

**LXE40
189 & 197
Lithium Forklift Truck
Service Manual**

Safety Notices and Text Mark-Ups

Safety instructions and important explanations are indicated by the following graphics:



DANGER

Means that failure to comply can cause risk to life and/or major damage to property.



WARNING

Please strictly adhere to these safety instructions to avoid personal injury or damage to equipment or personal property.



CAUTION

Please pay attention to the important safety instructions.



NOTE

Pay attention to information that could be helpful.

 **WARNING**

- Do not operate this truck unless authorized and trained to do so and have read all warnings and instructions in this Operator's Manual and on this truck. Read, understand, and comply with the information on the truck's nameplate at all times.
- Do not operate this truck until you have performed the Daily Operator Checklist. Report any problems to the designated authority and do not use the truck until they are corrected by a qualified technician.
- If there is a fault code on the BDI/display, recycle the key and see if the code displays again. If the code displays again, do not operate the truck. Investigate the fault code and contact a service technician.
- This truck must not be modified without written manufacturer's consent.
- Operate truck only from designated operating position.
- Operate cautiously on ramps, slopes, and uneven floors. Travel slowly and do not angle or turn. This truck is not for use on mezzanines or balcony areas.
- Before operating, inspect the floor area it will be used on and be certain it will support the truck at full capacity and lift height. Identify and avoid holes, drop-offs, bumps, and obstructions.
- Keep hands, feet, and all body parts inside of the operator's compartment. Never place any part of your body into the mast structure or between the mast and the truck.
- Do not carry passengers.
- Before and during all truck operations ensure that adequate clearance is maintained from overhead obstructions and energized electrical conductors and parts.
- Operate tilting mechanism slowly and smoothly. Do not tilt forward when elevated except when picking up or depositing a load.
- Elevate forks only to pick up a load. Lift and lower with mast vertical or slightly tilted back, never forward. Watch for obstructions overhead.
- Ensure loads are centered and do not contact any obstructions in the truck's vicinity.
- Maintain a clear view of the ground while traveling and a safe distance from obstacles in the truck's path. Ensure personnel in the vicinity are aware of the truck's movement. Travel at a safe speed for the conditions the truck is operating in.
- Observe applicable traffic regulations. Yield right of way to pedestrians. Slow down and sound horn at cross aisles and wherever vision is obstructed. Avoid hazardous locations.
- When leaving the truck unattended, remove the key to prevent unauthorized use.
- Start, stop, travel, steer, and brake smoothly. Slow down for turns and on uneven or slippery surfaces that could cause the truck to slide or overturn. Use special care when traveling without a load as the risk of overturn can be greater.
- Travel with lifting mechanism as low as possible and tilted back. Always look in direction of travel. Keep a clear view. When the load interferes with visibility, travel with the load trailing.
- Do not handle loads that are taller than the load backrest unless secured to prevent falling.
- Do not expose truck or battery to water as there is no ingress protection

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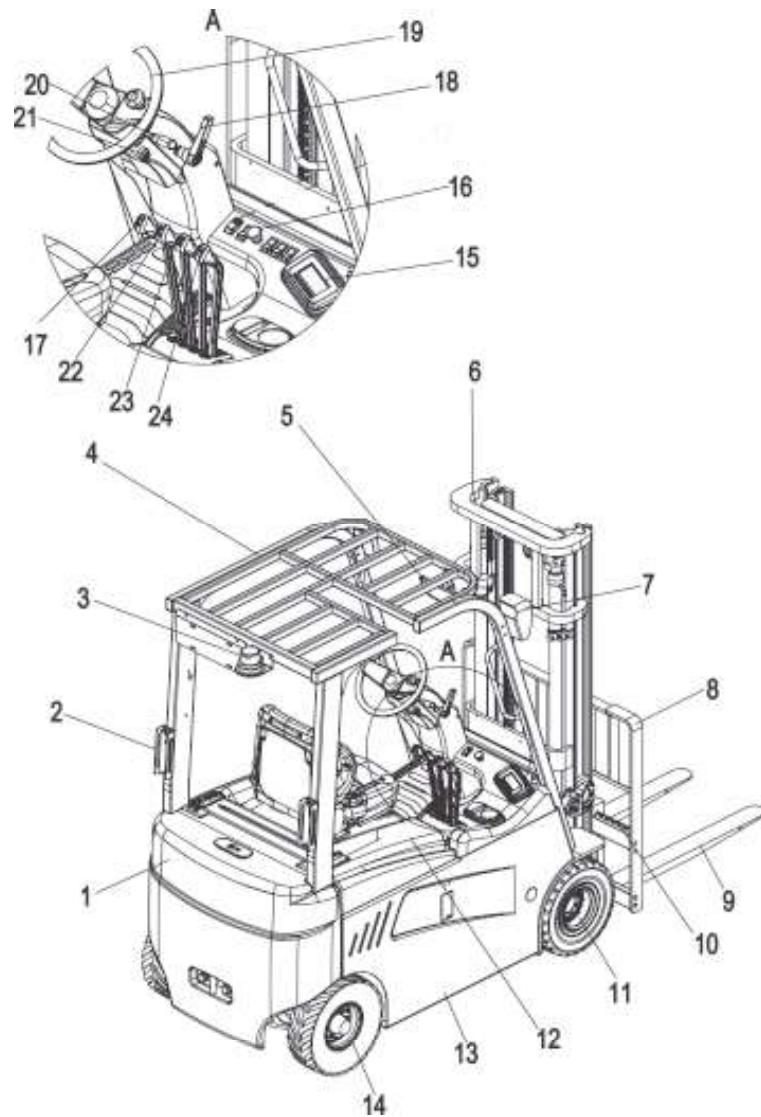
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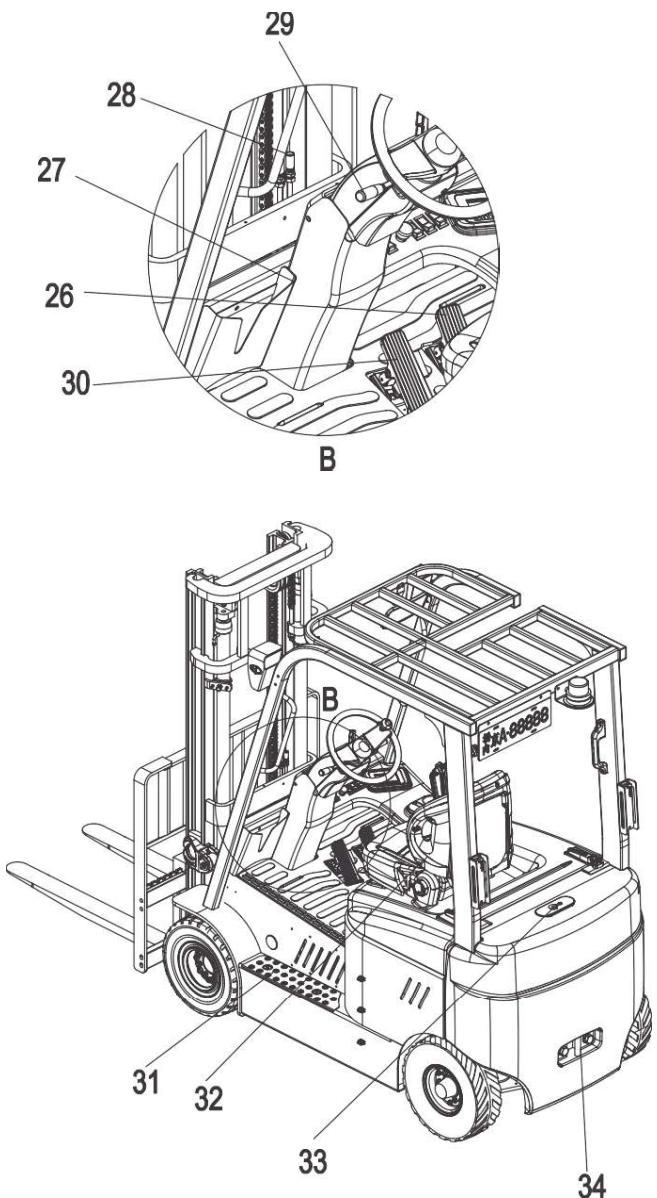
INFORMATION & SPECIFICATIONS

1.1 Truck Components



1	Counterweight	13	Chassis
2	Rear combination lights	14	Rear wheel
3	Caution light	15	Battery Discharge Indicator (BDI) / Display
4	Overhead guard	16	Emergency stop switch
5	Rearview mirror	17	Lifting/lowering lever
6	Mast	18	Steering column tilting angle adjuster
7	Headlight	19	Steering wheel
8	Load backrest	20	Combined lamp switch
9	Forks	21	Key switch
10	Fork carriage	22	Tilting lever
11	Front wheel	23	Side shift lever
12	Battery cover	24	Attachment lever

Truck Components (continued)



26	Accelerator pedal
27	Document box
28	Handrail
29	Travel combination switch
30	Brake pedal
31	Safety step
32	Seat
33	Sling point
34	Towing pin

1.2 Common Tools

No.	Name	Description
1	Hex Head Socket Wrench	8#~27# One Set
2	Phillips Screwdriver	2# One Piece
3	Slotted Screwdriver	2# One Piece
4	Sockets and Knobs	One Set
5	Circlip Pliers	One for holes and one for shaft
6	Hammer	One Piece
7	Spreader, Crane	One Pair
8	Cylinder Wrenches	For removal and installation of cylinders
9	Diagonal Pliers	One Piece
10	Cylinder Pliers	One Piece
11	Grease Gun	One Piece
12	Socket Wrench	22#/27# One of Each

1.3 General Tightening Torques

Screws or bolts used on the truck are of 8.8 grade or higher performance level. When conducting truck maintenance, refer to Table 1.4.1 and Table 1.4.2 to select the suitable screws or bolts for replacement.

Table 1.4.1 Screws/Bolts Performance Levels			
Performance Level		Material	Specification (mm)
	5.8 grade	Low carbon steel	M6 ~ M48
	8.8 grade	Quenched and tempered medium carbon steel	M6 ~ M48
	10.9 grade	Quenched and tempered medium carbon alloy steel	M6 ~ M48
	12.9 grade	Quenched and tempered medium carbon alloy steel	M6 ~ M48



CAUTION

- The performance levels of screws or bolts are marked on the heads of the screws or bolts.
- If screws or bolts used in certain positions are not marked with performance level, select spare parts with performance level of at least 8.8 grade or higher level for replacement.

Table 1.4.2 Metric Screws/Bolts Tightening Torque Table (n•m)

Nominal Diameter (mm)	Performance Level			
	5.8	8.8	10.9	12.9
	Proof Stress (MPa)			
	380	600	830	970
M6	7~8	10~12	14~17	17~20
M8	16~18	25~30	34~41	41~48
M8×1	17~20	27~32	37~43	43~52
M10	31~36	49~59	68~81	81~96
M10×1	35~41	55~66	76~90	90~106
M12	55~64	86~103	119~141	141~167
M12×1.5	57~67	90~108	124~147	147~174
M14	87~103	137~164	189~224	224~265
M14×1.5	144~170	149~179	206~243	243~289
M16	136~160	214~256	295~350	350~414
M16×1.5	144~170	228~273	314~372	372~441
M18	186~219	294~353	406~481	481~570
M18×1.5	210~247	331~397	457~541	541~641
M20	264~312	417~500	576~683	683~808
M20×1.5	294~345	463~555	640~758	758~897
M22	360~431	568~680	786~941	918~1099
M22×1.5	395~473	624~747	803~1034	1009~1208
M24	457~547	722~864	998~1195	1167~1397
M24×2	497~595	785~940	1086~1300	1269~1520
M27	669~801	1056~1264	1461~1749	1707~2044
M27×2	723~865	1141~1366	1578~1890	1845~2208
M30	908~1087	1437~1717	1984~2375	2318~2775
M30×2	1005~1203	1587~1900	2196~2629	2566~3072
M36	1587~1900	2506~3000	3466~4150	4051~4850
M36×3	1680~2011	2653~3176	3670~4394	4289~5135
M42	2538~3039	4088~4798	5544~6637	6479~7757
M42×3	2731~3269	4312~5162	5965~7141	6921~8345
M48	3813~4564	6020~7207	8327~9969	9732~11651
M48×3	4152~4970	6556~7848	9069~10857	10598~12688

MAINTENANCE

2.1 Overview

Regular truck maintenance and repair can help ensure the continuous and reliable use of the truck.

Only specially trained and qualified personnel are capable of maintenance and repair operations of the equipment. If you want to perform the maintenance and repair on your own, it is recommended that on-site training should be conducted to your maintenance personnel by the service representative of the vendor.

NOTE

- Under harsh working conditions: such as, the external temperature is too high or too low, dusty, or implementing multiple shifts per day, the maintenance and care interval should be shortened.
- Prior to lubrication, replacement of filters or operating the hydraulic system, clean the external parts carefully and use a clean container.
- Only compliant lubricants can be used See Table 2.2 Lubricants.

Working conditions:

- The truck must be parked on level ground reserved for maintenance (area needs to be clean and with less dust), block the wheels with wooden wedges, disconnect the key switch and disconnect the battery connections.
- When lifting the truck, the lifting tools can only be installed on the fixed positions as specified.
- When raising the truck, appropriate tools, such as wedge blocks, wooden blocks, and so on, must be used to secure the truck to prevent the occurrence of accidental rolling or tipping over.



WARNING

When lifting load components, sufficiently strong chains or safety devices must be used to secure the vehicle.



CAUTION

Do not make modifications to truck, especially to the safety devices, without written permission from manufacturer.

2.2 Maintenance

2.2.1 Cleaning

- Do not use flammable liquids to clean the truck.
- Before starting to clean, all necessary safety measures must be taken to prevent sparks (short circuit) during operation. If the truck is powered by battery, disconnect it.
- When cleaning electrical and electronic components, use compressed dry air. Meanwhile, clean the dust on the surface of components with non-conductive and antistatic brush.
- Do not use a pressure washer to clean the truck.

Regular inspection and maintenance under harsh conditions of use:

Under harsh working conditions, especially:

- Dusty environment
- Corrosive environment
- Cold storage environment

The maintenance intervals should be shortened by half.

2.2.2 Inspection

Regular inspection and maintenance under normal conditions of use:

Operating Hours (h)	Requirements
50	At least once per 7 days
250	At least once per 60 days
500	At least once per 90 days
1000	At least once every 6 months
2000	At least once per year



CAUTION

After approximately 100 hours of operation, the equipment user must check the fastening of wheel nuts and bolts and re-tighten/torque them if necessary.

Table 2.1 Inspection & Maintenance List

Interval in days/months/years	7 d	60 d	90 d	6 m	1y
Interval in hours	50	250	500	1000	2000
Functions and Control					
Check the functions of the operation switches and display	A				
Check alarm system functions	A				
Check parking brake functions	A				
Check the emergency switch functions	A				
Check the steering wheel functions	A				
Check the cables for damage and if the terminals are secure		A			
Check the seat switch functions	A				
Check and tighten the controllers and contactors					A
Check accelerator pedal functions	A				
Check fault information records and operating hours				A	
Power Supply & Drive System					
Check the battery cables for damage and replace if necessary				A	
Check the battery charge connector				A	
Check if the cable connections between battery terminals are secure, apply some grease to electrodes if necessary				A	
Check electrolyte fluid level				A	
Check electrolyte density				A	
Check battery temperature				A	
Check battery locking mechanism				A	
Check and tighten motor mounting bolts					A
Check the connections of motor connectors					A

A = Check / Adjust

Please refer to Inspection & Maintenance List for regular inspection and maintenance of the vehicles.

L = Lubrication

Under harsh conditions, the lubrication intervals should be shortened by half.

Table 2.1 Inspection & Maintenance List (Continued)

Interval in days/months/years	7 d	60 d	90 d	6 m	1y	
Interval in hours	50	250	500	1000	2000	
Power Supply & Drive System						
Check the position of various bearings for noise				A		
Replace the gear oil		Replace once every 1000 hours				
Check the gearbox for abnormal noise or leaks				A		
Check the drive wheel and steering wheel for worn or damage	A					
Check and lubricate the wheel bearings				A / L		
Check the travel speed					A	
Hydraulic System						
Check the functions of hydraulic system	A					
Check if the hoses, pipes and interfaces are fastened or sealed securely, and check if there is damage				A		
Check the connections of pump motor connectors					A	
Check and tighten pump motor mounting bolts					A	
Check the gear pump fixation and check for leaks				A		
Check the cylinders for leaks				A		
Check the cylinders for damages and check the fixation					A	
Check the oil tank fixation and check for leaks					A	
Check the hydraulic oil level				A		
Replace the hydraulic oil		Replace once every 2000 hours				
Check and clean oil tank air filter				A		
Replace the oil tank air filter and filter					A	
Check the relief pressure					A	

A = Check / Adjust

Please refer to Inspection & Maintenance List for regular inspection and maintenance of the vehicles.

L = Lubrication

Under harsh conditions, the lubrication intervals should be shortened by half.

