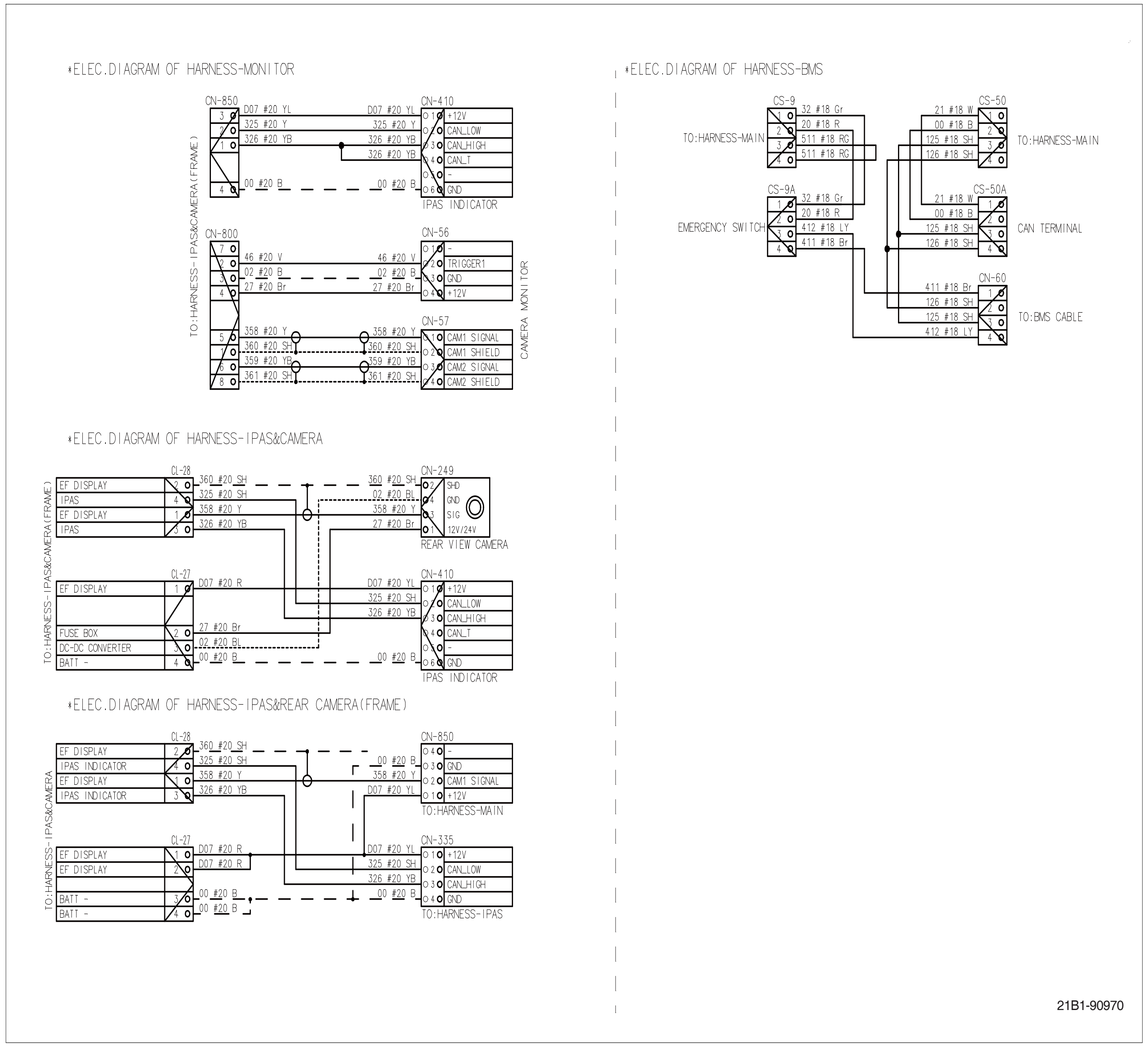


· ELECTRICAL CIRCUIT (13/15, COLD STORAGE, 25B-9U : ~#800, 30B-9U : ~#390, 32B-9U : ~#152, 35B-9U: ~#205)

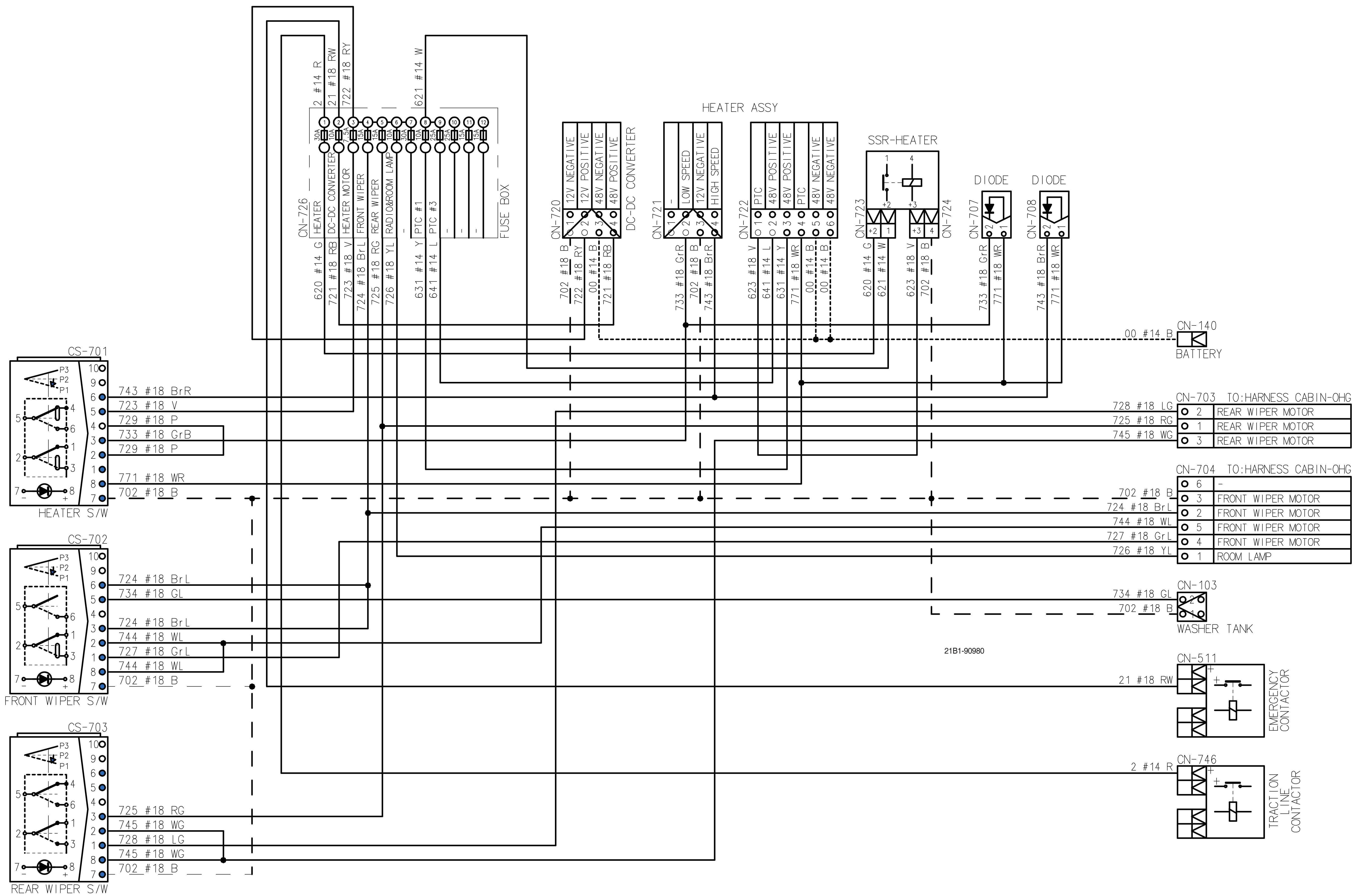
COLD STORAGE WIRING



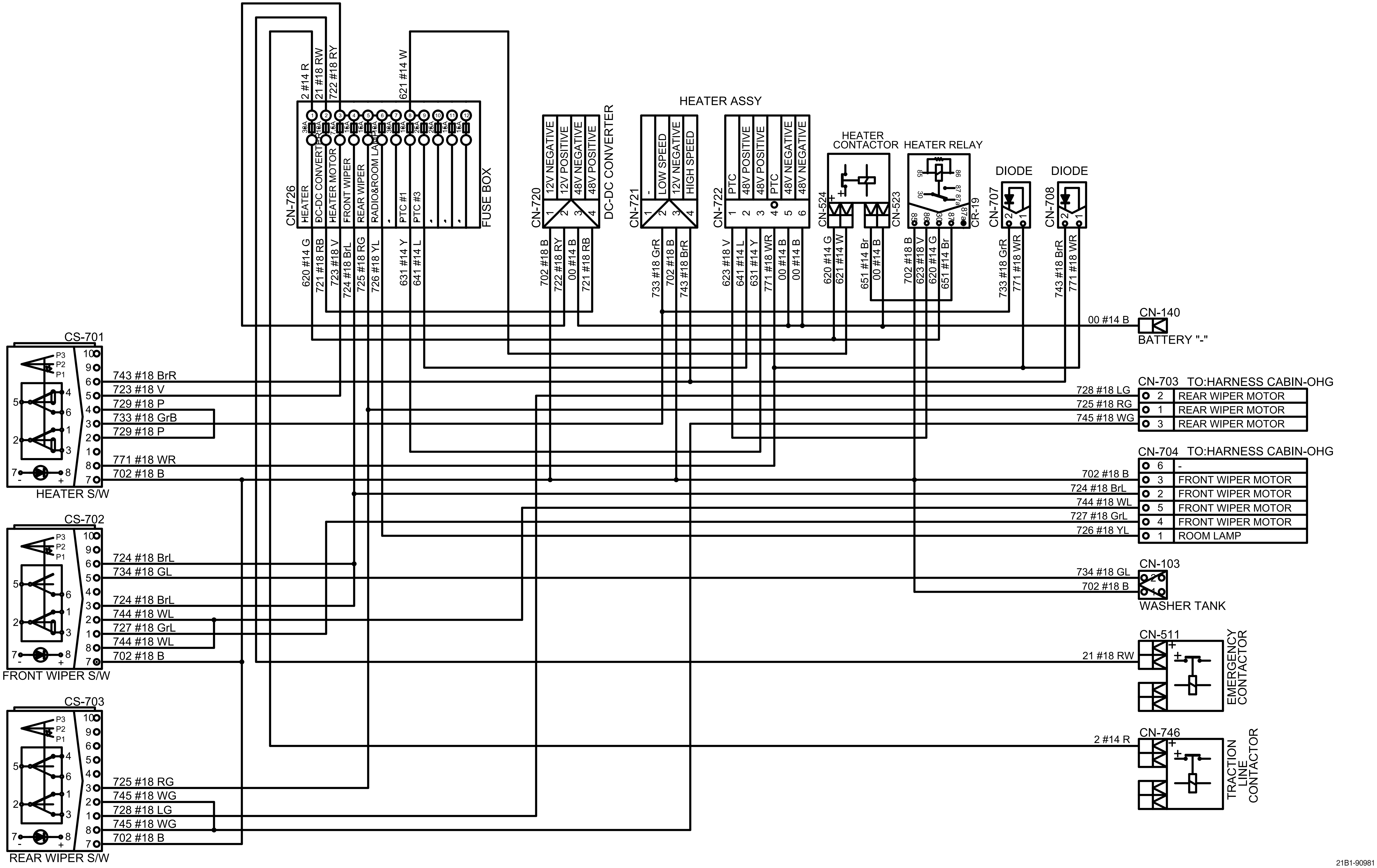

· ELECTRICAL CIRCUIT (14/15, OPTION, 25B-9U:#801~, 30B-9U: #391~, 32B-9U: #153~, 35B-9U: #206~)



· ELECTRICAL CIRCUIT (15/15, CABIN FRAME, 25B-9U : #801~#1182, 30B-9U: #391~#546, 32B-9U: #153~#253, 35B-9U: #206~#301)



· ELECTRICAL CIRCUIT (15-1/15, CABIN FRAME, 25B-9U : #1183~, 30B-9U: #547~, 32B-9U: #254~, 35B-9U: #302~)



## GROUP 3 ELECTRIC COMPONENTS

### 1. FUNCTIONS OF BATTERY FORKLIFT TRUCK AND ELECTRIC COMPONENTS

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

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

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

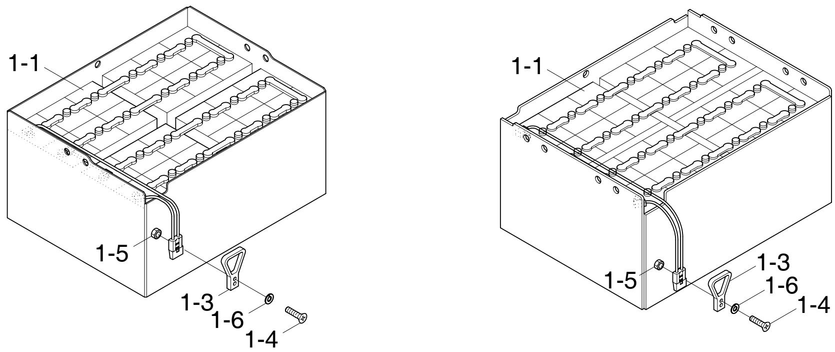
The CONTROL SYSTEM includes some protective circuits that protect the equipment and components from malfunctioning.

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

## 2. BATTERY

### 1) STRUCTURE

Standard type | Option type, without SBR

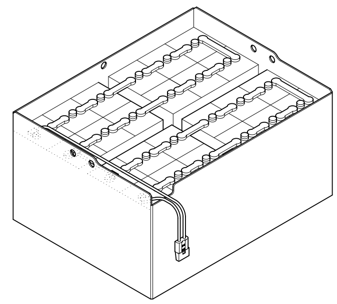



25B9UEL03

| | | | | | |
|---|---|---|---|---|---|
| 1 | Cells | 3 | Handle | 5 | Weld nut |
| 2 | Battery connector | 4 | Screw | 6 | Spring washer |

2) GENERAL

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



25B9UEL04

3) SPECIFICATION AND SERVICE DATA

| Item | Unit | 25B-9U | 30/32/35B-9U |
|---|---|---|---|
| Type | – | Lead Acid | |
| Rated voltage | V | 48 | |
| Capacity | AH/hr | 660 | 715 |
| Electrolyte | – | WET | |
| Dimension (W×D×H) | mm | 1030×796×533 | 1030×990×533 |
| Connector | – | SB 350 or SR 350 (SBE 320 BLUE) | |
| Weight | kg | 1090 | 1150 |

| | |
|---|---|
| Fully charged specific gravity | 1.280 (25°C) |
| End of discharge specific gravity | 1.120 (25°C) |
| Discharge end voltage | 48V |
| Electrolyte | Refined dilute sulfuric |
| Replenishment fluid | Refined (pure) water |
| Insulation resistance | 1MΩ |

## 4) SAFETY PRECAUTIONS

### (1) When sulfuric acid contact with skin

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

### (2) Strict prohibition of fire and ventilation

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

### (3) Never place metallic articles on the batteries

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

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

### (4) Handling of charger

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

## 5) OPERATION PRECAUTIONS

### (1) Avoid over-discharge

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

### (2) Avoid over-charge

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

### (3) Avoid excessive elevation of temperature

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

## 6) CHECKING

### (1) Unpacking

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

(2) Performance and maintenance of batteries

① Initial charge

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

a. By modified constant voltage charger

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

b. By constant voltage constant current charger (standard)

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

c. By constant current charger

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

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

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

② Discharge and capacity

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

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

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

③ Specific gravity of electrolyte

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

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

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

$S_t$ : Actually measured specific gravity at t°C

t : Electrolyte temperature (°C)

The standard specific gravity for this type of battery is 1.280±0.01(25°C) at full charge condition.

If the electrolyte is decreased naturally while using, distilled water shall be replenished up to the specified level. (Never refill sulfuric acid).

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

④ Normal charge

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

a. Charging by modified constant voltage automatic charger

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

b. Charging by constant current constant voltage automatic charger

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

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

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

c. Charging by constant current charger

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

⑤ Equalizing charge

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

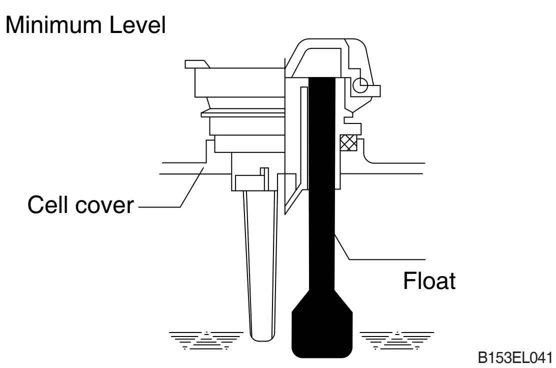
⑥ Replenishment of distilled water

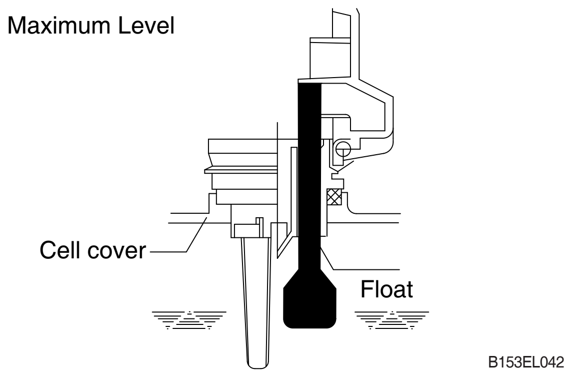
Only the water content of electrolyte is decreased due to electrolysis of distilled water during charge and natural evaporation. If a battery used with the electrolyte decreased excessively, plates will deteriorate resulting in markedly shortening of battery life. Be sure to check the electrolyte level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

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

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

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



⑦ Cleaning

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

⑧ Notice on charging

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

⑨ Repair of failure cell

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

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

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

⑩ Summary of daily maintenance

a. Avoid overcharge. After discharge, charge the batteries immediately. The standard frequency of equalizing charge is more than once every month.

b. Be sure to check the electrolyte level once every week. If found decreased, replenish distilled water up to the specified level.

c. The top surface of battery cells should be kept clean and dry.

d. Be sure to keep open the cover of battery housing tray during charge.

e. Never draw near open fires such as lighted cigarettes or burning matches during charge.

(3) Others

① Storage of batteries

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

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

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

② Maintenance record

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

③ Electrolyte temperature

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

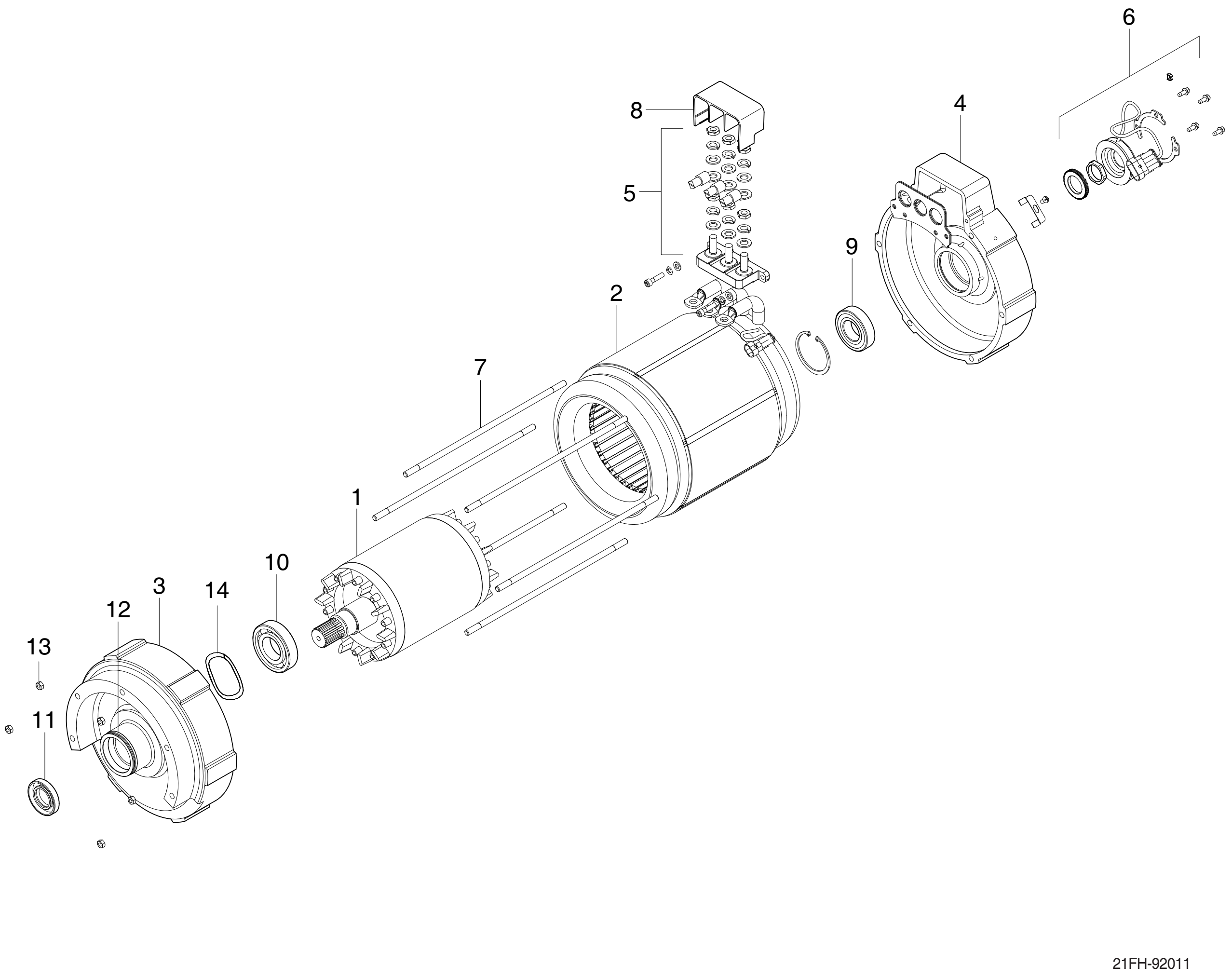
Contrarily if the temperature is high, especially if used at above 55°C, the battery life will be considerably shortened. Care must be taken so that the temperature during charge will be maintained at 55°C or lower. Even under unavoidable circumstances it should not exceed 55°C.

## 7) TROUBLESHOOTING

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

## 3. DRIVE MOTOR

### 1) STRUCTURE




| | | | | | |
|---|---|---|---|---|---|
| 1 | Rotor assy | 6 | Speed sensor kit | 11 | Oil seal |
| 2 | Stator assy | 7 | Stud bolt | 12 | O-ring |
| 3 | Endbell De | 8 | Protector-Terminal | 13 | Flange nut |
| 4 | Endbell | 9 | Bearing | 14 | Wave washer |
| 5 | Block-Terminal A | 10 | Bearing | | |

## 2) SPECIFICATION

| Item | Unit | Specification |
|---|---|---|
| Type | - | AQDG4001 |
| Rated voltage | Vac | 32 |
| Rated output | kW | 7.0×2 |
| Insulation | - | Class F |

## 3) MAINTENANCE INSTRUCTION

※ Before starting the maintenance please disconnect the power supply.

### (1) Ball bearing

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

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

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

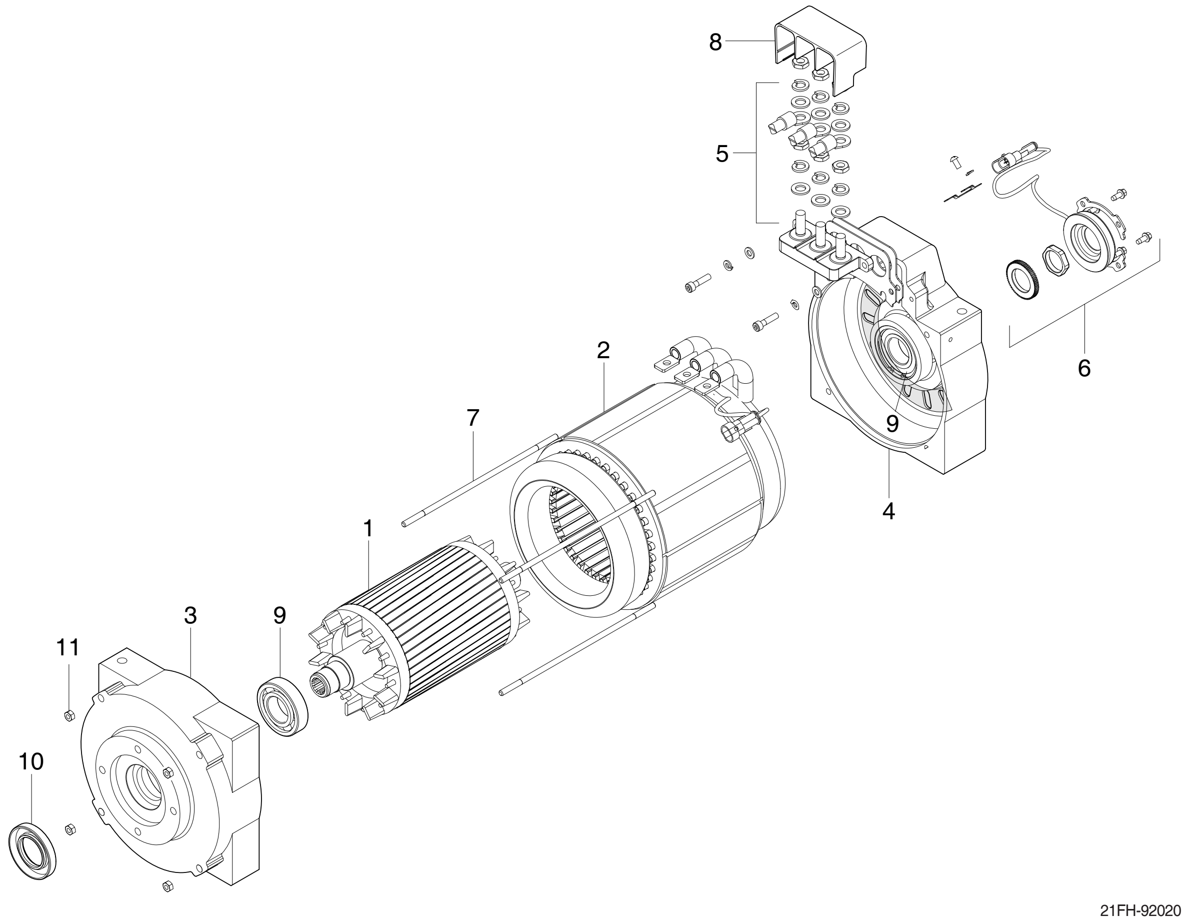
### (2) Disassembly and assembly

The motor is assembled and disassembled according to the relevant sectional drawing and part list. (See page 7-19)

## 4. PUMP MOTOR

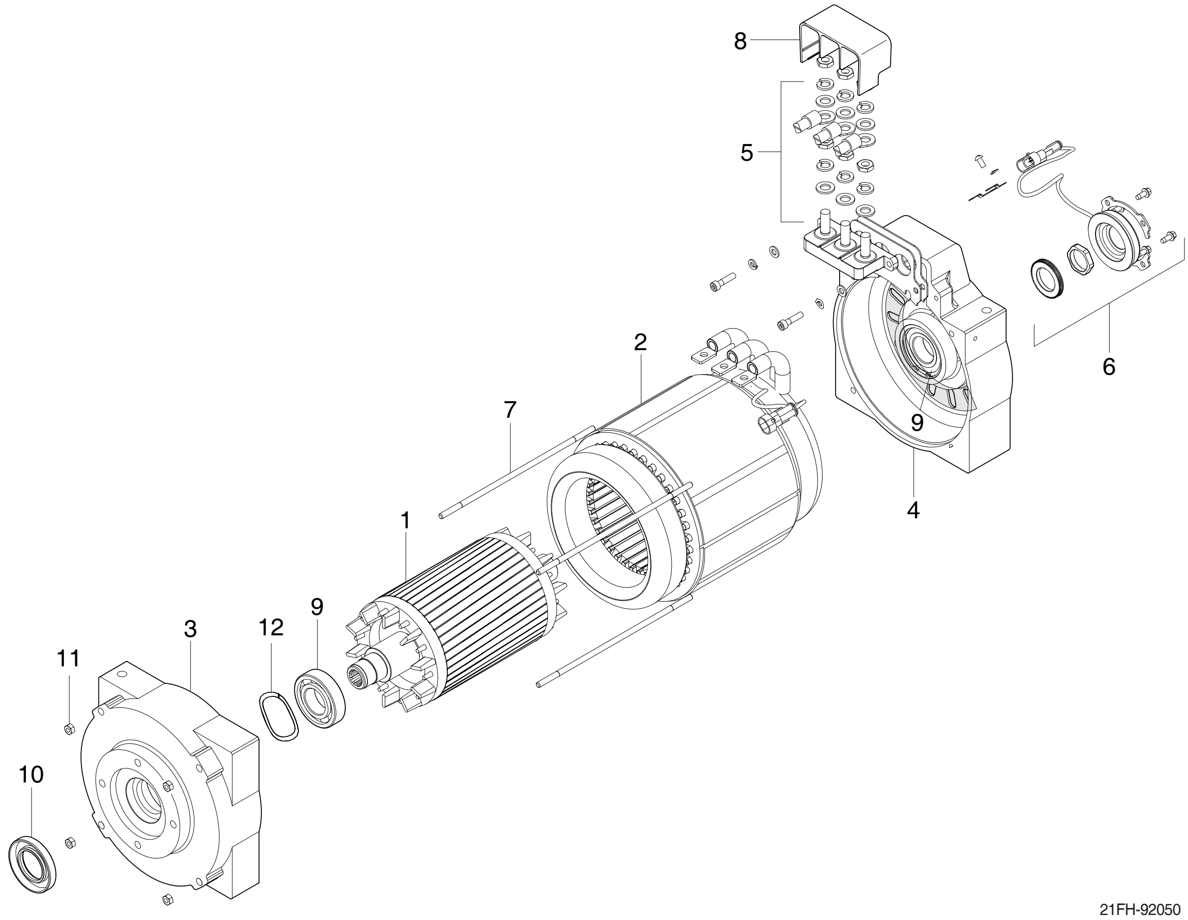
### 1) STRUCTURE

#### (1) 25B/30B-9U - CLOSE TYPE




| | | | | | |
|---|---|---|---|---|---|
| 1 | Rotor assy | 5 | Block-Terminal A | 9 | Bearing |
| 2 | Stator assy | 6 | Speed sensor kit | 10 | Oil seal |
| 3 | Endbell De | 7 | Stud bolt | 11 | Flange nut |
| 4 | Endbell | 8 | Protector-Terminal | | |

## (2) 32B/35B-9U - CLOSE TYPE




| | | | | | |
|---|---|---|---|---|---|
| 1 | Rotor assy | 5 | Block-Terminal A | 9 | Bearing |
| 2 | Stator assy | 6 | Speed sensor kit | 10 | Oil seal |
| 3 | Endbell De | 7 | Stud bolt | 11 | Flange nut |
| 4 | Endbell | 8 | Protector-Terminal | 12 | Wave washer |

## 2) SPECIFICATION

| Item | Unit | Specification | |
|---|---|---|---|
| | | 25B/30B-9U | 32B/35B-9U |
| Type | - | AMDL4001 | AMDL4001B |
| Rated voltage | Vac | 30 | |
| Rated output | kW | 17 | |
| Insulation | - | Class F | |

## 3) INTERNAL INVOLUTE SPLINE DATA

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

## 4) MAINTENANCE INSTRUCTION

※ Before starting the maintenance please disconnect the power supply.

### (1) Ball bearing

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

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

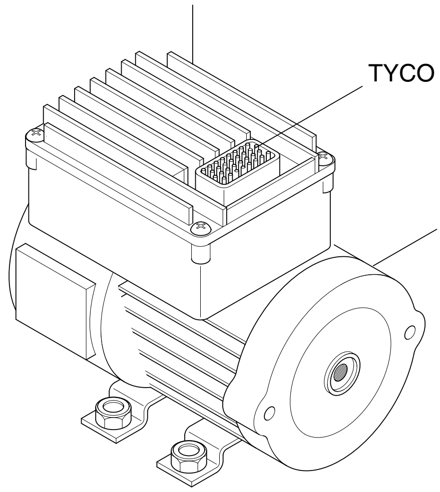
After approximately 10,000 operating hours the bearings have to be replaced.

### (2) Disassembly and assembly

The motor is assembled and disassembled according to the relevant sectional drawing and part list. (See page 7-21)

## 4. EPS MOTOR

### 1) STRUCTURE




21B1-98340

### 2) SPECIFICATION

| Item | Unit | Specification |
|---|---|---|
| Model | - | G1063806 |
| Type | - | AC |
| Rated voltage | Vac | 48V |
| Rated output | kW | 600W |
| Insulation | - | Class F |

### 3) INVOLUTE SPLINE DIMENSIONS

| Item | | Unit | Specification |
|---|---|---|---|
| Shift coefficient | | - | +0.800 |
| Tool | Tooth profile | - | Low tooth |
| | Module | - | 1.0 |
| | Pressure angle | Degree | 20 |
| Number of teeth | | EA | 10 |
| Reference pitch diameter | | mm | 10 |
| Teeth thickness | Class | - | A |
| | Over pin diameter | mm | $13.564^{-0.100}_{-0.166}$ (PIN Diameter = Ø1.8) |

## 4) MAINTENANCE INSTRUCTION

### (1) General information

The used fluid grease produces a permanent lubricant film with good adhesive power, thus ensuring a long service life of the transmission parts. Under normal operating conditions, this fluid grease serves as lifetime lubrication. In case of a damaged shaft seal on the axle carrier and a resulting loss of grease, a repair on the helical gear transmission is necessary. On this occasion, the fluid grease must be removed and replaced.

We would therefore recommend to have any required repair and thus necessary change of fluid grease carried out by ZF Services. Ensure disposal of the removed grease and used detergent in accordance with the regulations.

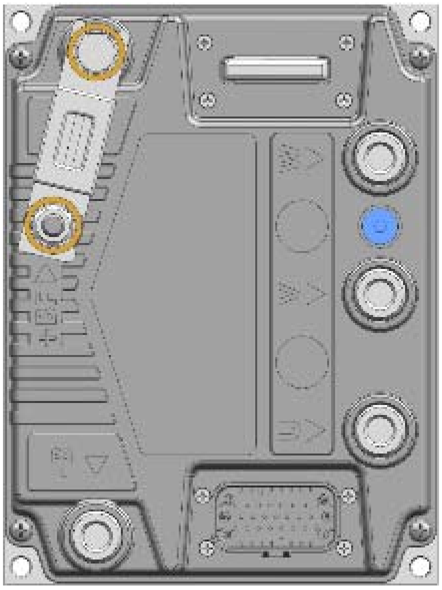
### (2) Check of grease level

It is not necessary to check the grease level of the EPS 3.20. Almost no maintenance is required for the three-stage helical gear transmission due to optimum adhesive and lubrication properties of the fluid grease. Multi-purpose grease is applied as one-time filling for lifetime lubrication on the ball bearings and tapered roller bearings of the transmission and the wheel bearing.

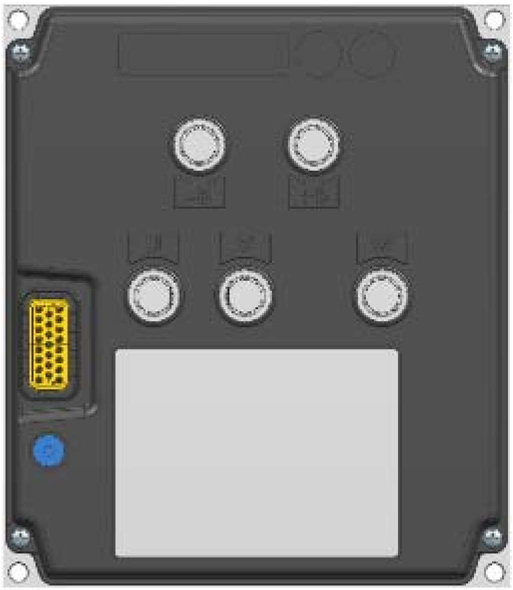
Repair action must be taken immediately in case of loss of lubricants!

## 6. CONTROLLER SYSTEM

### 1) STRUCTURE

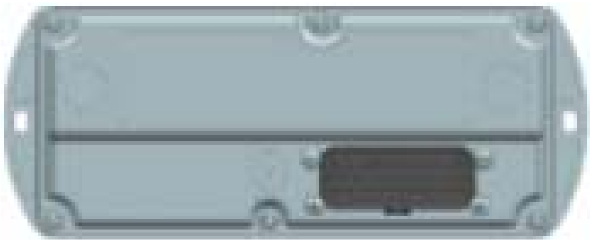


Traction controller



Pump controller

EPS controller



VCM controller (option)

25B9UEL10

### Specification

| Model | Application | Type | Power | Current limit |
|---|---|---|---|---|
| ACE2 | Traction | MOSFET | 36-48V, 350A x2 | 350A/2min |
| ACE3 | Pump | MOSFET | 36-48V, 600A | 600A/2min |
| EPS ACW | Eps | MOSFET | 36-48V, 70A | 70A/2min |
| VCM RETAIL | Fingertip | VALVE CONTROLLER | 36-48V | - |

## 2) OPERATIONAL FEATURES (Traction and Pump controller)

### (1) Features

① Speed control

② Optimum behavior on a slope due to the speed feedback:
the motor speed follows the accelerator, starting a regenerative braking if the speed exceeds the setpoint.

③ Electrical stop on a ramp: the machine is electrically held on a slope for a programmable time.

④ Stable speed in every position of the accelerator.

⑤ Regenerative release braking based upon deceleration ramps.

⑥ Regenerative braking when the accelerator pedal is partially released (deceleration).

⑦ Direction inversion with regenerative braking based upon deceleration ramp.

⑧ Regenerative braking and direction inversion without contactors: only the main contactor is present.

⑨ The release braking ramp can be modulated by an analog input, so that a proportional brake feature is obtained.

⑩ Optimum sensitivity at low speeds.

⑪ Voltage boost at the start and with overload to obtain more torque (with current control).

⑫ The inverter settings can drive an electromechanical brake.

⑬ High efficiency of motor and battery due to high frequency commutations.

⑭ Double microcontroller for safety functions.

### (2) Protection features

The ACE2 is protected against some controller injuries and malfunctions:

① Battery polarity inversion : It is necessary to fit a main contactor to protect the inverter against reverse battery polarity and for safety reasons.

② Connection errors : All inputs are protected against connection errors.

③ Voltage monitoring : Protected against battery undervoltage and overvoltage.

④ Thermal protection : If the controller temperature exceeds 85 °C, the maximum current is reduced in proportion to the thermal increase. The temperature can never exceed 105 ° C.

⑤ External agents : The inverter is protected against dust and the spray of liquid to a degree of protection meeting IP65. Nevertheless, it is suggested to carefully study controller installation and position. With little simple shrewdness, the controller protection degree can be strongly increased.

⑥ Protection against uncontrolled movements :
The main contactor will not close if:
- The power unit is not working.
- The logic board doesn't work perfectly.
- The output voltage of the accelerator does not fall below the minimum voltage value stored, with 1 V added.
- Running microswitch in closed position.
- Low battery charge

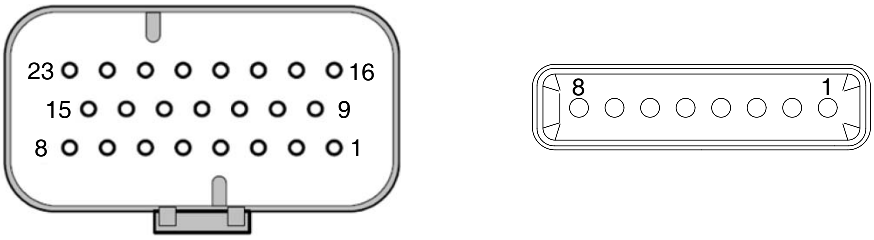
When the battery charge is low, the maximum current is reduced to the half of the maximum current programmed.

⑦ Protection against accidental start up : A precise sequence of operations are necessary before the machine will start. Operation cannot begin if these operations are not carried out correctly. Requests for drive must be made after closing the key switch.

### 3) DESCIPTION OF THE CONNECTORS

#### (1) Traction and Pump controller

ACE2 is equipped with a 23-poles Ampseal connector like that of the figure. Each of the 23 pins is referred to as “A#”, where “A” denotes the connector name and “#” is the pin number, from 1 to 23.




