HELI

OPERATION & SERVICE MANUAL

G3 Series Three-wheel Lithium Battery Counterbalanced Forklift Truck(Front Drive)

1.3-2t

Foreword

To meet the demand of the market, based on the absorption the advantage of battery forklift truck both at home and abroad, combined with the company to introduce advanced technology at home and abroad and the development of new products, our company developed the battery powered counterbalance forklift truck. They are particularly suitable for railway stations, ports, freight yard, warehouse and food, light textile industry, as well as general industrial goods loading and unloading, transporting, stacking, etc.

This truck is not suitable for dusty, electrify dust, high temperature, high corrosion environment! For the work in a small amount of dust (non-conductive) environment, regular cleaning and maintenance of the components is necessary!

Because of this product adopts the new PI concept and man-machine engineering design, it has low noise and high efficiency double-drive bridge, large angle steering bridge, wide view lifting system, tailless frame structure body and other advanced components. It is also equipped with high quality motor, battery, MOSFET electronic control and large color screen combination instrument, hydraulic operating valve, full suspension seat and multi-function armrest, full LED lamps and other advanced components. Therefore, it has superior performance, easy to operate, wide field of vision, flexible steering, reliable braking, good dynamic performance, small noise, pollution-free, beautiful appearance and other advantages.

This manual mainly introduces the technical parameters of this series of products, the main components of the structure, working principle and operation, maintenance and other aspects of the content. It can help operators to use the battery forklift correctly, so that it can make the maximum efficiency. Hope that operators and equipment manager can read carefully before operating the forklift.

To keep your forklift in the best working condition, please follow the rules and precautions in this manual strictly.

This manual is the description of standard and optional trucks. Non-standard trucks shall prevail in kind. If you have any technical questions, please consult the manufacturer.

This manual content might not correspond with the actual condition because of the improving of our products. Our products are subject to improvements and changes without notice.

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I. Safety regulations for driving and operation of forklift truck

1. Fundamental principle

Drivers and superiors of the truck should always keep “SAFTY FIRST” in mind. Operate according to the OPERATION & SERVICE MANUAL and OPERATOR’S MANUAL.

2. The delivery of the truck

Pay attention to the following items when delivering the forklift truck by car:

(1) Pull up the hand brake;

(2) Fix the mast and the counter weight with rope and wedge the four wheels well;

(3) Sling points should be the positions specified in sling decal when hoisting up the forklift truck.

3. The storage of the truck

(1) Lower the mast to the lowest point;

(2) Close the key and start the parking brake;

(3) Wedge the four wheels well;

(4) Apply anti-rust to the surface of the unpainted surface and lubrication oil to the lifting chains.

4. Preparations before use

(1) Don’t check fuel leakage and lever or instruments where there is open flame. Never fill the fuel tank with the engine running;

(2) Check the tyre pressure; (this step is omitted when the solid tire is fitted)

(3) Check for sound, light and alarm devices: various lights, buzzers and horns (including rear handle buttons);

(4) The forward and backward gear handle should be in the middle position (zero position);

(5) Check the condition of the knobs and the pedals;

(6) Complete the preparation work before starting;

(7) Loose the parking brake;

(8) Carry out the operation of mast lifting and lowering, forward and backward tilting, steering and braking.

5. Operation of forklift truck

(1) Only trained and authorized operator shall be permitted to operate the truck;

(2) Wear safety guards such as shoes, helmet, clothing and gloves while operating the truck;

(3) Inspect the control devices and alarming devices and operate after repairing if there is damage or fault;

(4) Overloaded operation is strictly prohibited. The fork should insert completely under the cargo and make the cargo placed on it evenly. Do not raise an object with one fork end;

(5) The starting, turning, driving, braking and stopping operation of the truck should be done smoothly. When steering on the humid or low friction road, the truck should be decelerated;

(6) Lower the goods as possible and tilt the mast when travelling with load;

(7) Be careful when travelling on a slope. If the gradient is more than 10%, drive forward when going up the slope and backward when down the slope. Never steer on a slope in preventing of overturning. Do not load or off-load goods when descending;

(8) Take care of the pedestrian, obstacle, bumpy road and clearance above the forklift truck;

(9) Persons are prohibited to stand on the forks or be carried on the truck;

(10) Never walk or stand under the raised fork;

(11) Never operate the truck or accessories out of the driver’s seat;

(12) Be care with the goods falling if the lifting height is over 3m. Take protective measures if necessary;

(13) Tilt the mast backward as possible if the lifting height is high. Load or unload with mast slightly forward or backward tilt;

(14) Slow down and be more careful when travelling on dock or bridge plate;

(15) When checking the battery or fuel tank level the driver should not be on the truck and make the truck shut down and stop steadily;

(16) Truck with accessories without load should be operated as truck with load;

(17) Do not carry unsecured or loosely stowed cargo, and handle larger cargo with care;

(18) Lower the fork to the ground, and put the knob in the neutral gear and shut off the engine or disconnect the battery when leaving the truck. Pull up the parking brake and wedge the four wheels if the truck stops on a slope;

(19) The pressure of the control valve, safety valve is regulated and can not be adjusted by users at will in preventing of damaging the hydraulic system or unit;

(20) For those trucks are fitted with pneumatic tyres, Inflate the tyre according to the tyre pressure decal;

(21) The maximum noise outside the forklift shall not be greater than 80dB(A), and the test method shall be according to JB/T3300;

(22) Be familiar with and master the contents of various plates on the forklift.

6. Daily maintenance of forklift truck

(1) Strating Method

a）Oil content of hydraulic oil: the oil level should be in the middle of the oil level scale;

b）Inspect pipes, joints, pumps and valves for leakage and damage;

c）Check the service brake:

The free travel of the brake pedal should be 20~30 mm;

The clearance between the front bottom and the pedal shall be greater than 20mm.

d）Check parking brake function: when parking brake starts, stop on the ramp with specified slope (no load);

e）Instruments and lighting fixtures, etc. : check whether all parts of instruments, lighting, connectors, switches and electrical lines work normally.

(2) Oil and grease for the truck

<table>
<tr><td>Name</td><td colspan="5">Grade, code and service temperature</td><td>Filling volume (L)</td></tr>
<tr><td rowspan="2">Hydraulic oil</td><td>Oil specification</td><td>4035 custom hydraulic oil (YYY-ZTSLT-4035)</td><td>Antifreeze hydraulic oil (YYY-LPL-HS32)</td><td>HELI custom hydraulic oil (HELI-DZYY01)</td><td>Hydraulic oil L-HM46（summer） (YYY-LPL-HM46)</td><td rowspan="2">1.3/1.5/1.6/1.8t：24
2t：29</td></tr>
<tr><td>Environment temperature</td><td>-45~+40℃</td><td>-30~+40℃</td><td>-20~+40℃</td><td>-10~+45℃</td></tr>
<tr><td>Brake fluid</td><td colspan="5">HZY3 synthetic brake fluid（GB 12891） or DOT3</td><td>/</td></tr>
<tr><td>Grease</td><td colspan="5">Normal ambient：3 # General lithium base grease（-20℃~+120℃）
Cold storage : 2# L-XDCBB2 low-temperature grease（-40℃~+120℃）</td><td>/</td></tr>
<tr><td rowspan="2">Gear oil</td><td colspan="2">Viscosity class</td><td colspan="3">ATF 220</td><td rowspan="2">GP19：0.35×2
GP25：0.45×2</td></tr>
<tr><td colspan="2">Environment temperature</td><td colspan="3">-40~+40℃</td></tr>
</table>

Note：1. The oil adding volume is given based on standard mast.

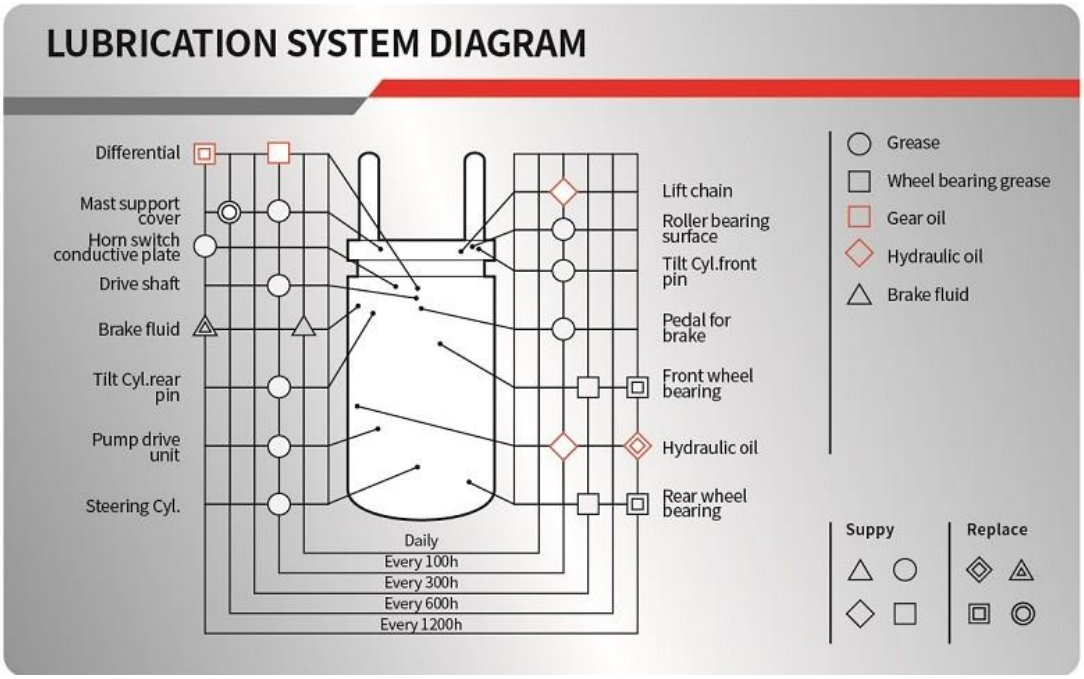
2. No special requirements, the truck would fill with HELI custom hydraulic oil;

3. Apply lubricating grease NYOGEL 782G to the conductive plate on the steering wheel horn switch.

4. It is recommended to increase the amount of fuel by 1L for every 0.5 meter increase of mast which height is more than 4m.

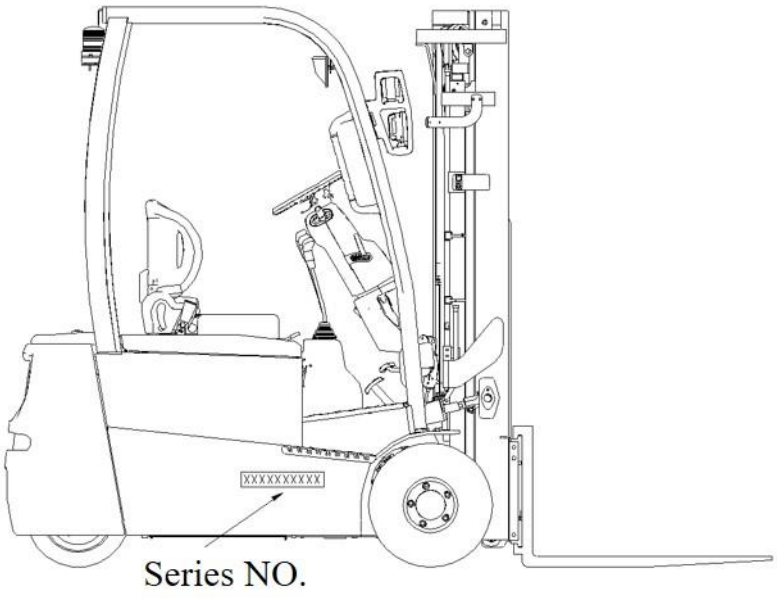
5. The total amount of gear oil of the dual drive type is twice that of the single drive unit gear oil on the left and right sides.

(3) The figure of Lubrication System



7. The Frame Number position

The unique series number (the same number as the product number) is marked on the frame of the forklift truck when leaving the factory, and it is permanently marked on the frame with steel marks, which can trace the production, sales, maintenance and other information of the truck. The series number of the truck(battery lift type) is located in the upper right corner of the right side panel of the truck body, the series number on other trucks(Side take type) is located in the upper left corner of the left side of the truck body, and its position is shown in the figure below.

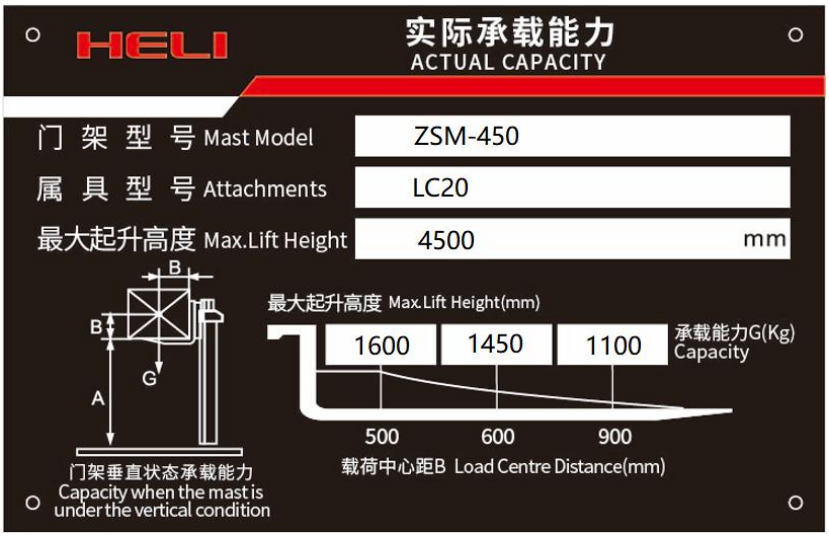


The series number position (battery lift type)

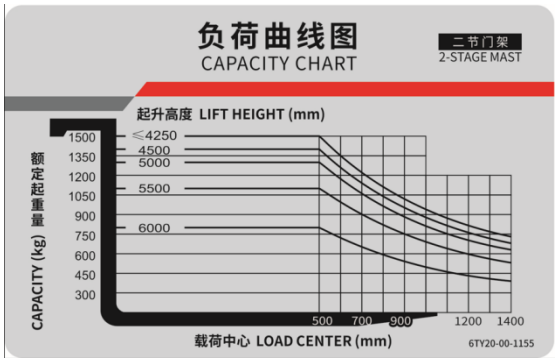
8. Capacity chart

It is forbidden to overload the forklift truck, otherwise overload may lead to structural damage, truck tipping over and other serious accidents. If the truck is equipped with attachments, such as side shifters and scraper pan, the actual carrying capacity is lower than the corresponding rated load. The actual bearing capacity and rated capacity are shown as follows.

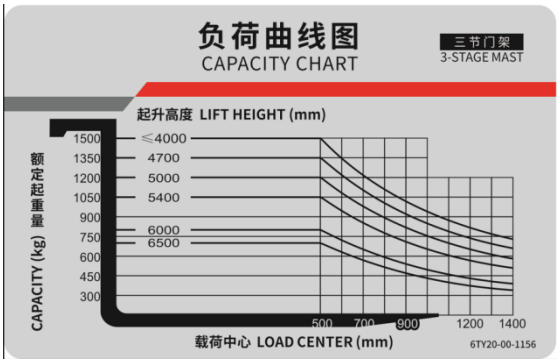
（1）The actual capacity of forklift truck(The following figure is an example)



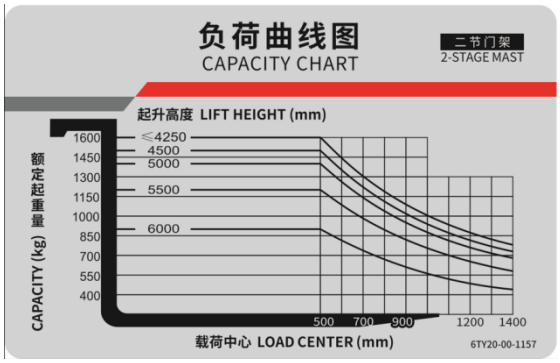
（2）The rated capacity chart of forklift trucks



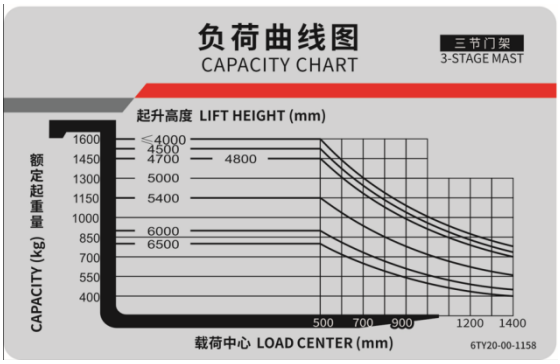
1.5t(2-stage mast)



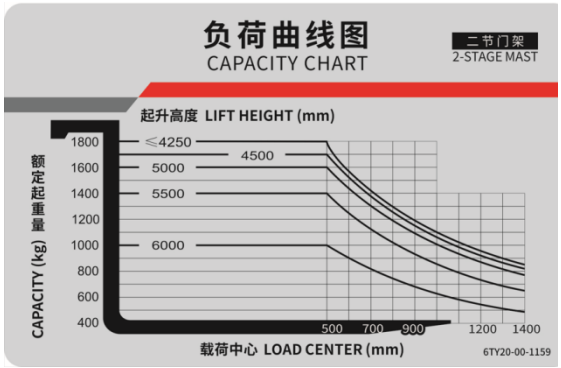
1.5t (3-stage mast)



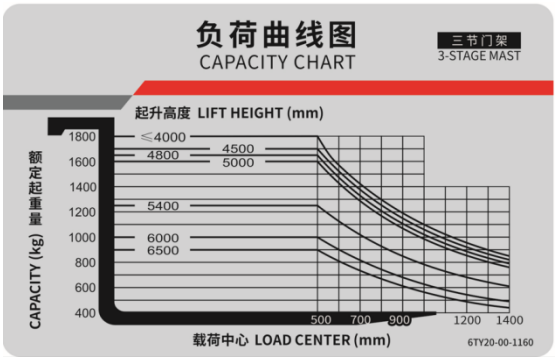
1.6t(2-stage mast)



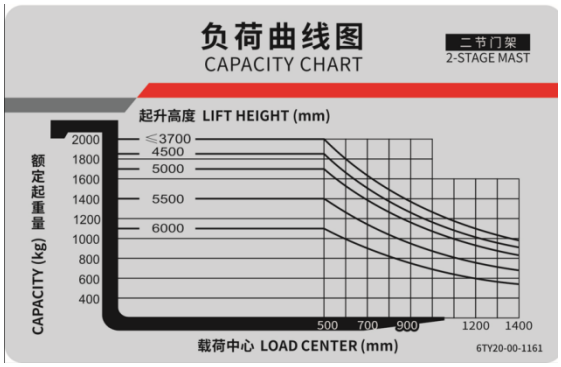
1.6t (3-stage mast)



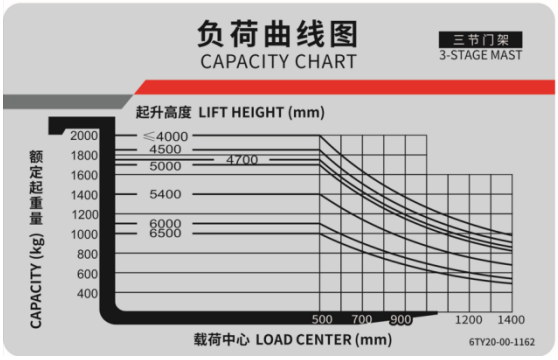
1.8t(2-stage mast)



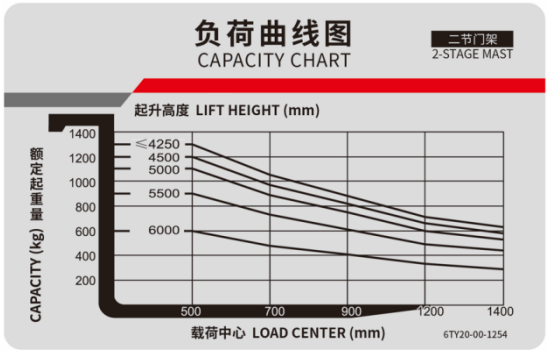
1.8t (3-stage mast)

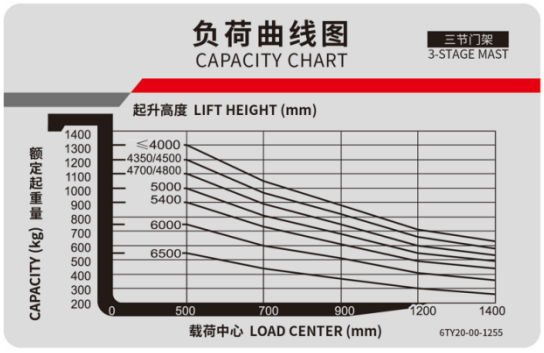


2t(2-stage mast)



2t (3-stage mast)





1.3t (2-stage mast)　　1.3t（3-stage mast）

9. Cold storage truck

The truck designed for low temperature cold storage material handling. Suitable for cold storage at -30℃. It can work for a long time in the cold storage at -18℃ and above. It is not possible to work continuously for a long time in the cold storage at -18℃ to -30℃, and intermittent alternating operation is required. The proportion of working time inside and outside the cold storage is the same, and the longest continuous operation time in the cold storage is less than 30 minutes.

Note:

1）Cold storage truck can not be left in the cold storage, which may lead to damage to the hydraulic system and electrical system, charging should be carried out outside the cold storage, and can not be charged in the cold storage.

2）Before entering the cold storage, the cold storage truck must do hydraulic and walking actions until the temperature of each component rises then enters the cold storage.

3）If there is condensate on the surface of the truck after it is discharged from the warehouse, it must be dried or wait for the condensate to dry out before entering the cold storage again.

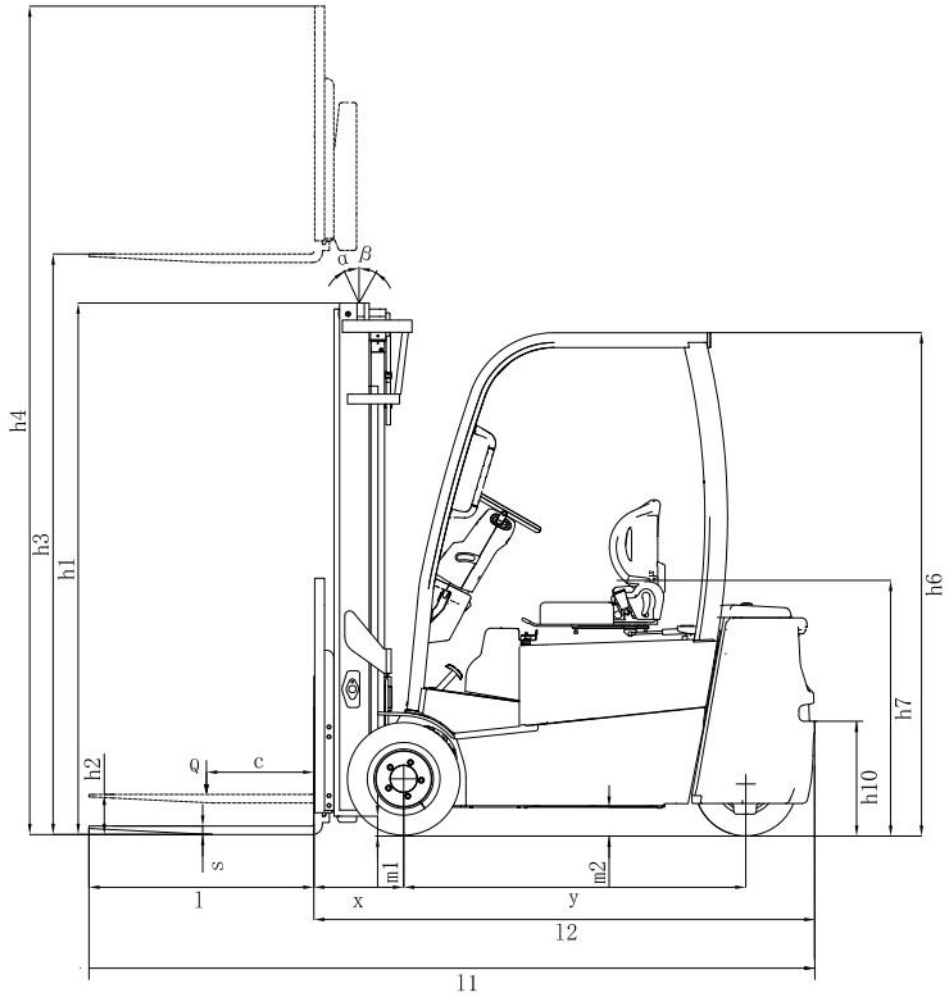
4）Use the designated cold storage special hydraulic oil and gear oil, regular maintenance and replacement.

5）Use the designated cold storage special grease to shorten the maintenance

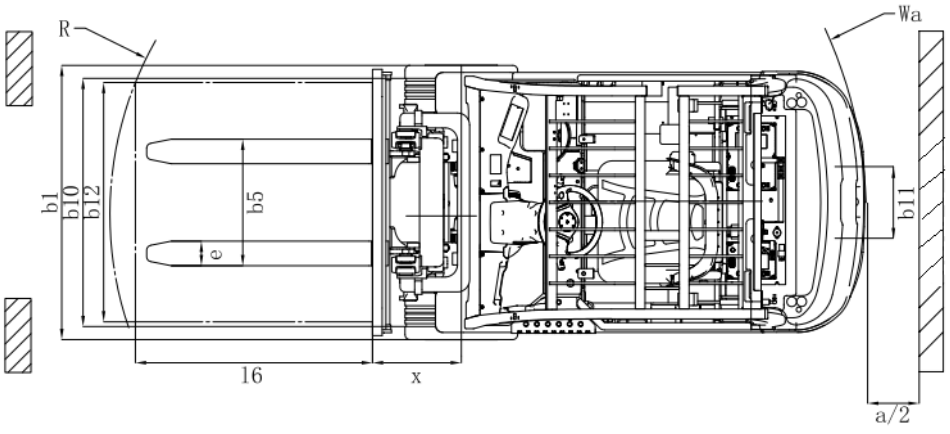
cycle of the lubrication point and prevent early wear of the lubrication point.

6）The electrical parts and mechanical parts of cold storage truck, although after rust prevention, corrosion prevention and low temperature treatment, but regular cleaning, lubrication and maintenance is very important, and must be done regularly

II. Primary Parameters of Forklift Truck



Ast: Right angle stacking aisle width
a: Clearance
b: Load length
b12: Load width



Primary Parameters

Speciality						
Model code			CPD15SQ	CPD16SQ	CPD18SQ	CPD20SQ
Configuration			GE2/6LI	GE2/6LI	GE2/6LI	GE2/6LI
Rated load weight	Q	kg	1500	1600	1800	2000
Load centre distance	c	mm	500			
Power source			Battery			
Operation type			Sit-on truck			
Tyre						
Tyre type			Super elastic solid tire			
Size of front tyre			18X7-8	18X7-8	200/50-10	200/50-10
Size of rear tyre			140/55-9	140/55-9	16X6-8	16X6-8
Dimension parameter						
Angle of mast, front/rear	α/β	°	5/7	5/7	5/7	5/7
Wheel base	y	mm	1292	1292	1400	1400
Lift height (Standard)	h_3	mm	3300	3300	3300	3300
Overhead guard height	h_6	mm	2040	2040	2040	2040
Overall Length (without Fork)	l_2	mm	1930	1930	2055	2055
Overall Width/Wheel width	b_1	mm	1060/1076	1060/1076	1060/1120	1060/1120
Outside Steering Radius	W_a	mm	1545	1545	1675	1675
Performance parameter						
Travel Speed (Full Load/No Load)		km/h	16/17	16/17	16/16	16/16
Lift Speed (Full Load/No Load)		m/s	0.45/0.65	0.45/0.65	0.41/0.6	0.4/0.6
Descent Speed (Full Load/No Load)		m/s	0.58/0.5	0.58/0.5	0.58/0.5	0.58/0.5
Max. Gradeability(Full Load/No Load)		%	22/30	22/30	22/30	22/30
Battery						
Battery voltage/ capacity（K5）		V/Ah	80/202	80/202	80/202	80/202
Weight of battery （min/max）		kg	260/320	260/320	260/320	260/320
Motor						
Drive motor power （S2-60min）		kW	5.5x2	5.5x2	5.5x2	5.5x2
Lifting motor Power （S3-15%）		kW	14	14	14	14

Main detachable parts dimensions and weights

Item \ Truck configuration		Unit	CPD15SQ	CPD16SQ	CPD18SQ	CPD20SQ
			GE2/6LI	GE2/6LI	GE2/6LI	GE2/6LI
Drive axle	Max external dimension	mm	485x230x370			
	Weight	kg	80			
Counterweight	Max external dimension	mm	1060×488×775	1060×488×775	1060×611×775	1060×611×775
	Weight	kg	1055	1090	1295	1390
Overhead guard	Max external dimension	mm	1450×950×1540		1550×950×1540	
	Weight	kg	90		95	
Mast（M300, excluding fork and tilting cylinder）	Max external dimension	mm	1010×420×2080			
	Weight	kg	485		495	

Primary Parameters

Speciality							
Model code			CPD13SQ	CPD15SQ	CPD16SQ	CPD18SQ	CPD20SQ
Configuration			A2LIG3-M	A2LI(L)G3-M	A2LI(L)G3-M	A2LI(L)G3-M	A2LI(L)G3-M
Rated load weight	Q	kg	1300	1500	1600	1800	2000
Load centre distance	c	mm	500				
Power source			Battery				
Operation type			Sit-on truck				
Tyre							
Tyre type			Super elastic solid tire				
Size of front tyre			18X7-8	18X7-8	18X7-8	200/50-10	200/50-10
Size of rear tyre			140/55-9				
Dimension parameter							
Angle of mast, front/rear	α/β	°	5/7	5/7	5/7	5/7	5/7
Wheel base	y	mm	1292	1292	1292	1292	1400
Lift height (Standard)	h_3	mm	3000	3000	3000	3000	3000
Overhead guard height	h_6	mm	2040	2040	2040	2040	2040
Overall Length (without Fork)	l_2	mm	1855	1900	1915	1945	2063
Overall Width/Wheel width	b_1	mm	1076	1076	1076	1120	1120
Outside Steering Radius	W_a	mm	1470	1515	1530	1560	1675
Performance parameter							
Travel Speed (Full Load/No Load)		km/h	16/16	16/16	16/16	16/16	16/16
Lift Speed (Full Load/No Load)		m/s	0.47/0.6	0.47/0.6	0.47/0.6	0.47/0.6	0.47/0.6
Descent Speed (Full Load/No Load)		m/s	0.4/0.5	0.4/0.5	0.4/0.5	0.4/0.5	0.4/0.5
Max. Gradeability(Full Load/No Load)		%	20	20	20	20	20
Battery							
Battery voltage/ capacity（K5）		V/Ah	80/150	80/202	80/202	80/202	80/202
Weight of battery （min/max）		kg	280	280	280	280	280
Motor							
Drive motor power （S2-60min）		kW	5.5x2	5.5x2	5.5x2	5.5x2	5.5x2
Lifting motor Power （S3-15%）		kW	12	16.5	16.5	16.5	16.5

Main detachable parts dimensions and weights

Item \ Truck configuration		Unit	CPD13SQ	CPD15SQ	CPD16SQ	CPD18SQ	CPD20SQ
			A2LIG3-M	A2LI(L)G3-M	A2LI(L)G3-M	A2LI(L)G3-M	A2LI(L)G3-M
Drive axle	Max external dimension	mm	485x230x370	485x230x370	485x230x370	485x230x370	485x230x370
	Weight	kg	80	80	80	80	80
Counterweight	Max external dimension	mm	1060×405×845	1060×450×845	1060×465×845	1060×495×845	1060×505×835
	Weight	kg	860	1000	1100	1250	1300
Overhead guard	Max external dimension	mm	1030×1301×1551	1030×1301×1551		1030×1301×1551	
	Weight	kg	78	78	78	78	78
Mast（M300, excluding fork and tilting cylinder）	Max external dimension	mm	1014×334×2000				
	Weight	kg	460	460	460	496	496

Primary Parameters

Speciality						
Model code			CPD15SQ	CPD16SQ	CPD18SQ	CPD20SQ
Configuration			A2LIPG3-M	A2LIPG3-M	A2LIPG3-M	A2LIPG3-M
Rated load weight	Q	kg	1500	1600	1800	2000
Load centre distance	c	mm	500			
Power source			Battery			
Operation type			Sit-on truck			
Tyre						
Tyre type			Super elastic solid tire			
Size of front tyre			18X7-8	18X7-8	200/50-10	200/50-10
Size of rear tyre			140/55-9			
Dimension parameter						
Angle of mast, front/rear	α/β	°	5/7	5/7	5/7	5/7
Wheel base	y	mm	1292	1292	1400	1400
Lift height (Standard)	h_3	mm	3000	3300	3300	3300
Overhead guard height	h_6	mm	2040	2040	2040	2040
Overall Length (without Fork)	l_2	mm	1900	1930	2055	2055
Overall Width	b_1	mm	1076	1076	1120	1120
Outside Steering Radius	W_a	mm	1515	1530	1560	1675
Performance parameter						
Travel Speed (Full Load/No Load)		km/h	16/16	16/16	16/16	16/16
Lift Speed (Full Load/No Load)		m/s	0.45/0.6	0.43/0.6	0.43/0.6	0.4/0.6
Descent Speed (Full Load/No Load)		m/s	0.47/0.5	0.47/0.5	0.47/0.5	0.47/0.5
Max. Gradeability(Full Load)		%	20	20	20	20
Battery						
Battery voltage/ capacity（K5）		V/Ah	80/202	80/202	80/202	80/202
Weight of battery）		kg	280	280	280	280
Motor						
Drive motor power （S2-60min）		kW	5.5x2	5.5x2	5.5x2	5.5x2
Lifting motor Power （S3-15%）		kW	16.5	16.5	16.5	16.5

Main detachable parts dimensions and weights

Item \ Truck configuration		Unit	CPD15SQ A2LIPG3-M	CPD16SQ A2LIPG3-M	CPD18SQ A2LIPG3-M	CPD20SQ A2LIPG3-M
Drive axle	Max external dimension	mm	485x230x370			
	Weight	kg	80			
Counterweight	Max external dimension	mm	1060×450×845	1060×465×845	1060×495×845	1060×505×835
	Weight	kg	1000	1100	1250	1300
Overhead guard	Max external dimension	mm	1030×1310×1551			
	Weight	kg	78			
Mast(M300, excluding fork and tilting cylinder)	Max external dimension	mm	1010×334×2000			
	Weight	kg	460		496	

III. The Structure, Principle, Adjustment and Maintenance of Forklift Truck

1. Transmission system

1.1 General description

The drive system of this series of electric forklift adopts the drive unit produced by German ZF Company, which is left and right drive units and arranged symmetrically. The drive system is mainly composed of two sets of wheel side reducer, two sets of AC asynchronous drive motors, one set of driving brake and parking system, the brake system is oil-cooled disc brake. Its outline and main dimensions are shown in Figure 1-1.

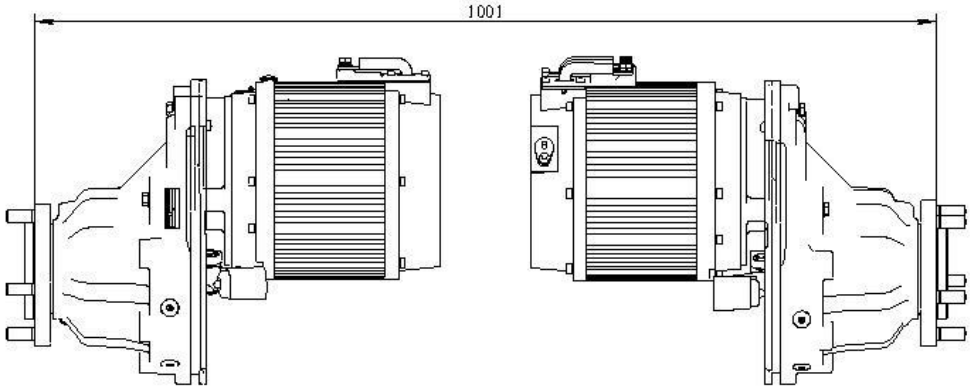


Fig.1-1 Drive axle dimensions

1.2 Drive wheel

The drive wheel is made up of solid tyre and rim. See the following for the specifications of solid tyre and rim:

Item	1.5-1.6t	1.8-2t
Tyre	18x7-8	200/50-10
Rim	4.33R-8	6.50F-10

1.3 Drive unit

1.3.1 Transport of Drive unit

The drive unit must be transported carefully or it may injure the person or the axle itself. When slinging, special slinging equipment must be used to sling from the slinging area (note: single driving unit and oil weight of about 80kg); During transportation, the drive unit must be fixed on a special pallet for transportation.

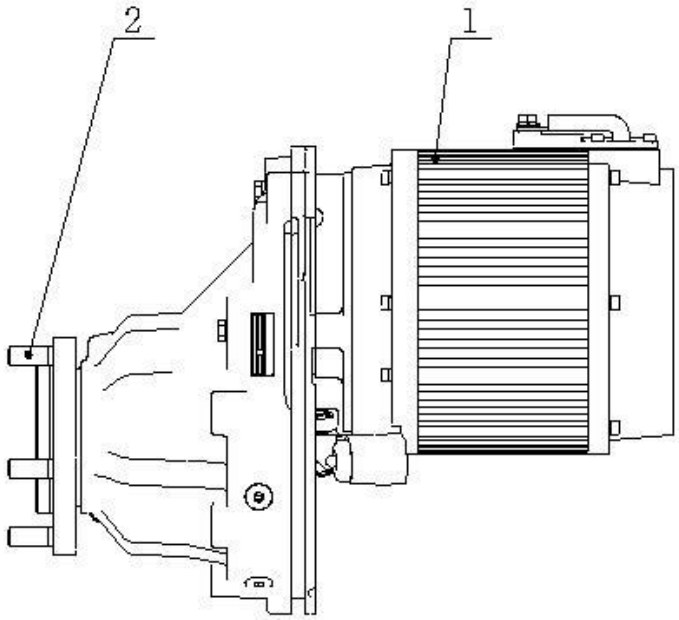


Fig.1-2 Transport of drive axle
1.Sling position 2.Wheel hub bolt

1.3.2 Storage of drive axle

After the drive axle stored for 6 months, the starting motor works at approximately 1000rpm maintained for 2 minutes, so that the gear oil inside the drive axle is fully agitated and reactivated to ensure that each part is lubricated. Repeat every six months for long-term storage.

If the drive axle is stored for more than 12 months at a time, the gear oil should be completely replaced before use. When adding gear oil again, the gear oil must conform to the provisions, specifications are specified in the preceding provisions.

1.3.3 Oil-way of drive axle

The drive axle has a total of three different oil way, independent of each other.

● One oil-way is gear box;

● One oil-way is hydraulic service brake

● One oil-way is hydraulic parking brake;

Gearbox oil-way is maintenance-free, while hydraulic oil circuit needs regular maintenance. The service brake and parking brake is realized by hydraulic oil-way, which apply force on a wet disc brake.

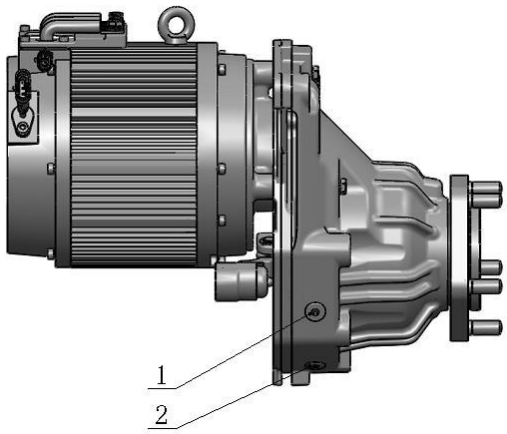


Fig.1-3 Position of each oil hole
1. Oil filling port of gear box 2. Oil drain hole of Gear box

1.3.4 The brake connection of the drive axle

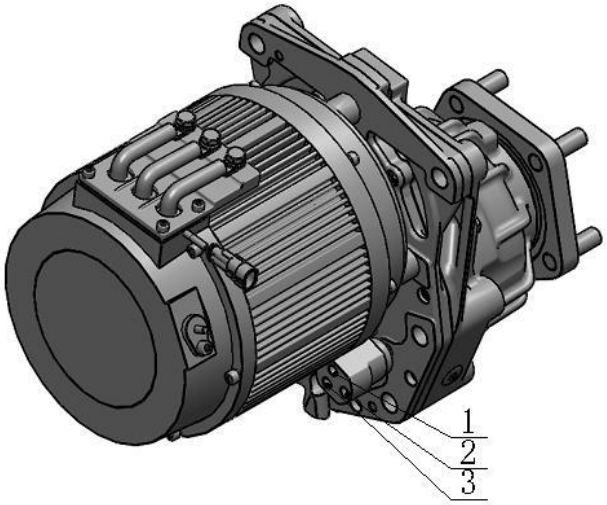


Fig.1-4 Position of brake oil port
1. Breathing cap connector 2. External braking hydraulic oil connector (M10X1)
3. External parking brake hydraulic oil connection (M10X1)

1.3.5 Electrical connection of the drive axle

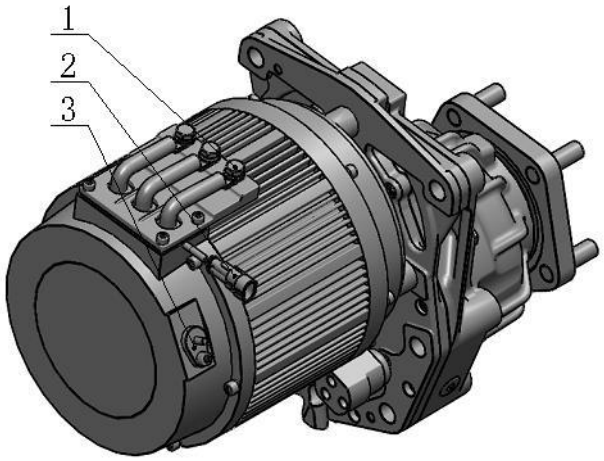


Fig.1-5 Electrical connection position
1.UVW binding post 2. Temperature sensor interface 3.Speed encoder interface

Incorrect connections may cause personal injury or damage to parts. Be sure to follow the electrical wiring diagram for proper connection. Maximum tightening torque of nuts on UVW binding posts is 8Nm. If connected according to the distribution of U, V and W, the rotation direction of the motor is clockwise (look from the input side of the motor).

1.3.6 Maintenance of drive axle

Perform the following checks during maintenance: wheel installation, leakage, damage, oil level.