Table 2.1 Inspection & Maintenance List (Continued)

Interval in days/months/years	7 d	60 d	90 d	6 m	1y	
Interval in hours	50	250	500	1000	2000	
Braking System						
Check the braking functions	A					
Check the release of brake pedal is normal				A		
Check the braking distance of brake					A	
Mast System						
Check the mast for damages					A	
Clean and lubricate the rolling surface of lift mast column with grease		A / L				
Check and lubricate mast rollers			A / L			
Check the fixation of lift mast				A		
Check the tubing on mast for connections and leaks			A			
Check the side shifter functions	A					
Check and lubricate the chains			A / L			
Check the lifting chains and chain guides for wear, adjust and grease				A		
Check the fork carriages for wear and damage				A		
Visual inspection of rollers, sliders, and stoppers				A		
Check the lifting and lowering speed					A	
Other						
Check if the signs are clear and complete				A		
Check the chassis for cracks or damages			A			
Check the connections of bolts and nuts			A			
Check the engine hood and lubricate the hinges				A / L		

A = Check / Adjust

Please refer to Inspection & Maintenance List for regular inspection and maintenance of the vehicles.

L = Lubrication

Under harsh conditions, the lubrication intervals should be shortened by half.

Table 2.1 Inspection & Maintenance List (Continued)					
Interval in days/months/years	7 d	60 d	90 d	6 m	1y
Interval in hours	50	250	500	1000	2000
Other					
Check the stability of battery and battery tray				A	
Check the seat stability and adjustment functions					A
Check the seat belt and functions	A				
Check the overhead guard and cabin					A
Checking covering parts for damages					A
Check if the optional features are functioning properly	A				

A = Check / Adjust

Please refer to Inspection & Maintenance List for regular inspection and maintenance of the vehicles.

L = Lubrication

Under harsh conditions, the lubrication intervals should be shortened by half.

2.3 Lubrication

2.3.1 Lubricant

- Improper operations may constitute hazards to the operator's health and life, as well as to the surrounding environment.
- When storing or adding lubricant, use clean containers. Do not mix different types and specifications of lubricants with each other (except for those that state that they can be mixed).

Please see Table 2.2 for the lubricants used in this truck.



CAUTION

The use and disposal of lubricants must be carried out in strict accordance with the manufacturer's regulations.

Table 1 Lubricants

Code	Type	Specification	Amount	Position
A	Anti-wear hydraulic oil	L-HM32 (Cleanliness grade 9, in compliance with NAS1638)	See Table1	Hydraulic System
B	Multi-purpose grease	Polylub GA352P	Appropriate amount	Sliding Surface (See Table2)
C	Heavy duty gear oil	85W-90GL-5	3.5L (Align with oiling port)	Drive axle

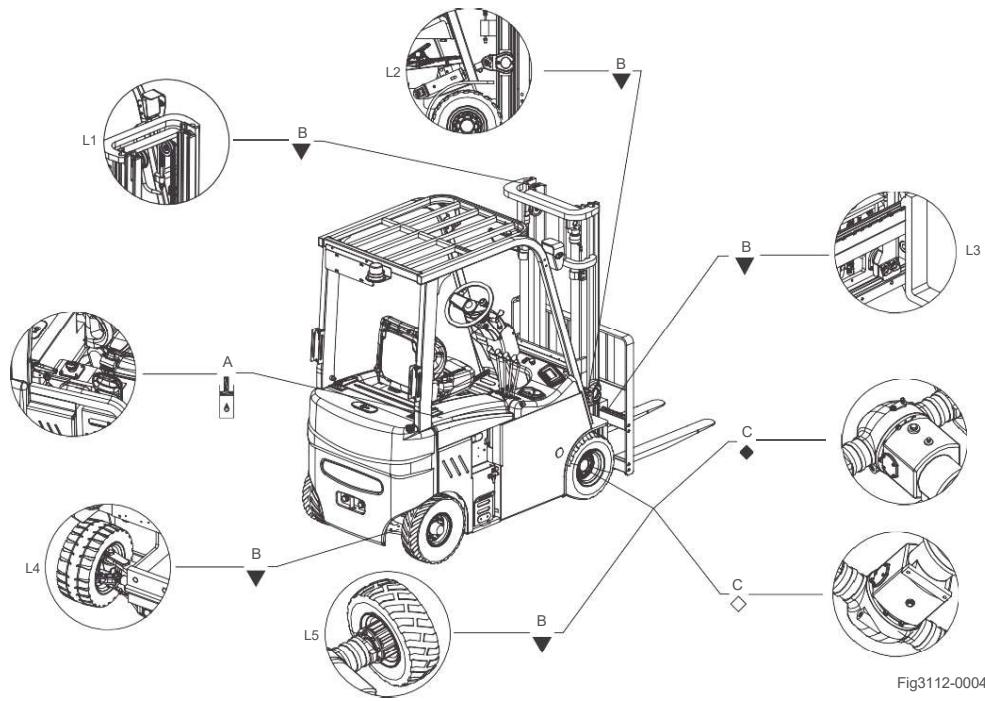


Fig3112-00048OM

Hydraulic oil fill point

Contact surface

Gear oil drain point

Gear oil fill point

STRUCTURE & FUNCTIONS

3.1 Structure & Functions

3.1.1 Traction Controller

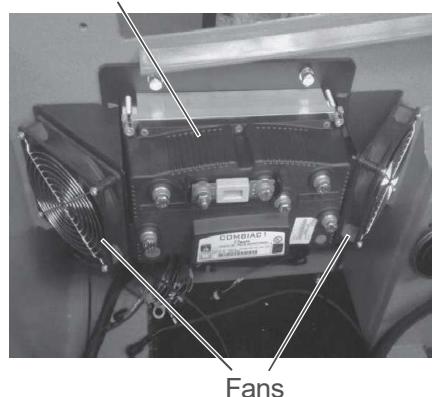
Location: electrical mounting plate.

Function: to control the speed of drive motor through the signal input by the accelerator.

Description: 48V operating voltage, to control the drive motor circuit.

Note: Unserviceable.

Traction Controller



3.1.2 Main Contactor

Location: vertical plate of the chassis.

Function: to connect and disconnect circuit and to control the power transmission of drive motor.

Description: to provide power loads through controller under the circumstances that the controller is failure-free.

Note: Unserviceable.



Main Contactor

3.1.3 DC-DC Converter

Location: left side of chassis.

Function: 48V DC-DC to provide 12V voltage for headlight and warning lights.

12V DC-DC to provide 5V voltage for accelerator and brake pedal.

Description: 48V to 12V DC transformer
12V to 5V DC transformer

Note: Unserviceable.



48V DC-DC Converter

3.1.4 Multi-way Manual Valve

Location: on the right of seat.

Function: connection and disconnection of oil passage.

Description: manual valve control.

Note: Unserviceable.

Control switch



Manual Valve

3.1.5 Pump Motor

Location: behind the drive motor.

Function: to provide power for gear pump for lifting.

Description: upon receiving the signal input by control switch, controller to control the power transmission of pump motor.

Note: Unserviceable.



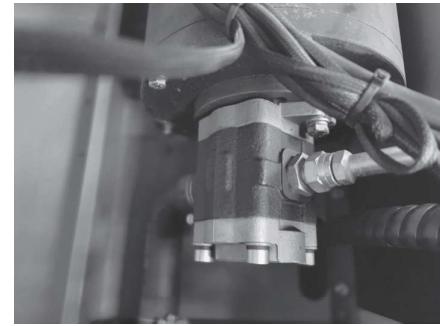
3.1.6 Gear Pump

Location: left side of the pump motor.

Function: to provide pressure for hydraulic system of the entire vehicle.

Description: N/A.

Note: Unserviceable.



CHASSIS SYSTEM

4.1 Steer Wheel

4.1.1 Removal and Installation

Removal



Fig3112-10001SM

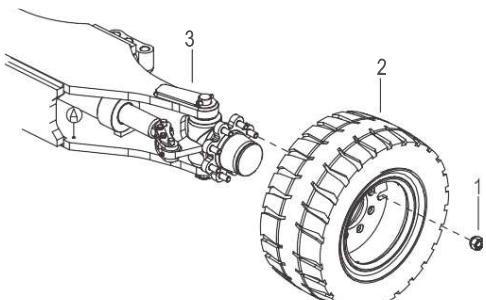
- Switch off the truck power connections and place a wooden wedge under the chassis near steer wheel, raise the wheel off the ground.

WARNING

Make sure the lifting equipment is solid and secure, and that the load capacity is greater than the total weight of the vehicle.

WARNING

When replacing wheels, be sure that the truck won't tilt.



(see Fig3111-70002SM)

- Unscrew the six nuts (1) on the steer wheel assembly (2).
- Remove the steer wheel assembly (2) from the steering bridge (3).

Installation and Commissioning

- Install in the reverse order of removal.

CAUTION

- Screw the six nuts as shown in Fig 3111-70003SM.
- Torque the nuts in the order shown 220Nm and mark with the torque.

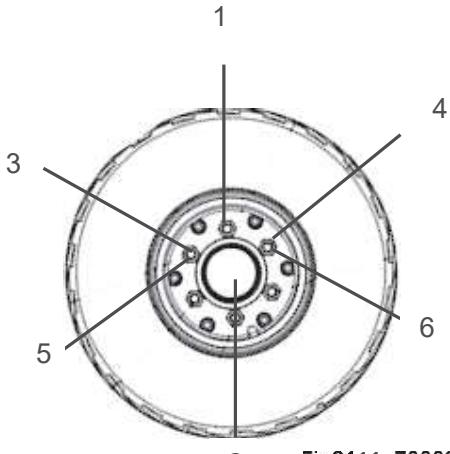


Fig3111-70003SM

- Turn the wheel to see if it is rotating smoothly, and if there is blocking or not.
- Run the truck to see if the steering wheel is functioning properly. If there is blocking or noise, please check if the wheel bearings are functioning properly (See Section 9.1).

CAUTION

Quality of tires directly affects the stability and driving performance of the device.

If you need to replace the factory-fitted tires, please use original spare parts provided by the equipment manufacturer to reach the original design performance of the truck.

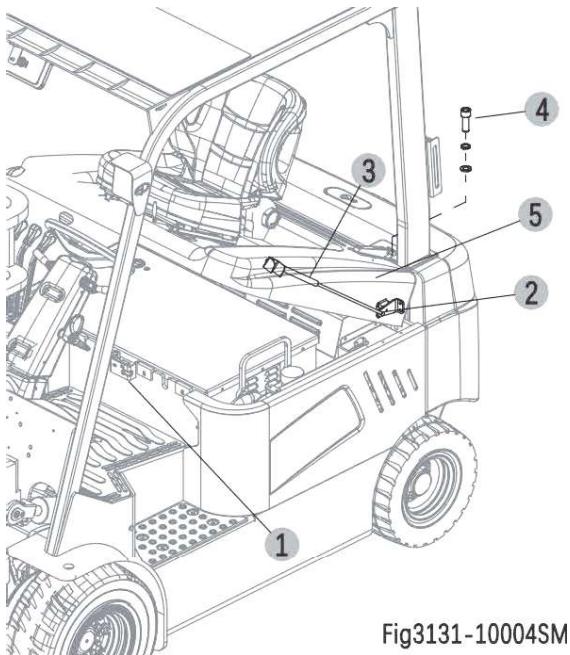
4.1.2 Faults and Causes

1	Fault	Bearing noise or jammed
	Cause	Bearing fatigue damage or foreign material
2	Fault	Abnormal tire wear, cracking, or degumming
	Cause	Improper use

4.2 Cover

4.2.1 Removal and Installation

Battery Cover (See Fig3131-10004SM)



- Unlock the battery cover (1) and open the battery cover (5).
- Disconnect the connection between the seat and main wiring harness.
- Loosen the two nuts (2) and remove the two gas cylinders (3).
- Unscrew the two screws (4) and remove the battery cover (5) from the chassis.
- Install in the reverse order of removal.

4.3 Seat

4.3.1 Removal and Installation

Removal (See Fig3131-10006SM)

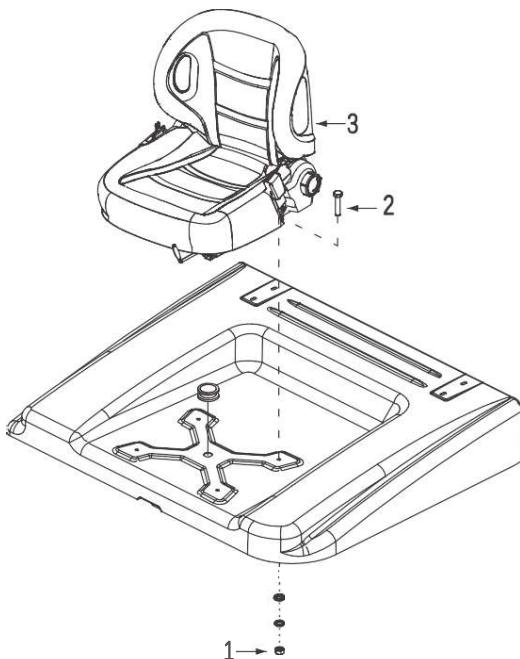


Fig3131-10006SM

- Remove the battery cover;(see section 4.2.1)
- Disconnect the connection between the seat switch and main wiring harness.
- Loosen the four nuts (1) and unscrew the four bolts (2), then remove the seat (3) from the battery cover.
- Install in the reverse order of removal.

Adjustment

- The seat position can be adjusted via the handle on the left of the seat.
- The seat back angle can be adjusted via the handle on the left of the seat.

DRIVE SYSTEM

5.1 Drive Wheel

5.1.1 Removal and Installation

Removal

- Turn off the truck power and remove the key.
- Place the jack (1) under the chassis near the drive wheels, lift the drive wheels off the ground.

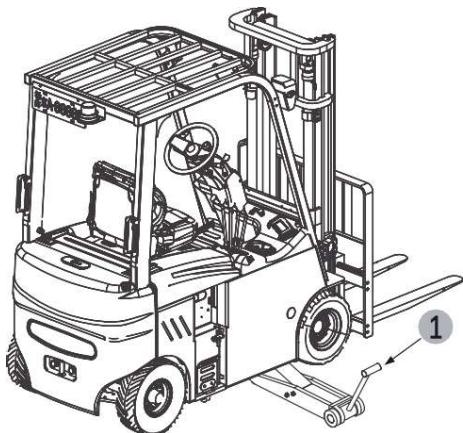


Fig3112-20001SM



WARNING

Make sure the lifting equipment is solid and secure, and the load capacity should be greater than the total weight of the vehicle. Lifting height of not more than 4in, to prevent the hazards to maintenance personnel working under the vehicle for wheel removal and installation.

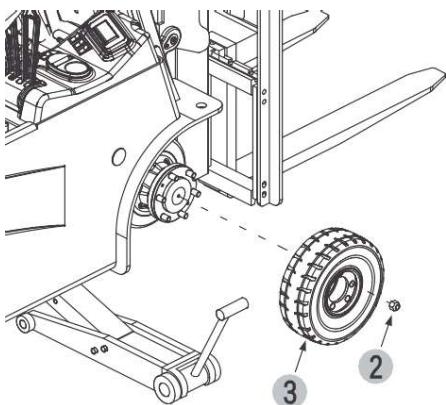


Fig3131-20003SM

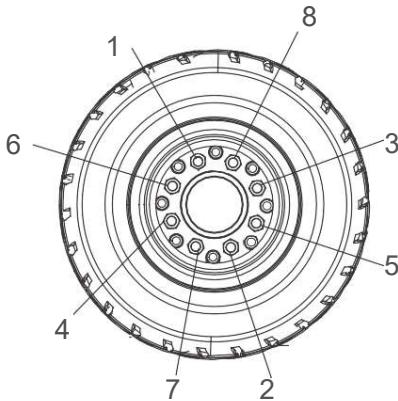
- Unscrew the eight nuts (2) and remove the drive wheel assembly (3).

Installation

- Install in the reverse order of removal.



- Screw the eight nuts as shown in Fig3111-10003SM.
- Torque the nuts in specified pattern to 220 Nm and mark with the torque: 220 Nm.



After installation, check whether the tire inflation reaches the specified value. After running for a short distance, check tightness and retorque if necessary.



Tire wear can affect the stability of the truck. Replace the drive wheel when heavily worn.

The quality of tires directly affects the stability and driving performance of the truck. If it is necessary to replace the factory-fitted tires, use original spare parts provided by the equipment manufacturer to maintain the original design performance of the truck.

5.1.2 Faults and Causes

1	Fault	Drive wheel slipping or jumping
	Cause	Wear
2	Fault	Drive wheel cracking or degumming
	Cause	Improper use
3	Fault	Vehicle sways while running
	Cause	Drive wheel lock nut loosening

- Unscrew the six nuts (1) and bolts, remove the drive motor (3) from the gearbox (2).