Connector A

Connector B (traction only)

25B9UEL11

① Traction controller (Right)

| Pin | Function | Description |
|---|---|---|
| A1 | KEY | Input of the key switch signal. |
| A2 | 5V | Positive supply for the accelerator pedal. (+5V 100mA maximum). |
| A3 | CPOT | Analog input of the accelerator pedal 1 signal. (0~5V). |
| A4 | FWD | Digital input, active when connected to +5V.<br>The default function is as FORWARD request; closing this input the truck moves forward. |
| A5 | BWD | Digital input, active when connected to +5V.<br>The default function is as BACKWARD request; closing this input the truck moves backward. |
| A6 | CPOT | Analog input. It is used for the brake pedal 2 request. (0~5V). |
| A7 | ENCA | Channel A of the incremental encoder of right traction motor. |
| A8 | PENC | Positive supply for the encoder of right traction motor. (+5 V, 150 mA maximum) |
| A10 | CPOT | Analog input. It is used for the brake pedal 1 request. (0~5V). |
| A11 | CANL | Low-level signal of CAN bus interface 2. |
| A12 | CANH | High-level signal of CAN bus interface 2. |
| A13 | CPOT | Analog input of the accelerator pedal 2 signal. (0~5V). |
| A14 | ENCB | Channel B of the incremental encoder of right traction motor. |
| A15 | GND | Negative supply for the encoder and the accelerator pedal. |
| A16 | NMC | Output of the main-contactor driver (driving to -B); PWM voltage controlled;<br>1.5A maximum continuous current. |
| A17 | PCOM | Connect the positive supply of coils (MC) to this pin. |
| A19 | SEAT | Digital input, active when connected to +B. It is used for SEAT input. |
| A20 | CANL | Low-level signal of CAN bus interface 1. |
| A21 | CANH | High-level signal of CAN bus interface 1. |

| Pin | Function | Description |
|---|---|---|
| A22 | THMOT | Positive terminal for the right motor thermal sensor. The internal pull-up is a fixed 2 mA current source (max 5 V). |
| A23 | - | Negative terminal for the right traction motor thermal sensor. |
| B1 | PCLRXD | Positive serial reception. |
| B2 | NCLRXD | Negative serial reception. |
| B3 | PCLTXD | Positive serial transmission. |
| B4 | NCLTXD | Negative serial transmission. |
| B5 | GND | Negative console power supply. |
| B6 | 12 | Positive console power supply. |
| B7 | FLASH | It must be connected to pin 8 for the Flash memory programming. |
| B8 | FLASH | It must be connected to pin 7 for the Flash memory programming. |

② Traction controller (Left)

| Pin | Function | Description |
|---|---|---|
| A1 | KEY | Input of the key switch signal. |
| A3 | CPOT | Analog input of the auto tilt leveling sensor 1. (0~5V). |
| A4 | BRAKE OIL | Digital input, active when connected to +5V.<br>The function is as BRAKE OIL request. |
| A5 | TILT LEVEL | Digital input, active when connected to +5V.<br>The function is as TILT LEVELING request. |
| A6 | CPOT | Analog input of the load sensor signal. (0~5V). |
| A7 | ENCA | Channel A of the incremental encoder of left traction motor. |
| A8 | PENC | Positive supply for the encoder of left traction motor. (+5V, 150mA maximum) |
| A9 | NAUX | Output of fan relay-coil driver (driving to -B); PWM voltage controlled;<br>2A maximum continuous current. |
| A11 | CANL | Low-level signal of CAN bus interface 2. |
| A12 | CANH | High-level signal of CAN bus interface 2. |
| A13 | CPOT | Analog input of the auto tilt leveling sensor 2. (0~5V). |
| A14 | ENCB | Channel B of the incremental encoder of left traction motor. |
| A15 | GND | Negative supply for the encoder and auto tilt leveling sensor. |
| A17 | PCOM | Connect the positive supply of coils (fan relay) to this pin. |
| A19 | SBR | Digital input, active when connected to +B. It is used for SBR input. |
| A20 | CANL | Low-level signal of CAN bus interface 1. |
| A21 | CANH | High-level signal of CAN bus interface 1. |
| A22 | THMOT | Positive terminal for the left traction motor thermal sensor. The internal pull-up is a fixed 2 mA current source (max 5V). |
| A23 | - | Negative terminal for the left traction motor thermal sensor. |
| B1 | PCLRXD | Positive serial reception. |

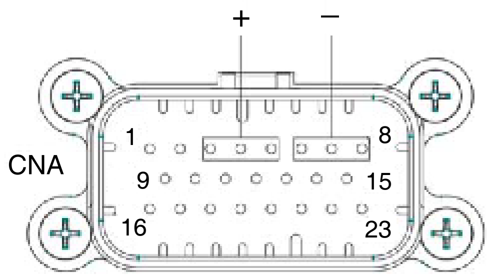
| Pin | Function | Description |
|---|---|---|
| B2 | NCLRXD | Negative serial reception. |
| B3 | PCLTXD | Positive serial transmission. |
| B4 | NCLTXD | Negative serial transmission. |
| B5 | GND | Negative console power supply. |
| B6 | +12 | Positive console power supply. |
| B7 | FLASH | It must be connected to pin 8 for the Flash memory programming. |
| B8 | FLASH | It must be connected to pin 7 for the Flash memory programming. |

③ Pump controller

| Pin | Function | Description |
|---|---|---|
| A1 | KEY | Input of the key switch signal. |
| A2 | PANIN | Positive supply for potentiometers: 5V output; keep load impedance > 0.5kOhm. |
| A3 | CPOT | Analog input of the lift sensor. (0 ~ 5V). |
| A4 | AUX1 | Digital input, active when connected to +5V.<br>The function is as AUX1 request. |
| A5 | AUX2 | Digital input, active when connected to +5V.<br>The function is as AUX2 request. |
| A7 | ENCA | Channel A of the incremental encoder of pump motor. |
| A8 | PENC | Positive supply for the encoder of pump motor. (+5V, 150mA maximum) |
| A9 | NAUX | Output of MCV solenoid-coil driver (driving to -B); PWM voltage controlled; 2 A maximum continuous current. |
| A10 | CPOT | Analog input. It is used for the tilt s/w request. (0 ~ 5 V). |
| A11 | CANL | Low-level signal of CAN bus interface 2. |
| A12 | CANH | High-level signal of CAN bus interface 2. |
| A14 | ENCB | Channel B of the incremental encoder of pump motor. |
| A15 | GND | Negative supply for the encoder and lift sensor. |
| A17 | PCOM | Connect the positive supply of coils (MCV solenoid) to this pin. |
| A19 | LIFT CB | Digital input, active when connected to +B.<br>It is used for LIFT CUTBACK input. |
| A20 | CANL | Low-level signal of CAN bus interface 1. |
| A21 | CANH | High-level signal of CAN bus interface 1. |
| A22 | THMOT | Positive terminal for the pump motor thermal sensor. The internal pullup is a fixed 2 mA current source (max 5 V). |
| A23 | - | Negative terminal for the pump motor thermal sensor. |

(2) EPS controller

23 poles AMPSEAL connector (CNA) assignment:



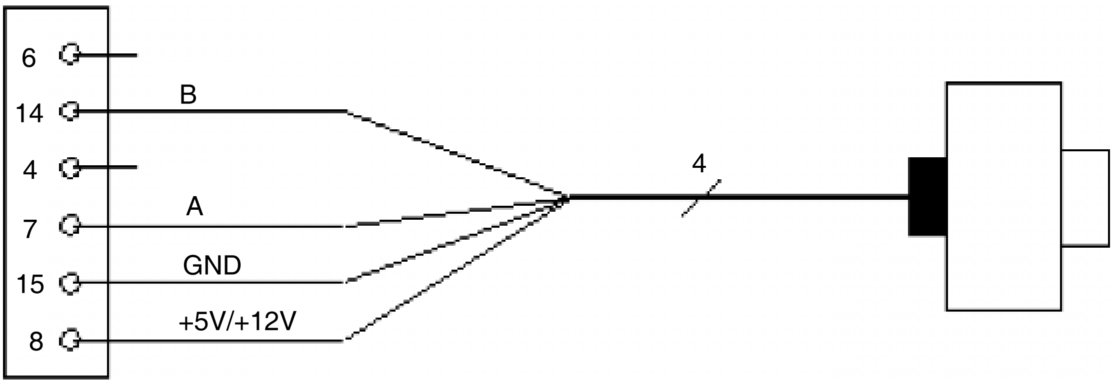

25B9UEL12

| Pin | Function | Description |
|---|---|---|
| A3 | PBATT | PBATT power connection |
| A4 | PBATT | PBATT power connection |
| A5 | PBATT | PBATT power connection |
| A6 | NBATT | NBATT power connection |
| A7 | NBATT | NBATT power connection |
| A8 | NBATT | NBATT power connection |
| A9 | PCOILS | Overload and short-circuit protected positive breaker for coils. A9 makes and takes Vbatt: 2Adc max @ Vbatt $\leq$ 48V. |
| A10 | NCOIL | Overload and short-circuit protected negative breaker for a proportional coil. A10 is a PWMout: 1.3Adc max @ Vbatt $\leq$ 48V |
| A14 | PCOIL2 | Short-circuit protected positive breaker for a proportional coil. Cascaded with A9. A14 is a PWMout: 0.7Adc max @ Vbatt $\leq$ 48V |
| A15 | KEY IN | Key input (Logic Supply input) |
| A16 | GND | GND. NBATT logic reference |
| A17 | CPOC2 | 2nd triangle wave shape PWM 5% to 95% or analog signal in the range 0.5V to 4.5V |
| A19 | GND | GND. NBATT logic reference |
| A20 | CPOC1 | 1st triangle wave shape PWM 5% to 95% or analog signal in the range 0.5V to 4.5V |
| A21 | VDD | 5Vdc 50mA supply output (PPOC positive supply for CPOC1-2) |
| A22 | CANL1 | CAN Bus channel LOW (No 120 termination aboard) |
| A23 | CANH1 | CAN Bus channel HIGH (No 120 termination aboard) |

(3) Connection of encoder (Traction and Pump)

ACE2 can handle different types of encoder. To control AC motor, it is necessary to install an incremental encoder with 2 phases shifted by 90°. The encoder supply can be 5 V or 12 V. For special applications it is possible to install incremental encoder with zero-position signal.

| | | | | |
|---|---|---|---|---|
| A8 | : | +5V/+12V | : | encoder positive power supply. |
| A15 | : | GND | : | encoder negative supply |
| A7 | : | ENC A | : | encoder phase A. |
| A14 | : | ENC B | : | encoder phase B. |




25B9UEL13

## 4) FUNCTION CONFIGURATION

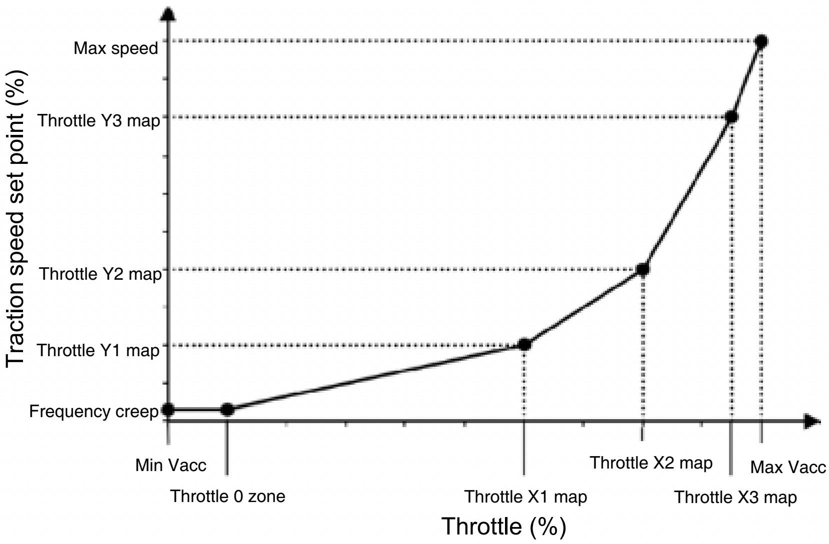
### (1) Right traction inverter -master

① Set option

| Function | Description |
|---|---|
| TRUCK MODEL SEL. | There are 2 options, 25B-9U, 30/32/35B-9U. |
| HOUR COUNTER | This option specifies the hour counter mode. It can be set one of two:<br>- RUNNING: The counter registers travel time only<br>- KEY ON: The counter registers when the "key" switch is closed. |
| BATTERY CHECK | This option specifies the management of the low battery charge situation. There are four levels of intervention:<br>- 0 : nothing happens; the battery charge level is evaluated but ignored, meaning that no action is taken when the battery runs out.<br>- 1 : the BATTERY LOW alarm occurs when the battery level is evaluated to be lower or equal to 10% of the full charge. With the BATTERY LOW alarm, the control reduces the maximum speed down and it also reduces the maximum current down to 50% of the full current.<br>- 2 : the BATTERY LOW alarm occurs when the battery level is evaluated to be lower or equal to 10% of the full charge.<br>- 3 : the BATTERY LOW alarm occurs when the battery level is evaluated to be lower or equal to 10% of the full charge. With the BATTERY LOW alarm, the control reduces the maximum speed down. |
| STOP ON RAMP | - ON : The stop on ramp feature (truck electrically hold on a ramp) is managed for a fixed time (6 sec.).<br>- OFF : The stop on ramp feature is not performed. |
| SET MOT. TEMPERAT | This parameter defines the type of motor temperature sensor adopted.<br>- NONE = no motor thermal sensor is connected.<br>- DIGITAL : a digital (ON/OFF) motor thermal sensor is connected to A23.<br>- OPTION#1 : an analog motor thermal sensor is connected to A23. The temperature sensor is a KTY 84-130 PTC (positive thermal coefficient resistance).<br>- OPTION#2 : an analog motor thermal sensor is connected to A23. The temperature sensor is a KTY 83-130 PTC (positive thermal coefficient resistance).<br>- OPTION#3 : an analog motor thermal sensor is connected to A23. The temperature sensor is a PT1000 PTC (positive thermal coefficient resistance). |
| LOAD SENSOR | - OFF : Load Sensing Function is deactivated<br>- ON : Load Sensing Function is activated. |

| Function | Description |
|---|---|
| OVERLOAD TYPE | This option specifies how overload alarm works in overloaded situation.<br>- NONE : There would'n be any kind of alarms or limitations.<br>If re-configuration of V.A.S.S LOAD is required, please set this parameter as NONE, then proceedure-configuration.<br>- Option #1 : If the weight of load filed on forks exceeds the overload weight set in overload parameter, OVERLOAD alarm will be displayed and followed by traction & pump limitation except lift down & steering function.<br>- Option #2 : If the weight of load filed on forks exceeds the overload weight set in overload parameter, OVERLOAD alarm will be displayed. |
| DISPLAY | This option set the communication check between traction and display.<br>- ON : Communication check is enable. If the traction can not detect the display communication signal, CAN BUS KO DISP is occured and travel speed cutback to turtle speed.<br>- OFF : Communication check is disable. |
| BMS | This option set the communication check between traction and Li-ion Battery Management System.<br>- ON : using BMS with Lithium Battery.<br>- OFF : not using BMS with Lithium Battery. |
| RS232 CONSOLE | This parameter enables or disables the console to change settings. |

② Adjustments

<table>
<tr><th>Function</th><th>Description</th></tr>
<tr><td>THROTTLE 0 ZONE</td><td>This parameter defines a dead band in the accelerator input curve. (Please refer to the accelerator input curve in the description of THROTTLE Y3 MAP)</td></tr>
<tr><td>THROTTLE X1 MAP</td><td>This parameter defines the accelerator input curve. (Please refer to the accelerator input curve in the description of THROTTLE Y3 MAP)</td></tr>
<tr><td>THROTTLE Y1 MAP</td><td>This parameter defines the accelerator input curve. (Please refer to the accelerator input curve in the description of THROTTLE Y3 MAP)</td></tr>
<tr><td>THROTTLE X2 MAP</td><td>This parameter defines the accelerator input curve. (Please refer to the accelerator input curve in the description of THROTTLE Y3 MAP)</td></tr>
<tr><td>THROTTLE Y2 MAP</td><td>This parameter defines the accelerator input curve. (Please refer to the accelerator input curve in the description of THROTTLE Y3 MAP)</td></tr>
<tr><td>THROTTLE X3 MAP</td><td>This parameter defines the accelerator input curve. (Please refer to the accelerator input curve in the description of THROTTLE Y3 MAP)</td></tr>
<tr><td>THROTTLE Y3 MAP</td><td>This parameter defines the accelerator input curve.<br>- Accelerator input curve<br>

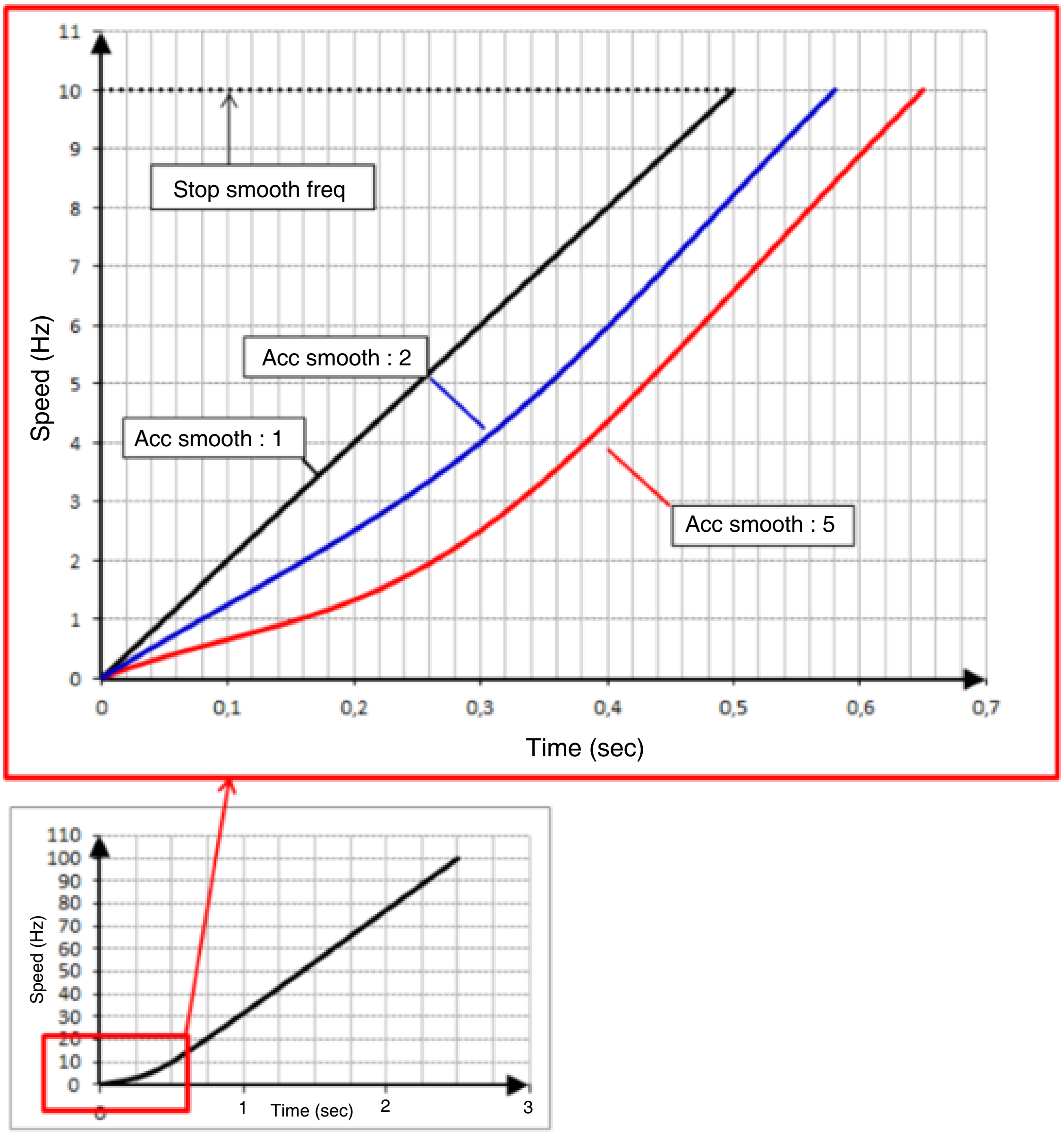
<br>The speed remains at the FREQUENCY CREEP value as long as the voltage from the accelerator potentiometer is below THROTTLE 0 ZONE. Basically this defines a dead zone close to the neutral position.</td></tr>
<tr><td>BAT. MIN ADJ.</td><td rowspan="2">After key on, the controller uses the following parameters to detect the BDI%.<br>BAT. MIN ADJ. : using after key on. (discharged battery level)<br>BAT. MAX ADJ. : using after key on. (charged battery level)</td></tr>
<tr><td>BAT. MAX ADJ.</td></tr>
<tr><td>BDI ADJ STUP MIN</td><td rowspan="2">At key on, the controller uses the following parameters to detect the new BDI%.<br>BDI ADJ STUP MIN : using at key on. (discharged battery level)<br>BDI ADJ STUP MAX : using at key on. (charged battery level)</td></tr>
<tr><td>BDI ADJ STUP MAX</td></tr>
<tr><td>BDI RESET</td><td rowspan="2">If the difference between the old BDI% and new BDI% is less than BDI RESET, the BDI% is not changed to new BDI%.<br>BDI RESET : using the old BDI% is over 30% before key off.<br>BDI RESET 2 : using the old BDI% is less than 30%(from 29% to 0%) before key off.</td></tr>
<tr><td>BDI RESET 2</td></tr>
<tr><td>MOTOR HIGH TEMP</td><td>This parameter defines the motor temperature above which a cutback is applied. Cutback is valid only during motoring, while during braking the 100% of the maximum current is always available independently by the temperature.</td></tr>
</table>

| Function | Description |
|---|---|
| MOT.SHUTDOWN TEM | This parameter defines the maximum motor temperature permitted, above which the controller stops driving the motor. |
| REF. LOAD WEIGHT | (This parameter is used for that LOAD SENSOR is ON)<br>This parameter is used to show and configurate the reference load weight. |
| OVERLOAD WEIGHT | (This parameter is used for that LOAD SENSOR is ON)<br>This parameter is used to show and configurate the trigger condition for OVERLOAD alarm.<br>If the loaded weight exceeds the weight indicated in this paramter, OVERLOAD alarm and function limitation will occur according to OVERLOAD TYPE paramter. |
| MAX LOAD WEIGHT | (This parameter is used for that LOAD SENSOR is ON)<br>This parameter is used to show and configurate the maximum load weight. |
| LOAD SPEED UPD. | (This parameter is used for that LOAD SENSOR is ON)<br>To increase accuracy, Load Sensor only works when the traction motor speed is lower than as set in this parameter. |

③ Parameter

| Function | Description |
|---|---|
| ACCELERATION 0 | It specifies the motor acceleration at 0 Hz. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases. |
| ACCELERATION 1 | It specifies the motor acceleration at ACC PROF. FREQ 1[Hz]. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases. |
| ACCELERATION 2 | It specifies the motor acceleration at ACC PROF. FREQ 2[Hz]. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases. |
| ACCELERATION 3 | It specifies the motor acceleration at ACC PROF. FREQ 3[Hz]. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases. |
| ACCELERATION 4 | It specifies the motor acceleration at ACC PROF. FREQ 4[Hz]. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases. |
| ACCELERATION 5 | It specifies the motor acceleration at ACC PROF. FREQ 5[Hz]. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases. |
| ACC PROF.FREQ 1 | In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 1 parameter. |
| ACC PROF.FREQ 2 | In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 2 parameter. |
| ACC PROF.FREQ 3 | In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 3 parameter |
| ACC PROF.FREQ 4 | In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 4 parameter. |
| ACC PROF.FREQ 5 | In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 5 parameter. |
| RELEASE BRAKING | This parameter defines the deceleration ramp performed after the running request is released. |
| INVERS. BRAKING | This parameter defines the deceleration ramp performed when the direction switch is toggled during drive. |
| DECEL. BRAKING | This parameter defines the deceleration ramp performed when the accelerator is released but not completely. |

| Function | Description |
|---|---|
| PEDAL BRAKING | This parameter defines the deceleration ramp performed when the braking pedal is pressed. |
| SPEED LIMIT BRK. | This parameter defines the deceleration ramp performed upon a speed-reduction request. |
| STEER BRAKING | This parameter defines the deceleration ramp related to the steering angle. |
| MAX SPEED FORW | This parameter defines the maximum speed in forward direction. |
| MAX SPEED BACK | This parameter defines the maximum speed in backward direction. |
| CUTBACK SPEED 1 | This parameter defines the maximum speed performed when the cutback switch is active. |
| TURTLE SPEED | This parameter defines the maximum speed at turtle mode. |
| BMS WRN1 CUTBACK | This parameter defines the maximum speed performed when the BMS warning 1 is active. |
| MOT.HT MAX SPEED | The Maximum speed when the Motor Temperature is reached to the "MOTOR HIGH TEMP " Setting |
| BATT. LOW SPEED | This parameter defines the maximum speed performed according to "BATTERY CHECK" parameter. |
| M.TRAC SPEED RED | Maximum speed when the MAINTENANCE is set to OPTOIN#2 or #3 |
| CURVE SPEED 1 | This parameter defines the maximum traction speed when the steering angle is equal to the STEER ANGLE 1 angle. |
| MAX ANGLE SPEED | This parameter defines the maximum traction speed when the steering angle is equal to the STEER ANGLE 1 angle. |
| OVERLOAD SPEED | This parameter defines the maximum traction speed according to the "OVERLOAD TYPE" parameter when the loaded weight exceeds the "OVERLOAD WEIGHT" parameter. |
| FREQUENCY CREEP | This parameter defines the minimum speed when the forward- or reverse request switch is closed, but the accelerator is at its minimum. |
| BMS WRN0 CUTBACK | This parameter defines the maximum current performed when the BMS warning 0 is active. |
| MOT.HT MAX CURRE | The Maximum Current when the Motor Temperature is reached to the " MOTOR HIGH TEMP " Setting |
| BATT. LOW CURRENT | This parameter defines the maximum current performed according to "BATTERY CHECK" parameter. |
| ACC. SMOOTH | This parameter defines the acceleration profile: 1 results in a linear ramp, higher values result in smoother parabolic profiles. |
| INV. SMOOTH | This parameter defines the acceleration profile performed when the truck changes direction: 1 results in a linear ramp, higher values result in smoother parabolic profiles. |
| STOP SMOOTH | This parameter defines the frequency at which the smoothing effect of the acceleration profile ends. |
| BRK SMOOTH | This parameter defines the deceleration profile: 1 results in a linear ramp, higher values result in smoother parabolic profiles. |
| STOP BRK SMOOTH | This parameter defines the frequency at which the smoothing effect of the deceleration profile ends. |

<table>
<tr><th>Function</th><th>Description</th></tr>
<tr><td colspan="2">※ Acceleration smoothness<br>Smoothing-related parameters define a parabolic profile for the acceleration or deceleration ramps close to 0 rpm.<br>Values have not a physical meaning: 1 means linear ramp, higher values (up to 5) result in smoother accelerations.<br>
</td></tr>
<tr><td>SEAT DELAY TIME</td><td>This parameter defines the delay time after the seat switch is off.</td></tr>
<tr><td>CHAT TIME</td><td>In seconds. When truck is key on, if the operator doesn't use the truck for the time (CHAT TIME), main contactor is open to save energy.</td></tr>
</table>

### (2) Left traction inverter-slave

① Set option

| Function | Description |
|---|---|
| TRUCK MODEL SEL. | There are 2 options, 25B-9U, 30/32/35B-9U. |
| COOLING FAN | Cooling fans installed on nearby motors and controllers will work as follows;<br>- None : fans don't work.<br>- Option #1 : fans work always.<br>- Option #2 : fans work in case a temperature of controller or motor exceeds a temperature set in FAN WORKING TEMP and FAN WORKING MOTOR.<br>- Option #3 : fans work when motors work. |
| FAN RELAY COIL | - ON : Using 12V Relay for cooling fan<br>- OFF : Not Using 12V Relay for cooling fan |
| BAT. VOLT. COMP | This parameter determines whether the main pull-in and holding voltages are battery voltage compensated<br>- ON : Using Battery Voltage Compensation |
| RS232 CONSOLE | This parameter enables or disables the console to change settings. |

② Adjustments

| Function | Description |
|---|---|
| FAN WORKING TEMP | (This parameter is used for that COOLING FAN is option #2)<br>If the temperature of inverter exceeds the temperature indicated in this paramter. |
| FANWORKING MOTOR | (This parameter is used for that COOLING FAN is option #2)<br>If the temperature of motor exceeds the temperature indicated in this paramter. |

### (3) Pump inverter

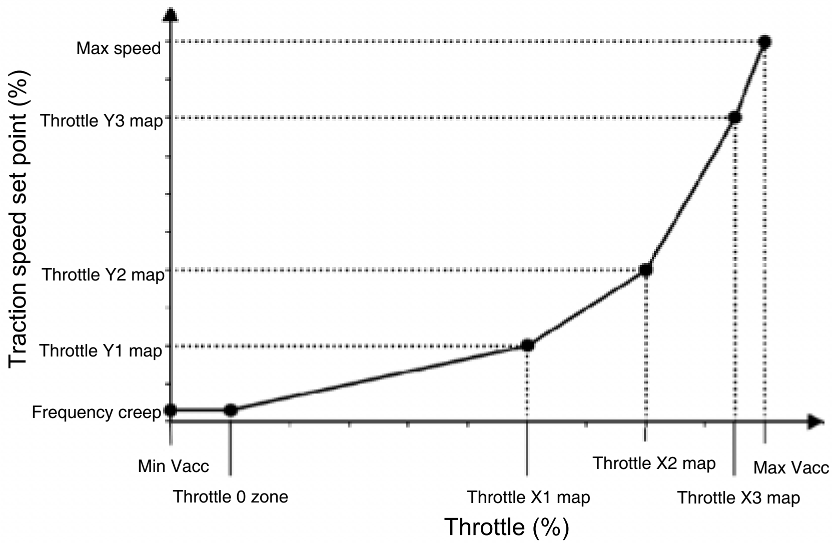
① Set option

| Function | Description |
|---|---|
| TRUCK MODEL SEL. | There are 2 options, 25B-9U, 30/32/35B-9U. |
| SET MOT. TEMPERAT | This parameter defines the type of motor temperature sensor adopted.<br>- NONE = no motor thermal sensor is connected.<br>- DIGITAL : a digital (ON/OFF) motor thermal sensor is connected to A23.<br>- OPTION#1 : an analog motor thermal sensor is connected to A23.<br>The temperature sensor is a KTY 84-130 PTC (positive thermal coefficient resistance).<br>- OPTION#2 : an analog motor thermal sensor is connected to A23.<br>The temperature sensor is a KTY 83-130 PTC (positive thermal coefficient resistance).<br>- OPTION#3 : an analog motor thermal sensor is connected to A23.<br>The temperature sensor is a PT1000 PTC (positive thermal coefficient resistance). |
| EVP TYPE | This parameter defines how the output A19 (EVP) operates.<br>- NONE : output not enabled, no load connected to A19.<br>- ANALOG : A19 manages a current-controlled PWM-modulated proportional valve.<br>- DIGITAL : A19 manages an on/off valve<br>(A19 : OPSS VALVE COIL) |

| Function | Description |
|---|---|
| OPSS | - ON : Present ( Using OPSS Coil )<br>- OFF : Absent ( Not using OPSS Coil ) |
| FINGERTIP | - ON : The truck model includes electro-hydraulic distributor and finger tips.<br>Can communication with VCM and Hydro CB zapi modules is enabled.<br>- OFF : The truck model includes mechanical lever distributor. |
| FINGERTIP MISM | - ON : Trigger the alarm if the fingertip output values are not within the admissible range;<br>- OFF : Alarm is not occurred even if the fingertip output values are not within the admissible range. |
| LEVER FULL | (This parameter is used for that FINGERTIP is ON.)<br>- ON : All combinations of hydraulic function are available.<br>- OFF : The combination of hydraulic function is not available at special condition for the safety. (Lift + tilt down) |
| AUX 1 FUNCTION | (This parameter is used for that FINGERTIP is ON.)<br>- OFF : The truck doesn't have the AUX 1 function (default)<br>- ON : The truck has the side shift function (Option) |
| AUX 2 FUNCTION | (This parameter is used for that FINGERTIP is ON.)<br>- OFF : The truck doesn't have the AUX 2 function (default)<br>- ON : The truck has the side shift function (Option) |
| FORK LEVELING | - OFF : Auto fork leveling function is not activated.<br>- ON : Auto fork leveling function is activated. |
| CUTBACK MODE | The taracrion / pump speed cutback when the A19 (P) pin is open. |

② Adjustments

| Function | Description |
|---|---|
| THROTTLE 0 ZONE | This parameter defines a dead band in the accelerator input curve.<br>(Please refer to the accelerator input curve in the description of THROTTLE Y3 MAP) |
| THROTTLE X1 MAP | This parameter defines the accelerator input curve.<br>(Please refer to the accelerator input curve in the description of THROTTLE Y3 MAP) |
| THROTTLE Y1 MAP | This parameter defines the accelerator input curve.<br>(Please refer to the accelerator input curve in the description of THROTTLE Y3 MAP) |
| THROTTLE X2 MAP | This parameter defines the accelerator input curve.<br>(Please refer to the accelerator input curve in the description of THROTTLE Y3 MAP) |
| THROTTLE Y2 MAP | This parameter defines the accelerator input curve.<br>(Please refer to the accelerator input curve in the description of THROTTLE Y3 MAP) |
| THROTTLE X3 MAP | This parameter defines the accelerator input curve.<br>(Please refer to the accelerator input curve in the description of THROTTLE Y3 MAP) |

<table>
<tr><th>Function</th><th>Description</th></tr>
<tr><td>THROTTLE Y3 MAP</td><td>This parameter defines the accelerator input curve.<br>- Accelerator input curve<br>


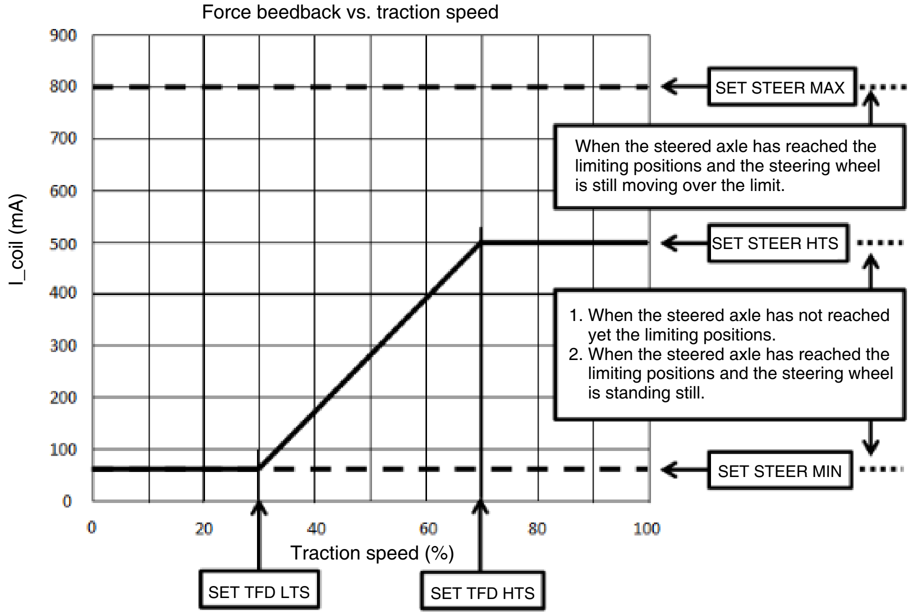
<br>The speed remains at the FREQUENCY CREEP value as long as the voltage from the accelerator potentiometer is below THROTTLE 0 ZONE. Basically this defines a dead zone close to the neutral position.</td></tr>
<tr><td>MOTOR HIGH TEMP</td><td>This parameter defines the motor temperature above which a cutback is applied.<br>Cutback is valid only during motoring, while during braking the 100% of the maximum current is always available independently by the temperature.</td></tr>
<tr><td>MOT.SHUTDOWN TEM</td><td>This parameter defines the maximum motor temperature permitted, above which the controller stops driving the motor.</td></tr>
<tr><td>FORK CENTER DEAD</td><td>(This parameter is used for that FORK LEVELING is ON)<br>It sets the pecentage of center dead zone from the center value , when fork leveling function is doing.</td></tr>
<tr><td>FORK APPR. RANGE</td><td>(This parameter is used for that FORK LEVELING is ON)<br>It sets the approach range from the center value , when fork leveling function is doing.</td></tr>
<tr><td>FORK VALVE MIN</td><td>(This parameter is used for that FORK LEVELING and FINGERTIP are ON)<br>It sets the pecentage of tilt valve current , when fork leveling function is doing.</td></tr>
</table>

③ Parameter

| Function | Description |
|---|---|
| ACCELER. DELAY | - |
| RELEASE BRAKING | This parameter defines the deceleration ramp performed after the running request is released. |
| DECEL. BRAKING | This parameter defines the deceleration ramp performed when the accelerator is released but not completely. |
| MAX SPEED LIFT | This parameter defines the maximum speed of the pump motor during lift. |
| TILT SPEED | This parameter defines the maximum speed of the pump motor during tilt. |
| AUX1 SPEED | This parameter defines the maximum speed of the pump motor during AUX1. |
| AUX2 SPEED | This parameter defines the maximum speed of the pump motor during AUX2. |
| CUTBACK SPEED 1 | This parameter defines the maximum speed performed when the cutback switch is active. |
| TURTLE SPEED | This parameter defines the maximum speed at turtle mode. |
| BMS WRN1 CUTBACK | This parameter defines the maximum speed performed when the BMS warning 1 is active. |
| MOT.HT MAX SPEED | The Maximum speed when the Motor Temperature is reached to the " MOTOR HIGH TEMP " Setting |
| BATT. LOW SPEED | This parameter defines the maximum speed performed according to "BATTERY CHECK" parameter. |
| M.PUMP SPEED RED | Maximum speed when the MAINTENANCE is set to OPTOIN #2 or #3 |
| FREQUENCY CREEP | This parameter defines the minimum speed when the forward- or reverse request switch is closed, but the accelerator is at its minimum. |
| BMS WRN0 CUTBACK | This parameter defines the maximum current performed when the BMS warning 0 is active. |
| MOT.HT MAX CURRE | The Maximum Current when the Motor Temperature is reached to the " MOTOR HIGH TEMP " Setting |
| BATT. LOW CURRENT | This parameter defines the maximum current performed according to "BATTERY CHECK" parameter. |
| ACC. SMOOTH | This parameter defines the acceleration profile: 1 results in a linear ramp, higher values result in smoother parabolic profiles. |
| STOP SMOOTH | This parameter defines the frequency at which the smoothing effect of the acceleration profile ends. |
| SEAT DELAY TIME | This parameter defines the delay time after the seat switch is off. |
| AUTO FORK SPEED | Pump speed at the Automatic Fork Leveling function is performed |
| FORK MIN SPEED | The maximum Tilt speed while approaching dead zone |

### (4) EPS inverter

① Parameter

| Function | Description |
|---|---|
| POTI REVOLUTIONS | From 3.0 to 9.0. This setting specifies the number of revolutions of the steering wheel for a side to side rotation of the steered axle. |
| SET STEER MIN. | 0 to 1000mA. The minimum Force Feedback value is set via SET STEER MIN.<br>(Please refer to the Force Feedback vs. Traction Speed in the description of SET TFD HTS) |
| SET STEER MAX. | 0 to 1000mA. The maximum Force Feedback value is set via SET STEER MAX.<br>(Please refer to the Force Feedback vs. Traction Speed in the description of SET TFD HTS) |
| SET STEER HTS | 0 to 1000mA. This parameter is used to handle the minimum Force Feedback value at HTS (High Traction Speed).<br>(Please refer to the Force Feedback vs. Traction Speed in the description of SET TFD HTS) |
| SET TFD LTS | This parameter is used to handle the minimum Force Feedback value at LTS (Low Traction Speed).<br>(Please refer to the Force Feedback vs. Traction Speed in the description of SET TFD HTS) |
| SET TFD HTS | This parameter is used to handle the minimum Force Feedback value at HTS (High Traction Speed).<br> |
| PERCUSSION DUTY | The time delay before switching off the Force Feedback when the steered axle has reached the limiting position and the steering wheel has been released is set by this parameter.<br>- LEVEL 0: 16 msec delay.<br>- LEVEL 1: 32 msec delay.<br>- LEVEL 2: 48 msec delay.<br>- LEVEL 9: 160 msec delay. |
| 1ST ANGLE GAIN | From 30 to 180 degrees. This parameter sets the maximum steered axle angle in the steering direction with FEEDBACK POT 1 value higher than 2.5V. |
| 2ND ANGLE GAIN | From 30 to 180 degrees. This parameter sets the maximum steered axle angle in the steering direction with FEEDBACK POT 1 value lower than 2.5V. |

### (5) VCM inverter

① Set option

| Function | Description |
|---|---|
| TRUCK MODEL SEL. | There are 2 options, 15/18/20BT-9U, 25/30/32/35B-9U. |
| HOUR COUNTER | This option specifies the hour counter mode. It can be set one of two:<br>- RUNNING: The counter registers travel time only<br>- KEY ON: The counter registers when the "key" switch is closed |
| OUT EV2 A7 DIAG | - ON : Diagnosis is ON<br>- OFF : Diagnosis is OFF |
| OUT EV1 A6 DIAG | - PRESENT : Diagnosis is present<br>- ABSENT : Diagnosis is absent |
| PROPORTIO. VALVE | - ON : Using proportional valve<br>- OFF : Not using proportional valve |

② Parameter

| Function | Description |
|---|---|
| I MIN EVP1 | This parameter adjusts the minimum current of valve 1 (Lift). |
| I MAX EVP1 | This parameter adjusts the maximum current of valve 1 (Lift). |
| I MIN EVP2 | This parameter adjusts the minimum current of valve 2 (Lowering). |
| I MAX EVP2 | This parameter adjusts the maximum current of valve 2 (Lowering). |
| I MIN EVP3 | This parameter adjusts the minimum current of valve 3 (Tilt in). |
| I MAX EVP3 | This parameter adjusts the maximum current of valve 3 (Tilt in). |
| I MIN EVP4 | This parameter adjusts the minimum current of valve 4 (Tilt out). |
| I MAX EVP4 | This parameter adjusts the maximum current of valve 4 (Tilt out). |
| I MIN EVP5 | This parameter adjusts the minimum current of valve 5 (AUX1 in). |
| I MAX EVP5 | This parameter adjusts the maximum current of valve 5 (AUX1 in). |
| I MIN EVP6 | This parameter adjusts the minimum current of valve 6 (AUX1 out). |
| I MAX EVP6 | This parameter adjusts the maximum current of valve 6 (AUX1 out). |
| I MIN EVP7 | This parameter adjusts the minimum current of valve 7 (AUX2 in). |
| I MAX EVP7 | This parameter adjusts the maximum current of valve 7 (AUX2 in). |
| I MIN EVP8 | This parameter adjusts the minimum current of valve 8 (AUX2 out ). |
| I MAX EVP8 | This parameter adjusts the maximum current of valve 8 (AUX2 out). |
| VOLTAGE EV2 | Supplying Voltage for EV2 |
| EVP1 OPEN DELAY | It determines the acceleration ramp on EVP1 |
| EVP1 CLOSE DELAY | It determines the deceleration ramp on EVP1 |
| EVP2 OPEN DELAY | It determines the acceleration ramp on EVP2 |
| EVP2 CLOSE DELAY | It determines the deceleration ramp on EVP2 |
| EVP3 OPEN DELAY | It determines the acceleration ramp on EVP3 |
| EVP3 CLOSE DELAY | It determines the deceleration ramp on EVP3 |
| EVP4 OPEN DELAY | It determines the acceleration ramp on EVP4 |

| Function | Description |
|---|---|
| EVP4 CLOSE DELAY | It determines the deceleration ramp on EVP4 |
| EVP5 OPEN DELAY | It determines the acceleration ramp on EVP5 |
| EVP5 CLOSE DELAY | It determines the deceleration ramp on EVP5 |
| EVP6 OPEN DELAY | It determines the acceleration ramp on EVP6 |
| EVP6 CLOSE DELAY | It determines the deceleration ramp on EVP6 |
| EVP7 OPEN DELAY | It determines the acceleration ramp on EVP7 |
| EVP7 CLOSE DELAY | It determines the deceleration ramp on EVP7 |
| EVP8 OPEN DELAY | It determines the acceleration ramp on EVP8 |
| EVP8 CLOSE DELAY | It determines the deceleration ramp on EVP8 |

### (6) Display

Operators can have below functions through display.

① Password

If determines to set the function of user password when key on.

- OFF : No use
- ON : Activate the user password (Default password is "00000" and it can be re-set at user menu)

② Maintenance

If determines to set the function of maintenance alarm when if come to service interval.

- OFF : No use
- ON : Activate the maintenance alarm function.

③ Hour counter

It indicates the machine operating hours.

- Key ON : Key on time
- Pump : Pump motor operating time.
- Traction : Traction motor operating time.

5) PROGRAMMING AND ADJUSTMENTS

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

※ Adjustments via buttons on a display, please refer to the display section. (page 7-64)

ADJUSTMENTS VIA SMART CONSOLE (Option)

Adjustment of parameters and changes to the inverter's configuration are made using the smart console.


25B9UEL17

※ Please connect and disconnect it after a key switch off.

### (1) Connected

If connection is successful, the display will show a page similar to the next one.

| |
|---|
| VMCM HY1.00 |
| 48v 0a 500H |
| NO CAN MSG N.05 |

25B9UEL18

This menu shows basic information about the controller.

- First line displays the controller firmware.
- Second line shows controller voltage, controller current and hour meter.
- Last line shows the current alarm code, if present.

Press OK to access the MAIN MENU.

| |
|---|
| *MAIN MENU* |
| PARAMETER CHANGE |
| TESTER |
| ALARMS |

25B9UEL19

Use UP and DOWN keys to navigate the list: once you find the desired menu press OK to enter it.