1.3.6.1 Reduction gearbox

On both sides of the gearbox, the oil usually needs to be replaced every 4000 working hours. Replace gear oil according to the following operation:

1. Oil drainage

(1) Clean the area around the drain plug thoroughly;

(2) Place a suitable container under the drain plug to receive the oil;

(3) Remove the oil plug and seal ring with tools;

(4) Drain the old gear oil completely into the container.

2. Refuel

(1) Clean the iron dust on the oil drain plug;

(2) Use a new sealing ring and tighten the drain plug with 16Nm torque;

(3) Use appropriate equipment (such as funnel, pipe, etc.) to add unused new gear oil; (The gear oil must meet the requirements.)

(4) Check the oil level, until it reach required; (The correct oil level is reached when the oil reaches the bottom edge of the filling hole. 0.35L on each side.)

(5) Use a new copper sealing ring and tighten the oil plug with 16Nm torque.

1.3.6.2 Braking

The middle brake normally needs to be replaced with brake oil every 1000 working hours. Replace the brake oil according to the following operation:

（1）Oil drainage

a) Clean the area around the drain plug thoroughly;

b) Place a suitable container under the drain plug to receive the oil;

c) Remove the oil plug and seal ring with tools;

d) Drain the old oil completely into the container.

（2）Refuel

a) Clean the iron dust on the oil drain plug;

b) Use a new sealing ring and tighten the drain plug with 16Nm torque;

c) Use appropriate equipment (such as funnel, pipe, etc.) to add unused new brake oil; (The brake oil must meet the requirements.)

d) Check the oil level, until it reach required; (The correct oil level is reached when the oil reaches the bottom edge of the filling hole. Oil mass is 3L.)

e) Use a new copper sealing ring and tighten the oil plug with 16Nm torque.

1.3.6.3 Waste disposal

Waste disposal should be conducive to environmental protection and comply with relevant local laws and regulations.

1.3.7 The drive axle is connected to the frame and wheels

The drive axle is mounted on the frame by 7 sets of bolts M14x1.5x70 (10.9S), the bolts shall add thread anti-loosening adhesive. The wheels are mounted on the drive axle by 5 groups of hub nuts of the left and right, bolts must add thread locking glue. The above fastening bolts shall be inspected regularly and the torque shall be rechecked to prevent loosening.

The tightening torque of the above bolts is marked in accordance with Fig.1-6 below.

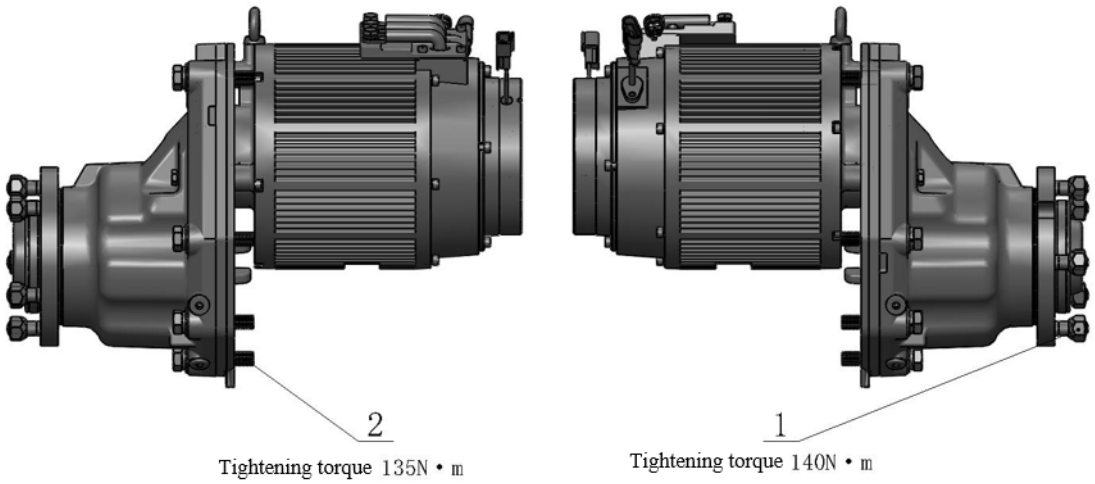


Fig.1-6 The drive axle and external connection

1.Hub nut 2. Bolts M14x1.5x70

2. Braking system

2.1 General description

Service brake system is mainly hydraulic power brake, mainly by the brake pedal, brake pump, oil cup and wet brake composition, wet brake integrated in the drive axle. Parking brake adopts pedal brake, By stepping on the brake pedal, the cable drives the left and right brake sub-pumps to realize parking braking.

2.2 Brake pedal

The driving brake system mainly consists of brake pedal, main pump, sub-pump and brake. The principle of service brake is shown in figure 2-1, and the structure of brake pedal is shown in figure 2-2, which is installed on the support assembly through pin shaft.The pedal and the mounting frame are kept in position by a tension spring.

The pedal force on the pedal is connected to the push rod of the brake master cylinder and the pedal, and the pedal force is transferred to the brake master cylinder, the brake master cylinder outputs the oil pressure, which is then conveyed to the oil port on the drive axle through the brake tubing assembly.

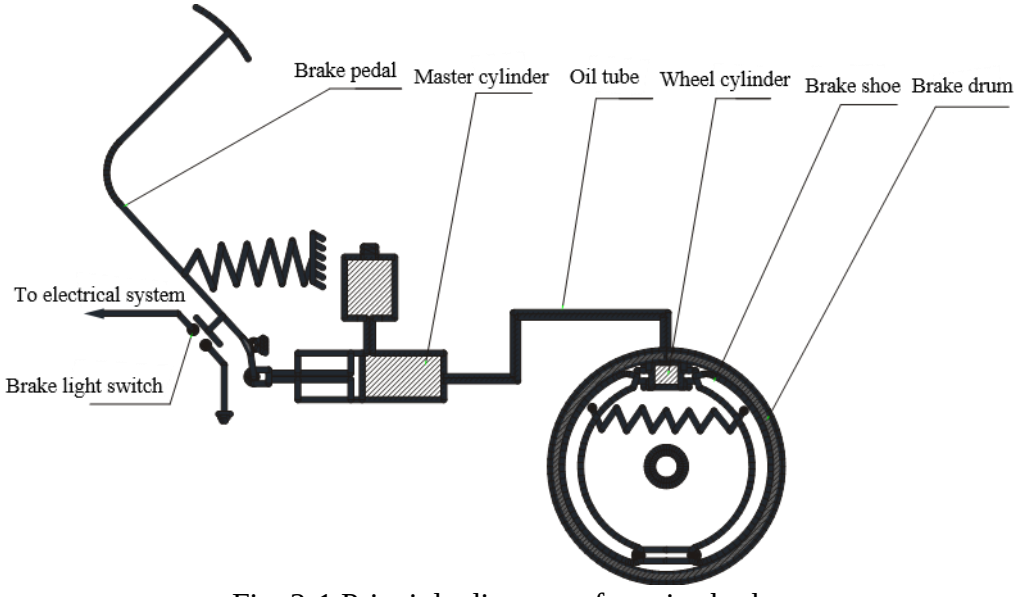


Fig. 2-1 Principle diagram of service brake

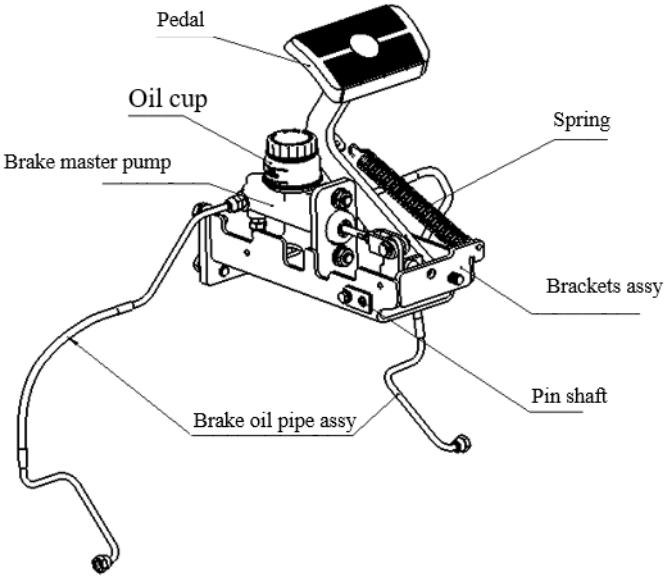


Fig.2-2 Service brake device

2.3 Brake pedal adjustment

(1) Shorten the push rod on the brake main pump;

(2) Adjust the stop bolt. As shown in the figure below, adjust the pedal height, which is about 60-75-mm; After stepping the pedal, the gap between the pedal and the front bottom plate should be greater than 20 mm;

(3) Step the brake pedal and lengthen the push rod until the front end of the push rod contacts the piston of the main pump;

(4) Tighten the push rod lock nut.

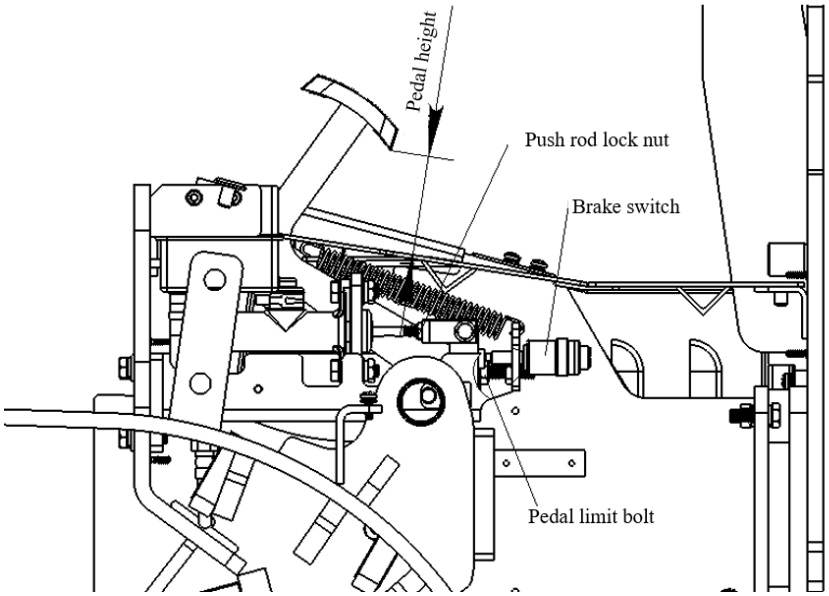
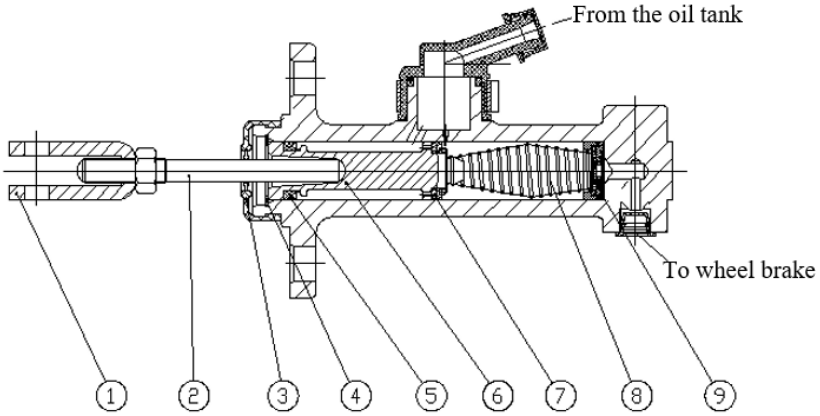


Fig.2-3 Brake pedal adjustment

2.4 Brake master pump

The master pump consists of a seat, a one-way valve, a return spring, and a leather bowl, piston and auxiliary leather bowl. The ends are secured with stop washers and stop wire, the exterior is protected by a rubber dust cap, and the master pump piston is actuated by a push rod with the help of an operating brake pedal. When step the brake pedal, push rod pushing the piston forward, the brake fluid in the pump body back to the storage tank through the return oil port , until the packing leather block the return oil port, after the main packing leather pushing through the return oil port, The brake fluid in the front chamber of the main pump is compressed and the one-way valve is opened, and flow to the sub-pump through the brake pipe, in this way, each sub-pump piston juts out to make brake shoe friction plate and drum brake contact, to achieve the effect of the deceleration or braking, at this point, after the piston back cavity supplement by the brake fluid from the return oil port. When releasing the brake pedal, the piston is pressed back to the original position by the return spring. Meanwhile, the brake fluid in each brake sub-pump is also compressed by the return spring of the brake shoe, so that the brake fluid returns to the main pump (piston front chamber) through the one-way valve, and the piston returns to the original position.The brake fluid in the master pump flow back to the fuel tank through the oil return port, adjust the one-way valve pressure into a certain proportion with residual pressure in the brake pipe and brake sub-pump ,makes the brake fluid in the sub-pump flow back to the fuel tank through the oil return port, adjust the one-way valve pressure into a certain proportion with residual pressure in the brake pipe and brake sub-pump, make sub-pump packing leather placed correctly in case of oil spill, and eliminate the gas resistance phenomenon may appear when emergency braking.



1	Connecting rod
2	Push rod
3	Dust cover
4	elastic collar
5	Auxiliary cup
6	Piston
7	Master cup
8	Spring
9	One-way valve

Fig.2-4 Brake master pump

2.5 The operation of parking brake

（1）Parking brake of CPD15/16/18/20SQ-GE2/6LI model truck adopts pedal brake, by stepping on the brake pedal, drive the brake cable, through the brake lever plate is divided into two ways, respectively drive the left cable and right cable to drive the brake sub-pump action, so as to achieve parking brake.

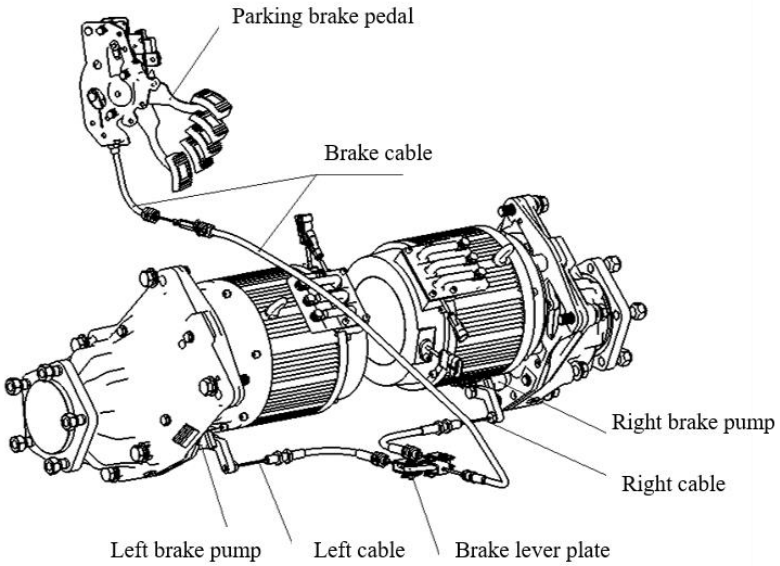


Fig. 2-5 Parking Brake Action Schematic

Parking brake pedal is installed on the lower left part of the instrument frame, and its function is to realize parking brake and release parking brake. The pedal is pressed down to realize parking braking, and the indicator light of parking brake on the instrument will light up when parking braking. When the brake pedal is pressed again, the parking brake pedal will automatically return to its position and release the parking brake.

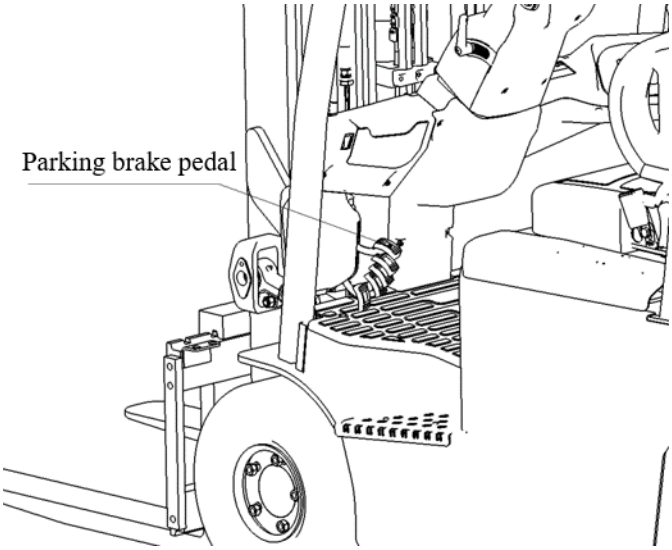


Figure 2-6 Parking brake pedal layout

The normal operation sequence of forklift travelling is as follows: in standby state, press down the parking brake pedal to reset it, the indicator light of instrument parking brake turns off, and then put the gear switch on forward or backward, press on the accelerator, and the forklift moves. When the parking brake pedal is pressed down, the gear switch is placed forward or backward, or the accelerator is stepped on to make the parking indicator light on the instrument, and the truck can not walk; It is necessary to step on the parking brake pedal again, after lifting the parking brake, the whole truck can travel normally.

(2) The parking brake operating device of CPD13/15/16/18/20SQ-A2LIG3-M model truck adopts a mechanical ratchet hand brake handle, which can provide different braking forces required for peaceful parking on ramps, as shown in figure 2-4. The method of adjusting the size of braking force is as follows: turn the regulator clockwise to increase the braking force; Turning the regulator counterclockwise reduces the braking force. The operating force of parking brake is 20~30kg.

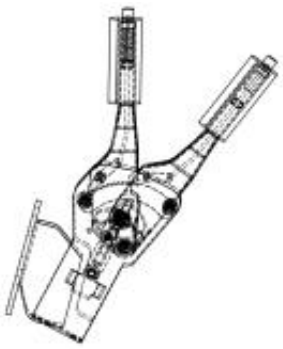


Figure 2-7 Parking brake handle

The normal operation sequence of forklift travelling is as follows: in the standby state, release the parking brake handle, the instrument parking brake indicator turns off, and then set the gear switch to forward or backward, step on the accelerator, and the forklift is moving. When the parking brake handle is tightened, set the gear switch to forward or backward, or step on the accelerator, so that the parking indicator on the instrument lights up and the truck cannot travel; It is necessary to release the parking brake handle and the truck can travel normally after release the parking brake.

2.6 Brake

The brake used in this product is slice wet brake, free of maintenance. The brake is integrated inside the left and right reduction boxes, and the external oil connection of the brake and the explanation of refueling and draining are described in the preceding chapter.

2.7 Fault diagnosis

Problem	Analysis of causes	Troubleshooting
Poor or no braking	1）insufficient brake fluid	Replenish brake fluid
	2）Impurities are mixed into the brake fluid	Check out and replace brake fluid
	3）Leakage of brake system	Repair
	4）Air are mixed into the brake fluid	Deflate
	5）Improper adjustment of brake pedal	Adjust
	6）Failure of brake master cylinder	Repair, replace

2.8 Adjustment of brake switch

a) Release the lock nut of the brake switch after the height of the brake pedal is adjusted;

b) Unplug the plug to separate the wires;

c) Turn the switch to make the gap A=1mm;

d) Confirm that the brake light should be on when the brake pedal is pressed.

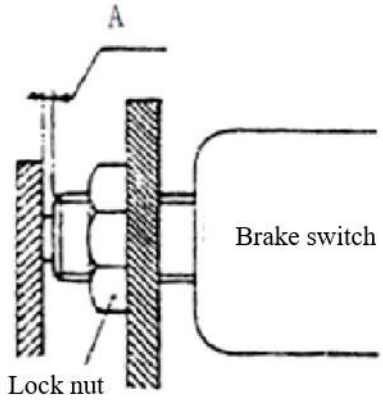


Fig.2-8 Installation of brake switch

Adjust parking brake cable method

a) loosen lock nut on both ends of a screw.

b) turn the screw to adjust brake cable, the specific requirements is the pedal needs to hit the four-layer and above.

c) and at the ends of the screw tight lock nut.

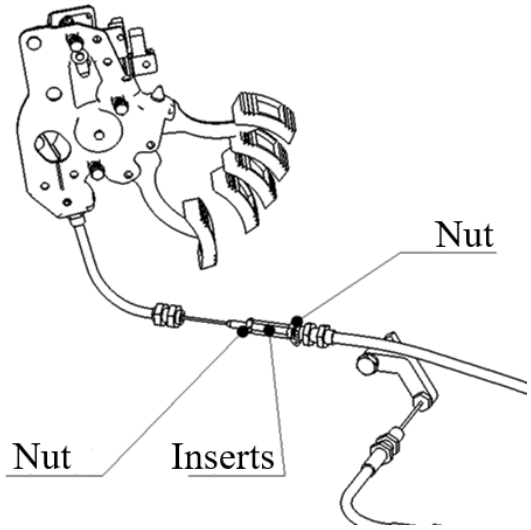


Figure 2-9 Parking Brake Cable Adjustment

3. Steering system

3.1 General description

The function of forklift steering system is to change the direction of forklift or keep the forklift traveling straight. The performance of steering system is directly related to driving safety, operating efficiency and operator's labour intensity.

According to the power source used for steering, the steering system can be divided into mechanical steering system (manual steering system) and power steering system. Mechanical steering system completely depends on the operator's physical ability to control the steering, to overcome the steering resistance moment. In the power steering system, the energy consumed to overcome the steering resistance moment is provided by the prime motor, and the driver controls the system with only a small force to control the steering.

Due to the requirements of the working characteristics of the forklift, the operating field and the path are narrow, the reversing direction is frequent, and the turning is often required at the minimum radius, so the steering system is required to work reliably and operate lightly. When the forklift is unloaded, the load of the steering bridge accounts for about 55-60% of the truck weight. Forklifts tend to use power steering (hydraulic power steering or full hydraulic steering) to reduce operator labor intensity. The power steering is compact in structure, light in operation and sensitive in movement, which is conducive to improving the operation efficiency of the forklift. The power steering system can also cushion the impact from ground to the steering system. At present, the forklift produced by our company adopts full hydraulic power steering system.

3.2 Working principle

While forklift turning, operator imposed steering torque on the wheel (steering control mechanism), make the wheel rotation displacement, and through the steering shaft to the steering gear, steering gear according to the size of the steering wheel turning angle, the appropriate volume of pressure oil through pipeline passed on to the steering cylinder, cylinder realize the steering through steering trapezoidal mechanism push the steering wheel.

The difference between the full hydraulic steering device and the hydraulic power steering device is that the full hydraulic steering device replaces the

mechanical components such as the mechanical steering device and the longitudinal pull rod, and the full hydraulic steering device is connected with the steering cylinder by high pressure tubing. Load sensing full hydraulic steering system circuit is equipped with priority valve, in any working condition can ensure the priority to the steering system to distribute the flow, to ensure sufficient oil supply, when the steering device in the middle only a few flow pass the steering device, to achieve systemic energy conservation.

3.3 Steering system composition

(1) Steering control mechanism

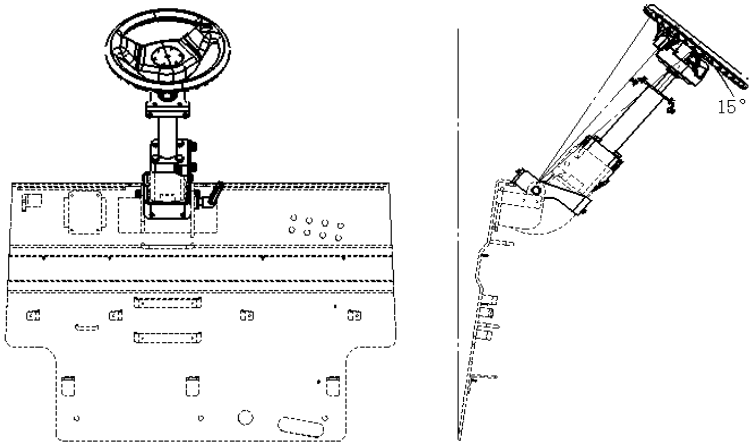


Fig.3-1 Steering control mechanism

G3 series of 1.5～2t forklift steering mechanism is mainly composed of the steering wheel, pipe column, connecting shaft, steering and mounting bracket, etc (as shown in figure 3-1), they are made up of mounting bracket is fixed on the instrument panel, steering wheel, pipe column, coupling shaft coupling together, steering gear fixed on the coupling shaft bottom, the steering wheel rotation will be driven in steering gear rotation.By adjusting the handle, the steering wheel can be adjusted to a comfortable position for the operator.

(2) Steering gear

G3 series 1.5～2t adopts the cycloidal rotary valve type full hydraulic steering gear, which is a closed dynamic load steering gear. (see hydraulic system for details).

(3) Steering transmission mechanism

The mechanism that deflected the left and right wheels in a certain relationship by passing the power output of the steering gear through the oil cylinder and the steering mechanism is called the steering transmission mechanism, which is realized by the horizontal oil cylinder steering bridge component (see the relevant steering axle section for more information).

3.5 Installation, commissioning and maintenance

3.5.1 Adjustment steps for pre-load on steering wheel bearings

(1) As shown in figure 3-2, grease the inner cavity of the wheel hub, inner and outer bearings and the wheel hub cover, and grease the lip of the oil seal;

(2) Fix the outer ring of the bearing onto the wheel hub and install the wheel hub onto the steering knuckle shaft;

(3) Install the plain washer and tighten the groove nut with a torque of 206-23N.m (21-24kgm), loosen the groove nut, and then tighten the groove nut with a torque of 9.8N.m(1kgm);

(4) Gently knock the wheel hub with a wooden hammer and rotate the wheel hub 3-4 times to ensure that the wheel hub is not loose;

(5) Tighten the groove nut so that the groove is aligned with the cotter pin hole on the steering knuckle;

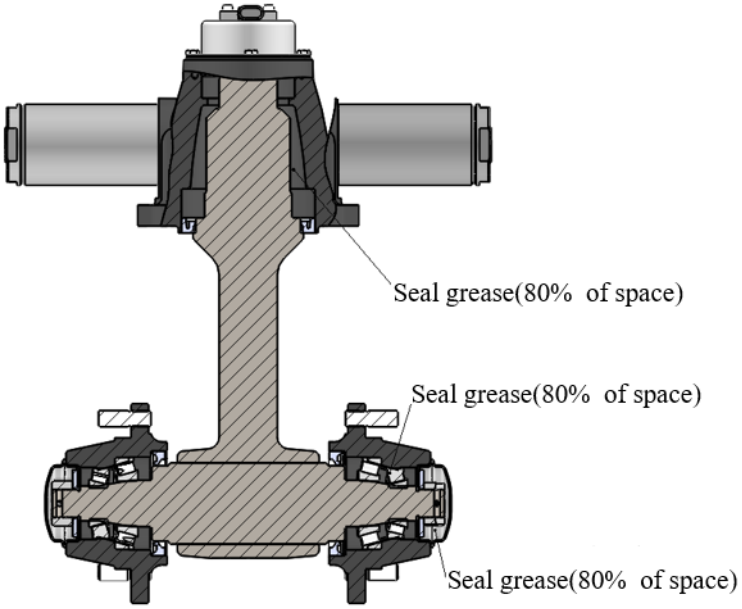


Fig. 3-2 Add grease and adjust preload

(6) Gently knock the wheel hub with a wooden hammer, turn the wheel hub 3 to 4 circles by hand to ensure smooth rotation, and measure the rotational torque of the wheel valley, whose value is 2.94~7.8N.m (0.3~0.8 kgm);

(7) When the rotational torque is higher than the specified value, it can be returned 1/6 circle and then measured the rotational torque;

(8) When the specified rotational torque is reached, lock the grooved nut with a split pin.

When removing or changing a tire, it should be noted that after installing a new tire, the wheel hub bolts should be coated with anaerobic anti-loosening adhesive to ensure the tightening torque of the wheel hub nut: 120~160N.m for 1-3.5t forklift.

3.5.2 Maintenance of steering system

Pay attention to check the working status of steering system during daily maintenance. When steering, the manual force acting on the steering wheel should be 6-20N; The difference of right and left steering force is no more than 5N; When the car travels in straight line at the maximum speed, there should be no obvious snake phenomenon. If there is a fault, it should refer to Tab.3-2 steering system fault analysis table for analysis and troubleshooting.

3.6 Steering axle

The steering axle (as shown in Figure 3-3) consists of steering cylinder, rotary support, supporting gear shaft and wheel hub. The oil cylinder moves reciprocally under the action of pressure oil, and the gear teeth on the piston rod of the oil cylinder drive the supporting gear shaft to rotate, so as to realize steering. There is a wheel hub on the left and right of the steering axle, and the wheel hub is installed on the wheel shaft with two tapered roller bearings. At the same time, the inner end of the wheel hub is installed with an oil seal, so that the grease is kept in the wheel hub and the wheel shaft cavity.

For steering axle tires, see Table 3-1 for rim models and tire pressure:

Table 3-1

Forklift tonnage	1.5-2t
Tyre	140/55-9
Rim	4.00 E-9
Tyre pressure	/

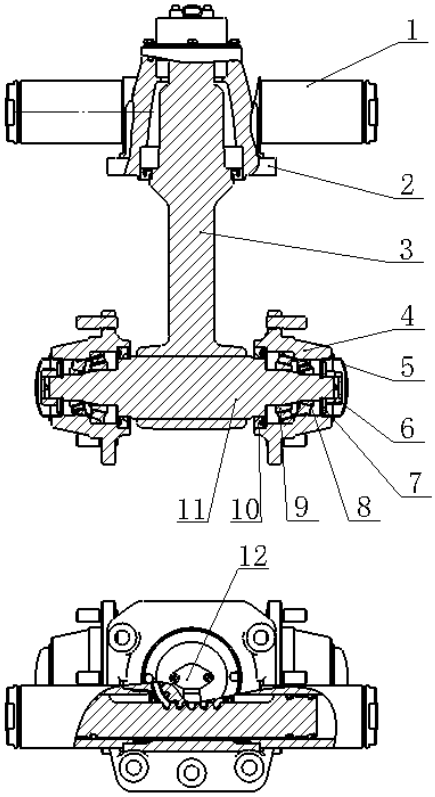


Figure 3-3 steering axle
1) steering cylinder 2) pivoting support 3) support gear shaft
4) hub 5) hub cover 6) lock nut 7) washer 8) bearing
9)bearing 10)oil seal 11)axle 12) Angle potentiometer

(1) Steering cylinder

The steering cylinder is a double-acting cylinder, and the piston rod is equipped with teeth in the middle. The pressure oil from the full hydraulic steering device drives the piston rod of the steering cylinder to move left and right, so as to drive the supporting tooth shaft to rotate and achieve left and right steering. Both sides of the piston rod are equipped with sealing rings and supporting rings in the cylinder, which is installed on the rotary bearing. (As shown in figure 3-4)

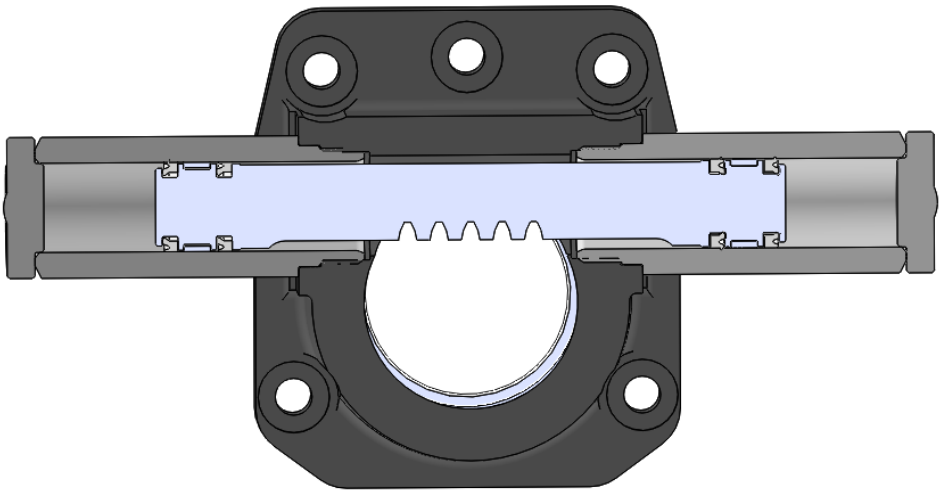


Figure 3-4 Steering cylinder

The hub is installed on the wheel shaft with two tapered roller bearings, and the wheel is installed on the hub through the rim. The end of the hub is equipped with an oil seal to keep the grease in the hub and shaft cavity, and a nut is used to adjust the tightness of the bearing.

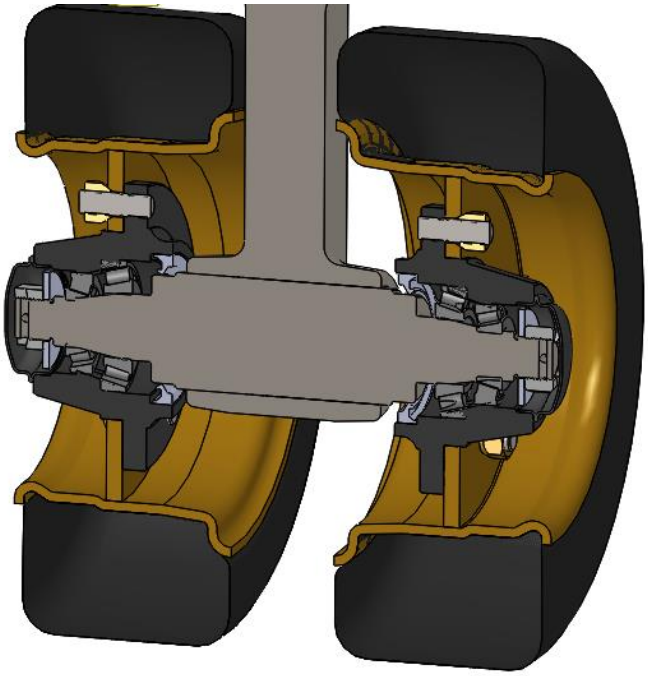


Fig. 3-5 wheel hub

3.7 Major steering system failures and troubleshooting

3.7.1 Inspect after reassembling the steering system

(1) Turning the steering wheel right and left to the limit position, inspect whether

the force applied is proper and the steering power is smooth.

(2) Check if the layout of hydraulic circuit is proper and the installation of left and right hoses is right.

(3) Lift up the rear wheels and slowly turn the steering wheel right and left several times to limit position so as to exhaust air from the hydraulic pipeline and the steering cylinder.

3.7.2 Steering system troubleshooting

Tab.3-2 Steering system troubleshooting

Problem	Analyses of trouble	Remedies
Fail to turn hand-wheel	Pump damaged or breaking down.	Replace
	Splite-flow valve damaged or blocked	Clean or replace
	Hose or joint damaged or pipeline blocked.	Clean or replace
Difficult to turn hand-wheel	The pressure of the splite-flow valve is too low.	Adjust the pressure
	Air in steering oil circuit.	Exhaust air
	Steering unit fail to recover due to spring piece damaged or elasticity-insufficient.	Replace spring piece
	Oil leakage in the steering cylinder.	Inspect the seal of the piston
Truck’s snacking or moving with oscillation	Excess steering flow	Adjust the flow of splite-flow valve
	Spring damaged or elasticity-insufficient.	Replace
Excessive noise	Too low oil level in the oil tank.	Refill oil
	Suction pipeline or oil filter blocked.	Clean or replace
Oil leakage	Seals of guide sleeve, pipeline or joint damaged.	Replace

4. Electric system

4.1 General description

The standard configuration of the electric system of G3 series 1.5-2t front-drive three-wheel forklift trucks is an AC control system, which can realize a silent, high efficient, smooth and safe control of the truck.

The electrical system is mainly composed of combined instrument, traction control system, lifting control system, lithium tank group, control switch and lighting device, wiring harness and so on.

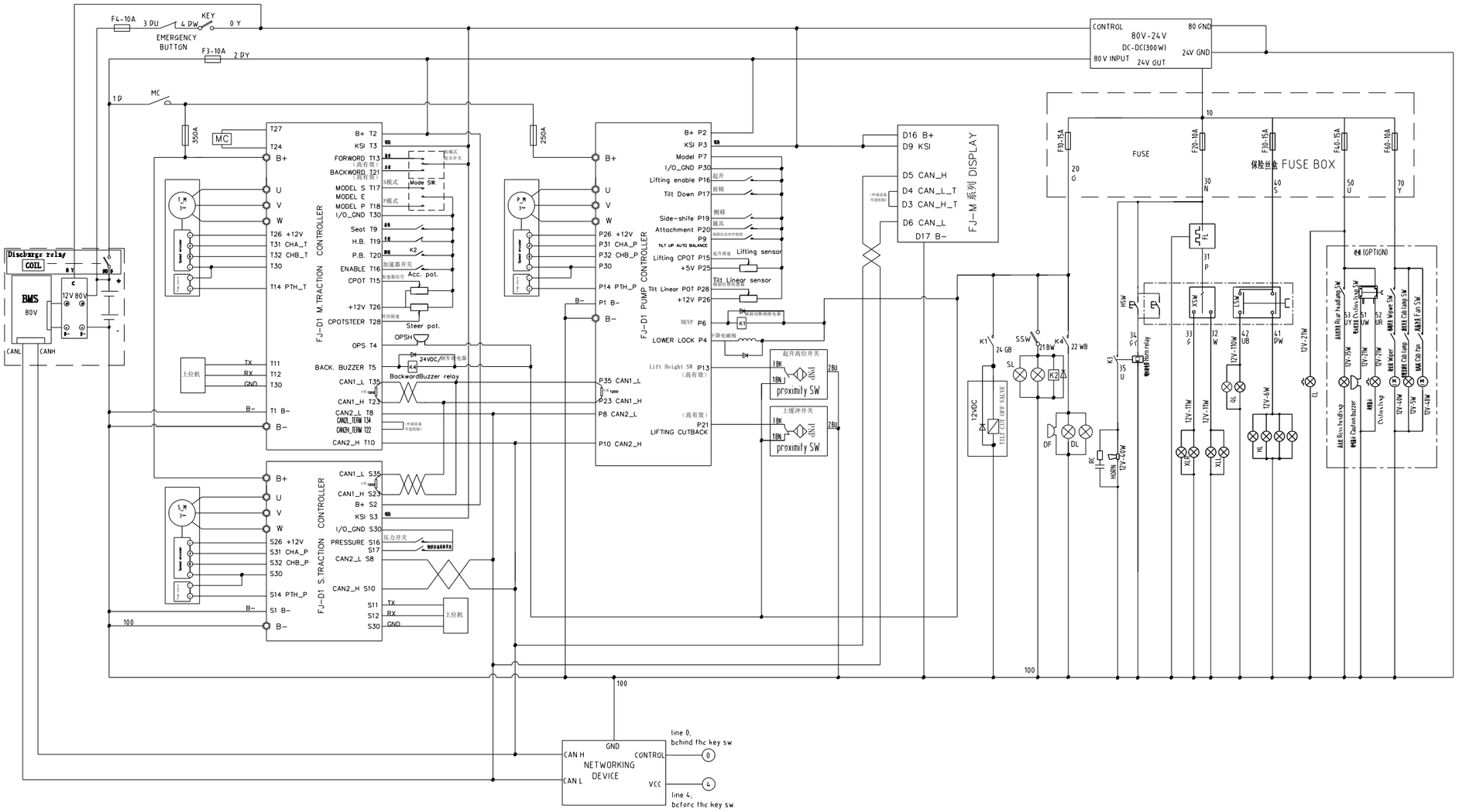
Among them, the traction control system constitute by combination switch, pedal accelerator, double handle of AC traction motor and traction control.

Hoisting control system by the valve control switch, lifting speed sensor, the exchange of lifting motor, lifting controller.

🕮 **Note**

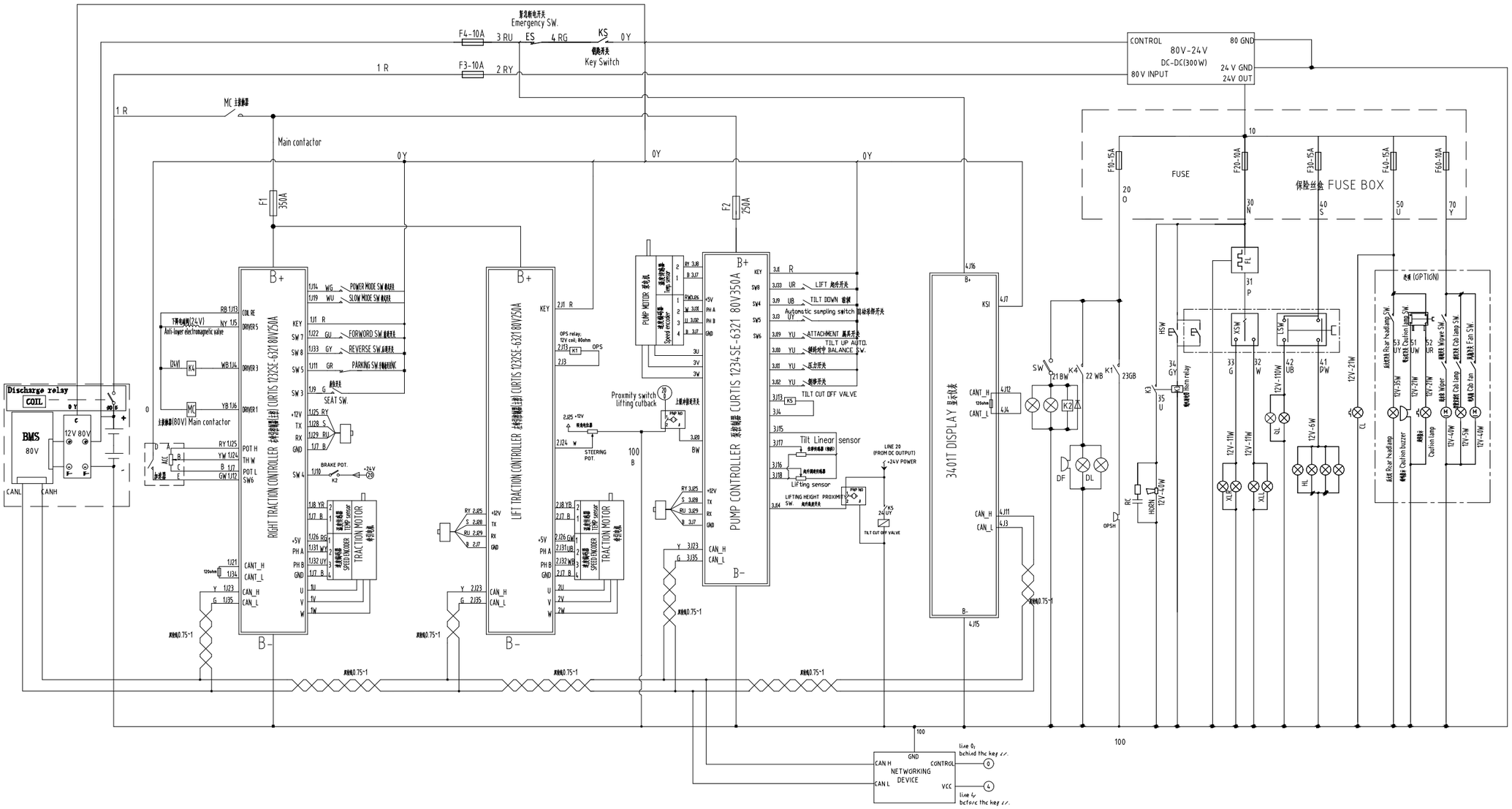
The manufacturer reserves the right to continuous improvement of the product. If there is any discrepancy between the physical object and the instructions, please consult the manufacturer.