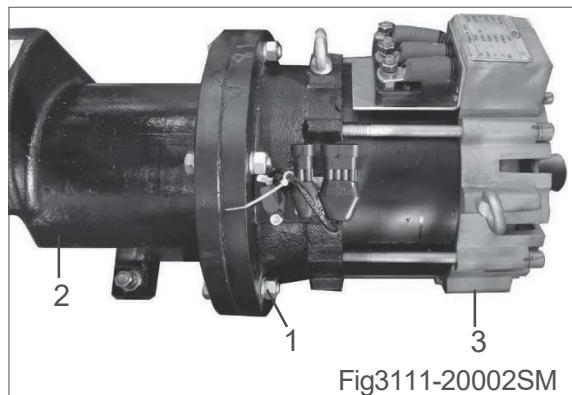


Fig3111-20002SM

5.2 Drive Motor

This truck obtains drive force through AC motor.

5.2.1 Removal and Installation

Drive Motor

Removal

Drive motor is mounted on the gearbox.

- Power off the truck and remove the key.
- Remove the mast; (see Section 8.1.1).
- Remove the drive wheel; (see Section 5.1.1).
- Remove the cushion and open the floorboard.
- Dismantle the drive assembly from the chassis; (see Section 5.3.1).

Installation

- Install in the reverse order of removal.

CAUTION

- *Motor gear should fully engage with the gear within the gearbox, rotate the gearbox without blocking, and then fix it with six screws.*



CAUTION

Before proceeding with the next step, fix the drive motor to prevent it from falling during removal, which could result in personal injury.

5.2.2 Faults and Causes

	Fault	Motor does not rotate
1	Cause	<ul style="list-style-type: none"> a. Cable U, V, or W is broken. b. Loosening connections to cable U, V or W. c. Stator coil open circuit. d. Motor bearing damage. e. Speed encoder or its circuit failure.
2	Fault	Motor is rotating in slow speed and reverse
	Cause	Cable connection error
	Fault	Motor with abnormal noise or vibration
3	Cause	<ul style="list-style-type: none"> a. Uneven clearance between stator and rotor. b. Bearing failures. c. Loosening fixing screws on motor housing.
4	Fault	Motor smoking or burning smell
	Cause	Stator winding short circuit, motor burnt
	Fault	Motor temperature too high, controller failure
5	Cause	<ul style="list-style-type: none"> a. Stator winding short circuit. b. Motor U, V and W terminals with surface. c. Bearing failure, resulting in severe heating. d. Motor cooling duct blockage with foreign body. e. Overload.
	Fault	On load, motor speed is turning slow
6	Cause	<ul style="list-style-type: none"> a. Insufficient voltage of battery. b. Overload. c. U, V, W terminals with abnormal voltage input. d. Speed encoder or its circuit failure.

5.2.3 Checking and Testing

U, V, W Terminals

- Identify if the motor windings are normal through measuring the resistance of U-V, V-W, and U-W respectively, if there is short circuit or breakage. See the following table:



Due to the small size of windings, when measuring with a multimeter, put it on a low resistance range.

Resistance Measurement	Judgment
200M Ω - 300M Ω	Normal *
0 Ω	Winding internal short circuit (replace the motor)
∞ Ω	Winding internal open circuit (replace the motor)

* The difference between the resistance values measured at U-V, V-W and U-W shall not be greater than 2%.

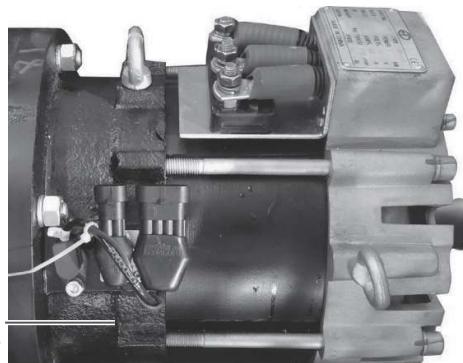
- Identify if there is leakage current through measuring the resistance between U, V, W and motor housing respectively. as shown in the following table:

Resistance Measurement	Judgment
0 Ω	Leakage current (replace the motor)
∞ Ω	Normal *

* For normal motor, U, V and W terminals are insulated from motor housing.

Temperature Sensor

Temperature sensor is used to monitor motor temperature.



Speed Encoder
Fig3112-20002SM

Measure the resistance between pin connector (39#) and (20#) with a multimeter to identify if the temperature sensor is normal.

As shown in the following table:

Resistance Measurement	Judgment
200 mΩ - 300 mΩ	Normal
0 Ω	Sensor short circuit (replace the motor)
∞ Ω	Sensor open circuit (replace the motor)

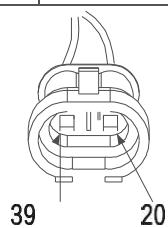


Fig3112-20003SM

Speed Encoder

Speed encoder is used to detect the speed of the motor and convert the speed into fixed signals.

Checking

- Check if the motor encoder and the appearance of cables are in good condition, and if the plug connection is secure.
- Remove the speed encoder and check its sensing surface for wear.

Testing

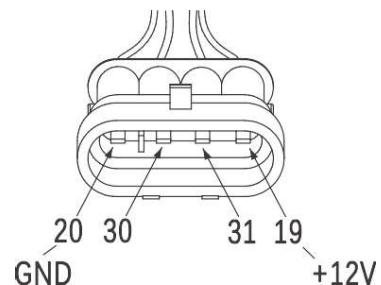


Fig3131-20010SM

- The truck is powered on, measure the voltage between pin connector (19#) and (20#) with a multimeter, normally should be 12V.
- Check if the connection between 30# and 31# is reversed. (If the two circuits are connected reversely, the controller won't report a failure, but the travel speed of the vehicle may slow down).

5.2.4 Control Circuit Troubleshooting

Drive Motor Control Circuit

Check if the circuit is broken by using a multi-meter:

- Set the multimeter to ON-OFF.
- Check if #19/#20/#30/#31 circuit (circuit between motor encoder and controller) is conductive.
- Check if #39/#20 circuit (circuit between motor temperature sensor and controller) is conductive.

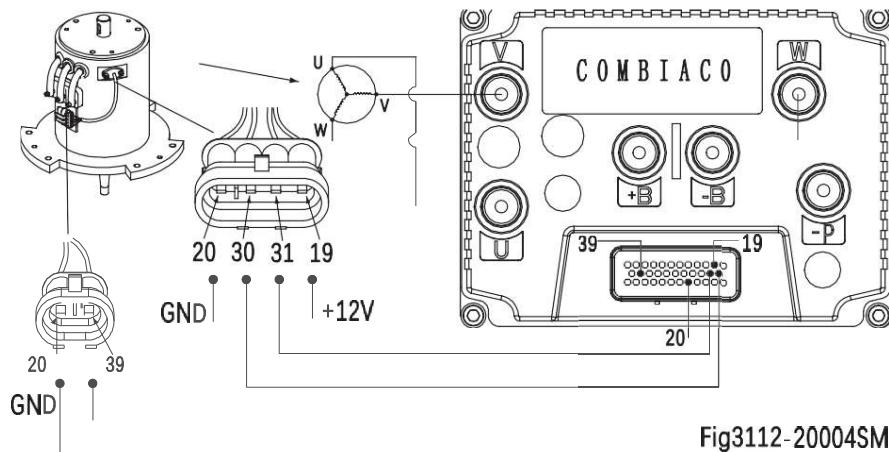


Fig3112-20004SM

5.3 Drive Axle

5.3.1 Removal and Installation

Removal

- Power off the truck and remove the key.
- Remove the mast, see Section 8.1.1.
- Remove the drive wheels, see Section 4.1.1.
- Remove the cushion and floorboard, then remove U, V and W cables on the drive motor.
- Disconnect the connection between the drive motor and main wiring cables.
- Remove the tubes on the brake.
- Loosen the oil drain plug and drain all gear oil (see Section 5.3.3).
- Unscrew the four bolts (1) and remove the bearing cap (2) from the chassis.
- Unscrew the two nuts (3) and bolts, then dismantle the drive assembly (4) from the chassis.

- Unscrew the ten bolts (5) and dismantle the drive axle (6) from the gear box.

Installation

- Install in the reverse order of removal.



CAUTION

After installing the new drive axle, please add gear oil (see Section 2.2.3 for specification and filling amount).

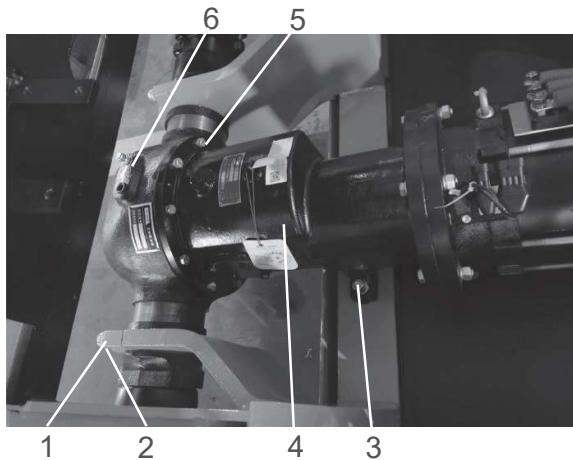


Fig3111-20003SM

5.3.2 Component

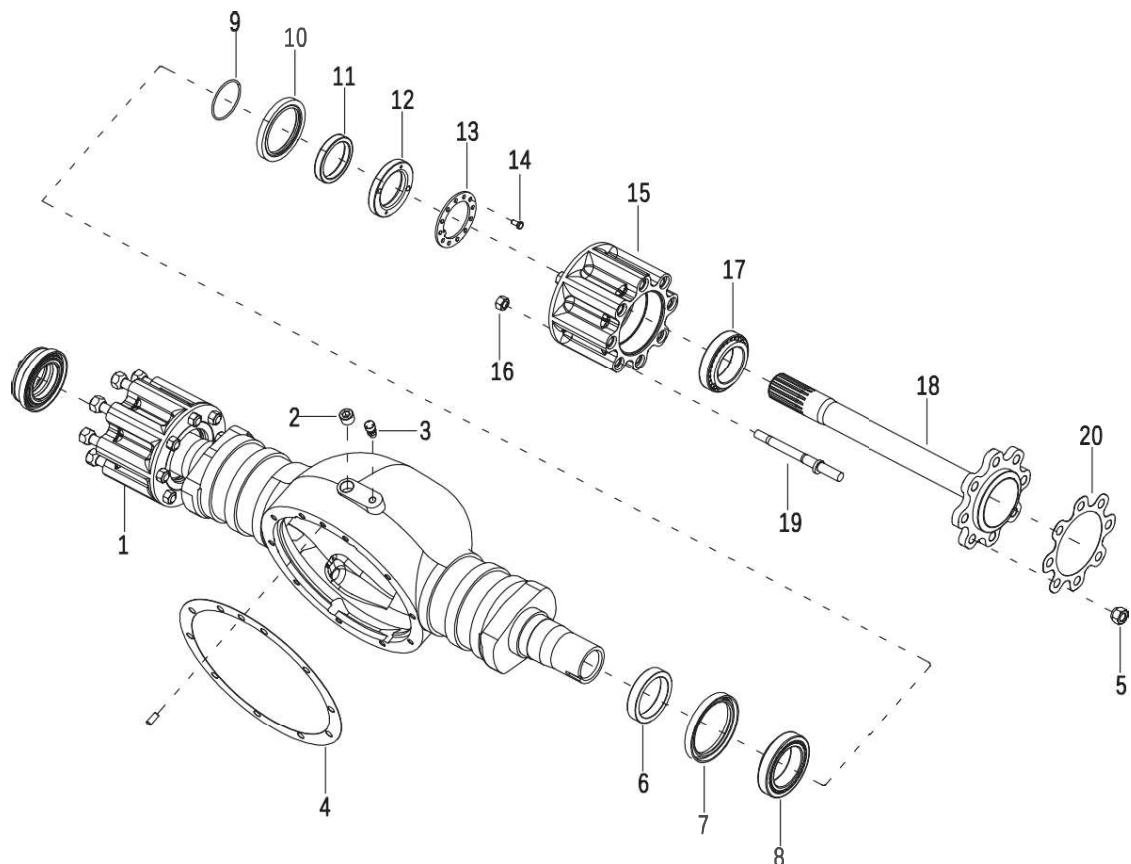


Fig3112-20005SM

No.	Name	No.	Name	No.	Name
1	Hub	8	Bearing	15	Hub
2	Plug	9	O-ring	16	Nut
3	Vent Plug	10	Seal	17	Bearing
4	Ventilated gasket	11	Collar	18	Half Axis
5	Nut	12	Nut	19	Bolt
6	Collar	13	Washer	20	Half Axis Washer
7	Seal	14	Bolt		

5.3.3 Gear Oil

Check gear oil level

- Loosen the oiling port plug (1, Fig3132-20011SM) and observe the oil level.
- If oil level is aligning with lower level of oiling port, it indicates that the oil level is normal.
- If the oil level is below the lower level of oiling port, it is necessary to add gear oil.

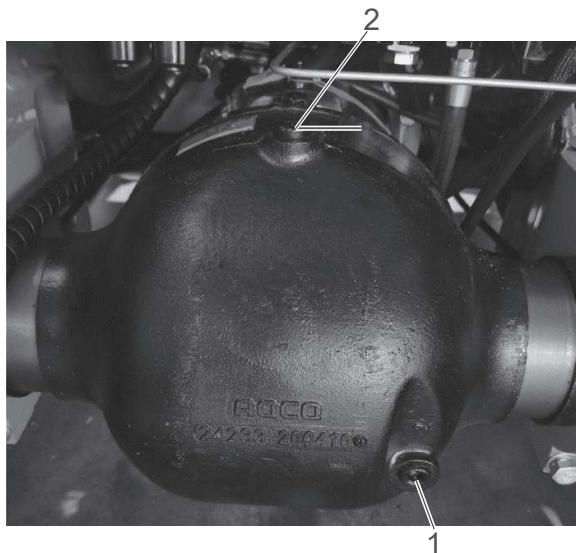


Fig3111-20005SM

Add / Replace Gear Oil

- Loosen the oil drain plug (3), drain the gear oil within the gearbox.
- Remount the oil drain plug (3), Loosen the oil fill plug (2) at the bottom of the drive axle and add the gear oil of same specification through oiling port.
- Remount the oil fill plug (2).



3 Fig3111-20006SM

CAUTION

Gear oil may damage truck parts and contaminate the environment. When replacing the gear oil, place a clean container under the drive axle for discharge of gear oil.

5.5 Gearbox

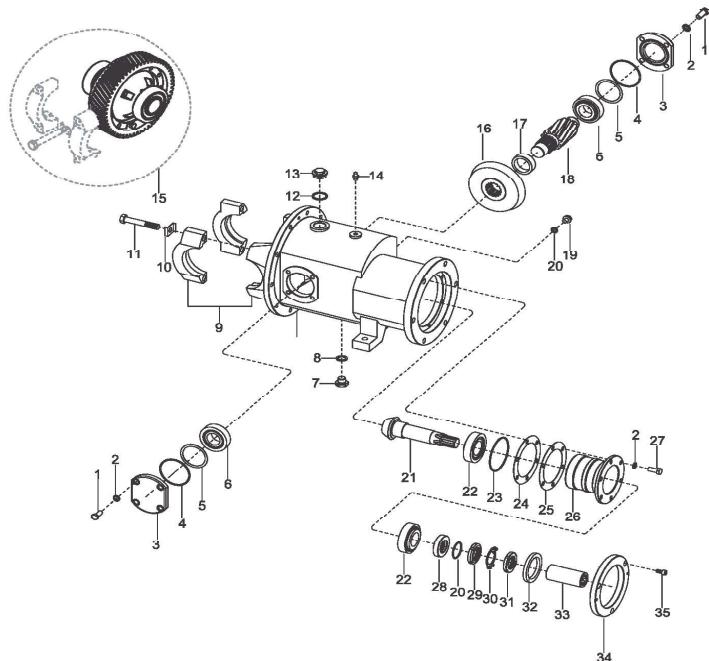
5.5.1 Removal and Installation

Removal (Fig3132-20004SM)

- Remove the drive assembly from the chassis and dismantle the drive axle; (see Section 5.2.1).
- Dismantle the differential; (see Section 5.4.1).
- Remove the drive motor from the gearbox.

Installation

- Install in the reverse order of removal.



No.	Name	No.	Name	No.	Name	No.	Name
1	Bolt M10*25	10	Bolt	19	Plug	28	Bushing
2	Lock washer $\Phi 10$	11	Locking plate	20	Gasket seal $\Phi 10$	29	O-Ring $\Phi 34.5*2.65$
3	Bearing Cap	12	Gasket seal $\Phi 30$	21	Taper tooth shaft	30	Nut M33*1.5
4	O-Ring $\Phi 75*3.1$	13	Plug	22	Bearing 31307	31	Spline housing $\Phi 33$
5	Washer	14	Plug	23	O-Ring 90*2.65	32	Grease seal
6	Bearing 32207	15	Differential assembly	24	Cushion	33	Spline housing
7	Plug	16	Spiral Bevel Gear	25	Tab	34	Plate
8	Gasket seal $\Phi 18$	17	Bush	26	Bearing Bracket	35	Screw M8*16
9	Box	18	Tooth axis	27	Bolt M10*30		

5.6 Accelerator Pedal

5.6.1 Removal and Installation

- Power off the truck and remove the key.
- Remove the floor mat.
- Disconnect the connection between the accelerator pedal wiring (1) and main wiring harness.
- Unscrew the two bolts (2) with wrench and remove the accelerator pedal (3) from the chassis.
- Install in the reverse order of removal.