### (2) How to modify parameters

From MAIN MENU enter the desired menu (for example the PARAMETER CHANGE menu).

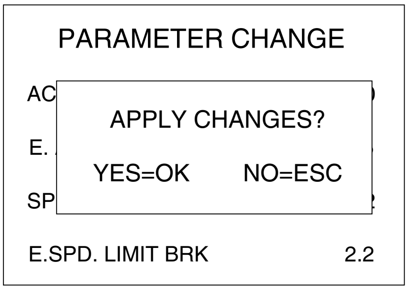
| PARAMETER CHANGE | |
|---|---|
| ACCELER DELAY | 1.0 |
| E. ACCELER DELAY | 1.5 |
| SPEED LIMIT BRK | 2.2 |
| E.SPD. LIMIT BRK | 2.2 |

25B9UEL20

With UP and DOWN keys you can scroll the list: once you have highlighted the parameter you want to modify, press either LEFT or RIGHT keys to decrease or increase the parameter value.

Keep LEFT/RIGHT button pressed to continuously repeat the value modification ("auto-repeat" function): this function will speed up the procedure in case many parameter values must be changed.

You can press ESC to exit the menu at any time. In case parameters have been modified, the console will prompt the request to confirm/discard changes.

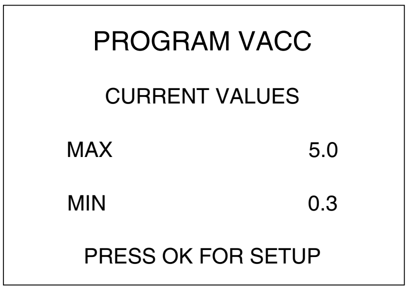



25B9UEL21

Description above is valid for every menu which contains parameters and options like SET OPTIONS, ADJUSTMENT, HARDWARE SETTINGS, etc.

### (3) Program Vacc

PROGRAM VACC menu has been slightly modified from old consoles. Upon entering this menu the console shows the current programmed values.



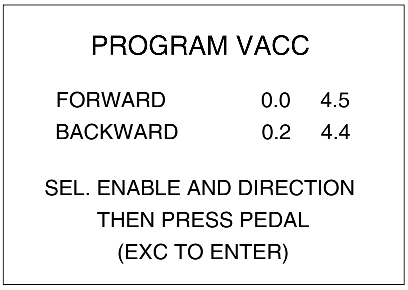

25B9UEL22

When OK is pressed, PROGRAM VACC procedure starts. Console invites you:

- To select the enable switch, if any;
- To select the direction switch (either forward or backward);
- To depress the pedal to its maximum excursion.

Displayed values vary accordingly to operator inputs.

Sequence above can slightly vary depending on controller firmware. Anyway the logic remains the same: before programming the min/max values, execute any starting sequence which is necessary, then press the pedal or push the joystick.




25B9UEL23

When ESC is pressed, console asks if programmed values must be saved or discarded.

## (4) Tester

It shows four variables at once: use UP/DOWN keys to scroll the list.

| TESTER | |
|---|---|
| MOTOR VALTAGE | 0% |
| FREQUENCY | 0 |
| ENCODER | 0 |
| BATTERY VOLTAGE | 24.5V |

25B9UEL24

## (5) Alarms

It shows all controller alarms at once.

| ALARMS | |
|---|---|
| NO CAN MESSAGE | 10h |
| INCORRECT START | 2h |
| NONE | 0h |
| NONE | 0h |
| NONE | 0h |
| F1 TO CLEAR LOGBOOK | |

25B9UEL25

Five is the maximum number of alarm codes which is stored inside the controller.

Colors are used to separate recurrent alarm codes from rare events. In order of increasing frequency, alarm names can be:

- White: up to 5 occurrences
- Yellow: up to 20,
- Orange: up to 40,
- Red: more than 40.

Use UP/DOWN to select a certain alarm in the list: if OK is pressed, additional pieces of information about that alarm are displayed. Press F1 to clear the alarm logbook of the controller: once F1 is pressed, the console asks for confirmation.

### 6) MORNITORING MENU

In smart console, this menu appears as “TESTER” MENU

#### (1) Right traction inverter -master

① Right traction master

| Function | Description |
|---|---|
| KEY VOLTAGE | Key voltage measured in real time. |
| BATTERY VOLTAGE | Battery voltage measured in real time (across the DC bus). |
| MOTOR VOLTAGE | Estimation of the DC current the inverter is drawing from the battery. |
| FREQUENCY | Frequency of the current sine-wave that the inverter is supplying to the motor. |
| MEASURED SPEED | Motor speed measured through the encoder and expressed in the same unit of FREQUENCY (Hz).<br>(measured value by master micom) |
| MEASURED SPD SLV | Motor speed measured through the encoder and expressed in the same unit of FREQUENCY (Hz). |
| SLIP VALUE | Motor slip, i.e. difference between the current frequency and the motor speed (in Hz). |
| CURRENT RMS | Root-mean-square value of the line current supplied to the motor.<br>(measured value by master micom) |
| CURRENT RMS SLV | Root-mean-square value of the line current supplied to the motor.<br>(measured value by slave micom) |
| IMAX LIM. TRA | Instantaneous value of the maximum current the inverter can apply to the motor to satisfy a traction request. The value is evaluated basing on actual conditions (inverter temperature, motor temperature, etc.). |
| IMAX LIM. BRK | Instantaneous value of the maximum current the inverter can apply to the motor to satisfy a braking request. The value is evaluated basing on actual conditions (inverter temperature, motor temperature, etc.). |
| MOT. POWER WATT | Estimation of the power supplied to the motor. |
| MOTION TORQUE NM | Estimation of the motor torque. |
| DC BUS CURRENT | Estimation of the DC current the inverter is drawing from the battery. |
| STEER ANGLE | Current steering-wheel angle. When the steering is straight ahead STEER ANGLE is zero. |
| BATTERY CHARGE | Estimation of the battery charge based on the battery voltage. |
| TEMPERATURE | Temperature measured on the inverter base plate. This temperature is used for the HIGH TEMPERATURE alarm. |
| MOTOR TEMPERAT. | Motor-windings temperature. This temperature is used for the MOTOR OVERTEMP alarm. |
| A19 SEAT SW | Status of the Seat Input on A19. |
| A4 FWD SWITCH | Status of the forward input A4. |
| A5 BWD SWITCH | Status of the backward inch input A5. |
| A10 BRAKE 1 SW | Status of the Pedal-Brake SW 1 input A10. |
| A6 BRAKE 2 SW | Status of the Pedal-Brake SW 2 input A6. |

| Function | Description |
|---|---|
| A13 ACC 1 | Voltage of the Accelerator-Pedal 1 (Decreasing analog signal) on A13. |
| A3 ACC 2 | Voltage of the Accelerator-Pedal 2 (Increasing analog signal) on A3. |
| A16 MAIN CONT. | Voltage applied over the main contactor coil. It corresponds to the duty cycle value of PWM applied and it is expressed in percentage. |
| CTRAP HW | This is a counter and it is showing the number of occurrences of hardware-overcurrent occurrences detection. |
| TRUCK SPEED | Speed of the truck. |
| ODOMETER KM | Odometer: overall distance traveled by the truck. |
| WEIGHT | This shows the measured load weight. |

② Right traction slave

| Function | Description |
|---|---|
| MEASURED SPD SLV | Motor speed measured through the encoder and expressed in the same unit of FREQUENCY (Hz). |
| CNA4 | Status of the forward input A4. |
| CNA5 | Status of the backward inch input A5. |
| CNA6 | Status of the Pedal-Brake SW 2 input A6. |
| CNA19 | Status of the Seat Input on A19. |
| A13 ACC 1 | Voltage of the Accelerator-Pedal 1 (Decreasing analog signal) on A13. |

### (2) Left traction inverter-slave

① Left traction master

| Function | Description |
|---|---|
| KEY VOLTAGE | Key voltage measured in real time. |
| BATTERY VOLTAGE | Battery voltage measured in real time (across the DC bus). |
| MOTOR VOLTAGE | Estimation of the DC current the inverter is drawing from the battery. |
| FREQUENCY | Frequency of the current sine-wave that the inverter is supplying to the motor. |
| MEASURED SPEED | Motor speed measured through the encoder and expressed in the same unit of FREQUENCY (Hz). |
| SLIP VALUE | Motor slip, i.e. difference between the current frequency and the motor speed (in Hz). |
| CURRENT RMS | Root-mean-square value of the line current supplied to the motor. |
| IMAX LIM. TRA | Instantaneous value of the maximum current the inverter can apply to the motor to satisfy a traction request. The value is evaluated basing on actual conditions (inverter temperature, motor temperature, etc.) |
| IMAX LIM. BRK | Instantaneous value of the maximum current the inverter can apply to the motor to satisfy a braking request. The value is evaluated basing on actual conditions (inverter temperature, motor temperature, etc.) |
| MOT. POWER WATT | Estimation of the power supplied to the motor. |
| MOTION TORQUE NM | Estimation of the motor torque. |
| DC BUS CURRENT | Estimation of the DC current the inverter is drawing from the battery. |
| BATTERY CHARGE | Estimation of the battery charge based on the battery voltage. |
| TEMPERATURE | Temperature measured on the inverter base plate. This temperature is used for the HIGH TEMPERATURE alarm. |
| MOTOR TEMPERAT. | Motor-windings temperature. This temperature is used for the MOTOR OVERTEMP alarm. |
| A4 BRAKE OIL | Status of the Brake oil SW Input on A4. |
| A5 LEVELING DIG | Status of the Tilt leveling SW input A5. |
| A19 SBR | Status of the SBR SW Input on A19. |
| A13 POT#1 | Status of the Auto tilt leveling 1 (Decreasing analog signal) input A13. |
| A6 POT#2 | Status of the Load sensor potentiometer (analog signal) input A6. |
| A3 POT#3 | Status of the Auto tilt leveling 2 (Increasing analog signal) input A6. |
| A10 POT#4 | Status of the Parking SW Input on A10. |
| A16 MAIN CONT. | Voltage applied over the main contactor coil. It corresponds to the duty cycle value of PWM applied and it is expressed in percentage. |
| CTRAP HW | This is a counter and it is showing the number of occurrences of hardware-overcurrent occurrences detection. |

② Left traction slave

| Function | Description |
|---|---|
| MEASURED SPEED | Motor speed measured through the encoder and expressed in the same unit of FREQUENCY (Hz). |
| CNA4 | Status of the Brake oil SW Input on A4. |
| CNA5 | Status of the Tilt leveling SW input A5. |
| CNA6 | Status of the Load sensor potentiometer (analog signal) input A6. |
| CNA19 | Status of the SBR SW Input on A19. |
| A13 TILT LEV 1 | Status of the Auto tilt leveling 1 (Decreasing analog signal) input A13. |

### (3) Pump inverter

① Pump master

| Function | Description |
|---|---|
| KEY VOLTAGE | Key voltage measured in real time. |
| BATTERY VOLTAGE | Battery voltage measured in real time (across the DC bus). |
| MOTOR VOLTAGE | Estimation of the DC current the inverter is drawing from the battery. |
| FREQUENCY | Frequency of the current sine-wave that the inverter is supplying to the motor. |
| MEASURED SPEED | Motor speed measured through the encoder and expressed in the same unit of FREQUENCY (Hz). |
| SLIP VALUE | Motor slip, i.e. difference between the current frequency and the motor speed (in Hz). |
| CURRENT RMS | Root-mean-square value of the line current supplied to the motor. |
| IMAX LIM. TRA | Instantaneous value of the maximum current the inverter can apply to the motor to satisfy a traction request. The value is evaluated basing on actual conditions (inverter temperature, motor temperature, etc.) |
| IMAX LIM. BRK | Instantaneous value of the maximum current the inverter can apply to the motor to satisfy a braking request. The value is evaluated basing on actual conditions (inverter temperature, motor temperature, etc.) |
| MOT. POWER WATT | Estimation of the power supplied to the motor. |
| MOTION TORQUE NM | Estimation of the motor torque. |
| DC BUS CURRENT | Estimation of the DC current the inverter is drawing from the battery. |
| BATTERY CHARGE | Estimation of the battery charge based on the battery voltage. |
| TEMPERATURE | Temperature measured on the inverter base plate. This temperature is used for the HIGH TEMPERATURE alarm. |
| MOTOR TEMPERAT. | Motor-windings temperature. This temperature is used for the MOTOR OVERTEMP alarm. |
| A4 TILT SWITCH | Status of the TILT SW Input on A4. |
| A5 AUX1 SWITCH | Status of the AUX1 SW Input on A5. |
| A11 AUX2 SWITCH | Status of the AUX2 SW Input on A11. |
| A13 LIFT CUTBACK | Status of the LIFT CUTBACK SW Input on A13. |
| A10 LIFT POT 1 | Status of the LIFT POT 2 (Decreasing analog signal) input A10. |
| A3 LIFT POT 2 | Status of the LIFT POT 1 (Increasing analog signal) input A3. |
| A19 SET EVP | This value shows the setpoint of proportional elevtrovalve (OPSS) EVP. |
| A16 MAIN CONT. | Voltage applied over the main contactor coil. It corresponds to the duty cycle value of PWM applied and it is expressed in percentage. |
| CTRAP HW | This is a counter and it is showing the number of occurrences of hardware overcurrent occurrences detection. |

② Pump slave

| Function | Description |
|---|---|
| MEASURED SPEED | Motor speed measured through the encoder and expressed in the same unit of FREQUENCY (Hz). |
| DI0-A4 | Status of the TILT SW Input on A4. |
| DI1-A5 | Status of the AUX1 SW Input on A5. |
| DI2-A11 | Status of the AUX2 SW Input on A11. |
| DI11-A13 | Status of the LIFT CUTBACK SW Input on A13. |
| A10 LIFT POT 1 | Status of the LIFT POT 2 (Decreasing analog signal) input A10. |
| A3 LIFT POT 2 | Status of the LIFT POT 1 (Increasing analog signal) input A3. |
| CTRAP THRESOLD | Threshold voltage of the hardware over current. |

### (4) EPS inverter

① EPS master

| Function | Description |
|---|---|
| FEEDBACK POT 1 | Real time analog value of input CPOT1 (A1). (STEERING AXLE SENSOR) |
| FEEDBACK POT 2 | Real time analog value of input CPOT2 (A2). (STEERING AXLE SENSOR) |
| FEEDBACK POT LIN | This reading supplies the linearized value for CPOT 1 |
| FEEDBACK ENC. | Voltage 0 to 5000mV. This is the value of the encoder counting scaled in a range 2500mV +/- 2500mV corresponding to a 0+/-180 degrees in the steered axle.<br>FEEDBACK ENC assumes 2500mV value when the encoder counting is null.<br>A steered axle angle in the range 0+/-90degrees corresponds to a FEEDBACK ENC of 2500V+/-1250mV (i.e. from 1250mV to 3750mV).<br>Adjustment SET STEER 0-POS must be set in order the encoder counting is null (and FEEDBACK ENC is 2500mV) when the steered axle is really straight ahead. |
| ENC COUNTING | Counts of the encoder vs. the straight ahead direction of the steered axle. Adjustment SET STEER 0-POS must be set in order the encoder counting is null (and FEEDBACK ENC is 2500mV) when the steered axle is really straight ahead. |
| GAP COUNT ENC FB | Gap between encoder counter and steer axle sensor. |
| ENC SPEED | This is the speed of the motor measured with the encoder on the motor shaft. |
| FREQUENCY | This is the frequency applied to the steering motor. |
| MOTOR CURRENT | Root Mean Square value of the line current in the motor. |
| IQ RMS | Root Mean Square value of the quadrature current in the motor (torque component). |
| ID RMS | Root Mean Square value of the direct current in the motor (flux component). |
| IMAX DYNAM LIMIT | Ampere value. Root Mean Square value of the motor current limitation. It changes dynamically from the absolute Imax |
| TEMPERATURE | Temperature of the controller base plate. |
| MOTOR TEMPERAT. | Temperature of the motor windings measured with the thermal sensor inside the motor and connected to CNG #7. |
| MOTOR VOLTAGE | It is a percentage. 100% means the sine waves in the motor have the maximum PWM amplitude. |
| CW LIMIT LEVEL | When the STEER ANGLE overtakes the superior limit for the steered wheel angle limitation, the steered wheel angle will be limited and CW LIMIT LEVEL turns ON (active). |
| ACW LIMIT LEVEL | When STEER ANGLE is lower than the inferior limit for the steered wheel angle limitation, the steered wheel angle will be limited and ACW LIMIT LEVEL turns ON (active). |
| TRUCK MOVING | This reading turns ON when the traction speed is not null. |
| I TFD | This is the real time measurement of the DC current [mA] in the load connected to CNA #10 (TFD COIL). |
| MOT POWER WATT | This is the real time measurement of the active power in Watts entering the motor. |
| STEER ANGLE | This reading supplies the angle of the steered axle in degrees with sign. |
| 4W RIGHT ANGLE | The right steering angle of 4 wheel truck. |
| TRUCK SPEED | This reading supplies the traction speed in percentage of the MAX SPEED TRAC |

| Function | Description |
|---|---|
| STATUS #9 | STATUS #9 is used to support the embedded troubleshooting. |
| STATUS #8 | STATUS #8 is used to support the embedded troubleshooting. |
| STATUS #7 | STATUS #7 is used to support the embedded troubleshooting. |
| STATUS #6 | STATUS #6 is used to support the embedded troubleshooting. |
| STATUS #5 | STATUS #5 is used to support the embedded troubleshooting. |
| STATUS #2 | STATUS #2 is used to support the embedded troubleshooting. |
| STATUS #1 | STATUS #1 is used to support the embedded troubleshooting. |

② EPS slave

| Function | Description |
|---|---|
| FEEDBACK POT 1 | Real time analog value of input CPOT 1 (A1). (STEERING AXLE SENSOR) |
| FEEDBACK POT 2 | Real time analog value of input CPOT 2 (A2). (STEERING AXLE SENSOR) |
| FEEDBACK POT LIN | This reading supplies the linearized value for CPOT 1 |
| FEEDBACK ENC. | Voltage 0 to 5000mV. This is the value of the encoder counting scaled in a range 2500mV +/- 2500mV corresponding to a 0+/-180 degrees in the steered axle.<br>FEEDBACK ENC assumes 2500mV value when the encoder counting is null.<br>A steered axle angle in the range 0+/-90degrees corresponds to a FEEDBACK ENC of 2500V+/-1250mV (i.e. from 1250mV to 3750mV).<br>Adjustment SET STEER 0-POS must be set in order the encoder counting is null (and FEEDBACK ENC is 2500mV) when the steered axle is really straight ahead. |
| ENC COUNTING | Counts of the encoder vs. the straight ahead direction of the steered axle. Adjustment SET STEER 0-POS must be set in order the encoder counting is null (and FEEDBACK ENC is 2500mV) when the steered axle is really straight ahead. |
| ENC SPEED | This is the speed of the motor measured with the encoder on the motor shaft. |
| FREQUENCY | This is the frequency applied to the steering motor. |
| MOTOR CURRENT | Root Mean Square value of the line current in the motor. |
| IQ RMS | Root Mean Square value of the quadrature current in the motor (torque component). |
| ID RMS | Root Mean Square value of the direct current in the motor (flux component). |
| IMAX DYNAM LIMIT | Ampere value. Root Mean Square value of the motor current limitation. It changes dynamically from the absolute Imax |
| TEMPERATURE | Temperature of the controller base plate. |
| MOTOR TEMPERAT. | Temperature of the motor windings measured with the thermal sensor inside the motor and connected to CNG #7. |
| CW LIMIT LEVEL | When the STEER ANGLE overtakes the superior limit for the steered wheel angle limitation, the steered wheel angle will be limited and CW LIMIT LEVEL turns ON (active). |
| ACW LIMIT LEVEL | When STEER ANGLE is lower than the inferior limit for the steered wheel angle limitation, the steered wheel angle will be limited and ACW LIMIT LEVEL turns ON (active). |
| TRUCK MOVING | This reading turns ON when the traction speed is not null. |
| I TFD | This is the real time measurement of the DC current [mA] in the load connected to CNA #10 (TFD COIL). |

| Function | Description |
|---|---|
| MOT POWER WATT | This is the real time measurement of the active power in Watts entering the motor. |
| STEER ANGLE | This reading supplies the angle of the steered axle in degrees with sign. |
| 4W RIGHT ANGLE | The right steering angle of 4 wheel truck |
| TRUCK SPEED | This reading supplies the traction speed in percentage of the MAX SPEED TRAC |
| STATUS #9 | STATUS #9 is used to support the embedded troubleshooting. |
| STATUS #8 | STATUS #8 is used to support the embedded troubleshooting. |
| STATUS #7 | STATUS #7 is used to support the embedded troubleshooting. |
| STATUS #6 | STATUS #6 is used to support the embedded troubleshooting. |
| STATUS #5 | STATUS #5 is used to support the embedded troubleshooting. |
| STATUS #2 | STATUS #2 is used to support the embedded troubleshooting. |
| STATUS #1 | STATUS #1 is used to support the embedded troubleshooting. |

### (5) VCM master

| Function | Description |
|---|---|
| BATTERY VOLTAGE | Battery voltage measured in real time (across the DC bus). |
| OUTPUT GROUP #1 | % value. Percentage of the maximum current applied on the output group #1 (EVP 1 and EVP 2). |
| OUTPUT GROUP #2 | % value. Percentage of the maximum current applied on the output group #2 (EVP 3 and EVP 4). |
| OUTPUT GROUP #3 | % value. Percentage of the maximum current applied on the output group #3 (EVP 5 and EVP 6). |
| OUTPUT GROUP #4 | % value. Percentage of the maximum current applied on the output group #4 (EVP 7 and EVP 8) |
| NEV2 OUTPUT | % value. Percentage of the battery voltage applied on the EV 2 |
| NEV1 OUTPUT | % value. Percentage of the battery voltage applied on the EV 1 |

### 7) GENERAL SUGGESTION FOR SAFETY

(1) Before doing any operation, ensure that the battery is disconnected.

(2) For traction applications, raise up or otherwise disable driving wheels to prevent the possibility of unexpected vehicle motion or motion in the wrong direction during initial commissioning. For hydraulic applications, open the valve to prevent the possibility of excessive pressure (in the event of a malfunction of the relief valve pressure).

(3) Take necessary precautions to not compromise safety in order to prevent injuries to personnel and damages to equipment.

(4) After operation, even with the key switch open, the internal capacitors may remain charged for some time. For safe operation onto the setup, it is recommended to disconnect the battery and to discharge the capacitors by means of a resistor of about 10~100 Ohm between +B and -B terminals of the inverter.

※ The method of discharging internal capacitor.
Bofore checking controllers, motors, cables and etc., discharge the internal capacitor in controllers by following below steps ;

① Disconnect the battery cable.

② Emergency contactor on and key on.

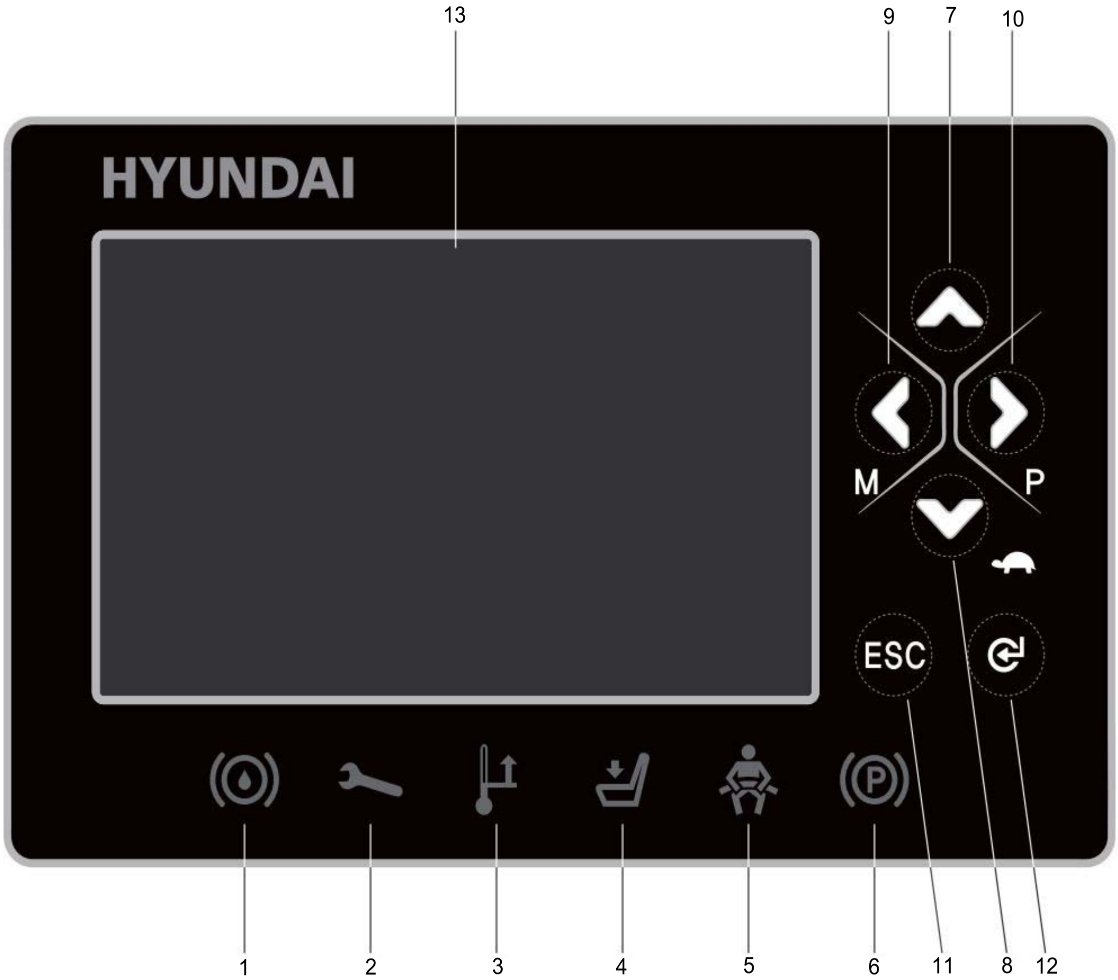
③ Wait until all warning lamps (red LED) on display become off.

④ Discharging process is finished.

## 9. INSTRUMENT PANEL : DISPLAY
(25B-9U : ~#994, 30B-9U : ~#452, 32B-9U : ~#214, 35B-9U : ~#254)

### 1) STRUCTURE

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



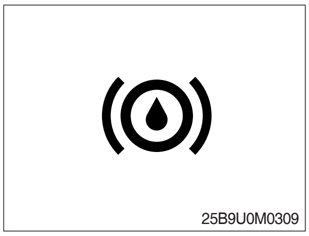

· LCD : TFT 4.3 inch IPS

25B9U0M0308

| | | | | | |
|---|---|---|---|---|---|
| 1 | Oil level warning lamp | 6 | Parking brake warning lamp | 11 | ESC button |
| 2 | Wrench warning lamp | 7 | Up button | 12 | Enter button |
| 3 | Thermometer warning lamp | 8 | Down/turtle button | 13 | LCD function |
| 4 | Seat warning lamp | 9 | Left/menu button | | |
| 5 | Seat belt warning lamp | 10 | Right/performance button | | |

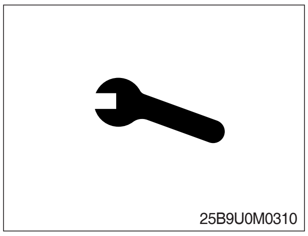
2) WARNING LAMP

(1) Brake oil level warning lamp



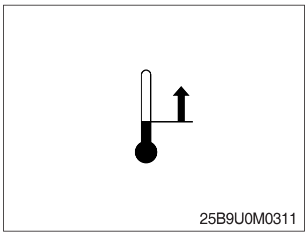

This LED lights when measured level of brake oil stored in reservoir tank is below the minimum acceptable mark.

(2) Wrench warning lamp



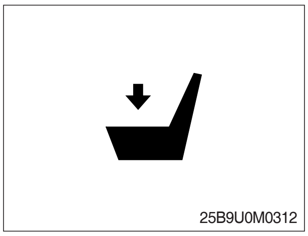

This LED lights when an electric device (controller, motor, cable, etc.) is in abnormal condition.

(3) Thermometer warning lamp



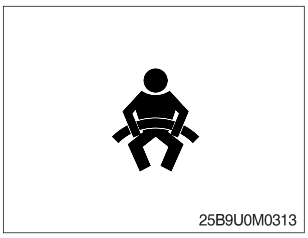

This LED lights when the controller or motor temperature is high.

(4) Seat warning lamp



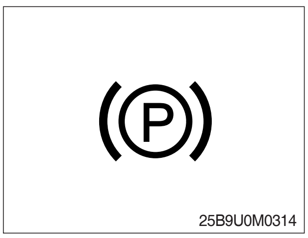

This LED lights when the operator is not on the seat.

(5) Seat belt warning lamp




(1) This LED blinks in following 2 cases.
① When operator starts the truck, LED blinks for 5 seconds, which means initial diagnosis is on going, and buttons on display will work properely just after the diagnosis is completed.
② LED blinks when the seat belt is not correctly fastened.

(6) Parking brake warning lamp




(1) This LED lights when the parking brake is activated.

3) BUTTON

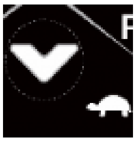
These buttons are used to select or change the menu and input value of the LCD function and display menu.

(1) Up button

25B9U0M0315

Press to select upward move.

(2) DOWN/TURTLE button




25B9U0M0316

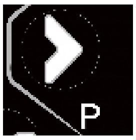
Press to select downward move.
TURTLE MODE ON/OFF

(3) LEFT/MENU button


25B9U0M0317

Press to select leftward move.
Go into the menu.

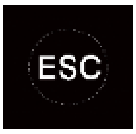
(4) RIGHT/PERFORMANCE button




25B9U0M0318

Press to select rightward move.
POWER MODE H/N/E

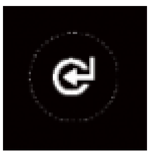
(5) Cancel (ESC) button




25B9U0M0319

Press to select cancel.
Keep pressing this button shows PASSWORD entry field.

(6) ENTER button



25B9U0M0320

Press to select Enter.

4) LCD FUNCTION


25B9U0M0321

| | | | |
|---|---|---|---|
| 1 | Current time | 6 | Hour meter |
| 2 | Turtle mode | 7 | Wheel position and running direction |
| 3 | Truck speed pointer | 8 | Power mode |
| 4 | Speed level | 9 | BDI (Battery Discharge Indicator) |
| 5 | Truck speed | 10 | Load weight (option) |

(1) Current time

The number shows the current time according to the setting, which can be changed by display setting at page 7-66.

(2) Turtle mode

The turtle symbol is normally off. When this symbol appears, the turtle mode is activated regardless of the power mode of the truck to reduce the maximum speed to the set-point. This mode can be activated by pressing the button.

(3) Truck speed pointer

The speed of the truck is indicated with a pointer.

(4) Speed level

It indicates the speed level by 2 km.

(5) Truck speed

The truck speed is shown in number. The unit can be km/h or mph according to the display setting (see 7-66 page).

(6) Hour meter

The number shows the hours worked. The letter present beside the hour meter number shows which hour meter is displayed.

– hK : the Key Hour shows the truck Key ON time;

– hT : the Traction Hour shows the Gate ON (driven) time of the traction motor.

– hP : the Pump Hour shows the Gate ON (driven) time of the pump motor.

(7) Wheel position and running direction

The arrow point is up when the truck is forward running and points down when the truck is reverse running. The arrow points the direction of the steering angle.

(8) Power mode

The letter H, N, or E, shows the power mode which is being used in the controller. The mode can be scrolled by pressing the  button sequentially. When a mode is selected, the related information will be sent via CAN-BUS to traction and pump controllers that will manage this data.

H (High) – corresponds to the highest performance

N (Normal) – corresponds to normal performance

E (Economic) – corresponds to economic performance

(9) BDI (battery's state of charge)

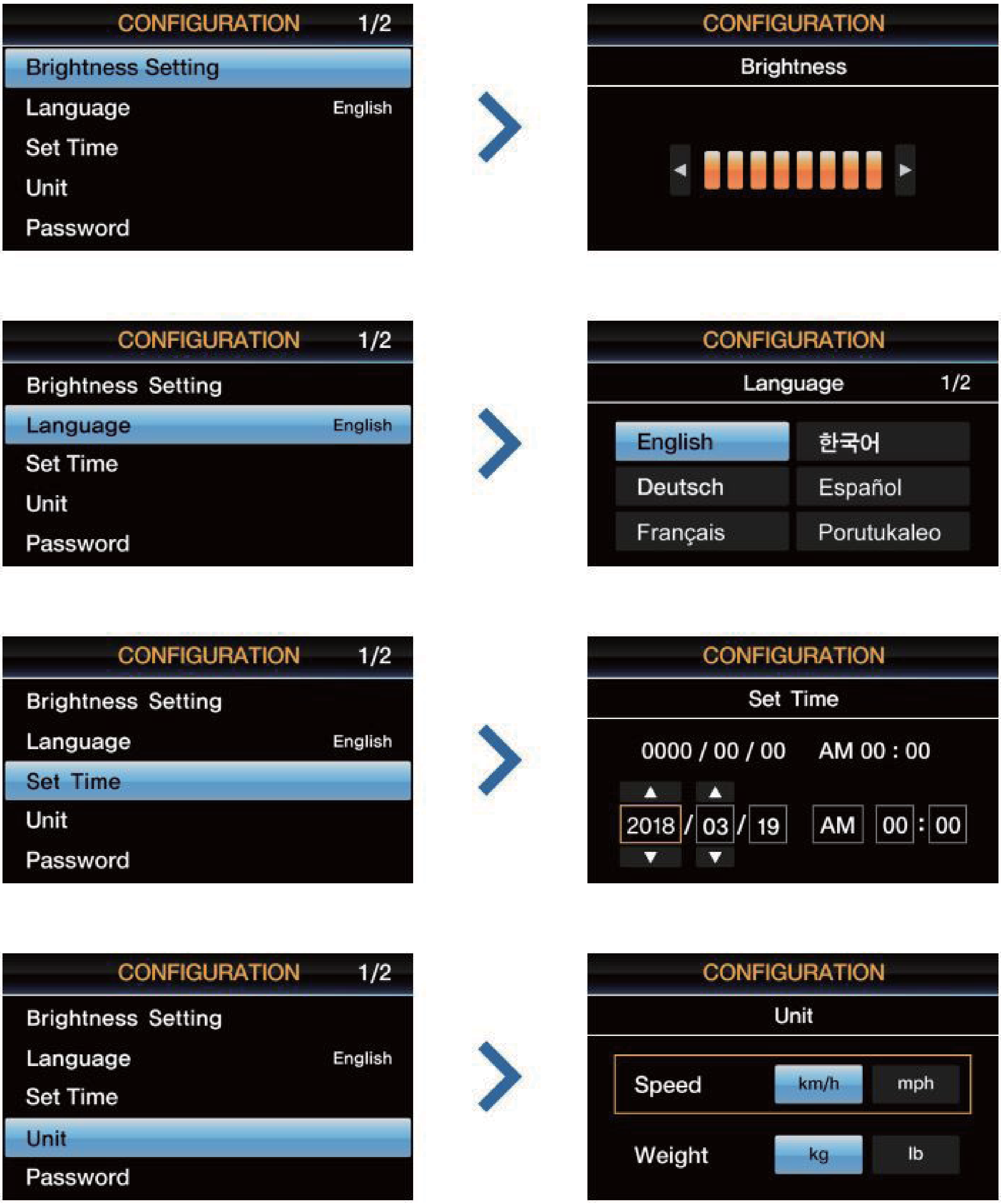
The battery's state of charge is shown by ten bars. Each bar represents the 10% of the battery charge. As the battery becomes discharged, the bars turn off progressively, one after another, in proportion to the value of the residual battery charge. When the residual battery charge is 20% or under, the bars displayed become red.

(10) Load weight (option)

The indicator shows the weight the machine carrying at load.

- Indicator range : 0~6375 kg

5) HOW TO SET THE DISPLAY MENU




25B9UOM0322


25B9UOM0323

## 6) DESCRIPTION OF THE TRUCK MENU

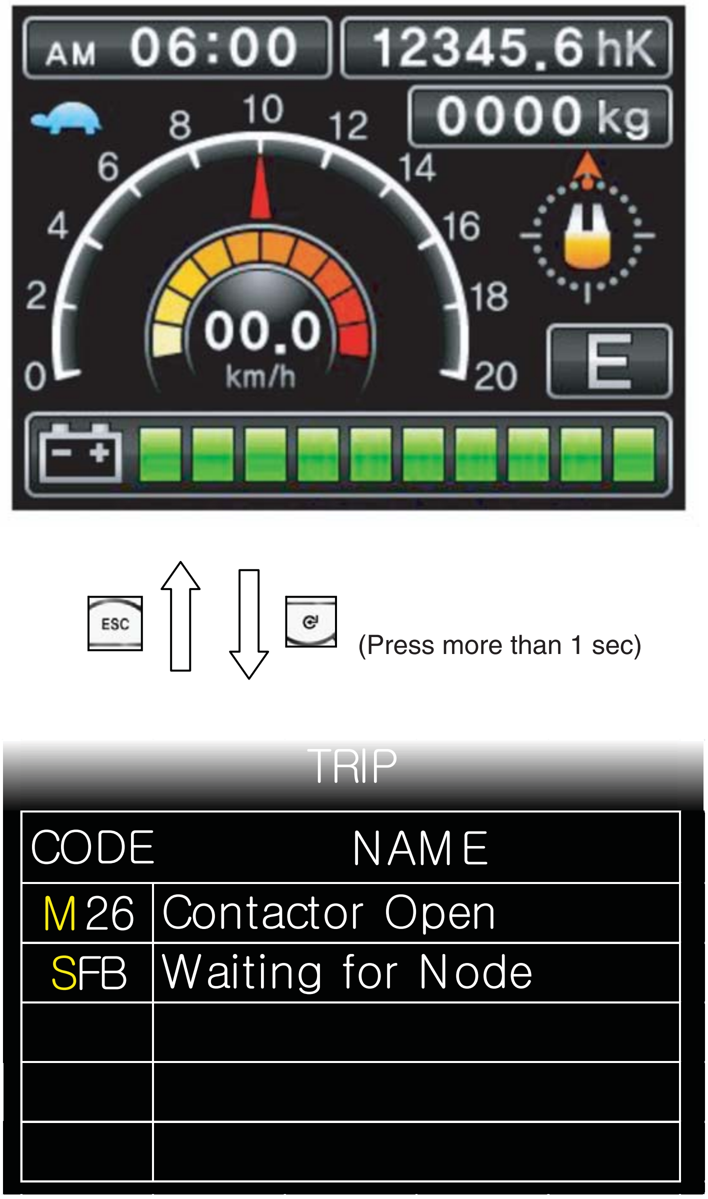
### (1) Access to truck menu

| Step | Display | Description |
|---|---|---|
| 1 |  | 1. When the vehicle key turns on, the initial screen as shown on the left appears.<br>2. Press "ESC" button for more than 1 second in the initial screen. |
| 2 |  | 1. The password input screen appears as shown on the left.<br>2. Enter the password using the "UP", "DOWN", "LEFT/MENU", "RIGHT/PERFORMANCE" buttons and press the "ENTER" button. |
| 3 |  | 1. After inputting the password, the initial screen appears as shown on the left.<br>2. Press the "LEFT / MENU" button. |
| 4 |  | 1. TRUCK MENU appears as shown on the left.<br>2. Use the "UP" and "DOWN/TURTLE" buttons to select the desired menu (HIGH-LIGHT in blue) and press the "ENTER" button to enter the menu.<br>3. To move to the upper menu, press "ESC" button to move. |

### 7) ALARM & ALARM HISTORY

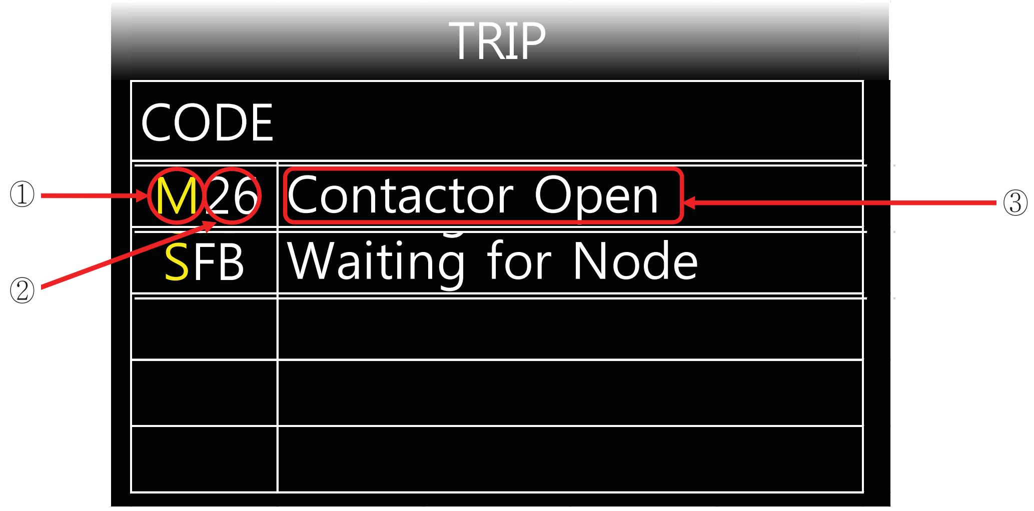
#### (1) How to check alarms

Normally, ALARM SCREEN pops up if any kind of a alarm happens, but service man can switch between a MAIN SCREEN and ALARM SCREEN with ESC , buttons as follows :




22B9EL35

(2) Detail description of ALARM SCREEN




22B9EL36

①First yellow capital letter shows in which controller the alarm happens as below;

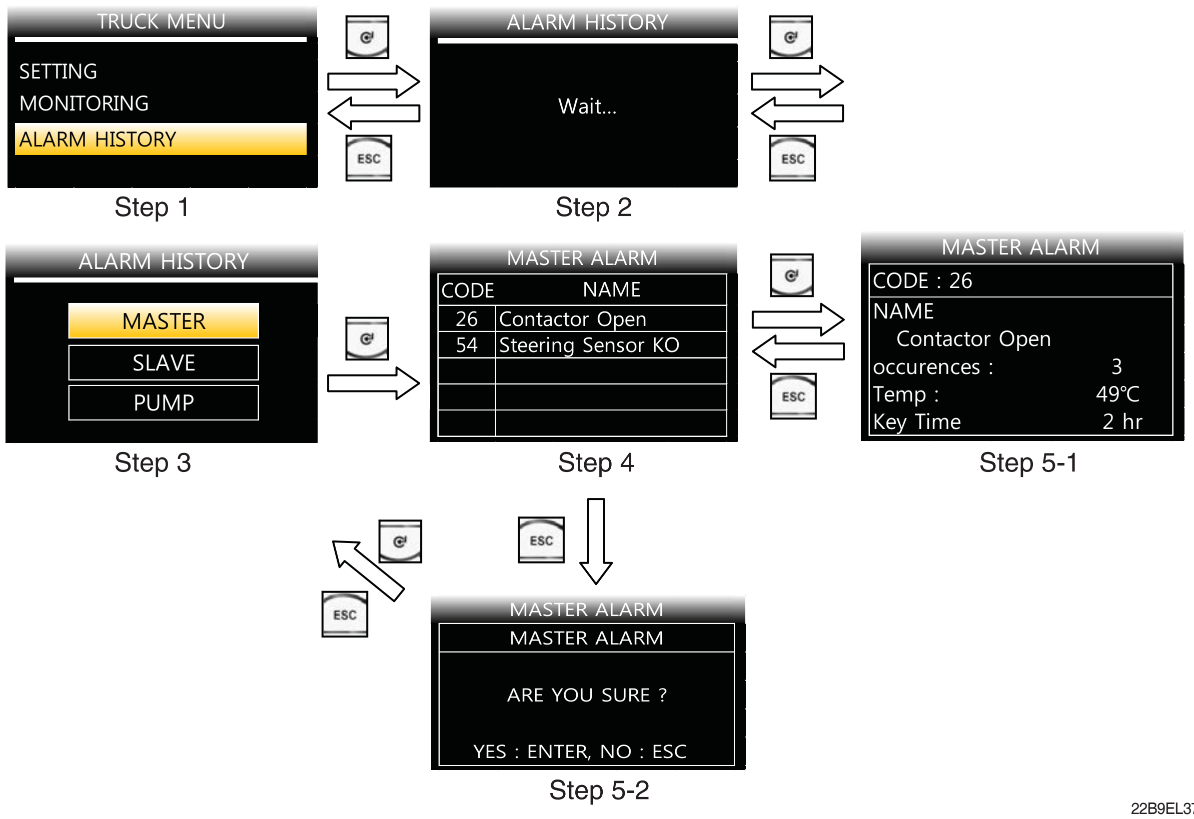
RM : Right Traction - Master
RS : Right Traction - Slave
LM : Left Traction - Master
LS : Left Traction - Slave
PM : Pump - Master
PS : Pump - Slave
EPSM : EPS - Master
EPSS : EPS - Slave
VCMM : VCM - Master
VCMS : VCM - Slave

②Following two letters or digits show alarm code. Please refer to 7. ALARM CODE (Page 7-77).