The principle diagram of the electrical system is shown in Fig. 4-1a, Fig. 4-1b, 4-1c and Fig. 4-1d.



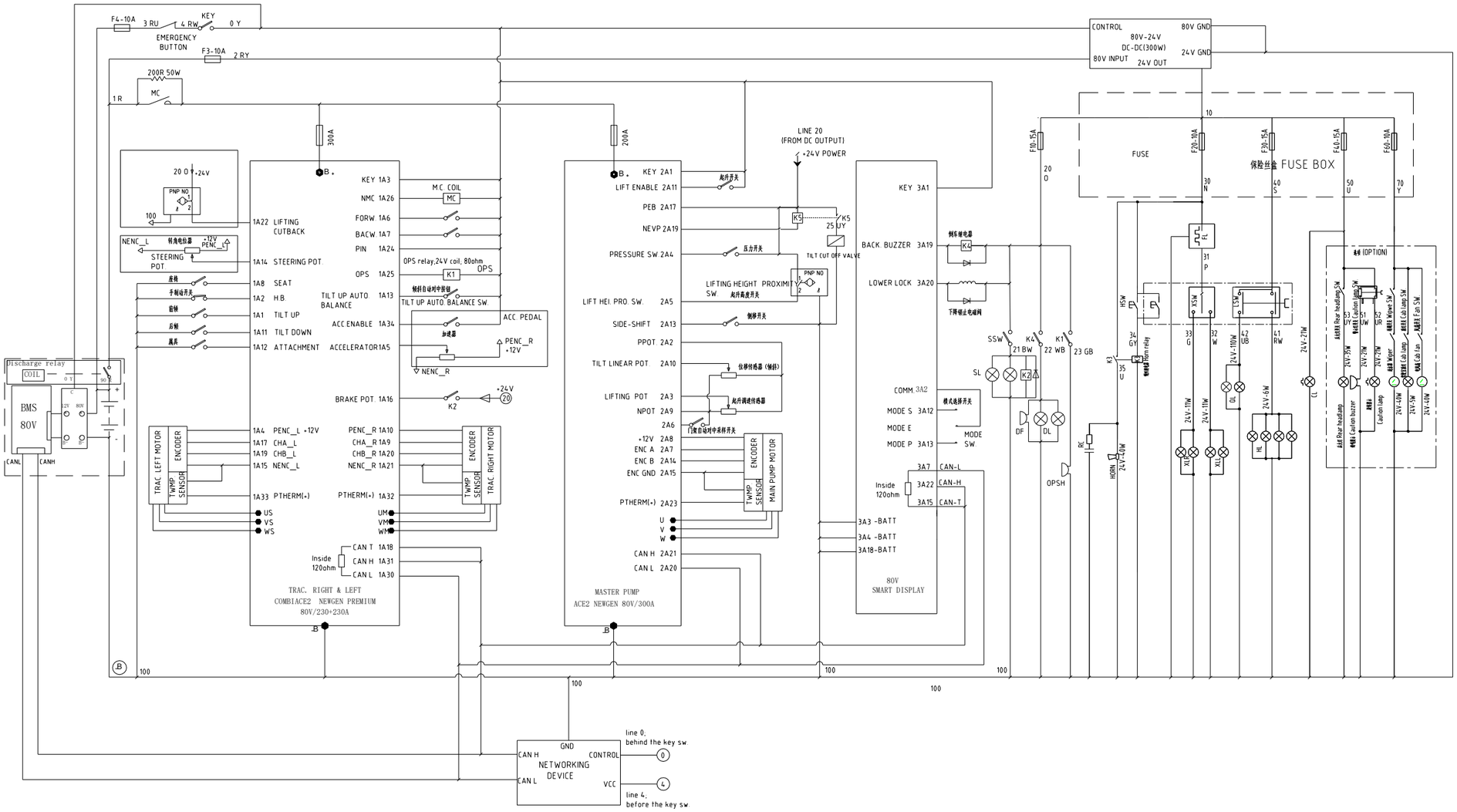
HL	示宽灯 Width lamp	QL	前大灯 Headlamp	RC	喇叭滤波器 Horn filter	SSW	刹车灯开关 Braking SW.
SL	刹车灯 Brake lamp	CL	警示灯 Caution lamp	FL	闪光器 Flasher	LSW	二档灯开关 Lamp SW.
XLL	左转向灯 Turning lamp (Left)	DL	倒车灯 Reverse lamp	HORN	喇叭 Horn	XSW	转向灯开关 Turning lamp SW.
XLR	右转向灯 Turning lamp (Right)	DF	倒车蜂鸣器 Reverse buzzer	HSW	喇叭按钮 Horn SW.	OPSH	警示蜂鸣器 Warning buzzer
K1	倾斜切断阀继电器Tilt cut off valve relay	K2	刹车继电器 Brake relay	K3	喇叭继电器 Horn relay	K4	倒车继电器 Reverse relay

Figure 4-1a Principle diagram of electric system(HELI technology system)



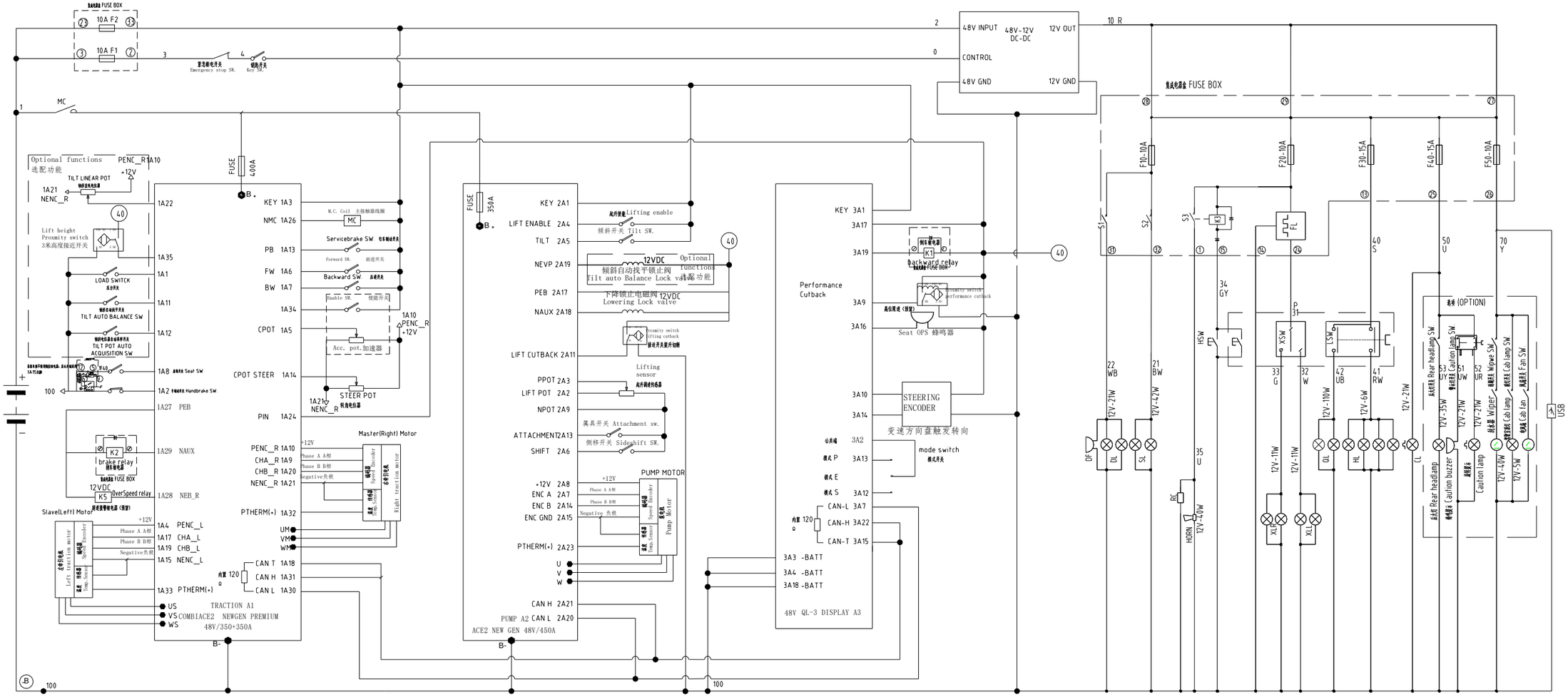
K5	倾斜切断阀 TILT CUT OFF VALVE						
HL	示宽灯 Width lamp	QL	前大灯 Headlamp	RC	喇叭滤波器 Horn filter	SSW	刹车灯开关 Braking SW.
SL	刹车灯 Brake lamp	CL	警示灯 Caution lamp	FL	闪光器 Flasher	LSW	二档灯开关 Lamp SW.
XLL	左转向灯 Turning lamp (Left)	DL	倒车灯 Reverse lamp	HORN	喇叭	XSW	转向灯开关 Turning lamp SW.
XLR	右转向灯 Turning lamp (Right)	DF	倒车蜂鸣器 Reverse buzzer	HSW	喇叭按钮 Horn SW.	OPSH	警示蜂鸣器 Warning buzzer
K1	OPS继电器 OPS relay	K2	刹车继电器 Brake relay	K3	喇叭继电器 Horn relay	K4	倒车继电器 Reverse relay

Figure 4-1b Principle diagram of electric system (Curtis system)



K5	倾斜切断阀 TILT CUT OFF VALVE						
HL	示宽灯 Width lamp	QL	前大灯 Headlamp	RC	喇叭滤波器 Horn filter	SSW	刹车灯开关 Braking SW.
SL	刹车灯 Brake lamp	CL	警示灯 Caution lamp	FL	闪光器 Flasher	LSW	二档灯开关 Lamp SW.
XLL	左转向灯 Turning lamp (Left)	DL	倒车灯 Reverse lamp	HORN	喇叭	XSW	转向灯开关 Turning lamp SW.
XLR	右转向灯 Turning lamp (Right)	DF	倒车蜂鸣器 Reverse buzzer	HSW	喇叭按钮 Horn SW.	OPSH	警示蜂鸣器 Warning buzzer
K1	OPS继电器 OPS relay	K2	刹车继电器 Brake relay	K3	喇叭继电器 Horn relay	K4	倒车继电器 Reverse relay

Figure 4-1c Principle diagram of electric system (ZAPI system, CPD15/16/18/20SQ-GE2/6Li)



1.5-1.6t泵电控使用350A；1.8-2.0t泵电控使用450A

HL	示宽灯 Width lamp	QL	前大灯 Headlamp	RC	喇叭滤波器 Horn filter	SSW	刹车灯开关 Braking SW.
SL	刹车灯 Brake lamp	CL	警示灯 Caution lamp	FL	闪光器 Flasher	LSW	二档灯开关 Lamp SW.
XLL	左转向灯 Turning lamp (Left)	DL	倒车灯 Reverse lamp	HORN	喇叭	XSW	转向灯开关 Turning lamp SW.
XLR	右转向灯 Turning lamp (Right)	DF	倒车蜂鸣器 Reverse buzzer	HSW	喇叭按钮 Horn SW.	OPSH	警示蜂鸣器 Warning buzzer
K1,S1	倒车继电器 Reverse relay	K2,S2	制动继电器 Brake relay	K3,S3	喇叭继电器 Horn relay	K4,S4	OPS继电器 OPS relay

Figure 4-1d Principle diagram of electric system (ZAPI system, CPD13/15/16/18/20SQ-A2LiG3-M,CPD15/16/18/20SQ-A2LiPG3-M,CPD15/16/18/20SQ-A2LiLG3-M)

4.2 Instrument

1) Panel layout 1

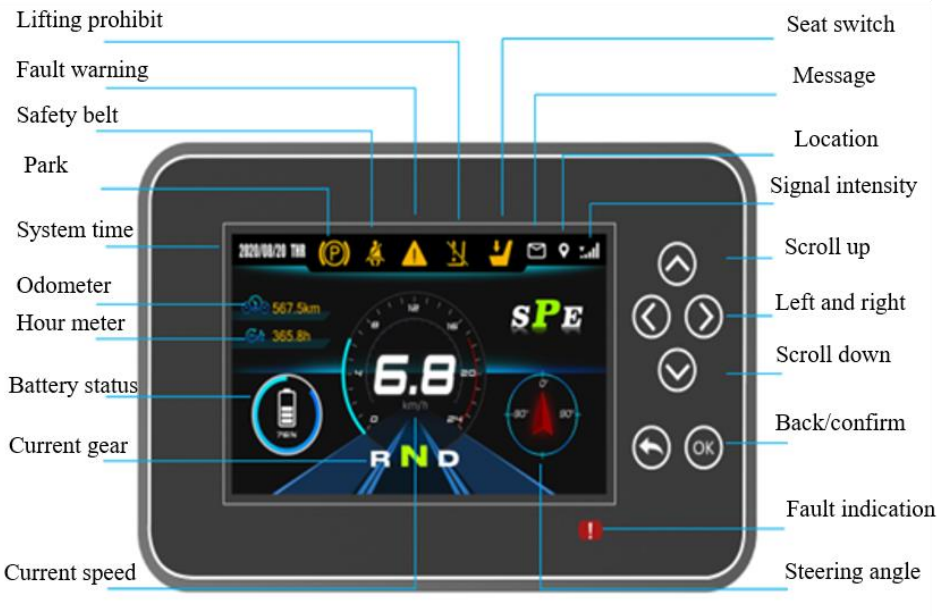


Fig. 4-2 Panel layout of HELI technology system

- The meaning of gear display is: D - Drive， R - Reverse， N - Neutral
- The speed mode value can be customized as required. The following types are available:
    - Type 1: S – high， P – middle， E – low
    - Type 2: S – low， P – middle， E – high
    - Type 3: S – low， E – middle， P – high
- The meanings of the current fault icon are as follows:
-  Fault indicator light, power-on self-test or fault light; If the fault light is off, there is no fault and communication is normal. If the fault indicator flashes, it indicates there is a fault. For details, check the fault code.
-  When the parking switch icon is always lighting, it indicates that the parking switch is off.
-  If the seat belt icon is always lighting, the driver is not wearing a seat belt.
-  If the fault icon flashes, a warning is displayed. The alarm code is displayed in the dialog box on the main window.
-  If the forbidden to lift icon is not flashing, the lifting is faulty.
-  If the seat switch icon is always lighting, it indicates that the seat switch is not turned off.

-  Notification icon, reserved, customizable according to customer requirements.
- Network signal quality：empty – none，one grid – poor，two grids – middle, three grids – good, More than four grids – excellent
- Internet cloud connect：the icon appears  – already connected to the cloud, the icon not appears –not connected to the cloud
- Positioning type: empty – No positioning,  – base station positioning,  – GPS positioning

2) Panel layout 2

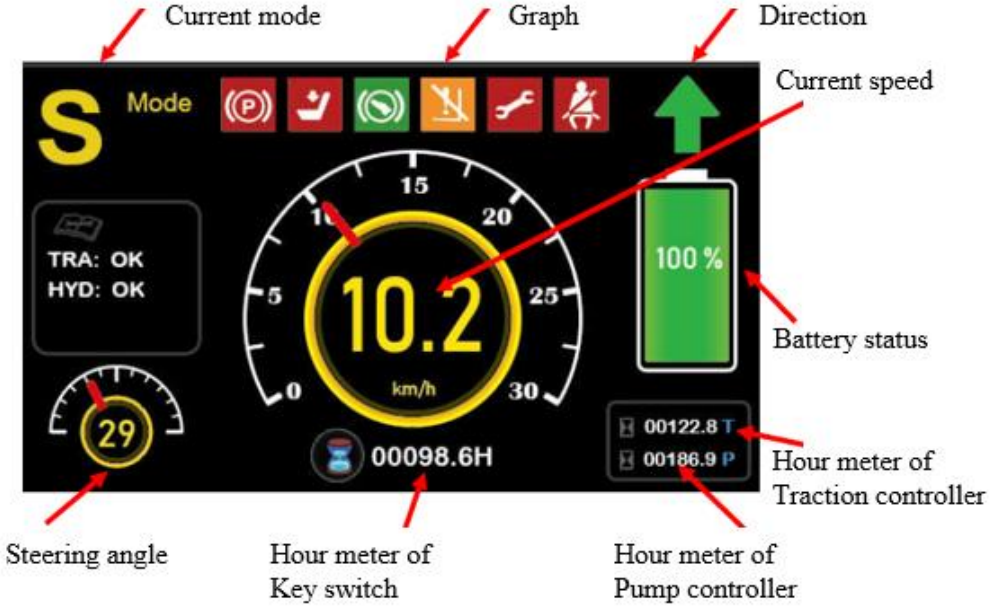


Figure 4-3 Panel layout of Curtis system

 Forward travel

 Reverse travel

 Power lower than 10%, lock indicator of lifting

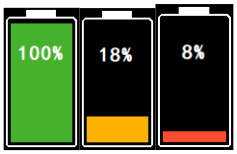
 Parking brake

 Pedal

 Seat indicator

 Seat belt indicator

 Fault indicator



3401T-5002 The battery icon on the main interface of the table would be displayed in different colors according to the battery quantity. The battery quantity range is 0~100%. The specific meanings of battery icons are as follows:

20%~100%： green

10%~19%： yellow with flashing

0%~9%：red with flashing. And the  show at main interface at the same time.

3）Panel layout 3



a. Working voltage input range： 20V ~100V

b. Rated working current： <150mA

c. Power output (Open-Drain Output): 1.5A continuous current

d. Protection grade: IP65

e. Working Temperature Range: -20~+70 ℃

f. Storage Temperature Range: -30~+85 ℃

g. Operating humidity: ＜95%

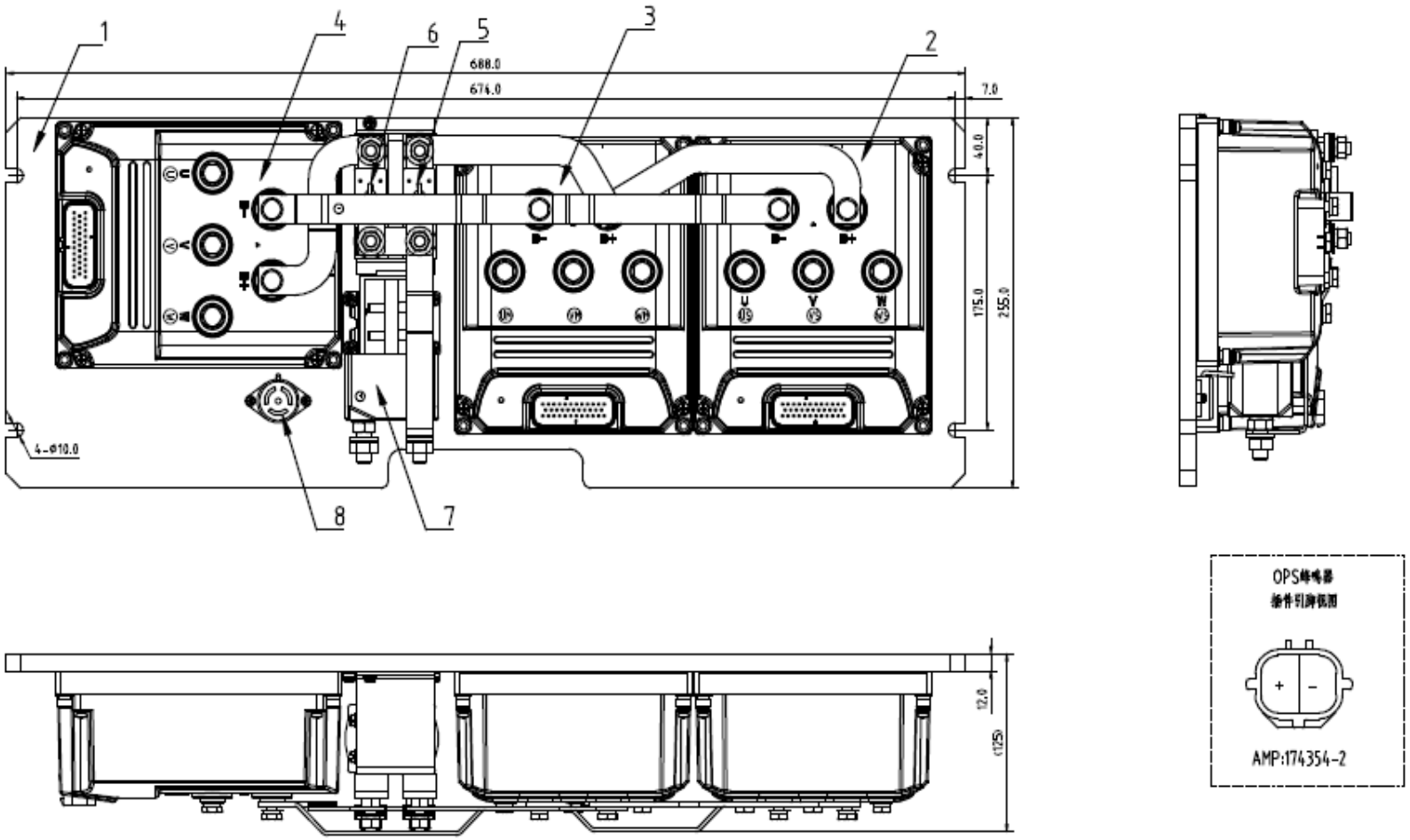
h. Communication type: CAN（125K /250K）

4.3 Electronic control

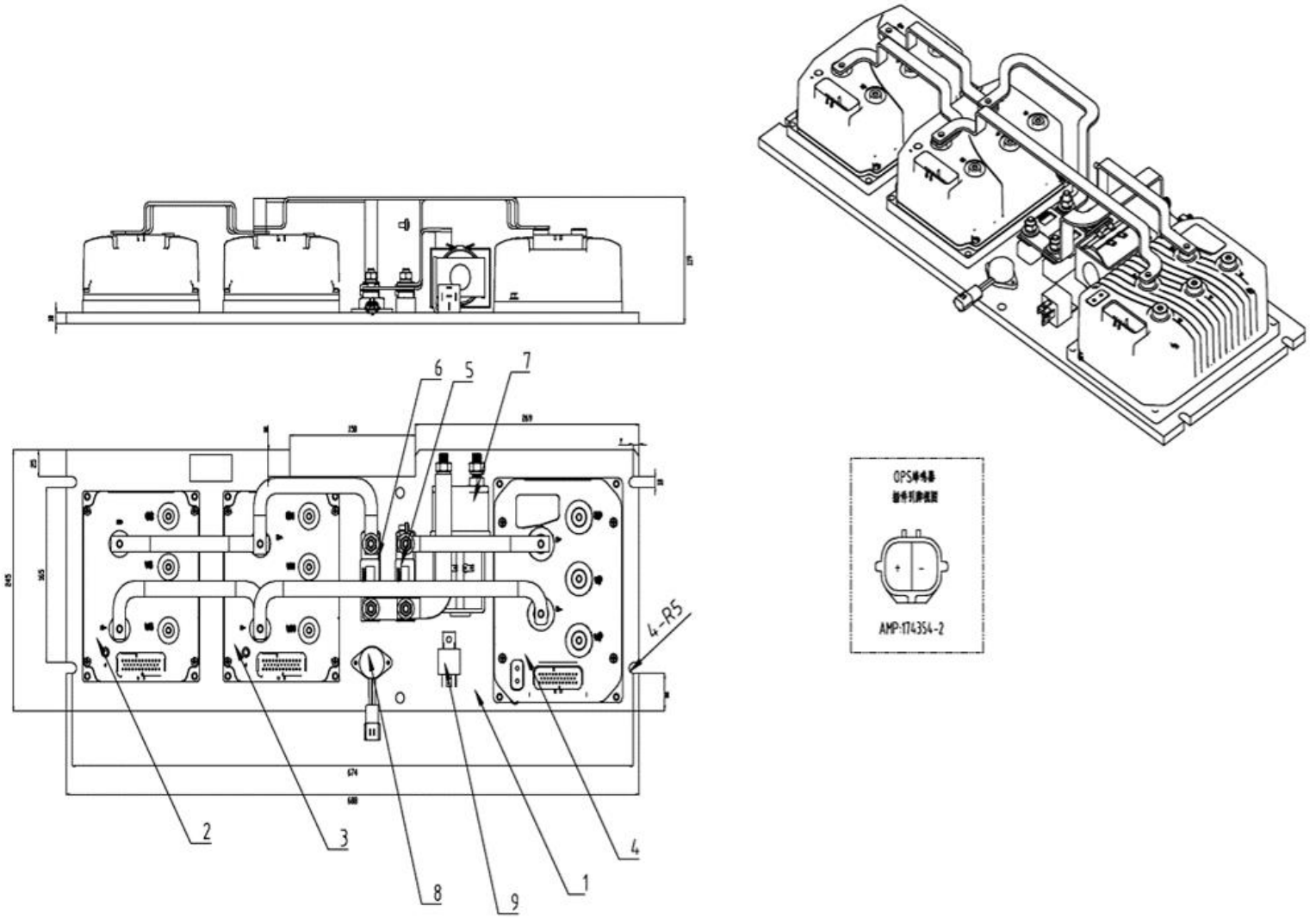
4.3.1 Genneral description

The controller assembly includes master slave controller, lift controller, contactor, relay, OPS warning buzzer and related wiring harness for the traction system.

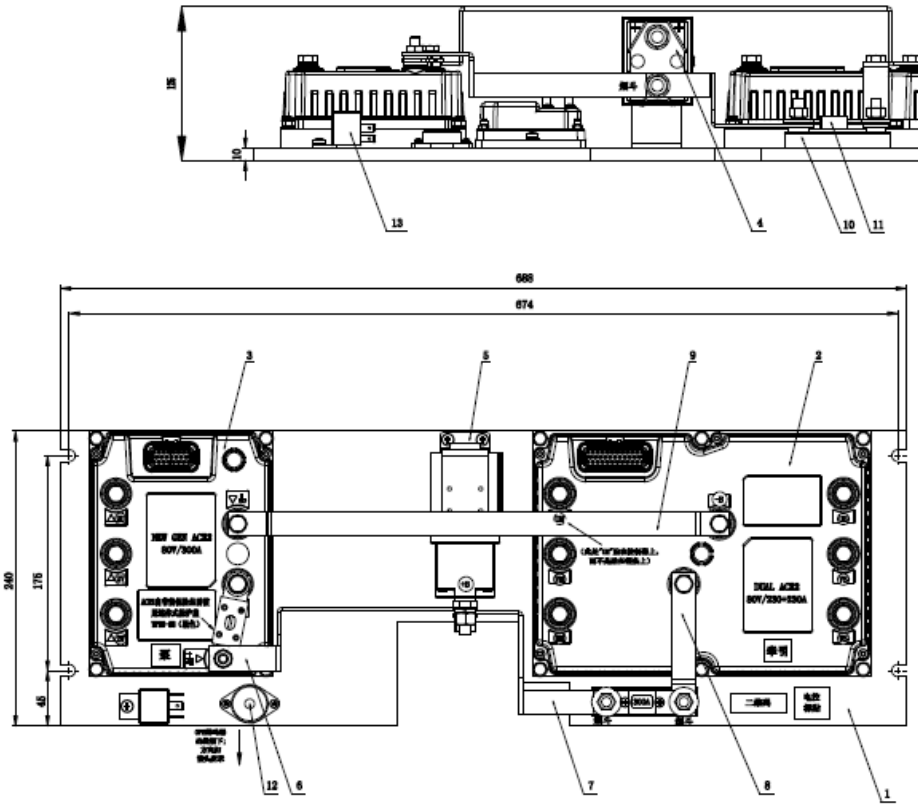
4.3.2 Electronic control assembly



1. Bottom plate 2. Driven AC controller 3. Drive AC controller
4. Pump AC controller 5. Fuse 6. Fuse 7. Contacter 8. OPS buzzer
Figure 4-4 Electronic control system assy (HELI technology system)



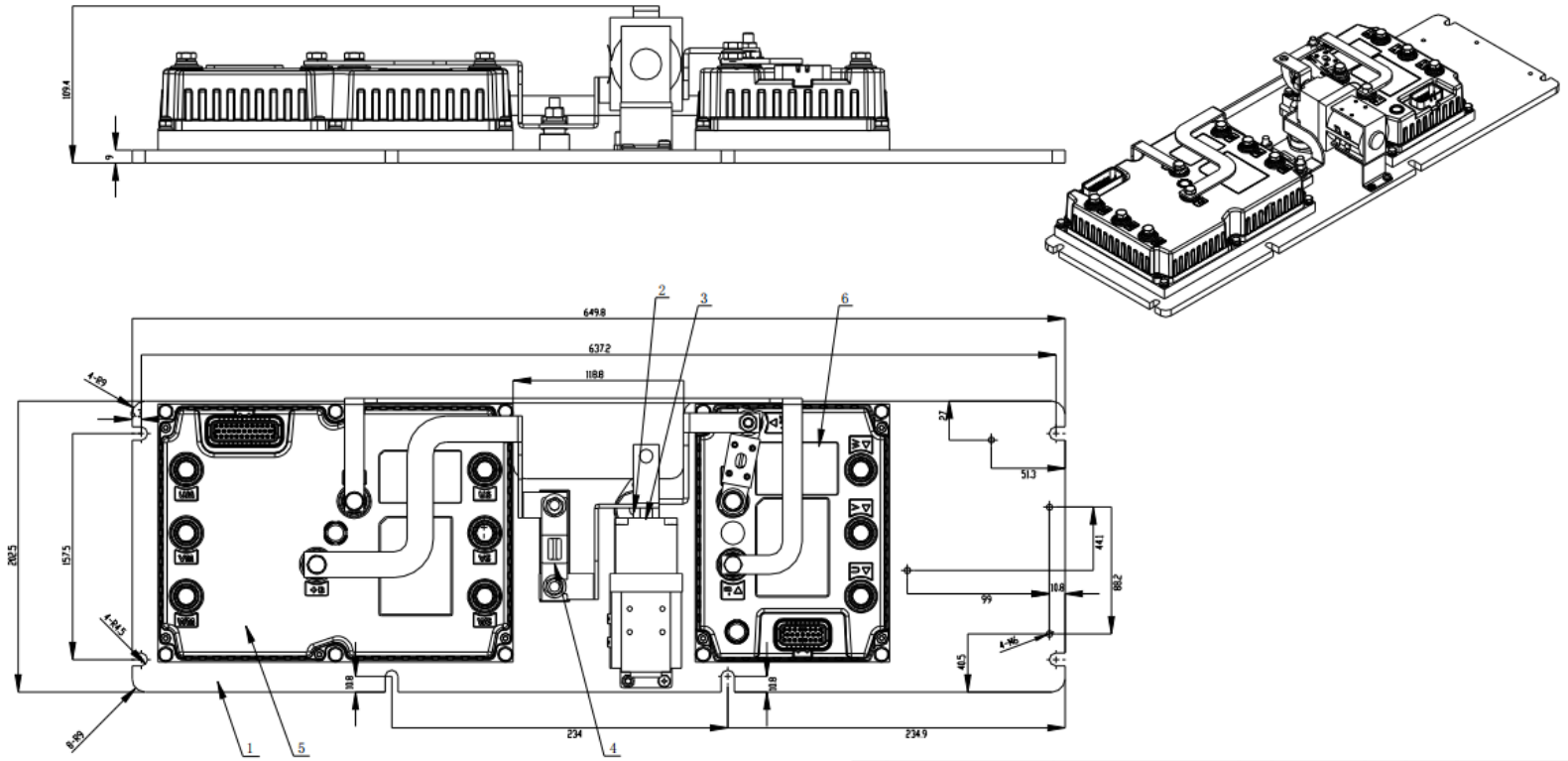
1. Bottom plate 2. Driven AC controller 3. Drive AC controller 4. Pump AC controller
5. Fuse 6. Fuse 7. Contacter 8. OPS buzzer(24 V) 9. 24V relay
Figure 4-5 Electronic control system assy (Curtis system)



13	FLS820-012-1C	继电器	1	成品			24V
12	QLB2.041G.701	OPS蜂鸣器		成品			备用
11	300A	熔断器	1	成品			
10	QLB7.100.307	熔断器座	1	成品			
9	QLB7.1000.004	铜排4	1	镀锡铜			
8	QLB7.1000.003	铜排3	1	镀锡铜			
7	QLB7.1000.002	铜排2	1	镀锡铜			
6	QLB7.1000.001	铜排1	1	镀锡铜			
5	QLB7.1000.201	SW200支架	1	A3			
4	SW200-583	主接触器	1	成品			
3	NEW GEN ACE2 80V/300A	泵控制器	1	成品			
2	DUAL ACE2 80V/230+230A	牵引控制器	1	成品			
1	QLB7.1000.101	电控底板	1	喷塑			
序号	代 号	名 称	数量	材 料	单重	处理	备 注

1. Electric control plate 2. Drive controller 3. Pump controller 4. Main contactor 5. SW200 bracket 6. Copper bar 1
7. Copper bar 2 8. Copper bar 3 9. Copper bar 4 10. Fuse holder 11. Fuse 12. OPS buzzer 13. Relay

Figure 4-6 Electronic control system assy (ZAPI system)



序号	代 号	名 称	数量	材 料	单重	总重	备 注
6	ACE2 NG 80V/300A	泵控制器	1	成品			ZAPI ；双CPU
5	DUALACE2 80V/230+230A	牵引控制器	1	成品			ZAPI ；双CPU
4	300A	熔断器	1	成品			
3	SW200-583	主接触器	1	成品			
2	QLB2.04.1G.701	12V OPS转换器	1	成品			
1	QLB7.1042.101	电控底板	1	喷铝			

Figure 4-7 Electronic control system assy (ZAPI system, CPD13/15/16/18/20SQ-A2LiG3-M， CPD15/16/18/20SQ-A2LiPG3-M，CPD15/16/18/20SQ-A2LiLG3-M)

A）Traction and pump motor controller (HELI technology system)

1）The main control adopts 32-bit embedded integrated motor controller, working frequency 120MHz;

2）Advanced and efficient control algorithm to achieve constant torque and power control of AC induction motor;

3）Advanced PWM technology is adopted to realize efficient utilization of power supply voltage.

4）Low control motor harmonic wave can suppress torque ripple, and maximize reducing the switching loss; Wide range of speed adjustment;

5）High or low speed can be smoothly controlled;

6)The control algorithm can adapt to the temperature change of the motor, which can keep the best performance under different conditions;

7）Rich external interface, multi-channel digital input, analog input, high power output, low power output;

8）Full Equipped alarm protection function, historical alarm record function;

9）With motor work timing, seat timing, truck mileage counting;

10） CAN communication is used to realize the integrated control system.

11）Power circuit adopts aluminum substrate design scheme, power device adopts low-voltage high-power MOSFET device,

12）It has wide voltage range, simple structure and flexible power matching.

13） The power base is aluminum plate with high thermal conductivity, which provides good heat transfer during heat dissipation and increases reliability.

B）Drive and pump motor controller (Curtis System)

1）The use of vector control technology, combined with Curtis's algorithm, ensures that the controller always provides peak torque and optimal efficiency.

2）The torque and speed working area is very wide and the regeneration performance is perfect.

3）Internal closed-loop control of speed and torque modes ensures optimal performance without the need for any other devices.

4）Through programming parameter setting, adjust drive and brake performance to the best.

5）Torque control mode provides unique performance, ensuring smooth transition and positive response in any state.

6）Unique pump control mode, quick response to hydraulic changes.

7）Design of automatic fail-safe power device

8）The hardware watchdog

9）Battery electrode reverse connection protection

10）Short circuit protection for output drive

11）Overheating protection, warning and automatic shutdown Settings provide motor and electronic protection.

12）IP65 protection level, meet the requirements of harsh environment.

C）Drive and pump motor controller（ZAPI system）

The models of drive and pump motor controllers are as follows: ZAPI ACE2 80V/230A+230A and ACE2 80V/300A

●ACE2 controller is a three-phase AC asynchronous motor inverter, which controls traction motor and pump motor. It has regenerative braking function, CAN BUS interface and digital control of microprocessor (based on motor speed feedback).

●The allowable working ambient temperature range is -30ºC～+40ºC, and the

maximum allowable working temperature is 85ºC.

●Protection functions of ACE2 motor controller:

a) Battery polarity protection b) Incorrect connection protection

c) Over heat protection; overload protection; short circuit protection

d) Protection class of controller 1P65 e）Out-of-control protection;

f) Battery over discharging protection g）Mis-starting protection.

●Through the controller's handheld unit(programmer), and the following functions can be conveniently realized:

a) On line inspection and adjusting on drive and lift system

b) It can modify the traveling accelerator and lifting speed regulation signals online, with better matching;

c) Fault detection and inquiry on drive and lift control system.

Note:

◆ Test the truck with four wheels raised (off the ground) after the controller being fixed, in that case there will be no danger even the connection is in error.

◆ A certain amount of voltage will remain in filter capacitance after the turn off of the electric switch. Cut off the battery and make the remained voltage short circuit by connecting the 10-100ohm resistance to the inverter before checking the inverter.

◆ Motor controller by the manufacturer to provide quality assurance, failure should promptly inform the manufacturer to provide after-sales service; If not authorized by the manufacturer, please do not open the maintenance without authorization, such as unauthorized maintenance caused by the user's personal and property losses, the user shall bear the responsibility.

4.4 Motor

Motor type: three phase AC type induction motor (free from maintenance)

Table 4-1 Motor specification

	Pump motor		
Truck	CPD15/16/18/20SQ-GE2/6Li	CPD13SQ-A2LiG3-M	CPD15/16/18/20SQ-A2Li(P)(L)G3-M
Power	14KW	12KW	16.5KW
Rated voltage	52V	54V	54V
Rated current	210A	172A	227A
Rated speed	2337rpm	2155rpm	2322rpm

Note

In the inspection and maintenance of the motor must be operated without power, to avoid accidents.

4.5 Lithium battery

4.5.1 Lithium Battery specification

Table 4-2 Lithium Battery specification (CPD15/16/18/20SQ-GE2/6Li)

Model	Voltage	Capacity	Brand	Type
A0KP2-40621G	80V	202AH	Heding	Standard
A0KP2-40631G	80V	271AH	Heding	Optional
A0KP2-40321G	80V	202AH	Pengcheng	Optional
A0KP2-40331G	80V	271AH	Pengcheng	Optional
A0KP2-40431G	80V	271AH	Yijiatong	Optional

Table 4-3 Lithium Battery specification（CPD13/15/16/18/20SQ-A2Li(L)G3-M）

Model	Voltage	Capacity	Brand	Type
A2WW2-40621	80V	202AH	Heding	Standard
A2WW2-40631	80V	230AH	Heding	Optional
A2WW2-40641	80V	280AH	Heding	Optional
A2WW2-40651	80V	300AH	Heding	Optional
A2WW2-40661	80V	404AH	Heding	2T Optional
A2WW2-40321	80V	200AH	Pengcheng	Optional
A2WW2-40331	80V	228AH	Pengcheng	Optional
A2WW2-40341	80V	268AH	Pengcheng	Optional
A2WW2-40351	80V	302AH	Pengcheng	Optional

A2WW2-40361	80V	346AH	Pengcheng	2T Optional
A2WW2-40371	80V	400AH	Pengcheng	2T Optional

Table 4-4 Lithium Battery specification（CPD15/16/18/20SQ-A2LiPG3-M）

Model	Voltage	Capacity	Brand	Type
A3DW2-40621	80V	202AH	Heding	1.5/1.6/1.8T Standard
A3DW2-40641	80V	280AH	Heding	1.5/1.6/1.8T Optional
A3DX2-40621	80V	202AH	Heding	2T Standard
A3DX2-40641	80V	280AH	Heding	2T Optional
A3DX2-40661	80V	404AH	Heding	2T Optional
A2DW2-40321	80V	200AH	Pengcheng	1.5/1.6/1.8T Optional
A2DW2-40331	80V	228AH	Pengcheng	1.5/1.6/1.8T Optional
A2DW2-40341	80V	268AH	Pengcheng	1.5/1.6/1.8T Optional
A2DW2-40351	80V	302AH	Pengcheng	1.5/1.6/1.8T Optional
A2DX2-40321	80V	200AH	Pengcheng	2T Optional
A3DW2-40621	80V	202AH	Pengcheng	1.5/1.6/1.8T Standard
A2DX2-40331	80V	228AH	Pengcheng	2T Optional
A2DW2-40341	80V	268AH	Pengcheng	2T Optional
A2DW2-40351	80V	302AH	Pengcheng	2T Optional
A2DW2-40361	80V	346AH	Pengcheng	2T Optional
A2DW2-40371	80V	400AH	Pengcheng	2T Optional

Table 4-5 Lithium Battery specification（CPD15/16/18/20SQ-A2LiLG3-M）

Model	Voltage	Capacity	Brand	Type
A2WW2-40621L	80V	202AH	Heding	Standard
A2WW2-40641L	80V	280AH	Heding	Optional
A2WW2-40661L	80V	404AH	Heding	2T Optional
A2WW2-40321L	80V	200AH	Pengcheng	Optional
A2WW2-40332L	80V	228AH	Pengcheng	Optional
A2WW2-40341L	80V	268AH	Pengcheng	Optional
A2WW2-40352L	80V	302AH	Pengcheng	Optional

A2WW2-40361L	80V	346AH	Pengcheng	2T Optional
A2WW2-40371L	80V	400AH	Pengcheng	2T Optional

4.5.2 Lithium battery routine usage-cautions

The right usage and routine maintenance of the lithium battery will influent lithium battery life and performance. So, the operator should maintain the lithium battery according to the manual and actual conditions.

(1) Please refer to the Product Instructions and Lithium-Ion Battery Instructions before use.

(2) When the vehicle power is low, please charge it in time; When not used for a long time, please press the emergency power off switch to prevent overdischarge.

(3) Lithium battery can not be charged below 0℃. In low temperature environment below 0℃, please charge the truck immediately after use.

(4) Lithium-ion batteries can be charged at any time, but it should be fully charged at least once a month in order to calibrate the battery level. It is recommended to fully charge the battery at least once a week during normal use

(5) Do not flush the lithium battery with water to prevent the battery from water.

🕮：Notice

(1) Do not use lithium batteries at temperatures above 55℃ or below -25℃.

(2) Do not flush the lithium battery box directly.

(3) Do not place heavy objects or conductors on the surface of the lithium battery box.