Fig3132-50004SM

5.6.2 Interface Description

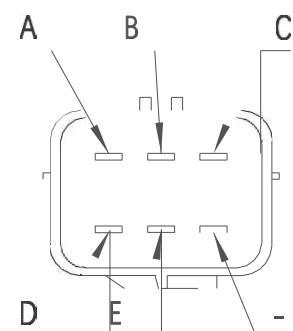
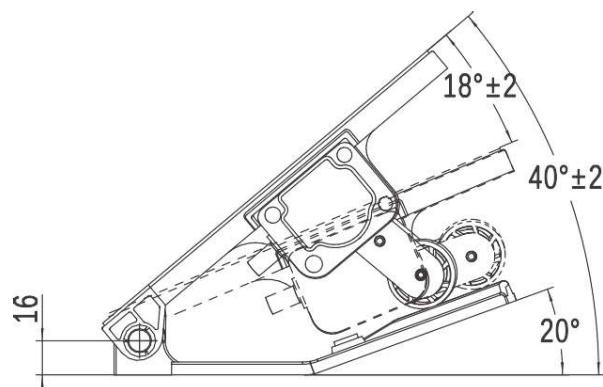


Fig3131-50017SM

Interface Description			
Pin	Description	Color	Remark
A	Pedal power supply	Red	10-15Vdc
B	Output signal	White	$0.2 \pm 0.1 \text{V} \sim 9 \pm 0.3 \text{V}$
C	Pedal signal grounding	Black	-
D	Pedal switch - positive electrode	Green	Switch output (10-60V)
E	Pedal switch output	Grey	Switch output

5.6.3 Checking and Testing

Checking

- Check if the accelerator pedal is reset properly and check for damage.
- Check if the accelerator pedal and its wiring harness are in good condition, and if the connectors are secure.

Testing

- Press the accelerator pedal, if the accelerator information on the display does not change, it indicates there is failure with the accelerator pedal or its circuit.

Turn off the vehicle to check the accelerator pedal and its wiring harness. (See Fig3131-50017SM).

- Provide a voltage of 12V between accelerator pedal harness connectors (A) and (C), check the voltage at each port of the wiring harness with a multimeter.
 - Place the accelerator pedal at original position Measure the voltage between the interfaces with a multimeter.
- As shown in the following table:

- Press the accelerator pedal. Measure the voltage between the interfaces with a multimeter. as shown in the following table:

Press the accelerator pedal	
Connection interface	Voltage Measurement
A-C	12 V
A-B	Changing within the range of 0V to 9V with the level of pressing
A-E	12 V
B-C	0 V

Accelerator pedal at original position

Connection interface	Voltage Measurement
A-C	12 V
A-B	0 V
A-E	12 V
B-C	0 V

OPERATING SYSTEM

6.1 Control Lever

Removal

- Remove the floorboards (see Section 4.2.1).
- Remove the horn cover (1), unscrew the nut, and pull up the steering wheel (2).
- Unscrew the four screws (8) and open the back cover plate (7).
- Disconnect the connection between the key switch (9) and main wiring harness, then remove the key switch and back cover plate (7).
- Unscrew the adjusting handle (5) and four screws (10), then remove the front cover plate (6).
- Cut off the connection between the combination switch (12 & 13) and the main wiring harness.
- Unscrew the four screws (11), remove the travel combination switch (12) and lighting combination switch (13) from the steering column (14).
- Unscrew the bolt (17) and screw (18), remove the gimbal (15).

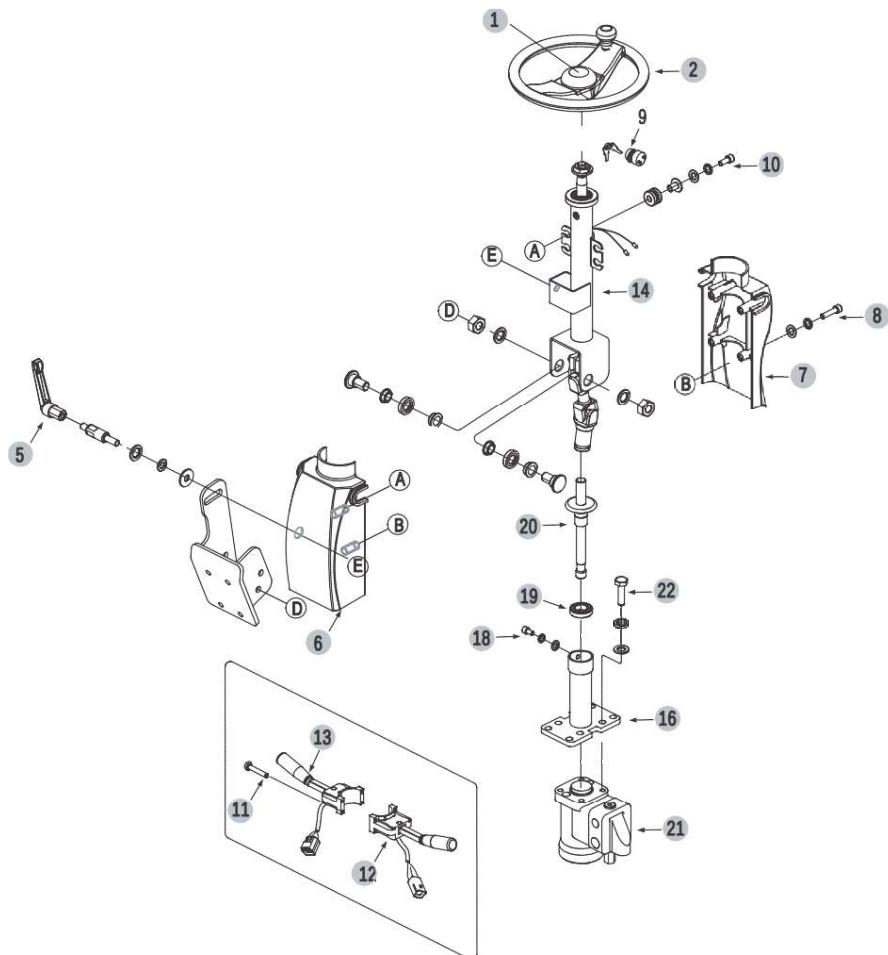


Fig3112-30001SM

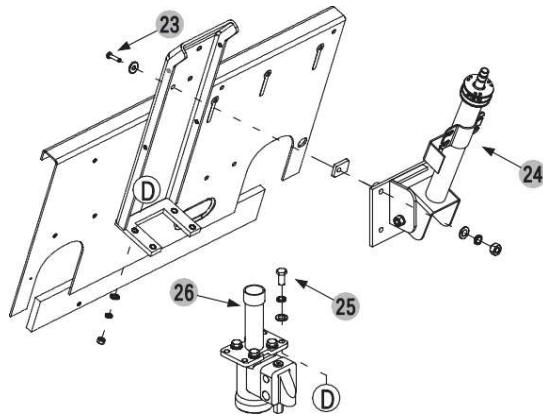


Fig3112-30001SM

- Unscrew the four bolts (23, Fig 3112-30001SM) and remove the steering column (24) from the chassis.
- Remove the steering shaft (20, Fig 3530-30001SM) and bearing (19) from the bracket (16).
- Remove the five tubes on the redirector (21).
- Unscrew the four bolts (22) and remove the redirector (21) from the bracket (16).
- Unscrew four nuts (25, Fig3530-30001SM) and four bolts, remove the redirector bracket (16) from the chassis.

Installation

- Install in the reverse order of removal.



CAUTION

When removing or installing, pay attention to protect the cables from being damaged.

6.2 Horn Button

Push button switch is the switch that makes the dynamic and static contacts ON or OFF to achieve the switching of circuits through push-button drive mechanism.

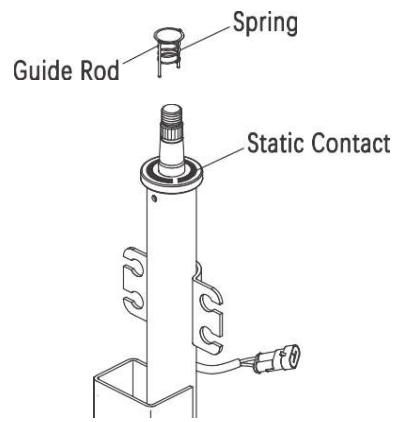


Fig3131-30003SM

6.2.1 Removal and Installation

See Section 6.1.

6.2.2 Faults and Causes

	Fault	Operate the horn switch, but the vehicle responds with no action
1	Cause	a. Horn switch spring blocked. b. Horn switch guide rod deformation and cannot contact the static contact on steering column. c. Static contact circuit not conducted.
	Fault	Horn switch not operated, but the vehicle responds with action
2	Cause	Horn switch spring blocked or failure, and the static contacts on guide rod and steering column are keeping contact.

6.2.3 Checking and Testing

Checking

- Check if the pushbutton switch and the appearance of cables are in good condition, and if the plug connection is secure.
- Check the horn switch guide rods and springs for abnormalities and deformation.

Testing

- Check if the horn switch circuit is connected.
- Carry out ON/OFF test to the push button switch with a multimeter:

Push button switch at original position = broken circuit.

Press the button (key switch to "ON"; emergency stop switch to "Pulled-out" status), the circuit is conducted.

6.2.4 Control Circuit Troubleshooting

Control Circuit (Fig3131-30004SM)

Check if the circuit is broken by using a multimeter:

- Set the multimeter to ON-OFF.
- Check if #13 circuit (circuit between press button and power supply positive electrode) is conductive.
- Check if #14 circuit (circuit between press button and horn) is conductive.

Horn Checks

Energize the horn with a voltage of 12V:

Horn sounds, the horn is working properly.

The horn does not sound, needs to be replaced.

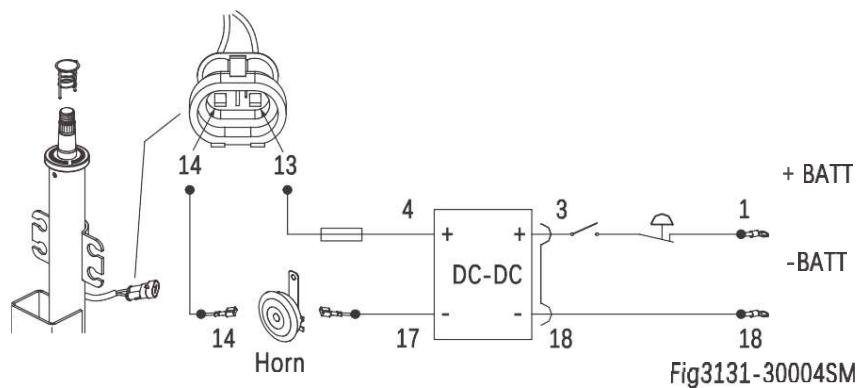


Fig3131-30004SM

6.3 Travel Combination Switch

For switching travel direction of truck: Forward (F) , Reverse (R) and Neutral (N).

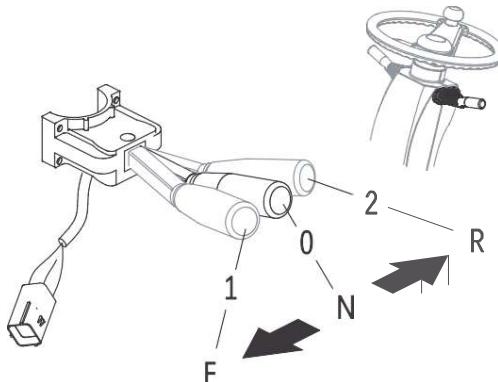


Fig3131-30005SM

6.3.1 Removal and Installation

See Section 6.1.

6.3.2 Faults and Causes

1	Fault	Operate the combination switch, but the vehicle cannot perform corresponding actions
	Cause	a. Combination switch failure. b. Combination switch circuit not conducted.
2	Fault	Combination switch not operated; the vehicle still performs certain action
	Cause	Combination switch failure

6.3.3 Checking and Testing

Checking

- Check if the appearance of combination switch and its wiring harness are in good condition, and if the connectors are connected securely.

Testing

- Check if the combination switch circuit is connected.

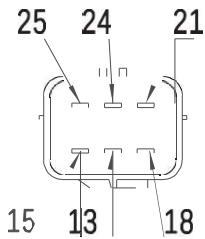


Fig3218-30001SM

- Carry out ON/OFF test to combination switch with a multimeter:

Travel combination switch should be at 0 position (N) of the lever

Test Interface	Status of Conduction
#25 - #21	Broken Circuit
#24 - #21	Broken Circuit
#13 - #15	Broken Circuit

Travel combination switch should be at 1 position (F) of the lever

Test Interface	Status of Conduction
#25 - #21	Broken Circuit
#24 - #21	Conducted Circuit
#13 - #15	Broken Circuit

Travel combination switch should be at 2 position (R) of the lever

Test Interface	Status of Conduction
#25 - #21	Conducted Circuit
#24 - #21	Broken Circuit
#13 - #15	Conducted Circuit

6.3.4 Control Circuit Troubleshooting

Control Circuit (Figure 60304)

Check if the circuit is broken by using a multimeter:

- Set the multimeter to ON-OFF.
- Check if #13 circuit (circuit between switch and DC-DC converter) is conducted.
- Check if #15 circuit (circuit between switch and light) is conducted.
- Check if #21/24/#25 circuit (circuit between switch and controller) is conducted.

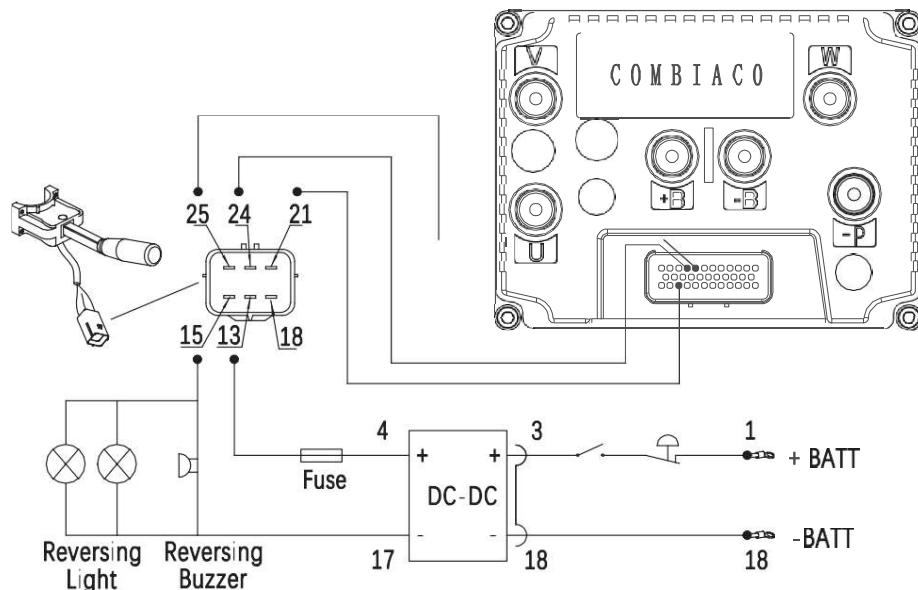


Fig3112-30002SM

6.4 Lighting Combination Switch

For lighting of forklift signal indicators: turn signal - left (L), turn signal - right (R), outline marker lights and headlights.

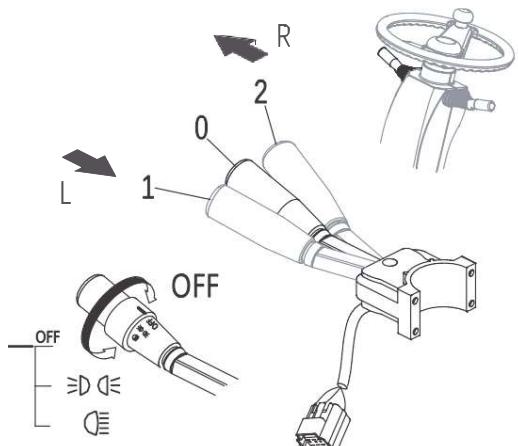


Fig3131-30009SM

6.4.1 Removal and Installation

See Section 6.1.

6.4.2 Faults and Causes

1	Fault	Operate the combination switch, but the vehicle cannot perform corresponding actions
	Cause	a. Combination switch failure. b. Combination switch circuit not conducted.
2	Fault	Combination switch not operated; the vehicle still performs certain action
	Cause	Combination switch failure

6.4.3 Checking and Testing

Checking

- Check if the appearance of combination switch and its wiring harness are in good condition, and if the connectors are connected securely.

Testing

- Check if the combination switch circuit is connected.