③This shows a name of ALARM. Please refer to 7. ALARM CODE (page 7-77).

(3) Alatm history

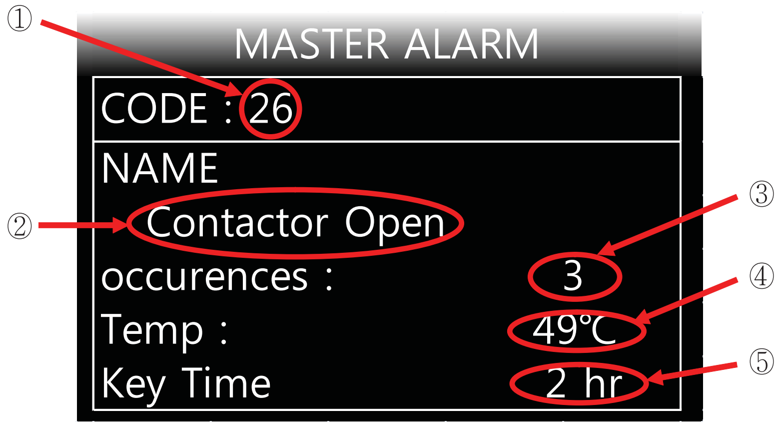
Alarm History can be looked up as follows ;




22B9EL37

① Step 1 : Service man can check the alarm history on ALARM HISTORY menu
② Step 2 : When service man enter the ALARM HISTORY menu, display read entire alarm records of all controller. So it takes 9~15 seconds to read.
③ Step 3 : When display finish to read alarm records, service man can choose each controller to read the alarm history.
④ Step 4 : When service man enters each controller's alarm history, service man can check simply up to 5 alarms and choose a specific alarm to read detail alarm information.
⑤ Step 5-1 : When service man press button at Step 4, operator can see a detail alarm information of chosen alarm. Please refer to (4) Detail alarm information (see below)
Step 5-2 : When service man press ESC button at Step 4, service man can see a alarm clear
⑥ menu. If service man press button, Recorded alarms of selected controller will be erased.
(to verify cleaned alarm records, service man should be back to Step 1 & 2 to refresh.)
If operator press ESC button, just escape to step 3 without clearing

### (4) Detail alarm information




22B9EL38

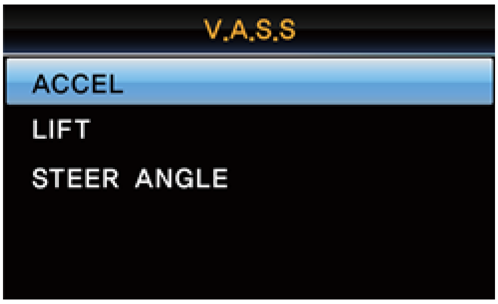
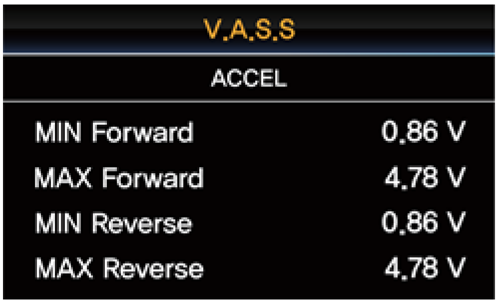
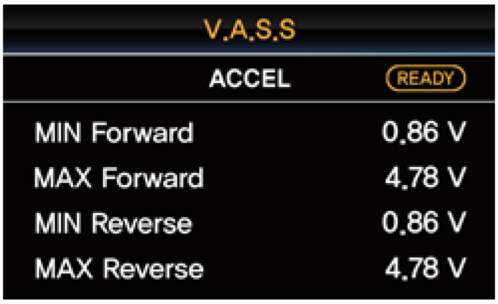
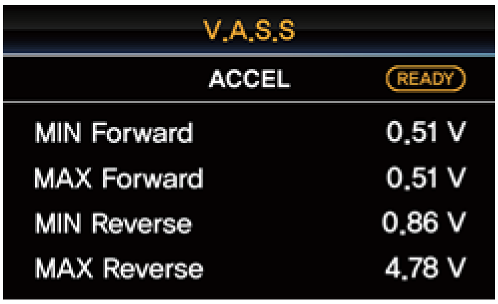
① Code of alarm
② Name of alarm
③ Count of alarm
④ Temperature of controller as alarm occurs.
⑤ Hourmeter of controller as alarm occurs.

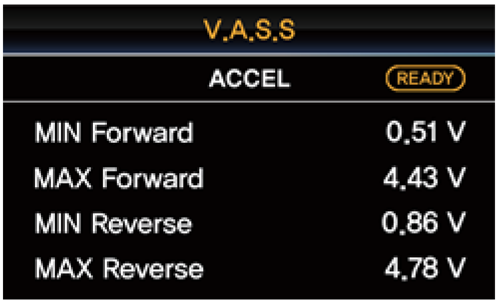
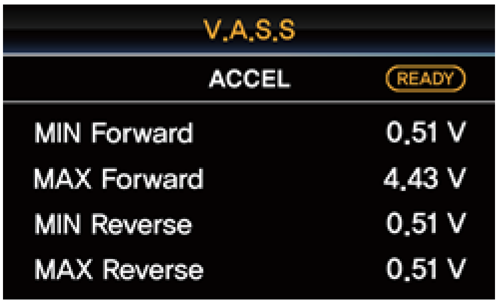
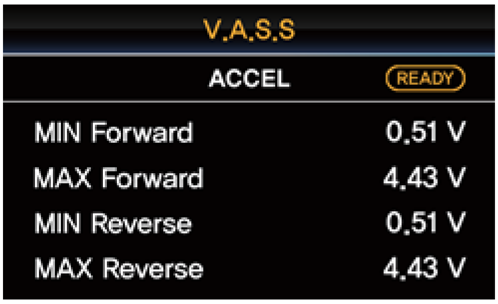
## 8) VASS SETUP USING DISPLAY MENU

This function searches and memorizes the minimum and maximum potentiometer wiper voltage of the accelerator pedal, lift lever, and steering sensor which use potentiometer sensors. The belows show how to use the VASS function of DISPLAY. (All figures in belows are just example.)

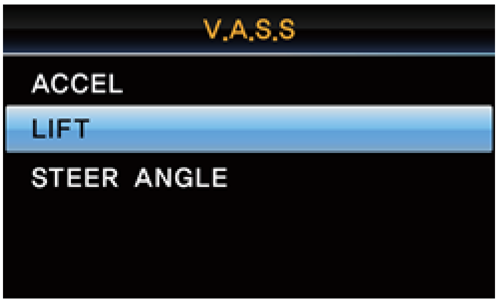
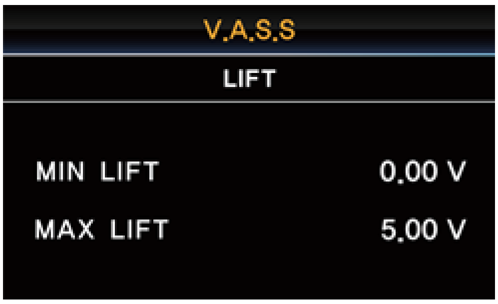
While even a motor is running, VASS can not be configurated properly, so please be sure that all motors are not running before entering configuration process & saving.

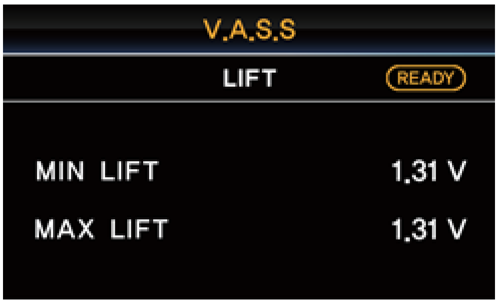
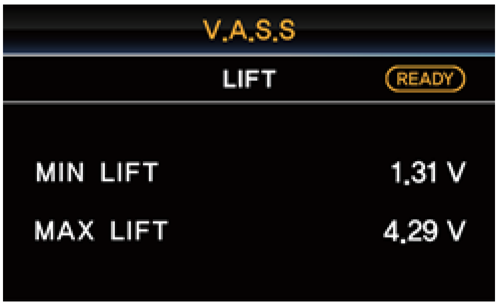
### (1) ACCEL VASS setting method

<table>
<tr><th>Step</th><th>Display</th><th>Description</th></tr>
<tr><td>1</td><td>
</td><td>1. Access the accelerator pedal setup screen via "TRUCK M ENU → S ETTING → V .A.S.S → ACCEL".</td></tr>
<tr><td>2</td><td>
</td><td>1. As shown on the left screen, the accelerator pedal setting screen appears.<br>※ Confirm that the forward / reverse gear is neutral and both the traveling and hydraulic motor are stopped.<br>2. Press the "ENTER" button to start the setting.</td></tr>
<tr><td>3</td><td>
</td><td>1. When the ready indicator appears in the upper right corner of the screen, start setting.<br>2. Place the forward / reverse gear in forward position.</td></tr>
<tr><td>4</td><td>
</td><td>1. Press the accelerator pedal all the way down and release it again</td></tr>
</table>

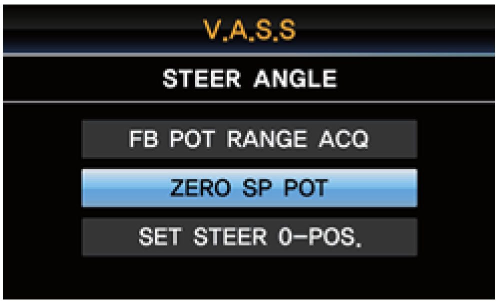
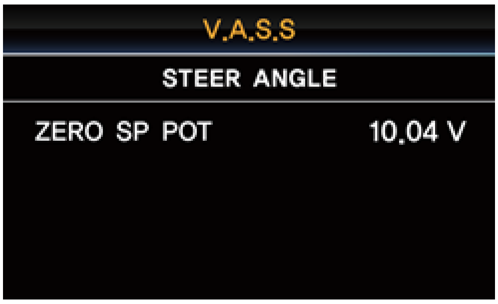
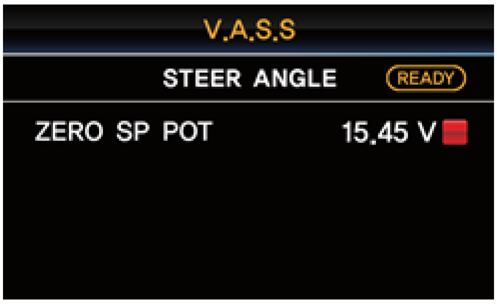
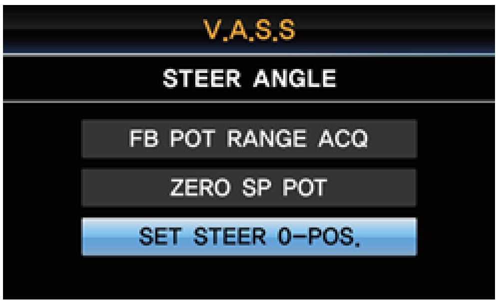
<table>
<tr><th>Step</th><th>Display</th><th>Description</th></tr>
<tr><td>5</td><td>
</td><td>1. You can see that MAX FORWARD has been changed.<br>2. Change the forward / reverse gear from forward to reverse.</td></tr>
<tr><td>6</td><td>
</td><td>1. MIN REVERSE (minimum value at backward) and MAX REVERSE (maximum value at backward) are changed to 0V ~ 0.9V state.<br>2. Place the forward / reverse gear in forward position.</td></tr>
<tr><td>7</td><td>
</td><td>1. You can see that MAX REVERSE has been changed.<br>※ Set the forward / reverse gear to neutral and check that all motors are stopped.<br>2. Press the "ENTER" button to save.</td></tr>
</table>

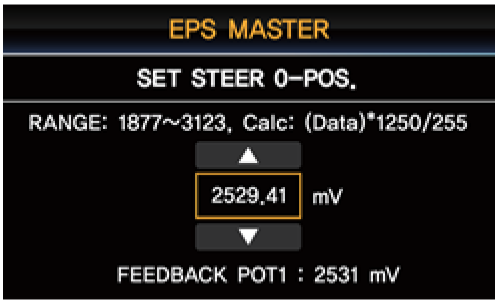
(2) LIFT VASS setting method

<table>
<tr><th>Step</th><th>Display</th><th>Description</th></tr>
<tr><td>1</td><td>
</td><td>1. Access the lift sensor setting screen via "TRUCK MENU → SETTING → V.A.S.S. → LIFT".</td></tr>
<tr><td>2</td><td>
</td><td>1. As shown on the left screen, the lift setting screen appears.<br>※ Confirm that the forward / reverse gear is neutral and both the traveling / hydraulic motor is stopped.<br>2. Press the "ENTER" button to start the setting.</td></tr>
</table>

<table>
<tr><th>Step</th><th>Display</th><th>Description</th></tr>
<tr><td>3</td><td></td><td>1. The READY indicator appears in the upper right corner of the screen, and the MIN LIFT and MAX LIFT values are aligned to the current minimum value.<br>2. Pull up the lift lever until it stops.</td></tr>
<tr><td>4</td><td></td><td>1. Pulling the LIFT LEVER all the way down will change the value when the MAX LIFT value is pulled to its maximum.<br>※ Set the forward / reverse gear to neutral and check that all motors are stopped.<br>2. Press the "ENTER" button to save.</td></tr>
</table>

## (3) STEER ANGLE VASS setting method

| Step | Display | Description |
|---|---|---|
| 1 |  | 1. Access the steering angle setting screen via "TRUCK MENU → SETTING → V.A.S.S → STEER ANGLE".<br>2. Enter the "ZERO SP POT" menu. |
| 2 |  | 1. Press the "ENTER" button on the left screen to start the setting. |
| 3 |  | 1. Position the steering wheel in the forward direction (steering knob at 8 o'clock) and press "ENTER" to save.<br> |
| 4 |  | 1. Access the steering angle setting screen via "TRUCK M ENU → SETTING → V.A.S.S. → STEER ANGLE".<br>2. Enter the "SET STEER 0-POS." menu. |
| 5 |  | ※ Make sure that the angle of the steering wheel (rear wheel) is in the complete forward direction (0.) before starting the setting.<br>1. Press the "ENTER" button on the left screen to start the setting. |

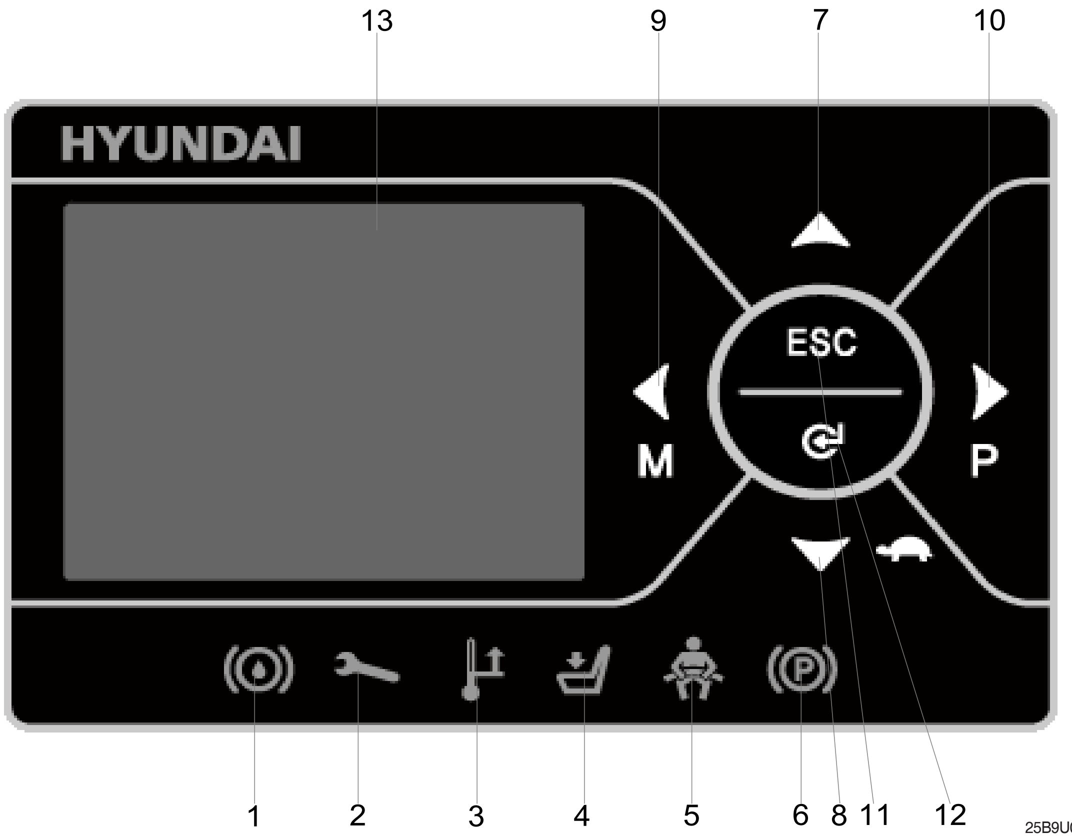
| Step | Display | Description |
| --- | --- | --- |
| 7 |  | 1. Press the "UP" and "DOWN / TURTLE" buttons to adjust the value to match the "FEEDBACK POT 1" value at the bottom of the screen and press "ENTER" to save. |

## 9. INSTRUMENT PANEL : DISPLAY

### (25B-9U : #995~, 30B-9U : #453~, 32B-9U : #215~, 35B-9U : #255~)

### 1) STRUCTURE

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



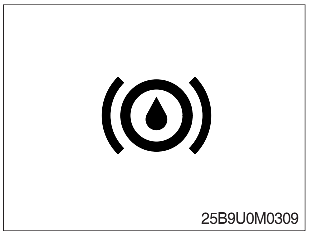

25B9U0M0308-1

· LCD : TFT 3.5 inch IPS

| | | | | | |
|---|---|---|---|---|---|
| 1 | Oil level warning lamp | 6 | Parking brake warning lamp | 11 | ESC button |
| 2 | Wrench warning lamp | 7 | Up button | 12 | Enter button |
| 3 | Thermometer warning lamp | 8 | Down/turtle button | 13 | LCD function |
| 4 | Seat warning lamp | 9 | Left/menu button | | |
| 5 | Seat belt warning lamp | 10 | Right/performance button | | |

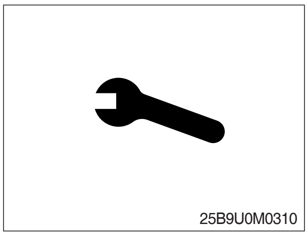
## 2) WARNING LAMP

### (1) Brake oil level warning lamp



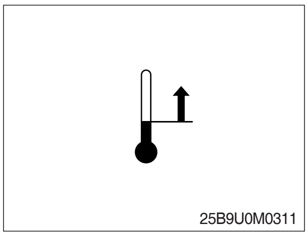

This LED lights when measured level of brake oil stored in reservoir tank is below the minimum acceptable mark.

### (2) Wrench warning lamp



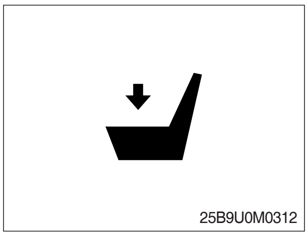

This LED lights when an electric device (controller, motor, cable, etc.) is in abnormal condition.

### (3) Thermometer warning lamp



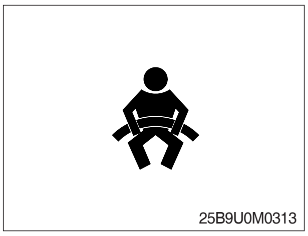

This LED lights when the controller or motor temperature is high.

### (4) Seat warning lamp



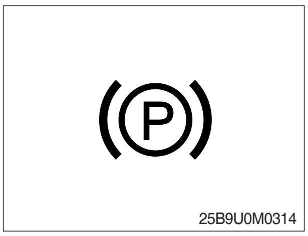

This LED lights when the operator is not on the seat.

### (5) Seat belt warning lamp




(1) This LED blinks in following 2 cases.
 ① When operator starts the truck, LED blinks for 5 seconds, which means initial diagnosis is on going, and buttons on display will work properely just after the diagnosis is completed.
 ② LED blinks when the seat belt is not correctly fastened.

### (6) Parking brake warning lamp




(1) This LED lights when the parking brake is activated.

3) BUTTON

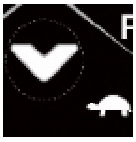
These buttons are used to select or change the menu and input value of the LCD function and display menu.

(1) Up button

25B9U0M0315

Press to select upward move.

(2) DOWN/TURTLE button



25B9U0M0316

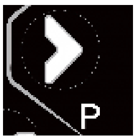
Press to select downward move.
TURTLE MODE ON/OFF

(3) LEFT/MENU button


25B9U0M0317

Press to select leftward move.
Go into the menu.

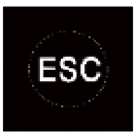
(4) RIGHT/PERFORMANCE button




25B9U0M0318

Press to select rightward move.
POWER MODE H/N/E

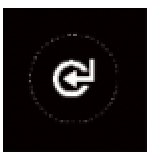
(5) Cancel (ESC) button




25B9U0M0319

Press to select cancel.
Keep pressing this button shows PASSWORD entry field.

(6) ENTER button



25B9U0M0320

Press to select Enter.

4) LCD FUNCTION


25B9U0M0321-1

1 Current time
2 Turtle mode
3 Truck speed pointer
4 Speed level
5 Truck speed
6 Hour meter
7 Wheel position & running direction
8 Power mode
9 BDI (Battery Discharge Indicator)
10 Load weight (option)

(1) Current time

The number shows the current time according to the setting, which can be changed by display setting at page 7-66.

(2) Turtle mode

The turtle symbol is normally off. When this symbol appears, the turtle mode is activated regardless of the power mode of the truck to reduce the maximum speed to the set-point. This mode can be activated by pressing the  button.

(3) Truck speed pointer

The speed of the truck is indicated with a pointer.

(4) Speed level

It indicates the speed level by 2 km.

(5) Truck speed

The truck speed is shown in number. The unit can be km/h or mph according to the display setting (see 7-66 page).

(6) Hour meter

The number shows the hours worked. The letter present beside the hour meter number shows which hour meter is displayed.

– hK : the Key Hour shows the truck Key ON time;
– hT : the Traction Hour shows the Gate ON (driven) time of the traction motor.
– hP : the Pump Hour shows the Gate ON (driven) time of the pump motor.

(7) Wheel position and running direction

The arrow point is up when the truck is forward running and points down when the truck is reverse running. The arrow points the direction of the steering angle.

(8) Power mode

The letter H, N, or E, shows the power mode which is being used in the controller. The mode can be scrolled by pressing the button sequentially. When a mode is selected, the related information will be sent via CAN-BUS to traction and pump controllers that will manage this data.

H (High) – corresponds to the highest performance
N (Normal) – corresponds to normal performance
E (Economic) – corresponds to economic performance

(9) BDI (battery's state of charge)

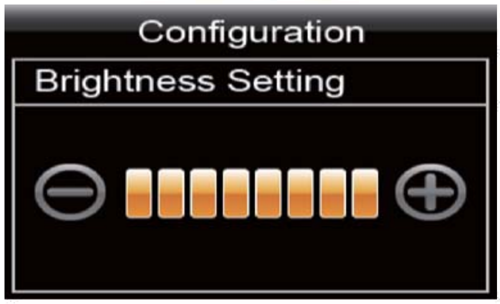
The battery's state of charge is shown by ten bars. Each bar represents the 10% of the battery charge. As the battery becomes discharged, the bars turn off progressively, one after another, in proportion to the value of the residual battery charge. When the residual battery charge is 20% or under, the bars displayed become red.

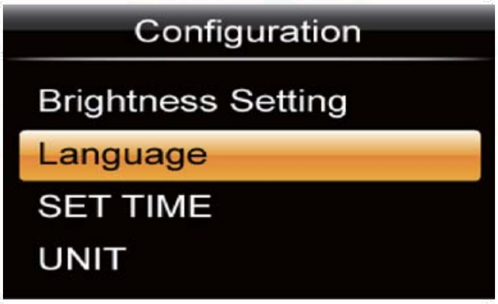
(10) Load weight (option)

The indicator shows the weight the machine carrying at load.

- Indicator range : 0~6375 kg

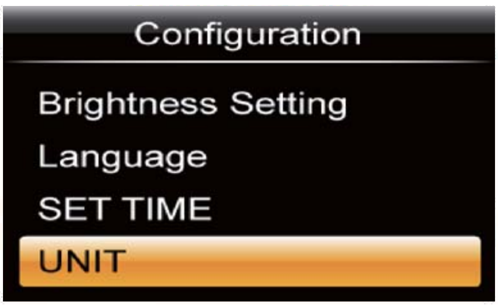
5) HOW TO SET THE DISPLAY MENU

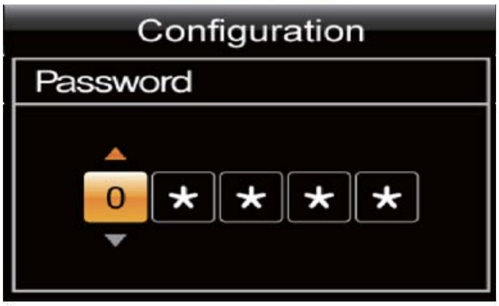






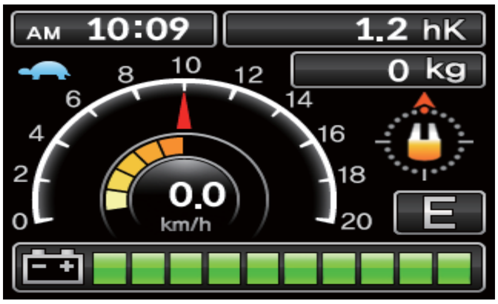
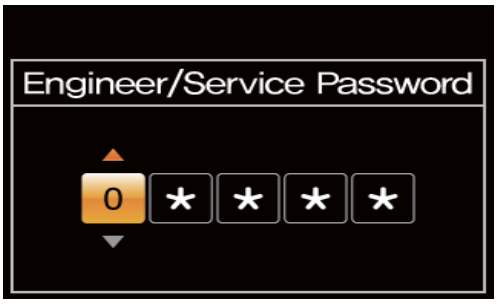
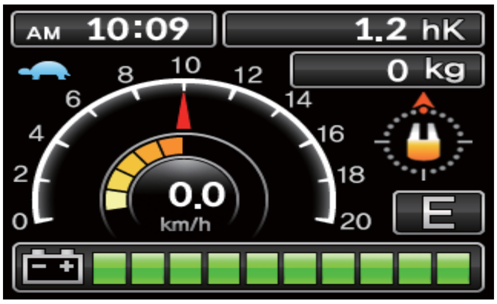
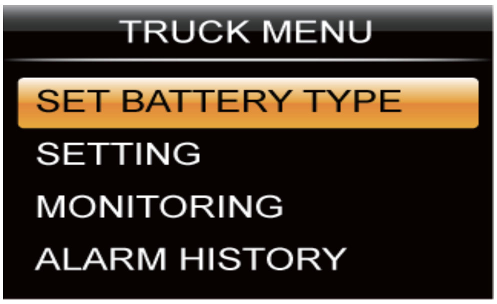


Configuration
Password
Display Version 1.0.01


Configuration
Password
0 * * * *

### 6) DESCRIPTION OF THE TRUCK MENU

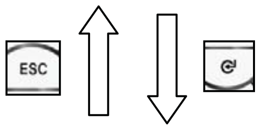
#### (1) Access to truck menu

| Step | Display | Description |
|---|---|---|
| 1 |  | 1. When the vehicle key turns on, the initial screen as shown on the left appears.<br>2. Press "ESC" button for more than 1 second in the initial screen. |
| 2 |  | 1. The password input screen appears as shown on the left.<br>2. Enter the password using the "UP", "DOWN", "LEFT/MENU", "RIGHT/PERFORMANCE" buttons and press the "ENTER" button. |
| 3 |  | 1. After inputting the password, the initial screen appears as shown on the left.<br>2. Press the "LEFT / MENU" button. |
| 4 |  | 1. TRUCK MENU appears as shown on the left.<br>2. Use the "UP" and "DOWN/TURTLE" buttons to select the desired menu (HIGH-LIGHT in orange) and press the "ENTER" button to enter the menu.<br>3. To move to the upper menu, press "ESC" button to move. |

## 7) ALARM & ALARM HISTORY

### (1) How to check alarms

Normally, ALARM SCREEN pops up if any kind of a alarm happens, but service man can switch between a MAIN SCREEN and ALARM SCREEN with ESC , buttons as follows :


(Press more than 1 sec)

(2) Detail description of ALARM SCREEN


①First yellow capital letter shows in which controller the alarm happens as below;

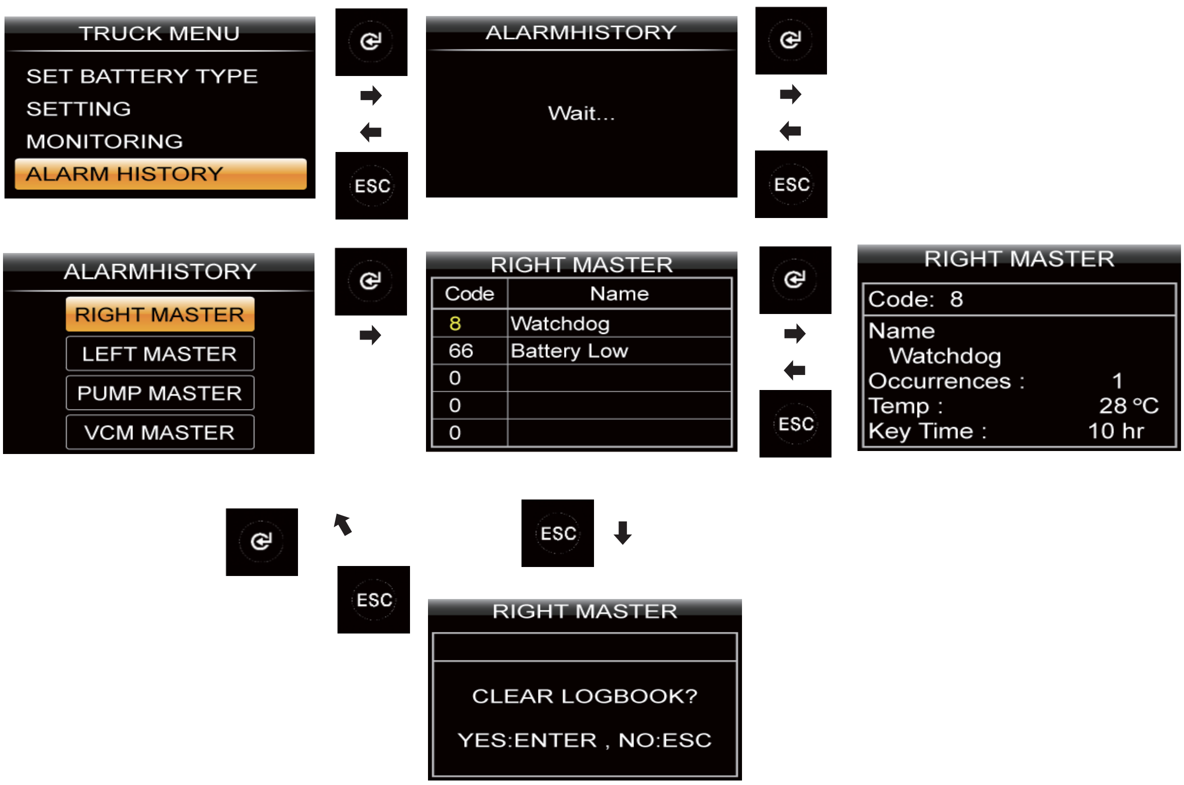
| | |
|---|---|
| RM : Right Traction - Master | PS : Pump - Slave |
| RS : Right Traction - Slave | EPSM : EPS - Master |
| LM : Left Traction - Master | EPSS : EPS - Slave |
| LS : Left Traction - Slave | VCMM : VCM - Master |
| PM : Pump - Master | VCMS : VCM - Slave |

②Following two letters or digits show alarm code. Please refer to 7. ALARM CODE (Page 7-77).

③This shows a name of ALARM. Please refer to 7. ALARM CODE (page 7-77).

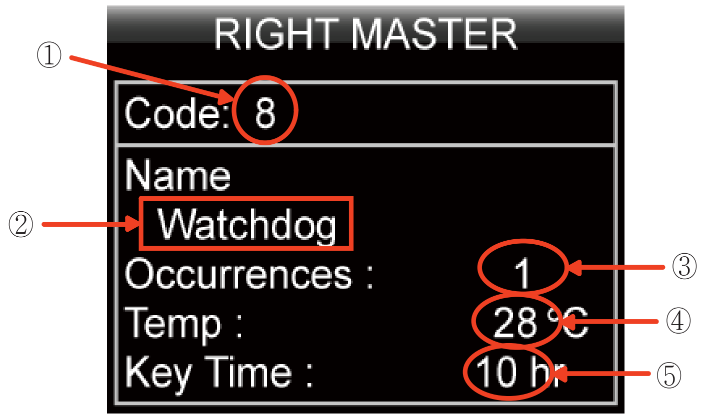
(3) Alatm history

Alarm History can be looked up as follows ;



① Step 1 : Service man can check the alarm history on ALARM HISTORY menu
② Step 2 : When service man enter the ALARM HISTORY menu, display read entire alarm records of all controller. So it takes 9~15 seconds to read.
③ Step 3 : When display finish to read alarm records, service man can choose each controller to read the alarm history.
④ Step 4 : When service man enters each controller's alarm history, service man can check simply up to 5 alarms and choose a specific alarm to read detail alarm information.
⑤ Step 5-1 : When service man press button at Step 4, operator can see a detail alarm information of chosen alarm. Please refer to (4) Detail alarm information (see below)
Step 5-2 : When service man press ESC button at Step 4, service man can see a alarm clear
⑥ menu. If service man press button, Recorded alarms of selected controller will be erased. (to verify cleaned alarm records, service man should be back to Step 1 & 2 to refresh.)
If operator press ESC button, just escape to step 3 without clearing

### (4) Detail alarm information



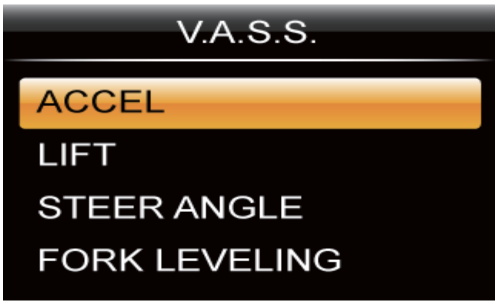
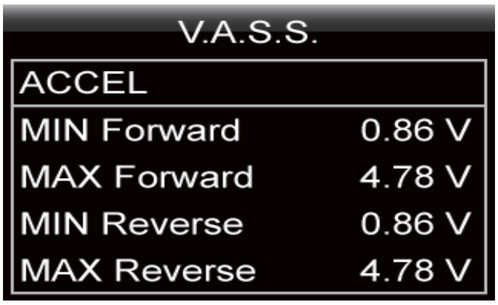
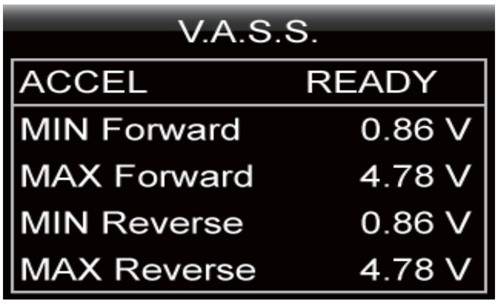
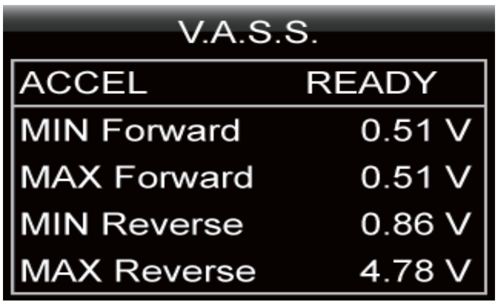

① Code of alarm
② Name of alarm
③ Count of alarm
④ Temperature of controller as alarm occurs.
⑤ Hourmeter of controller as alarm occurs.

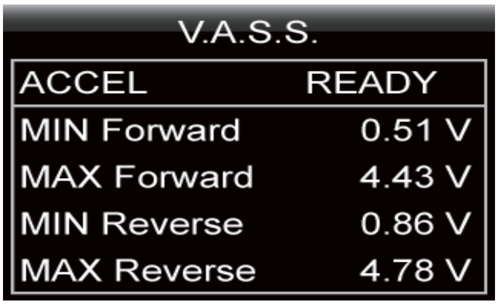
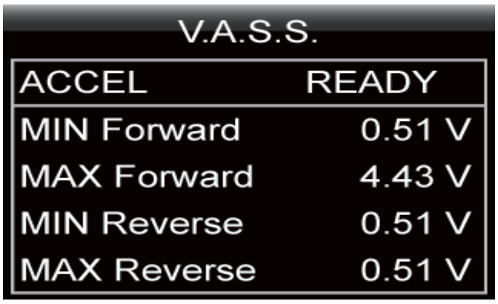
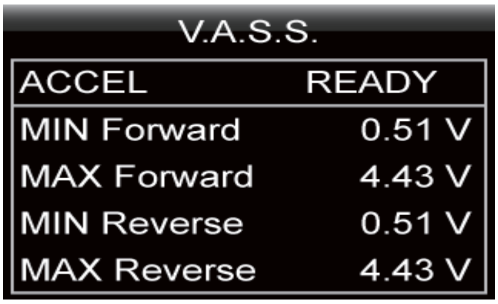
8) VASS SETUP USING DISPLAY MENU

This function searches and memorizes the minimum and maximum potentiometer wiper voltage of the accelerator pedal, lift lever, and steering sensor which use potentiometer sensors. The belows show how to use the VASS function of DISPLAY. (All figures in belows are just example.)

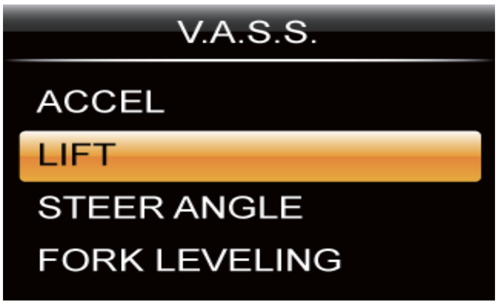
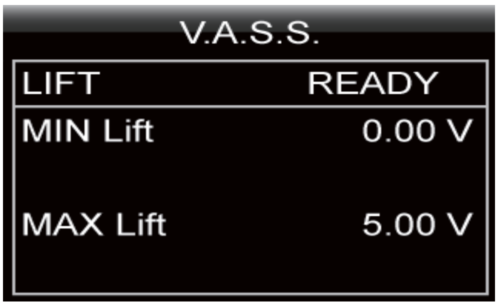
While even a motor is running, VASS can not be configurated properly, so please be sure that all motors are not running before entering configuration process & saving.