(4) Keep children or other animals out of touch with lithium battery boxes.

(5) Personnel not authorized by the battery manufacturer shall not disassemble the lithium battery pack to prevent damage to the internal components of the battery pack.

4.5.3 Lithium battery maintenance

>>Matters needing attention in Lithium-ion battery maintenance - General

(1) In the maintenance and overhaul of lithium batteries must be

required to wear protective equipment, such as insulating gloves, goggles, ladle shoes, etc.

(2) In the lithium battery maintenance must use special electrical tools or the corresponding insulation tools, when the use of ordinary tools for temporary maintenance to work on the insulation treatment.

(3) Please designate qualified electrical engineers to carry out system maintenance, inspection or replacement. Non-professional personnel are strictly prohibited from disassembling. During use or maintenance operation, it is strictly prohibited to wear or damage the connections inside and outside the system to avoid danger.

(4) After the power system is used for half a year, the fastening degree of fuse connecting bolts, contactor connecting bolts and other connecting bolts on the power main circuit should be inspected.

(5) Ensure that the low-voltage power supply of the truck is disconnected before maintenance, and then ensure that the truck is disconnected from the power loop of the battery system. Maintenance can be carried out after completion of the above confirmation.

(6) when two people or two or more persons jointly operation, should avoid cross work, in order to prevent tool collision during the working process of the battery short circuit or get an electric shock accidents.

>>Lithium-ion battery maintenance matters needing attention – second cell

(1) Disconnect the main switch of the power supply and unplug the main interface of the voltage acquisition line before removing the single battery in the module, so as to avoid burning out the management system due to too large pressure difference in the disassembly process; In the disassembly process to have been removed terminal insulation treatment.

(2) When charging a battery cell, reverse charging the battery is strictly prohibited. A reverse charging can lead to the battery voltage returning to 0 and scrap in advance

(3) In any case, the terminal voltage of the battery cell must be detected in real time when testing or using the battery. It is strictly prohibited to carry out series charging and discharging test on the battery pack without a management system or protection plate, so as to avoid causing overcharging or discharging of the battery.

>>Lithium-ion battery maintenance matters needing attention -- others

(1) Battery safety valve is a safety protection device designed to avoid battery abnormalities. It is strictly prohibited to twist or block the battery safety valve without permission.

(2) Be careful during the battery connection operation to avoid the phenomenon that the whole group or part of the battery is connected in reverse, or the whole group or part of the battery is short circuit.

(3) In the process of taking the battery, it should be guaranteed that the battery is upright, Shall not be inverted.

(4) After the battery pack is connected, be sure to use a multimeter to confirm the total voltage of the main and main and negative terminals is correct before it can be connected to the switch box.

(5) The pole bolt must be tightened during the battery installation to avoid the increase of contact resistance due to poor contact. If the bolt is not firmly connected, the pole part of the battery pack will be seriously heated when the battery pack is charged and discharged with large current. The battery life will decrease sharply if the temperature exceeds 75℃, and the battery will be burned out if the temperature exceeds 125℃. However,

the pole bolt should not be tightened too hard, so as not to lead to pole screw slip tooth; Once the pole internal thread slip due to excessive force, please use a screw tap and other tools to refurbishment the tooth.

4.5.4 Lithium Battery storage and keep

(1) Before long-term storage, it should be confirmed that the battery system power is not less than 50%.

(2) Charging maintenance should be carried out once every three months: charge to 100%.

(3) Store it for more than three months, and confirm whether the battery power system has a fault alarm before using it again. If so, please contact the after-sales service department for maintenance.

(4) The storage environment should be kept dry and ventilated, away from heat source.

🕮: **Notes**

(1) If the SOC of the battery system is lower than 20%, please charge it in time.

(2) Please use the special charging equipment authorized by the manufacturer to charge.

(3) In case of fault alarm during charging, both the battery system and the charger will stop charging, and the charger will display fault information.

(4) The charging environment should be dry and ventilated, without flammable and explosive items around.

(5) The battery system should be fully charged once a week.

4.5.5 Lithium Battery fault and resolution

The cause that made the lithium battery error is various, except the effect of the

quality manufacture and transport storage, mostly due to the improper maintenance. Find out the faults and analyze the causation as soon as possible to exclude.

Table 4-6 Lithium battery faults and treatment methods

No	Fault phenomenon	Causes	Troubleshooting
1	Instrument report corresponding fault code	Something's wrong with the corresponding component	Find the fault code table for fault handling
2	Whole truck without electricity	1) The truck wiring harness or power cord connector fails. 2) lithium battery system malfunction.	1) Check whether the wiring harness of the truck and the connecting objects are normally connected; 2) judge whether battery system can discharge normally.
3	The battery life of the truck is significantly shorter	1) The battery is not fully charged. 2) acquisition problems or damage of BMS. 3) bad battery cell consistency.	1) Charge the battery to 100% before use. 2) check the acquisition wire and BMS. 3) battery cell is damaged, replace it.
4	SOC jumping or continue unchanged or growing	1) Lithium-ion battery forklift works in lead-acid mode. 2) the consistency of the battery cell. 3) the current sensor is damaged. 4)BMS fault.	1) Check whether the operation mode is normal. 2) battery cell performance test. 3) replace the current sensor. 4) Replace BMS.
5	The battery can not charge	1) The EV Charger is not inserted in place or the battery charger is not connected. 2) battery temperature below -30 ℃ or above 60 ℃ 3) charger or truck shows fault 4) EV Charger holder damage, contactor is not closed, BMS fault, etc.	1) Replug the EV Charger and connect the battery charger source. 2) allows the battery before charging heating or cooling, place the truck in the appropriate temperature environment, recharging when the temperature is normal. 3) check if the truck instrument has battery system trouble light lighting, or there is charging system fault clue, or show the battery charger failure, then stop charging, suggest to contact authorized professional maintenance personnel. 4) test EV Charger, see if charging contactor is close, replace BMS.

4.5.6 Daily maintenance

(1) Check the appearance of the box: check the battery system outer box for foreign matter, obvious deformation, rust and other abnormal conditions.

(2) National standardized charging port: in the state of power off, check the interface for abnormal conditions such as damage, foreign body, corrosion and so on.

(3) Connector: In the state of power off, check whether the connector is loose, damaged and other abnormal conditions.

(4) State detection: observe the battery system voltage, temperature and other state information on the display screen of the charger during charging to ensure that all state information is within the normal range.

4.6 Parking brake pedal

（1）The parking brake of CPD15/16/18/20SQ-GE1/2/6LI model truck adopts pedal brake. When whole truck is stationary, the opreationer leave the seat, please use parking brake pedal, and the hand brake light  lighting up constantly, the travelling function has been limited.

When operate the truck again, the parking brake pedal must be step on again, the hand brake switch light  is out, the travelling function limited is released, the work could be started.

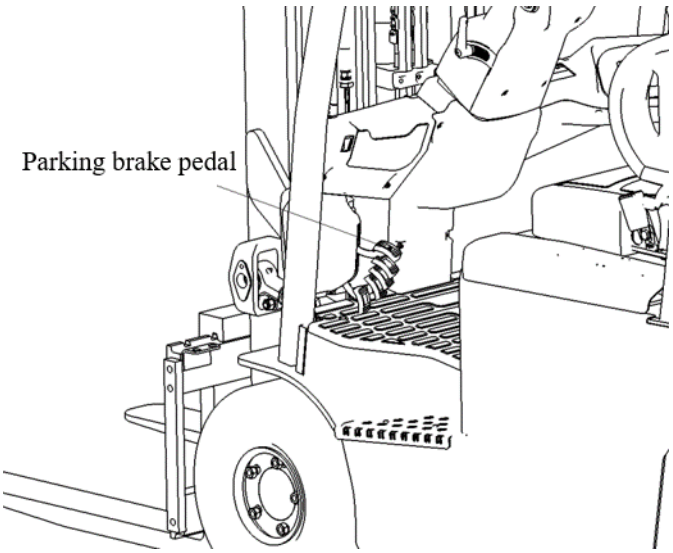


Figure 4-8 Parking brake pedal

（2）The CPD15/16/18/20SQ-A2LIG3-M truck adopts handle brake. When the truck is stationary and the driver leaves the seat, please pull down the parking brake handle. At this time, the parking indicator (P) on the instrument light up continuedly, and the truck driving function is limited.

When the driver driving the forklift again, the parking brake handle must be reset, the parking indicator (P) on the instrument is turned off, the driving function restriction is lifted, and the truck can start to work.

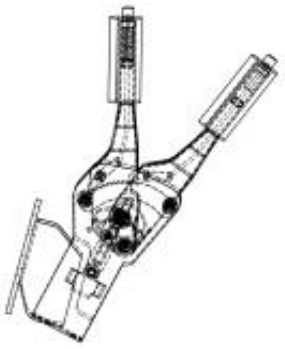


Figure 4-9 The parking brake handle

Danger

Do not step on the parking brake pedal/ pull down the parking brake handle **when the forklift is travelling.**

In some cases, if step on the parking brake pedal/ pull down the parking brake handle **suddenly, the goods may fall from the pallet fork;**

Only when the forklift is travelling, if can't stop the forklift truck by the brake pedal, then use the parking brake pedal/ pull down the parking brake handle**;**

4.7 Emergency power off switch

Before the truck working, please start emergency power off switch manually.

when the truck is maintained, transported, or stored for a long time, please turn off emergency power off switch manually.



Figure 4-10 Emergency power off switch

Danger

Do not turn off emergency power off switch when truck is travelling.

in some cases, if turn off emergency switch suddenly, the goods would fall off from the fork, causes damage of people and goods.

Only when forklift is travelling, if it is impossible to stop forklift by other ways, then turn off emergency power off switch manually.

4.8 Fault diagnosis

The traction control system, lifting control system, steering control system and intelligent instrument system used in the truck are microprocessor controllers that continuously monitor and perform a diagnostic program for the main functions. The diagnostic program consists of the following four points:

(1) Diagnostics for electric lock closing: the watchdog circuit, current sensor,

capacitor charging, phase voltage, contactor drive, CAN-BUS interface, whether the operation sequence of the switch is correct; Whether the output of the accelerator is correct; Whether the two microprocessors are synchronized; Whether the input to the security-related hardware Is available.

(2) Standby detection: watchdog circuit, phase voltage, contactor driver, current sensor, CAN-BUS interface.

(3) Detection during working: watchdog circuit, contactor driver, current sensor, CAN-BUS interface.

(4) Continuous detection: inverter temperature, motor temperature.

Diagnostics can be provided in two ways: one is to use a digital handheld unit, which can provide detailed fault information; The other is that the fault codes are transmitted by CAN-BUS, and the fault codes and module nodes are displayed on the intelligent instrument.

A. Common fault (HELI technology system)

(1) Common fault of drive system

Fault code	Fault name	Details
1	Battery overvoltage protection	1. Check whether the battery is properly connected to the electric control system with cable. 2. Check whether the battery voltage is normal. 3. Replace the control unit.
2	Battery undervoltage protection	1. Check whether the battery cables are incorrectly connected and whether the positive and negative electrode connectors are seriously corroded. 2. Check the status of the battery. If the battery electrolyte is partially exhausted, the controller undervoltage protection fault may be triggered. Undervoltage protection faults can also be triggered when the battery power level is already low and the motor is operating at a high current (e.g. at full load). 3. Replace the control unit.
3	The accelerator pedal was steped down before starting	1. If the fault code is caused by the driver steped the accelerator pedal before the system power-on self-test (the main circuit breaker is not closed), please restart the system after release the accelerator pedal. 2. Check the numerical setting of accelerator pedal calibration to

		see whether the setting of minimum and maximum voltage of accelerator pedal is accurate. If not, recalibrate the accelerator pedal. You can set the accelerator pedal monitoring software or instrument. 3. Check whether the control unit in the main harness is correctly connected to the accelerator pedal. If there is no problem with the connection, press down the accelerator pedal through the monitoring software of the upper computer and observe whether the feedback voltage value of the pedal is in the correct range. 4. Replace the control unit.
4	Maintenance warning	1. Maintain the truck, and retime the maintenance timer in the controller through FJ monitoring software or instrument. 2.Shut down this fuction.
5	Flash memory fault	1. Flash reloads defaults: Use the FJ controller programming tool to "Restore Factory Settings" operation 2. After executed solution 1, If the fault persists with powered on again, replace the control unit.
6	Driver bus low voltage alarm	1. When power on, must start work after the main circuit breaker sucked. 2. Check that the coil control terminal of the main circuit breaker is properly connected to the main harness connection terminal. 3. Check whether the main fuse is in good condition.
7	Overvoltage current limiting activation warning	1. Check whether the battery is properly connected. 2. The battery related parameters match.
8	Overcurrent failure of drive motor power unit	1. Check whether the UVW three-phase cable connection between the drive module and the motor is short-circuited (short-circuited between three-phase cables or short-circuited between a phase cable and the truck frame), and check whether the motor coil has a burning smell. 2. Check whether the cables between the control unit and the power module are properly connected (only for V series products). 3. Disconnect the UVW cable of the driver module, and use a multimeter to check whether the resistance value between the +/-B terminal of the module and the UVW terminal is symmetrical. If the resistance value of one phase is found to be significantly different from the other phases, the power module can be determined to be burned down and needs to be replaced. 4. Replace the control unit.
9	The precharge capacitor charges too fast	1. Replace the main circuit breaker. 2. Replace power modules one by one to exclude drive and oil pump power modules (only for V2 series products).

		3. Replace the control unit.
11	The precharge capacitor failed to discharge effectively during system startup	1. Check whether the UVW connection cable between the oil pump motor and the oil pump power module is properly connected. 2. Check whether the cable between the power module of the oil pump and the control unit is properly connected (only for V series products). 3. Replace oil pump motor power module (only for V series products). 4. Replace the main circuit breaker. 5. Replace the control unit.
12	Battery low voltage alarm	1. Charge the battery. Note that if the battery voltage level is still lower than the "Battery Reset value" after charging. Then the fault code will not be eliminated. Only when the voltage level of the battery is higher than the "battery reset value" after charging, can the fault code be eliminated and the electric control be allowed to work normally. 2. Measure the battery voltage. If the measured voltage is inconsistent with the battery discharge protection value, replace the control unit.
13	High temperature alarm of drive motor	If the fault occurs when the motor is not hot: 1. Use a handheld multimeter, put it in resistance measurement mode, measure the resistance value between the two lines of the motor temperature sensor, compare with the true value table of the motor temperature sensor, if the measured value is inconsistent with the actual temperature of the motor, then replace the temperature sensor. 2. Replace the control unit. If the fault occurs when the motor is very hot: 1. If the temperature value read from the monitoring software or instrument of the upper computer is consistent with the actual temperature of the motor, check whether the motor housing is clean and whether the heat dissipation of the motor is normal. 3. Detect whether the drive motor is working normally, or whether there is brake locked or other abnormal situation.
15	Loss of drive motor current	1. Check whether the cables between the motor power module and the control unit are correctly connected (only for V2 series products). 2. Replace the power module (V2 series products only).
16	Drive motor fan valve control coil open	1. Check whether the coil of the main circuit breaker is short-circuited externally. 2. Check the connection wire. 3. Replace the control unit.
17	Main circuit breaker	1. Check whether the coil of the main circuit breaker is

	coil overcurrent alarm	short-circuited externally. 2. Replace the main circuit breaker. 3.Replace the control unit.
18	The main circuit breaker control coil is open	1. Check whether the control port of the main circuit breaker is disconnected. 2. Detection control wiring harness; 3. Replace the main circuit breaker.
19	Contact adhesion of main circuit breaker	1. Replace the main circuit breaker.
20	Drive motor power module overheat	1. The fault may be caused by insufficient heat dissipation. Check the heat dissipation between the power module and the aluminum plate as well as between the aluminum plate and the frame. Note: you can read the temperature of the motor power module through Fanji upper computer software or instrument. 2. If the heat dissipation measures of the above modules are all good, it is necessary to check whether the drive motor works normally. If it does not work properly, the power module will overheat. Second, replace the power module. 3.Replace the control unit.
21	Dual-MCU system Communication timeout	1. Replace the control unit.
22	The solenoid brake coil is broken	1. Check the electromagnetic brake control coil. 2. Check the connection wire. 3.Replace the control unit.
23	DRIVE1 channel overcurrent	1. Check the external connection corresponding to DRIVE1 channel, whether the connection is large load. 2. Check DRIVE1 channel corresponding external connection, whether the input high voltage. 3.Replace the control unit.
25	Astern buzzer control port load disconnection	1. Check the reversing buzzer 2. Check the connection wire 3. Replace the control unit
27	Controller output overload	1. Ensure that the threshold is set properly. 2. Check whether there is a short circuit between the UVW three-phase cable connection between the drive module and the motor (short circuit between three-phase cables or a phase cable and the truck frame), and check whether the motor coil has a burning smell. 3. Disconnect the UVW cable of the power module, and use a multimeter to check whether the resistance value between the +/-B terminal of the power module and the UVW terminal is symmetrical. If the resistance value of one phase is found to be significantly different from the other phases, the power module

		is burned down and the controller needs to be replaced.
28	Drive power unit software overcurrent	1. Check the drive load. 2. Check the UVW three-phase connection cable. 3. Determine the over current threshold setting is reasonable. 4. Replace the drive unit.
29	DRIVE2 channel overcurrent	1. Check the external connection corresponding to DRIVE2 channel, whether the connection is large load. 2. Check DRIVE2 channel corresponding external connection, whether the input high voltage. 3.Replace the control unit.
30	DRIVE3 channel overcurrent	1. Check the external connection corresponding to DRIVE3 channel, whether the connection is large load. 2. Check DRIVE3 channel corresponding external connection, whether the input high voltage. 3.Replace the control unit.
31	The output of the drive power unit default phase	1. Check whether the U, V, and W power cables of the motor are connected reliably. 2. Replace the driver module.
33	Battery pack is low voltage, output current limit	1. Check the battery connection 2. Determine the residual capacity, whether under voltage 3. Reasonable setting current limiting threshold
35	Astern buzzer controls overcurrent output at port	1. Check the load 2. Check the connection wire 3. Replace the control unit
37	Control unit 5V voltage output fault	1. Check whether the 5V output is grounded, and check whether the wiring of each motor encoder is correct. 2. Check the correct use of external devices of the control unit 5V output one by one. 3.Replace the control unit.
38	Control unit 12V voltage output fault	1. Check whether the 12V output is grounded, usually may be caused by the wrong wiring of the following components: Accelerator pedal Lifting sensor Steering sensor Instrument 2. Check the correct use of external devices of the control unit 12V output one by one. 3.Replace the control unit.
39	Drive motor stall (blocked) failure	1. Check the drive motor encoder 2. Check the connection wire 3. Check the state of drive load 4. Ensure that the maximum output current threshold is set properly
40	HP_OUT1 output	1. Check whether the output port is overloaded.

	port overcurrent	2. Check whether the corresponding output port connection wiring harness is short circuit. 3. Replace the controller.
41	HP_OUT2 output port overcurrent	1. Check whether the output port is overloaded. 2. Check whether the corresponding output port connection wiring harness is short circuit. 3. Replace the controller.
42	HP_OUT3 output port overcurrent	1. Check whether the output port is overloaded. 2. Check whether the corresponding output port connection wiring harness is short circuit. 3. Replace the controller.
43	HP_OUT4 output port overcurrent	1. Check whether the output port is overloaded. 2. Check whether the corresponding output port connection wiring harness is short circuit. 3. Replace the controller.
44	HP_OUT5 output port overcurrent	1. Check whether the output port is overloaded. 2. Check whether the corresponding output port connection wiring harness is short circuit. 3. Replace the controller.
45	DO6 output port overcurrent	1. Check whether the output port is overloaded. 2. Check whether the corresponding output port connection wiring harness is short circuit. 3. Replace the controller.
46	DO7 output port overcurrent	1. Check whether the output port is overloaded. 2. Check whether the corresponding output port connection wiring harness is short circuit. 3. Replace the controller.
47	Safety belt warning buzzer port output overcurrent	1. Check the load 2. Check the connection wire 3. Replace the control unit
48	Safety belt warning buzzer port load open circuit	1. Check the load 2. Check the connection wire 3. Replace the control unit
49	ISO control coil open circuit	1. Check the load 2. Check the connection wire 3. Replace the control unit
58	D1 series controller: The module type is incorrect	1. Check the wiring harness. 2. Check module type parameters.
59	“Emergency Reverse” is not released	1. Check whether the Emergency Reverse switch is normal and restart the system.
60	“Emergency Reverse” startup	1. Release the Emergency Reverse switch. 2. Check whether the Emergency Reverse switch is normal.

	condition error	
61	Traction motor overheat shutdown	If the motor is not hot when the problem occurs: 1. Using a hand held multimeter, placed in the resistance measurement mode, measure resistance value between two lines of motor temperature sensor, and compare to motor temperature sensor truth table, if measured values do not tally with the actual temperature of motor, then replace the temperature sensor. 2.Replace the control unit. If the motor is very hot when the problem occurs: 1. If the temperature value read from the monitoring software or instrument of the upper computer is consistent with the actual temperature of the motor, check whether the motor housing is clean and whether the heat dissipation of the motor is normal. 2. Test whether the drive motor is working normally, whether there is brake lock or other abnormal conditions.
62	Direction switch failure	1. Check the direction switch. 2. Check the related wiring harness. 3.Replace the control unit.
63	The seat switch is not closed during startup	1. Check whether the seat switch is connected incorrectly or damaged. 2.Replace the control unit.
64	The direction switch is activated during startup	1. Check whether the forward/backward switches are activated when the truck starts. 2. If the direction switch is not activated, check whether the direction switch connection terminal is correctly connected to the main cable connection terminal. The monitoring software of Fanji can be used for auxiliary detection. 3. Check the direction switch. 4. Replace the control unit.
66	Drive motor power module overheat shutdown	1. The fault may be caused by insufficient heat dissipation. Check the heat dissipation between the power module and the aluminum plate as well as between the aluminum plate and the truck frame. Note: you can read the temperature of the motor power module through Fanji upper computer software or instrument. 2. If the heat dissipation measures of the above modules are all good, it is necessary to check whether the drive motor works normally. If it does not work properly, the power module will overheat. Second, replace the power module. 3. Replace the control unit.
67	The parking is not released while driving	1. Release the handbrake or accelerator pedal;
69	Remote lock the car	1. Check whether remote car lock or CAN communication is

		normal
70	Electromagnetic brake port output overcurrent	1. Check the load. 2. Check the connection wire. 3. Replace the control unit.
71	The drive motor power unit temperature sensor is faulty	1. Check whether the cable connection between the power module of the drive motor and the control unit is normal (only for V series products). 2. Replace the drive motor power module (only V series products). 3. Replace the control unit.
74	Drive motor encoder fault	1. Check whether the encoder is correctly connected with the motor and control unit. 2. If the connections are correct and good, replace the encoder. 3. Replace the control unit.
75	ISO solenoid valve control port output overcurrent	1. Check the load. 2. Check the connection wire. 3. Replace the control unit.
76	The output current of the fan control port is overcurrent	1. Check the load. 2. Check the connection wire. 3. Replace the control unit.
77	Drive motor temperature sensor failure	1. Check whether the connection between the temperature sensor of the driving motor and the main cable is normal. 2. Replace the drive motor temperature sensor. 3. Replace the control unit.
78	Built-in contactor overcurrent	1. Check the load. 2. Replace the control unit.
80	Drive motor power unit temperature sensor failure	1. Check whether the cable between the control unit and the driver module is properly connected (only for V series products). 2. Replace the drive power module (only V series products). 3. Replace the control unit.
81	Accelerator pedal voltage over range failure	1. Detect the accelerator pedal and related wiring harness;
83	Default parameter error	1. Reset the controller and power it on again. 2. Replace the control unit.
84	Parameter limit error	1. Reset the controller and power it on again. 2. Replace the control unit.
85	Wrong starting sequence	1. Release the accelerator pedal and activate the direction switch before pressing the accelerator pedal.
86	Forbidden warning for the simultaneous operation of accelerator and lifting	1. Release the lifting lever 2. Modify the threshold or block this functionality
87	Communication	1. Check the CAN communication line between walking and oil

	between modules is interrupted	pump module.
89	Accelerator pedal feedback deviation is too large	1. Reset the detection threshold. 2. Detect the accelerator pedal. 3. Check the related wiring harness.
90	On startup, the lift potentiometer is activated	1. Release the lift potentiometer. 2. Recalibrate the dead band value. 3. Change the potentiometer 4. Replace the control unit.
91	Steering sensor failure	1. Check whether the connection wire of the steering sensor. 2. If the wire connection is correct, recalibrate the clockwise value, middle value, and anticlockwise value of steering sensor. 3. Replace the steering sensor, and recalibrate. 4. Replace the control unit.
92	Accelerator failure	1. Check the value setting of "Accelerator pedal Calibration" to see whether the minimum and maximum voltage values of the accelerator pedal are set accurately. If not, recalibrate the accelerator pedal and set it with the monitoring software of the upper computer. 2. Check whether the control unit in the main bundle is correctly connected to the accelerator pedal. If there is no problem with the connection, press down the accelerator pedal through the monitoring software of the upper computer and observe whether the feedback voltage value of the pedal is in the correct range. 3. Replace the accelerator pedal. 4. Replace the control unit.
95	Drive motor temperature sensor short circuit failure	1. Check whether the connection between the temperature sensor of the driving motor and the main cable is normal. 2. Replace the drive motor temperature sensor. 3. Replace the control unit.
97	Drive motor temperature sensor open circuit failure	1. Check whether the connection between the temperature sensor of the drive motor and the main line is normal. 2. Replace the drive motor temperature sensor. 3. Replace the control unit.
98	Capacitor precharge is too slow	1. Check whether the cables between the control unit and the two power modules are correctly connected (only for V series products). 2. Replace the power module individually, exclude drive and pump power module (only V series products). 3. Replace the control unit.
99	The interlock switch failure	1. Check interlock switch. 2. Check wiring harness. 3. Replace the control unit.
100	Meter M1	1. Check meter M1.

	communication timeout	2. Check connecting wire harness. 3. Replace the control unit.
101	CAN bus communication timeout	1. Check whether the communication unit is lost. 2. Check whether the contact between communication unit and controller is good. 3. Replace the communication unit. 4. Replace the control unit.
102	Module type error	1. Check wire harness. 2. Check module type parameters.
115	Temperature protection of lithium battery pack	Check lithium battery pack.
124	Secondary lithium cell over discharge	Check lithium battery pack.
126	Lithium battery pack overtemperature protection	Check lithium battery pack.
132	Lithium battery pack total voltage high	Check lithium battery pack.
133	Lithium battery pack overcurrent	Check lithium battery pack.
134	Lithium battery pack cut-out protection	Check lithium battery pack.
135	Lithium battery pack charging connect	Check lithium battery pack.
159	Lithium battery pack secondaru cell undervoltage	Check lithium battery pack.
167	Lithium battery pack current-limiting protection	Check lithium battery pack.
188	External meter communication timed out	1. Confirm whether the external communication unit is lost. 2. Check whether the wire haness between communication unit and electronic controller. 3. Replace communication unit. 4. Replace the control unit.
190	The main contactor temperature sensor failure	1. Replace the control unit.
191	The main contactor overtemperature failure	1. Check the load status 2. Replace the control unit
193	The load of overspeed warning	1. Check the overspeed warning buzzer port load status. 2. Check the connecting wiring harness,

	buzzer port is open circuit	3. Replace the control unit
194	Parking warning buzzer port output overcurrent	1. Check the overspeed warning buzzer port load status. 2. Check the connection wire harness; 3. Replace the control unit
195	Parking warning buzzer port load open circuit	1. Check the overspeed warning buzzer port load status. 2. Check the connection wire harness; 3. Replace the control unit
196	Brake relay port output overcurrent	1. Check the overspeed warning buzzer port load status. 2. Check the connection wire harness; 3. Replace the control unit
197	The load of brake relay port is open circuit	1. Check the overspeed warning buzzer port load status. 2. Check the connection wire harness; 3. Replace the control unit
199	Communication between dual-drive modules is interrupted	1. Check the communication wire harness between the dual drives; 2. Check the module parameters "drive motor type" setting is correct;

(2) Common faults of pump control system

Fault code	Fault name	Details
10	Oil pump motor power unit overheat alarm	1. The fault may be caused by inefficient heat dissipation. Check the heat dissipation between the power module and the aluminum plate and between the aluminum plate and the frame. An even amount of thermal grease between the module and the aluminum plate and between the aluminum plate and the frame is necessary to ensure effective heat dissipation. Note: The temperature of the power module of the oil pump motor can be read through the monitoring interface or instrument of the Fanji upper computer software. 2. If cooling measures of the module is normal, so please check whether the oil pump motor is working properly, especially need to check the multi-way valve lever lifting potentiometer and whether can reset the switch control signal normally. 3. Replace oil pump power module (only V series products). 4. Replace the control unit.
14	Pump motor overtemperature warning	If the fault occurs when the motor is not hot: 1. Use a handheld multimeter, placed in the resistance measurement mode, measure the resistance value between the two lines of the motor temperature sensor, compare with the true value table of the motor temperature sensor, if the measured value is inconsistent with the actual temperature of the motor,

		then replace the temperature sensor. 2. Replace the control unit. If the fault occurs when the motor is very hot: 3. If the temperature value read from the monitoring software or instrument of the upper computer is consistent with the actual temperature of the motor, check whether the motor housing is clean and whether the heat dissipation of the motor is normal. 4. Check whether the motor works normally. In particular, it is necessary to check whether the oil pump electricity keeps working for a long time because the multi-way valve joystick potentiometer or switch signal cannot be reset normally. The oil pump electricity working for a long time would lead to its very high temperature.
24	Oil pump motor power unit is unsaturated or overcurrent	1. Check whether the UVW three-phase cable connection between the oil pump module and the motor is short-circuited (short-circuited between three-phase cables or short-circuited between a phase cable and the frame), and check whether the motor coil has a burning smell. 2. Check the cable connection of the control unit and the oil pump module is normal connection (only V series products). 3. Disconnect the UVW cable of the oil pump module, and use a multimeter to check whether the resistance value between the +/-B terminal of the module and the UVW terminal is symmetrical. If the resistance value of one phase is found to be significantly different from other phases, it can be determined that the power module has been burned out and needs to be replaced. 4. Replace the control unit.
26	Oil pump power unit software overcurrent	1. Check pump motor load status. 2. Check the UVW three-phase connection cable 3. Confirm the threshold value setting of overcurrent is reasonable. 4. Replace the drive unit
32	Oil pump power unit output phase loss	1. Check whether the U, V, and W power cables of the motor are connected reliably. 2. Replace oil pump module.
34	Oil pump motor temperature control fan control valve load open circuit	1. Check the load status, 2. Check the wire harness, 3. Replace the control unit.
36	Oil pump motor current loss	1. Check whether the cable between the power module of the oil pump and the control unit is correctly connected (only for V series products). 2. Replace the oil pump power module (only V series products).

		3. Replace the control unit.
50	Pump motor command lever has being activated when system startup	1. Reset all commands that activated already (include lifting potentiometer and each switching signal) 2. Detect whether the potentiometer voltage exceeds the set value, you can use Fanji controller programming tool software recalibration. 3. Replace the control unit.
51	The 12V voltage output of the oil pump control unit failure	1. Check whether the 12V output is grounded, which may be caused by wiring errors in the following devices: Accelerator pedal Lifting sensor Steering sensor Meter 2. Exclude external devices that use 12V output from the control unit one by one. 3. Replace the control unit.
52	5V voltage output fault of oil pump control unit	1. Check whether the 5V output is grounded, and check whether the wiring of each motor encoder is correct. 2. Exclude external devices that use 5V output from the control unit one by one. 3. Replace the control unit.
53	Flash memory failure alarm of oil pump	1. Flash memory reloading default value: Use FJ controller programming tool to "Restore factory Settings" operation 2. After solution 1 carried out, If the alarm persists after power on again, replace the control unit.
54	Oil pump DRIVE1 channel overcurrent	1. Check the oil pump DRIVE1 channel corresponding external connections, whether it connect to larger load. 2. Check the external connection corresponding to the pump DRIVE1 channel, whether it input of higher voltage 3. Replace the control unit.
55	Oil pump DRIVE2 channel overcurrent	1. Check the oil pump DRIVE2 channel corresponding external connections, whether it connect to larger load. 2. Check the external connection corresponding to the pump DRIVE2 channel, whether it input of higher voltage 3. Replace the control unit.
56	Oil pump DRIVE3 channel overcurrent	1. Check the oil pump DRIVE3 channel corresponding external connections, whether it connect to larger load. 2. Check the external connection corresponding to the pump DRIVE3 channel, whether it input of higher voltage 3. Replace the control unit.
57	Incorrect default parameters of oil pump	1. Restore the factory settings using the Fanji controller programming tool. 2. If the fault code still exists, replace the control unit.
65	Oil pump motor	If the fault occurs when the motor is not hot:

	overheat shutdown	1. Use a handheld multimeter, placed in the resistance measurement mode, measure the resistance value between the two lines of the motor temperature sensor, compare with the true value table of the motor temperature sensor, if the measured value is inconsistent with the actual temperature of the motor, then replace the temperature sensor. 2. Replace the control unit. If the fault occurs when the motor is very hot: 1. If the temperature value read from the monitoring software or instrument of the upper computer is consistent with the actual temperature of the motor, check whether the motor housing is clean and whether the heat dissipation of the motor is normal. 2. Check whether the motor works normally. In particular, it is necessary to check whether the oil pump electricity keeps working for a long time because the multi-way valve joystick potentiometer or switch signal cannot be reset normally. The oil pump electricity working for a long time would lead to its very high temperature.
68	Oil pump motor power unit overheat shutdown	1. The fault may be caused by inefficient heat dissipation. Check the heat dissipation between the power module and the aluminum plate and between the aluminum plate and the truck frame. An even amount of thermal grease between the module and the aluminum plate and between the aluminum plate and the frame is necessary to ensure effective heat dissipation. Note: The temperature of the power module of the oil pump motor can be read through the monitoring interface or instrument of the Fanji upper computer software. 2. If cooling measures of the module is normal, so please check whether the oil pump motor is working properly, especially need to check the multi-way valve lever lifting potentiometer and whether can reset the switch control signal normally. 3. Replace oil pump power module (only V series products). 4. Replace the control unit.
72	The oil pump motor power unit temperature sensor failure	1. Check whether the cable connection between the power module of the oil pump motor and the control unit is normal (only for V series products). 2. Replace the oil pump motor power module (only V series products). 3. Replace the control unit.
73	Oil pump motor encoder fault	1. Check the encoder is connected to the motor and control unit properly: 2. If the connections are correct and good, replace the encoder. 3. Replace the control unit.
79	Oil pump temperature	1. Check whether the connection between the temperature sensor

	sensor failure	of the oil pump motor and the main cable is normal. 2. Replace the oil pump motor temperature detector. 3. Replace the control unit.
82	Oil pump power unit temperature sensor failure	1. Check whether the cable between the control unit and the oil pump module is properly connected (only for V series products). 2. Replace the oil pump motor power module (only V series products). 3. Replace the control unit.
88	Oil pump fan control port output overcurrent	1. Check load status 2. Check connect wire harness 3. Replace control unit.
93	The lifting potentiometer failure	1. To detect whether the potentiometer voltage exceeds the set value, you can recalibrate it using the Fanji controller programming tool. 2. Replace the lifting potentiometer 3. Replace the control unit.
94	Oil pump motor temperature sensor short circuit failure	1. Check whether the wire harness between the temperature sensor of the oil pump motor and the main cable is normal. 2. Replace the oil pump motor temperature sensor. 3. Replace the control unit.
96	Oil pump motor temperature sensor open circuit failure	1. Check whether the wire harness between the temperature sensor of the oil pump motor and the main cable is normal. 2. Replace the oil pump motor temperature sensor. 3. Replace the control unit.
198	Oil pump motor stall (blocked) failure	1. Check the oil pump motor encoder 2. Check the wiring harness 3. Check the oil pump load state 4. Ensure that the maximum output current threshold is set properly

B. Common Faults (Curtis system)

Code	PROGRAMMER LCD DISPLAY	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
12	Controller Overcurrent	1. External short of phase U,V, or W motor connections. 2. Motor parameters are mis-tuned. 3. Controller defective. 4. Speed encoder noise problems.	Set: Phase current exceeded the current measurement limit. Clear: Cycle KSI.
13	Current Sensor Fault	1. Leakage to vehicle frame from phase U, V, or W (short in motor stator). 2. Controller defective.	Set: Controller current sensors have invalid offset reading. Clear: Cycle KSI.
14	Precharge Failed	1. See Monitor menu » Battery:	Set: The precharge failed to

		Capacitor Voltage. 2. External load on capacitor bank (B+ connection terminal) that prevents the capacitor bank from charging.	charge the capacitor bank. Clear: Cycle Interlock input or use VCL function Enable_Precharge().
15	Controller Severe Undertemp	1. See Monitor menu » Controller: Temperature. 2. Controller is operating in an extreme environment.	Set: Heatsink temperature below -40°C. Clear: Bring heatsink temperature above -40°C, and cycle interlock or KSI.
16	Controller Severe Overtemp	1. See Monitor menu » Controller: Temperature. 2. Controller is operating in an extreme environment. 3. Excessive load on vehicle. 4. Improper mounting of controller.	Set: Heatsink temperature above +95°C. Clear: Bring heatsink temperature below +95°C, and cycle interlock or KSI.
17	Severe Undervoltage	1. Battery parameters are misadjusted. 2. Non-controller system drain on battery. 3. Battery resistance too high. 4. Battery disconnected while driving. 5. Blown fuse or main contactor did not close.	Set: Capacitor bank voltage dropped below the Severe Undervoltage limit with FET bridge enabled. Clear: Bring capacitor voltage above Severe Undervoltage limit.
18	Severe Overvoltage	1. Battery parameters are misadjusted. 2. Battery resistance too high for given regen current. 3. Battery disconnected while regen braking.	Set: Capacitor bank voltage exceeded the Severe Overvoltage limit with FET bridge enabled. Clear: Bring capacitor voltage below Severe Overvoltage limit, and then cycle KSI.
22	Controller Overtemp Cutback	1. Controller is operating in an extreme environment. 2. Excessive load on vehicle. 3. Improper mounting of controller.	Set: Heatsink temperature exceeded 85°C. Clear: Bring heatsink temperature below 85°C.
23	Undervoltage Cutback	1. Normal operation. Fault indicates the batteries need recharging. Controller is performance limited at this voltage. 2. Battery parameters are	Set: Capacitor bank voltage dropped below the Undervoltage limit with the FET bridge enabled. Clear: Bring capacitor

		misadjusted. 3. Non-controller system drain on battery. 4. Battery resistance too high. 5. Battery disconnected while driving. 6. Blown B+ fuse or main contactor did not close.	voltage above the Undervoltage limit.
24	B+ Overvoltage Cutback	1. Normal operation. Fault shows that regen braking currents elevated the battery voltage during regen braking. Controller is performance limited at this voltage. 2. Battery parameters are misadjusted. 3. Battery resistance too high for given regen current. 4. Battery disconnected while regen braking.	Set: Capacitor bank voltage exceeded the Overvoltage limit with the FET bridge enabled. Clear: Bring capacitor voltage below the Overvoltage limit.
25	5V Supply Failure	1. External load impedance on the +5V supply (pin 26) is too low.	Set: +5V supply (pin 26) outside the 5 V±10% range. Clear: Bring voltage within range.
26	Digital Out 6 Open/Short	1. External load impedance on Digital Output 6 driver (pin 19) is too low.	Set: Digital Output 6 (pin 19) current exceeded 1 Amp. Clear: Remedy the overcurrent cause and use the VCL function Set_DigOut() to turn the driver on again.
27	Digital Out 7 Open/Short	1. External load impedance on Digital Output 7 driver (pin 20) is too low.	Set: Digital Output 7 (pin 20) current exceeded 1 Amp. Clear: Remedy the overcurrent cause and use the VCL function Set_DigOut() to turn the driver on again.
28	Motor Temp Hot Cutback	1. Motor temperature is at or above the programmed Temperature Hot setting, and the current is being cut back. 2. Motor Temperature Control	Set: Motor temperature is at or above the Temperature Hot parameter setting. Clear: Bring the motor temperature within range.

		Menu parameters are mis-tuned. 3. See Monitor menu » Motor: Temperature and » Inputs: Analog2. 4. If the application doesn't use a motor thermistor, Temp Compensation and Temp Cutback should be programmed Off.	
29	Motor Temp Sensor Fault	1. Motor thermistor is not connected properly. 2. If the application doesn't use a motor thermistor, Motor Temp Sensor Enable should be programmed Off.	Set: Motor thermistor input (pin 8) is at the voltage rail (0 V or 10 V). Clear: Bring the motor thermistor input voltage within range.
31	Coil 1 Driver Open/Short	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	Set: Driver 1 (pin 6) is either open or shorted. This fault can be set only when Main Enable = Off. Clear: Correct open or short, and cycle driver.
31	Main Open/Short	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	Set: Main contactor driver (pin 6) is either open or shorted. This fault can be set only when Main Enable = On. Clear: Correct open or short, and cycle driver
32	Coil2 Driver Open/Short	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	Set: Driver 2 (pin 5) is either open or shorted. This fault can be set only when EM Brake Type = 0. Clear: Correct open or short, and cycle driver.
32	EMBrake Open/Short	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	Set: Electromagnetic brake driver (pin 5) is either open or shorted. This fault can be set only when EM Brake Type >0. Clear: Correct open or short, and cycle driver.
33	Coil3 Driver Open/Short	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	Set: Driver 3 (pin 4) is either open or shorted. Clear: Correct open or short, and cycle driver.
34	Coil4 Driver	1. Open or short on driver load.	Set: Driver 4 (pin 3) is

	Open/Short	2. Dirty connector pins. 3. Bad crimps or faulty wiring.	either open or shorted. Clear: Correct open or short, and cycle driver.
35	PD Open/Short	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	Set: Proportional driver (pin 2) is either open or shorted. Clear: Correct open or short, and cycle driver.
36	Encoder Fault	1. Motor encoder failure. 2. Bad crimps or faulty wiring.	Set: Motor encoder phase failure detected. Clear: Cycle KSI.
37	Motor Open	1. Motor phase is open. 2. Bad crimps or faulty wiring.	Set: Motor phase U, V, or W detected open. Clear: Cycle KSI.
38	Main Contactor Welded	1. Main contactor tips are welded closed. 2. Motor phase U or V is disconnected or open. 3. An alternate voltage path (such as an external precharge resistor) is providing a current to the capacitor bank (B+ connection terminal).	Set: Just prior to the main contactor closing, the capacitor bank voltage (B+ connection terminal) was loaded for a short time and the voltage did not discharge. Clear: Cycle KSI
39	Main Contactor Did Not Close	1. Main contactor did not close. 2. Main contactor tips are oxidized, burned, or not making good contact.* 3. External load on capacitor bank (B+ connection terminal) that prevents capacitor bank from charging. 4. Blown B+ fuse.	Set: With the main contactor commanded closed, the capacitor bank voltage (B+ connection terminal) did not charge to B+. Clear: Cycle KSI.
41	Throttle Wiper High	1. Throttle pot wiper voltage too high.	Set: Throttle pot wiper (pin 16) voltage is higher than the high fault threshold (can be changed with the VCL function Setup_Pot_Faults()). Clear: Bring throttle pot wiper voltage below the fault threshold.
42	Throttle Wiper Low	1. Throttle pot wiper voltage too low.	Set: Throttle pot wiper (pin 16) voltage is lower than the low fault threshold (can be changed with the VCL function

			Setup_Pot_Faults()). Clear: Bring throttle pot wiper voltage above the fault threshold.
43	Pot2 Wiper High	1. Pot2 wiper voltage too high.	Set: Pot2 wiper (pin 17) voltage is higher than the high fault threshold (can be changed with the VCL function Setup_Pot_Faults()). Clear: Bring Pot2 wiper voltage below the fault threshold.
44	Pot2 Wiper Low	1. Pot2 wiper voltage too low.	Set: Pot2 wiper (pin 17) voltage is lower than the low fault threshold (can be changed with the VCL function Setup_Pot_Faults()). Clear: Bring Pot2 wiper voltage above the fault threshold.
45	Pot Low Overcurrent	1. Combined pot resistance connected to pot low is too low.	Set: Pot low (pin 18) current exceeds 10 mA. Clear: Clear pot low overcurrent condition and cycle KSI.
46	EEPROM Failure	1 Failure to write to EEPROM memory. This can be caused by EEPROM memory writes initiated by VCL, by the CAN bus, by adjusting parameters with the programmer, or by loading new software into the controller.	Set: Controller operating system tried to write to EEPROM memory and failed. Clear: Download the correct software (OS) and matching parameter default settings into the controller and cycle KSI.
47	HPD/Sequencing Fault	1. KSI, interlock, direction, and throttle inputs applied in incorrect sequence. 2. Faulty wiring, crimps, or switches at KSI, interlock, direction, or throttle inputs.	Set: HPD (High Pedal Disable) or sequencing fault caused by incorrect sequence of KSI, interlock, direction, and throttle inputs. Clear: Reapply inputs in correct sequence.