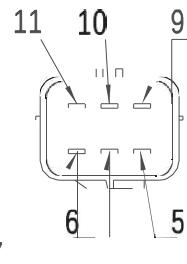


Fig3112-30003SM

- Carry out ON/OFF test to combination switch with a multimeter:

Lighting combination switch should be at 0 position (F) of the lever	
Test Interface	Status of Conduction
#11 - #9	Broken Circuit
#10 - #9	Conducted Circuit

Lighting combination switch should be at 1 position (L) of the lever

Test Interface	Status of Conduction
#11 - #9	Broken Circuit
#10 - #9	Conducted Circuit

Lighting combination switch should be at 2 positions (R) of the lever

Test Interface	Status of Conduction
#11 - #9	Conducted Circuit
#10 - #9	Broken Circuit

Lighting combination switch should be at the position (OFF) of the knob

Test Interface	Status of Conduction
#7 - #5	Broken Circuit
#6 - #5	Broken Circuit

Lighting combination switch should be at the position (□) of the knob	
Test Interface	Status of Conduction
#7 - #5	Conducted Circuit
#6 - #5	Conducted Circuit

6.4.4 Control Circuit Troubleshooting

Control Circuit (Fig3131-30011SM)

Check if the circuit is broken by using a multimeter:

- Set the multimeter to ON-OFF.
- Check if #10/#11 circuit (circuit between switch and turn signal) is conducted.
- Check if #5/#9 circuit (circuit between switch and power supply positive electrode) is conducted.
- Check if #7 circuit (circuit between switch and headlight) is conducted.
- Check if #6 circuit (circuit between switch and outline marker light) is conducted.

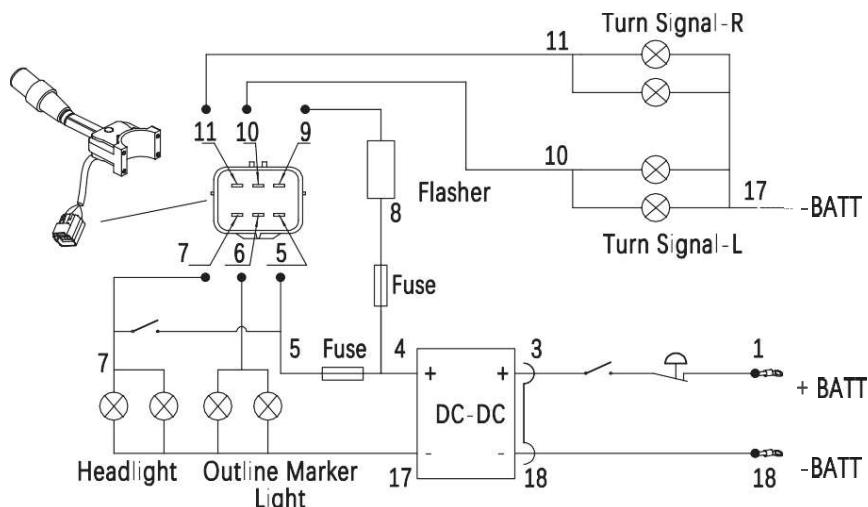


Fig3112-30004SM

6.5 Key Switch

Key switch is used to START / STOP the truck.

6.5.1 Removal and Installation

See Section 6.1.

6.5.2 Faults and Causes

1	Fault	Turn the key switch to "ON", the vehicle won't start.
	Cause	a. Key switch failure. b. Key switch circuit not conducted.
2	Fault	Turn the key switch to "OFF", the vehicle won't stop.
	Cause	a. Key switch failure. b. Key switch shorted (short circuit).

6.5.3 Checking and Testing

Checking

- Check if the appearance of key switch its wiring harness are in good condition, and if the connectors are connected securely.

Testing

- Check if the key switch circuit is conducted.
- Carry out ON/OFF test to the key switch with a multimeter:
key switch at "OFF" position, open circuit; place the key switch at "ON" position, the circuit is conducted.

6.5.4 Control Circuit Troubleshooting

Control Circuit (Fig3112-30005SM)

Check if the circuit is broken by using a multimeter:

- Set the multimeter to ON-OFF.
- Check if #2/#83 circuit (circuit between key switch and emergency switch) is conducted.
- Check if #3 circuit (circuit between key switch and controller) is conducted.
- Check if #81 circuit (circuit between key switch and Battery BMS) is conducted.

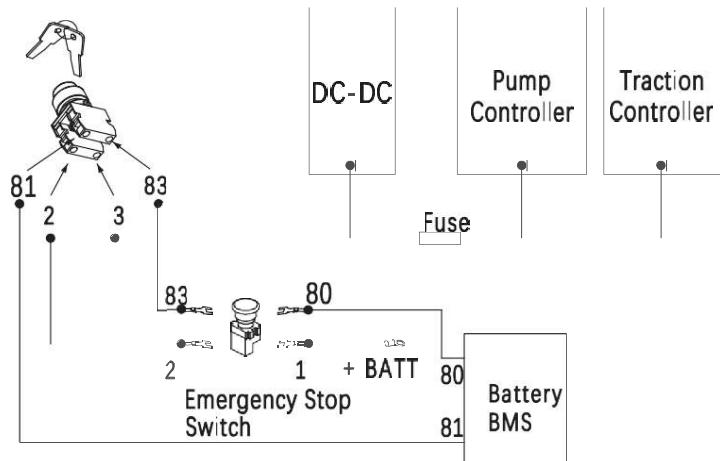


Fig3112-30005SM

6.7 Emergency Switch

Emergency switch is used for emergency cut-off of the power supply to all the control circuits.

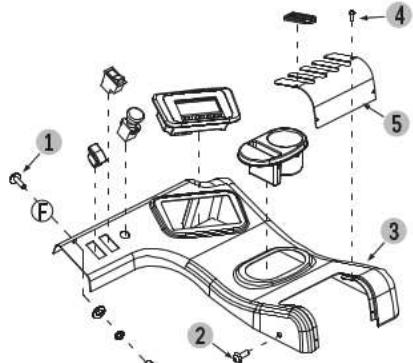


Fig3112-30006SM

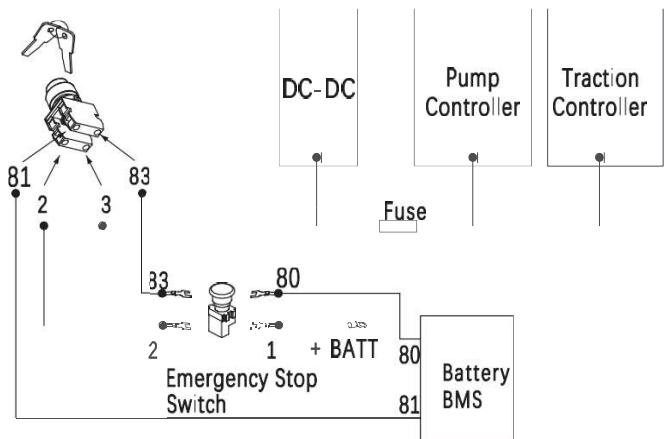


Fig3112-30005SM

6.7.1 Removal and Installation

(See Fig3112-30006SM)

- Unscrew the four screws (4), remove the multi-way valve basket (5).
- Unscrew the screws (1) and screws (2), then remove the right hood (3) from the chassis.
- Remove the wirings from the emergency stop switch.
- Remove the emergency stop switch from the right hood.
- Install according to the reverse order of removal.

6.7.2 Faults and Causes

	Fault	Emergency switch at pulled-out status, the vehicle not energized
1	Cause	a. Emergency switch failure. b. Emergency switch circuit not conducted.
	Fault	Emergency switch pressed; the vehicle still energized
2	Cause	a. Emergency switch failure. b. Emergency switch shorted (short circuit)

6.7.3 Checking and Testing

Checking

- Check if the appearance of emergency switch its wiring harness are in good condition, and if the connectors are connected securely.

Testing

- Check if the emergency switch circuit is conducted.
- Carry out ON/OFF test to emergency switch with a multimeter:
Emergency switch in pulled-out status, circuit conducted.
press the emergency switch, the circuit is opened.

6.7.4 Control Circuit Troubleshooting

Control Circuit (Fig3112-30005SM)

Check if the circuit is broken by using a multimeter:

- Set the multimeter to ON-OFF.
- Check if #2/#83 circuit (between key switch and emergency switch) is conducted.
- Check if #1/#80 circuit (between key switch and battery BMS) is conducted.

6.9 Control Switch

Control switch will provide the vehicle with input signals for starting the pump motor.

See Section 3.1 for mounting positions of control switch.

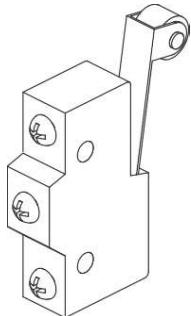


Fig1221-50011SM

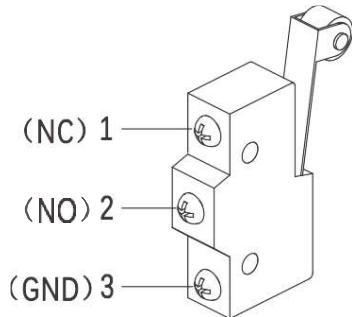


Fig1221-50012SM

Normally-open (NO):
Terminal (2) and Terminal (3) for connection of wiring harness connector to switch base.

6.9.1 Removal and Installation

See Section 7.4.1.

6.9.2 Faults and Causes

1	Fault	Operate the handwheel, but the vehicle cannot perform corresponding actions
	Cause	a. Control switch failure. b. Control switch circuit not conducted.
2	Fault	Handwheel not operated, the vehicle still performs certain action
	Cause	Remote control switch failure

6.9.3 Connection Mode

There are three terminals on the control switch, as shown in Fig1221-50012SM.

By pulling the handwheel, the switch can be switched between OFF and ON to control the OFF and ON of the circuit.

6.9.4 Checking and Testing

Checking

- Check if the appearance of control switch is in good condition, also check for deformation of handwheel.
- Check if the handwheel is working smoothly and if there is foreign body blockage.

Testing

- Enter the TESTER Menu to check the status of switches: toggle each control switch separately to check the ON/OFF status. If the display does not change, it indicates there is failure with the control switch or its circuit; (see Section 9.8)
- Turn the key switch to "OFF", remove key. Pull out the battery plug and disconnect the power supply.
- Check the ON/OFF normally-open (NO) terminal with a multimeter:
with handwheel at natural position, Terminal (2) and (3) not conducted.
toggle the handwheel, Terminal (2) and (3) conducted.
- Check the ON/OFF normally closed (NC) terminal with a multimeter: with handwheel at natural position, Terminal (1) and (3) conducted.
Toggle the handwheel, Terminal (1) and (3) not conducted.

6.9.5 Control Circuit Troubleshooting

Proportional Lift Switch Control Circuit (Fig3112-30008SM)

Check if the circuit is broken by using a multimeter:

- Set the multimeter to ON-OFF.
- Check if #56 circuit (circuit between control switch and controller) is conducted.
- Check if #156/#157 circuit (circuit between control switch and 12V DC-DC converter) is conducted.

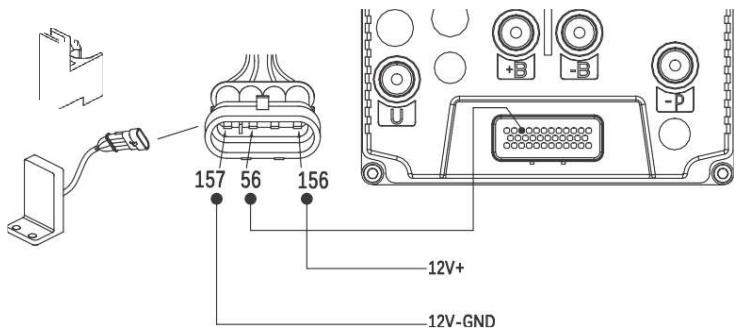


Fig3112-30008SM

Forward Tilting – Backward Tilting Switch Control Circuit (Fig3112-30007SM)

Check if the circuit is broken by using a multimeter:

- Set the multimeter to ON-OFF.
- Check if #21/#62 circuit (circuit between control switch and controller) is conducted.

Left Shifting – Right Shifting Switch Control Circuit (Fig3112-30007SM)

Check if the circuit is broken by using a multimeter:

- Set the multimeter to ON-OFF.
- Check if #21/#65 circuit (circuit between control switch and controller) is conducted.

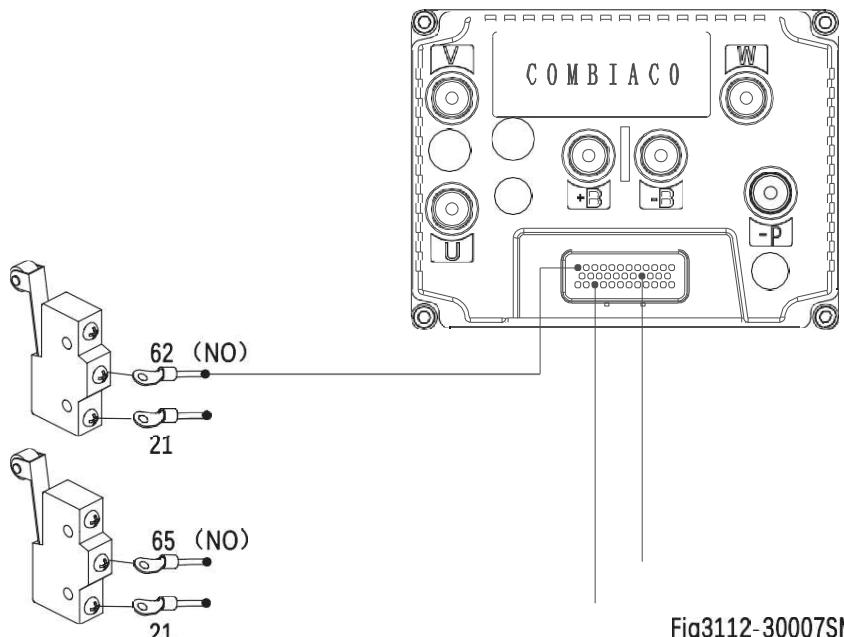


Fig3112-30007SM

HYDRAULIC SYSTEM

The system pressure of the entire hydraulic system pressure is provided by hydraulic power unit system, which is used for lifting. While the hydraulic power unit is equipped with a relief valve to ensure that the entire system pressure is always within the safety limits that can lift the maximum load capacity.

Solenoid valve on the valve body is used for the control of lowering. Throttle valve is used for the control of lowering speed. Inlet is equipped with a filter to prevent the impurities in the hydraulic oil from entering into the pump.

Oil pipeline explosion-proof valve is installed at the hydraulic cylinder to prevent the free falling of the load after system failure.

Hydraulic Schematic Diagram is as shown in Fig3131-40001SM.

See Section 7.11 for hydraulic symbol descriptions.

7.1 Overview

- Lower the mast to the bottom, remove the air filter on cylinder, observe the oil level with the oil dipstick. When adding hydraulic oil, please use hydraulic oil of the same specifications.
- When the mast occasionally jitters, that may be leaks in the cylinder, or there could be leaks on the valve body. Dismantle and clean (to clean with hydraulic oil of the same specifications) the valve on the valve body, discharge the foreign bodies within the valve body through repeatedly lifting and lowering of the mast.
- If hydraulic oil is becoming less, thoroughly check the hydraulic system for leaks.
- Disassembly of cylinder needs to be performed in a clean environment. Before removing the cylinder, the stains on the cylinder must be removed first. Carefully remove the piston rod to prevent the cylinder wall from being scratched by its end surface or damaged part. Every time when replacing the cylinder, also replace the cylinder seals.

Hydraulic Oil

Hydraulic oil for truck:

Specifications: Anti-wear Hydraulic Oil L-HM46.

* For cold storage: Low Temperature Anti-wear Hydraulic Oil L-HV32.

Hydraulic Seals

The seals installed within the cylinder are made of rigid polyurethane. The deformation during assembly due to compression will not cause a permanent deformation.

When assembling, pay attention to prevent the seals from being broken, rolled, and undercut.

Assembly Instructions

The tools used to install the seals must be made of soft metal or suitable plastic, without burrs and sharp edges on surfaces. It is prohibited to use tools that can easily damage the surface of seals, such as screwdriver or other similar tools with hard front edges.

Where the hydraulic seals to be installed should be free of burrs, sharp edges, and cracks. If the installation of seals needs to cross sharp edges, grooves or cuts, protective devices must be used for protection. Before installing, lubrication should be performed to the seals and the mounting positions first.



The lubricant used during assembly must be of the same specifications as the hydraulic oil used in the vehicle.