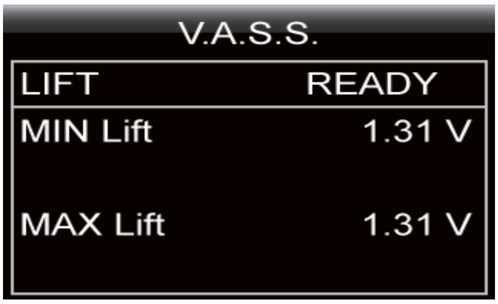
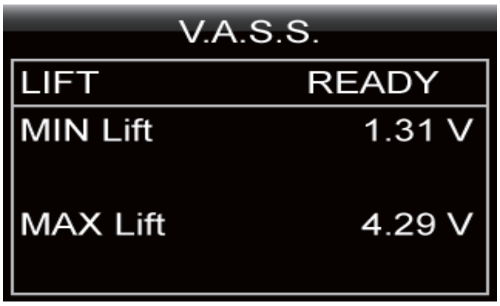
(1) ACCEL VASS setting method

| Step | Display | Description |
|---|---|---|
| 1 |  | 1. Access the accelerator pedal setup screen via "TRUCK M ENU → S ETTING → V .A.S.S → ACCEL". |
| 2 |  | 1. As shown on the left screen, the accelerator pedal setting screen appears.<br>※ Confirm that the forward / reverse gear is neutral and both the traveling and hydraulic motor are stopped.<br>2. Press the "ENTER" button to start the setting. |
| 3 |  | 1. When the ready indicator appears in the upper right corner of the screen, start setting.<br>2. Place the forward / reverse gear in forward position. |
| 4 |  | 1. Press the accelerator pedal all the way down and release it again |

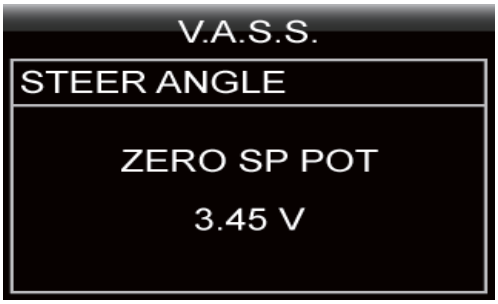
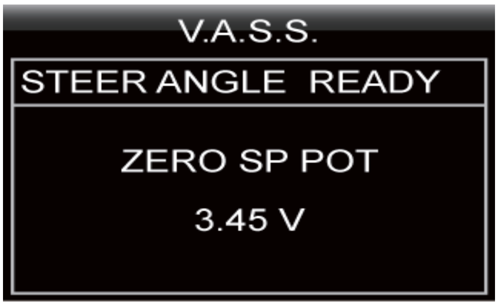
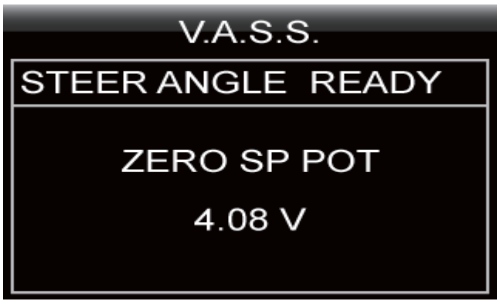
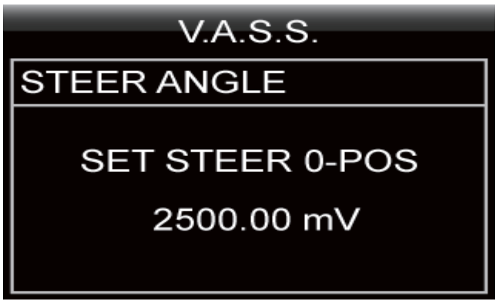
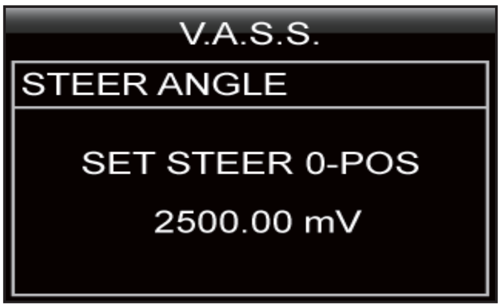
<table>
<tr><th>Step</th><th>Display</th><th>Description</th></tr>
<tr><td>5</td><td>
</td><td>1. You can see that MAX FORWARD has been changed.<br>2. Change the forward / reverse gear from forward to reverse.</td></tr>
<tr><td>6</td><td>
</td><td>1. MIN REVERSE (minimum value at backward) and MAX REVERSE (maximum value at backward) are changed to 0V ~ 0.9V state.<br>2. Place the forward / reverse gear in forward position.</td></tr>
<tr><td>7</td><td>
</td><td>1. You can see that MAX REVERSE has been changed.<br>※ Set the forward / reverse gear to neutral and check that all motors are stopped.<br>2. Press the "ENTER" button to save.</td></tr>
</table>

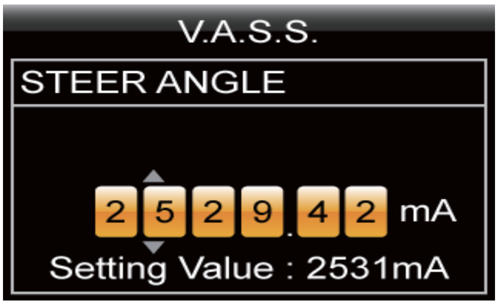
(2) LIFT VASS setting method

<table>
<tr><th>Step</th><th>Display</th><th>Description</th></tr>
<tr><td>1</td><td>
</td><td>1. Access the lift sensor setting screen via "TRUCK MENU → SETTING → V.A.S.S. → LIFT".</td></tr>
<tr><td>2</td><td>
</td><td>1. As shown on the left screen, the lift setting screen appears.<br>※ Confirm that the forward / reverse gear is neutral and both the traveling / hydraulic motor is stopped.<br>2. Press the "ENTER" button to start the setting.</td></tr>
</table>

| Step | Display | Description |
|---|---|---|
| 3 |  | 1. The READY indicator appears in the upper right corner of the screen, and the MIN LIFT and MAX LIFT values are aligned to the current minimum value.<br>2. Pull up the lift lever until it stops. |
| 4 |  | 1. Pulling the LIFT LEVER all the way down will change the value when the MAX LIFT value is pulled to its maximum.<br>※ Set the forward / reverse gear to neutral and check that all motors are stopped.<br>2. Press the "ENTER" button to save. |

(3) STEER ANGLE VASS setting method

| Step | Display | Description |
|---|---|---|
| 1 |  | 1. Access the steer angle sensor setting screen via "TRUCK MENU → SETTING → V.A.S.S. → STEER ANGLE"<br><br>2. You can see the "ZERO SP POT" screen. |
| 2 |  | 1. Press the "ENTER" button on the left screen to start the setting. |
| 3 |  | 1. Position the steering wheel in the forward direction (steering knob at 8 o'clock) and press "ENTER" to save.<br><br>2. You have to key-off and key-on the forklift after the save. |
| 4 |  | 1. Access the steer angle sensor setting screen via "TRUCK MENU -> SETTING -> V.A.S.S. -> STEER ANGLE"<br><br>2. Press the " " DOWN button.<br><br>3. You can see the "SET STEER 0-POS" screen. |
| 5 |  | ※ Make sure that the angle of the steering wheel (rear wheel) is in the complete forward direction (0.) before starting the setting.<br><br>1. Press the "ENTER" button on the left screen to start the setting. |

| Step | Display | Description |
| --- | --- | --- |
| 7 |  | 1. Press the "UP" and "DOWN / TURTLE" buttons to adjust the value to match the "Setting Value" at the bottom of the screen and press "ENTER" to save. |

## 10. ALARM CODE

### 1) TRACTION AND PUMP CONTROLLER

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 8 | WATCHDOG | O | O | Cause:<br>This is a safety related test. It is a self-diagnosis test that involves the logic between master and supervisor microcontrollers.<br>Troubleshooting:<br>This alarm could be caused by a CANbus malfunctioning, which blinds master-supervisor communication. |
| 17 | LOGIC FAILURE #3 | O | O | Cause:<br>A hardware problem in the logic board due to high currents (overload). An overcurrent condition is triggered even if the power bridge is not driven.<br>Troubleshooting:<br>The failure lies in the controller hardware. Replace the controller. |
| 18 | LOGIC FAILURE #2 | O | | Cause:<br>Fault in the hardware section of the logic board which deals with voltage feedbacks of motor phases.<br>Troubleshooting:<br>The failure lies in the controller hardware. Replace the controller. |
| 19 | LOGIC FAILURE #1 | O | O | Cause:<br>This fault is displayed when the controller detects an undervoltage condition at the KEY input (A1). Undervoltage threshold depends on the nominal voltage of the controller.<br>- Nominal voltage : 36/48V<br>- Undervoltage threshold : 10V<br>Troubleshooting (fault at startup or in standby):<br>- Fault can be caused by a key input signal characterized by pulses below the undervoltage threshold, possibly due to external loads like DC/DC converters starting-up, relays or contactors during switching periods, solenoids energizing or de-energizing. Consider to remove such loads.<br>- If no voltage transient is detected on the supply line and the alarm is present every time the key switches on, the failure probably lies in the controller hardware. Replace the logic board.<br>Troubleshooting (fault displayed during motor driving):<br>- If the alarm occurs during motor acceleration or when there is a hydraulic-related request, check the battery charge, the battery health and power-cable connections. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 30 | VMN LOW | O | | Cause 1:<br>Start-up test. Before switching the LC on, the software checks the power bridge:<br>it turns on alternatively the high-side power MOSFETs and expects the phase voltages increase toward the positive rail value. If one phase voltage is lower than a certain percentage of the rail voltage, this alarm occurs.<br><br>Cause 2:<br>Motor running test. When the motor is running, the power bridge is on and the motor voltage feedback tested; if it is lower than expected value (a range of values is considered), the controller enters in fault state.<br><br>Troubleshooting:<br>- If the problem occurs at start up (the LC does not close at all), check:<br>- Motor internal connections (ohmic continuity);<br>- Motor power-cables connections;<br>- If the motor connections are OK, the problem is inside the controller;<br>Replace it.<br>- If the alarm occurs while the motor is running, check:<br>- Motor connections;<br>- That the LC power contact closes properly, with a good contact;<br>- If no problem is found, the problem is inside the controller.<br>Replace it. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 31 | VMN HIGH | O | | Cause 1:<br>Before switching the LC on, the software checks the power bridge: it turns on alternatively the low-side power MOSFETs and expects the phase voltages decrease down to -B. If the phase voltages are higher than a certain percentage of the nominal battery voltage, this alarm occurs.<br><br>Cause 2:<br>This alarm may also occur when the start-up diagnosis has succeeded and so the LC has been closed. In this condition, the phase voltages are expected to be lower than half the battery voltage. If one of them is higher than that value, this alarm occurs.<br><br>Troubleshooting:<br>- If the problem occurs at start-up (the LC does not close), check:<br>- Motor internal connections (ohmic continuity);<br>- Motor power cables connections;<br>- If the motor connections are OK, the problem is inside the controller.<br>Replace it.<br>- If the alarm occurs while the motor is running, check:<br>- Motor connections;<br>- That the LC power contact closes properly, with a good contact;<br>- If no problem is found, the problem is inside the controller.<br>Replace it. |
| 37 | CONTACTOR CLOSED | O | | Cause:<br>Before driving the LC coil, the controller checks if the contactor is stuck. The controller drives the power bridge for several dozens of milliseconds, trying to discharge the capacitors bank. If the capacitor voltage does not decrease by more than a certain percentage of the key voltage, the alarm is raised.<br><br>Troubleshooting:<br>It is suggested to verify the power contacts of LC; if they are stuck, is necessary to replace the LC. |
| 38 | CONTACTOR OPEN | O | | Cause:<br>The LC coil is driven by the controller, but it seems that the power contacts do not close. In order to detect this condition the controller injects a DC current into the motor and checks the voltage on power capacitor. If the power capacitors get discharged it means that the main contactor is open.<br><br>Troubleshooting:<br>- LC contacts are not working. Replace the LC.<br>- If LC contacts are working correctly, contact a Hyundai dealer. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 52 | PUMP I=0 EVER | O | | Cause:<br>While truck is running, current value is 0 for more than 1 sec.<br>Remedy:<br>- Check the Main contactor<br>- Check the controller |
| 53 | STBY I HIGH | O | | Cause:<br>In standby, the sensor detects a current value different from zero.<br>Troubleshooting:<br>The current sensor or the current feedback circuit is damaged. Replace the controller. |
| 60 | CAPACITOR CHARGE | O | | Cause:<br>When the key is switched on, the inverter tries to charge the power capacitors through the series of a PTC and a power resistance, checking if the capacitors are charged within a certain timeout. If the capacitor voltage results less than a certain percentage of the nominal battery voltage, the alarm is raised and the main contactor is not closed.<br>Troubleshooting:<br>- Check if an external load in parallel to the capacitor bank, which sinks current from the capacitors-charging circuit, thus preventing the caps from charging well. Check if a lamp or a dc/dc converter or an auxiliary load is placed in parallel to the capacitor bank.<br>- The charging resistance or PTC may be broken. Insert a power resistance across line-contactor power terminals; if the alarm disappears, it means that the charging resistance is damaged.<br>- The charging circuit has a failure or there is a problem in the power section.<br>Replace the controller. |
| 62 | TH. PROTECTION | O | | Cause:<br>The temperature of the controller base plate is above 85 °C. The maximum current is proportionally decreased with the temperature excess from 85 °C up to 105 °C. At 105 °C the current is limited to 0 A.<br>Troubleshooting:<br>It is necessary to improve the controller cooling. To realize an adequate cooling in case of finned heat sink important factors are the air flux and the cooling-air temperature. If the thermal dissipation is realized by applying the controller base plate onto the truck frame, the important factors are the thickness of the frame and the planarity and roughness of its surface.<br>If the alarm occurs when the controller is cold, the possible reasons are a thermal-sensor failure or a failure in the logic board. In the last case, it is necessary to replace the controller. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 66 | BATTERY LOW | O | | Cause:<br>Parameter BATTERY CHECK is other than 0 (SET OPTION list, at page 7-34) and battery charge is evaluated to be lower than BATT.LOW TRESHLD.<br><br>Troubleshooting:<br>- Check the battery charge and charge it if necessary.<br>- If the battery is actually charged, measure the battery voltage through a voltmeter and compare it with the BATTERY VOLTAGE reading in the TESTER function. If they are different, adjust the ADJUST BATTERY parameter with the value measured through the voltmeter.<br>- If the problem is not solved, replace the logic board. |
| 74 | DRIVER SHORTED | O | | Cause:<br>The driver of the LC coil is shorted.<br><br>Troubleshooting:<br>- Check if there is a short or a low impedance pull-down between NLC (A16) and -B.<br>- The driver circuit is damaged; replace the logic board. |
| 75 | CONTACTOR DRIVER | O | | Cause:<br>The LC coil driver is not able to drive the load. The device itself or its driver circuit is damaged.<br><br>Troubleshooting:<br>This type of fault is not related to external components; replace the logic board. |
| 78 | VACC NOT OK | O | | Cause:<br>At key-on and immediately after that, the travel demands have been turned off.<br>This alarm occurs if the ACCELERATOR reading (in TESTER function) is above the minimum value acquired during the PROGRAM VACC procedure.<br><br>Troubleshooting:<br>- Check the wirings.<br>- Check the mechanical calibration and the functionality of the accelerator potentiometer.<br>- Acquire the maximum and minimum potentiometer value through the PROGRAM VACC function.<br>- If the problem is not solved, replace the logic board. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 79 | INCORRECT START | O | | Cause:<br>Incorrect starting sequence. Possible reasons for this alarm are:<br>- A travel demand active at key-on.<br>- Man-presence sensor active at key on.<br><br>Troubleshooting:<br>- Check wirings.<br>- Check microswitches for failures.<br>- Through the TESTER function, check the states of the inputs are coherent with microswitches states.<br>- If the problem is not solved, replace the logic board. |
| 80 | FORW + BACK | O | | Cause:<br>This alarm occurs when both the travel requests (FW and BW) are active at the same time.<br><br>Troubleshooting:<br>- Check that travel requests are not active at the same time.<br>- Check the FW and BW input states through the TESTER function.<br>- Check the wirings relative to the FW and BW inputs.<br>- Check if there are failures in the microswitches.<br>- If the problem is not solved, replace the logic board. |
| 82 | ENCODER ERROR | O | | Cause:<br>This fault occurs when the frequency supplied to the motor is higher than 30 Hz and the signal feedback from the encoder has a too high jump in few tens of milliseconds. This condition is related to an encoder failure.<br><br>Troubleshooting:<br>- Check the electrical and the mechanical functionality of the encoder and the wires crimping.<br>- Check the mechanical installation of the encoder, if the encoder slips inside its housing it will raise this alarm.<br>- Also the electromagnetic noise on the sensor can be the cause for the alarm. In these cases try to replace the encoder.<br>- If the problem is still present after replacing the encoder, the failure is in the controller. |
| 86 | PEDAL WIRE KO | O | | Cause:<br>Fault in accelerator negative (NPOT) input circuit<br><br>Troubleshooting: - |
| 134 | PEDAL BRAKE MISM | O★1 | | Cause:<br>BRAKE 1 and BRAKE 2 inputs have a different value.<br><br>Troubleshooting:<br>- Check the wirings. |

★1 : Traction controller only

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 135 | DISPLAY ENABLE | O | | Cause:<br>The display enable signal has not been received to operate the truck.<br>Troubleshooting: - |
| 136 | FORK POT MISM. | O | | Cause:<br>The sum of TILT LEVELING 1 and TILT LEVELING 2 input voltages do not match the supply voltage of the sensor.<br>Troubleshooting:<br>- Check the wirings.<br>- Check the tilt leveling sensor output voltages. |
| 137 | FORK S.WRONG DIR | O | | Cause:<br>Direction of “AUTO TILT LEVELING” movement is not correct.<br>Troubleshooting:<br>- Check if operator operates truck correctly.<br>- Check the Tilt Sensor of Fork leveling Option.<br>- Re-configurate Tilt Sensor of Fork leveling Option. |
| 138 | FORK S. OUT RNG. | O | | Cause:<br>Value of tilt sensor (AUTO TILT LEVELING) is out of range.<br>Troubleshooting:<br>- Check the Tilt Sensor of AUTO TILT LEVELING Option.<br>- Re-configurate Tilt Sensor of AUTO TILT LEVELING Option |
| 139 | FORK SENS LOCK | O | | Cause:<br>Value of tilt sensor (AUTO TILT LEVELING) is fixed even tilt request is activated.<br>Troubleshooting:<br>- Check the Tilt Sensor of AUTO TILT LEVELING Option.<br>- Re-configurate Tilt Sensor of AUTO TILT LEVELING Option. |
| 140 | FINGERTIPS ACQ | O | | Cause:<br>Fingertip calibration is not correct.<br>Troubleshooting:<br>- Acquire the correct value of parameters LIFT MAX, LIFT MIN, LOWER MAX, LOWER MIN, TILT UP MAX, TILT UP MIN, TILT DOWN MAX, TILT DOWN MIN, AUX1 UP MAX, AUX1 UP MIN, AUX1 DOWN MAX, AUX1 DOWN MIN, AUX2 UP MAX, AUX2 UP MIN, AUX2 DOWN MAX, AUX2 DOWN MIN |
| 141 | LOAD SENS. ERROR | O | | Cause:<br>The signal of LOAD SENSOR input is not valid.<br>Troubleshooting:<br>- Acquire the correct value of parameters ADJ MIN LOAD, ADJ REF LOAD<br>- Check the wirings. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 142 | OVERLOADED | O | | Cause:<br>The signal of LOAD SENSOR indicates a weight greater than parameter OVER LOAD WEIGHT.<br>Troubleshooting:<br>- Check if the operator operates truck correctly.<br>- Acquire the correct value of parameters ADJ MIN LOAD, ADJ REF LOAD.<br>- Verify the value of parameter OVERLOAD WEIGHT.<br>- Check the wirings. |
| 143 | FINGERTIP MISM | O | | Cause:<br>The sum of input voltages from one of the fingertip sensors do not match the supply voltage of the sensor.<br>Troubleshooting:<br>- Check the wirings.<br>- Check the fingertip sensor output voltages. |
| 144 | CAN REC VMC ERR | O | | Cause:<br>CAN communication problem with the VCM.<br>Troubleshooting:<br>- Check the CAN wirings.<br>- Verify if the VCM is off or damaged. |
| 145 | SBR S/W OPEN | O | | Cause:<br>SBR (Side Battery Removal) sensor is open.<br>Troubleshooting:<br>- To remove warning cause.<br>- Check the sensor. |
| 146 | BRAKE OIL | O | | Cause:<br>Lack of brake oil.<br>Troubleshooting:<br>Check the brake oil tank & sensor. |
| 147 | MAINT PRE WARN | O | | Cause:<br>The truck hours reached MAINT PRE WARN parameter value.<br>Troubleshooting:<br>Perform the truck maintainance and reset the alarm using MAINTEN. RESET parameter. |
| 148 | MOTOR HIGH TEMP | O | | Cause:<br>The temperature of left or right or both motors is high.<br>Troubleshooting:<br>- To remove warning cause.<br>- Check the motor temp-sensor. |
| 150 | BMS WARNING 1 | O | | Cause:<br>The battery monitoring system is in WARNING 1 status. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 151 | BMS WARNING 0 | O | | Cause:<br>The battery monitoring system is in WARNING 0 status. |
| 152 | BMS FAULT | O | | Cause:<br>The battery monitoring system is in FAULT status. |
| 153 | BMS NOT READY | O | | Cause:<br>The battery monitoring system is in BMS NOT READY status. |
| 154 | POT MISMATCH | O | | Cause:<br>The sum of ACC 1 and ACC 2 input voltages do not match the supply voltage of the sensor.<br>Troubleshooting:<br>- Check the wirings.<br>- Check the accelerator sensor output voltages. |
| 155 | WAIT MOTOR STILL | O | | Cause:<br>The controller is waiting for the motor to stop rotating. This warning can only appear in ACE 2 for brushless motors. |
| 161 | RPM HIGH | O | | Cause:<br>This alarm occurs in Gen. Set versions when the speed exceeds the threshold speed. |
| 162 | BUMPER STOP | O | | Cause:<br>The two digital inputs dedicated to the bumper functionality are high at the same time. The alarm can occur only if parameter BUMPER STOP = ON and only if ACE 2 is in CAN OPEN configuration.<br>Troubleshooting:<br>- Turn off one or both inputs dedicated to the bumper functionality.<br>- If the alarm occurs even if the inputs are in the rest position, check if the microswitches are stuck.<br>- In case the problem is not solved, replace the logic board. |
| 163 | ED SLIP MISMATCH | O | | Cause:<br>The control detects a mismatch between the expected slip and the evaluated one. This diagnostic occurs only if ED COMPENSATION = TRUE. |
| 164 | PWM ACQ. ERROR | O | | Cause:<br>This alarm occurs only when the controller is configured to drive a PMSM and the feedback sensor selected in the HARDWARE SETTINGS list is ENCODER ABI + PWM.<br>The controller does not detect correct information on PWM input at start-up.<br>Troubleshooting:<br>- Re-cycle the key.<br>- Check the sensor in order to verify that it works properly.<br>- Check the wiring.<br>- If the problem occurs permanently it is necessary to substitute logic board. |

| Code | Alarm | Master | Slave | Description |
| --- | --- | --- | --- | --- |
| 168 | SIN/COS D.ERR XX | O | | Cause:<br>This alarm occurs only when the controller is configured as PMSM and the feedback sensor selected is sin/cos. The signal coming from sin/cos sensor has a wrong direction. The hexadecimal value "XX" facilitates Hyundai dealer debugging the problem.<br>Troubleshooting:<br>- Check the wirings.<br>- If the motor direction is correct, swap the sin and cos signals.<br>- If the motor direction is not correct, swap two of the motor cables.<br>- If the problem is not solved, contact a Hyundai dealer. |
| 169 | ENCODER D.ERR XX | O | | Cause:<br>This alarm occurs only when the controller is configured as PMSM and the feedback sensor selected is the encoder. The A and B pulse sequence is not correct. The hexadecimal value "XX" facilitates Hyundai dealer debugging the problem.<br>Troubleshooting:<br>- Check the wirings.<br>- If the motor direction is correct, swap A and B signals.<br>- If the motor direction is not correct, swap two of the motor cables.<br>- If the problem is not solved, contact a Hyundai dealer. |
| 170 | WRONG KEY VOLT. | O | | Cause:<br>The measured key voltage is not the right one for the inverter.<br>Troubleshooting:<br>- Check if the SET KEY VOLTAGE parameter in the ADJUSTMENTS list is set in accordance with the key voltage.<br>- Check if the key voltage is ok using a voltmeter, if not check the wiring.<br>- In case the problem is not solved, replace the logic board. |
| 171 | ACQUIRING A.S. | O | | Cause:<br>Controller is acquiring data from the absolute feedback sensor.<br>Troubleshooting:<br>The alarm ends when the acquisition is done. |
| 172 | ACQUIRE ABORT | O | | Cause:<br>The acquiring procedure relative to the absolute feedback sensor aborted. |
| 173 | ACQUIRE END | O | | Cause:<br>Absolute feedback sensor acquired. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 175 | SPEED FB. ERROR | O | | Cause:<br>This alarm occurs if the absolute position sensor is used also for speed estimation. If signaled, it means that the controller measured that the motor was moving too quick.<br><br>Troubleshooting:<br>- Check that the sensor used is compatible with the software release.<br>- Check the sensor mechanical installation and if it works properly.<br>- Also the electromagnetic noise on the sensor can be a cause for the alarm.<br>- If no problem is found on the motor or on the speed sensor, the problem is inside the controller, it is necessary to replace the logic board. |
| 176 | HOME SENS.ERR XX | O | | Cause:<br>The controller detected a difference between the estimated absolute orientation of the rotor and the position of the index signal (ABI encoder).<br><br>It is caused by a wrong acquisition of the angle offset between the orientation of the rotor and the index signal. The hexadecimal value “XX” facilitates Hyundai dealer debugging the problem.<br><br>Troubleshooting:<br>Repeat the auto-teaching procedure. |
| 177 | COIL SHOR. EB. | O | | Cause:<br>This alarm occurs when an overload of the EB driver (output NEB A18) occurs.<br><br>Troubleshooting:<br>- Check the connections between the controller outputs and the loads.<br>- Collect information about characteristics of the coil connected to the driver and ask for assistance to a Hyundai dealer in order to verify that the maximum current that can be supplied by the hardware is not exceeded.<br>- In case no failures/problems have been found, the problem is in the controller, which has to be replaced. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 178 | MOTOR SHUTDOWN | O | | Cause:<br>The temperature sensor has overtaken the threshold defined by MOT.SHUTDOWN TEM.<br>Troubleshooting:<br>- Check the temperature read by the thermal sensor inside the motor through the MOTOR TEMPERATURE reading in the TESTER function.<br>- Check the sensor ohmic value and the sensor wiring.<br>- If the sensor is OK, improve the cooling of the motor.<br>- If the warning is present when the motor is cool, replace the controller. |
| 179 | STEER SENSOR KO | O | | Cause:<br>The voltage read by the microcontroller at the steering-sensor input is not within the STEER RIGHT VOLT ÷ STEER LEFT VOLT range, programmed through the STEER ACQUIRING function.<br>Troubleshooting:<br>- Acquire the maximum and minimum values coming from the steering potentiometer through the STEER ACQUIRING function. If the alarm is still present, check the mechanical calibration and the functionality of the potentiometer.<br>- If the problem is not solved, replace the logic board. |
| 180 | OVERLOAD | O | | Cause:<br>The motor current has overcome the limit fixed by hardware.<br>Troubleshooting:<br>If the alarm condition occurs again, ask for assistance to a Hyundai dealer. The fault condition could be affected by wrong adjustments of motor parameters. |
| 181 | WRONG ENC SET | O | | Cause:<br>Mismatch between “ENCODER PULSES 1” parameter and “ENCODER PULSES 2” parameter.<br>Troubleshooting:<br>Set the two parameters with the same value, according to the adopted encoder. |
| 186 | WAIT MOT.P STILL | O | | The controller is waiting for the motor to stop rotating. This warning can only appear in ACE 2 or ACE 3 for brushless motors. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 187 | LIFT+LOWER | O | | Cause:<br>Both the pump requests (LIFT and LOWER) are active at the same time.<br><br>Troubleshooting:<br>- Check that LIFT and LOWER requests are not active at the same time.<br>- Check the LIFT and LOWER input states through the TESTER function.<br>- Check the wirings. |
| 188 | PUMP VACC NOT OK | O | | Cause:<br>At key-on and immediately after that, the travel demands have been turned off.<br>This alarm occurs if the ACCELERATOR reading (in TESTER function) is above the minimum value acquired during the PROGRAM VACC procedure.<br><br>Troubleshooting:<br>- Check the wirings.<br>- Check the mechanical calibration and the functionality of the accelerator potentiometer.<br>- Acquire the maximum and minimum potentiometer value through the PROGRAM VACC function.<br>- If the problem is not solved, replace the logic board. |
| 189 | PUMP INC START | O | | Cause:<br>Man-presence switch is not enabled at pump request.<br><br>Troubleshooting:<br>- Check wirings.<br>- Check microswitches for failures.<br>- Through the TESTER function, check the states of the inputs are coherent with microswitches states.<br>- If the problem is not solved, replace the logic board. |
| 192 | FORK S.WRONG DIR | | O | Cause:<br>TILT LEVELING input is ON and the TILT LEVELING analog sensor output is not moving to the center values direction.<br><br>Troubleshooting:<br>- Release TILT LEVEL command.<br>- Check wirings and TILT LEVELING sensor. |
| 193 | FORK S. OUT RNG. | | O | Cause:<br>TILT LEVELING input is outside admitted range.<br><br>Troubleshooting:<br>- Acquire the correct value of parameters FORK LEVEL MIN, FORK LVL CENTER, FORK LEVEL MAX.<br>- Check wirings and TILT LEVELING sensor. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 194 | FORK SENS LOCK | | O | Cause:<br>TILT LEVELING sensor is frozen (stuck) more than 1.5sec at the correct direction movement.<br><br>Troubleshooting:<br>- Release the tilt leveling command.<br>- Check if the tilt function is working correctly or if it is mechanically locked.<br>- Check wirings and TILT LEVELING sensor. |
| 195 | FINGERTIPS ACQ | | O | Cause:<br>Fingertip calibration is not correct.<br><br>Troubleshooting:<br>- Acquire the correct value of parameters LIFT MAX, LIFT MIN, LOWER MAX, LOWER MIN, TILT UP MAX, TILT UP MIN, TILT DOWN MAX, TILT DOWN MIN, AUX1 UP MAX, AUX1 UP MIN, AUX1 DOWN MAX, AUX1 DOWN MIN, AUX2 UP MAX, AUX2 UP MIN, AUX2 DOWN MAX, AUX2 DOWN MIN |
| 196 | MOT.PHASE SH. | O | | Cause:<br>Short circuit between two motor phases. The hexadecimal value “XX” identifies the shorted phases:<br>36: U – V short circuit<br>37: U – W short circuit<br>38: V – W short circuit<br><br>Troubleshooting:<br>- Verify the motor phases connection on the motor side.<br>- Verify the motor phases connection on the inverter side.<br>- Check the motor power cables.<br>- Replace the controller.<br>- If the alarm does not disappear, the problem is in the motor. Replace it. |
| | LOAD SENS. ERROR | | O | Cause:<br>The signal of LOAD SENSOR input is not valid.<br><br>Troubleshooting:<br>- Acquire the correct value of parameters ADJ MIN LOAD, ADJ REF LOAD<br>- Check the wirings. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 197 | WRONG SLAVE VER. | O | | Cause:<br>Wrong software version on supervisor uC.<br>Troubleshooting:<br>Upload the correct software version or ask for assistance to a Hyundai dealer. |
| | OVERLOADED | | O | Cause:<br>The signal of LOAD SENSOR indicates a weight greater than parameter OVER LOAD WEIGHT.<br>Troubleshooting:<br>- Check if the operator operates truck correctly.<br>- Acquire the correct value of parameters ADJ MIN LOAD, ADJ REF LOAD.<br>- Verify the value of parameter OVERLOAD WEIGHT.<br>- Check the wirings. |
| 198 | M/S PAR CHK MISM | O | | Cause:<br>At start-up there is a mismatch in the parameter checksum between the master and the supervisor microcontrollers.<br>Troubleshooting:<br>Restore and save again the parameters list. |
| 199 | PARAM TRANSFER | O | | Cause:<br>Master uC is transferring parameters to the supervisor.<br>Troubleshooting:<br>Wait until the end of the procedure. If the alarm remains longer, re-cycle the key. |
| | BUMPER STOP | | O | Cause<br>The two digital inputs dedicated to the bumper functionality are high at the same time. The alarm can occur only if parameter BUMPER STOP = ON and only if ACE 2 is in CAN OPEN configuration.<br>Troubleshooting<br>- Turn off one or both inputs dedicated to the bumper functionality.<br>- If the alarm occurs even if the inputs are in the rest position, check if the microswitches are stuck.<br>- In case the problem is not solved, replace the logic board. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 200 | VDC OFF SHORTED | O | | Cause:<br>The logic board measures a voltage value across the DC-link that is constantly out of range, above the maximum allowed value.<br>Troubleshooting:<br>- Check that the battery has the same nominal voltage of the inverter.<br>- Check the battery voltage, if it is out of range replace the battery.<br>- If the battery voltage is ok, replace the logic board. |
| | STEER SENSOR KO | | O | Cause:<br>The voltage read by the microcontroller at the steering-sensor input is not within the STEER RIGHT VOLT ÷ STEER LEFT VOLT range, programmed through the STEER ACQUIRING function.<br>Troubleshooting:<br>- Acquire the maximum and minimum values coming from the steering potentiometer through the STEER ACQUIRING function. If the alarm is still present, check the mechanical calibration and the functionality of the potentiometer.<br>- If the problem is not solved, replace the logic board. |
| 201 | TORQUE PROFILE | O | | Cause:<br>There is an error in the choice of the torque profile parameters.<br>Troubleshooting:<br>Check in the HARDWARE SETTINGS list the value of those parameters. |
| | WRONG ENC SET | | O | Cause:<br>Mismatch between “ENCODER PULSES 1” parameter and “ENCODER PULSES 2” parameter.<br>Troubleshooting:<br>Set the two parameters with the same value, according to the adopted encoder. |

<table>
<tr><th>Code</th><th>Alarm</th><th>Master</th><th>Slave</th><th>Description</th></tr>
<tr><td>202</td><td>VDC LINK OVERV.</td><td>O</td><td>O</td><td>Cause:<br>This fault is displayed when the controller detects an overvoltage condition.<br>Overvoltage threshold depends on the nominal voltage of the controller.<br><table><tr><th>Nominal voltage</th><th>24V</th><th>36/48V</th><th>72/80V</th><th>96V</th></tr><tr><td>Overvoltage threshold</td><td>35V</td><td>65V</td><td>115V</td><td>130V</td></tr></table><br>As soon as the fault occurs, power bridge and MC are opened. The condition is triggered using the same HW interrupt used for undervoltage detection, uC discerns between the two evaluating the voltage present across DC-link capacitors:<br>- High voltage Overvoltage condition<br>- Low/normal voltage Undervoltage condition<br><br>Troubleshooting:<br>If the alarm happens during the brake release, check the line contactor contact and the battery power-cable connection.</td></tr>
<tr><td>204</td><td>BRAKE RUN OUT</td><td>O</td><td></td><td>Cause:<br>The CPOT BRAKE input read by the microcontroller is out of the range defined by parameters SET PBRK. MIN and SET PBRK. MAX.<br><br>Troubleshooting:<br>- Check the mechanical calibration and the functionality of the brake potentiometer.<br>- Acquire the minimum and maximum potentiometer values.<br>- If the alarm is still present, replace the logic board.</td></tr>
<tr><td>205</td><td>EPS RELAY OPEN</td><td>O</td><td></td><td>Cause:<br>The controller receives from EPS information about the safety contacts being open.<br><br>Troubleshooting:<br>Verify the EPS functionality.</td></tr>
</table>

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 206 | INIT VMN HIGH | O | | Cause:<br>Before closing the LC, the software checks the power-bridge voltage without driving it. The software expects the voltage to be in a "steady state" value.<br>If it is too high, this alarm occurs. The hexadecimal value "XX" identifies the faulty phase:<br>81: phase U<br>82: phase V<br>83: phase W<br>Troubleshooting:<br>- Check the motor power cables.<br>- Check the impedance between U, V and W terminals and -B terminal of the controller.<br>- Check the motor leakage to truck frame.<br>- If the motor connections are OK and there are no external low impedance paths, the problem is inside the controller. Replace it. |
| 207 | INIT VMN LOW | O | | Cause:<br>Before closing the LC, the software checks the power-bridge voltage without driving it. The software expects the voltage to be in a "steady state" value. If it is too low, this alarm occurs. The hexadecimal value "XX" identifies the faulty phase:<br>01: phase U<br>02: phase V<br>03: phase W<br>Troubleshooting:<br>- Check the motor power cables.<br>- Check the impedance between U, V and W terminals and -B terminal of the controller.<br>- Check the motor leakage to truck frame.<br>- If the motor connections are OK and there are no external low impedance paths, the problem is inside the controller. Replace it. |
| 208 | EEPROM KO | O | O | Cause:<br>A HW or SW defect of the non-volatile embedded memory storing the controller parameters. This alarm does not inhibit the machine operations, but it makes the truck to work with the default values.<br>Troubleshooting:<br>Execute a CLEAR EEPROM procedure (refer to the Console manual). Switch the key off and on to check the result. If the alarm occurs permanently, it is necessary to replace the controller. If the alarm disappears, the previously stored parameters will be replaced by the default parameters. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 209 | PARAM RESTORE | O | O | Cause:<br>This is a confirmation that a clear eeprom parameter was correctly performed.<br>Troubleshooting:<br>Recycle the key. |
| 210 | WRONG RAM MEM. | O | O | Cause:<br>Deterministic Finite Automaton (DFA) is characterized by state transitions. As a protective measure any state transition is commanded by assigning two variables (state label and its complement). These two variables identify the new state (redundancy in the state label). This redundancy has been thought in order to avoid that a failure in the RAM memory leads to a wrong destination state for the DFAs. In case the two state labels are inconsistent or not complemented in between, this alarm occurs.<br>Troubleshooting:<br>If it is repetitive, it reports a problem in the controller. |
| 211 | STALL ROTOR | O | | Cause:<br>The traction rotor is stuck or the encoder signal is not correctly received by the controller.<br>Troubleshooting:<br>- Check the encoder condition.<br>- Check the wiring.<br>- Through the TESTER function, check if the sign of REQUENCY and ENCODER are the same and if they are different from zero during a traction request.<br>- If the problem is not solved, replace the logic board. |
| | BMS NOT READY | | O | Cause:<br>The battery monitoring system is in BMS NOT READY status. |
| 212 | POWER MISMATCH | O | | Cause :<br>The error between the power setpoint and the estimated power is out of range.<br>Troubleshooting :<br>Ask for assistance to a Hyundai dealer about the correct adjustment of the motor parameters. |
| | W.SET. TG-EB XX | | O | Cause:<br>Supervisor microcontroller has detected that the master microcontroller has imposed a wrong setpoint for TG or EB output.<br>Troubleshooting:<br>- Check the matching of the parameters between master and supervisor.<br>- Ask for the assistance of a Hyundai dealer.<br>- If the problem is not solved, replace the logic board. |

<table>
<tr><th>Code</th><th>Alarm</th><th>Master</th><th>Slave</th><th>Description</th></tr>
<tr><td rowspan="2">213</td><td>POSITIVE LC OPEN</td><td>O</td><td></td><td>Cause<br>The positive voltage of LC is different from expected.<br><br>Troubleshooting<br>- Verify LC coil is properly connected.<br>- Verify CONF. POSITIVE LC parameter is set in accordance with the actual coil positive supply. Software, depending on the parameter value, makes a proper diagnosis; a mismatch between the hardware and the parameter configuration could generate a false fault.<br>- In case no failures/problems have been found, the problem is in the controller, which has to be replaced.</td></tr>
<tr><td>INPUT MISMATCH</td><td></td><td>O</td><td>Cause:<br>The supervisor microcontroller records different input values with respect to the master microcontroller.<br><br>Troubleshooting:<br>- Compare the values read by master and slave through the TESTER function.<br>- Ask for the assistance to a Hyundai dealer.<br>- If the problem is not solved, replace the logic board.</td></tr>
<tr><td>214</td><td>EVP COIL OPEN</td><td>O</td><td></td><td>Cause:<br>No load is connected between the NEVP output (A19) and the electrovalve positive terminal.<br><br>Troubleshooting:<br>- Check the EVP condition.<br>- Check the EVP wiring.<br>- If the problem is not solved, replace the logic board.</td></tr>
<tr><td>215</td><td>EVP DRIV. SHORT.</td><td>O</td><td></td><td>Cause:<br>- The EVP driver (output A19) is shorted.<br>- The microcontroller detects a mismatch between the valve set-point and the feedback of the EVP output.<br><br>Troubleshooting:<br>- Check if there is a short circuit or a low-impedance conduction path between the negative of the coil and -B.<br>- Collect information about:<br>· The voltage applied across the EVP coil.<br>· The current in the coil.<br>· Features of the coil.<br>Ask for assistance to Zapi in order to verify that the software diagnoses are in accordance with the type of coil employed.<br>- If the problem is not solved, it could be necessary to replace the controller.</td></tr>
</table>

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 216 | EB. COIL OPEN | O | | Cause:<br>This fault appears when no load is connected between the NEB output (A18) and the EB positive terminal PCOM (A17).<br>Troubleshooting:<br>- Check the EB coil.<br>- Check the wiring.<br>- If the problem is not solved, replace the logic board. |
| 217 | PEV NOT OK | O | | Cause:<br>Terminal PCOM is not connected to the battery or the voltage is different from that defined by parameter SET POSITIVE PEB. This alarm can occur if output NAUX 1 is present (and the related setting is active) or the AUX OUT function is active.<br>Troubleshooting:<br>- Check PCOM terminal: it must be connected to the battery voltage (after the main contactor).<br>- Set the nominal PCOM voltage in parameter SET POSITIVE PEB in ADJUSTMENTS list. |
| | BMS FAULT | | O | Cause:<br>The battery monitoring system is in FAULT status. |
| 218 | SENS MOT TEMP KO | O | | Cause:<br>The output of the motor thermal sensor is out of range.<br>Troubleshooting:<br>- Check if the resistance of the sensor is what expected measuring its resistance.<br>- Check the wiring.<br>- If the problem is not solved, replace the logic board. |
| 219 | PEB-PEVP NOT OK | O★2 | | Cause:<br>Terminal PEB is not connected to the battery or the voltage is different from that defined by parameter SET POSITIVE PEB.<br>Troubleshooting:<br>- Check PEB terminal: it must be connected to the battery voltage (after the main contactor).<br>- Set the nominal PEB voltage in parameter SET POSITIVE PEB |
| 220 | VKEY OFF SHORTED | O | | Cause:<br>At key-on, the logic board measures a voltage value of the KEY input that is constantly out of range, above the maximum allowed value.<br>Troubleshooting:<br>- Check that the battery has the same nominal voltage of the inverter.<br>- Check the battery voltage, if it is out of range replace the battery.<br>- In case the problem is not solved, replace the logic board. |