47	Emer Rev HPD	1. Emergency Reverse operation has concluded, but the throttle, forward and reverse inputs, and interlock have not been returned to neutral.	Set: At the conclusion of Emergency Reverse, the fault was set because various inputs were not returned to neutral. Clear: If EMR_Interlock = On, clear the interlock, throttle, and direction inputs. If EMR_Interlock = Off, clear the throttle and direction inputs.
49	Parameter Change Fault	1. This is a safety fault caused by a change in certain parameter settings so that the vehicle will not operate until KSI is cycled. For example, if a user changes the Throttle Type this fault will appear and require cycling KSI before the vehicle can operate.	Set: Adjustment of a parameter setting that requires cycling of KSI. Clear: Cycle KSI.
51 Drive	GPS ID Identification Fault	1. The GPS function is enabled, but no identification message is received	Set: the error of GPS module Clear: replace the GPS module
51 Driven	Steer Sensor Fault	1. the voltage value of the Angle sensor is 0	Set: Angle sensor output problem Clear: 24 foot controller input voltage value
51 Pump	Reserved		
52 Drive	CAN PDO Timeout	1. No instrument PDO communication data was received during travelling	Set: Communication fault between the instrument and travelling Clear: Inspect CAN signal of instrument, recover communication data of instrument.
52 Driven	Standby		
52 Pump	Standby		
53 Drive	Traction HPD	1. Forward, backward or accelerator signal access is detected during startup	Set: Wrong startup sequence Clear: The direction switch and acceleration back in the middle.

53 Driven	Standby		
53 Pump	Hydraulic HPD	1. When starting up, lift, tilt, side shift, and the input of the accessory is turned on first	Set: Wrong startup sequence Clear: Restore the hydraulic input switch
54 Drive	Unmatched Pump	1. Pump controller does not match	Set: Failed to handshake between travelling and pump Clear: Check CAN bus and resume boot up and pump handshake
54 Driven	Standby		
54 Pump	Standby		
55 Drive	Standby		
55 Driven	Standby		
55 Pump	Standby		
56 Drive	GPS Lock Grade 1	1. Received the GPS Grade 1 truck lock signal	Set: Received the GPS Grade 1 truck lock signal Clear: GPS cancel the lock the truck
56 Driven	Standby		
56 Pump	Standby		
57 Drive	BMS Hot	1. Received overheating signal from BMS	Set: the controller overheating in the receiving BMS transfer information Clear: Check the lithium battery
57 Driven	Standby		
57 Pump	Standby		
58 Drive	BMS Severe Overvoltage	1. Received Overvoltage signal from BMS	Set: Received Overvoltage signal sent by BMS Clear: Check the lithium battery

58 Driven	Standby		
58 Pump	Standby		
59 Drive	GPS No Communication Fault	1. No GPS module communication is received	Set: The GPS can open, but cannot receive the GPS information Clear: Check the CAN communication
59 Driven	Standby		
59 Pump	Standby		
61 Drive	Unmatched Display	1. Startup travelling and instrument handshake failure	Set: Travelling and instrument communication failed Clear: Check the CAN communication between travelling and instrument
61 Driven	Standby		
61 Pump	Standby		
62 Drive	BMS current limit	1. Received the current limiting signal sent by BMS	Set: The controller received BMS transfer current limiting information Clear: Check the lithium battery
62 Driven	Standby		
62 Pump	Standby		
63 Drive	GPS Lock Grade 2	1. Received the GPS Grade 2 truck lock signal	Set: Received the GPS Grade 2 truck lock signal Clear: GPS cancel the lock signal of the truck
63 Driven	Standby		
63 Pump	Standby		
64 Drive	Battery charging	1. Received the charging signal from BMS	Set: The battery is charging Clear: Charging signal cancel
64	Standby		

Driven			
64 Pump	Standby		
65 Drive	BMS Overcurrent	1. Received overcurrent signal from BMS	Set: lithium battery overcurrent Clear: check the reason of the battery overcurrent
65 Driven	Standby		
65 Pump	Standby		
66 Drive	BMS CAN PDO Timeout	1. BMS communication timeout, controller isn't received BMS message.	Set: Controller isn't received BMS message for a long time. Clear: Check the CAN communication between travelling and BMS.
66 Driven	Standby		
66 Pump	Standby		
67 Drive	BMS Undervoltage	1. Received undervoltage signal from BMS	Set: BMS battery undervoltage alarm Clear: Check the battery
67 Driven	Standby		
67 Pump	Standby		
68	VCL RunTime Error	1. VCL code encountered a runtime VCL error.	Set: Runtime VCL code error condition. Clear: Edit VCL application software to fix this error condition; flash the new compiled software and matching parameter defaults; cycle KSI.
69	External Supply Out of Range	1. External load on the 5V and 12V supplies draws either too much or too little current. 2. Fault Checking Menu parameters Ext Supply Max and Ext Supply Min are mis-tuned.	Set: The external supply current (combined current used by the 5V supply [pin 26] and 12V supply [pin 25]) is either greater than the upper current threshold or lower than the lower current threshold.

			The two thresholds are defined by the External Supply Max and External Supply Min parameter settings. Clear: Bring the external supply current within range.
71	OS General	1. Internal controller fault.	Set: Internal controller fault detected. Clear: Cycle KSI.
72	PDO Timeout	1. Time between CAN PDO messages received exceeded the PDO Timeout Period.	Set: Time between CAN PDO messages received exceeded the PDO Timeout Period. Clear: Cycle KSI or receive CAN NMT message.
73	Stall Detected	1. Stalled motor. 2. Motor encoder failure. 3. Bad crimps or faulty wiring. 4. Problems with power supply for the motor encoder.	Set: No motor encoder movement detected. Clear: Either cycle KSI, or if parameter LOS Upon Encoder Fault = On and Interlock has been cycled, then the Stall Detected fault is cleared and Encoder LOS fault (code 93) is set, allowing limited motor control.
74	Fault On Other Traction Controller	1. One controller of the dual-drive system reported a failure	Set: double drive system and one controller report fault Clear: check for another controller and eliminate the fault
75	Dual Severe Fault	1. Both controllers of dual-drive system report serious faults	Set: two controllers of double drive system both report fault Clear: Check the fault message from controllers and eliminate the fault
77	Supervisor Fault	1. The Supervisor has detected a mismatch in redundant readings. 2. Internal damage to Supervisor microprocessor. 3. Switch inputs allowed to be within	Set: Mismatched redundant readings; damaged Supervisor; illegal switch inputs. Clear: Check for noise or

		upper and lower thresholds for over 100 milliseconds. (for recurring errors, check the switches for moisture).	voltage drift in all switch inputs; check connections; cycle KSI.
78	Supervisor Incompatible	1. The main OS is not compatible with the Supervisor OS.	Set: Incompatible software. Clear: Load properly matched OS code or update the Supervisor code; cycle KSI.
82	Bad Calibrations	1. Internal controller fault.	Set: Internal controller fault detection. Clear: Cycle KSI.
83	Driver Supply	1. Internal controller fault in the voltage supply for the driver circuits.	Set: Internal controller fault detection. Clear: Cycle KSI.
87	Motor Characterization Fault	1. Motor characterization failed during characterization process. 0 = sequencing error. Normally caused by turning off Motor Characterization Test Enable before running the test. 1 = encoder signal seen but step size not auto-detected; set up Encoder Steps manually 2 = motor temp sensor fault 3 = motor temp hot cutback fault 4 = controller overtemp cutback fault 5 = controller undertemp cutback fault 6 = undervoltage cutback fault 7 = severe overvoltage fault 8 = encoder signal not seen, or one or both channels missing 9 = motor parameters out of characterization range 20 = Sin/Cos sensor not found 21 = phasing not detected 22 = Sin/Cos sensor characterization failure 23 = started characterization procedure while motor rotating.	Set: Motor characterization failed during the motor characterization process. Normally caused by turning off Motor_Characterization_Test_Enable before running test. Needs controller reset. Clear: Correct fault; cycle KSI, or VCL reset.
88	Encoder Pulse Count Fault	1. Encoder Steps parameter does not match the actual motor encoder.	Set: Detected wrong setting of the Encoder Steps

			parameter. Clear: Ensure the Encoder Steps parameter matches the actual encoder; cycle KSI.
89	Motor Type Fault	2. The Motor_Type parameter value is out of range.	Set: Motor_Type parameter is set to an illegal value. Clear: Set Motor_Type to correct value and cycle KSI.
91	VCl/OS Mismatch VCL/OS	1. The VCL software in the controller does not match the OS software in the controller.	Set: VCL and OS software do not match; when KSI cycles, a check is made to verify that they match and a fault is issued when they do not. Clear: Download the correct VCL and OS software into the controller.
92	EM Brake Failed to Set	1. Vehicle movement sensed after the EM Brake has been commanded to set. 2. EM Brake will not hold the motor from rotating.	Set: After the EM Brake was commanded to set and time has elapsed to allow the brake to fully engage, vehicle movement has been sensed. Clear: 1. Activate the Throttle (EM Brake type 2). 2. Activate the Interlock (EM Brake type 1).
93	Encoder LOS (Limited Operating Strategy)	1. Limited Operating Strategy (LOS) control mode has been activated, as a result of either an Encoder Fault (Code 36) or a Stall Detected fault (Code 73). 2. Motor encoder failure. 3. Bad crimps or faulty wiring. 4. Vehicle is stalled.	Set: Encoder Fault (code 36) or Stall Detected (code 73) was activated, if parameter LOS Upon Encoder Fault = On and Interlock has been cycled, then the Encoder LOS (code 93) control mode is activated, allowing limited motor control. Clear: Cycle KSI or, if LOS mode was activated by the Stall Detected fault, clear by ensuring encoder senses proper operation, Motor RPM = 0, and Throttle

			Command = 0.
94	Emer Rev Timeout	1. Emergency Reverse was activated and concluded because the EMR Timeout timer has expired. 2. The emergency reverse input is stuck On.	Set: Emergency Reverse was activated and ran until the EMR Timeout timer expired. Clear: Turn the emergency reverse input Off.
98	Illegal Model Number	1. Model_Number variable contains illegal value. 2. Software and hardware do not match. 3. Controller defective.	Set: Illegal Model_Number variable; when KSI cycles, a check is made to confirm a legal Model_Number, and a fault is issued if one is not found. Clear: Download appropriate software for your controller model.
99	Dualmotor Parameter Mismatch	1. Dual drive enabled on only one controller. 2. Incorrect position feedback type chosen for motor technology in use. 3. Dual drive is enabled in torque mode.	Set: When the Dual Drive software is enabled, the controller must be set to either Speed Mode Express or Speed Mode; otherwise this fault is set. Motor Techology=0 must be paired with Feedback Type=1, and Motor Technology=1 must be paired with Feedback Type=2; otherwise this fault is set. Clear: Adjust parameters to appropriate values and cycle KSI.

C. Common fault（ZAPI system）

(1) Common fault of drive system

CAN CODE	ALARM	ALARMS OF NODE 3.0/4.0
8	WATCHDOG	Cause: This is a safety related test. It is a self-diagnosis test that involves the logic between master and supervisor microcontrollers
		Troubleshooting: This alarm could be caused by a CAN bus malfunctioning, which blinds master-supervisor communication

17	LOGIC FAILURE #3	Cause 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.
		Troubleshooting The failure lies in the controller hardware. Replace the controller.
18	LOGIC FAILURE #2	Cause Fault in the hardware section of the logic board which deals with voltage feedbacks of motor phases.
		Troubleshooting The failure lies in the controller hardware. Replace the controller.
19	LOGIC FAILURE #1	Cause This fault is displayed when the controller detects an undervoltage condition at the key input . Undervoltage threshold is 11V for 36/48V controllers and 30 V for 80V controllers.
		Troubleshooting (fault at startup or in standby) - 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. - 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. Troubleshooting (fault displayed during motor driving) - 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.
28	PUMP VMN HIGH	Cause: This test is carried out when the pump motor is turning (PWM applied). The pump motor output is higher than expected, considering the PWM applied.
		Troubleshooting: - Motor internal connections - If motor windings/cables have leakages towards truck frame - If no problem are found on the motors, the problem is inside the controller, it is necessary to replace the logic board.
29	VMN LOW	Cause 1 Start-up test. Before switching the LC on, the software checks the power bridge: 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.
		Cause 2

		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.
		Troubleshooting - If the problem occurs at start up (the LC does not close at all), check: - motor internal connections (ohmic continuity); - motor power-cables connections;
30	VMN LOW	Cause 1 Start-up test. Before switching the LC on, the software checks the power bridge: 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.
		Cause 2 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.
		Troubleshooting - If the problem occurs at start up (the LC does not close at all), check: - motor internal connections (ohmic continuity); - motor power-cables connections;
31	VMN HIGH	Cause 1 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.
		Cause 2 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.
		Troubleshooting - If the problem occurs at start-up (the LC does not close), check: - motor internal connections (ohmic continuity); - motor power cables connections; - if the motor connections are OK, the problem is inside the controller. Replace it.

		- If the alarm occurs while the motor is running, check: - motor connections; - that the LC power contact closes properly, with a good contact; - if no problem is found, the problem is inside the controller. Replace it.
37	CONTACTOR CLOSED	Cause 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.
		Troubleshooting It is suggested to verify the power contacts of LC; if they are stuck, is necessary to replace the LC.
38	CONTACTOR OPEN	Cause 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.
		Troubleshooting - LC contacts are not working. Replace the LC. - If LC contacts are working correctly, contact a Zapi technician.
52	PUMP I=0 EVER	Cause: While the pump motor is running, the current feedback is constantly stuck to zero.
		Troubleshooting: - Check the motor connection, that there is continuity. If the motor connection is opened, the current cannot flow, so the test fails and the error code is displayed; - If everything is ok for what it concerns the motor, the problem could be in the current sensor or in the related circuit.
53	STBY I HIGH	Cause In standby, the sensor detects a current value different from zero.
		Troubleshooting The current sensor or the current feedback circuit is damaged. Replace the controller.
60	CAPACITOR CHARGE	Cause 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 20% of the

		nominal battery voltage, the alarm is raised and the main contactor is not closed.
		Troubleshooting - 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. - 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. - The charging circuit has a failure or there is a problem in the power section. Replace the controller.
62	TH. PROTECTION	Cause: 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.
		Troubleshooting: 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. 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.
65	MOTOR TEMPERAT.	Cause: This warning occurs when the temperature sensor is open (if digital) or if it has overtaken the MAX MOTOR TEMP threshold (if analog)
		Troubleshooting: - Check the temperature read by the thermal sensor inside the motor through the MOTOR TEMPERATURE reading in the TESTER function. - Check the sensor ohmic value and the sensor wiring. - If the sensor is OK, improve the cooling of the motor. - If the warning is present when the motor is cool, replace the controller.
66	BATTERY LOW	Cause: The battery charge is evaluated to be lower than 10% (10% with lithium battery ,15% with lead-acid battery) of the full charge and

		the BATTERY CHECK setting is other than 0 (refer to SET OPTION menu).
		Troubleshooting: - Check the battery charge and charge it if necessary. - If the battery is actually charged, measure the battery voltage through a voltmeter and compare it with the value in the BATTERY VOLTAGE reading in the TESTER function. If they are different, adjust the ADJUST BATTERY parameter with the value measured through the voltmeter. - If the problem is not solved, replace the logic board.
74	DRIVER SHORTED	Cause The driver of the LC coil is shorted, or parameter was wrong
		Troubleshooting - Check if there is a short or a low impedance pull-down between NLC and –BATT. - The driver circuit is damaged; replace the logic board.
75	CONTACTOR DRIVER	Cause The LC coil driver is not able to drive the load. The device itself or its driver circuit is damaged.
		Troubleshooting This type of fault is not related to external components; replace the logic board.
78	VACC NOT OK	Cause: At key-on and immediately after that, the travel demands have been turned off. This alarm occurs if the ACCELERATOR reading (in TESTER function) is more than 1 V above the minimum value acquired during the PROGRAM VACC procedure.
		Troubleshooting: - Check the wirings. - Check the mechanical calibration and the functionality of the accelerator potentiometer. - Acquire the maximum and minimum potentiometer value through the PROGRAM VACC function. - If the problem is not solved, replace the logic board.
79	INCORRECT START	Cause: Incorrect starting sequence. Possible reasons for this alarm are: - A travel demand active at key-on. - Man-presence sensor active at key on.
		Troubleshooting: - Check wirings. - Check microswitches for failures. - Through the TESTER function, check the state of the inputs are coherent with microswitches states.

		- If the problem is not solved, replace the logic board.
80	FORW+BACK	Cause: This alarm occurs when both the travel requests (FW and BW) are active at the same time.
		Troubleshooting: - Check that travel requests are not active at the same time. - Check the FW and BW input states through the TESTER function. - Check the wirings relative to the FW and BW inputs. - Check if there are failures in the microswitches. - If the problem is not solved, replace the logic board.
86	PEDAL WIRE KO	This is not implemented in DUALACE2. Troubleshooting: - Ask for help to a heli technician.
114	WAIT DISP AUTH	Cause: the traction parameter "DISP TYPE" was wrong
		Troubleshooting: Check the parameter.
115	NO CAN DISP	Cause: the display is disconnected
		Troubleshooting: Check the wiring,or ask for help to a Zapi technician.
116	BMS1	Cause： Lithium battery alarm ; battery total voltage high . when this alarm appears, the truck should stop work , inhibit traction and lifting and tilt ,only steering function can work as normal
		Troubleshooting:Check the lithium battery,ask for help to the lithium battery manufacturer
117	BMS2	Cause： Lithium battery alarm ; The cell of battery over-discharge .when this alarm appears , the truck should stop work , inhibit traction and lifting and tilt ,only steering function can work as normal
		Troubleshooting:Check the lithium battery,ask for help to the lithium battery manufacturer
118	BMS3	Cause： Lithium battery alarm ; Communication interruption .when this alarm appears , the truck should stop work , inhibit traction and lifting and tilt ,only steering function can work as normal .
		Troubleshooting:Check the lithium battery,ask for help to the lithium battery manufacturer
119	BMS4	Cause： Lithium battery alarm ; The cell of battery undervoltage .when this alarm appears , traction speed will reduce to 50% of the maximum speed and traction max current also will be reduced to 50% of the maximum current , inhibit lifting and tilt function , only steering function can work as normal .
		Troubleshooting:Check the lithium battery,ask for help to the lithium battery manufacturer

120	BMS5	Cause: Lithium battery alarm ; High current . when this alarm appears , the truck should stop to work , inhibit traction and lifting and tilt ,only steering function can work as normal
		Troubleshooting:Check the lithium battery,ask for help to the lithium battery manufacturer
121	BMS6	Cause: Lithium battery alarm ;Battery stop temperature ,battery temperature is high ,when this alarm appears , the truck should stop to work , inhibit traction and lifting and tilt ,only steering function can work as normal
		Troubleshooting:Check the lithium battery,ask for help to the lithium battery manufacturer
122	BMS7	Cause: Lithium battery alarm ;Battery warning temperature . when this alarm appears , traction speed will reduce to 50% of the maximum speed and traction max current also will be reduced to 50% of the maximum current, pump current also will be reduced to 50% of maximum current , tilt and steering function can work as normal .
		Troubleshooting:Check the lithium battery,ask for help to the lithium battery manufacturer
123	BMS8	Cause: Lithium battery alarm ;Battery is charging .when this alarm appears ,the controller should inhibited all functions and open the all the contactors,include traction contator ,main pump contator and hydrosteer pump contator
		Troubleshooting:Check the lithium battery,ask for help to the lithium battery manufacturer
124	BMS9	Cause: Lithium battery alarm ; Current limiting protection . when this alarm appears , traction speed will be reduced to 50% of maximum speed and traction current also will be reduced to 50% of maximum current , pump current also will be reduced to 50% of maximum current , tilt and steering function can work as normal
		Troubleshooting:Check the lithium battery,ask for help to the lithium battery manufacturer
125	BMS10	Cause: Lithium battery alarm ; Current cut-out protection . when this alarm appears , the truck should stop to work , inhibit traction and lifting and tilt ,only steering function can work as normal
		Troubleshooting:Check the lithium battery,ask for help to the lithium battery manufacturer
126	2ND LEV INHIBIT	Cause: Networking alarm ; the traction inverter received the "2ND LEV INHIBIT" request (1AA message) from the remote device,then truck should inhibit lifting , but tilt , side shift , attachment , steering function can work as normal . Traction speed is reduced to 50% of maximum speed .

		Troubleshooting: Stop to send the "2ND LEV INHIBIT" request,or set traction parameter "NETWORKING" to "OFF" (in set options menu).
127	1ST LEV INHIBIT	Cause：Networking alarm ; the traction inverter received the "1ST LEV INHIBIT" request (1AA message) from the remote device,then truck should inhibit all the functions .
		Troubleshooting: Stop to send the "1ST LEV INHIBIT " request,or set traction parameter "NETWORKING" to "OFF" (in set options menu).
128	AUTH. FAILED	Cause： Networking alarm ; the truck can not read card correct , so all functions are inhibited.
		Troubleshooting:Ask for help to the networking device manufacturer ,or set traction parameter "NETWORKING" to "OFF" (in set options menu).
129	0X1AA TIMEOUT	Cause：Networking alarm ; the traction inverter received the 1AA message from the networking device,if the inverter lost this message,this alarm will appears, the truck should inhibit lifting and traction function , but tilt , side shift , attachment , steering function can work as norma
		Troubleshooting:Check the networking device if works properly,or ask for help to the networking device manufacturer ,or set traction parameter "NETWORKING" to "OFF" (in set options menu).
130	REM DEV INIT ERR	Cause： Networking alarm ; when key switch is closed, the traction inverter try to receive the 1AA message from the remote device, if the inverter can't receive this message,this alarm will appears, the truck should inhibit lifting and traction function , but tilt , side shift , attachment , steering function can work as norma
		Troubleshooting:Check the networking device if works properly,or ask for help to the networking device manufacturer ,or set traction parameter "NETWORKING" to "OFF" (in set options menu).
131	HEIGHT WR. IN:	This alarm isn't used for this truck.
132	HEIGHT ENC ERROR	This alarm isn't used for this truck.
133	HEIGHT WR. TOL	This alarm isn't used for this truck.
134	HEIGHT ZERO	This alarm isn't used for this truck.
135	HEIGHT ENC LOCK.	This alarm isn't used for this truck.
136	HEIGHT FREE L.	This alarm isn't used for this truck.
137	SHELF WR. REQ.	This alarm isn't used for this truck.
138	SHELF WAIT HEIG.	This alarm isn't used for this truck.
139	SHELF WR. INP:	This alarm isn't used for this truck.
140	REACH POT OUTRNG	This alarm is not implemented in traction.

141	SHIFT POT OUTRNG	This alarm is not implemented in traction.
142	2F1 TIMEOUT	Cause: Lithium battery alarm ; when key switch is closed, traction inverter received the 2F1 message from the lithium battery,if inveter lost this message, this alarm will appears,and truck should stop work , inhibit traction and lifting and tilt , only steering function can work as normal
		Troubleshooting:Check the lithium battery,recycle the key switch,or ask for help to the lithium battery manufacturer
143	2F0 TIMEOUT	Cause: Lithium battery alarm ; the traction inverter lost the 2F0 message,and the inverter can't receive this message again within 800ms , when this alarm will appears, truck should stop work , inhibit traction and lifting and tilt , only steering function can work as normal
		Troubleshooting:Check the lithium battery,recycle the key switch ,or ask for help to the lithium battery manufacturer
144	2F0 INIT. ERR.	Cause: Lithium battery alarm ; when key switch is closed, traction inverter will try to receive the 2F0 message from the lithium battery,if inverter can't receive this message within 1500ms, this alarm will appears,and truck should stop work , inhibit traction and lifting and tilt , only steering function can work as normal
		Troubleshooting:Check the lithium battery,ask for help to the lithium battery manufacturer
145	SHIFT POT NOT OK	This alarm is not implemented in traction.
146	TILT POT NOT OK	This alarm is not implemented in traction.
147	LIFT POT NOT OK	This alarm is not implemented in traction.
149	POS.EB.SHORT PIN	Cause: The voltage on terminal PEB (pin A27) is at the high value even if the high side driver is turned OFF
		Troubleshooting:Verify that the parameter POSITIVE EB is set in accordance with the actual coil positive supply . Since the software makes a proper diagnosis depending on the parameter, a wrong setting could generate a false fault. Check if there is a short or a low impedance path between PEB (pin A27) and the positive battery terminal +B. In case no failures/problems can be found, the problem is in the controller, which has to be replaced.
150	POS.EB.SHORT GND	Cause: The voltage on terminal PEB (pin A27) is at the low value even if the high side driver is turned ON
		Troubleshooting:Verify that the parameter POSITIVE EB is set in accordance with the actual coil positive supply . Since the software makes a proper diagnosis depending on the parameter, a wrong setting could generate a false fault. Check if there is a short or a low impedance path between PEB (pin A27) and the negative battery terminal -B. In case no

		failures/problems can be found, the problem is in the controller, which has to be replaced.
151	TH. PROT. PUMP	Cause: The temperature of the pump 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
		Troubleshooting: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. 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.
152	IIC BUS ERROR	This type of fault is not related to external components; replace the logic board.
154	OUT MISMATCH XX	Cause This is a safety related test. Supervisor μC has detected that the Master μC is driving traction motor in a wrong way (not correspondent to the status of operator commands).
		Troubleshooting (1).Checks the correspondence of the parameters between Master and Supervisor (2).Ask for assistance to a heli technician
155	SP MISMATCH XX	Cause This is a safety related test. The Master μC has detected a Supervisor μC wrong set point
		Troubleshooting (1) Checks the correspondence of the parameters between Master and Supervisor (2) Ask for assistance to a heli technician (3) If the problem is not solved it is necessary to replace the logic board
156	REMA T. ALARM	This alarm isn't used for this truck.
157	INPUT MISMATCHXX	This alarm isn't used for this truck.
158	NOT RDY DRV. POW.	This alarm isn't used for this truck.
159	HVIL FAIL	This alarm isn't used for this truck.
160	SENS BAT TEMP KO	This alarm isn't used for this truck.
161	RPM HIGH	This alarm occurs in Gen. Set versions when the speed exceeds the threshold speed.

162	BUMPER STOP	Cause 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 DUALACE2 is in OPEN CAN configuration
		Troubleshooting Turn off one or both inputs dedicated to the bumper functionality. If the alarm occurs even if the inputs are in the rest position, check if the microswitches are stuck.In case the problem is not solved, replace the logic board
163	ED SLIP MISMATCH	The control detects a mismatch between the expected slip and the evaluated one. This diagnostic occurs only if ED COMPENSATION = TRUE
164	POT MISMATCH	This alarm isn't used for this truck.
165	SHORT CIRCUIT KO	Cause The HW dedicated to detect faults on power bridge does not work properly
		Troubleshooting - Replace the controller.
166	SHORT CIRCUIT	Cause The controller continuously checks that the Three-phase bridge works properly and that a short-circuit between motor phases is not present.
		Troubleshooting - Check that motor phases are correctly connected. - Verify that motor phases are not shot-circuited. - Replace the controller. - In case the problem is not solved, replace the motor.
167	IMS ERROR	Cause At start-up, the controller checks the presence of IMS board. If the IMS board is not well connected, this alarm appears.
		Troubleshooting - Replace the controller.
168	SPEED FB. ERROR	Cause This alarm occurs if the absolute position sensor is used also for speed estimation. If signaled, it means that the controller measured that the engine was moving too quick.
		Troubleshooting - Check that the sensor used is compatible with the software release. - Check the sensor mechanical installation and if it works properly. - Also the electromagnetic noise on the sensor can be a cause

		for the alarm. - 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.
169	WAIT MOTOR STILL	Cause: If DC Pump option is set to ON, the software expects the voltage on -P output to be at a “steady state” value, before switching the LC on. If the voltage is different, it could be due to the fact that the motor connected to -P is not still. For this reason, the software waits 30 seconds for the voltage to be at the “steady state” value (and for the pump motor to be still). After this time, the software assumes that the problem is not due to the fact that the pump motor is not still, and show the PUMP VMN NOT OK alarm.
		Troubleshooting: - If the motor connected to -P is still moving, just wait for it to be still. - If not, in 30 seconds the alarm PUMP VMN NOT OK will appear.
170	WRONG KEY VOLT.	Cause: The inverter key voltage is wrong .
		Troubleshooting: Check the battery level if is correct.
171	ACQUIRING A.S.	Cause: Controller is acquiring data from the absolute feedback sensor.
		Troubleshooting: The alarm ends when the acquisition is done.
172	ACQUIRE ABORT	Cause: The acquiring procedure relative to the absolute feedback sensor aborted.
173	ACQUIRE END	Cause: Absolute feedback sensor acquired.
174	OFFSET SPD.SENS.	This alarm isn't used for this truck.
175	SPEED OVERHEAD	Cause: the speed overtakes the speed set-point
		Troubleshooting: try to replace a new encoder ,if this alarm still present,please replace the controller
176	REACH POT NOT OK	This alarm is not implemented in traction.
177	COIL SHOR. EB.	Cause This alarm occurs when an overload of the EB driver occurs
		Troubleshooting - Check the connections between the controller outputs and the loads. - Collect information about characteristics of the coil connected

		to the driver and ask for assistance to a Zapi technician in order to verify that the maximum current that can be supplied by the hardware is not exceeded. - In case no failures/problems have been found, the problem is in the controller, which has to be replaced
178	MOTOR TEMP. STOP	Cause: The temperature sensor has overtaken the STOP MOTOR TEMP. Threshold
		Troubleshooting: - Check the temperature read by the thermal sensor inside the motor through the MOTOR TEMPERATURE reading in the TESTER function. - Check the sensor ohmic value and the sensor wiring. - If the sensor is OK, improve the cooling of the motor. - If the warning is present when the motor is cool, replace the controller.
179	STEER SENSOR KO	Cause: 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
		Troubleshooting: - 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. - If the problem is not solved, replace the logic board
180	OVERLOAD	Cause The motor current has overcome the limit fixed by hardware.
		Troubleshooting Reset the alarm by switching key off and on again. If the alarm condition occurs again, ask for assistance to a Zapi technician. The fault condition could be affected by wrong adjustments of motor parameters.
181	WRONG ENC SET	Cause Mismatch between “ENCODER PULSES 1” parameter and “ENCODER PULSES 2” parameter (see paragraph 7.2.5).
		Troubleshooting Set the two parameters with the same value, according to the adopted encoder.
185	TILLER ERROR	Cause: Input mismatch between Hard&Soft input and tiller input : the two inputs are activated at the same time.

		Troubleshooting: - Check if there is wrong connection in the external wiring. - Using the “Tester” menu of the controller verify that what the controller sees in input is in accordance with the actual state of the external switch inputs. - Check if there is short circuit between A6 and A1 - In case no failures/problems have been found, the problem is in the controller, which has to be replaced.
186	WAIT MOT.P STILL	Cause: If DC Pump option is set to ON, the software expects the voltage on -P output to be at a “steady state” value, before switching the LC on. If the voltage is different, it could be due to the fact that the motor connected to -P is not still. For this reason, the software waits 30 seconds for the voltage to be at the “steady state” value (and for the pump motor to be still). After this time, the software assumes that the problem is not due to the fact that the pump motor is not still, and show the PUMP VMN NOT OK alarm.
		Troubleshooting: - If the motor connected to -P is still moving, just wait for it to be still. - If not, in 30 seconds the alarm PUMP VMN NOT OK will appear.
187	LIFT+LOWER	Cause: Both the pump requests (LIFT and LOWER) are active at the same time.
		Troubleshooting: - Check that LIFT and LOWER requests are not active at the same time. - Check the LIFT and LOWER input states through the TESTER function. - Check the wirings. - Check if there are failures in the microswitches. - If the problem is not solved, replace the logic board.
188	INT. CANBUSKO	Cause: the can-bus interface is not correct
		Troubleshooting: Check the wiring of Can-bus if is correct;if this alarm always present, try to replace the controller
189	PUMP INC START	Cause: Man-presence switch is not enabled at pump request.
		Troubleshooting: - Check wirings.

		- Check microswitches for failures. - Through the TESTER function, check the states of the inputs are coherent with microswitches states. - If the problem is not solved, replace the logic board.
190	PUMP VMN NOT OK	Cause: Switching the LC on, the software checks the output voltage on -P connector, and expects that it is at a “steady state” value (if DC PUMP option is set to ON). If the voltage is too low, this alarm occurs.
		Troubleshooting: Please check: - The motor connected to -P must be completely still before this alarm occurs. The software waits 30 seconds before showing this alarm. During this time it shows the WAIT MOTOR STILL warning. - Motor internal connections - Motor power cables connections - Motor leakage to truck frame - If the motor connections are ok, the problem is inside the controller it is necessary to replace the logic board.
191	PUMP VACC NOT OK	Cause: The minimum voltage of the lift potentiometer is not correctly set.
		Troubleshooting: It is suggested to repeat the acquiring procedure of MIN LIFT and MAX LIFT (see paragraph 9.2).
192	PUMP VACC RANGE	Cause: The voltage on A30 is outside of the parameters range.
		Troubleshooting: If the EVP TYPE parameter is set to ANALOG , please acquire again the values of MIN LOWER and MAX LOWER. If the controller is in configuration COMBI and lifting is proportional, please acquire again also the values of MIN LIFT and MAX LIFT.
193	SMART DRIVER KO	Cause: There is a hardware problem in the smart driver circuit . The driver is set to be ON but the output voltage does not increase
		Troubleshooting: - Verify that the EB coil is connected correctly . - Verify that the parameter POSITIVE E.B.is set in accordance with the actual configuration . The software, in fact, depending on specific parameter value, makes a proper diagnosis; a wrong configuration of this parameter could generate a false fault. - In case no failures/problems have been found, the problem is

		in the controller, which has to be replaced
194	AUX BATT. SHORT.	Cause: The voltage on PEB output is at high value even if it should not. For the versions where the smart driver is not installed (36/48V), it is possible to decide where the positive supply for pin A27 comes from by choosing a dedicated hardware configuration. The parameter POSITIVE E.B. has to be set in accordance with the hardware configuration , because the software makes a proper diagnosis depending on the parameter; a wrong setting could generate a false fault. The available choices are:0 = PEB is managed by the smart driver (available for 24V version only). 1 = PEB comes from the TILLER input . 2 = PEB comes from PAUX . PAUX must be connected to terminal +B of the controller. This is the default configuration for 36/48V and 80V version. This alarm can only appear if POSITIVE E.B. is set as 1 TILLER/SEAT.
		Troubleshooting: Verify that the parameter POSITIVE E.B. is set in accordance with the actual coil positive supply (see paragraph 8.2.5). In case no failures/problems have been found, the problem is in the controller, which has to be replaced.
195	POS. EB. SHORTED	Cause: The voltage on terminal PEB is at the high value even if the smart driver is turned OFF.
		Troubleshooting: Verify that the parameter POSITIVE EB is set in accordance with the actual coil positive supply . Since the software makes a proper diagnosis depending on the parameter, a wrong setting could generate a false fault. Check if there is a short or a low impedance path between PEB and the positive battery terminal +B. In case no failures/problems can be found, the problem is in the controller, which has to be replaced.
196	MOT.PHASE SH. （36/37/38）	Cause Short circuit between two motor phases. The number that follows the alarm identifies where the short circuit is located: - 36 à U – V short circuit - 37 à U – W short circuit - 38 à V – W short circuit
		Troubleshooting - Verify the motor phases connection on the motor side - Verify the motor phases connection on the inverter side

		- Check the motor power cables. - Replace the controller. - If the alarm does not disappear, the problem is in the motor. Replace it.
197	WRONG SLAVE VER.	Cause: Wrong software version on supervisor uC.
		Troubleshooting: Upload the correct software version or ask for assistance to a Zapi technician.
198	M/S PAR CHK MISM	Cause: At start-up there is a mismatch in the parameter checksum between the master and the supervisor microcontrollers.
		Troubleshooting: Restore and save again the parameters list.
199	PARAM TRANSFER	Cause: Master uC is transferring parameters to the supervisor.
		Troubleshooting: Wait until the end of the procedure. If the alarm remains longer, re-cycle the key.
200	VDC OFF SHORTED	Cause The logic board measures a key voltage value that is constantly out of range, above the maximum allowed value.
		Troubleshooting - Check that the battery has the same nominal voltage of the inverter. - Check the battery voltage, if it is out of range replace the battery. - In case the problem is not solved, replace the logic board.
201	CURRENT PROFILE	Cause: There is an error in the choice of the torque profile parameters.
		Troubleshooting: Check in the HARDWARE SETTING menu the value of those parameters.
202	VDC LINK OVERV.	Cause This fault is displayed when the controller detects an overvoltage condition. Overvoltage threshold is 65 V for 36/48V controllers and 116 V for 80V controllers. 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: - High voltage à Overvoltage condition - Low/normal voltage à Undervoltage condition
		Troubleshooting

		If the alarm happens during the brake release, check the line contactor contact and the battery power-cable connection.
204	BRAKE RUN OUT	Cause: The CPOT BRAKE input read by the microcontroller is at its maximum value without the hand-brake request.
		Troubleshooting: Check the mechanical calibration and the functionality of the brake potentiometer. If the alarm is still present, replace the logic board.
205	EPS RELAY OPEN	Cause: The controller receives from EPS information about the safety contacts being open.
		Troubleshooting: Verify the EPS functionality.
206	INIT VMN HIGH	Cause Before switching the LC on, 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 high, this alarm occurs.
		Troubleshooting - Check the motor power cables; - Check the impedance between U, V and W terminals and -Batt terminal of the controller. - Check the motor leakage to truck frame. - 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	Cause Before switching the LC on, 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.
		Troubleshooting - Check the motor power cables. - Check the impedance between U, V and W terminals and -Batt terminal of the controller. - Check the motor leakage to truck frame. - 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	Cause: 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.
		Troubleshooting:

		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.
209	PARAM RESTORE	Cause: The controller has restored the default settings. If a CLEAR EEPROM has been made before the last key re-cycle, this warning informs you that EEPROM was correctly cleared.
		Troubleshooting: - A travel demand or a pump request cancels the alarm. - If the alarm appears at key-on without any CLEAR EEPROM performed, replace the controller.
210	WRONG RAM MEM.	Cause The algorithm implemented to check the main RAM registers finds wrong contents: the register is “dirty”. This alarm inhibits the machine operations.
		Troubleshooting Try to switch the key off and then on again, if the alarm is still present replace the logic board.
211	STALL ROTOR	Cause: The traction rotor is stuck or the encoder signal is not correctly received by the controller.
		Troubleshooting: - Check the encoder condition. - Check the wiring. - Through the TESTER function, check if the sign of FREQUENCY and ENCODER are the same and if they are different from zero during a traction request. - If the problem is not solved, replace the logic board.
212	POWER MISMATCH	Cause The error between the power setpoint and the estimated power is out of range.
		Troubleshooting Ask for assistance to a Zapi technician about the correct adjustment of the motor parameters.
213	POSITIVE LC OPEN	Cause The voltage feedback of LC driver is different than expected
		Troubleshooting - Verify that the coil is connected correctly. - Verify that the parameters “Positive LC” is set in accordance with the actual coil positive supply. The software, in fact,

		depending by specific parameter value, makes a proper diagnosis; a wrong configuration of the parameter could generate a false fault. - In case no failures/problems have been found, the problem is in the controller, which has to be replaced.
214	EVP COIL OPEN	Cause: No load is connected between the NEVP output and the electrovalve positive terminal.
		Troubleshooting: - Check the EVP condition. - Check the EVP wiring. - If the problem is not solved, replace the logic board.
215	EVP DRIV. SHORT.	Cause - The EVP driver is shorted . - The microcontroller detects a mismatch between the valve set-point and the feedback of the EVP output.
		Troubleshooting - Check if there is a short circuit or a low-impedance conduction path between the negative of the coil and -BATT.
216	EB. COIL OPEN	Cause: No load is connected between the NEB output and the EB positive terminal PEB
		Troubleshooting: Check the EB coil. Check the wiring. If the problem is not solved, replace the logic board.
217	PEB NOT OK	Cause: The PEV connector is not connected to the battery or the voltage is different from expected. This alarm occurs if one output among EVP, EV1, EV2, EV3, EV4 and EV5 is present or the AUX OUT function is active (POSITIVE EB = 1 or 2).
		Troubleshooting: Check connector B1: it must be connected to the battery voltage (after the main contactor).
218	SENS MOT TEMP KO	Cause: The output of the motor thermal sensor is out of range.
		Troubleshooting: - Check if the resistance of the sensor is what expected measuring its resistance. - Check the wiring. - If the problem is not solved, replace the logic board.
219	PEB-PEVP NOT OK	Cause: The voltage of traction A24 pin is wrong, A24 pin voltage is +80V, from the key, if the voltage is wrong,this alarm will appears

		Troubleshooting: - Check if the A24 pin if has 80V input - Check the wiring,if A24 connected well? - Check the fuse box if works properly,maybe the fuse is burned.
220	VKEY OFF SHORTED	Cause The logic board measures a key voltage that is constantly out of range, below the minimum allowed value.
		Troubleshooting - Check that the battery has the same nominal voltage of the inverter. - Check the battery voltage, if it is out of range replace the battery. - In case the problem is not solved, replace the logic board.
221	HANDBRAKE	Cause: Handbrake input is active.
		Troubleshooting: - Check that handbrake is not active by mistake. - Check the SR/HB input state through the TESTER function. - Check the wirings. - Check if there are failures in the microswitches. - If the problem is not solved, replace the logic board.
222	LIFT POT OUTRNG	This alarm is not implemented in traction.
223	COIL SHOR. MC	Cause This alarm occurs when an overload of the MC driver occurs.
		Troubleshooting - Check the connections between the controller outputs and the loads. - Collect information about characteristics of the coil connected to the driver and ask for assistance to a Zapi technician in order to verify that the maximum current that can be supplied by the hardware is not exceeded. - In case no failures/problems have been found, the problem is in the controller, which has to be replaced.
224	WAITING FOR NODE	Cause: The controller receives from the CAN bus 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.
		Troubleshooting: Check if any other device on the CAN bus is in fault condition.
225	TILT POT OUTRNG	This alarm is not implemented in traction.
226	VACC OUT RANGE	Cause:

		The CPOT input read by the microcontroller is not within the MIN VACC ÷ MAX VACC range, programmed through the PROGRAMM VACC function . The acquired values MIN VACC and MAX VACC are inconsistent.
		Troubleshooting: 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. If the problem is not solved, replace the logic board.
227	HW FAULT	Cause1: At each start-up the supervisor microcontroller checks that the hardware circuit for enabling and disabling of the power bridge works properly.
		Cause2:At each start-up the supervisor microcontroller checks that the hardware circuit intended to enable and disable the LC driver works properly.
		Troubleshooting This type of fault is not related to external components. Replace the logic board
228	TILLER OPEN	Cause: Tiller/seat input has been inactive for more than 30 seconds.
		Troubleshooting: - Activate the tiller/seat input. - Check the tiller/seat input state through the TESTER function. - Check the wirings. - Check if there are failures in the microswitches. - If the problem is not solved, replace the logic board.
229	HW FAULT EB.	Cause: At start-up, the hardware circuit dedicated to enable and disable the EB driver is found to be faulty. The hexadecimal value “XX” facilitates Zapi technicians debugging the problem.
		Troubleshooting: This type of fault is not related to external components. Replace the logic board.
230	LC COIL OPEN	Cause This fault appears when no load is connected between the NLC output and the positive voltage (for example +KEY).
		Troubleshooting - Check the wiring, in order to verify if LC coil is connected to the right connector pin and if it is not interrupted. - If the alarm is still present, than the problem is inside the logic board; replace it.
231	PUMP I NO ZERO	Cause: In standby condition (pump motor not driven), the feedback

		coming from the current sensor in the pump chopper gives a value out of a permitted range, because the pump current is not zero.
		Troubleshooting: This type of fault is not related to external components; replace the controller.
232	CONT. DRV. EV	Cause: One or more on/off valve drivers are not able to drive the load. For the meaning of code “XX”, refer to paragraph 0.
		Troubleshooting: The device or its driving circuit is damaged. Replace the controller.
233	POWERMOS SHORTED	Cause The DC-link voltage drops to zero when a high-side MOSFET is turned on.
		Troubleshooting - Check that motor phases are correctly connected. - Check that there is no dispersion to ground for every motor phases. - In case the problem is not solved, replace the controller.
234	DRV. SHOR. EV	Cause: One or more on/off valve drivers are shorted.
		Troubleshooting: Check if there is a short circuit or a low impedance path between the negative terminals of the involved coils and -B. If the problem is not solved, replace the logic board.
235	CTRAP THRESHOLD	Cause This alarm occurs when a mismatch is detected between the setpoint for the overcurrent detection circuit (dependent on parameter DUTY PWM CTRAP) and the feedback of the actual threshold value.
		Troubleshooting The failure lies in the controller hardware. Replace the logic board.
236	CURRENT GAIN	Cause: The maximum current gain parameters are at the default values, which means the maximum current adjustment procedure has not been carried out yet.
		Troubleshooting: Ask for assistance to a Zapi technician in order to do the adjustment procedure of the current gain parameters.
237	ANALOG INPUT	Cause 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.
		Troubleshooting If the problem occurs permanently it is necessary to replace the logic board.
238	HW FAULT EV.	Cause: At start-up, the hardware circuit dedicated to enable and disable the EV drivers is found to be faulty. The hexadecimal value "XX" facilitates Zapi technicians debugging the problem.
		Troubleshooting: This type of fault is not related to external components. Replace the logic board.
239	CONTROLLER MISM.	Cause: 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. According with this "sign", only the customized firmware can be uploaded.
		Troubleshooting - Upload the correct firmware. - Ask for assistance to a Zapi technician in order to verify that the firmware is correct.
240	EVP DRIVER OPEN	Cause: The EVP driver is not able to drive the EVP coil. The device itself or its driving circuit is damaged.
		Troubleshooting: This fault is not related to external components. Replace the logic board.
241	COIL SHOR. EVAUX	Cause: 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 disappears by releasing and then enabling a travel demand.
		Troubleshooting: - Check the EVs conditions. - Check the wiring. - Collect information about characteristics of EV coils and ask assistance to a Zapi technician. - If the problem is not solved, replace the logic board.
242	OPEN COIL EV.	Cause: This fault appears when no load is connected between the NAUX1 output and the positive terminal PCOM .
		Troubleshooting: - Check the EB coil.