7.1.1 Hydraulic Schematic Diagram

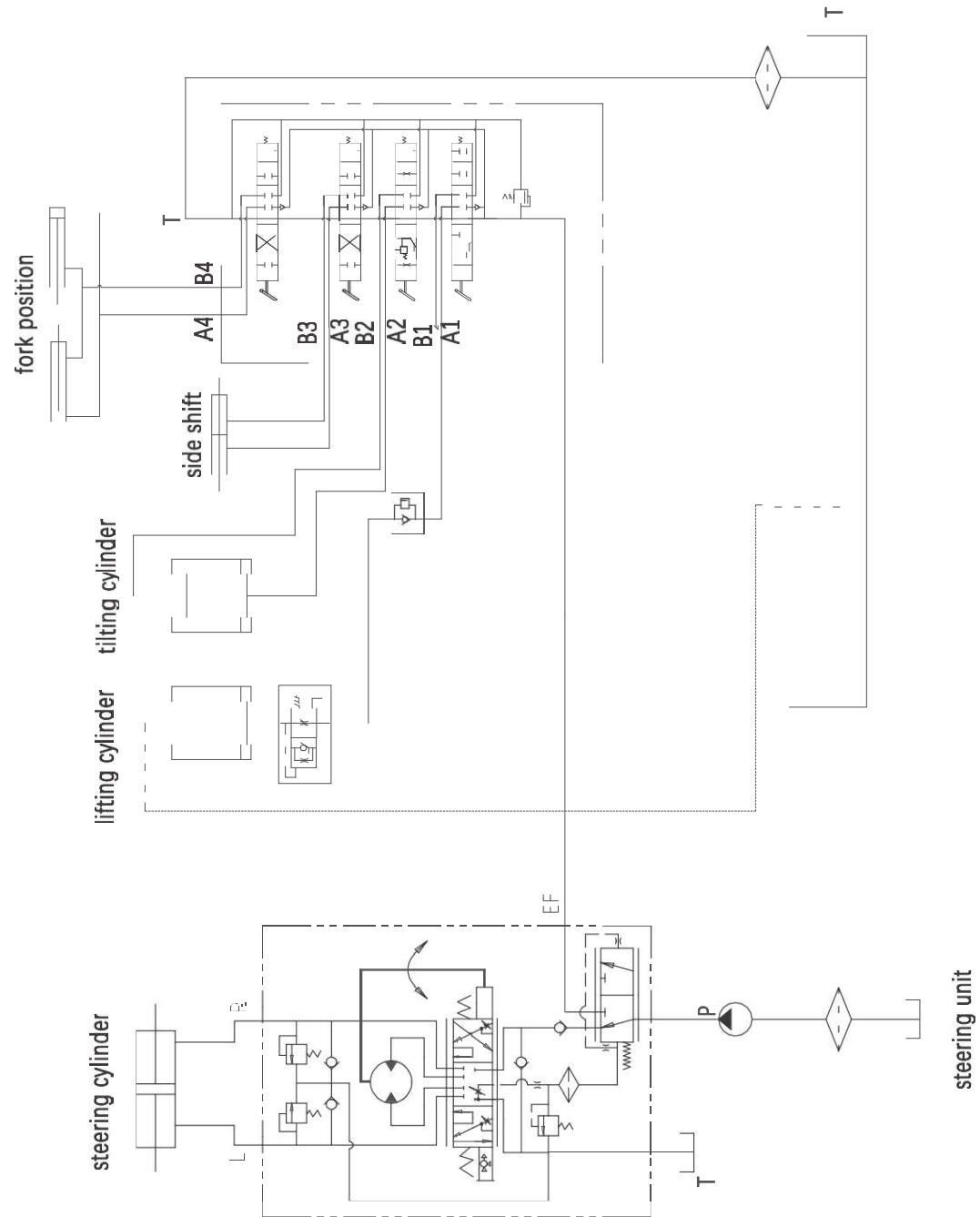


Fig3131-40001SM

7.2 Hydraulic Power Unit

7.2.1 Removal and Installation

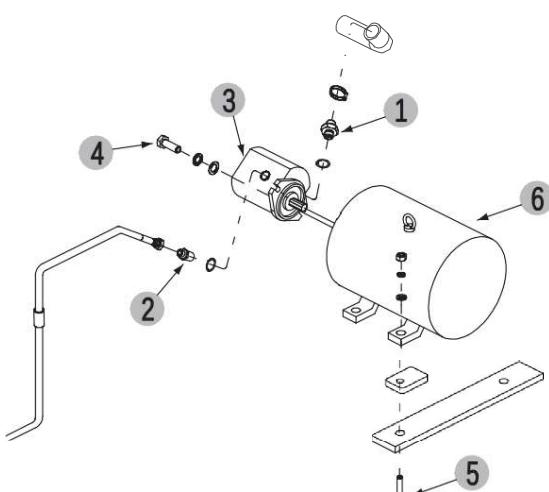


Fig3112-40001SM

Removal

- Open the battery cover.
- Remove the AMP connector on the pump motor, then remove the two cables connected to the controller.
- Remove the tubing head (1&2) between gear pump (3) and redirector with a wrench, then remove the tubing.
- Unscrew the two bolts (4), then remove the gear pump (3) from the pump motor (6).

Installation

- Install the reverse order of removal.



CAUTION

When removing the tubing and gear pump, the system will lose some hydraulic oil, refer to Section 2.2.3 for supplementary adding of hydraulic oil.

7.3 Pump Motor

This truck obtains hydraulic power through the DC pump motor.

7.3.1 Removal and Installation

See Section 7.2.1.

7.3.2 Faults and Causes

	Fault	Motor does not rotate
1	Cause	<ul style="list-style-type: none"> a. Negative electrode cable broken. b. Motor positive and negative electrode with loose terminals. c. Armature winding with broken circuits. d. Motor bearing damaged and blocked. e. Serious wearing of carbon brush.
2	Cause	<ul style="list-style-type: none"> a. Insufficient voltage of battery. b. Carbon brush worn or carbon brush spring pressure decreases. c. Bearing wear or lack of lubricating oil. d. Armature winding has short circuit elements. e. Carbon brush winding grounded.
3	Cause	<ul style="list-style-type: none"> a. Motor positive and negative electrode with loose terminals and poor connection. b. Carbon brush wear and tear. c. Armature winding has circuit broken unit.
4	Fault	Motor with abnormal noise or vibration
	Cause	<ul style="list-style-type: none"> a. Uneven clearance between stator and rotor. b. Bearing failures. c. Loosening fixing screws on motor housing.

7.3.3 Checking and Testing

Checking

- Check if the drive motor and appearance of cables are in good condition, and if the plug connection is secure.
- Check if the circuit is connected.

Testing

- Remove the cables on the drive motor.
- Carry out ON/OFF test to motor positive and negative electrodes with a multimeter:
 - If connected, the motor is normal,
 - If not connected:
 - 1) Broken circuits in rotor coils (replace the motor).
 - 2) Carbon brush wearing, move on to the next step.
- Replace the carbon brush.



CAUTION

When replacing the carbon brush, replace the complete set of carbon brushes.

7.4 Multi-way Reversing Manual Valve

The valve rod is driven by lever to switch the ON and OFF of tubing within the valve body, to control the Lifting - Lowering, Forward Shifting - Retract, Tilting Forward - Tilting Backward and Left Shifting - Right Shifting of the vehicle.

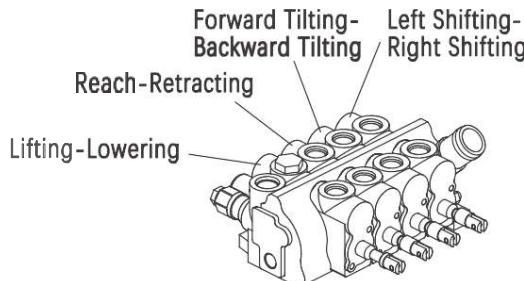


Fig3131-40011SM

7.4.1 Removal and Installation

Removal

- Remove the pedal from the cabin.
- Unscrew the two screws (1) and remove the cover (2) from the mounting bracket (3).
- Remove the tubing on multi-way valve (4) and wiring harness (5) on control switch (6).
- Remove the cotter pin on pin shaft (7), remove the connecting rod (8) between multi-way valve and control lever.
- Unscrew the two bolts (9) and remove the multi-way valve from the mounting bracket (3).
- Unscrew the bolt (10) and remove the control switch mounting plate (12) from the multi-way valve.
- Unscrew the screws (11) and remove the control switch (6) from the mounting plate (12).
- Unscrew the two screws (13) and remove the potentiometer switch mounting plate (14).
- Unscrew the two screws (15), then remove the potentiometer switch (16).
- Unscrew the nut (17), remove the main control pin shaft (18) and control lever (20) from the control lever mounting base (19).

Installation

- Install in the reverse order of removal.

CAUTION

Some hydraulic oil will be lost when removing the manual multi-way solenoid valve. Add appropriate amount of hydraulic oil after the replacement is completed (see Section 2.2.3 for specifications and adding amount).

Adjustment

- Adjust the length of the connecting rod through operating the nut on the connecting rod (8). When the valve rod of multi-way valve is at original position, adjust the control lever (20) to a vertical position.

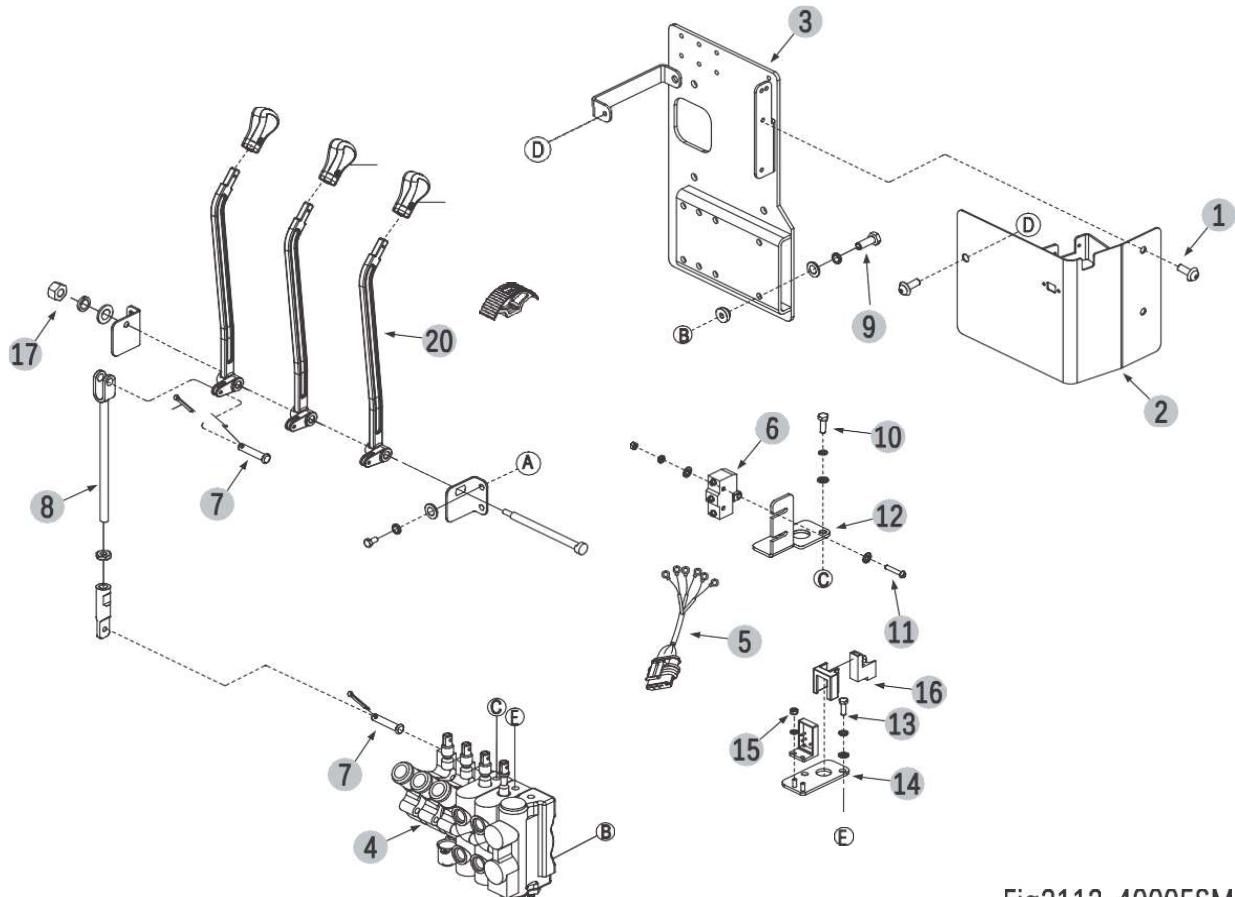
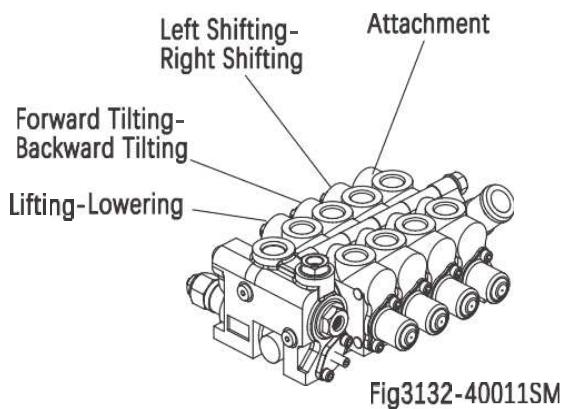


Fig3112-40005SM

7.4.2 Interface Description



7.4.3 Faults and Causes

	Fault	The vehicle cannot perform the hydraulic control instructions
1	Cause	<ul style="list-style-type: none"> a. Valve failure. b. Valve seat blocked by large impurities. c. External leakage: sealing damaged. poor threaded connection; valve body defects. d. High viscosity of hydraulic oil. e. High frequency of use, service life has expired already.
2	Fault	Slow pace of actuator
2	Cause	<ul style="list-style-type: none"> a. Overflow valve in the connection block started. b. Valve seat leakage. c. Valve rod cannot push/pull to bottom; the channel cannot be fully opened. d. High viscosity of hydraulic oil. e. High frequency of use, service life has expired already.

7.4.4 Checking and Testing

Checking

- Check the valve body for leakage and damage.
- Check the control switch connector for loosening or poor connection of leads.

Testing

- Switch off the power supply of the vehicle.
- Measure the ON/OFF of control switch and its circuit with a multimeter.
(See Section 6.9.5)

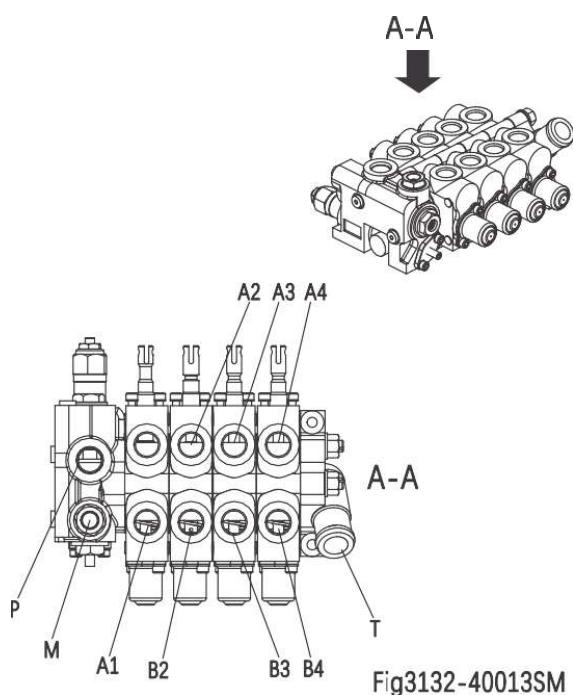


Fig3132-40013SM

Symbol	Interface Function	Connection Terminals	Interface Size
A1	Lifting, lifting / lowering solenoid valve controls	Lift Cylinder	M20×1.5
A2	Backward tilting, backward tilting solenoid valve controls	Tilt Cylinder	M20×1.5
B2	Forward tilting, forward tilting solenoid valve controls	Tilt Cylinder	M20×1.5
A3	Right shifting, right shifting solenoid valve controls	Side-Shift Cylinder	M20×1.5
B3	Left shifting, left shifting solenoid valve controls	Side-Shift Cylinder	M20×1.5
A4	Attachment	Reach Cylinder	M20×1.5
B4	Attachment	Reach Cylinder	M20×1.5
P	Oil Inlet	Gear Pump	M22×1.5
T	Drain back	Tank	ø25
M	Oil Inlet	Redirector	M16*1.5

7.5 Gear Pump

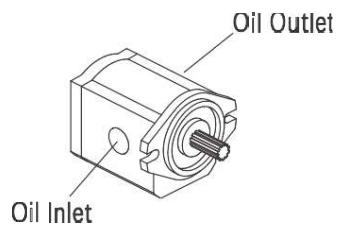


Fig3131-40014SM

	Fault	Oil leaks
4	Cause	<ul style="list-style-type: none"> a. Pump body defects. b. Seal skeleton spring off. c. Shaft sealing surface scratched.
	Fault	Pump is not functioning properly or blocked
5	Cause	<ul style="list-style-type: none"> a. Pump body defects. b. Pressure valve malfunction. c. Poor alignment of pump and motor coupling. d. Impurities in the pump.

7.5.1 Removal and Installation

See Section 7.2.1.