★2 : pump controller only

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 221 | EPS OPEN | | O | Cause:<br>The EPS is in alarm state. |
| 222 | SEAT MISMATCH | O | | Cause:<br>This alarm can appear only in a Traction + Pump configuration or in a multi-motor one.<br>There is an input mismatch between the traction controller and the pump controller relatively to the TILLER/SEAT input (A6): the two values recorded by the two controllers are different.<br>Troubleshooting:<br>- Check if there are wrong connections in the external wiring.<br>- Using the TESTER function, verify that the seat inputs are in accordance with the actual state of the external switch.<br>- In case no failures/problems have been found, the problem is in the controller, which has to be replaced. |
| 223 | COIL SHOR. MC | O | | Cause:<br>This alarm occurs when an overload of the MC driver (output NMC A16) occurs.<br>Troubleshooting:<br>- Check the connections between the controller outputs and the loads.<br>- Collect information about characteristics of the coil connected to the driver and ask for assistance to a Hyundai dealer in order to verify that the maximum current that can be supplied by the hardware is not exceeded.<br>- In case no failures/problems have been found, the problem is in the controller, which has to be replaced. |
| 224 | WAITING FOR NODE | O | | Cause:<br>The controller receives from the CANbus the message that another controller in the net is in fault condition; as a consequence the controller itself cannot enter into an operative status, but it has to wait until the other node comes out from the fault status.<br>Troubleshooting:<br>Check if any other device on the CANbus is in fault condition. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 226 | VACC OUT RANGE | O | | Cause:<br>- The CPOT input read by the microcontroller is not within the MIN VACC ÷ MAX VACC range, programmed through the PROGRAMM VACC function.<br>- The acquired values MIN VACC and MAX VACC are inconsistent.<br>Troubleshooting:<br>- Acquire the maximum and minimum potentiometer values through the PROGRAM VACC function. If the alarm is still present, check the mechanical calibration and the functionality of the accelerator potentiometer.<br>- If the problem is not solved, replace the logic board. |
| 227 | HW FAULT | O | | Cause:<br>At start-up, some hardware circuit intended to enable and disable the power bridge or the LC driver (output A16) is found to be faulty. The hexadecimal value "XX" facilitates Hyundai dealer debugging the problem.<br>Troubleshooting:<br>This type of fault is related to internal components. Replace the logic board. |
| | OUT MISMATCH XX | | O | Cause:<br>This is a safety related test. Supervisor μC has detected that master μC is driving traction motor in a wrong way (not corresponding to the operator request). The hexadecimal value "XX" facilitates Hyundai dealer debugging the problem.<br>Troubleshooting:<br>- Checks the matching of the parameters between Master and Supervisor.<br>- Ask for assistance to a Hyundai dealer.<br>- If the problem is not solved, replace the logic board. |
| 228 | CHAT TIME | O | | Cause:<br>The chat time has expired.<br>Troubleshooting:<br>To activate traction or pump request |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 229 | HW FAULT EB. | O | | Cause:<br>At start-up, the hardware circuit dedicated to enable and disable the EB driver (output A18) is found to be faulty. The hexadecimal value "XX" facilitates Hyundai dealer debugging the problem.<br>Troubleshooting:<br>This type of fault is not related to external components. Replace the logic board. |
| | NO CAN WR MSG. XX | | O | Cause<br>CANbus communication does not work properly. The hexadecimal value "XX" identifies the faulty node.<br>Troubleshooting<br>- Verify the CANbus network (external issue).<br>- Replace the logic board (internal issue). |
| 230 | LC COIL OPEN | O | | Cause:<br>This fault appears when no load is connected between the NLC output A16 and the positive voltage (for example +KEY).<br>Troubleshooting:<br>- Check the wiring, in order to verify if LC coil is connected to the right connector pin and if it is not interrupted.<br>- If the alarm is still present, than the problem is inside the logic board; replace it. |
| | SOFTWARE ERROR | | O | Cause:<br>A software issue has been detected. This alarm code is reserved for factory tests during the development of the application. |
| 232 | CONT. DRV. EV | O | | Cause:<br>AUX valve driver is not able to drive the load.<br>Troubleshooting:<br>The device or its driving circuit is damaged. Replace the controller. |
| 233 | POWERMOS SHORTED | O | | Cause:<br>The DC-link voltage drops to zero when a high-side or low-side MOSFET is turned on.<br>Troubleshooting:<br>- Check that motor phases are correctly connected.<br>- Check that there is no dispersion to ground for every motor phases.<br>- In case the problem is not solved, replace the controller. |
| 234 | DRV. SHOR. EV | O | | Cause:<br>AUX valve driver is shorted.<br>Troubleshooting:<br>Check if there is a short circuit or a low impedance path between the negative terminal of the coils and -B. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 235 | CTRAP THRESHOLD | | O★2 | Cause:<br>This alarm occurs when a mismatch is detected between the setpoint for the overcurrent detection circuit and the feedback of the actual threshld value.<br>Troubleshooting:<br>The failure lies in the controller hardware. Replace the logic board. |
| 236 | CURRENT GAIN | O | | Cause:<br>The maximum current gain parameters are at the default values, which means that the maximum current adjustment procedure has not been carried out yet.<br>Troubleshooting:<br>Ask for assistance to a Hyundai dealer in order to do the adjustment procedure of the current gain parameters. |
| 237 | ANALOG INPUT | O | O | Cause:<br>This alarm occurs when the A/D conversion of the analog inputs returns frozen values, on all the converted signals, for more than 400 ms. The goal of this diagnosis is to detect a failure in the A/D converter or a problem in the code flow that skips the refresh of the analog signal conversion.<br>Troubleshooting<br>If the problem occurs permanently it is necessary to replace the logic board. |
| 238 | HW FAULT EV. | O | | Cause:<br>At start-up, the hardware circuit dedicated to enable and disable the EV driver (output A9) is found to be faulty.<br>Troubleshooting:<br>This type of fault is not related to external components. Replace the logic board. |
| 239 | CONTROLLER MISM. | O | O | Cause:<br>The software is not compatible with the hardware. Each controller produced is “signed” at the end of line test with a specific code mark saved in EEPROM according to the customized Part Number.<br>According with this “sign”, only the customized firmware can be uploaded.<br>Troubleshooting:<br>- Upload the correct firmware.<br>- Ask for assistance to a Hyundai dealer in order to verify that the firmware is correct. |

★2 : pump controller only

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 240 | EVP DRIVER OPEN | O | | Cause:<br>The EVP driver (output NEVP) is not able to drive the EVP coil. The device itself or its driving circuit is damaged.<br>Troubleshooting:<br>This fault is not related to external components. Replace the logic board. |
| | OUT MISMATCH PU | | O | Cause:<br>This is a safety related test. Supervisor μC has detected that master μC is driving traction motor in a wrong way (not corresponding to the operator request). The hexadecimal value "XX" facilitates Hyundai dealer debugging the problem.<br>Troubleshooting:<br>- Checks the matching of the parameters between Master and Supervisor.<br>- Ask for assistance to a Hyundai dealer.<br>- If the problem is not solved, replace the logic board. |
| 241 | COIL SHOR. EVAUX | O★2 | | Cause:<br>This alarm occurs when there is an overload of one or more EV driver. As soon as the overload condition has been removed, the alarm disappers by releasing and then enabling a travel demand.<br>Troubleshooting:<br>- Checks the Evs conditions.<br>- Check the wiring.<br>- Collect information about characteristics of EV coils and ask assistance to a Hyundai dealer.<br>- If the problem is not solved, replace the logic board. |
| | SP MISMATCH PUMP | | O★2 | Cause:<br>This is a safety related test. The master μC has detected a supervisor μC wrong set point. The hexadecimal value "XX" facilitates Hyundai dealer debugging the problem.<br>Troubleshooting:<br>- Check the matching of the parameters between master and supervisor.<br>- Ask for assistance to a Hyundai dealer.<br>- If the problem is not solved, replace the logic board. |

★2 : pump controller only

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 242 | OPEN COIL EV. | O | | Cause:<br>This fault appears when no load is connected between the NAUX 1 output (A9) and the positive terminal PCOM (A17).<br><br>Troubleshooting:<br>- Check the EB coil.<br>- Check the wiring.<br>- If the problem is not solved, replace the logic board. |
| | SP MISMATCH XX | | O | Cause:<br>This is a safety related test. The master μC has detected a supervisor μC wrong set point. The hexadecimal value “XX” facilitates Hyundai dealer debugging the problem.<br><br>Troubleshooting:<br>- Check the matching of the parameters between master and supervisor.<br>- Ask for assistance to a Hyundai dealer.<br>- If the problem is not solved, replace the logic board. |
| 243 | THROTTLE PROG. | O | | Cause:<br>A wrong profile has been set in the throttle profile.<br><br>Troubleshooting:<br>Set properly the throttle-related parameters. |
| 244 | WARNING SLAVE | O | | Cause:<br>Warning on supervisor uC.<br><br>Troubleshooting:<br>Connect the Console to the supervisor uC and check which alarm is present. |
| 245 | IQ MISMATCHED | O | | Cause:<br>The error between the Iq (q-axis current) setpoint and the estimated Iq is out of range.<br><br>Troubleshooting:<br>Ask for assistance to a Hyundai dealer in order to do the correct adjustment of the motor parameters. |
| 246 | EB. DRIV.OPEN | O | | Cause:<br>The EB coil driver is not able to drive the load. The device itself or its driving circuit is damaged.<br><br>Troubleshooting:<br>This type of fault is not related to external components. Replace the logic board. |
| 247 | DATA ACQUISITION | O | | Cause:<br>Controller in calibration state.<br><br>Troubleshooting:<br>The alarm ends when the acquisition is done. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 248 | NO CAN MSG. | O | O | Cause<br>CANbus communication does not work properly. The hexadecimal value "XX" identifies the faulty node.<br><br>Troubleshooting<br>- Verify the CANbus network (external issue).<br>- Replace the logic board (internal issue). |
| 249 | MAINTENANCE HOUR | O | | Cause:<br>The truck hours reached MAINTEINANCE HOUR parameter value.<br><br>Troubleshooting:<br>Perform the truck maintainance and reset the alarm using MAINTEN. RESET parameter. |
| 250 | THERMIC SENS. KO | O | | Cause:<br>The output of the controller thermal sensor is out of range.<br><br>Troubleshooting:<br>This kind of fault is not related to external components. Replace the controller. |
| 251 | WRONG SET BAT. | O | | Cause:<br>At start-up, the controller checks the battery voltage (measured at key input) and it verifies that it is within a range of ±20% around the nominal value.<br><br>Troubleshooting:<br>- Check that the SET BATTERY parameter inside the ADJUSTMENTS list matches with the battery nominal voltage.<br>- If the battery nominal voltage is not available for the SET BATTERY parameter inside the ADJUSTMENTS list, record the value stored as HARDWARE BATTERY RANGE parameter in the SPECIAL ADJUST. list and contact a Hyundai dealer.<br>- Through the TESTER function, check that the KEY VOLTAGE reading shows the same value as the key voltage measured with a voltmeter on pin A1. If it does not match, then modify the ADJUST BATTERY parameter according to the value read by the voltmeter.<br>- Replace the battery. |
| 252 | WRONG ZERO | O | | Cause:<br>At start-up, the amplifiers used to measure the motor voltage sense voltages outside a fixed range.<br><br>Troubleshooting:<br>This fault is related to internal components. Replace the logic board. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 253 | FIELD ORIENT. KO | O | | Cause:<br>The error between the Id (d-axis current) setpoint and the estimated Id is out of range.<br>Troubleshooting:<br>Ask for assistance to a Hyundai dealer in order to do the correct adjustment of the motor parameters. |
| 254 | EB. DRIV.SHRT. | O | | Cause:<br>- The EB driver is shorted.<br>- The microcontroller detects a mismatch between the valve setpoint and the feedback at the EB output.<br>Troubleshooting:<br>- Check if there is a short or a low impedance path between the negative coil terminal and -B.<br>- Check if the voltage applied is in accordance with the parameters settings.<br>- If the problem is not solved, replace the controller. |

### 2) EPS CONTROLLER

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 8 | WATCHDOG | O | O | Cause:<br>MuC and SuC communicate on a local CANbus communication system. Communication between them requires a stuffing bit (stuffing bit must be reversed at any new frame). In case the stuffing bit is frozen longer than 100msec this alarm occurs.<br>Troubleshooting:<br>If it is repetitive, it reports a problem in the controller. |
| 13 | EEPROM KO | O | O | Cause:<br>Every microcontroller has its own Eeprom with two parameters lists (to have a local back up copy). Each list has its own checksum. When both checksums are wrong, this alarm occurs. In case a parameter list has a wrong checksum it will be repaired using the second list (back up copy with a correct checksum).<br>Troubleshooting:<br>Make a Clear Eeprom. If the problem persists replace controller. |
| 16 | LOGIC FAILURE #4 | O | O | Cause:<br>This alarm occurs in the rest state if the output of the voltage amplifier on the linked voltage Vu-Vw have a drift larger than +/-0.25V (vs. the rest value it had at key-on).<br>Troubleshooting:<br>It is necessary to replace the controller. |
| 17 | LOGIC FAILURE #3 | O | O | Cause:<br>This alarm occurs in the rest state if the output of the voltage amplifier on the linked voltage Vv-Vu have a drift larger than +/-0.25V (vs. the rest value it had at key-on).<br>Troubleshooting:<br>It is necessary to replace the controller. |
| 32 | VMN NOT OK | O | O | Cause:<br>This alarm occurs at key on, in case at least one amplifiers on linked voltage Vv-Vu and Vu-Vw is not in a narrow window of +/-300mV around 2.4Vdc 10msec long (sampling time 2msec for 5 consecutive samples). (Admitted outputs at rest are from 2.1V to 2.7V).<br>Troubleshooting:<br>If it is repetitive, it is necessary to replace the controller. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 48 | MAIN CONT. OPEN | O | O | Cause:<br>This warning is active when the steering controller is receiving via CANbus the information that the power line contactor is open.<br>Troubleshooting:<br>This is not a problem in the E-steering motor controller. When this warning is raised up it means the VCM has open (or not closed yet) the line contactor. |
| 53 | STBY I HIGH | O | O | Cause:<br>This alarm occurs when the eps E-steering motor controller is at rest, in case at least one current amplifiers on phases U and W is not in a narrow window of +/- 300mV around 2.5Vdc 10msec long (sampling time 2msec for 5 consecutive samples). (Admitted outputs at rest are from 2.2V to 2.8V).<br>Troubleshooting:<br>If it is repetitive, it is necessary to replace the controller. |
| 60 | CAPACITOR CHARGE | O | O | Cause:<br>This alarm occurs at key on in case the DC Bus (rail capacitors) doesn't reach a minimum value of 14Vdc within 3.2secs despite it is expected to do. STATUS #5 supplies the real time value of the battery link (+B) in its short duration instance.<br>Troubleshooting:<br>Some cases:<br>- if this alarm is only reported in the steering controller, check the continuity of cables to CNA#3-4-5 from battery source and E-steering motor controller.<br>- if the cables to CNA #3-4-5 are OK, measure the voltage between CNA#3-4-5 and –B within 3 sec after key-on. Only in case the voltage measured is higher than 14Vdc (and short duration instance on STATUS#5 is lower instead) replace the controller.<br>- In case the voltage measured between CNA#3-4-5 and –B is close to 0 there are two possibilities:<br>· Short circuit on the DC rail and –B inside the E-steering motor controller (disconnect CNA#3-4-5 and measure the voltage in the traction controller DC bus (+B to –B posts): replace E-steering motor controller in case DC bus voltage of the traction controller raises up to higher than 14Vdc.<br>· Short circuit on the DC rail and –B on another unit in the truck. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 61 | HIGH TEMPERATURE | O | O | Cause:<br>This alarm occurs when the temperature in the power mosfets is higher than 80 degrees.<br><br>Troubleshooting:<br>Improve the cooling of the controller; otherwise it is necessary to replace the controller. |
| 65 | MOTOR TEMPERAT. | O | O | Cause:<br>This alarm occurs only when DIAG MOTOR TEMP is analog and the thermal sensor inside the motor measures a temperature higher than 120 degrees. It occurs also when trying to acquire the motor resistance with a temperature in the motor higher than 120 degrees.<br><br>Troubleshooting:<br>Check the thermal sensor in the motor is right working. If it is, improve the cooling of the motor. |
| 70 | HIGH CURRENT | O | O | Cause:<br>This alarm occurs two ways:<br>- At key on, in case the circuit for limiting the max current via Hardware is always active (can be due to a failure of a current amplifier).<br>- After key on, in case the circuit for limiting the max current via Hardware acts frequently.<br><br>Troubleshooting:<br>If it is repetitive, it is necessary to replace the controller. |
| 71 | POWER FAILURE #3 | O | O | Cause:<br>Current in phase W of the motor very low 100msec long even if it is commanded higher than 14% Imax.<br><br>Troubleshooting:<br>If it is repetitive, check if the battery is connected to the controller. Otherwise the problem can be a failure in the power three phase bridge or in the motor. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 72 | POWER FAILURE #2 | O | O | Cause:<br>This alarm is raised by the MuC when the current in phase V of the motor very low 100msec long even if it is commanded higher than 14% Imax. Zapi Universal 2.0: this alarm is raised by the SuC at key on, in case the contactor on the DC-rail to the E-steering controller is welded in its closed position (MAIN CONTACTOR to OPTION #1 only).<br>Troubleshooting:<br>MuC: If it is repetitive, check if the battery is connected to the controller. Otherwise the problem can be a failure in the power three phase bridge or in the motor.<br>SuC: if the contactor on the DC-rail to the E-steering controller is welded in its closed position, replace it. |
| 73 | POWER FAILURE #1 | O | O | Cause:<br>This alarm is raised by the MuC when the current in phase U of the motor is very low 100msec long even if it is commanded higher than 14% Imax.<br>Zapi Standard 1ST Gen and Universal 2.0: this alarm is raised by the SuC in case the $I^2t$ of the current in the battery overtakes the admitted limit of $22000A^2s$ (i.e. overload protection of the battery connections).<br>Troubleshooting:<br>MuC: if it is repetitive, check if the battery is connected to the controller. Otherwise the problem can be a failure in the power three phase bridge or in terminal U motor connection.<br>SuC: an overload is occurred in the steering controller. One possibility is too much friction in the transmission. Launch selfcheck #2 with the steered wheel lifted up (and then on the floor) to measure the current in the motor when turning the steered axle. Check the diagnostic response (STATUS #2 and alarm message). |
| 91 | DRIVER 2 KO | O | O | Cause:<br>This alarm occurs in case the safety switch between CNA #9 and CNA #14 is detected short circuited at key-on and option AUX OUTPUT #1 is set to PRESENT.<br>Troubleshooting:<br>It reports either a short circuit to GND of the load connected to CNA #14 or a problem in the controller. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 98 | INPUT ERROR #2 | O | O | Cause:<br>The revolution of the sensor at the steering wheel is split in 4 quadrants:<br>1ST: 0 to 90 degrees<br>2ND: 90 to 180 degrees<br>3RD: 180 to 270 degrees<br>4TH: 270 to 360 degrees<br>This alarm occurs in case the configuration of the two outputs jumps to a NOT ADIACENT quadrant.<br>In practice, when the configuration of the two outputs:<br>- Is in the 1ST quadrant, shift to 3RD quadrant is not admitted<br>- Is in the 2ND quadrant, shift to 4TH quadrant is not admitted<br>- Is in the 3RD quadrant, shift to 1ST quadrant is not admitted<br>- Is in the 4TH quadrant, shift to 2ND quadrant is not admitted<br>Single event raises the alarm.<br><br>Troubleshooting:<br>Check the connections of the analog sensor at the steering wheel (CNA #20 and CNA #17). Disturb or interference on the sensor. |
| 204 | SELF CHECK #3 | O | O | Cause:<br>This warning occurs when the SELFCHECKING routine #3 is in progress and the check result has not been determined yet. This selfchecking routine carries out an embedded monitoring of the encoder and of the current in the motor when commanded to move side to side cyclically. We suggest to launch SELFCHECK #3 with the steered wheel lifted up. The goal of this selftest is to check the functionality of encoder and mechanical components (transmission, sensor bearings, gears, pinion). After the gathered data have been processed and an unexpected result occurred, this warning message will turn in an alarm information.<br><br>Troubleshooting:<br>Recycle the key to exit the SELFCHECK #3 warning. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 205 | SELF CHECK #2 | O | O | Cause:<br>This warning occurs when the SELFCHECKING routine #2 is in progress and the check result has not been determined yet. This selfchecking routine carries out an embedded monitoring of the encoder and of the current in the motor when commanded to move at a fixed speed of 25Hz. We suggest to launch SELFCHECK #2 with the steered wheel lifted up. The goal of this selftest is to check the functionality of encoder and mechanical components (transmission, sensor bearings, gears, pinion). After the gathered data have been processed and an unexpected result occurred, this warning message will turn in an alarm information.<br>Troubleshooting:<br>Recycle the key to exit the SELFCHECK #2 warning. |
| 206 | SELF CHECK #1 | O | O | Cause:<br>This warning occurs when the SELFCHECKING routine #1 is in progress and the check result has not been determined yet. This selfchecking routine carries out a voltammeter measure of the motor resistances between phase V and W (Rvw) and between phase W and U (Rwu) by injecting a fixed 14.7Adc current (sqrt(3/2) * ID RMS MAX). The goal of this selftest is to check the functionality of motor and three phase power bridge. After the gathered data have been processed and an unexpected result occurred, this warning message will turn in an alarm information.<br>Troubleshooting:<br>Recycle the key to exit the SELFCHECK #1 warning. |
| 207 | WRONG HW SET | O | | Cause:<br>A Zapi adjusted hardware setting, called HW TYPE, specifies the hardware characteristics of the controller where the SW has been downloaded (absolute max current and battery voltage). In case HW TYPE has an inconsistent value (i.e. specifies a not foreseen pair, battery voltage and absolute max current) this alarm occurs.<br>Troubleshooting:<br>Call Hyundai dealer or replace the controller. |
| | SP MISMATCH | | O | Cause:<br>MuC and SuC calculate independently each other the set point for speed in the motor and position at the wheel. This alarm is raised by the SuC in case it calculates different set points than the MuC.<br>Troubleshooting:<br>If it is repetitive, it reports a problem in the controller. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 208 | OUTPUT MISMATCH | | O | Cause:<br>SuC compares the set points of motor current, motor speed and position at the wheel with the actual values. If there is a mismatch SuC raises this alarm. Imax in the motor with the correct sign is an exception: no alarm in this case.<br>Troubleshooting:<br>If it is repetitive, it it reports a problem in the controller. |
| 209 | W.D. SYNCRO | O | O | Cause:<br>SuC doesn't receive synchronization signal frpm MuC longer than 90msec.<br>Troubleshooting:<br>Recycle the key. If the problem remains replace the controller. |
| 210 | WRONG SLAVE VER. | O | O | Cause:<br>This alarm is raised by MuC in case the Software release in MuC and SuC are not matched (different release).<br>Troubleshooting:<br>Download the same software release (same number) on both microcontrollers. |
| 211 | TFD FEEDB. ERROR | O | O | Cause:<br>MuC raises this alarm in case the actual current and the set point current in the TFD (to friction the steering wheel) stays unmatched more than 150mA 120msec long.<br>Troubleshooting:<br>Problem can be the resistance of the TFD coil is too high (coil broken) or the wires to the TFD coil broken or a problem in the controller. |
| 212 | WRONG RAM MEM. | O | O | Cause:<br>Deterministic Finite Automaton (DFA) is characterized by state transitions. As a protective measure any state transition is commanded by assigning two variables (state label and its complement). These two variables identify the new state (redundancy in the state label). This redundancy has been thought in order to avoid that a failure in the RAM memory leads to a wrong destination state for the DFAs. In case the two state labels are inconsistent or not complemented in between, this alarm occurs.<br>Troubleshooting:<br>If it is repetitive, it reports a problem in the controller. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 213 | PARAM RESTORE | O | O | Cause:<br>This is a confirmation that a clear eeprom parameter was correctly performed.<br><br>Troubleshooting:<br>Recycle the key. |
| 214 | SP JERK | O | O | Cause:<br>This alarm occurs if an output of the sensor at the steering wheel has a step wider than 586mV between two consecutive samples and confirmed for further ten samples (all the samples are picked up with a sampling delay is 4msec).<br><br>Troubleshooting:<br>Read STATUS #9 when the alarm occurs to find the output between CNA #20 and CNA #17 had the widest step. Check the continuity of the cables from sensor to controller. Check for a disturb, noise, interference between sensor in the steering wheel and controller. Check the cable between steering wheel and controller is shorter than 2meters. |
| 215 | CAN BUS KO M/S | O | O | Cause:<br>MuC and SuC communicate via a local (embedded) CanBus communication system. If a node does not receive any response from the other node longer than 100msec, this alarm occurs.<br><br>Troubleshooting:<br>If it is repetitive, it is a problem in the steering controller. |
| 216 | TFD WRONG RESIST | O | O | Cause:<br>Parameter TFD OHM IMPED. sets the expected resistance of the TFD coil @ 25°C. This parameter is used for a coarse check of the integrity of the TFD coil. E-steering motor controller measures the TFD coil resistance with a voltammeter test (V_in_the_coil/ Current_in_the_coil). When the measured resistance is outside the range from 1/3 to 3 times TFD OHM IMPED 180msec long, MuC raises this alarm.<br>V_in_the_coil is calculate using VCNA#9 –VCNA#10, if V in_the_ coil expected is lower than 2.3V diagnosis is not done due to a too low precision in value V_in_the_coil.<br><br>Troubleshooting:<br>Problem can be the resistance of the TFD coil is too high (coil broken) or too low (a short circuit inside the TFD) or the wires to the TFD are broken or the parameter called TFD OHM IMPED has been wrong set or a problem in the controller. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 218 | CONTROLLER MISM. | O | O | Cause:<br>This alarm occurs when the embedded SW is not compatible with Hardware.<br>Troubleshooting:<br>Update the embedded SW. |
| 220 | MOTOR LOCKED | O | O | Cause:<br>This alarm occurs when the current in the motor stays higher than 90% Imax longer than 1 secs when the traction speed is higher than 15% (delay becomes 5 secs when the traction speed is lower than 5%).<br>Troubleshooting:<br>Too much torque required to steer or problem in the encoder (launch selfcheck #2). |
| 221 | M/S PAR CHK MISM | O | O | Cause:<br>MuC compares its checksum for the parameters list with the checksum of the parameters list in the SuC. In case they are mismatched, MuC raises this alarm.<br>Troubleshooting:<br>Check which parameter(s) is different between MuC and SuC and update (write) the unmatched parameter(s). To easily fix the problem make a Clear Eeprom. |
| 223 | FB JERK | O | O | Cause:<br>This alarm occurs if the encoder counting has a step wider than 21° between two consecutive samples and confirmed for further thirteen samples (all the samples are picked up with a sampling delay is 16msec). The diagnostic routine uses an encoder counting scaled in the range 2048ud+/-2048ud (corresponding to a steered axle angle of 0+/-180˚) and the threshold for the alarm is +/-244ud corresponding to an angle of 244/2048*180˚=21˚.<br>Troubleshooting:<br>See reading SLOPE PEAK of the tester menu (with DEBUG OUTPUT temporary set to Level 13) to have a real time monitoring of the max step detected by the diagnostic routine. Check the encoder is right working. Use also STATUS # 2 to have a feedback on the encoder functionality (see topic 16: TROUBLESHOOTING). |
| 225 | CURRENT GAIN | O | O | Cause:<br>This alarm occurs when the gains of the current amplifiers (ADJUSTMENT #03 and ADJUSTMENT #04) are set to their default values (Imax has not been regulated yet).<br>Troubleshooting:<br>Call Hyundai dealer. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 226 | STOP TRAC WR. | O | O | Cause:<br>The eps is inhibiting the traction movement due to a wrong parameter configuration or calibration of the eps controller. |
| 227 | CALIBRATION | O | O | Cause:<br>The wheel performed a rotation of 180 degrees. |
| 228 | POSITION ERR | O | O | Cause:<br>This alarm occurs when the displacement between position of the steered wheel measured with the encoder (FEEDBACK ENC) and with the first output of the analog sensor (FBPOT1 AT ENC) is wider than 173mV (for six subsequent samples picked up with a sampling delay is 16msec). STATUS #7 can be used to detect real time the peak value of the displacement (to be compared with the alarm threshold of 175mV) and the values of the variables involved when that peak of the displacement has been recorded.<br>Troubleshooting:<br>Check STATUS #7 when alarm occurred. Check the analog value of the sensor on CND #2 (FEEDBACK POT 1). Verify also the encoder works correctly. |
| 235 | TFD SHRT/VOLT KO | O | O | Cause:<br>This diagnosis is processed only at key on the Circuit in. Two tests:<br>Q3 is initially off: CNA #9 is expected to be lower than 5Vdc.<br>In case it isn't this alarm occurs; otherwise Q3 is switched on.<br>Q3 is on: CNA #9 is expected to be higher than 60% of the DC bus.<br>In case it isn't this alarm occurs.<br>This alarm (with alarm number 40h) is raised also by the SuC in case the key input stays lower than 12.5V longer than 200msec.<br>Troubleshooting:<br>It reports either a short circuit to GND of the load connected to CNA #9 or a problem in the controller (on safety switch Q3). |
| 236 | TFD STB I HIGH | O | O | Cause:<br>If the output of the amplifier to measure the current in the TFD is not Zero at rest, this alarm occurs.<br>Zero for MuC is 0.5V (alarm when it is higher than 1V). (For MuC output increases when the current is not null).<br>Zero for SuC is 4.5V (alarm when it is lower than 4V). For SuC output decreases when the current is not null.<br>Troubleshooting:<br>It reports a problem in the controller. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 237 | SLAVE ALARM | O | | Cause:<br>When SuC raises an alarm, steering motor cannot be actuated and the MuC informs the SuC has cut off the power stage by raising this warning. In the Zapi console, MuC specifies the LSByte of the SuC alarm code. For instance, in case of SuC alarm code FFD0 (OUTPUT MISMATCH), MuC raises SLAVE ALARM D0. (i.e. XX assumes the two last nibbles of the SuC alarm code.)<br>Troubleshooting:<br>If it is repetitive, it reports a problem in the controller. |
| | WAITING MASTER | | O | Cause:<br>When MuC raises an alarm, steering motor cannot be actuated and the SuC informs the MuC has cut off the power stage by raising this warning. In the Zapi console, SuC specifies the LSByte of the MuC alarm code. (i.e. XX assumes the two last nibbles of the MuC alarm code.)<br>Troubleshooting:<br>If it is repetitive, it reports a problem in the controller. |
| 238 | EPS NOT ALIGNED | O | O | - |
| 239 | WAITING FOR TRAC | O | O | - |
| 240 | LOGIC SUPPLY ERR | O | O | Cause:<br>This alarm occurs in case the 13.5V logic supply voltage to drive the three phase power bridge is detected lower than 11Vdc.<br>Troubleshooting:<br>Recycle the key. If it is repetitive, it reports a problem in the controller. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 241 | FB SENSOR LOCKED | O | O | Cause:<br>This alarm occurs if the actual position (steered wheel angle measured via the encoder counting) does not pursuit the commanded position (steering wheel) longer than 500msec @ traction speed higher than 15% (at lower traction speed, time delay increases up to 2.5secs when traction speed is lower than 5%). If the displacement between commanded position and the encoder counting (i.e. steered wheel angle) is higher than 10degrees and the encoder counting increases less than 2degrees within the time delay of 500msec, this alarm occurs.<br>Troubleshooting:<br>STATUS #2 Selfchecking routine helps to found the root of the problem. This alarm can be due to:<br>- At least one encoder channel broken.<br>- Too much friction in the transmission/gears.<br>- A failure in the power controller.<br>- A failure in the motor (e.g. a sensor bearing locked or a motor phase broken). |
| 242 | ENC 3CH FAILURE | O | O | Cause:<br>This alarm is raised by the MuC when the steered axle positions measured by the first encoder and by the second encoder have a displacement larger than 5mm longer than 88msec.<br>Troubleshooting:<br>If it is repetitive, replace the controller. |
| 243 | LUBRICATION CYCL | O | O | Cause:<br>This warning is raised by the MuC when a lubrication procedure is in progress (parameter LUBR. AND BLEED. set to ON).<br>Troubleshooting:<br>Recycle the key when the procedure has been finished. |
| 244 | PARAM TRANSFER | O | O | Cause:<br>Master uC and Slave uC has its own parameter list (with its local back up copy). Change of a parameter is handled by the MuC only. MuC writes its own parameter and commands the SuC to do the same for its parameter list. Execution of the write command in the SuC is protected by a password. This alarm is raised up by the MuC in case SuC refuses to do the write command.<br>Troubleshooting:<br>Try to change one more time a parameter. If problem persists replace controller. |

| Code | Alarm | Master | Slave | Description |
| --- | --- | --- | --- | --- |
| 245 | DATA ACQUISITION | O | O | Cause:<br>This alarm occurs during max current regulation (factory adjusted) and when a procedure to acquire the motor resistance is launched.<br><br>Troubleshooting:<br>Recycle the key. |
| 247 | CAN BUS KO | O | O | Cause:<br>If a node does not receive its dedicated CANbus message longer than 100msec, this alarm occurs.<br><br>Troubleshooting:<br>Problem can be in the CANbus wires, or in the CANbus transceiver inside VCM, E-steering motor controller or another unit in the truck. Identification of the root of the problem needs a CANbus analyzer. |
| 248 | S.P OUT OF RANGE | O | O | Cause:<br>If occurs when the displacement between actual and expected conditions of the analog sensor at the steering wheel is wider than a threshold (16 subsequent samples picked up with a sampling delay is 4msec).<br>PWM sensor: this threshold is a displacement of +/-5.5% of duty cycle when the speed of the steering wheel is null; linearly increasing up to 11% when the speed of the steering wheel is 5rev/sec.<br>Analog sensor: this threshold is +/-250mV for the SuC and +/-400mV for the MuC.<br>In case it gets higher than 250mVdc (or 400mVdc) or lower than -250mVdc (or 400mVdc) this alarm occurs. Diagnosis is split into 4 quadrants (0 to 90, 90 to 180, 180 to 270, 270 to 360 degrees).<br>STATUS #8 can be used to detect real time the peak value of the displacement (to be compared with the alarm threshold of 250mV) and the values of the outputs when that peak of the displacement has been recorded).<br><br>Troubleshooting:<br>Check STATUS #8 when alarm occurred. Check the connections of the analog sensor at the steering wheel (CNA #20 and CNA #17).<br>Disturb or interference on the sensor. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 249 | F.B OUT OF RANGE | O | O | Cause:<br>This alarm occurs in case of fault of the feedback potentiometer (CPOT).<br>Troubleshooting:<br>Check the connections of the feedback potentiometer. This alarm occurs when one connection of the feedback potentiometer is broken. |
| 250 | INPUT MISMATCH | | O | Cause:<br>MuC and SuC read the inputs independently each other. SuC takes care the values that it is reading are matched real time with the values the MuC is reading. The inputs are:<br>- Steering Wheel sensor (CNA #20 and CNA #17)<br>- Steered Wheel analog sensor<br>- Encoder in the motor<br>SuC raises this alarm in case they are mismatched<br>Troubleshooting:<br>If it is repetitive, it reports a problem in the controller. |
| 251 | INIT VMN NOT OK | O | O | Cause:<br>After key-on, with the three phase power bridge off, the DC bus voltage is expected to raises up to 14Vdc within 3.2secs (alarm CAPACITOR CHARGE below if it isn't). In the same time, steering controller monitors the common voltage at the motor terminals (see STATUS #5 (MONITORING list)) and raises this alarm when the 3.2secs time-out is expired and:<br>- The common voltage is lower than 7Vdc (bottom power mosfet shortcircuited to –B).<br>OR<br>- The common voltage is stuck to the DC Bus (top power mosfet shorcircuited to +B). (It is considered stuck in case it is in a window of +/- 1Vdc around the DC Bus).<br>STATUS #5 in the TESTER menu, supplies the real time value of this common voltage on its long duration instance.<br>Troubleshooting:<br>Try to disconnect all the motor terminals from the controller, recycle the key and read STATUS #5. If the long duration instance (i.e. 1ST value) is in a window 8 to 13.5Vdc, the problem is a dispersion (lost of insulation of the motor). Otherwise replace the controller. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 252 | TWIN POT MISMAT. | O | O | Cause:<br>it occurs when the displacement between actual and expected conditions (FEEBACK POT 1 + FEEDBACK POT 2=5Vdc) of the analog sensor at the steered wheel (tire) is wider than 490mVdc six subsequent samples picked up with a sampling delay is 16msec. STATUS #6 can be used to detect real time the peak value of the displacement (to be compared with the alarm threshold of 490mV) and the values of the outputs when the peak of the displacement has been recorded.<br>Troubleshooting:<br>Check STATUS #6 when alarm occurred. Check the connections (mechanical and electrical) of the analog sensor at the steered axle. Replace the sensor if nothing is found. |
| 253 | ANALOG | O | O | Cause:<br>At key on, the A/D converter is switched on and it is expected to complete a conversion of the analog inputs within 16msec. In case it isn't, this alarm occurs.<br>Troubleshooting:<br>Recycle the key. If problem persists replace the controller. |
| 254 | NO SP REFRESH | O | O | Cause:<br>This alarm is alive only when the sensor at the steering wheel is of PWM type (not analog). Then, in case at least one output between CPOC 1 and CPOC 2 (CNA #20 and CNA #17) has a PWM period shorter than 4msec or longer than 6msec confirmed for 92msec long, this alarm occurs (NO SP REFRES 02 and NO SP REFRES 04).<br>It occurs also when at least one between CPOC 1 and CPOC 2 does not switch longer than 12msec (2 period lost) with alarm NO SP REFRES20 (i.e. 20h=32dec).<br>Troubleshooting:<br>Check the sensor at the steering wheel and the wiring from the steering wheel to the controller. |

### 3) VCM CONTROLLER

<table>
<tr><th>Code</th><th>Alarm</th><th>Master</th><th>Slave</th><th>Description</th></tr>
<tr><td>8</td><td>WATCHDOG</td><td>O</td><td>O</td><td>Cause:<br>A software watchdog is programmed inside each microcontroller. Its role is to check the correct operation of the software. All functions are blocked.<br>Troubleshooting:<br>it is an internal error, the module must be replaced.</td></tr>
<tr><td>19</td><td>LOGIC FAILURE #1</td><td>O</td><td>O</td><td>This alarm signals that an undervoltage at the key input has been detected.<br>All functions are blocked.<br>Troubleshooting depends on which is the reason of the alarm:<br>- A real undervoltage situation happened. The alarm should disappear by simply switching off and on again the key. The cause of the undervoltage event has to be found on the application. For example: a truck function requesting a very large battery current may decrease too much the battery voltage.<br>- Fault in the circuit which detects the undervoltage condition. The board must be replaced.</td></tr>
<tr><td>199</td><td>OUT1/2 COIL SH.</td><td></td><td>O</td><td>Cause:<br>This alarm occurs when there is a short circuit of the EVP 1 or EVP 2 coil.<br>After the overload condition has been removed, the alarm exits automatically by releasing and then enabling a travel demand.<br>Troubleshooting:<br>- The typical root cause for this error code to be displayed is in the harness or in the load coil. So the very first check to carry out concerns connections between controller outputs and loads.<br>- In case no failures/problems have been found externally, the problem is in the controller, which has to be replaced.</td></tr>
<tr><td rowspan="2">200</td><td>WRONG PARAMETER</td><td>O</td><td></td><td>Cause:<br>This is an alarm related to the throttle configuration.<br>Troubleshooting:<br>Check the parameters.</td></tr>
<tr><td>OUT3/4 COIL SH.</td><td></td><td>O</td><td>Cause:<br>This alarm occurs when there is a short circuit of the EVP 3 or EVP 4 coil.<br>After the overload condition has been removed, the alarm exits automatically by releasing and then enabling a travel demand.<br>Troubleshooting:<br>- The typical root cause for this error code to be displayed is in the harness or in the load coil. So the very first check to carry out concerns connections between controller outputs and loads.<br>- In case no failures/problems have been found externally, the problem is in the controller, which has to be replaced.</td></tr>
</table>