		- Check the wiring. - If the problem is not solved, replace the logic board.
243	THROTTLE PROG.	Cause: A wrong profile has been set in the throttle profile.
		Troubleshooting: Set properly the throttle-related parameters.
244	WARNING SLAVE	Cause: Warning on supervisor uC.
		Troubleshooting: Connect the Console to the supervisor uC and check which alarm is present.
245	IQ MISMATCHED	Cause The error between the Iq (q-axis current) setpoint and the estimated Iq is out of range.
		Troubleshooting Ask for assistance to a Zapi technician in order to do the correct adjustment of the motor parameters.
246	EB. DRIV.OPEN	Cause: The EB driver is not able to drive the load. The device itself or its driving circuit is damaged.
		Troubleshooting: This type of fault is not related to external components. Replace the logic board.
247	DATA ACQUISITION	Cause: Controller in calibration state.
		Troubleshooting: The alarm ends when the acquisition is done.
248	NO CAN MSG.	Cause: This is a safety related test. It is a self-diagnosis test that checks the communication between master and supervisor microcontrollers.
		Troubleshooting: This alarm could be caused by a CAN bus malfunctioning, which blinds master- supervisor communication
249	CHECK UP NEEDED	Cause: This is a warning to point out that it is time for the programmed maintenance.
		Troubleshooting: Turn on the CHECK UP DONE option after that the maintenance service.
250	THERMIC SENS. KO	Cause: The output of the controller thermal sensor is out of range.
		Troubleshooting:

		This kind of fault is not related to external components. Replace the controller.
251	WRONG SET BAT.	Cause 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.
		Troubleshooting - Check that the SET BATTERY parameter inside the ADJUSTMENT list matches with the battery nominal voltage. - 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. - Replace the battery.
253	FIELD ORIENT. KO	Cause The error between the Id (d-axis current) setpoint and the estimated Id is out of range.
		Troubleshooting Ask for assistance to a Zapi technician in order to do the correct adjustment of the motor parameters.
254	EB. DRIV.SHRT.	Cause: - The EB driver is shorted. - The microcontroller detects a mismatch between the valve setpoint and the feedback at the EB output.
		Troubleshooting: - Check if there is a short or a low impedance path between the negative coil terminal and -BATT. - Check if the voltage applied is in accordance with the parameters set . - If the problem is not solved, replace the controller.

(2) Common faults of pump control systems

① Pump master CPU fault

CAN CODE	ALARM	ALARMS OF NODE 5.0
8	WATCHDOG	Cause: This is a safety related test. It is a self-diagnosis test that involves the logic between master and supervisor microcontrollers
		Troubleshooting: This alarm could be caused by a CAN bus malfunctioning, which blinds master-supervisor communication
17	LOGIC	Cause

	FAILURE #3	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.
		Troubleshooting The failure lies in the controller hardware. Replace the controller.
18	LOGIC FAILURE #2	Cause Fault in the hardware section of the logic board which deals with voltage feedbacks of motor phases.
		Troubleshooting The failure lies in the controller hardware. Replace the controller.
19	LOGIC FAILURE #1	Cause This fault is displayed when the controller detects an undervoltage condition at the key input . Undervoltage threshold is 11V for 36/48V controllers and 30 V for 80V controllers.
		Troubleshooting (fault at startup or in standby) - 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. - 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. Troubleshooting (fault displayed during motor driving) - 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.
28	PUMP VMN LOW	Cause: The pump motor output is lower than expected, considering the PWM duty cycle applied.
		Troubleshooting: A) If the problem occurs at start up (the LC does not close at all), check: - Motor internal connections; - Motor power cables connections; - If the motor connection are OK, the problem is inside the controller. B) If the problem occurs after closing the LC (the LC closes and then opens back again), check: - Motor internal connections; - If motor windings/cables have leakages towards truck frame; - If no problem are found on the motors, the problem is inside the controller. C) If the alarm occurs during motor running, check:

		- Motor internal connections; - If motor windings/cables have leakages towards truck frame; - That the LC power contact closer properly, with a good contact; - If no problem are found on the motors, the problem is inside the controller, it is necessary to replace the logic board.
29	PUMP VMN HIGH	Cause: This test is carried out when the pump motor is turning (PWM applied). The pump motor output is higher than expected, considering the PWM applied.
		Troubleshooting: - Motor internal connections - If motor windings/cables have leakages towards truck frame - If no problem are found on the motors, the problem is inside the controller, it is necessary to replace the logic board.
30	VMN LOW	Cause 1 Start-up test. Before switching the LC on, the software checks the power bridge: 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.
		Cause 2 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.
		Troubleshooting - If the problem occurs at start up (the LC does not close at all), check: - motor internal connections (ohmic continuity); - motor power-cables connections;
31	VMN HIGH	Cause 1 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.
		Cause 2 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.
		Troubleshooting - If the problem occurs at start-up (the LC does not close), check: - motor internal connections (ohmic continuity);

		- motor power cables connections; - if the motor connections are OK, the problem is inside the controller. Replace it. - If the alarm occurs while the motor is running, check: - motor connections; - that the LC power contact closes properly, with a good contact; - if no problem is found, the problem is inside the controller. Replace it.
37	CONTACTOR CLOSED	Cause 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.
		Troubleshooting It is suggested to verify the power contacts of LC; if they are stuck, is necessary to replace the LC.
38	CONTACTOR OPEN	Cause 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.
		Troubleshooting - LC contacts are not working. Replace the LC. - If LC contacts are working correctly, contact a Zapi technician.
52	PUMP I=0 EVER	Cause: While the pump motor is running, the current feedback is constantly stuck to zero.
		Troubleshooting: - Check the motor connection, that there is continuity. If the motor connection is opened, the current cannot flow, so the test fails and the error code is displayed; - If everything is ok for what it concerns the motor, the problem could be in the current sensor or in the related circuit.
53	STBY I HIGH	Cause In standby, the sensor detects a current value different from zero.
		Troubleshooting The current sensor or the current feedback circuit is damaged. Replace the controller.
60	CAPACITOR CHARGE	Cause 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 20% of the nominal battery voltage, the alarm is raised and the main contactor is not closed.
		Troubleshooting - 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. - 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. - The charging circuit has a failure or there is a problem in the power section. Replace the controller.
62	TH. PROTECTION	Cause: 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.
		Troubleshooting: 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. 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.
65	MOTOR TEMPERAT.	Cause: This warning occurs when the temperature sensor is open (if digital) or if it has overtaken the MAX MOTOR TEMP threshold (if analog)
		Troubleshooting: - Check the temperature read by the thermal sensor inside the motor through the MOTOR TEMPERATURE reading in the TESTER function. - Check the sensor ohmic value and the sensor wiring. - If the sensor is OK, improve the cooling of the motor. - If the warning is present when the motor is cool, replace the controller.
66	BATTERY LOW	Cause: The battery charge is evaluated to be lower than 10% (10% with lithium battery ,15% with lead-acid battery) of the full charge and the BATTERY CHECK setting is other than 0 (refer to SET OPTION

		menu).
		Troubleshooting: - Check the battery charge and charge it if necessary. - If the battery is actually charged, measure the battery voltage through a voltmeter and compare it with the value in the BATTERY VOLTAGE reading in the TESTER function. If they are different, adjust the ADJUST BATTERY parameter with the value measured through the voltmeter. - If the problem is not solved, replace the logic board.
74	DRIVER SHORTED	Cause The driver of the LC coil is shorted, or parameter was wrong
		Troubleshooting - Check if there is a short or a low impedance pull-down between NLC and –BATT. - The driver circuit is damaged; replace the logic board. - Check the traction right parameter "SET POSITIVE PEB",the correct value should be 80V ,if this parameter is wrong ,maybe this alarm will be displayed.(maybe 74 on node 3.0)
75	CONTACTOR DRIVER	Cause The LC coil driver is not able to drive the load. The device itself or its driver circuit is damaged.
		Troubleshooting This type of fault is not related to external components; replace the logic board.
78	VACC NOT OK	Cause: At key-on and immediately after that, the travel demands have been turned off. This alarm occurs if the ACCELERATOR reading (in TESTER function) is more than 1 V above the minimum value acquired during the PROGRAM VACC procedure.
		Troubleshooting: - Check the wirings. - Check the mechanical calibration and the functionality of the accelerator potentiometer. - Acquire the maximum and minimum potentiometer value through the PROGRAM VACC function. - If the problem is not solved, replace the logic board.
79	INCORRECT START	Cause: Incorrect starting sequence. Possible reasons for this alarm are: - A travel demand active at key-on. - Man-presence sensor active at key on.
		Troubleshooting: - Check wirings. - Check microswitches for failures.

		- Through the TESTER function, check the state of the inputs are coherent with microswitches states. - If the problem is not solved, replace the logic board.
80	FORW+BACK	Cause: This alarm occurs when both the travel requests (FW and BW) are active at the same time.
		Troubleshooting: - Check that travel requests are not active at the same time. - Check the FW and BW input states through the TESTER function. - Check the wirings relative to the FW and BW inputs. - Check if there are failures in the microswitches. - If the problem is not solved, replace the logic board.
82	ENCODER ERROR	Cause This fault occurs in the following conditions: the frequency supplied to the motor is higher than 40 Hz and the signal feedback from the encoder has a jump higher than 40 Hz in few tens of milliseconds. This condition is related to an encoder failure.
		Troubleshooting - Check the electrical and the mechanical functionality of the encoder and the wires crimping. - Check the mechanical installation of the encoder, if the encoder slips inside its housing it will raise this alarm. - Also the electromagnetic noise on the sensor can be the cause for the alarm. In these cases try to replace the encoder. - If the problem is still present after replacing the encoder, the failure is in the controller.
86	PEDAL WIRE KO	This is not implemented in DUALACE2. Troubleshooting: - Ask for help to a heli technician.
113	TILT LIN ACQUIS.	Cause: This is a warning the tilt linear pot. is doing the acquisition
		Troubleshooting: Once the acquisition is done,re-cycle the key, then this alarm will disappear
114	TILT LIN OUT RAN	Cause: Th input of tilt linear pot. is not in the acquired range
		Troubleshooting:Acquire the maximum and minimum potentiometer values through pump "ADJUSTMENT "menu.
115	LIFT CTB OUTRNG	Cause: Th input of lift cutback pot. (or lift promixity switch) is not in the acquired range
		Troubleshooting:Acquire the maximum and minimum potentiometer values through pump "ADJUSTMENT "menu.
116	WAIT DISP	Cause: the traction parameter "DISP TYPE" was wrong

	AUTH	Troubleshooting: Check the parameter.
117	NO CAN DISP	Cause: the display is disconnected
		Troubleshooting: Check the wiring,or ask for help to a Zapi technician.
118	2F4 TIMEOUT	This alarm is not implemented in pump.
119	2F3 TIMEOUT	This alarm is not implemented in pump.
120	2F2 TIMEOUT	This alarm is not implemented in pump.
121	HARDWARE WRONG	This type of fault is not related to external components.Please contact with controller manufacturer
122	LIFT POT OUTRNG	Cause: 1.The LIFT POT. input read by the microcontroller is not comprised in the range "MIN LIFT" ÷ "MAX LIFT". 2.The LOWER POT. input read by the microcontroller is not comprised in the range "MIN LOWER" ÷ "MAX LOWER".
		Troubleshooting Acquire the maximum and minimum lift potentiometer value through the pump "ADJUSTMENT" menu. If the alarm is still present, check the mechanical calibration and the functionality of the potentiometer. If the alarm is not disappeared the failure is in the pump controller logic board, replace it.
123	LIFT POT NOT OK	Cause The software detected the "LIFT POT." input read by the microcontroller is 1V higher (or lower) than "MIN LIFT" but lift enable still is not closed
		Troubleshooting 1.Please check the lift enable if works fine,if it works fine,then acquire the maximum and minimum lift potentiometer value through the pump "ADJUSTMENT" menu. 2.If this alarm is not disappeared after the acquisition, the failure is in the pump controller logic board, replace it.
124	TILT POT OUTRNG	Cause: The TILT POT. input read by the microcontroller is not comprised in the range "MIN TILT UP" ÷ "MAX TILT UP" （or "MIN TILT DOWN" ÷ "MAX TILT DOWN")
		Troubleshooting Acquire the maximum and minimum TILT potentiometer value through the pump "ADJUSTMENT" menu. If the alarm is still present, check the mechanical calibration and the functionality of the potentiometer. If the alarm is not disappeared the failure is in the pump controller logic board, replace it.
125	TILT POT NOT OK	Cause The software detected the "TILT POT." input read by the microcontroller is 1V higher (or lower) than minimum TILT potentiometer value but tilt enable still is not closed
		Troubleshooting

		1.Please check the tilt enable if works fine,if it works fine,then acquire the maximum and minimum tilt potentiometer value through the pump "ADJUSTMENT" menu. 2.If this alarm is not disappeared after the acquisition, the failure is in the pump controller logic board, replace it.
126	SHIFT POT OUTRNG	Cause: The SHIFT POT. input read by the microcontroller is not comprised in the range "MIN SHIFT RIGHT" ÷ "MAX SHIFT RIGHT" （or "MIN SHIFT LEFT" ÷ "MAX SHIFT LEFT")
		Troubleshooting Acquire the maximum and minimum SHIFT potentiometer value through the pump "ADJUSTMENT" menu. If the alarm is still present, check the mechanical calibration and the functionality of the potentiometer. If the alarm is not disappeared the failure is in the controller logic board, replace it.
127	SHIFT POT NOT OK	Cause The software detected the "SHIFT POT." input read by the microcontroller is 1V higher (or lower) than minimum SHIFT potentiometer value but shift enable still is not closed
		Troubleshooting 1.Please check the shift enable if works fine,if it works fine,then acquire the maximum and minimum shift potentiometer value through the pump "ADJUSTMENT" menu. 2.If this alarm is not disappeared after the acquisition, the failure is in the controller logic board, replace it.
128	AUX POT OUTRNG	Cause: The AUX. POT. input read by the microcontroller is not comprised in the range "MIN AUX IN" ÷ "MAX AUX IN" （or "MIN AUX OUT" ÷ "MAX AUX OUT")
		Troubleshooting Acquire the maximum and minimum Aux. potentiometer value through the pump "ADJUSTMENT" menu. If the alarm is still present, check the mechanical calibration and the functionality of the potentiometer. If the alarm is not disappeared the failure is in the controller logic board, replace it.
129	AUX POT NOT OK	Cause The software detected the "AUX. POT." input read by the microcontroller is 1V higher (or lower) than minimum AUX. potentiometer value but Aux. enable still is not closed
		Troubleshooting 1.Please check the Aux. enable if works fine,if it works fine,then acquire the maximum and minimum Aux. potentiometer value through the pump "ADJUSTMENT" menu. 2.If this alarm is not disappeared after the acquisition, the failure is in the

		controller logic board, replace it.
130	FROM VCM	Cause: This is a warning on pump and there is an alarm present on VCM
		Troubleshooting Please check the alarm on VCM, when VCM alarm be solved, this alarm will disappear
131	LI CURR CUT PRO.	This alarm is not implemented in pump.
132	LI CURR LIM PRO.	This alarm is not implemented in pump.
133	LI CHARGING	This alarm is not implemented in pump.
134	LI WARNING TEMP	This alarm is not implemented in pump.
135	LI STOP TEMP	This alarm is not implemented in pump.
136	LI HIGH CURR	This alarm is not implemented in pump.
137	LI CELL VOL LOW	This alarm is not implemented in pump.
138	LI COMM INTER	This alarm is not implemented in pump.
139	LI CELL OVER DIS	This alarm is not implemented in pump.
140	LI TOT VOL HIGH	This alarm is not implemented in pump.
141	2F1 TIMEOUT	This alarm is not implemented in pump.
142	2F0 TIMEOUT	This alarm is not implemented in pump.
143	2F0 INIT. ERR.	This alarm is not implemented in pump.
144	2ND LEV INHIBIT	This alarm is not implemented in pump.
145	1ST LEV INHIBIT	This alarm is not implemented in pump.
146	AUTH. FAILED	This alarm is not implemented in pump.
147	0X1AA TIMEOUT	This alarm is not implemented in pump.
148	REM DEV INIT ERR	This alarm is not implemented in pump.
149	WR. SET TEMP MOT	Cause:“SET MOTOR TEMP.” Parameter out of range (-20, +20),
		Troubleshooting:Try to adjust the motor temperature.Tryyo do a clear eeprom, if this alarm still present,please replace the controller
150	ENCODER PHASES	Cause:Encoder phases signals not consistent
		Troubleshooting:Try to recycle the key, or change the encoder.
151	POT MISMATCH	Cause:Twin potentiometer signals not consistent (only with twin potentiometer)
		Troubleshooting:check the signals of the twin potentiometer

152	SENSOR SUPPLY XX	Cause:The current supplied on pin PENC A10 (A8) or PPOT A4 (A2) is outside the range MIN.CURR.SUPPLY1/2 through 200 mA. The hexadecimal value “XX” defines the following cases:
		Troubleshooting: SENSOR SUPPLY 01: PENC A10 (A8) below MIN.CURR.SUPPLY1. SENSOR SUPPLY 02: PENC A10 (A8) above 200 mA. SENSOR SUPPLY 11: PPOT A4 (A2) below MIN.CURR.SUPPLY2. SENSOR SUPPLY 12: PPOT A4 (A2) above 200 mA.
153	OFFSET SPD. SENS.	Cause:It is necessary to acquire the offset angle between the stator and the speed sensor, i.e. they mutual angular misalignment. An automatic function is dedicated to this procedure
		Troubleshooting:Perform the teaching procedure: in OPTIONS, select ABS.SENS.ACQUIRE.
154	SIXSTEP ERROR	This alarm is not implemented in this truck
155	WAIT MOTOR STILL	Cause:The controller is waiting for the motor to stop rotating. This warning can only appear in ACE2 for brushless motors.
156	REMA T. ALARM	This alarm is not implemented in this truck
157	FAULT DRV. POWER	This alarm is not implemented in this truck
158	NOT RDY DRV. POW.	This alarm is not implemented in this truck
159	HVIL FAIL	This alarm is not implemented in this truck
160	SENS BAT TEMP KO	This alarm is not implemented in this truck
161	RPM HIGH	Cause: This alarm occurs in Gen. Set versions when the speed exceeds the threshold speed.
162	BUMPER STOP	Cause The two digital inputs dedicated to the bumper functionality are high at the same time.
		Troubleshooting - Turn off one or both inputs dedicated to the bumper functionality; - If the alarm occurs even if the inputs are in the rest position, check if the microswitches are stuck. - In case the problem is not solved, replace the logic board.
163	ED SLIP MISMATCH	Cause The control detects a mismatch between the expected slip and the evaluated one. This diagnostic occurs only if ED COMPENSATION = TRUE,this alarm is not implemented in this truck
164	PWM ACQ.	Cause

	ERROR	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. The controller does not detect correct information on PWM input at start-up
		Troubleshooting - Re-cycle the key. - Check the sensor in order to verify that it works properly. - Check the wiring. - If the problem occurs permanently it is necessary to substitute logic board
165	SHORT CIRCUIT KO	Cause The HW dedicated to detect faults on power bridge does not work properly
		Troubleshooting - Replace the controller.
166	SHORT CIRCUIT	Cause The controller continuously checks that the Three-phase bridge works properly and that a short-circuit between motor phases is not present.
		Troubleshooting - Check that motor phases are correctly connected. - Verify that motor phases are not shot-circuited. - Replace the controller. - In case the problem is not solved, replace the motor.
167	IMS ERROR	Cause At start-up, the controller checks the presence of IMS board. If the IMS board is not well connected, this alarm appears.
		Troubleshooting - Replace the controller.
168	SIN/COS D.ERR.XX	Cause: 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 Zapi technicians debugging the problem
		Troubleshooting: Check the wirings. If the motor direction is correct, swap the sin and cos signals. If the motor direction is not correct, swap two of the motor cables. If the problem is not solved, contact a Zapi technician
169	ENCODER D.ERR.XX	Cause: 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
		Troubleshooting:

		- Check the wirings. - If the motor direction is correct, swap A and B signals. - If the motor direction is not correct, swap two of the motor cables. - If the problem is not solved, contact a Zapi technician
170	WRONG KEY VOLT.	Cause: The inverter key voltage is wrong .
		Troubleshooting: Check the battery level if is correct.
171	ACQUIRING A.S.	Cause: Controller is acquiring data from the absolute feedback sensor.
		Troubleshooting: The alarm ends when the acquisition is done.
172	ACQUIRE ABORT	Cause: The acquiring procedure relative to the absolute feedback sensor aborted.
173	ACQUIRE END	Cause: Absolute feedback sensor acquired.
175	SPEED FB. ERROR	Cause This alarm occurs if the absolute position sensor is used also for speed estimation. If signaled, it means that the controller measured that the engine was moving too quick.
		Troubleshooting - Check that the sensor used is compatible with the software release. - Check the sensor mechanical installation and if it works properly. - Also the electromagnetic noise on the sensor can be a cause for the alarm. - 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 SNES. ERR XX	Cause The controller detected a difference between the estimated absolute orientation of the rotor and the position of the index signal (ABI encoder). It is caused by a wrong acquisition of the angle offset between the orientation of the rotor and the index signal
		Troubleshooting Repeat the auto-teaching procedure.
177	COIL SHOR. EB.	Cause This alarm occurs when an overload of the EB driver occurs
		Troubleshooting - Check the connections between the controller outputs and the loads. - Collect information about characteristics of the coil connected to the driver and ask for assistance to a Zapi technician in order to verify

		that the maximum current that can be supplied by the hardware is not exceeded. - In case no failures/problems have been found, the problem is in the controller, which has to be replaced
178	MOTOR TEMP. STOP	Cause: The temperature sensor has overtaken the STOP MOTOR TEMP. threshold (if analog, see paragraph 7.2.3).
		Troubleshooting: - Check the temperature read by the thermal sensor inside the motor through the MOTOR TEMPERATURE reading in the TESTER function. - Check the sensor ohmic value and the sensor wiring. - If the sensor is OK, improve the cooling of the motor. - If the warning is present when the motor is cool, replace the controller.
179	STEER SENSOR KO	Cause: 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
		Troubleshooting: - 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. - If the problem is not solved, replace the logic board
180	OVERLOAD	Cause The motor current has overcome the limit fixed by hardware.
		Troubleshooting Reset the alarm by switching key off and on again. If the alarm condition occurs again, ask for assistance to a Zapi technician. The fault condition could be affected by wrong adjustments of motor parameters.
181	WRONG ENC SET	Cause Mismatch between “ENCODER PULSES 1” parameter and “ENCODER PULSES 2” parameter (see paragraph 7.2.5).
		Troubleshooting Set the two parameters with the same value, according to the adopted encoder.
182	EVP2 COIL OPEN	Cause: No load is connected between the EVP2 output and the electrovalve positive terminal
		Troubleshooting:

		- Check the EVP2 condition. - Check the EVP2 wiring - If the problem is not solved, replace the logic board.
183	EVP2 DRIV. SHORT	Cause - The EVP2 driver is shorted. - The microcontroller detects a mismatch between the valve set-point and the feedback of the EVP2 output
		Troubleshooting - Check if there is a short circuit or a low-impedance conduction path between the negative of the coil and -B. - Collect information about: o the voltage applied across the EVP2 coil, o the current in the coil, o features of the coil. Ask for assistance to Zapi in order to verify that the software diagnoses are in accordance with the type of coil employed. - If the problem is not solved, it could be necessary to replace the controller
184	EVP2 DRIVER OPEN	Cause: The EVP2 driver is not able to drive the EVP2 coil. The device itself or its driving circuit is damaged
		Troubleshooting: This fault is not related to external components. Replace the logic board.
185	TILLER ERROR	Cause: Input mismatch between Hard&Soft input and tiller input : the two inputs are activated at the same time.
		Troubleshooting: - Check if there is wrong connection in the external wiring. - Using the “Tester” menu of the controller verify that what the controller sees in input is in accordance with the actual state of the external switch inputs. - Check if there is short circuit between A6 and A1 - In case no failures/problems have been found, the problem is in the controller, which has to be replaced.
186	WAIT MOT.P STILL	Cause: If DC Pump option is set to ON, the software expects the voltage on -P output to be at a “steady state” value, before switching the LC on. If the voltage is different, it could be due to the fact that the motor connected to -P is not still. For this reason, the software waits 30 seconds for the voltage to be at the “steady state” value (and for the pump motor to be still). After this time, the software assumes that the problem is not due to the fact that the pump motor is not still, and show the PUMP VMN NOT

		OK alarm.
		Troubleshooting: - If the motor connected to -P is still moving, just wait for it to be still. - If not, in 30 seconds the alarm PUMP VMN NOT OK will appear.
187	LIFT+LOWER	Cause: Both the pump requests (LIFT and LOWER) are active at the same time.
		Troubleshooting: - Check that LIFT and LOWER requests are not active at the same time. - Check the LIFT and LOWER input states through the TESTER function. - Check the wirings. - Check if there are failures in the microswitches. - If the problem is not solved, replace the logic board.
188	PUMP VACC NOT OK	Cause: The minimum voltage of the lift potentiometer is not correctly set.
		Troubleshooting: It is suggested to repeat the acquiring procedure of MIN LIFT and MAX LIFT (see paragraph 9.2).
189	PUMP INC START	Cause: Man-presence switch is not enabled at pump request.
		Troubleshooting: - Check wirings. - Check microswitches for failures. - Through the TESTER function, check the states of the inputs are coherent with microswitches states. - If the problem is not solved, replace the logic board.
190	PUMP VMN NOT OK	Cause: Switching the LC on, the software checks the output voltage on -P connector, and expects that it is at a “steady state” value (if DC PUMP option is set to ON, see paragraph 8.2.1 – HYDRO SETTINGS). If the voltage is too low, this alarm occurs.
		Troubleshooting: Please check: - The motor connected to -P must be completely still before this alarm occurs. The software waits 30 seconds before showing this alarm. During this time it shows the WAIT MOTOR STILL warning. - Motor internal connections - Motor power cables connections - Motor leakage to truck frame - If the motor connections are ok, the problem is inside the controller it is necessary to replace the logic board.

191	PUMP I NO ZERO	Cause: In standby condition (pump motor not driven), the feedback coming from the current sensor in the pump chopper gives a value out of a permitted range, because the pump current is not zero.
		Troubleshooting: This type of fault is not related to external components; replace the controller.
192	PUMP VACC RANGE	Cause: The voltage on A30 is outside of the parameters range.
		Troubleshooting: If the EVP TYPE parameter is set to ANALOG , please acquire again the values of MIN LOWER and MAX LOWER. If the controller is in configuration COMBI and lifting is proportional, please acquire again also the values of MIN LIFT and MAX LIFT.
193	SMART DRIVER KO	Cause: There is a hardware problem in the smart driver circuit . The driver is set to be ON but the output voltage does not increase
		Troubleshooting: - Verify that the EB coil is connected correctly . - Verify that the parameter POSITIVE E.B.is set in accordance with the actual configuration . The software, in fact, depending on specific parameter value, makes a proper diagnosis; a wrong configuration of this parameter could generate a false fault. - In case no failures/problems have been found, the problem is in the controller, which has to be replaced
194	AUX BATT. SHORT.	Cause: The voltage on PEB output is at high value even if it should not. For the versions where the smart driver is not installed (36/48V), it is possible to decide where the positive supply for pin A27 comes from by choosing a dedicated hardware configuration. The parameter POSITIVE E.B. has to be set in accordance with the hardware configuration , because the software makes a proper diagnosis depending on the parameter; a wrong setting could generate a false fault. The available choices are:0 = PEB is managed by the smart driver (available for 24V version only). 1 = PEB comes from the TILLER input . 2 = PEB comes from PAUX . PAUX must be connected to terminal +B of the controller. This is the default configuration for 36/48V and 80V version. This alarm can only appear if POSITIVE E.B. is set as 1 TILLER/SEAT.
		Troubleshooting: Verify that the parameter POSITIVE E.B. is set in accordance with the actual coil positive supply (see paragraph 8.2.5). In case no

		failures/problems have been found, the problem is in the controller, which has to be replaced.
195	POS. EB. SHORTED	Cause: The voltage on terminal PEB is at the high value even if the smart driver is turned OFF.
		Troubleshooting: Verify that the parameter POSITIVE EB is set in accordance with the actual coil positive supply . Since the software makes a proper diagnosis depending on the parameter, a wrong setting could generate a false fault. Check if there is a short or a low impedance path between PEB and the positive battery terminal +B. In case no failures/problems can be found, the problem is in the controller, which has to be replaced.
196	MOT.PHASE SH. （36/37/38）	Cause Short circuit between two motor phases. The number that follows the alarm identifies where the short circuit is located: - 36 à U – V short circuit - 37 à U – W short circuit - 38 à V – W short circuit
		Troubleshooting - Verify the motor phases connection on the motor side - Verify the motor phases connection on the inverter side - Check the motor power cables. - Replace the controller. - If the alarm does not disappear, the problem is in the motor. Replace it.
197	WRONG SLAVE VER.	Cause: Wrong software version on supervisor uC.
		Troubleshooting: Upload the correct software version or ask for assistance to a Zapi technician.
198	M/S PAR CHK MISM	Cause: At start-up there is a mismatch in the parameter checksum between the master and the supervisor microcontrollers.
		Troubleshooting: Restore and save again the parameters list.
199	PARAM TRANSFER	Cause: Master uC is transferring parameters to the supervisor.
		Troubleshooting: Wait until the end of the procedure. If the alarm remains longer, re-cycle the key.
200	VDC OFF SHORTED	Cause The logic board measures a key voltage value that is constantly out of range, above the maximum allowed value.

		Troubleshooting - Check that the battery has the same nominal voltage of the inverter. - Check the battery voltage, if it is out of range replace the battery. - In case the problem is not solved, replace the logic board.
201	TORQUE PROFILE	Cause: There is an error in the choice of the torque profile parameters.
		Troubleshooting: Check in the HARDWARE SETTING menu the value of those parameters.
202	VDC LINK OVERV.	Cause This fault is displayed when the controller detects an overvoltage condition. Overvoltage threshold is 65 V for 36/48V controllers and 116 V for 80V controllers. 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: - High voltage à Overvoltage condition - Low/normal voltage à Undervoltage condition
		Troubleshooting If the alarm happens during the brake release, check the line contactor contact and the battery power-cable connection.
203	HW FAULT MC	Cause: At start-up, the hardware circuit dedicated to enable and disable the MC driver is found to be faulty. The hexadecimal value “XX” facilitates Zapi technicians debugging the problem
		Troubleshooting: This type of fault is not related to external components. Replace the logic board.
204	BRAKE RUN OUT	Cause: The CPOT BRAKE input read by the microcontroller is at its maximum value without the hand-brake request.
		Troubleshooting: Check the mechanical calibration and the functionality of the brake potentiometer. If the alarm is still present, replace the logic board.
205	EPS RELAY OPEN	Cause: The controller receives from EPS information about the safety contacts being open.
		Troubleshooting: Verify the EPS functionality.
206	INIT VMN HIGH	Cause Before switching the LC on, 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 high, this alarm occurs.
		Troubleshooting - Check the motor power cables; - Check the impedance between U, V and W terminals and -Batt terminal of the controller. - Check the motor leakage to truck frame. - 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	Cause Before switching the LC on, 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.
		Troubleshooting - Check the motor power cables. - Check the impedance between U, V and W terminals and -Batt terminal of the controller. - Check the motor leakage to truck frame. - 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	Cause: 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.
		Troubleshooting: 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.
209	PARAM RESTORE	Cause: The controller has restored the default settings. If a CLEAR EEPROM has been made before the last key re-cycle, this warning informs you that EEPROM was correctly cleared.
		Troubleshooting: - A travel demand or a pump request cancels the alarm. - If the alarm appears at key-on without any CLEAR EEPROM performed, replace the controller.
210	WRONG RAM MEM.	Cause The algorithm implemented to check the main RAM registers finds wrong contents: the register is "dirty". This alarm inhibits the machine operations.
		Troubleshooting

		Try to switch the key off and then on again, if the alarm is still present replace the logic board.
211	STALL ROTOR	Cause: The traction rotor is stuck or the encoder signal is not correctly received by the controller.
		Troubleshooting: - Check the encoder condition. - Check the wiring. - Through the TESTER function, check if the sign of FREQUENCY and ENCODER are the same and if they are different from zero during a traction request. - If the problem is not solved, replace the logic board.
212	POWER MISMATCH	Cause The error between the power setpoint and the estimated power is out of range.
		Troubleshooting Ask for assistance to a Zapi technician about the correct adjustment of the motor parameters.
213	POSITIVE LC OPEN	Cause The voltage feedback of LC driver is different from expected, i.e. it is not in accordance with the driver operation.
		Troubleshooting - Verify LC coil is properly connected. - 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. - In case no failures/problems have been found, the problem is in the controller, which has to be replaced.
214	EVP COIL OPEN	Cause: No load is connected between the NEVP output and the electrovalve positive terminal.
		Troubleshooting: - Check the EVP condition. - Check the EVP wiring. - If the problem is not solved, replace the logic board.
215	EVP DRIV. SHORT.	Cause - The EVP driver is shorted . - The microcontroller detects a mismatch between the valve set-point and the feedback of the EVP output.
		Troubleshooting - Check if there is a short circuit or a low-impedance conduction path between the negative of the coil and -BATT.
216	EB. COIL OPEN	Cause:

		No load is connected between the NEB output and the EB positive terminal PEB
		Troubleshooting: Check the EB coil. Check the wiring. If the problem is not solved, replace the logic board.
217	PEV NOT OK	Cause: The PEV connector is not connected to the battery or the voltage is different from expected. This alarm occurs if one output among EVP, EV1, EV2, EV3, EV4 and EV5 is present or the AUX OUT function is active (POSITIVE EB = 1 or 2).
		Troubleshooting: Check connector B1: it must be connected to the battery voltage (after the main contactor).
218	SENS MOT TEMP KO	Cause: The output of the motor thermal sensor is out of range.
		Troubleshooting: - Check if the resistance of the sensor is what expected measuring its resistance. - Check the wiring. - If the problem is not solved, replace the logic board.
219	PEB-PEVP NOT OK	Cause: The voltage of A17 pin is wrong, if the voltage is wrong,this alarm will appears
		Troubleshooting: - Check if the DC-DC works properly, - Check the wiring,if A17 connected well? - Check the fuse box if works properly,maybe the fuse is burned.
220	VKEY OFF SHORTED	Cause The logic board measures a key voltage that is constantly out of range, below the minimum allowed value.
		Troubleshooting - Check that the battery has the same nominal voltage of the inverter. - Check the battery voltage, if it is out of range replace the battery. - In case the problem is not solved, replace the logic board.
221	HANDBRAKE	Cause: Handbrake input is active.
		Troubleshooting: - Check that handbrake is not active by mistake. - Check the SR/HB input state through the TESTER function. - Check the wirings. - Check if there are failures in the microswitches. - If the problem is not solved, replace the logic board.
222	SEAT MISMATCH	Cause This alarm can appear only in a Traction + Pump configuration. There

		is an input mismatch between the traction controller and the pump controller relatively to the seat input: the two values recorded by the two controllers are different.
		Troubleshooting - Check if there are wrong connections in the external wiring. - Using the TESTER function verify that the seat inputs are in accordance with the actual state of the external switch. - In case no failures/problems have been found, the problem is in the controller, which has to be replaced.
223	COIL SHOR. MC	Cause This alarm occurs when an overload of the MC driver occurs.
		Troubleshooting - Check the connections between the controller outputs and the loads. - Collect information about characteristics of the coil connected to the driver and ask for assistance to a Zapi technician in order to verify that the maximum current that can be supplied by the hardware is not exceeded. - In case no failures/problems have been found, the problem is in the controller, which has to be replaced.
224	WAITING FOR NODE	Cause: The controller receives from the CAN bus 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.
		Troubleshooting: Check if any other device on the CAN bus is in fault condition.
226	VACC OUT RANGE	Cause: The CPOT input read by the microcontroller is not within the MIN VACC ÷ MAX VACC range, programmed through the PROGRAMM VACC function (see paragraph 9.1). The acquired values MIN VACC and MAX VACC are inconsistent.
		Troubleshooting: 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. If the problem is not solved, replace the logic board.
227	HW FAULT	Cause1: At each start-up the supervisor microcontroller checks that the hardware circuit for enabling and disabling of the power bridge works properly.
		Cause2:At each start-up the supervisor microcontroller checks that the hardware circuit intended to enable and disable the LC driver works properly.
		Troubleshooting

		This type of fault is not related to external components. Replace the logic board
228	TILLER OPEN	Cause: Tiller/seat input has been inactive for more than 30 seconds.
		Troubleshooting: - Activate the tiller/seat input. - Check the tiller/seat input state through the TESTER function. - Check the wirings. - Check if there are failures in the microswitches. - If the problem is not solved, replace the logic board.
229	HW FAULT EB.	Cause: At start-up, the hardware circuit dedicated to enable and disable the EB driver is found to be faulty. The hexadecimal value "XX" facilitates Zapi technicians debugging the problem.
		Troubleshooting: This type of fault is not related to external components. Replace the logic board.
230	LC COIL OPEN	Cause This fault appears when no load is connected between the NLC output and the positive voltage (for example +KEY).
		Troubleshooting - Check the wiring, in order to verify if LC coil is connected to the right connector pin and if it is not interrupted. - If the alarm is still present, than the problem is inside the logic board; replace it.
232	CONT. DRV. EV	Cause: One or more on/off valve drivers are not able to drive the load. For the meaning of code "XX", refer to paragraph 0.
		Troubleshooting: The device or its driving circuit is damaged. Replace the controller.
233	POWERMOS SHORTED	Cause The DC-link voltage drops to zero when a high-side MOSFET is turned on.
		Troubleshooting - Check that motor phases are correctly connected. - Check that there is no dispersion to ground for every motor phases. - In case the problem is not solved, replace the controller.
234	DRV. SHOR. EV	Cause: One or more on/off valve drivers are shorted.
		Troubleshooting: Check if there is a short circuit or a low impedance path between the negative terminals of the involved coils and -B. If the problem is not solved, replace the logic board.
235	CTRAP	Cause

	THRESHOLD	This alarm occurs when a mismatch is detected between the setpoint for the overcurrent detection circuit (dependent on parameter DUTY PWM CTRAP) and the feedback of the actual threshold value.
		Troubleshooting The failure lies in the controller hardware. Replace the logic board.
236	CURRENT GAIN	Cause: The maximum current gain parameters are at the default values, which means the maximum current adjustment procedure has not been carried out yet.
		Troubleshooting: Ask for assistance to a Zapi technician in order to do the adjustment procedure of the current gain parameters.
237	ANALOG INPUT	Cause 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.
		Troubleshooting If the problem occurs permanently it is necessary to replace the logic board.
238	HW FAULT EV.	Cause: At start-up, the hardware circuit dedicated to enable and disable the EV drivers is found to be faulty. The hexadecimal value “XX” facilitates Zapi technicians debugging the problem.
		Troubleshooting: This type of fault is not related to external components. Replace the logic board.
239	CONTROLLER MISM.	Cause: 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. According with this “sign”, only the customized firmware can be uploaded.
		Troubleshooting - Upload the correct firmware. - Ask for assistance to a Zapi technician in order to verify that the firmware is correct.
240	EVP DRIVER OPEN	Cause: The EVP driver is not able to drive the EVP coil. The device itself or its driving circuit is damaged.
		Troubleshooting: This fault is not related to external components. Replace the logic board.