7.5.2 Faults and Causes

1	Fault	Gear pump does not absorb oil or of small flow
	Cause	<ul style="list-style-type: none"> a. Insufficient hydraulic oil. b. Pump body defects. c. Poor sealing with leakage. d. Oil filter clogging. e. Oil temperature is too high.
2	Fault	Insufficient gear pump output pressure
	Cause	<ul style="list-style-type: none"> a. Pump body defects. b. Pump body with cracks or leaks. c. Impurities in the pump, oil filter clogging. d. Low viscosity of hydraulic oil. e. Oil temperature is too high. f. Pressure of relief valve adjusted too low or adjustment failure.
3	Fault	Too much vibration and noise
	Cause	<ul style="list-style-type: none"> a. Pump body defects. b. Gear pump inlet tubing diameter is too small. c. Oil filter clogging, or motor speed is too high. d. Motor and oil pump shaft misalignment.

7.5.3 Checking and Testing

Checking

Check the pump body for leakage and damage.

- Check if the connection of pump and motor is normal if oil inlet/outlet is connected reversely.

CAUTION

If the gear pump has failed, it is recommended to replace the gear pump.

7.6 Redirector

7.6.1 Removal and Installation

See Section 6.1.

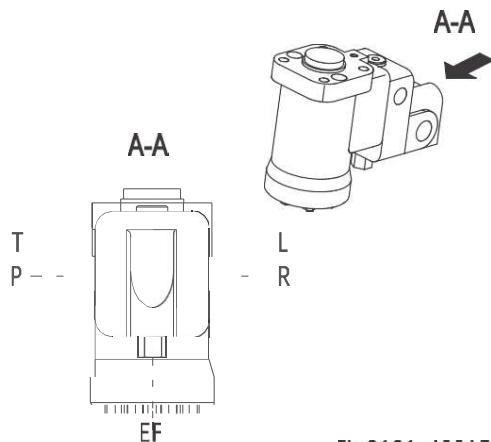


Fig3131-40015SM

7.6.3 Checking and Testing

Checking

- Check the redirector body for leakage and damage.
- Check if the connection of redirector and tubing is normal.



CAUTION

If the redirector fails, replace it.

Symbol	Interface Function	Connection Terminals	Interface Size
T	Drain back	Tank	M18×1.5
P	Oil Inlet	Gear Pump	M20×1.5
L	Left turning, steering wheel controls	Steering Bridge	M18×1.5
R	Right turning, steering wheel controls	Steering Bridge	M18×1.5
EF	Port, to the Port P of multi-way valve	Multi-way Valve	M20×1.5

7.6.2 Faults and Causes

1	Fault	Oil leaks
	Cause	a. Redirector defects. b. Poor sealing with leakage.
2	Fault	Redirector is not functioning properly or noise
	Cause	a. Redirector defects. b. Insufficient oil. c. There is air in the oil. d. High viscosity of oil. e. Pressure of relief valve adjusted too low or adjustment failure.

7.7 Tilt Cylinder

7.7.1 Cylinder Removal Precautions

- Before removing the cylinder, relieve the hydraulic circuit first by lowering the lifting mast to the bottom. This helps to avoid high pressure hydraulic oil spray that could cause personal injury.

Turn off the power source, so the entire hydraulic system will stop functioning, then the connecting tubing can be loosened; to avoid the residual pressure within the circuit, the tubing joint should be loosened slowly, loosen the joint by half and shake the tubing to see if there is overflow of pressured oil, and then go on with the removal.

- Cylinder is the powered actuator in the hydraulic system. Therefore, before removing the cylinder from the equipment, the connection part must be supported to avoid personal injury or damage to the equipment.
- Upon disassembly of the cylinder, know the main structure of the cylinder to avoid sightless removal. Due to the different size, structure, purpose of use of the cylinders, the sequences and methods used for removal are also different.
- When removing each part, do not hammer forcefully, in such case that cannot be avoided, lay a copper rod on top to avoid damage to the parts; special tools must be used for the parts having such requirements, do not hammer forcefully or pry. Fine pitch threaded cylinder cap, after being shaken loose, loosen it with cylinder wrench with even force, copper rod can be used to hammer the part that cannot easily deform, do avoid violent shocks.

- Upon removal, be careful not to damage cylinder threads, oil port threads, cylinder cap threads, piston rod surface and inner cylinder wall.

To prevent piston rod from bending or deformation, support it with a wooden block when placing.

When removing seals, the use of sharp tools should be avoided, so as not to stab the seals. For the seals that are difficult to remove, soak them with boiled water, remove them when softened.

- Before removing, try to create conditions to prevent the cylinder parts from being contaminated by the surrounding dust and impurities. For example, try to disassemble the equipment in a clean environment; after the disassembly, all parts should be covered with plastic, do not cover with cotton cloth or other cloth used during operation.
- For the cylinder which is found with internal or external leakage during use, if the piston rod or cylinder tube is not scratched, such case may be due to wear or aged seals.



CAUTION

When the seals need to be replaced, replace them with the complete set of seals in the cylinder repair kit.

- Pay special attention to the cylinder tube, piston rod and other moving parts for bumps and scratches. If only minor damage, sand the edge point around the damaged part with fine stone and then polish the part smooth with metallographic sandpaper.

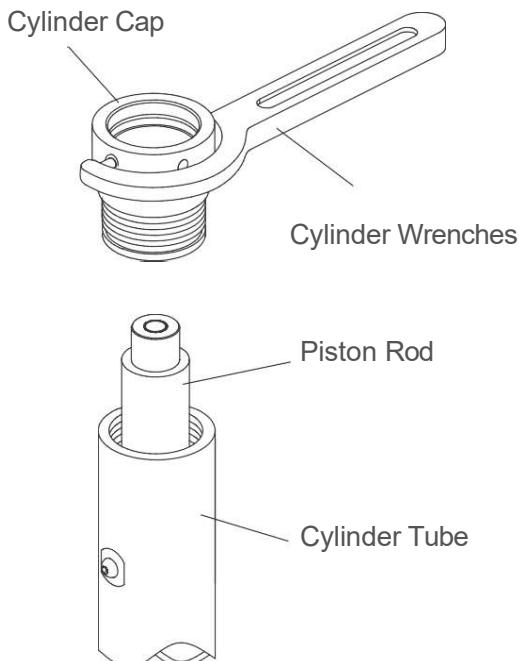


Fig0000-90001SM

- * See Appendix A - Service Manual - Mast for the removal of lift cylinder and side shift cylinder.

7.7.2 Cylinder Installation Precautions

- All parts should be cleaned up before assembly, then to be assembled after being dried; (during assembly, apply appropriate amount of hydraulic oil for lubrication)
- The tools used to install the seals must be made of soft metal or suitable plastic, without burrs and sharp edges on surfaces. It is prohibited to use tools that can easily damage the surface of seals, such as screwdriver or other similar tools with hard front edges.

Where seals are installed should be free of burrs, sharp edges, and cracks. If the installation of seals needs to cross sharp edges, grooves or cuts, protective devices must be used for protection. Before installing, hydraulic oil should be applied to the seals and the mounting positions.

CAUTION

- O-ring is flexible and easy to install, but it must not be stretched to the extent of permanent deformation, nor rolled while installing.
- Y-ring or X-ring needs to be identified if it is for shaft or hole to avoid misplacement.
- The removed O-rings and dust rings should be replaced with new ones.
- Cylinder parts must not be arbitrarily replaced, the original products provided by the manufacturer should be used.
- After maintenance and assembly of the cylinder is completed, pressure leak testing must be carried out before it can be put operation once again.

Before the testing, discharge the air within the cylinder, run the cylinder in a small range of movement for several times, and pay

attention if it is moving without blocking and if there is uneven resistance while moving. When pressure testing, raise the pressure slowly and observe carefully for leaks.

- * See Appendix A - Service Manual - Mast for the installation of lift cylinder and side shift cylinder.

7.7.3 Removal and Installation

The cylinder is installed on the chassis and outer mast.

- Fix the masts, block the truck wheel with a wooden wedge, press the emergency stop switch and disconnect the key switch.
- Remove the pedal from the cabin.
- Remove the two tubes (6) from the tilt cylinder (3).



CAUTION

Hydraulic oil may damage truck parts and contaminate the environment. When removing joints or tubing, place a clean container under it for discharge of hydraulic oil.

- Unscrew the anchor bolt (1) from the outer mast with socket wrench and pull out the pin shaft (2).

- Unscrew the anchor bolt (4) from the chassis with socket wrench and pull out the pin shaft (5).
- Remove the tilt cylinder (3).
- Replace it with a new cylinder and install in reverse order.
- Add hydraulic oil of the same specifications into the tank, see Section 2.2.3.
- Pull out the emergency switch and turn on the key switch.
- Repeat tilt cylinder to discharge the air within the tubing and cylinder.
- Check the hydraulic oil level and make sure that the liquid is at standard level.

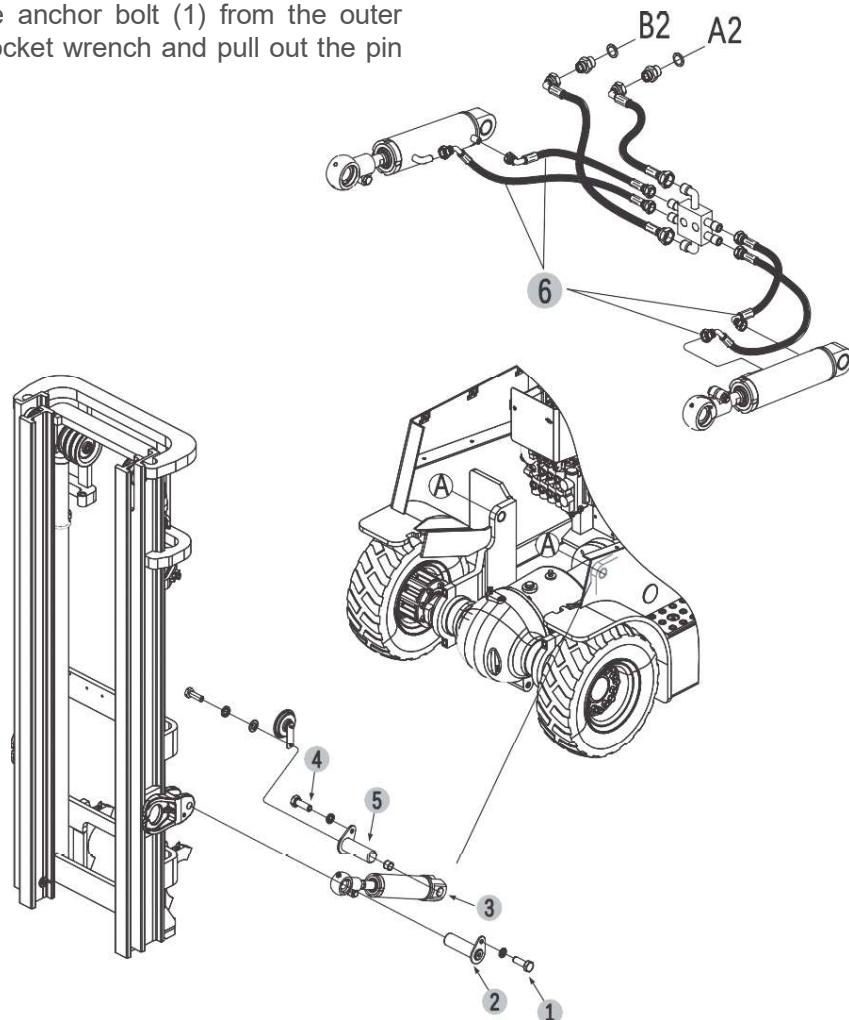


Fig3112-40003SM

7.7.4 Cylinder Maintenance ($H \geq 4350\text{mm}$)

⚠ CAUTION

- Use suitable hose clamps to avoid cylinder deformation caused by severely tight hose clamps.
- Carry out the maintenance work in a clean environment to prevent impurities from entering into cylinder, causing cylinder damage.
- During the installation, hydraulic oil of the same specifications must be used for cleaning or lubrication.

- Secure the cylinder to hose clamp and gently clamp the cylinder bottom.
- Unscrew the nut (4, Fig3530-40004SM) and bolt (3), then remove the ear (2) from the piston rod (18).
- Unscrew the cylinder cap (13) with cylinder wrench.
- Remove the dust ring (6), check ring (7), retainer ring (8), seal (9), and check ring (10) from the cylinder cap (13).
- Remove the bearing (14), O-ring (11) and retainer ring (12) from the cylinder cap (13).
- Pull out the piston rod (18) from cylinder block (15).
- Remove the seal (16) and support ring (17) from the piston rod.
- Clean with hydraulic oil of the same specifications.
- Replace the problem parts and assemble in reverse steps.

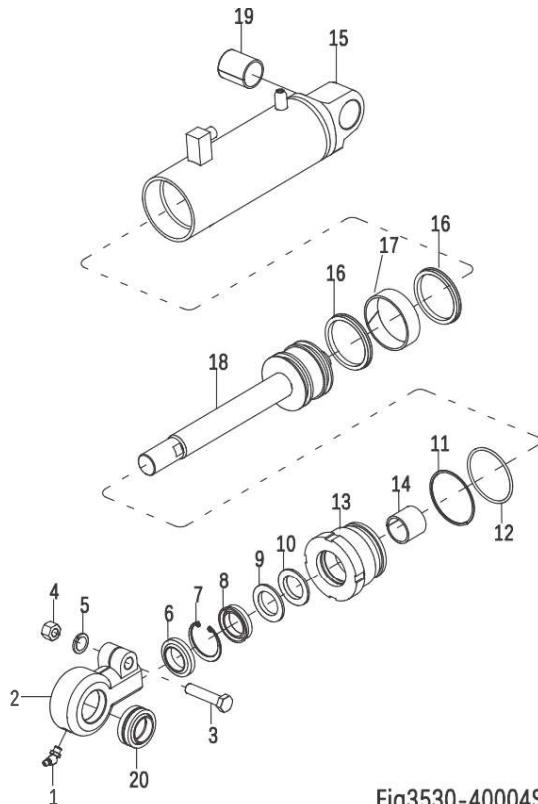


Fig3530-40004SM

⚠ CAUTION

- If the piston rod or cylinder tube is damaged, replace the entire cylinder.
- If the seals are aged or damaged, replace the complete set of seals.
- When replacing or repairing the cylinder, refill the lubricant through the grease nipples at both ends of the cylinder.

7.7.5 Cylinder Maintenance (H<4350mm)

 **CAUTION**

- Use suitable hose clamps to avoid cylinder deformation caused by severely tight hose clamp.
- Carry out the maintenance work in a clean environment to prevent impurities from entering into the cylinder, causing cylinder damage.
- During the installation, hydraulic oil of the same specifications must be used for cleaning or lubrication.

- Secure the cylinder to hose clamp and gently clamp the cylinder bottom.
- Unscrew the nut (20, Fig3112-40004SM) and bolt (21), then remove the ear (2) from the piston rod (3).
- Unscrew the cylinder cap (6) with cylinder wrench.
- Remove the dust ring (4), circlip (5), check ring (7), snap ring (8) and seal (9) from the cylinder cap (13).
- Remove the support ring (10), snap ring (11) and O-ring (12) from the cylinder cap (13).
- Pull out the piston rod (3) from cylinder block (13).
- Unscrew the nut (18), remove the piston rod (3) from the piston (14).
- Remove the two seals (15) and support ring (17) from the piston (14).

- Clean with hydraulic oil of the same specifications.
- Replace the problem parts and assemble in reverse steps.

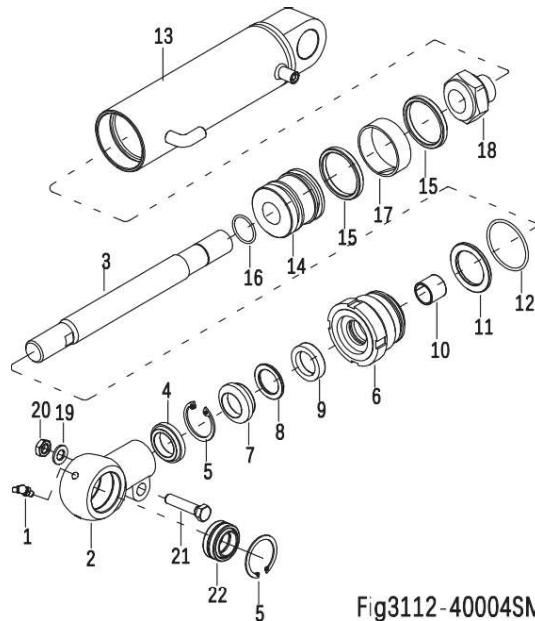


Fig3112-40004SM

 **CAUTION**

- If the piston rod or cylinder tube is damaged, replace the entire cylinder.
- If the seals are aged or damaged, replace the complete set of seals.
- When replacing or repairing the cylinder, please refill the lubricant through the grease nipples at both ends of the cylinder.