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 201 | WRONG SLAVE VER. | O | | Cause:<br>Wrong software version on supervisor uC.<br>Troubleshooting:<br>Install the correct software version in the supervisor uC. |
| | OUT5/6 COIL SH. | | O | Cause:<br>This alarm occurs when there is a short circuit of the EVP 5 or EVP 6 coil.<br>After the overload condition has been removed, the alarm exits automatically by releasing and then enabling a travel demand.<br>Troubleshooting:<br>- The typical root cause for this error code to be displayed is in the harness or in the load coil. So the very first check to carry out concerns connections between controller outputs and loads.<br>- In case no failures/problems have been found externally, the problem is in the controller, which has to be replaced. |
| 202 | HM MISMATCH | O | | Cause:<br>Mismatch between VCM and traction regarding the Hour Meter.<br>Troubleshooting:<br>Check the parameter setting concerning the HM. |
| | OUT7/8 COIL SH. | | O | Cause:<br>This alarm occurs when there is a short circuit of the EVP7 or EVP8 coil.<br>After the overload condition has been removed, the alarm exits automatically by releasing and then enabling a travel demand.<br>Troubleshooting:<br>- The typical root cause for this error code to be displayed is in the harness or in the load coil. So the very first check to carry out concerns connections between controller outputs and loads.<br>- In case no failures/problems have been found externally, the problem is in the controller, which has to be replaced. |
| 203 | TILLER MISMATCH | O | | - |
| | LASER COIL SH. | | O | - |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 204 | BATTERY LOW | O | | Cause:<br>It occurs when the battery charge is calculated being less than or equal to 10% of the full charge and the BATTERY CHECK setting is other than 0 (refer to SET OPTION menu).<br>Troubleshooting:<br>Get the battery charged. If it doesn't work, measure with a voltmeter the battery voltage and compare it with the value in the BATTERY VOLTAGE parameter. If they are different adjust the value of the ADJUST BATTERY function. |
| | BAT OUT COIL SH. | | O | Cause:<br>This alarm occurs when there is a short circuit of the EV 1 coil. After the overload condition has been removed, the alarm exits automatically by releasing and then enabling a travel demand.<br>Troubleshooting:<br>- The typical root cause for this error code to be displayed is in the harness or in the load coil. So the very first check to carry out concerns connections between controller outputs and loads.<br>- In case no failures/problems have been found externally, the problem is in the controller, which has to be replaced. |
| 205 | LOAD BRK COIL SH | | O | Cause:<br>This alarm occurs when there is a short circuit of the EVP 9 coil. After the overload condition has been removed, the alarm exits automatically by releasing and then enabling a travel demand.<br>Troubleshooting:<br>- The typical root cause for this error code to be displayed is in the harness or in the load coil. So the very first check to carry out concerns connections between controller outputs and loads.<br>- In case no failures/problems have been found externally, the problem is in the controller, which has to be replaced. |
| 206 | ALARM COIL SH. | | O | Cause:<br>This alarm occurs when there is a short circuit of the EV 2 coil. After the overload condition has been removed, the alarm exits automatically by releasing and then enabling a travel demand.<br>Troubleshooting:<br>- The typical root cause for this error code to be displayed is in the harness or in the load coil. So the very first check to carry out concerns connections between controller outputs and loads.<br>- In case no failures/problems have been found externally, the problem is in the controller, which has to be replaced. |
| 207 | WATCH DOG MASTER | | O | Cause:<br>An Hardware watchdog is present inside to synchronize the microcontrollers.<br>All functions are blocked.<br>Troubleshooting:<br>It is an internal error, the module must be replaced. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 208 | EEPROM KO | O | O | Cause:<br>Fault in the area of memory where the parameters are stored or problems during the read/write operations of this memory. This alarm does not inhibit machine operation but default parameters are used.<br>Troubleshooting:<br>If the fault continues when the key switch is re-cycled, replace the board. If the fault disappears, the previously stored parameters will have been replaced by the default parameters. |
| 209 | PARAM RESTORE | O | O | Cause:<br>This warning appears when the controller restored the default values.<br>Troubleshooting:<br>If a CLEAR EEPROM was mode before the last keyon-recycle, this warning just means that the EEPROM was correctly cleared. A travel demand or a pump request cancel the alarm. If this alarm appears at keyon without any CLEAR EEPROM request by the operator, there could be a problem inside. |
| 210 | WRONG RAM MEM. | O | O | Cause:<br>The algorithm implemented to check the main RAM registers finds a wrong contents: the register is “dirty”. This alarm inhibit the machine operations.<br>Troubleshooting:<br>Try to switch the key off and then on, if the alarm is still present replace the logic board. |
| 211 | PUMP INC. START | O | | Cause:<br>This is a warning for an incorrect starting sequence.<br>Troubleshooting:<br>The possible reasons for this alarm is (use the readings in the TESTER to facilitate the troubleshooting) pump demand active at key on or a pump demand is present without the seat input active. Check the wirings. Check the micro-switches. It could be also an error sequence made by the operator. A failure in the logic is possible too; so when all of the above conditions were checked and nothing was found, replace the controller. |
| | PEV DRV. OPEN | | O | Cause:<br>VCM is not able to drive the high side driver of output PEVP 1.<br>Troubleshooting:<br>This type of fault is not related to external components; replace the logic board. |
| 212 | PEV DRV. SHORT. | | O | Cause:<br>The high side driver of output PEVP 1 is shorted.<br>Troubleshooting:<br>- Check if there is a short or a low impedance pull-up between pin A13 and +BATT.<br>- The driver circuit is damaged in the logic board, which has to be replaced. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 213 | ENCODER LOCKED 1 | O | | Cause:<br>The encoder n°1 is stuck or the encoder signals are not correctly received by the controller.<br>Troubleshooting:<br>Please check if the ENCODER 1 on the tester menu is different than zero during a lifting request.<br>Check the wirings and check that the sensor works correctly.<br>A failure in the logic is possible too; so when all of the above conditions were checked and nothing was found, replace the controller. |
| | VALVE MISM. OUT | | O | Cause:<br>Mismatch between uC Master and uC slave for output set point calculation.<br>Troubleshooting:<br>The logic board has to be replaced. |
| 214 | ENCODER LOCKED 2 | O | | Cause:<br>The encoder n°2 is stuck or the encoder signals are not correctly received by the controller.<br>Troubleshooting:<br>Please check if the ENCODER 2 on the tester menu is different than zero during a lifting request.<br>Check the wirings and check that the sensor works correctly.<br>A failure in the logic is possible too; so when all of the above conditions were checked and nothing was found, replace the controller. |
| 215 | OUT PORT PULL-UP | O | O | Cause:<br>This is an alarm related to the hardware configuration.<br>Troubleshooting:<br>The problem is on the logic board, which must be replaced. |
| 217 | ANALOG INPUT | O | O | Cause:<br>There is a problem in the analog-to-digital module of the microcontroller. All functions are stopped.<br>Troubleshooting:<br>This a failure internal to the microcontroller, replace the |
| 218 | IN. MISM. D | | O | Cause:<br>Mismatch on digital input between Master and Slave.<br>Troubleshooting:<br>Compare the values read by Master and Slave by tester menu of console.<br>Ask the assistance of a Hyundai dealer. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 219 | VALVE ENABLE | O | | Cause:<br>It occurs when the uC master try to activate an output but the supervisor uC doesn’t activate the enable.<br>Troubleshooting:<br>Check if some alarm is present on supervisor uC. Otherwise a fault in the hardware is present, the board must be replaced. |
| | IN. MISM. A/E | | O | Cause:<br>Mismatch on analog inputs or encoder inputs between Master and Slave.<br>Troubleshooting:<br>Compare the values read by Master and Slave by tester menu of console.<br>Ask the assistance of a Hyundai dealer. |
| 223 | NO CAN MSG. 5 | O | | Cause:<br>Timeout on the local CANbus.<br>Troubleshooting:<br>Switch OFF and ON. If the alarm is still present replace the board. |
| | NO CAN MSG. C | | O | Cause:<br>No CAN message from traction controller.<br>Troubleshooting:<br>Check the CAN connection on traction controller side. Verify that the traction communicates on CANbus. |
| 224 | WAITING FOR NODE | O | | Cause:<br>The controller receives from the CAN the message that another controller in the net is in fault condition; as a consequence the VCM controller itself cannot enter an operative status, but has to WAIT for the other controller coming out from the fault status. |
| | NO CAN MSG. 4 | | O | Cause:<br>Timeout on the local CANbus.<br>Troubleshooting:<br>Switch OFF and ON. If the alarm is still present replace the board. |
| 225 | CONTROLLER MISM. | O | O | Cause:<br>Wrong customer ID code found in the protected area of memory where this parameter are stored.<br>Troubleshooting:<br>Replaced the controller. |
| 226 | PUMP IN ALARM | O | | Cause:<br>Alarm on pump controller.<br>Troubleshooting:<br>Check the alarm on pump controller. |
| 227 | NO CAN MSG. 14 | O | O | Cause:<br>No CAN message from pump controller.<br>Troubleshooting:<br>Check the CAN connection on pump controller side. Verify that the pump communicates on CANbus. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 228 | NO CAN MSG. A | O | O | Cause:<br>No CAN message from the Mini Lever or Joystick.<br>Troubleshooting:<br>Check the CAN connection on Mini Lever or Joystick side. Verify that the Mini Lever or Joystick communicate on CANbus. |
| 229 | SDO TRAC. | O | | Cause:<br>There is a problem in the communication of HM between VCM and traction.<br>Troubleshooting:<br>Verify the communication between the two controllers. If all is ok try to replace the board. |
| 231 | DRV. SHRT A | | O | Cause:<br>VCM is not able to drive one of the first eight outputs.<br>Troubleshooting:<br>- Check if there is a short or a low impedance pull-down between one of the output and –BATT.<br>- The driver circuit is damaged in the logic board, which has to be replaced. |
| 232 | DRV. OPEN A | | O | Cause:<br>The driver of one of the first eight outputs is shorted.<br>Troubleshooting:<br>This type of fault is not related to external components; replace the logic board. |
| 233 | DRV. SHRT B | | O | Cause:<br>The driver of one of the outputs NEV 1,.., NEV 3 is shorted.<br>Troubleshooting:<br>- Check if there is a short or a low impedance pull-down between one of the outputs and –BATT.<br>- The driver circuit is damaged in the logic board, which has to be replaced. |
| 234 | DRV. OPEN B | | O | Cause:<br>VCM is not able to drive one of the outputs NEV 1,.., NEV 3.<br>Troubleshooting:<br>This type of fault is not related to external components; replace the logic board. |
| 241 | M/S PAR CHK MISM | O | | Cause:<br>Parameters are saved both in the master Eeprom and in the slave Eeprom.<br>The two non-volatile memories must contains the same parameter values and they are compared periodically. If a difference is found, this alarm is raised. This alarm does not inhibit machine operation but default parameters are used.<br>Troubleshooting:<br>Try to save again the parameters.<br>If the fault continues when the key switch is re-cycled, replace the board. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 242 | PARAM TRANSFER | O | | Cause:<br>Parameters are saved both in the master Eeprom and in the slave Eeprom.<br>The two non-volatile memories must contains the same parameter values and they are compared periodically. If the master is not able to transfer the parameters to the slave, this alarm is raised.<br>Troubleshooting:<br>Try to save again the parameters.<br>If the fault continues when the key switch is re-cycled, replace the board. |
| 243 | COIL OPEN A | | O | Cause:<br>This fault appears when the  no load is connected between one of the outputs NEVP 1, NEVP 2….NEVP 8 and the positive terminal.<br>Troubleshooting:<br>- It is suggested to check the harness, in order to verify if some coil is connected to the right connector pin and if it is not interrupted.<br>- If, even connecting the coil to the right pin or replacing it, the alarm is still present than the problem is inside the controller logic board, replace it. |
| 244 | CHECK UP | O | | Cause:<br>This is just a warning to call for the time programmed maintenance.<br>Troubleshooting:<br>It is just enough to turn the CHECK UP DONE option to level ON after the maintenance is executed. |
| | COIL OPEN B | | O | Cause:<br>This fault appears when no load is connected between one of the outputs NEV 1….NEV 3 and the positive terminal.<br>Troubleshooting:<br>- It is suggested to check the harness, in order to verify if some coil is connected to the right connector pin and if it is not interrupted.<br>- If, even connecting the coil to the right pin or replacing it, the alarm is still present than the problem is inside the controller logic board, replace it. |
| 245 | COIL OPEN BRAKE | | O | Cause:<br>This fault appears when no load is connected between the output NEVP9 and the positive terminal.<br>Troubleshooting:<br>- It is suggested to check the harness, in order to verify if some coil is connected to the right connector pin and if it is not interrupted.<br>- If, even connecting the coil to the right pin or replacing it, the alarm is still present than the problem is inside the controller logic board, replace it. |
| 246 | NO CAN MSG.   C | O | | Cause:<br>No CAN message from traction controller.<br>Troubleshooting:<br>Check the CAN connection on traction controller side. Verify that the traction communicates on CANbus. |

| Code | Alarm | Master | Slave | Description |
|---|---|---|---|---|
| 247 | NO CAN MSG. 6 | O | | Cause:<br>No CAN message from EPS.<br>Troubleshooting:<br>Check the CAN connection on steering controller side. Verify that the steering module communicates on CANbus. |
| 248 | NO CAN MSG. 10 | O | | Cause:<br>No CAN message from DISPLAY.<br>Troubleshooting:<br>Check the CAN connection on display side. Verify that the display communicates on CANbus. |
| 249 | CAN BUS DISPLAY | O | | Cause:<br>The key relay driven by display is open.<br>Troubleshooting:<br>Check the relay. |

## 11. BATTERY CHARGER

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

### 1) BASIC INFORMATION

#### (1) What is charger

Charger is a device which makes a battery accept D.C electricity under optimal condition as it transforms A.C provided from external source of electricity.

The charger is a constant-current and constant-voltage way, SCR type charger that it has advantages as follows

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

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

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

④ It prevents from under charging and overcharging.

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

#### (2) Notice on caring chargers

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

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

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

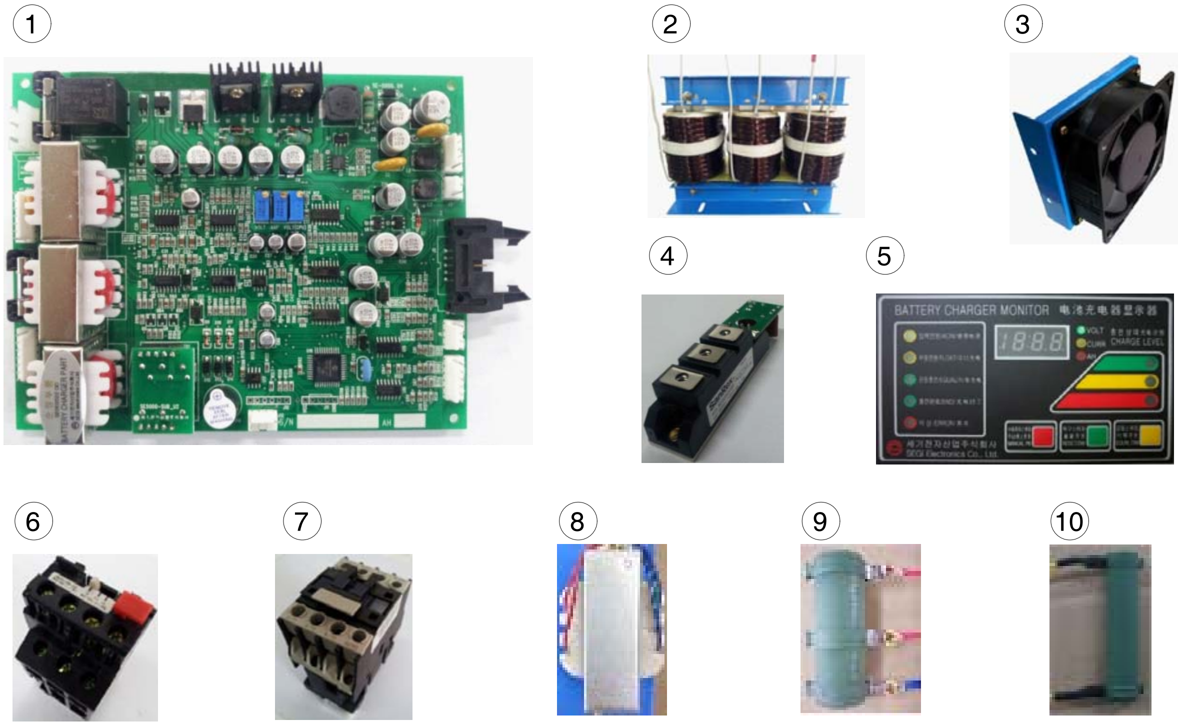
④ Check the electrolyte  of the battery every week and provide distilled water immediately if it is required. (Electrolyte has to be provided between 10~12 mm level on the positive plate inside storage battery)

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

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

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

(3) Names of each part (independent items)




22B9BAT30

1 Main PCB board
2 Main trans (Class H)
3 Cooling fan
4 SCR module
5 Monitor PCB
6 Overload
7 MG S/W
8 Assistant trans
9 Resistance (RD)
10 Resistance (DR)

## 2) CHARGER INSTALLATION METHOD

### (1) Location for charger installation

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

### (2) Check points before installing charger

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

### (3) Table for capacity of charger input cable

<table>
<tr><th>48 V battery</th><th>Capacity of cable</th><th>Input voltage</th><th>Remarks</th></tr>
<tr><td>200-365 AH</td><td>4P - 2.5 $mm^2$</td><td rowspan="10">Based on<br>3Ø380 V<br>3Ø440 V</td><td rowspan="10">For 3Ø220V, one step higher capacity cable should be used.<br>(2.5 $mm^2$ → 4$mm^2$)</td></tr>
<tr><td>400-80 AH</td><td>4P - 4 $mm^2$</td></tr>
<tr><td>600-800 AH</td><td>4P - 6 $mm^2$</td></tr>
<tr><td>850-1000 AH</td><td>4P - 10 $mm^2$</td></tr>
<tr><td>24 V battery</td><td>-</td></tr>
<tr><td>200-600 AH</td><td>4P - 2.5 $mm^2$</td></tr>
<tr><td>700-1000 AH</td><td>4P - 4 $mm^2$</td></tr>
<tr><td>80V battery</td><td>-</td></tr>
<tr><td>500-600 AH</td><td>4P - 6 $mm^2$</td></tr>
<tr><td>700-800 AH</td><td>4P - 10 $mm^2$</td></tr>
</table>

### 3) HOW TO USE A CHARGER

(1) General charging method (Floating charging)

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

② Connect battery connecter and charger connecter.


22B9BAT01

· According to charging condition

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

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

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

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

BOP7BAT02

(2) Equalized charging

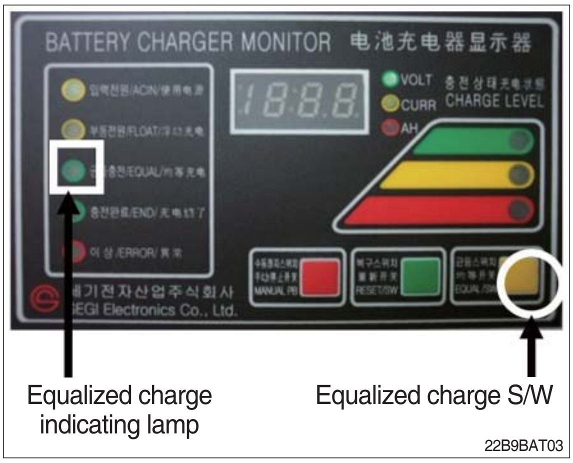
① Equalized charging is
Equalized charging is to correct the battery when it does not normally perform its functions as the voltage differences are too big between cells of a battery.
When equalized charging is required?

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

② Tips for equalized charging

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

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




22B9BAT03

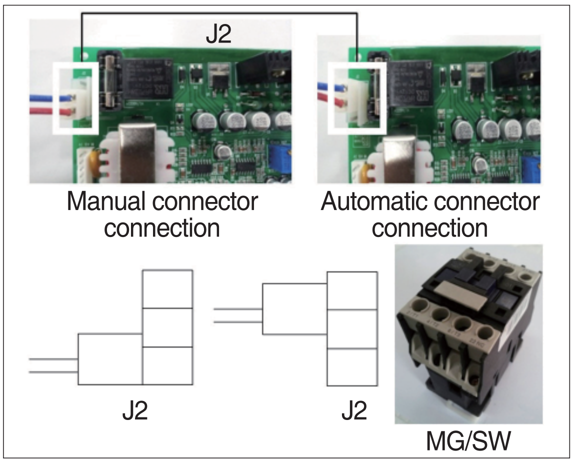
**(3) Automatic/Manual switching method**

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

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

⊙ MG/SW operation

(Refer to the charger trouble SHEET components manual)




22B9BAT04

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

① Plug it into a manual connector and input after 5 sec., a floating charge, charging status red LED lights up.

② After 15 sec., charging status yellow LED lights up.

③ After a green LED lights up, if measured voltage comes out as lulua63V ~ lula64V by measuring output voltage of battery connector side with multi-meter, then it is normal.

④ After 30 sec. of switching to a manual connector, if a buzzer sound rings continuously for 10 sec. and completion LED lights up, then it is normal.

⑤ If you confirm that the charger operates in normal after checking manual switching of the charger, make sure that the charger is switched to automatic.


BOP7BAT10

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

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

※ **Display error code on the front cover as following table.**

22B9BAT11

| No | Code | Description of error |
|---|---|---|
| 1 | E.F | EPROM fail |
| 2 | O.V | Over voltage - Refer to page 7-86 |
| 3 | O.C | Over current - Refer to page 7-85, 7-87. |
| 4 | F.B | Battery error (After starting charging, the voltage doesn't go over 52V for 2 hours.)<br>Check the battery. |
| 5 | O.T | Transformer over heat (Stop charging when it is over 160°C).<br>- If input voltage is high, output current is over normal value and there is heat in the trans because of SCR control part fault.<br>- Check the output current and PCB control board |
| 6 | O.H | Heatsink over heat (Stop charging when it is over 100°C).<br>- Check the cooling fan, SCR connection cable contact point and control part. |
| 7 | A.O | Power supply error (input power 220/380V wrong wiring). - Refer to page 7-84. |
| 8 | A.F | Power supply error (absent phase) - Check if input cable is open. |
| 9 | A.C | AC fail (black out) - Check if input voltage is right. |
| 10 | L.C | Low current (If this sign is on for setting value (60 sec), charging is over). |
| 11 | F | Manual stop. |

### 4) CHECK POINTS BEFORE APPLYING A/S

(1) AC input power source switch is input.

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

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

(4) Check the front cover indicator.

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

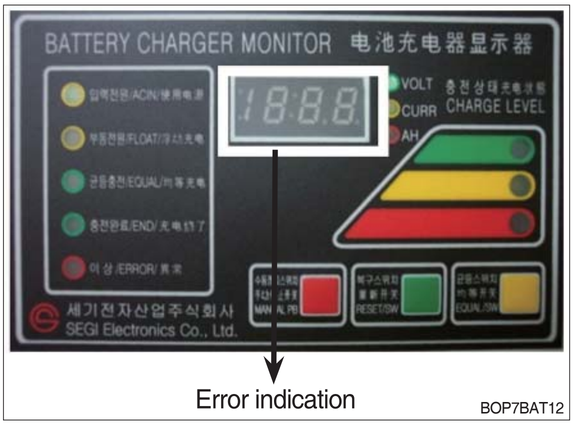
② A.O : Error on selection of input power source of 220V or 380V - Check it appropriately with full three phases.

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

④ O.C : Check the electric current, as charging current of the battery is over-standards condition.

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

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



BOP7BAT12

## 5) ERROR DETECTION

### (1) Error list

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

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

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

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

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

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

⑦ SCR module checking method

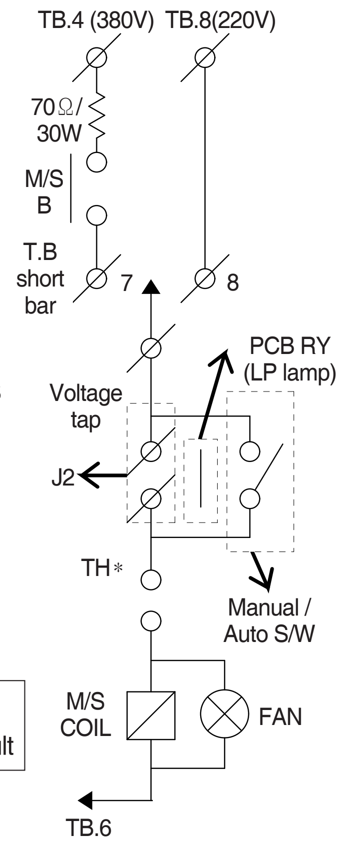
## (2) Troubleshooting

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

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

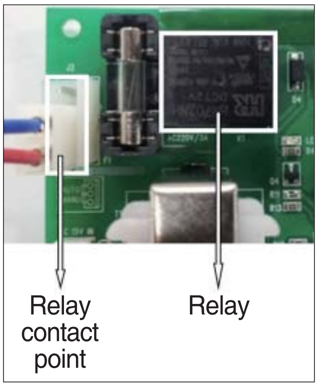
MS electric socket

Manual/Auto TAP (J2)

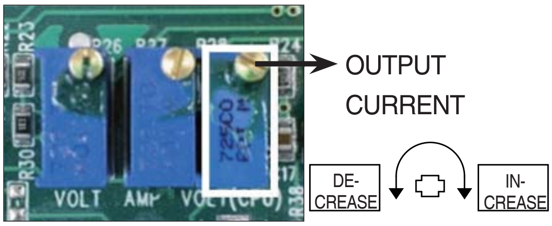



M/S electrical circuit

**Check the rated voltage**
- YES → Insert automatic/manual connector (J2) at the upper part of PCB to manual, after separating battery connector. → **AC INPUT MS switch ON**
  - YES → **PCB LP lamp lights up**
    - YES → CN4 contact fault / PCB RY contact fault
    - NO → Change PCB
  - NO → Put a black lead of multi-tester to input voltage switch No. 6 and measure voltage between tab No.8,PCB CN4,TH contact points with a red lead. → **Voltage 220V**
    - YES → MS COIL fault
    - NO → TH contact fault / CN4 contact fault / PCB RELAY fault / TH manual restoration release
- NO → Input power supply is not supplied.
  - Check external lead cable.
  - Check the connection of external input connecter
  - Check external NFB TRIP



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




Trans noise is severe at MS ON status

NO

Measure output current using DC current measure

Current value : 10~16A /100AH

NO

Exceed Standard current

Adjust output current AMP, VR within PCB Re-adjust to VR

YES

· TH Setting fault
· Re-adjust TH setting value

TH. TRIP

YES

Change TH

NO

Complete

Rated Current SETTING

YES

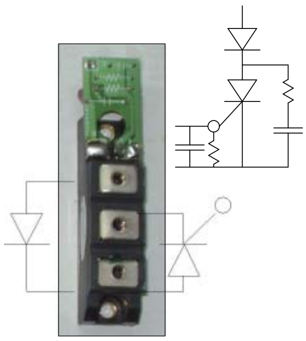
Complete

NO

Change PCB

YES

* Refer to SCR Module checking method



Separate the battery connector and tune the charger off

Check SCR Module

NO

Change SCR MODULE

YES

Check MAIN TRANS VOLT

NO

Change PCB

YES

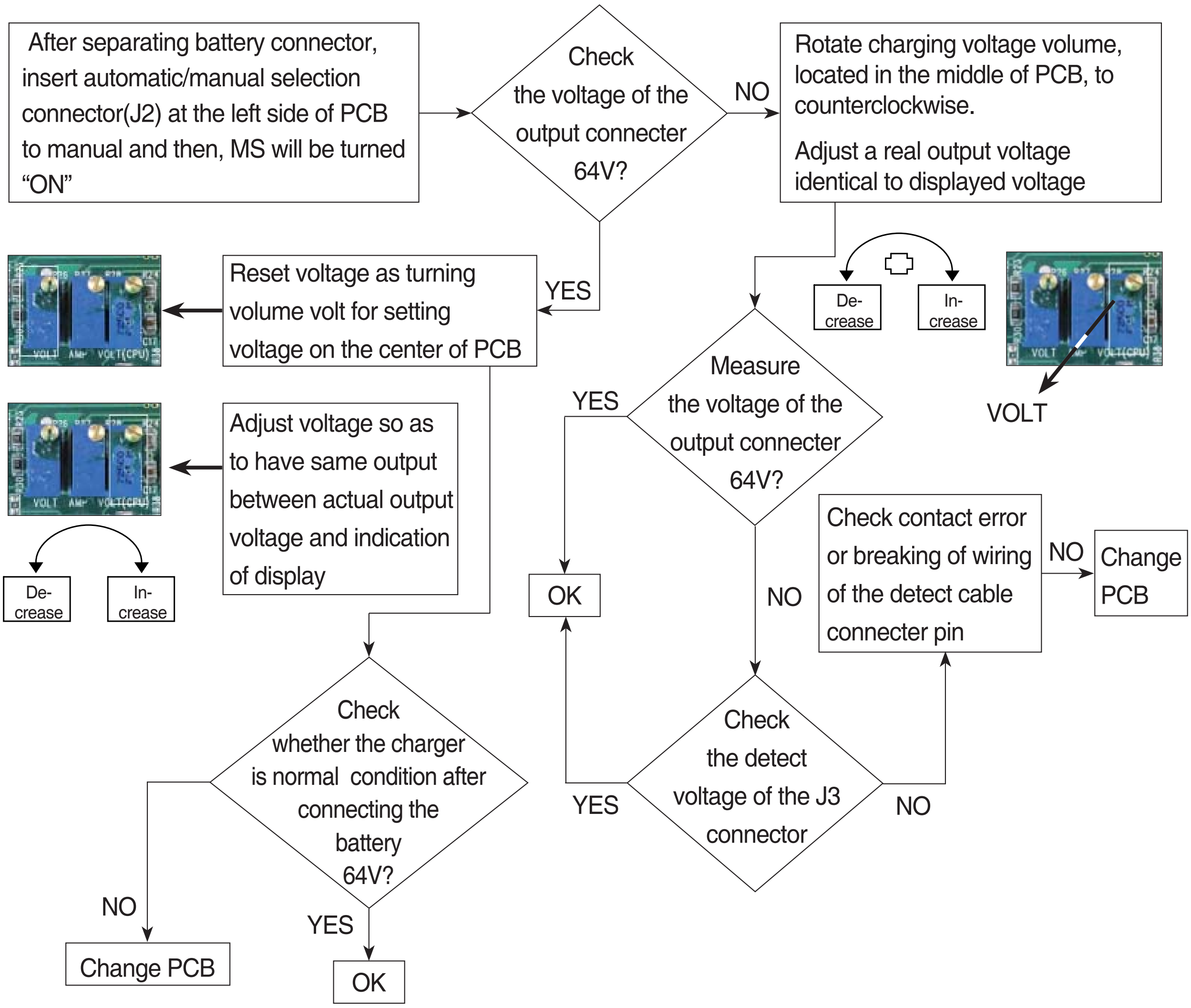
Check the normal operating condition of the charger

③ Charger TRIP is occurred after abnormality lamp is on.

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

34V (In case of BATT 24V)

108V (In case of BATT 80V)



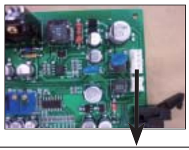
④ Charger TRIP is occurred after abnormality lamp is on.
After opening the cover which is located on the front bottom side of the charger.
In case error code is "O.C" → Output over current, established as 110~120% of the rated current.

Restart the charger as pushing reset switch in the monitor.


Monitor display

Measure the output current by DC current measure 10~16A/100AH

NO

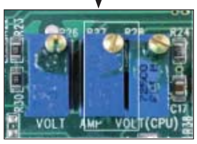


Check poor contact of current connector (J1), located right side of PCB; check if there is disconnection (cleaning and wiring )

YES

Re-establish charge current volume (AMP) on the center side of PCB as turning it anti clockwise rotation

Request A/S if problem persists after adjustment




De-crease

In-crease

Measure the output current by DC current measure

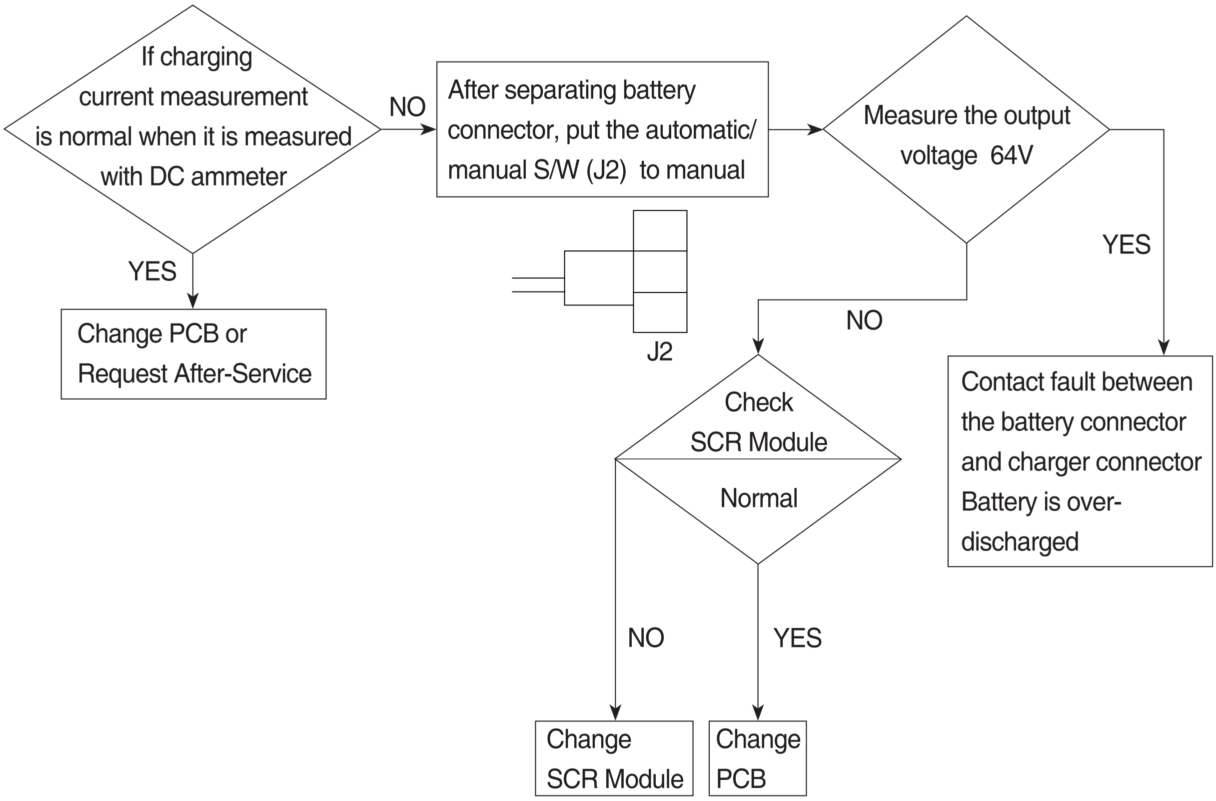
YES

OK

NO

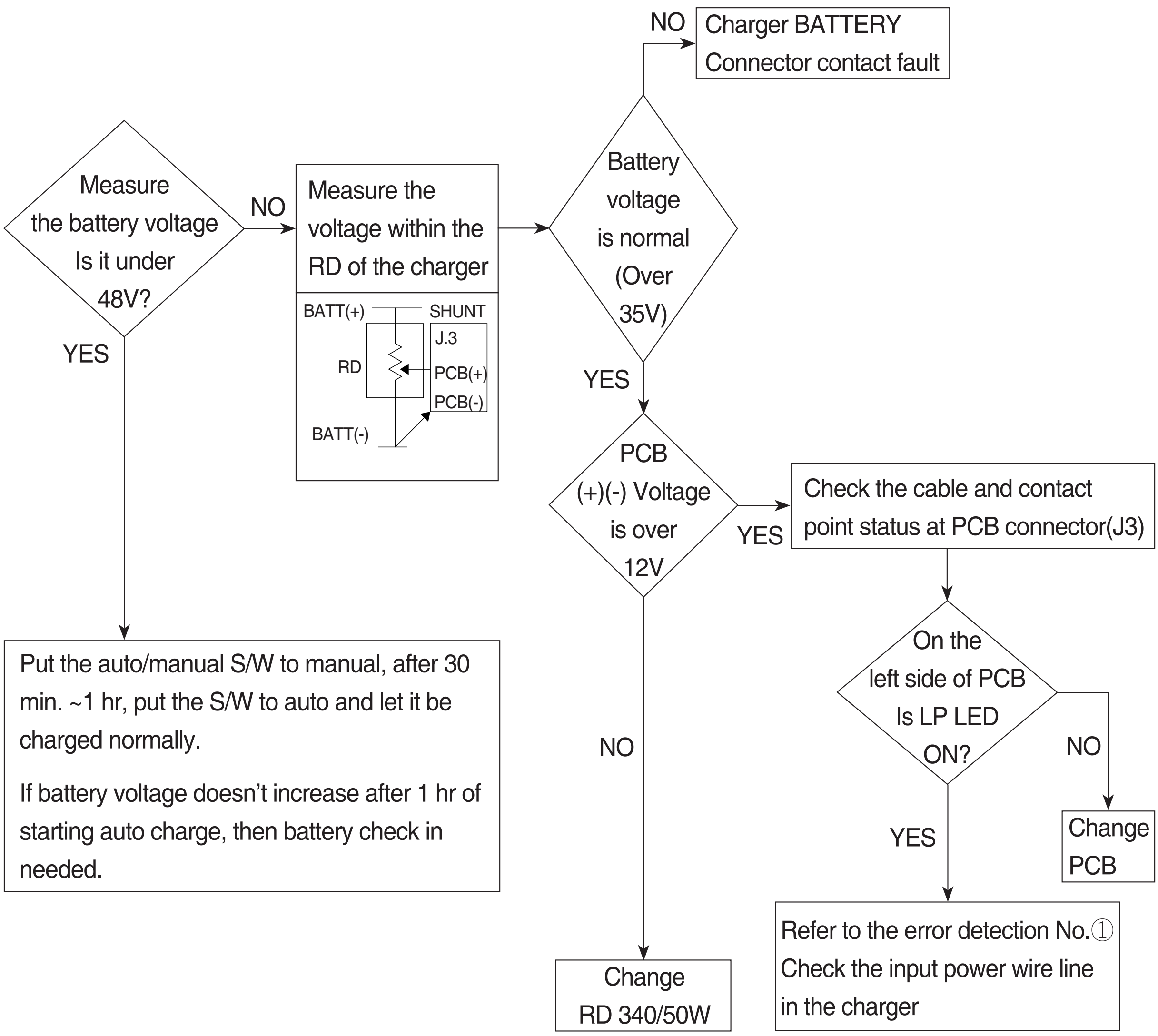
Change PCB

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



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

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





BATT(+)

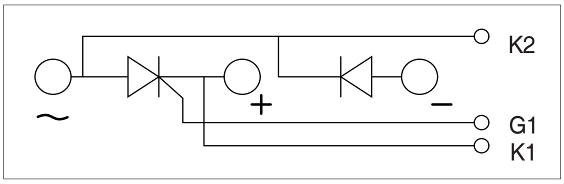
70Ω 12V or higher

BATT(-)

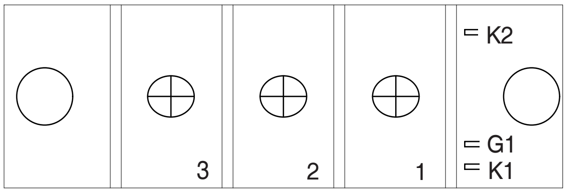
( based on 48V)

## 7) HOW TO CHECK THE SCR MODULE

Circuit

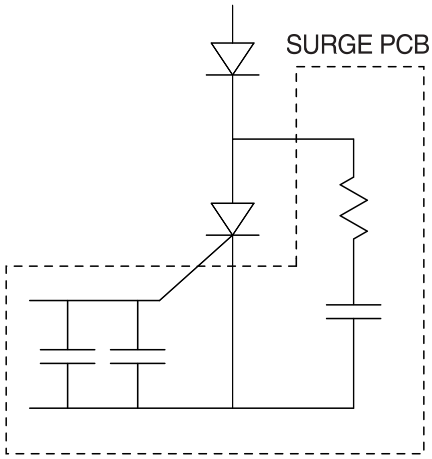



Real diagram

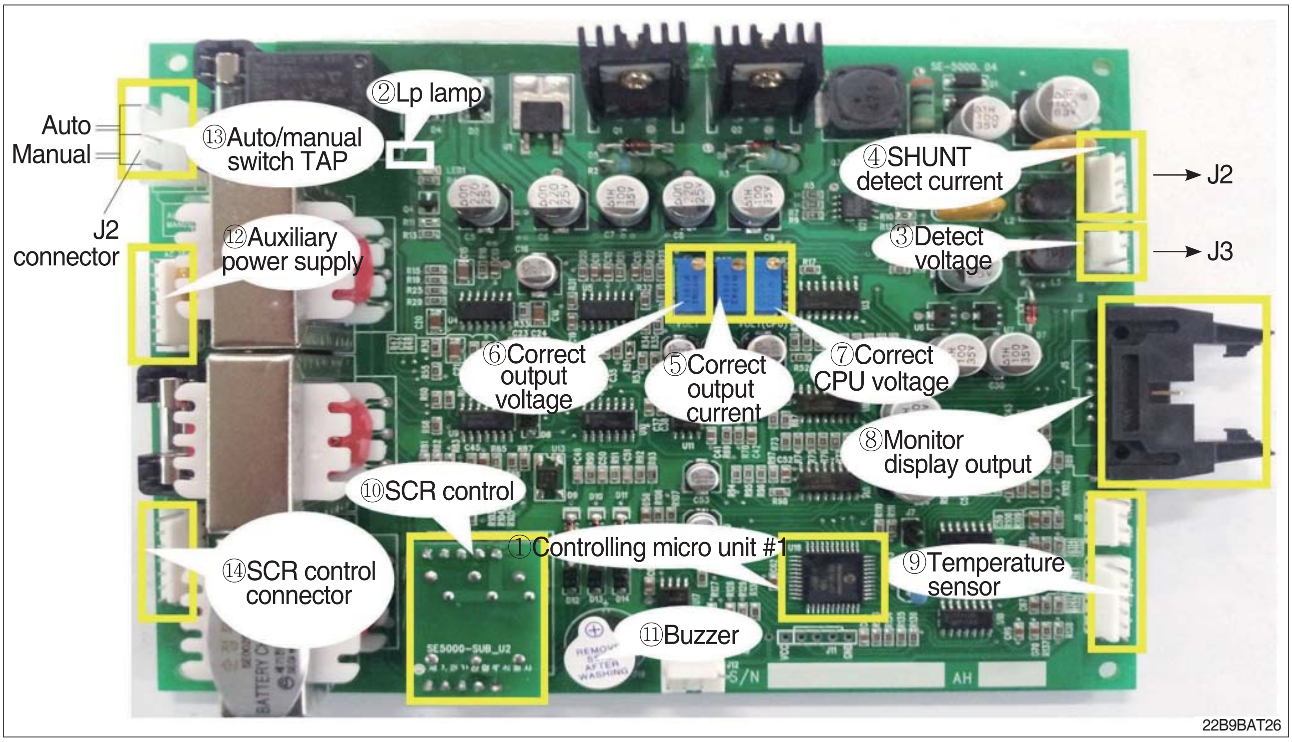



* Before checking SCR MODULE, be sure to disconnect bus bar and wire on the terminal.