241	COIL SHOR. EVAUX	Cause: 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 disappears by releasing and then enabling a travel demand.
		Troubleshooting: - Check the EVs conditions. - Check the wiring. - Collect information about characteristics of EV coils and ask assistance to a Zapi technician. - If the problem is not solved, replace the logic board.
242	OPEN COIL EV.	Cause: This fault appears when no load is connected between the NAUX1 output and the positive terminal PCOM .
		Troubleshooting: - Check the EB coil. - Check the wiring. - If the problem is not solved, replace the logic board.
243	THROTTLE PROG.	Cause: A wrong profile has been set in the throttle profile.
		Troubleshooting: Set properly the throttle-related parameters.
244	WARNING SLAVE	Cause: Warning on supervisor uC.
		Troubleshooting: Connect the Console to the supervisor uC and check which alarm is present.
245	IQ MISMATCHED	Cause The error between the Iq (q-axis current) setpoint and the estimated Iq is out of range.
		Troubleshooting Ask for assistance to a Zapi technician in order to do the correct adjustment of the motor parameters.
246	EB. DRIV.OPEN	Cause: The EB driver is not able to drive the load. The device itself or its driving circuit is damaged.
		Troubleshooting: This type of fault is not related to external components. Replace the logic board.
247	DATA ACQUISITION	Cause: Controller in calibration state.
		Troubleshooting: The alarm ends when the acquisition is done.
248	NO CAN MSG.	Cause: This is a safety related test. It is a self-diagnosis test that checks the

		communication between master and supervisor microcontrollers.
		Troubleshooting: This alarm could be caused by a CAN bus malfunctioning, which blinds master- supervisor communication
249	CHECK UP NEEDED	Cause: This is a warning to point out that it is time for the programmed maintenance.
		Troubleshooting: Turn on the CHECK UP DONE option after that the maintenance service.
250	THERMIC SENS. KO	Cause: The output of the controller thermal sensor is out of range.
		Troubleshooting: This kind of fault is not related to external components. Replace the controller.
251	WRONG SET BAT.	Cause 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.
		Troubleshooting - Check that the SET BATTERY parameter inside the ADJUSTMENT list matches with the battery nominal voltage. - 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. - Replace the battery.
252	WRONG ZERO	Cause: At start-up the amplifiers used to measure the motor voltage sense voltages above 3 V or below 2 V.
		Troubleshooting: This type of fault is not related to external components. Replace the logic board.
253	FIELD ORIENT. KO	Cause The error between the Id (d-axis current) setpoint and the estimated Id is out of range.
		Troubleshooting Ask for assistance to a Zapi technician in order to do the correct adjustment of the motor parameters.
254	EB. DRIV.SHRT.	Cause: - The EB driver is shorted. - The microcontroller detects a mismatch between the valve setpoint and the feedback at the EB output.
		Troubleshooting:

		- Check if there is a short or a low impedance path between the negative coil terminal and -BATT. - Check if the voltage applied is in accordance with the parameters set . - If the problem is not solved, replace the controller.

② Pump auxiliary CPU fault

CAN CODE	ALARM	ALARMS OF NODE 5.1
8	WATCHDOG	Cause: This is a safety related test. It is a self-diagnosis test that involves the logic between master and supervisor microcontrollers
		Troubleshooting: This alarm could be caused by a CAN bus malfunctioning, which blinds master-supervisor communication
17	LOGIC FAILURE #3	Cause An hardware problem in the logic board due to high currents (overload). An overcurrent condition is triggered even if the power bridge is not driven.
		Troubleshooting The failure lies in the controller hardware. Replace the controller.
19	LOGIC FAILURE #1	Cause: This fault is displayed when the controller detects an undervoltage condition at the key input. Undervoltage threshold is 11V for 36/48V controllers and 30 V for 80V controllers. - 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. - 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.
		Troubleshooting (fault displayed during motor driving) - 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.
198	REMA T. ALARM	This is not implemented in PUMP.
199	BUMPER STOP	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

		ACE2 is in CAN OPEN configuration
		Troubleshooting - Turn off one or both inputs dedicated to the bumper functionality. - If the alarm occurs even if the inputs are in the rest position, check if the microswitches are stuck. - In case the problem is not solved, replace the logic board
200	STEER SENSOR KO	Cause: The voltage read by the microcontroller at the steering-sensor input is not within the range from STEER RIGHT VOLT to STEER LEFT VOLT, programmed through the STEER ACQUIRING function .
		Troubleshooting: - Acquire the maximum and minimum values from the steering potentiometer through the STEER ACQUIRING function. - Check the mechanical calibration and the functionality of the potentiometer. - If the problem is not solved, replace the logic board.
201	WRONG ENC SET	Cause Mismatch between “ENCODER PULSES 1” parameter and “ENCODER PULSES 2” parameter .
		Troubleshooting Set the two parameters with the same value, according to the adopted encoder.
202	VDC LINK OVERV.	Cause This fault is displayed when the controller detects an overvoltage condition. Overvoltage threshold is 65 V for 36/48V controllers and 116 V for 80V controllers. 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: - High voltage à Overvoltage condition - Low/normal voltage à Undervoltage condition
		Troubleshooting If the alarm happens during the brake release, check the line contactor contact and the battery power-cable connection.
208	EEPROM KO	Cause: 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.
		Troubleshooting: 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.
209	PARAM RESTORE	Cause: The controller has restored the default settings. If a CLEAR EEPROM has been made before the last key re-cycle, this warning informs you that EEPROM was correctly cleared.
		Troubleshooting: - A travel demand or a pump request cancels the alarm. - If the alarm appears at key-on without any CLEAR EEPROM performed, replace the controller.
210	WRONG RAM MEM.	Cause The algorithm implemented to check the main RAM registers finds wrong contents: the register is “dirty”. This alarm inhibits the machine operations.
		Troubleshooting Try to switch the key off and then on again, if the alarm is still present replace the logic board.
212	W.SET. TG-EB XX	Cause: Supervisor microcontroller has detected that the master microcontroller has imposed a wrong setpoint for TG or EB output
		Troubleshooting: - Check the matching of the parameters between master and supervisor. - Ask for the assistance of a Zapi technician. - If the problem is not solved, replace the logic board.
213	INPUT MISMATCH	Cause: The supervisor microcontroller records different input values with respect to the master microcontroller.
		Troubleshooting: - Compare the values read by master and slave through the TESTER function. - Ask for the assistance to a Zapi technician. - If the problem is not solved, replace the logic board.
227	OUT MISMATCH XX	Cause: 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).
		Troubleshooting: - Checks the matching of the parameters between Master and Supervisor. - Ask for assistance to a Zapi technician. - If the problem is not solved, replace the logic board.

229	NO CAN WR MSG.XX	Cause CANbus communication does not work properly. The hexadecimal value “XX” identifies the faulty node.
		Troubleshooting - Verify the CANbus network (external issue). - Replace the logic board (internal issue).
230	SOFTWARE ERROR	Cause:The software of the slave microcontroller is wrong,ask help to the inveter manufacturer
235	CTRAP THRESHOLD	Cause This alarm occurs when a mismatch is detected between the setpoint for the overcurrent detection circuit (dependent on parameter DUTY PWM CTRAP) and the feedback of the actual threshold value.
		Troubleshooting The failure lies in the controller hardware. Replace the logic board.
237	ANALOG INPUT	Cause 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.
		Troubleshooting If the problem occurs permanently it is necessary to replace the logic board.
239	CONTROLLER MISM.	Cause: 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. According with this “sign”, only the customized firmware can be uploaded.
		Troubleshooting - Upload the correct firmware. - Ask for assistance to a Zapi technician in order to verify that the firmware is correct.
240	OUT MISMATCH PU	Cause: This is a safety related test. Supervisor μC has detected that the Master μC is driving DC motor in a wrong way (not correspondent to the status of operator commands).
		Troubleshooting: - Checks the correspondence of the parameters between Master and Supervisor - Ask the assistance of a Zapi technician. - If the problem is not solved it is necessary to replace the logic board.

241	SP MISMATCH PUMP	Cause: This is a safety related test. The Master μC has detected a Supervisor μC wrong set point for DC Pump motor.
		Troubleshooting: - Checks the correspondence of the parameters between Master and Supervisor - Ask the assistance of a Zapi technician. - If the problem is not solved it is necessary to replace the logic board.
242	SP MISMATCH XX	Cause: This is a safety related test. The master μC has detected a supervisor μC wrong set point.
		Troubleshooting: - Check the matching of the parameters between master and supervisor. - Ask for assistance to a Zapi technician. - If the problem is not solved, replace the logic board.
248	NO CAN MSG.	Cause CANbus communication does not work properly. The hexadecimal value “XX” identifies the faulty node.
		Troubleshooting - Verify the CANbus network (external issue). - Replace the logic board (internal issue).

(3) Common faults of ZAPI instrument system (" ON NODE 16 "is displayed ON the second line of the instrument, as shown in Table 4-12)

Table 4-12 Common Failures of ZAPI Instrument System

CAN CODE	**ALARM**	**ALARMS OF NODE 16.0**
13	EEPROM KO	Cause: 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.
		Troubleshooting: 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.
18	LOGIC FAILURE #2	This alarm is not implemented in smart.
19	LOGIC	Cause:

	FAILURE #1	This fault is displayed when the controller detects an undervoltage condition at the key input . atically by releasing and then enabling a travel demand
		Troubleshooting: check the key voltage if is correct .
76	COIL SHORTED	Cause: This alarm occurs when there is a short circuit of the AUXILIARY coil connected to CNB#1 output. After the overload condition has been removed, the alarm exits automatically by releasing and then enabling a travel demand
		Troubleshooting: 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 dashboard outputs and loads. In case no failures/problems have been found externally, the problem is in the logic card, which has to be replaced
102	CAN BUS KO MAST	Cause: Smart Display does not receive messages from canbus line automatically by releasing and then enabling a travel demand
		Troubleshooting: If this fault code is displayed together with other alarm messages, the fault is probably to be looked for in the Smart Display can interface, since the Display seems to be unable to receive any can message. So it is suggested to check Smart Display canbus wiring and connection. - Otherwise, the fault is in the can interface of other modules present on canbus net
103	SERVICE REQUIRED	Cause:It defines the truck behaviour when a maintenance is required
		Troubleshooting:Set parameter "CHECK UP DONE" to ON, then switch off and on.
104	HARDWARE WRONG	Cause: The hardware of smart display has a problem
		Troubleshooting: Replace the smart display

5. Hydraulic system

5.1 General description

The hydraulic system is composed of oil pump, multi-way valve, priority valve, lifting oil cylinder, tilting oil cylinder, high and low pressure oil pipe, joint and other parts. The lifting motor drives the oil pump, which converts mechanical energy into hydraulic energy and supplies the system with oil, which is distributed to each cylinder through multiple valves.

5.1.1 Oil pump

The main parts of the gear pump used by forklift trucks are a pair of meshing outer gears. Its working principle is shown in Figure 5-1.

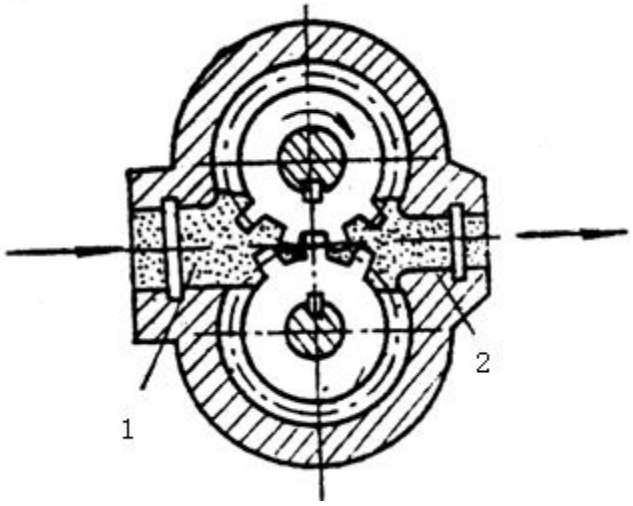


Figure 5-1 gear pump working principle diagram
(1) Oil absorption cavity (2) Pressure oil cavity

A pair of meshing involute gears are installed inside the casing, and the two end faces of the gears are sealed. The casing of the pump is separated into two sealing oil cavities by the gears, marked with numbers 1 and 2 are shown in the figure. When the gear of the gear pump rotates according to the direction shown in the diagram, the volume of the space indicated by the number 1 (gear tooth disengagement engagement) increases from small to large, forming a vacuum. The oil in the oil tank enters the oil suction cavity through the pump suction tubing under the action of

atmospheric pressure, and fills between the teeth. The volume of the space represented by the number 2 (where the gear enters the engagement) decreases from large to small, and the oil is hydraulic into the pressure oil path. Namely 1 is oil suction cavity, 2 is pressure oil cavity, they are separated by the meshing point of two gears. The gear rotates continuously, and the oil suction and discharge port of the pump continuously absorbs oil and discharges oil.

The oil pump is to transform the mechanical energy of the motor into hydraulic energy, so the oil pump is the power mechanism of the hydraulic system of the forklift truck.

The main pump consists of a pump body, a pair of gears, a liner and an oil seal. The gear backlash is minimized by a pressure-balanced bearing and a special lubrication method. The pressure-balanced method is due to the oil drainage between the liner and the pump body, which causes the liner to press to the side of the gear, as shown in Fig. 5-2.

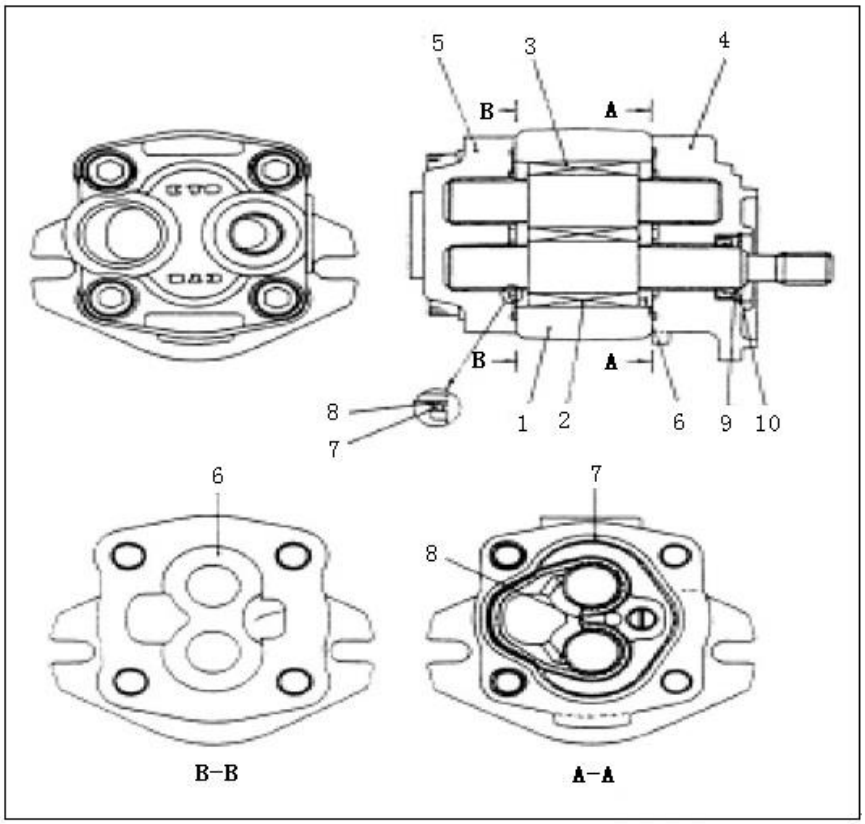


Figure 5-2 Gear pump structure outline diagram

(1) pump body (2) drive gear (3) passive gear (4) front end cover (5) rear end cover (6) liner plate (7) sealing ring (8) retaining ring (9) oil seal (10) elastic retaining ring

5.1.2 Multiway valve

The multiway valve appearance is shown in Fig.5-3.

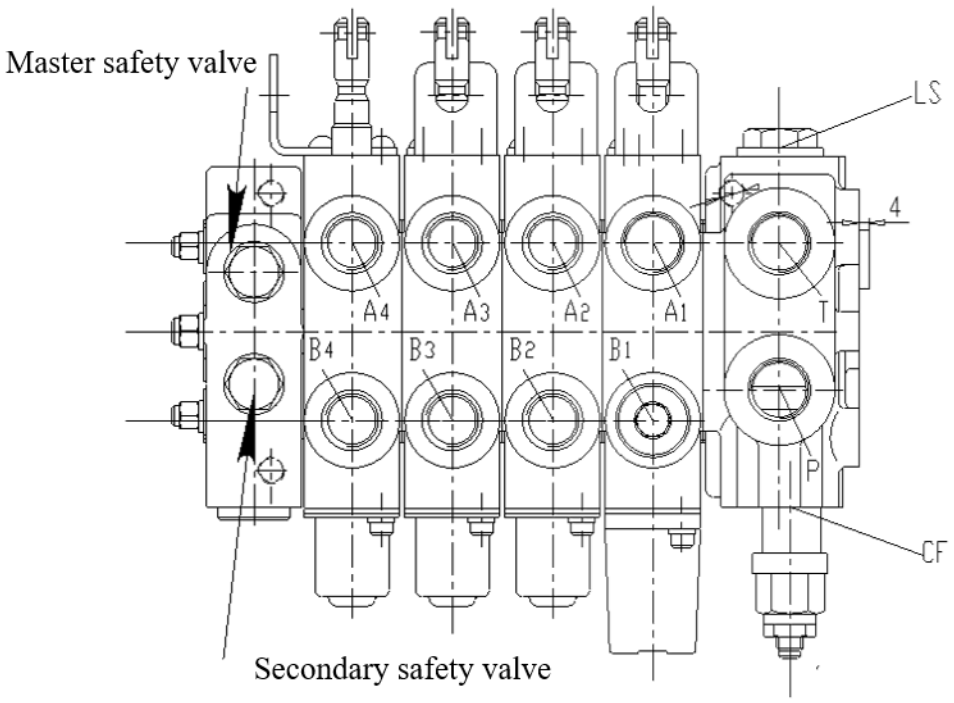


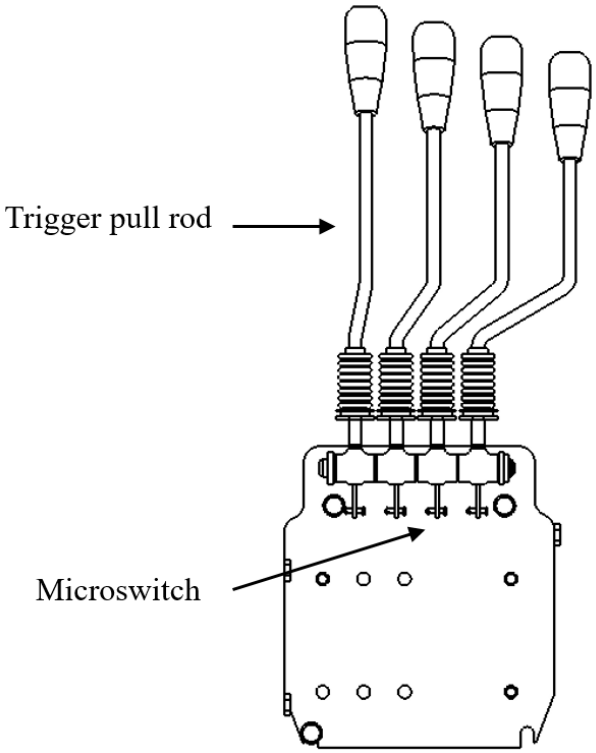
Fig.5-3 Outline drawing of multiple valve

The multi-way valve adopts two pieces of four-type, the hydraulic oil from the working oil pump is controlled by the multi-way valve stem, and the high-pressure oil is distributed to the lifting cylinder or tilting cylinder. There are safety valves and self-locking valves inside the multi-way valve. The safety valve is located on the upper side of the multi-way valve inlet to control the system pressure; The self-locking valve is set on the tilting valve plate, which is mainly used to prevent the tilting cylinder from causing serious consequences due to the misoperation of the joystick in the absence of pressure source. A one-way valve is arranged between the oil inlet and the oil inlet of the lifting valve plate and between the oil inlet of the lifting valve plate and the oil inlet of the tilting valve plate.

(1) Multi-way valve operation

The multi-way valve is operated by the joystick, all the joysticks are installed on

a connecting shaft, the shaft is fixed on the front valve connecting plate of the frame through the bracket, the joystick operates the multi-way valve through the connecting rod. The multi-way valve mounting bracket is provided with a trigger pull rod and a micro switch. As shown in Fig. 5-4 and Fig. 5-5.



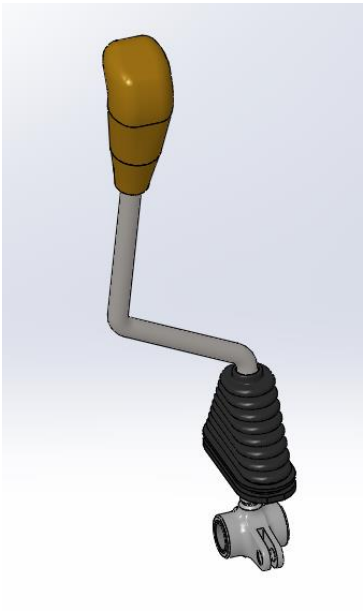
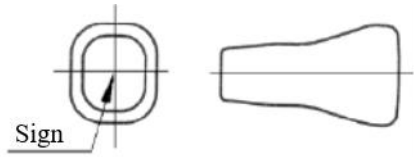


Figure 5-4 Multi-way valve control device

Figure 5-5 Joystick



NO	Sign	Name
1		Descend and Lift
2		Tilt

Fig. 5-6 Multi-way valve control handle identification

According to the direction of the arrow shown in figure 5-6, push forward and pull back the lifting handle, the mst will rise and fall, push forward and pull back the tilting handle, and the mast will tilt forward and backward.

(2) Limit solenoid valve

One end of the limit solenoid valve is connected with the oil outlet of the multi-way valve tilting valve plate, and the other end is connected with the tilting steel pipe to cooperate with the micro-switch in the valve operation, as shown in Fig. 5-7.

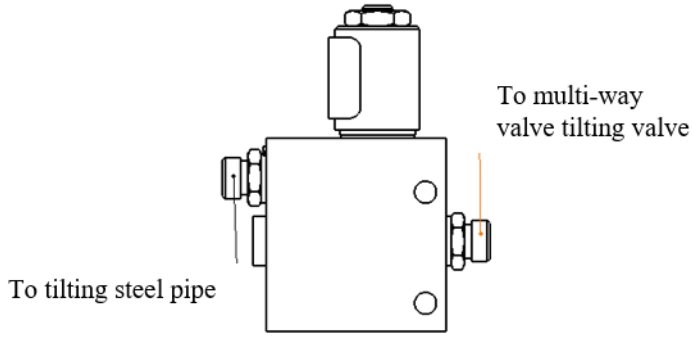


Figure 5-7

(3) Multi-way valve pressure adjustment

Safety valve pressure adjusting method(Fig. 5-8)

The pressure of the relief valve can not be adjusted at will. If it must be adjusted, follow the following steps.

a) Unscrew the measuring hole screw plug of the inlet part of the multi-way valve, and install an oil pressure gauge that can measure 25MPa.

b) Operate the tilting handle to measure the pressure at the bottom of the cylinder stroke.

c) When the oil pressure is different from the specified value, loosen the lock nut of the relief valve and turn the adjusting screw left and right to adjust to the specified value. Turn left when pressure is high, turn right when pressure is low.

d) Tighten the nuts after adjustment.

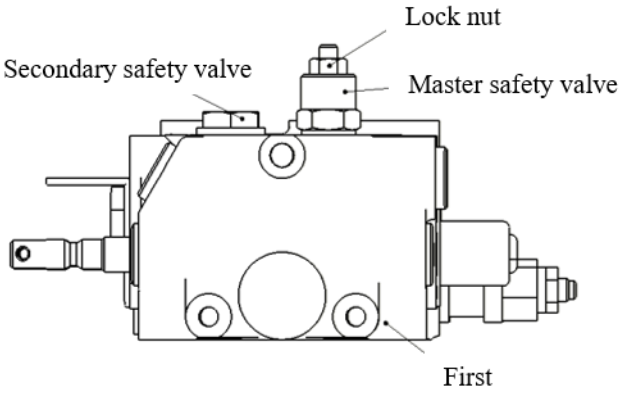
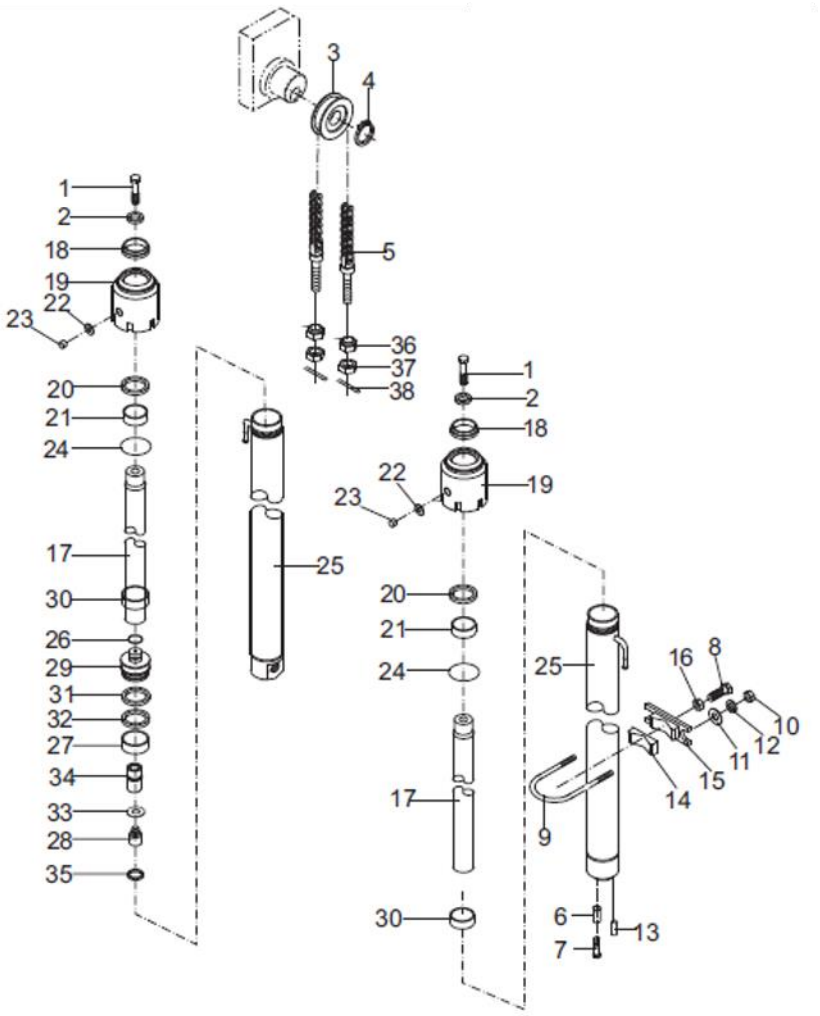


Figure 5-8

5.1.3 Lifting cylinder

The lifting cylinder adopts the single acting piston hydraulic cylinder. It is composed of cylinder block, piston and piston rod, cylinder head, cut-off valve, seals, etc. (see Fig.5-8) cylinder head is equipped with steel back bearing and oil seal to support piston rod and prevent dust from entering.

When the lifting slide valve of the multiway reversing valve is in the rising position, the hydraulic oil from the priority valve to the reversing valve enters the lower part of the piston of the oil cylinder, pushing the piston rod up and lifting the cargo. When the lift slide valve of the multiway reversing valve is placed in the descending position, the piston rod is lowered under the action of goods, mast, fork arm carrier and the mass of the piston itself, and the hydraulic oil is pressed back to the oil tank. A cut-off valve is installed at the bottom of the cylinder (see Fig.5-9). If the mast is raised, the high-pressure pipe rupture can be a safety protection.



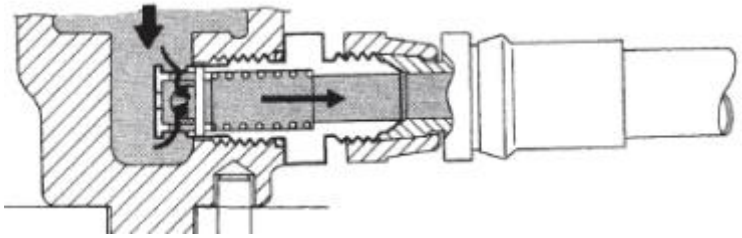
1.Bolt M16×1.5×40 2.Gasket 16 3.Chain wheel 4.Retainer ring 40 5.Chain assy' 6.Sleeve 7.Bolt M12×1.25×25 8.Bolt M12×1.25×50 9.U bolt 10.Nut M10×1.25 11.Gasket 10 12.Gasket 10 13.Pin B10×26 14.Adjusting block 15.Cylinder support block 16.Nut M12×1.25 17.Piston rod 18.Scraper seal 40×52×7/10 19.Guide sleeve 20.Seal ring 40×50×6 21.Steel-backed bearing 4030 22.Gasket 23.Bolt M5×6 24.O-type seal ring d49.7×2.4 25.Cylinder block 26.Steel cable baffle ring 27.Back-up ring 50×10×2.5 28.valve assy 29.piston 30.Adjusting sleeve φ48×40.5 31.catch 50×40×3 32.Sealing rings for hole 50×40×6 33.Gasket 34.Sleeve 35.Round wire snap rings for hole 36.Spherical nut 37.Nut M14×1.5 38.Pin 3.2×30

Fig.5-9 Lifting cylinder

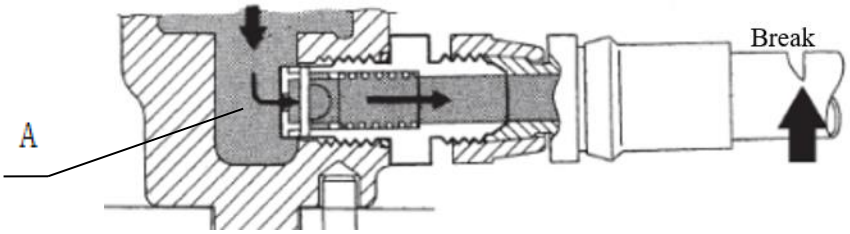
5.1.4 Stop valve

The cut-off valve is installed at the bottom of the lifting cylinder (see figure 5-9) to prevent a sharp drop of goods in the event of a sudden rupture of the high pressure pipe. When the oil from the lifting cylinder returns to the tank, it shall pass through the A hole on the outer circumference of the valve core. If the flow rate of the oil

through the hole is less than the set value of the valve, the pressure difference before and after the valve core is less than the spring force, then the valve core does not move and the slide valve does not act. If the flow rate through the spool hole exceeds the set value when the high pressure pipe is broken or for other reasons, the pressure difference between the spool and the spool will be greater than the spring force so that the spool moves left. In this way hole A is closed, only A small amount of oil flows out of the small gap between the valve core and the valve sleeve, and the goods drops slowly.



when the flow is below the specified value



when the flow is above the specified value

Fig. 5-10 Operating principle of cut-off valve

5.1.5 Speed limit valve

The speed limit valve is installed in the lifting oil line to limit the descending speed of the fork under heavy load, as shown in Fig.5-10. When the multi-way slide valve is in the lifting position, the high pressure oil from the multi-way valve passes through cavity A, B and hole C, D, E, F and cavity G without throttling, and then flows into the lifting cylinder. When multi-way slide valve in the down position, from lifting cylinder oil through cavity G oil hole, E, F, D, C and B, A cavity flow through the whole valve, at this point in B and A cavity is created between the pressure difference, and open the ball valve (item 8), when the pressure difference exceeds the

spring force of spring 2, 7 to the right valve core, the oil flow rate due to the smaller of D, C, This reduces the flow through the throttle orifice.

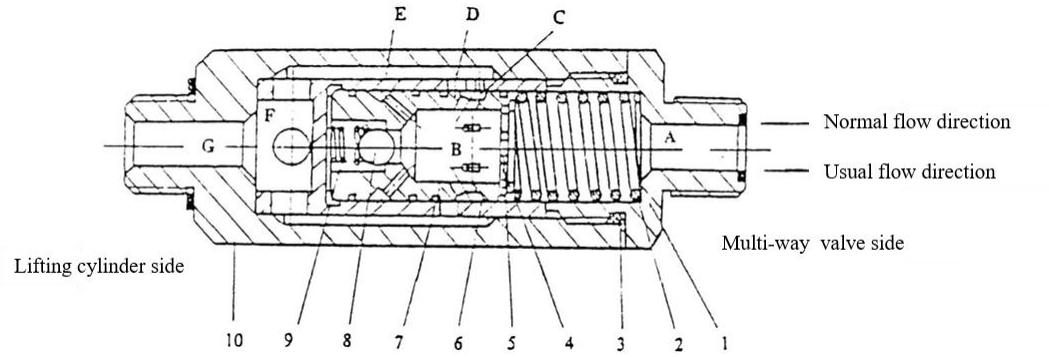


Fig.5-11 The speed limit valve

(1) Speed Limit Valve connector (2) spring (3) sealing element
(4) clamp (5) Throttle Slice (6) valve core (7) valve bush
(8) steel ball (9) one-way valve spring (10)valve body

5.1.6 Tilting cylinder

The tilting cylinder is a double-acting piston hydraulic cylinder mounted on both sides of the mast, and its piston rod end is connected with the mast. The bottom of the tilting cylinder is connected with the connecting end of the frame and the mast. Tilting forward and backward of the mast are accomplished by the action of the tilting cylinder.

The tilting cylinder is mainly composed of piston, piston rod, cylinder block, cylinder bottom, guide sleeve and sealing element. Piston and piston rod adopts welding structure, piston outer edge is equipped with a supporting ring and two Yx sealing rings, in the guide sleeve hole is equipped with Yx sealing ring, retaining ring and dust proof ring, the shaft sleeve supports the piston rod, sealing ring, retaining ring and dust proof ring can prevent oil leakage and dust, together with the "O" ring on the cylinder body. When the piston moves, the oil comes in from one mouth and out from the other, and the piston rod is equipped with adjusting threads to adjust the difference between the tilting angles. (See Fig.5-12)

When the tilting slide valve is pushed forward, the high pressure oil enters from the bottom of the oil cylinder, thus pushing the piston forward to make the mast tilt

forward; When the slide valve is pulled back, the high-pressure oil enters from the front of the cylinder block, pushing the piston backwards until the mast tilts back into place.

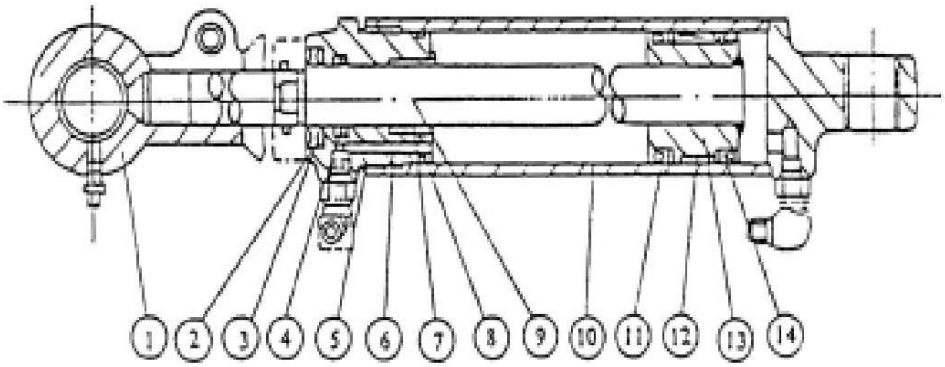


Fig.5-12 Tilt cylinder

(1) Earring (2) Dust ring (3) Retaining ring (4)Yx seal ring (5) O-ring (6) Guide sleeve (7) Bearing (8) O-ring (9) Piston rod (10) Cylinder block (11)Yx seal ring (12) Supporting ring (13) Piston (14)Yx seal ring

5.1.7 Hydraulic oil tank

The hydraulic tank is equipped with oil suction filter, return oil filter and respirator to ensure the cleanness of the oil in the hydraulic system.

5.1.8 Hydraulic system oil circuit

The hydraulic system schematic diagram is shown in Fig. 5-13. The hydraulic pipeline is shown in Fig. 5-14.

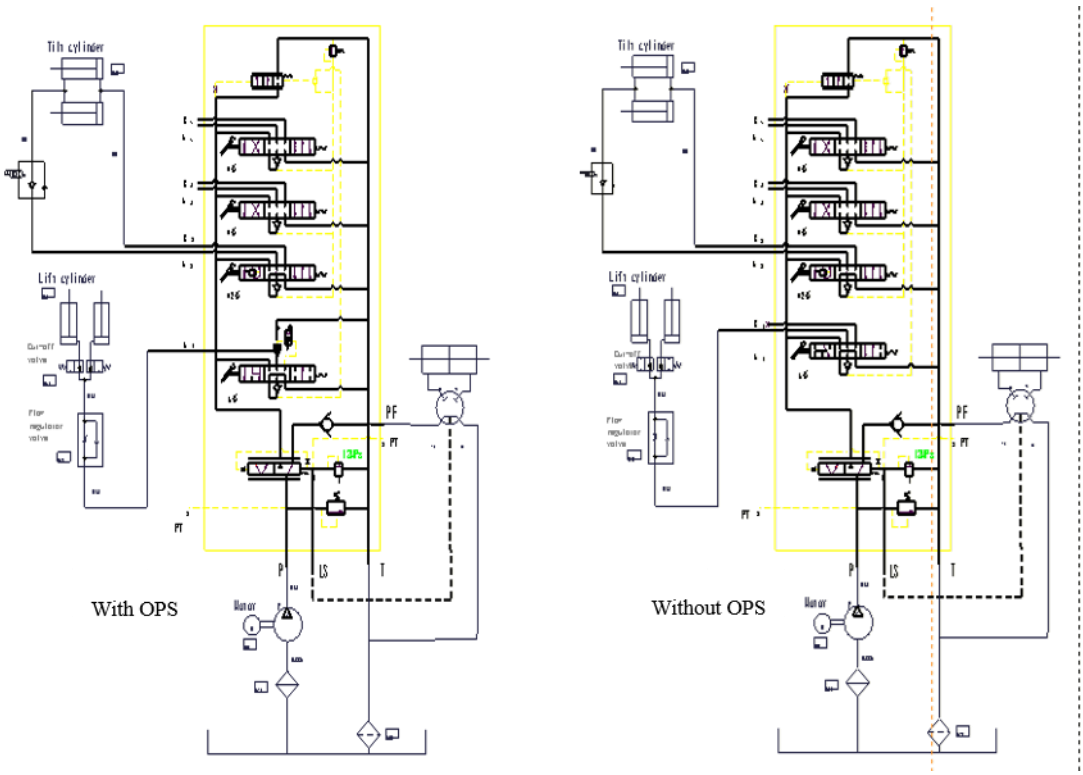


Fig. 5-13 Schematic diagram of hydraulic system

(1) Hydraulic oil tank (2) Oil suction filter (3) Pump motor (4) Gear pump
(5) Multi-way valve (6) Steering gear (7) Steering cylinder
(8) Speed Limit Valve (9) Stop valve (10) Lifting cylinder
(11) Tilt cylinder (12) Attachment cylinder (13) Return oil filter

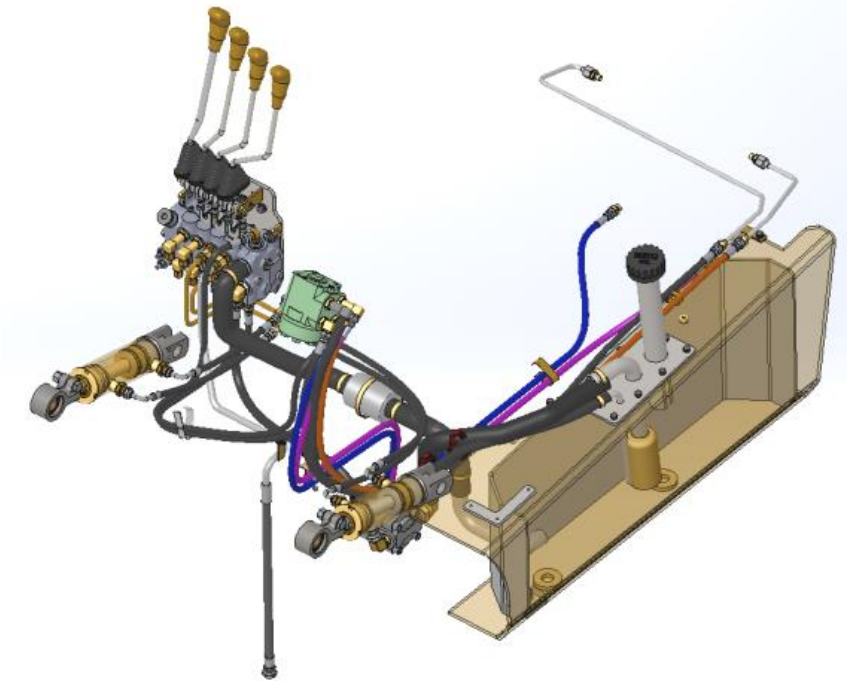


Fig. 5-14 Hydraulic Piping Diagram

5.2 Maintenance, fault analysis and troubleshooting methods

5.2.1 Maintenance

Before and after the shift, check whether there is leakage or serious oil leakage in the pipe joint, lifting cylinder, tilting cylinder, oil pump, full hydraulic steering gear and steering cylinder of the hydraulic transmission system; Check whether there is enough working oil in the working tank; Check and clean the strainer of oil filter installed in the working tank once a week. The first replacement time of the oil return filter is 300 hours (or one and a half months), and the subsequent replacement cycle is 1200 hours (or six months). The filter must be replaced when replacing the hydraulic oil.