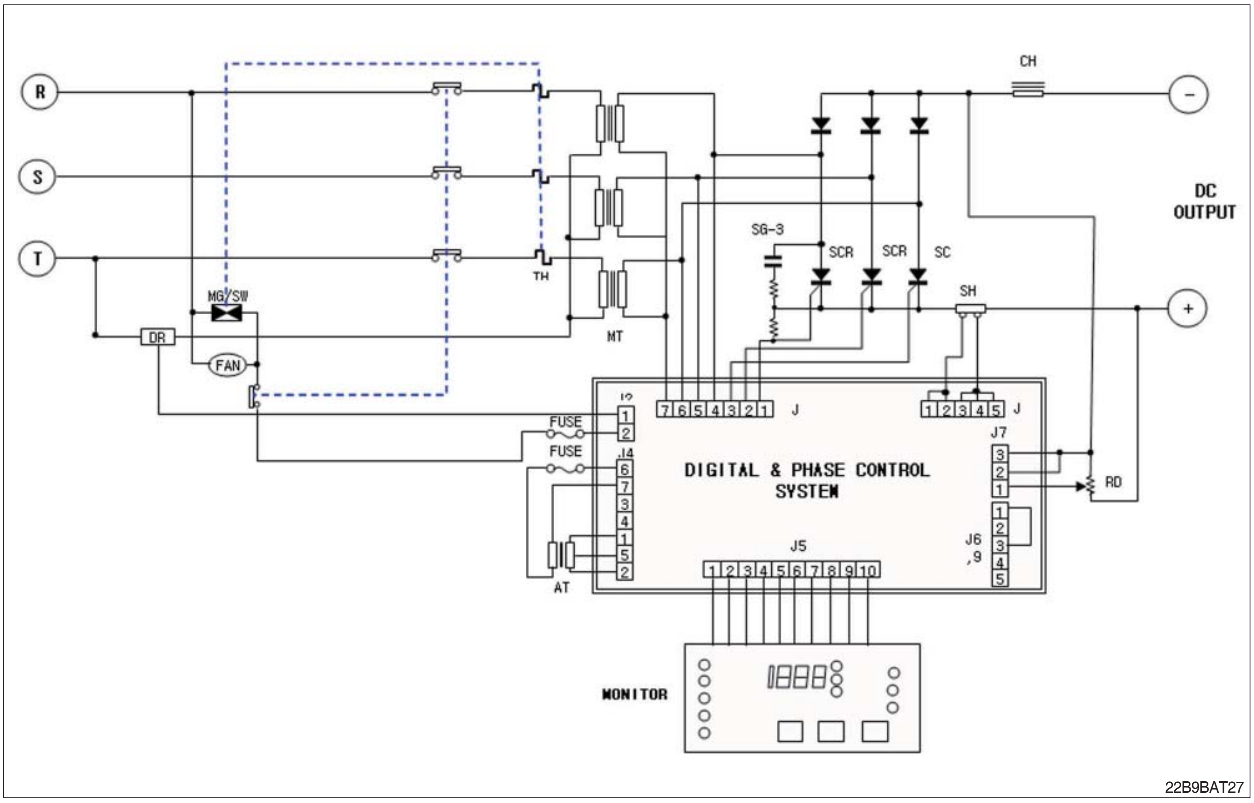
| No. | Measuring point (Real diagram) | Measure value (Measurement of digital tester) |
|---|---|---|
| 1 | No.1 ~ No.3 | Forward : Under 100 k ohm<br>Reverse : Infinity ( ∞ ) |
| 2 | No.2 ~ No.3 | Forward : Infinity ( ∞ )<br>Reverse : Infinity ( ∞ ) |
| 3 | G1 ~ K1 | Forward : Under 100 ohm<br>Reverse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



## 8) PCB MAJOR PARTS (NAME AND LOCATION)

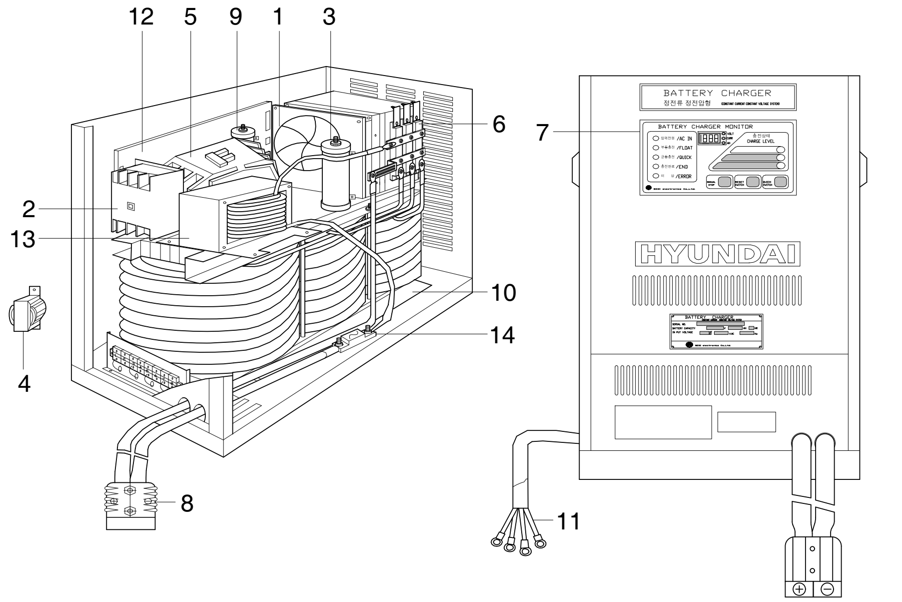



| | | | | | |
|---|---|---|---|---|---|
| 1 | Controlling MICOM #1 | 6 | Correct output voltage | 11 | Buzzer |
| 2 | Lp lamp | 7 | Correct CPU voltage | 12 | Auxiliary power supply |
| 3 | Detect voltage | 8 | Monitor display output | 13 | Auto/manual switch TAP |
| 4 | SHUNT detect current | 9 | Temperature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



R
S
T
CH
DC
OUTPUT
SG-3
SCR
SCR
SC
TH
MG/SW
DR
FAN
MT
SH
J
J
J2
FUSE
FUSE
J4
J7
RD
DIGITAL & PHASE CONTROL
SYSTEM
J5
J6
,9
AT
MONITOR
22B9BAT27

## CHARGER INTERIOR PARTS



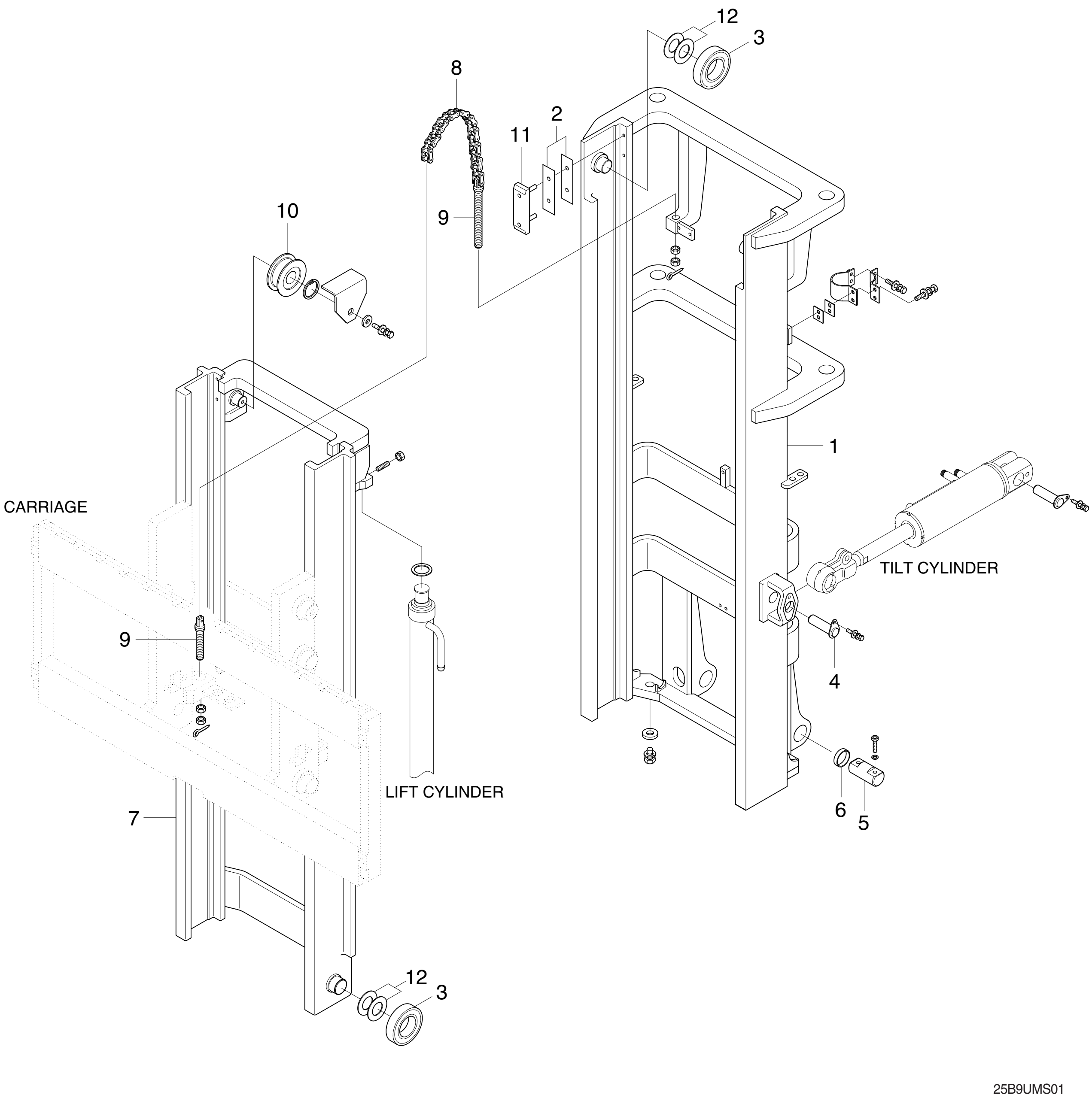

22B9BAT28

1 AC fan
2 Over load
3 Resistor assy - RD
4 Auxiliary trans
5 Magnet switch
6 SCR module
7 Monitor board assy
8 DC output cable
9 DR resistor
10 Main transformer
11 AC input cable
12 Main board assy
13 Choke filter
14 Fuse

# SECTION 8 MAST

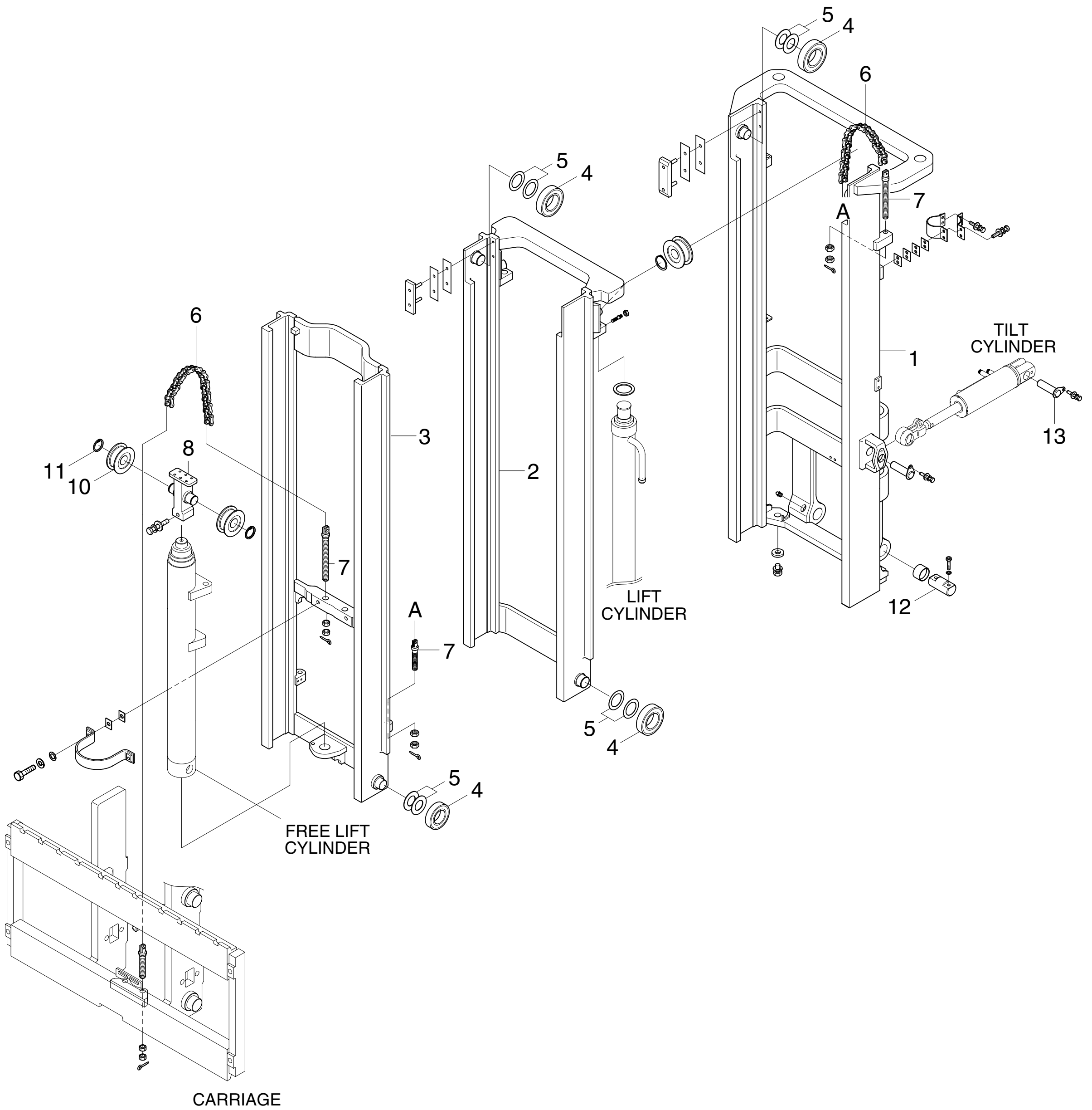
## GROUP 1 STRUCTURE

### 1. 2 STAGE MAST (V MAST)



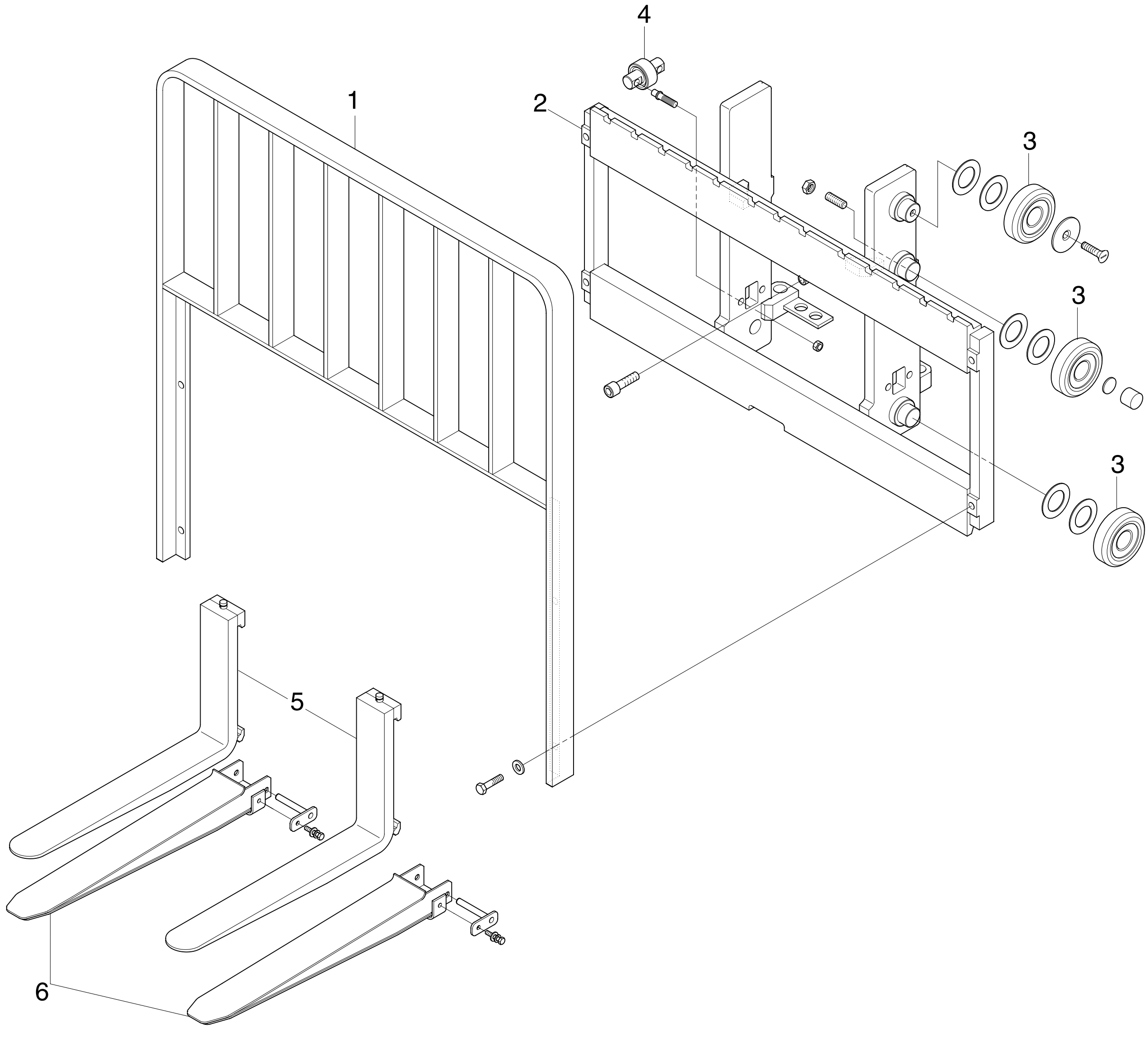

| | | | | | |
|---|---|---|---|---|---|
| 1 | Outer mast | 5 | Mast mounting pin | 9 | Anchor bolt |
| 2 | Shim (0.5, 1.0t) | 6 | Bushing | 10 | Chain sheave |
| 3 | Roller | 7 | Inner mast | 11 | Back up liner |
| 4 | Tilt cylinder pin | 8 | Lift chain | 12 | Shim (0.5, 1.0t) |

## 2. 3 STAGE MAST (TF MAST)




| | | | | | |
|---|---|---|---|---|---|
| 1 | Outer mast | 5 | Shim (0.5, 1.0t) | 10 | Chain sheave |
| 2 | Middle mast | 6 | Lift chain | 11 | Retaining ring |
| 3 | Inner mast | 7 | Anchor bolt | 12 | Mast mounting pin |
| 4 | Roller | 8 | Sheave bracket | 13 | Tilt cylinder pin |

## 3. CARRIAGE, BACKREST AND FORK



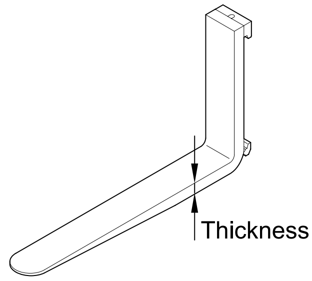

| | | | | | |
|---|---|---|---|---|---|
| 1 | Backrest | 3 | Load roller | 5 | Fork assembly |
| 2 | Carriage | 4 | Side roller | 6 | Extension fork |

## GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

### 1. OPERATIONAL CHECKS

#### 1) FORKS

(1) Measure thickness of root of forks and check that it is more than specified value.
- · EU, N/America : 1200 mm (47.2 in)
- · Except above : 1050 mm (41.3 in)



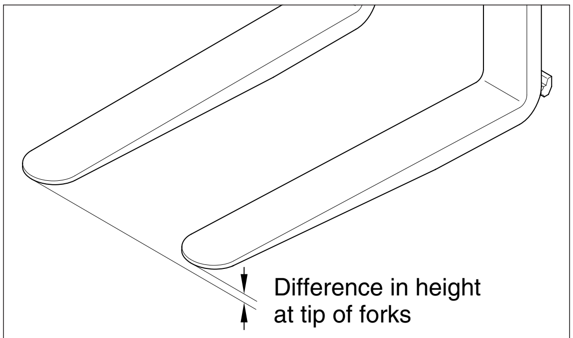
B153FK01

mm (in)

| Country | STD Fork assy | Model | Std | Limit |
|---|---|---|---|---|
| EU, N/America | 64HN-21030 | 25B-9U | 45 (1.8) | 40 (1.6) |
| | 64HN-31020 | 30/32/35B-9U | 45 (1.8) | 40 (1.6) |
| Except adove | 64HN-21040 | 25B-9U | 45 (1.8) | 40 (1.6) |
| | 64HN-31040 | 30/32/35B-9U | 45 (1.8) | 40 (1.6) |

(2) Set forks in middle and measure difference in height at tip of forks.

| Model | Fork length (mm) | Height difference(mm) |
|---|---|---|
| All | equal or below 1500 | 3 |
| | above 1500 | 4 |



D255FK02

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

#### 2) MAST

(1) Check for cracks at mast stay, tilt cylinder bracket, guide bar, fork carriage and roller shaft weld. Check visually or use crack detection method. Repair any abnormality.

(2) Set mast vertical, raise forks about 10cm from ground and check front-to-rear clearance and left-to-right clearance between inner mast and fork carriage, and between outer mast and inner mast. Use these figures to judge if there is any play at roller or rail.
- · Front-to-rear clearance : Within 2.0 mm (0.08 in)
- · Left-to-right clearance : Within 2.5 mm (0.10 in)

(3) Check that there is an oil groove in bushing at mast support.

(4) Set mast vertical, raise forks about 10cm from ground, and push center of lift chain with finger to check for difference in tension.
If there is any difference in tension, adjust chain stopper bolt.

(5) Check visually for abnormalities at thread of chain anchor bolt, and at contact surface between chain wheel and chain.
Rotate chain wheel by hand and check for any play of bearing.

## 2. TROUBLESHOOTING

### 1) MAST

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

2) FORKS

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

## GROUP 3 ADJUSTMENT

### 1. MAST LOAD ROLLER (V, VF MAST)

#### 1) INNER/OUTER MAST ROLLER CLEARANCE ADJUSTMENT

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

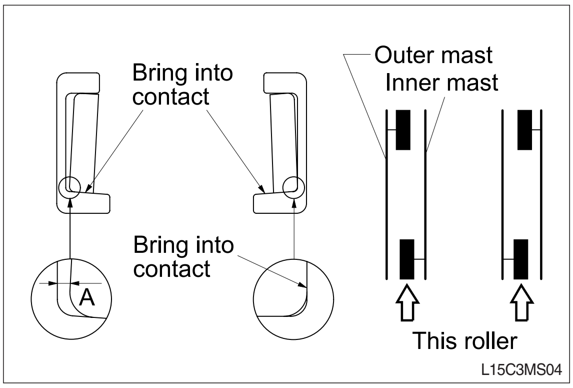
(2) Shift the inner mast to one side to bring the roller into contact with the outer mast, and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the inner/outer mast roller shim.

· Standard clearance A, B = 0~0.6 mm

· Shim thickness 0.5, 1.0 mm

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

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



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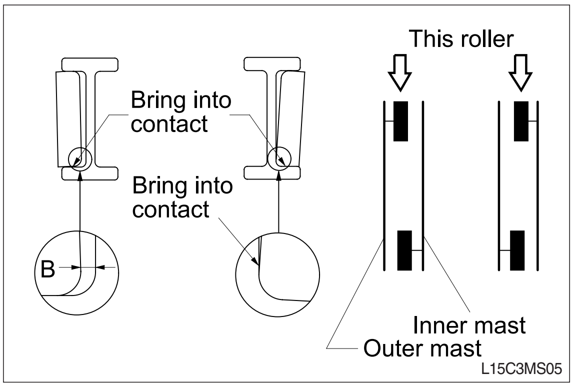

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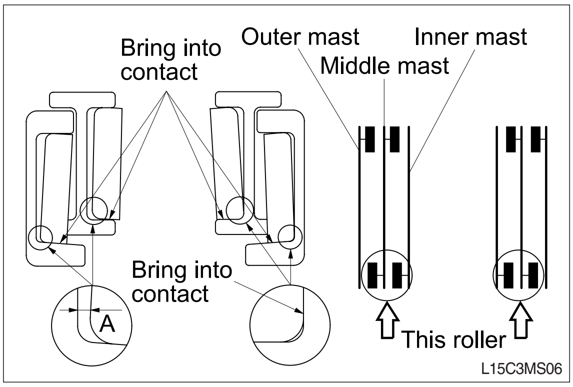
## 2. MAST LOAD ROLLER (TF MAST)

### 1) INNER AND MIDDLE MAST ROLLER CLEARANCE ADJUSTMENT



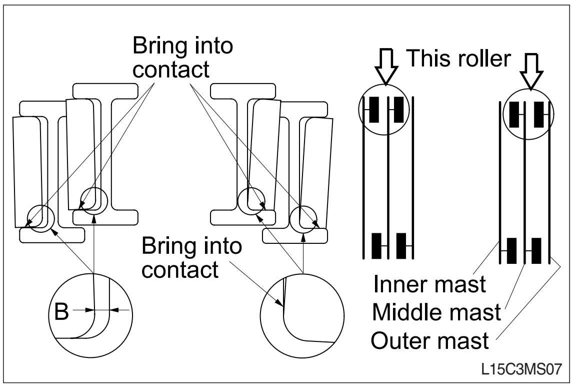

(1) Measure the clearance with the mast overlap at near 480 mm.

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

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

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

### 2) OUTER AND MIDDLE MAST UPPER ROLLER CLEARANCE ADJUSTMENT



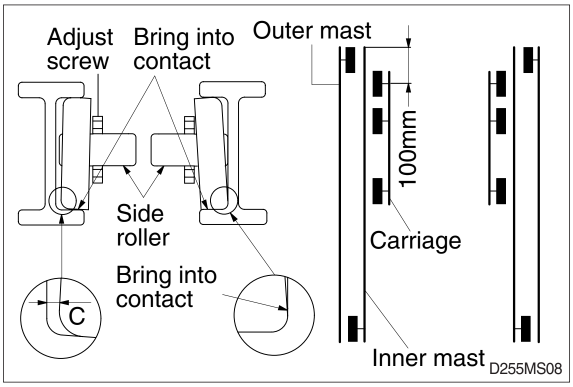

(1) Measure the clearance with the mast overlap at near 480 mm.

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

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

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

### 3) CARRIAGE LOAD ROLLER



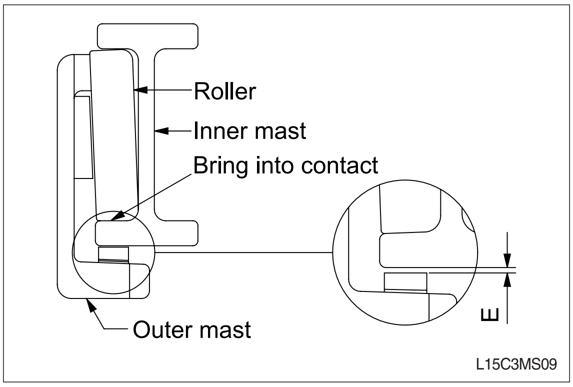

(1) Measure the clearance when the center of the carriage upper roller is 100 mm from the top of the inner mast.

(2) Measure the clearance at upper, middle and lower rollers after loosen the adjust screws from the side rollers. Shift the carriage to one side to bring the roller into contact with the inner mast, and measure the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the carriage roller shim.
- · Standard clearance C = 0~0.6 mm
- · Shim thickness 0.5, 1.0 mm

(3) Distribute the shim thickness equally to the left and right roller. Refer to Carriage assembly.

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

### 4) MAST BACK UP LINER




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

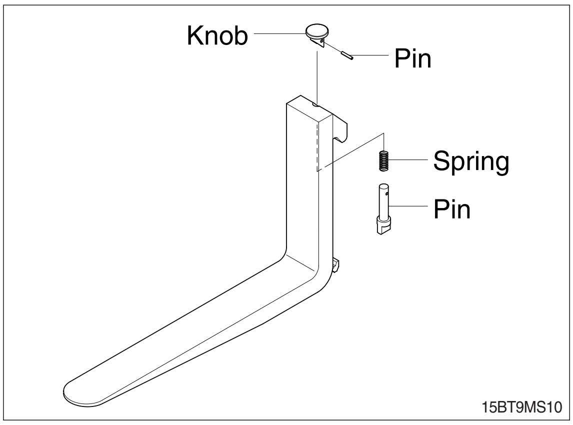
(2) With the middle mast in contact with the outer mast roller, adjust the clearance between the mast back up liner and middle mast to the following value by inserting the back up liner shim.
- · Standard clearance E = 0.2 ~ 0.6 mm
- · Shim thickness 0.5, 1.0 mm

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

## GROUP 4 REMOVAL AND INSTALLATION

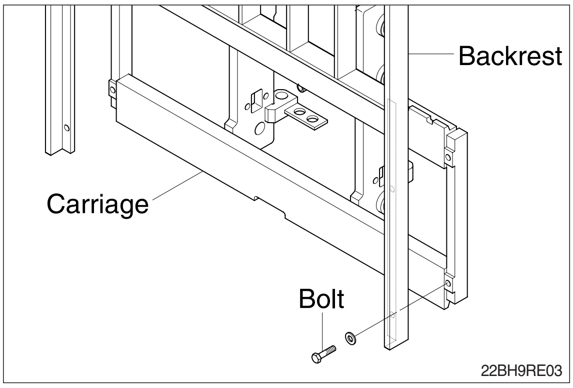
### 1. FORKS

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




### 2. BACKREST

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




### 3. CARRIAGE ASSEMBLY

#### 1) CARRIAGE

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

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

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

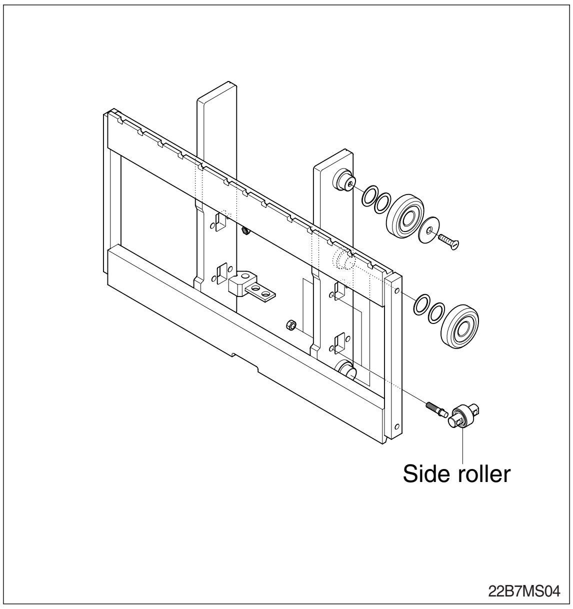
**⚠ Replace the split pin of chain anchor with new one.**

2) SIDE ROLLER

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

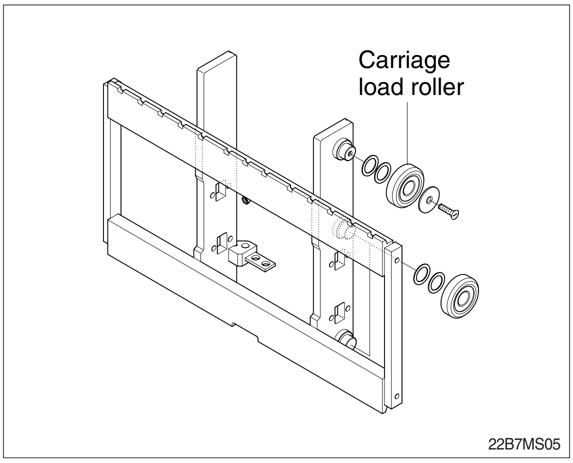
※ Adjustment

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




3) CARRIAGE LOAD ROLLER

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



## 4. MAST LOAD ROLLER AND BACK UP LINER

### 1) 2 STAGE MAST (V MAST)

(1) Remove the carriage assembly and move them to one side.

(2) Loosen and remove hexagon bolts and washers securing lift cylinders to inner mast.

(3) Loosen and remove hexagon bolts and nuts securing lift cylinders to inner mast.

(4) Attach chains or sling to the inner mast section at top crossmember. Using an overhead hoist, slowly raise the inner mast high enough to clear lift cylinder.

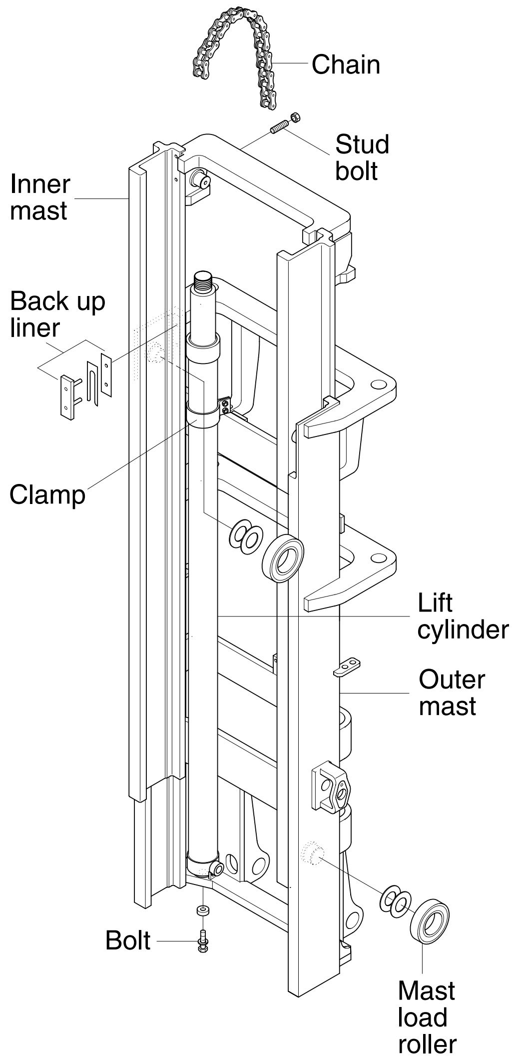
(5) After lowering the lift cylinder rods, and disconnecting lift cylinder hose, tilt the lift cylinders LH and RH and them with ropes to the outer mast.

(6) Using the overhead hoist, lower inner mast until top and bottom rollers and back up liners are exposed.

(7) Using a pryer, remove load rollers from load roller bracket. Remove back up liners and shims.

(8) Thoroughly clean, inspect and replace all worn or damaged parts.

(9) Reverse the above procedure to assemble. Refer to MAST LOAD ROLLER ADJUSTMENT paragraph.

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## 2) 3 STAGE MAST (TF MAST)

(1) Remove the carriage assembly and move it to one side.

(2) Loosen and remove hexagon bolt securing bottom cylinder from outer mast.

(3) Loosen and remove band and special washers securing lift cylinders to middle mast. Remove the spring pin.

(4) Attach chains or sling to the inner and middle mast section at top crossmember. Using an overhead hoist, slowly raise the uprights high enough to clear lift cylinder.

(5) After lowering the lift cylinder rods, and disconnecting lift cylinder hose, tilt the lift cylinders LH and RH and tie them with ropes to the outer mast.

(6) Using the overhead hoist raise inner and middle masts. Place 4 inch block of wood under the free lift cylinder bracket of the inner mast then lower mast sections (this will create slack in the chains).

(7) Remove retaining rings securing chain sheaves to sheave support brackets. While support chains, remove chain sheaves and let chains hang free. The upper outer and lower middle mast rollers and back up liners are now exposed.

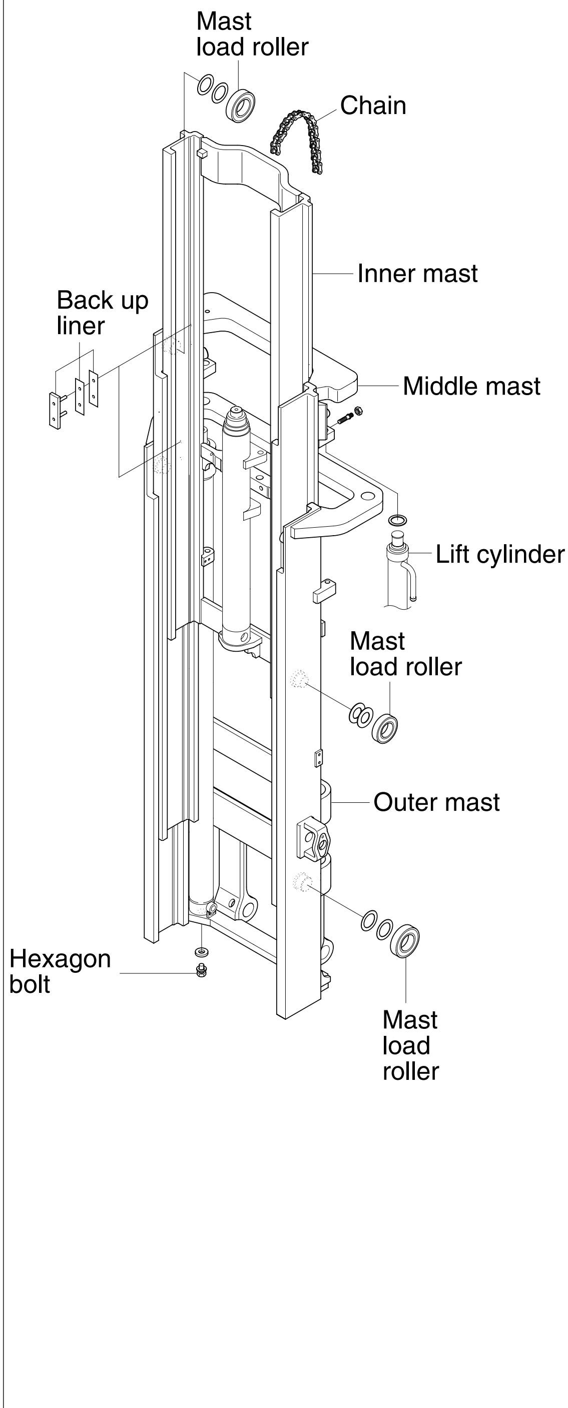
(8) Using a player, remove load rollers from load bracket. Remove back up liners and shims.

(9) Attach chains or sling to the middle mast section at top crossmember. Using an overhead hoist, slowly raise the middle mast until top and bottom rollers are exposed.

(10) Using a pryer, remove load rollers from load roller bracket.

(11) Thoroughly clean, inspect and replace all worn or damaged parts.

(12) Reverse the above procedure to assemble. Refer to MAST LOAD ROLLER ADJUSTMENT paragraph.



## 5. ELEVATING MAST

### 1) INNER MAST (V MAST)

(1) After completing all necessary steps for load rollers and back up liner removal use an overhead hoist and sling or chain around upper crossmember of the inner mast section.

(2) Lift inner mast upright straight up and out of outer mast section.

(3) Replace and reverse above procedure to install. Make all necessary measurements and adjustments.

### 2) INNER AND MIDDLE MAST (TF MAST)

(1) After completing all necessary steps for load rollers and back up liner removal. Remove rear chains and sheave support if not already done.

(2) Disconnect free lift cylinder hose. Drain hose into a suitable pan or container and cap hose.

(3) While supporting free lift cylinder assembly, remove bolts and washers securing cylinder to mast crossmember.

(4) Place a sling around free lift cylinder and attach to an overhead hoist. Slowly raise and move cylinder to one side.

(5) Attach chains or sling to the inner mast section at top crossmember. Using an overhead hoist slowly raise the upright straight up and out of middle mast section.

(6) Attach chains or sling to the middle mast section at top crossmember. Using an overhead hoist slowly raise the upright straight up and out of outer mast section.

(7) Replace upright and reverse above procedure to install. Make all necessary measurements and adjustments.

## 6. CHAIN

### 1) CHAIN SHEAVE (V MAST)

(1) Place a sling around carriage and attach to an overhead hoist. Lift carriage high enough so that the tension on the chain over sheaves is relieved after the carriage is blocked. Position wooden blocks under the carriage and lower it.

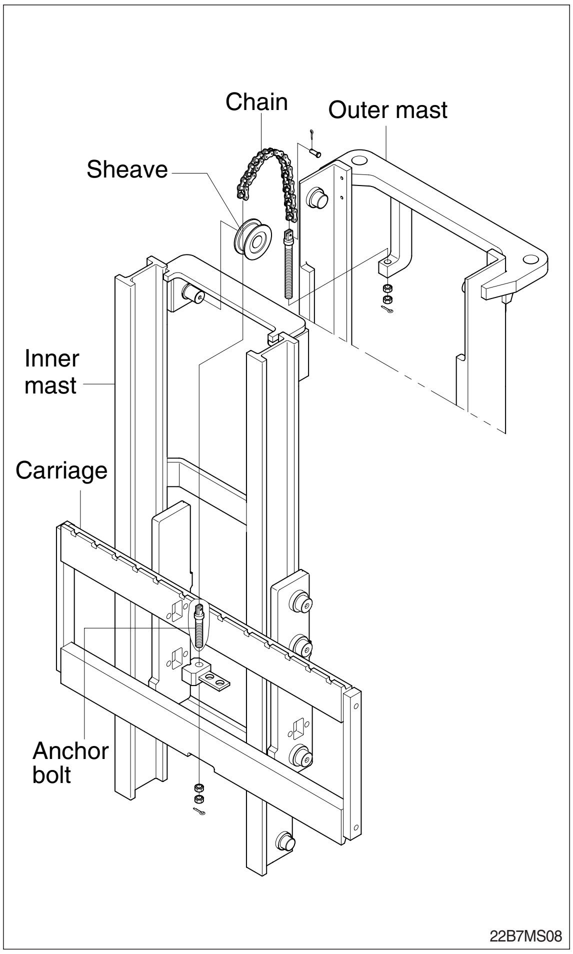
(2) Remove the split pin securing the chain anchor pins and discard.
While supporting the chains, remove the chain anchor pins and drape the chains over the carriage.

(3) Remove retaining ring securing sheaves to sheave support. Remove sheaves with bearings.

(4) Remove bearing retaining ring from sheave and press bearings from sheaves.

(5) Thoroughly clean, inspect and replace all worn or damaged parts.

(6) Reverse the above to assemble and install. Use new split pins in chain anchor pins.




### 2) REAR CHAIN SHEAVE (TF MAST)

(1) Raise and securely block carriage and inner mast section.

(2) Remove the split pin securing the chain anchor pins and discard. While supporting the chains, remove the chain anchor pins from outer mast section.

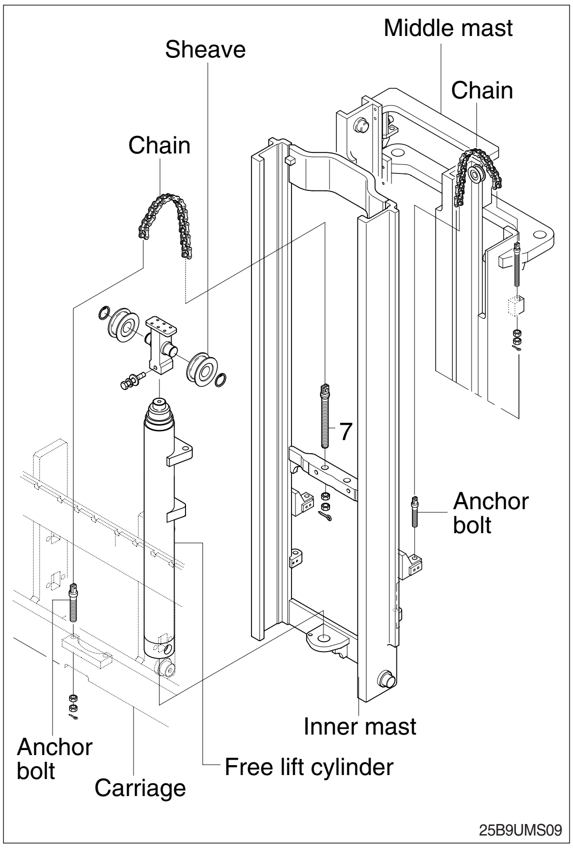
(3) Remove chains.

(4) Remove retaining ring securing chain sheaves to sheave support. Pry off sheaves with bearings.

(5) Remove bearing retaining ring from sheave and press bearings from sheaves.

(6) Thoroughly clean, inspect and replace all worn or damaged parts.

(7) Reverse the above procedure to assemble and install. Use new split pins in chain anchor pins.



### 3) CHAIN WHEEL BEARING SUPPORT (TF MAST)

(1) Remove the carriage assembly and move to one side.
After removing bolt to securing chain wheel bearing support assembly to free lift cylinder.

(2) After a sling to the chain wheel bearing support assembly. Using an overhead hoist, lift support assembly straight up and off of free lift cylinder. Move assembly to work area.

(3) Remove retaining ring securing chain wheel bearing to chain wheel bearing support.

(4) Remove bearing retaining ring from chain wheel bearing and press bearings from chain wheel bearings.

(5) Thoroughly clean, inspect and replace all worn or damaged parts.

(6) Reverse the above procedure to install.

### 4) REAR CHAIN (TF MAST)

(1) Remove the carriage assembly and move to one side. Refer to carriage removal and installation.

(2) Raise and securely block truck approximately 6 inches from the floor.

(3) Using a sling or chain around inner mast section attached to an overhead hoist, slowly raise inner mast until there is enough slack in the chains to remove them. Block inner mast section.

(4) Remove split pins and chain anchor pins securing chains to chain anchor (part of inner mast).
While supporting the chains, remove split and chain anchor pins securing chains to chain anchors attached to outer mast section.

(5) Remove chains.

(6) Reverse the above to assemble and install. Use new split pins in chain anchor pins. Refer to this

(7) section for Load chain lubrication and adjustment.

### 5) CARRIAGE CHAIN

(1) Place a sling around carriage front plate and attach to an overhead hoist. Lift and secure carriage high enough so that split and chain anchor pins on carriage can be easily be removed.
Remove chain anchor pins from carriage and drape chains out over carriage.

(2) Place a wooden block under the carriage and lower the carriage on the block.

(3) While supporting the chains, remove split pins and chain anchor pins from chain anchors.

(4) Remove chains and wash them with solvent. Refer to this section for Load chain inspection and maintenance.

(5) Reverse the above procedure to assemble and install. Use new split pins in chain anchor pins.
Refer to this section for Load chain lubrication and adjustment.

### 6) LOAD CHAIN INSPECTION AND MAINTENANCE

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

#### (1) Wear

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

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

(2) Rust and corrosion

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

(3) Cracked plate

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

(4) Tight joints

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

Tight joints in lift chains can be caused by :

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

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

(5) Protruding or turned pins

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

(6) Chain side wear

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

(7) Chain anchors and chain wheel bearings

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

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

(8) Chain wear scale

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

· Determine pitch length of chain using 6 inch scale on one side of wear scale.
· If pitch is 1/2 (12.7 mm), 3/4 (19.05 mm), 1 (25.4 mm), 1-1/2 (38.1 mm), 2 (50.8 mm), use side A of scale.
· If pitch is 5/8 (15.875 mm), 1-1/4 (31.75 mm) or 2 (50.8 mm), use side B.
· Align point A or B to center of a pin and note position of the opposite A or B point.
· If other point also lines up with a pin, the chain is worn and should be replaced.

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

7) LOAD CHAIN LUBRICATION AND ADJUSTMENT

(1) Lubrication

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

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

⚠ Wear eye protection.

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

(2) Replacement

Replace chains as a pair. It will be virtually impossible to maintain uniform loading between the strands if a new chain is put into service opposite an old chain. The joints in the old chain will be greater than that on the new chain, greatly complicating the problem of maintaining equal chain tension. The new chain will wear more slowly causing it to bear the major portion of the load resulting in premature wear and fatigue failure. Don’t steam clean or decrease new chains.

The manufacturer’s grease is effective in reducing wear and corrosion. If the original factory lube is dried out or wiped off, soak the new chain in heavy engine oil for at 1/2 hour prior to installing on truck. After the old chains have been stripped from the mast, very carefully inspect chain anchors and chain wheel bearing. Broken, cracked or worn anchor must be replaced using the new anchor pin and split pin. Do not paint newly replaced chain after it has been installed.

(3) Adjustment

Chain adjustments are important for the following reasons :

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

(4) Adjustment procedure

- With mast in its fully collapsed and vertical position, lower the fork to the floor.
- Adjust the chain length by loosening or tightening nut on the chain anchor.

After making adjustment on the mast, be sure to tighten the nut.