Under normal circumstances, the oil in the working tank should be replaced every 1200~1500 hours. All grades of oil should not be mixed.

5.2.2 Fault analysis and troubleshooting methods

Fault	Fault cause	Troubleshoots
Inability to lift or can not lift	1) Excessive wear and gap between oil pump gear and pump body.	Replace worn parts or oil pump.
	2) Lifting cylinder piston seals wear, gap is excessive, too much internal leakage.	Replace the piston seal ring.
	3) The safety valve spring in the multi-way reversing valve fails.	Replace with a new spring.
	4) Multi-way valve reversing valve control stem and valve body wear, excessive oil leakage	The clearance between the valve stem and the hole after chrome plating is 0.01~0.02.
	5) Oil leakage between the body of the multi-way reversing valve.	Replace the sealing ring and tighten the screws in order.
	6) Oil leakage of Hydraulic pipe.	Check the sealing gasket, connection nut for damage and tighten the joint.
	7) Hydraulic oil temperature too high (should ≤80℃), The oil is too thin.	Replace the improper hydraulic oil, stop to reduce the oil temperature check the oil temperature is too high.
	8) Over load.	Lift as specified lifting weight.
Piston rod of the lifting cylinder has a large	1) Leakage in the piston Yx seal ring of the lifting cylinder.	Replace Yx type seal ring.
	2) Leakage in the A-type slide valve of the multi-way reversing valve.	Replace O seal ring in the slide valve.
	3) Oil leakage in the lifting part.	Replace the O seal ring in the

amount of slide		articulated joint and tighten the joint bolt.
oil pump pressure insufficient	1) Leakage caused by wear of the sealing ring at the fastener. 2) The hydraulic oil is foaming after mixed with air, and the suction pipe is leaking, the hydraulic oil is not enough. 3) The sealing ring in the pump cover groove is damaged. 4) Wear of end face of bearing sleeve. 5) Oil pump gear wear. 6) The oil pump rotates in the wrong direction.	Replace seal ring. Remove air and replenish hydraulic fluid. Replace. Replace. Replace oil pump. Replace.
Tilting cylinder has a large amount of self-tilting	1) Multiple directional control valve internal leakage. 2) The "O" seal ring of the tilting cylinder piston rod is damaged and the internal leakage. 3) The YX seal ring and "O" seal ring in the guide sleeve are damaged and leak oil.	Replace the "O" seal ring, repair the rod and redistribute the clearance between rod and hole to 0.01 ~ 0.02. Replace. Replace.
Hard steering	1) The oil supply from the oil pump is insufficient. The slow steering wheel is light, while the fast steering wheel is hard. 2) There is air in the steering system and foam in the oil, which makes an irregular sound. The steering wheel turns, and the oil cylinder sometimes moves and sometimes does not. 3) The steel ball one-way valve in the valve body fails, the fast and slow steering wheels are both heavy, and there is no pressure for steering. 4) The overflow valve pressure is lower than the working pressure or the overflow valve is stuck by dirt, light or empty load to light steering, increased load to heavy steering. 5) Oil viscosity is too high.	Select suitable oil pump or check whether the oil pump is normal. Eliminate air from system and check suction line. Check for the presence of the ball and for any dirt that may have stuck the ball. Adjust overflow valve pressure or clean overflow valve. Use the recommended viscosity oil.

6. Lifting system

6.1 General description of basic type lifting system

The lifting system is of the two-stage roller type with vertical up and down. It consists of the inner mast, the outer mast, two rear lifting cylinder, fork carrier, etc.

6.1.1 Inner and outer mast

The inner and outer portal frames are welded parts, the weight is mainly supported on the truck frame, and the whole outer mast is mounted on front axle of the frame by Harvard bearing. The middle part of the outer mast is connected with the frame through the tilting cylinder. Under the action of the tilting cylinder, it can tilt forward and backward. The channel of outer mast is C type, and combination rollers is installed in its upper end; the channel of inner mast is C type, and its lower part is installed with combination rollers. The inner mast keeps the relative position of the inner mast and the outer mast throughout the movement process by rolling the combination rollers.

Take care when maintaining the upper combination roller of the outer mast.

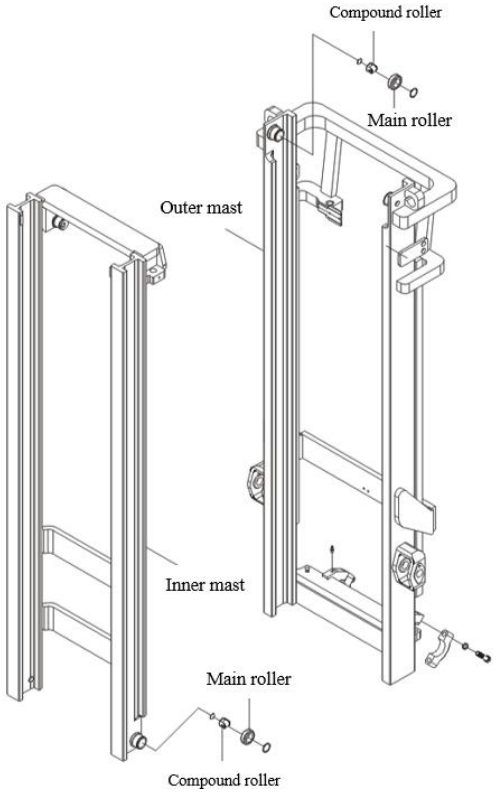
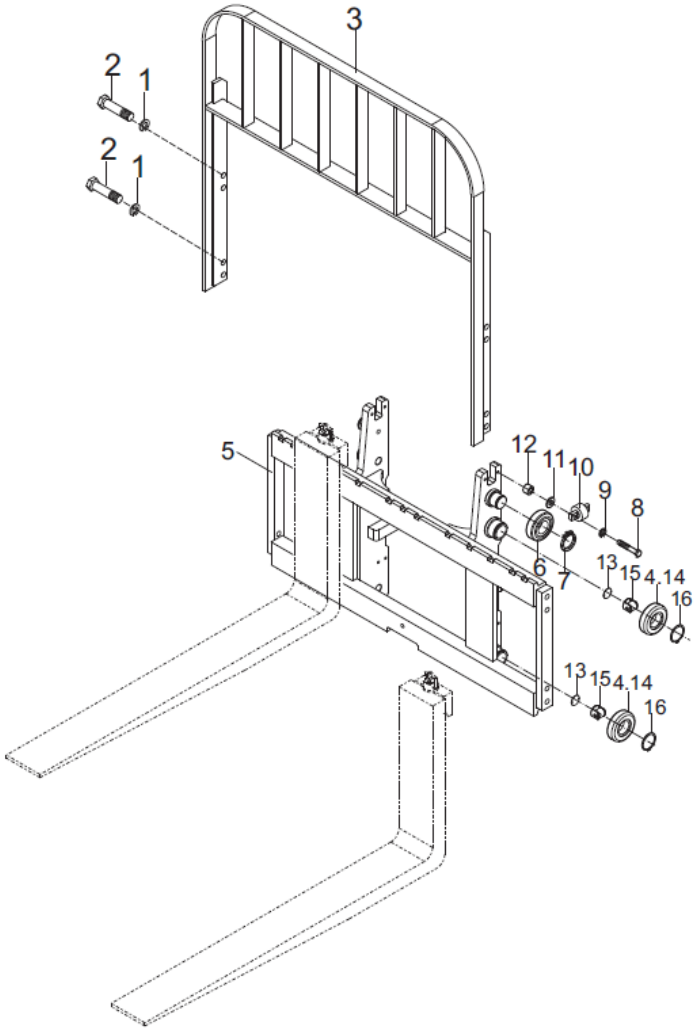


Fig.6-1 Inner and outer mast

6.1.2 Fork carrier

The fork carrier rolls through the main roller inside the inner mast. The main roller is mounted on the main roller shaft and stuck with elastic retaining ring. The middle and bottom rollers adopt compound rollers; The main roller shaft is welded to the fork carrier, and the side roller of the plate is bolted to the fork carrier. The longitudinal load is borne by the main roller, which is exposed from the top of the mast when the fork is lifted to the top, and the transverse load is borne by the side roller in the compound roller.



1. Gasket 2. Bolts 3. Load-backrest 4. Compound roller (including 13-16)
5. Goods fork carrier 6. The main roller 7. retainer ring 8. Bolt
9. gasket 10. side roller 11. Adjusting gasket 12. cushion block
Figure 6-2 Fork carrier

6.1.3 Adjustment method of roller

8 compound rollers, respectively installed on the upper end of the outer mast (2), the lower end of the inner mast (2), and both sides of lower end and middle of the fork carrier (4); Two main rollers are mounted on the upper end of the column plate of the fork carrier. 2 side rollers, are mounted on the top of the column plate of the fork carrier.

The compound rollers not only bear the load in the front and rear directions but also bear the lateral load. The main rollers in the upper end of the fork carrier only bear the load in the front and rear directions, while the side rollers bear the lateral load in the left and right directions. Compound roller, main roller and side roller are used together to make the inner mast and fork carrier move freely.

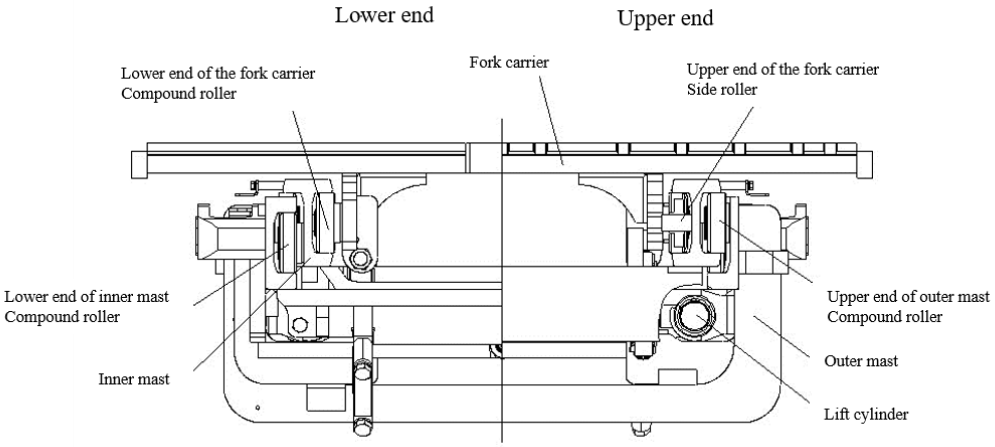


Fig.6-3 Roller layout

Note :(a) Adjust the clearance of side rollers to be 0~0.5mm;

(b) Butter the main roller surface and the contact surface of the mast.

(Announcements: the maintenance of the upper compound roller of the inner and outer mast belongs to the high maintenance, and safety shall be paid attention to. After repairing or replacing the roller, the clearance between the side roller and the ventral plate of channel steel shall be adjusted to 0~0.5mm.)

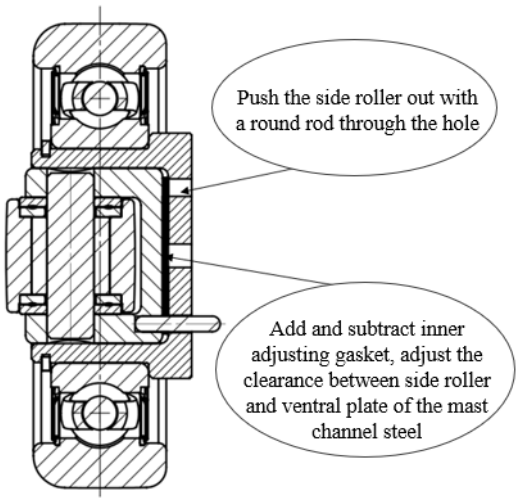


Fig.6-4 Clearance adjustment of the side roller

Note: The clearance adjustment method of the side roller of the compound roller is as shown in the figure. Special gaskets are added between the side roller and the roller shaft.

6.1.4 Repair

（1）Adjusting of the lifting cylinder

Readjust the stroke of the lift cylinder when the lift cylinder, the inner mast or the outer mast is replaced. As following:

(a) Place piston rod heads into the upper beam of the inner mast without shims.

(b) Slowly lift the mast to the maximum stroke of the cylinder, check whether the two cylinders stroke terminal are synchronized. When the motion stops at different times, the stroke of the left and right cylinders is different. By increasing or decreasing adjusting shims to make sure that the two cylinders are synchronization. Add adjustment shim between the piston rod head and the inner door frame beam (The thickness of shim is 0.5mm and 1mm).

(c) Adjust the tension of the chain.

Take care when adjusting the lifting cylinder.

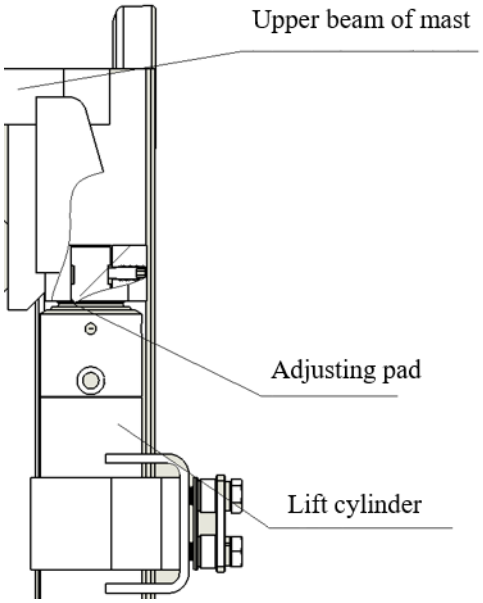


Fig.6-5

（2）Adjustment of fork carrier height

(a) Park the truck on a level ground and ensure the mast is vertical.

(b) Make the bottom of the fork touch the ground, adjust the adjusting nut of the upper end joint of the chain so that there is an A distance(24~28mm) between the main roller and the mast channel, as shown in the Fig.6-6.

(c) Make the fork carrier fall to the ground and tilt back in place, adjust the adjusting nut of the upper end joint of the chain, so that the tension of the two chains is the same.

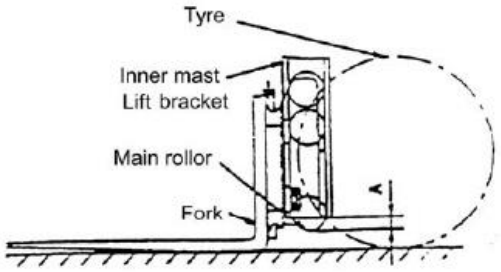


Fig. 6-6

（3）Replacing rollers of the fork carrier

(a) Place a pallet on the forks and make the forklift stop on the horizontal ground.

(b) Make the forks and pallet descend to the ground.

(c) Take down the connector on top of the chains. And take out chains from chain wheel.

(d) Make the inner mast rise.

(e) The forklift can be reversed when the fork carrier disengaged from the outer mast.

(f) Replacing main rollers:

●Take apart all of snap ring and take out main rollers. Take care to keep the shims.

●Confirm the new roller is the same type as the old one, Fit the new main roller to replace the old one, and fastened with snap ring in the meantime.

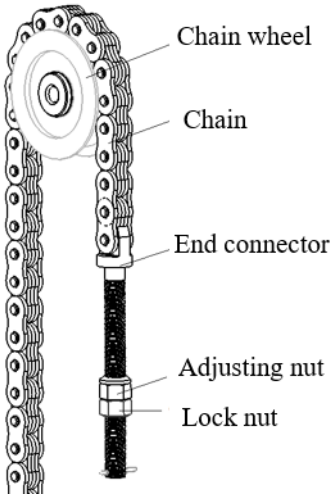


Fig. 6-7

（4）Replacing rollers of masts

(a) Take apart the fork carrier from the inner mast, then replace the main roller follows the way as 6.1.4(3).

(b) Park the truck on the horizontal ground and lift up the front-wheel 250～300mm from the ground

(c) Pull parking brake level fully, and use a wedge to make back-wheel stationary.

(d) Take apart bolts which fastened lift cylinders and the inner mast. Hang up the inner mast without losing shims of the piston rod heads carefully.

(e) Take apart bolts which jointed lift cylinders and the bottom of outer mast and take apart the oil-pipe between two lift cylinders without loosing the nipple.

(f) Lay down the inner mast and remove the main roller at the bottom of the inner mast.

(g) When the main rollers on the upper outer mast will come out from the inner mast top end, then the main roller can be removed.

(h) Replacing main rollers

● Take apart the upper main rollers without losing shims.

● Fit the new main roller and shims together on the outer mast.

(i) Hang up the inner masts and let all rollers in the inner mast.

(j) Assembly the lift cylinder and the fork carrier as disassembly contrarily.

6.2 Genneral description of two-stage full free lifting system

The two-stage full free lifting system is a two-stage roller vertical lifting and shrinking system, which consists of two masts, two rear lifting cylinders, one front lifting cylinder and fork carrier.

6.2.1 Inner and outer masts

The inner and outer masts are welding parts, and the weight is mainly supported on the truck frame. The bottom of the outer mast is connected with the front axle of the truck frame by the Harvard bearing, and the middle of the outer mast is connected with the truck frame by the tilting cylinder, it can be tilted forward and backward under the action of tilting cylinder. The channel steel of the outer mast is C type, the upper part is installed with compound roller, the channel steel of the inner mast is H type, and the bottom is installed with compound roller. The inner mast keeps the relative position of the inner mast and the outer mast in the process of movement through the rolling of compound roller.

Inner and outer mast on the compound roller maintenance is high maintenance, should pay attention to safety.

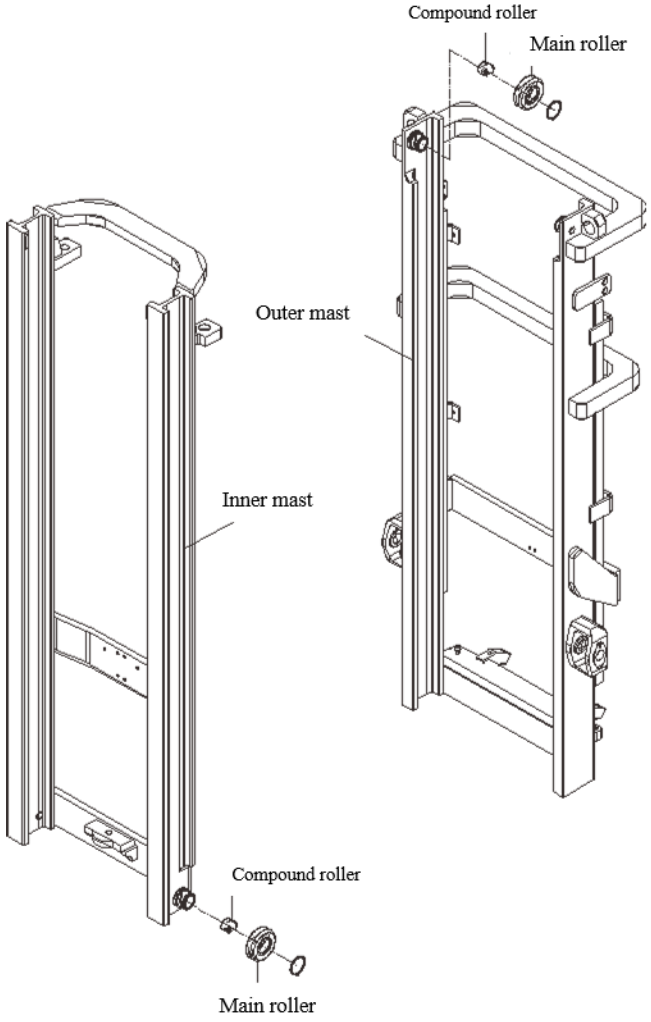
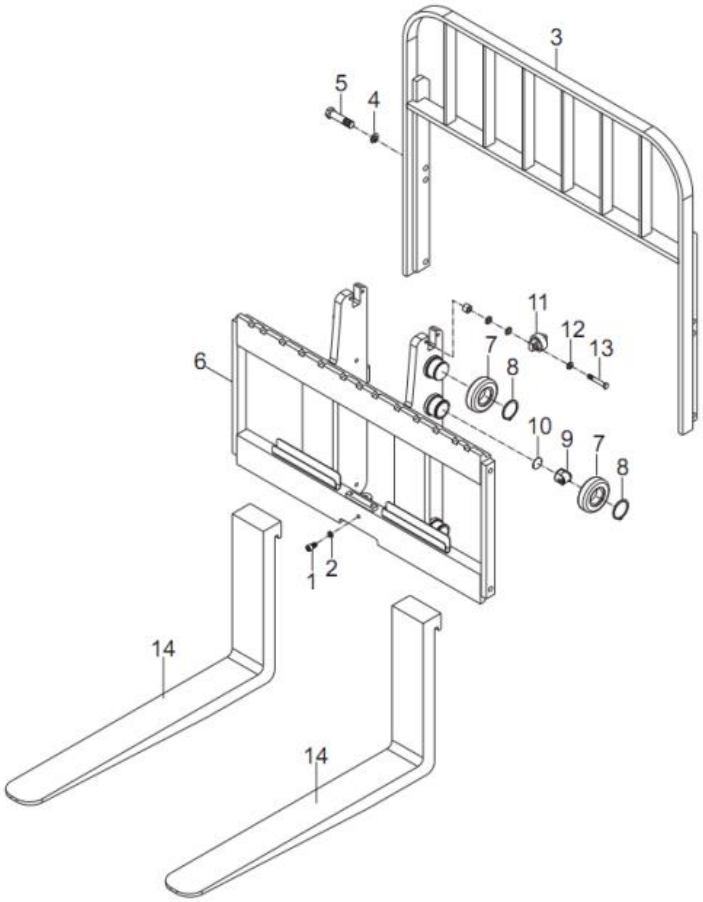


Fig. 6-8 Inner and outer mast

6.2.2 Fork carrier

The fork carrier rolls through the compound roller, the main and side rollers inside the inner mast. The main roller at the upper end of the column plate is mounted on the main roller shaft and stuck with the elastic retaining ring. The main roller shaft is welded to the fork carrier, and the side roller of the column plate is bolted to the fork carrier. The longitudinal load is borne by the main roller, which is exposed from the top of the mast when the fork reaches the top, and the transverse load is borne by the compound roller.



1. Limit screw 2. Washer 3. Load-backrest 4. Washer 5. Bolt 6. Fork carrier
7. Main roller 8. Retainer ring 9. Compound roller 10. Adjusting gasket
11. Side roller 12. Washer 13. Bolt 14. Fork assembly
Fig. 6-9 Fork carrier

6.2.3 Adjustment method of roller

As described in 6.1.3.

6.2.4 Repair

（1）Adjusting of the lifting cylinder

When the lifting cylinder, inner mast or outer mast are disassembled and replaced, the stroke of the rear lifting cylinder shall be adjusted again (Note: there is no need to carry out the front lifting cylinder). The adjustment methods are as follows:

(a) Install the piston rod head into the beam of inner mast without adjusting pad.

(b) Slowly lift the mast to the maximum stroke of the oil cylinder, and observe whether the stroke terminals of the two oil cylinders are in sync. If they are not stopped at the same time, it indicates that the stroke of the left and right oil cylinders

is not in sync; Add and subtract gaskets at the top of piston rod to synchronize the travel; An adjustment pad shall be added between the piston rod head and the beam of inner mast, and the thickness of the adjustment pad shall be 0.5mm and 1mm.

(c) Adjust the tension of the chain.

The adjustment of lifting cylinder also belongs to high maintenance, should pay attention to safety.

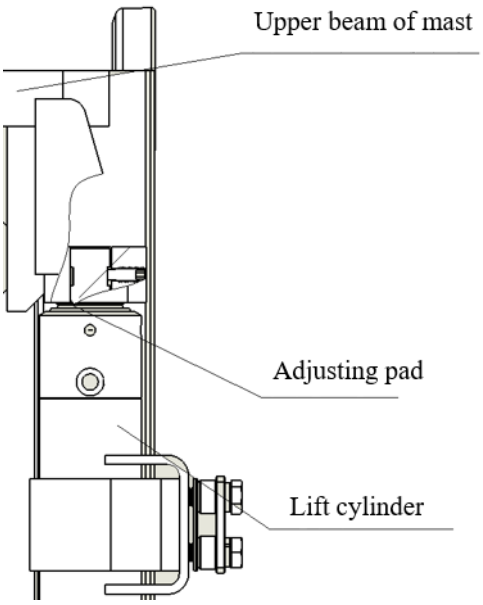


Fig. 6-10

(e) When the front cylinder needs to be replaced, the fork carrier needs to be removed. The disassembling and assembling method is the same as 6.1.4(3). Remove the fork carrier as a whole, and then remove and replace the oil cylinder before lifting, as shown in the figure below.

(2) Adjust the height of the fork carrier

As described in 6.1.4 (2).

(3) Replace the roller of fork carrier

(a) Hold a pallet on the fork and park on the level ground.

(b) Drop forks and pallets to the ground.

(c) Remove the upper end joint of the chain and remove the chain from chain wheel (Fig. 6-12).

(d) Lift the inner mast.

(e) Take out the fork after confirming that the fork has been independent of the inner mast.

(f) Replace main roller:

● Remove all spring collars and remove the main roller with a drawing tool, keep the adjustment pad.

● Confirm that the new roller is the same as the replaced roller. Replace the original roller with the new roller and install the elastic collar in place.

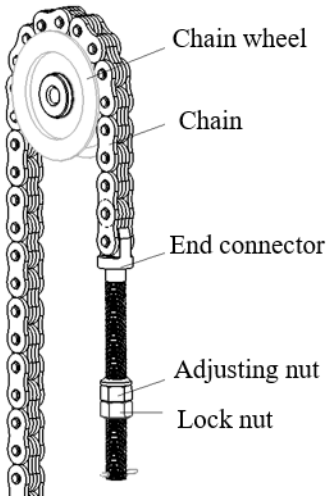


Fig. 6-11

（4）Replace roller of the mast

(a) Remove the fork carrier from the inner mast in the same method of the replacement fork rack roller as described in the 6.2.4(3).

(b) Drive the forklift truck to the level ground and lift the front wheel 250 ~ 300mm.

(c) Pull the hand braking and wedge the rear wheel.

(d) Remove the fixing bolts of rear lifting cylinder and inner mast. Sling the inner mast and be careful not to lose the adjusting pad on the piston rod head.

(e) Remove the connection bolt between the lifting cylinder and the bottom of the outer mast. Remove the lifting cylinder and the oil pipe between the two cylinders. Do not loosen the tubing joint.

(f) Lower the inner mast and remove the main roller at the bottom of the inner mast.

(g) The main roller on the outer mast will also be exposed from the top of the inner mast, then remove the main roller.

(h) Replace the main roller:

● Remove upper main roller with drawing tool, do not lose adjusting pad.

● Install the new roller with the adjustment pad removed in step (a).

(i) Sling the inner mast until all rollers enter the mast.

(j) Follow the steps opposite to disassembly to install the lifting cylinder and fork carrier.

6.3 Three-stage full free lifting system

The three-stage free lifting system is a three-stage roller vertical lifting and shrinking system, which consists of three masts, two rear lifting cylinders, one front lifting cylinder and fork carrier.

6.3.1 Inner, middle and outer masts

The inner, middle and outer mast are welding parts, and the weight is mainly supported on the axle housing. The bottom of the outer mast is connected with the axle housing by the supporting shaft, and the middle of the outer mast is connected with the truck frame by the tilting cylinder, which can be tilted forward and backward under the action of the tilting cylinder. The channel steel of the outer mast is C-type, with the compound roller mounted on the upper part; Middle mast channel steel is H type, upper and lower part installed a pair of compound rollers; The channel steel of the inner mast is H type, and a pair of compound rollers are installed at the bottom. The inner and middle mast keeps the relative position in the process of movement of the inner, middle mast and the outer mast through compound roller rolling.

Maintenance of the compound roller on the inner, middle and outer masts is high maintenance, should pay attention to safety.

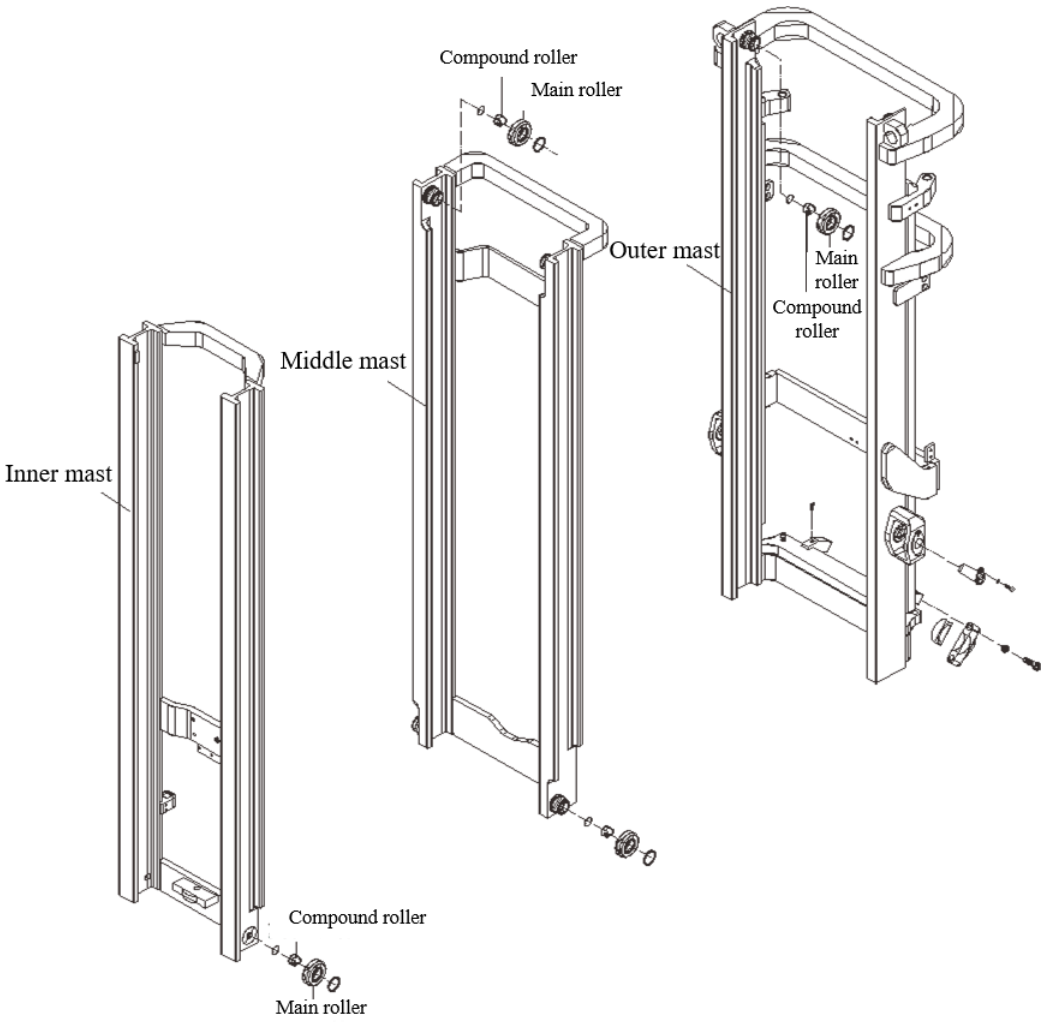
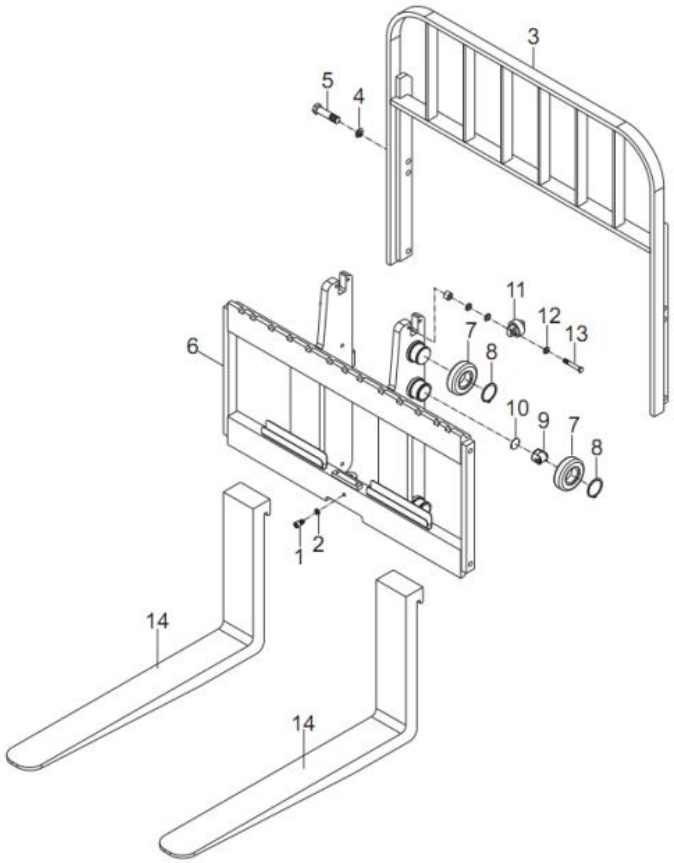


Fig. 6-12 Inner, middle and outer masts

6.3.2 Fork carrier

The fork carrier rolls through the compound roller, the main and side rollers inside the inner mast, the main roller at the upper end of the fork carrier is mounted on the main roller shaft and stuck with the elastic retaining ring. The main roller shaft is welded to the fork carrier, and the side roller on the upper end of fork carrier is bolted to the column plate of fork carrier. The longitudinal load is borne by the main roller, which emerges from the top of the mast when the fork reaches the top, and the transverse load is borne by the compound roller.



1. Limit screw 2. Washer 3. Load-backrest 4. Washer 5. Bolt 6. Fork carrier
7. Main roller 8. Retainer ring 9. Compound roller 10. Adjusting gasket
11. Side roller 12. Washer 13. Bolt 14. Fork assembly
Fig. 6-13 Fork carrier

6.3.3 Adjustment method for roller

12 compound rollers, respectively installed on the upper end of the outer mast (2), the upper end of the middle mast (2), the lower end of the middle mast (2), the lower end of the inner mast (2), and 4 at the two sides of the middle and lower end of the fork carrier; 2 main rollers at the fork carrier.

Two side rollers are mounted on the top of the column plate of the fork carrier.

The compound roller on the fork rack and the mast not only bears the load from the front and rear directions but also bears the lateral load. The main roller on the upper end of the column plate of the fork carrier only bears the load from the front and rear directions, while the side roller bears the lateral load in the left and right directions. Main roller and side roller are used together to make the inner mast and fork carrier move freely.

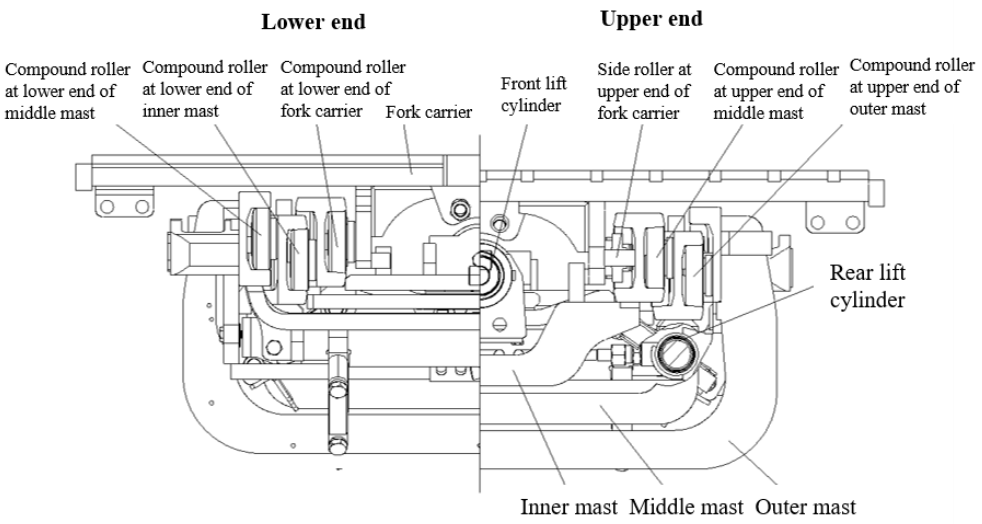


Fig. 6-14 Roller layout

Note :(a) Adjust the clearance of side rollers to be 0 ~ 0.5mm;

(b) Butter the main roller surface and the contact surface of the mast.

(Note: The maintenance of the upper compound roller of the inner, middle and outer mast belongs to the high maintenance, safety shall be paid attention to. After repairing or replacing the compound roller, the clearance between the side roller and the ventral plate of channel steel shall be adjusted to 0 ~ 0.5mm.)

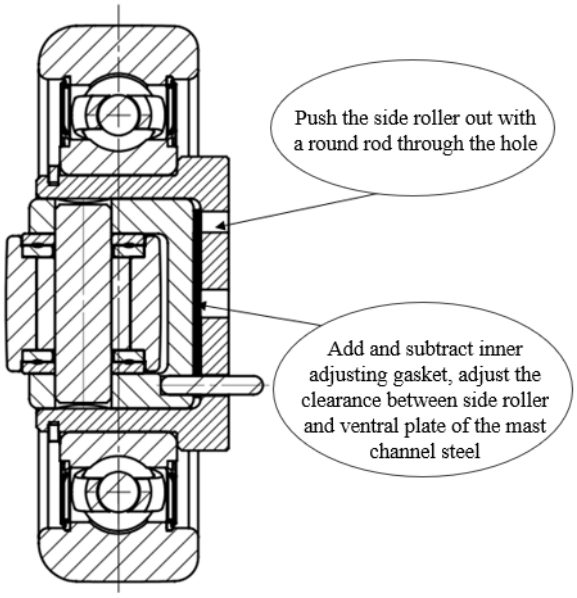


Fig. 6-15 The compound roller

Note: The clearance adjustment method of the side roller of compound roller is as shown in the figure. Special gaskets are added between the side roller and the roller shaft.

6.3.4 Repair

（1）Adjusting of the lifting cylinder

When the lifting cylinder, inner mast or outer mast are removed and replaced, the stroke of the rear lifting cylinder shall be adjusted again (Note: there is no need to carry out the front lifting cylinder). See Fig. 6-16. Adjustment methods are as follows:

(a) Install the piston rod head into the cylinder support of the middle mast without adjusting pad.

(b) Slowly lift the mast to the maximum stroke of the cylinder, and observe whether the stroke terminals of the two cylinders are in sync. If they are not stopped at the same time, it indicates that the stroke of the left and right cylinders is not in sync; Add or subtract gaskets at the head of piston rod to synchronize the travel; An adjustment pad is added between the piston rod head and the cylinder support of the middle mast, and the thickness of the adjustment pad is 0.5mm and 1mm.

(c) Adjust the tension of the chain.

The adjustment of lifting cylinder also belongs to high maintenance, should pay attention to safety.

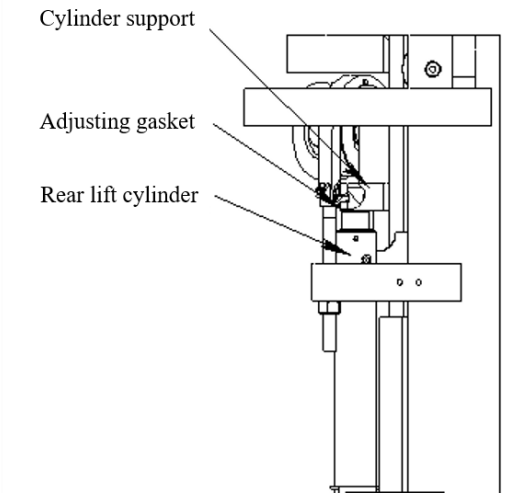


Fig. 6-16 Adjust rear lifting cylinder synchronously

(e) When the front cylinder needs to be replaced, it is necessary to remove the fork carrier. The disassembly method is the same as 6.1.4（3）. Remove the fork carrier as a whole and then remove and replace the lifting cylinder.

(2) Adjust the height of the fork carrier

The same as described in 6.2.4 (2).

(3) Replace the roller of fork carrier

The same as described in 6.2.4 (3).

(4) Replace the roller of mast

(a) Remove the fork carrier from the inner mast in the same manner to replace the roller of mast as described in the 6.2.4 (3).

(b) Drive the truck to the level ground and lift the front wheel 250~300mm.

(c) Pull the hand braking and wedge the rear wheel.

(d) Remove the upper end of the chain on the head of the rear cylinder and remove the chain from the chain wheel.

(e) Lower the inner mast until the rollers of the lower and middle mast are exposed.

(f) Replace the main roller:

● Remove upper main roller with drawing tool, do not lose adjusting pad.

● Install the new roller with the adjustment pad which removed at above step.

(g) Remove fixing bolts between the lift cylinder and middle mast. Sling the inner and middle masts together, taking care not to lose the piston and adjusting pad on the head of the rod.

(h) Remove the connection bolt between the lifting cylinder and the bottom of the outer mast. Remove the lifting cylinder and the oil tube between the two cylinders. Do not loosen the tubing joint.

(i) Lower the inner and middle masts until the rollers on the lower part of the middle mast and the outer mast are exposed.

(j) Replace the main roller, same as (f).

(k) Lift the inner and middle masts until all rollers enter the corresponding masts.

(l) Install the lifting cylinder and fork carrier in the reverse steps of disassembly.

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