7.8 Hydraulic Troubleshooting

Fault Symptom		Failure Causes	Troubleshooting Measures
1	Noisy pump	a. Insufficient oil. b. High viscosity of oil. c. Oil suction pipe air leak. d. Filters clogged by impurities. e. Hydraulic oil with foam.	1. Check the hydraulic oil level. 2. Replace the hydraulic oil. 3. Check the oil suction pipe. 4. Clean the oil inlet piping, replace the filter, if necessary. 5. See Fault 2.
2	Hydraulic oil with foam	a. Pump cavitation. b. There is water in the oil.	1. Check the amount of oil. 2. Check if the viscosity of hydraulic oil is normal. 3. Check the oil inlet piping for air leaks. 4. Discharge and clean and replace with new hydraulic oil.
3	Pump or oil temperature is too high	a. Oil is too thin. b. Pump cavitation. c. Valve body internal relief.	1. Discharge, clean, and add new hydraulic oil. 2. Check the oil inlet piping for air leaks. 3. Replace the valve body.
4	Low System Pressure	a. Insufficient oil. b. Relief valve failure. c. Pump wear, internal leakage.	1. Check the hydraulic oil level. 2. See Fault 6. 3. Replace the gear pump.
5	On load, declined	a. Solenoid valve failure. (TW Series) a. Multi-way valve failure. (TV Series)	1. Check and clean the solenoid valve spool. 1. Check the multi-way manual valve and its installation.
6	Relief valve pressure unstable or too low	a. Pressure adjustment screw too loose. b. Relief valve spring breakage or deformation. c. Relief valve spool wear or blocked.	1. Adjust to proper pressure through hydraulic pressure gauge. 2. Replace the relief valve. 3. Clean or replace the relief valve.

7.9 Hydraulic Symbol

Symbol	Description	Symbol	Description
	Tank Pipe end below liquid level		Explosion-proof valve
	Tank Pipe end above liquid level	M○—	Check valve
—△—	Filter		Cylinder Single-acting direction
	Service line (Supply or return line)		Cylinder Double-acting direction
	Control line (Drain line)		Relief valve
•	Connecting pipe	—○—	Solenoid valve Two-way two-pass
—→	Port (Test port)	—X—	Solenoid valve Three-way four-pass
(M)	Motor		Balancing valve
○▲	Hydraulic pump	—X—	Manual valve Three-way six-pass
—○—	Brake valve		Speed regulating valve

STEERING SYSTEM

8.1 Steering Bridge

8.1.1 Removal and Installation

Removal

- Fix the wheels with triangular wooden wedge.

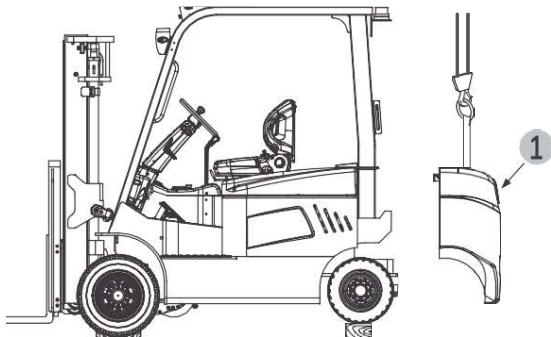


Fig3131-70002SM

- Lift the counter-weight (1) slightly, unscrew two bolts and remove the counter-weight (1) from the chassis.
- Place a wooden wedge under the chassis near steering wheel, make the wheel off the ground.



WARNING

Make sure the lifting equipment is solid and secure, and the load capacity should be greater than the total weight of the vehicle.



WARNING

When replacing wheels, be sure that the truck won't tilt.

- Remove the steering wheels; (See Section 4.1)

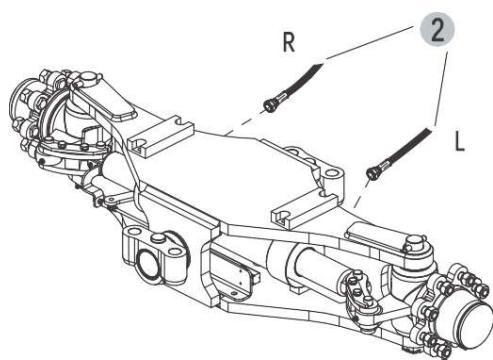


Fig3131-70003SM

- Remove the two tubes (2, Fig3131-70003SM) from the steering bridge.
- Remove the steering displacement sensor. (See Section 8.2)

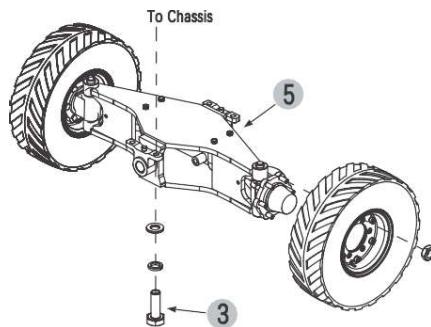


Fig3112-70002SM

- Unscrew the four bolts (3) and remove the steering bridge (5) from the frame.

Installation

- Install in the reverse order of removal.

8.1.2 Faults and Causes

	Fault	Steering Bridge Abnormal Noise
1	Cause	a. Supporting bearing wear. b. Gear wear, the gap is too big.
2	Fault	Steering Bridge Oil Leaks
	Cause	Oil seal wear or aged
3	Fault	Steering Bridge Stuck
	Cause	a. Gear damage. b. Support bearing damage.

8.1.3 Component

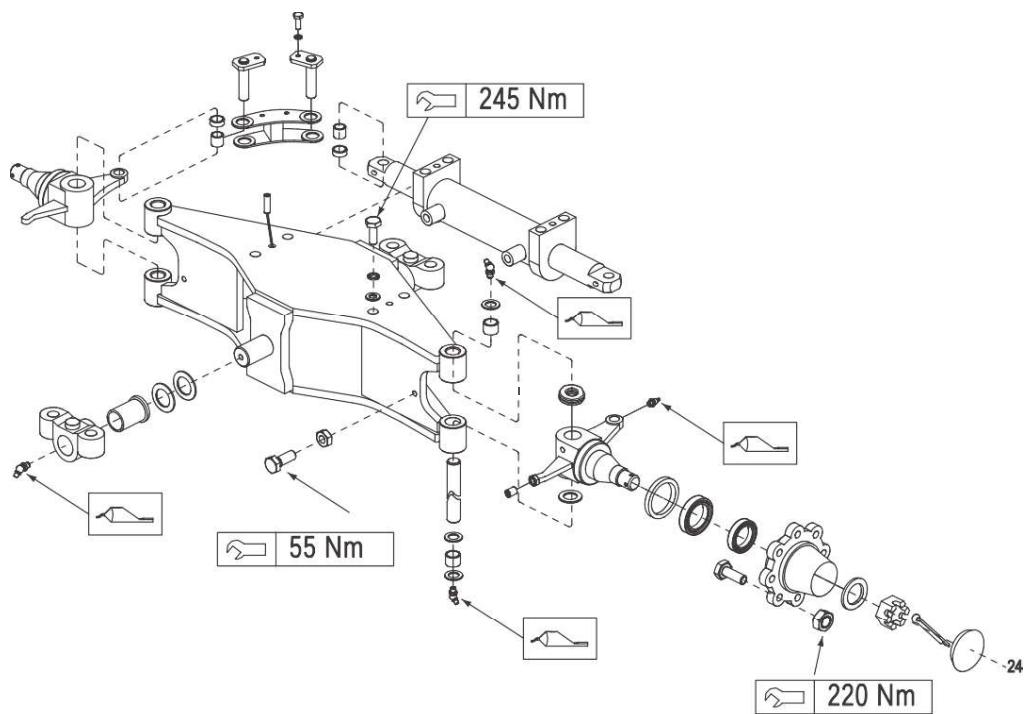


Fig3112-70003S

Please add grease (see Section 2.2.3 for specification).

Be sure to bend the cotter pin.

8.2 Steering Cylinder

8.2.1 Removal and Installation

See Section 8.1.3

8.2.2 Cylinder Maintenance

CAUTION

- Use suitable hose clamps to avoid cylinder deformation caused by severely tight hose clamps.
- Carry out the maintenance work in a clean environment to prevent impurities from entering into cylinder, causing cylinder damage.
- During the installation, hydraulic oil of the same specifications must be used for cleaning or lubrication.
- Secure the cylinder to hose clamp and gently clamp the cylinder middle.
- Unscrew the cylinder cap (4) with cylinder wrench.
- Remove the dust ring (9), seal-ring (5), O-ring (2) from the cylinder cap (4).

- Pull out the piston rod (10) from cylinder block (1).
- Separate the piston (14) from the piston rod.
- Remove the spacer O-ring (12) and (15), seal, support ring from the piston (14).
- Clean with hydraulic oil of the same specifications.
- Replace the problem parts and assemble in reverse steps.

CAUTION

- If the piston rod or cylinder tube is damaged, replace the entire cylinder.
- If the seals are aged or damaged, replace the complete set of seals.
- When replacing or repairing the cylinder, refill the lubricant through the grease nipples at both ends of the cylinder.

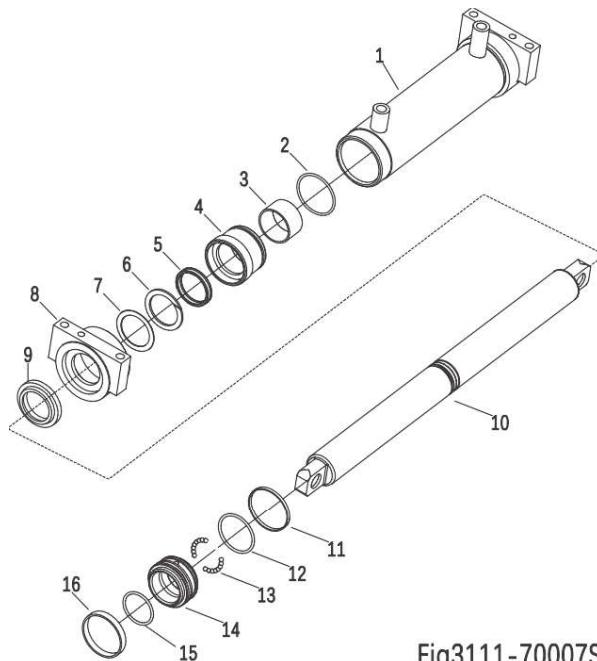


Fig3111-70007SM

ELECTRICAL SYSTEM

9.1 Controller

Controller Functions

Electrical control of this truck is mainly driven by master controller.

9.1.1 Removal and Installation

Removal

- Fix the wheels with triangular wooden wedge.
- Open the battery cover.
- Remove the wiring harness, cables on the controller.
- Unscrew the four screws (1) with a wrench and remove the controller (2) from the mounting plate.
- Unscrew the two screws (3) and remove the main contactor (4) from the chassis.
- Unscrew the four screws (5) and remove the DC-DC converter (6) from the chassis.

Installation

- Apply appropriate amount of thermal grease on the back of controller.
- Place the controller onto the electrical mounting plate, tighten the screws with a wrench.
- Plug the wiring harness and cables into corresponding ports.

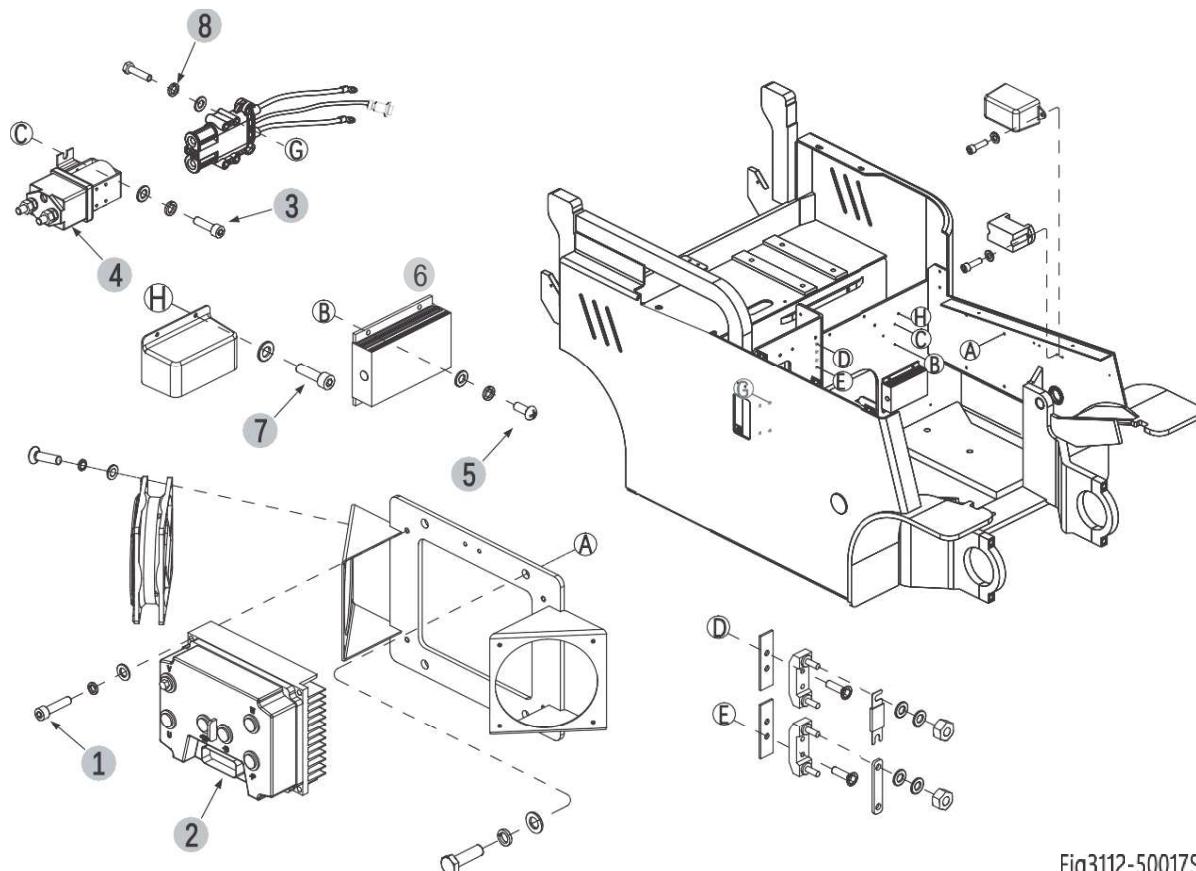


Fig3112-50017SM

ELECTRICAL SYSTEM

9.1.1 Controller Interface Function

Controller (COMBIAC0)

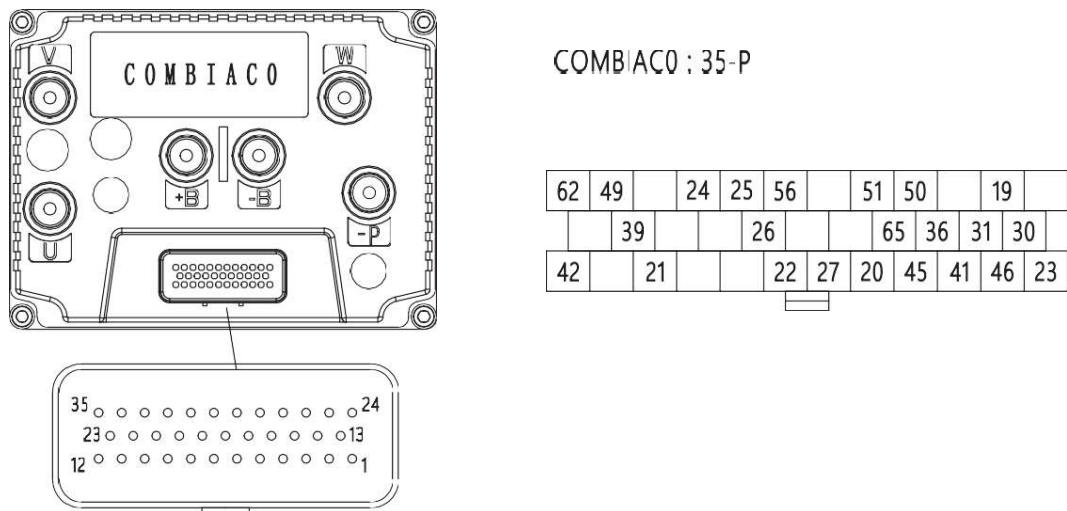


Fig3112-50002SM

A Interface		
Pin No.	Signal Name	Description
A#1	DI0	Digital input DI0.
A#2	PEB	Positive supply of the electromechanical brake.
A#3	PAUX	Positive supply of electrovalves: EV1, EV2, EV3, EV4, EV5, EVP1, EVP2, HORN.
A#4	NEB	Driving output for the electromechanical brake (driving to -B).
A#5	NENC	Negative of the Encoder.
A#6	DI2	Digital input DI2.
A#7	DI6	Input of the switch DI6.
A#8	EV5	Driving output for the on/off electrovalve EV5.
A#9	EV1	Driving output for the on/off electrovalve EV1 (driving to -B).
A#10	KEY	Input of the key switch signal.
A#11	EV2	Driving output for the PWM voltage-controlled electrovalve EV2 (driving to -B).
A#12	NMC	Driving output for the main contactor (driving to -B).
A#13	ENCB	Phase B of the traction motor encoder.

ELECTRICAL SYSTEM

A Interface - Continued		
Pin No.	Signal Name	Description
A#14	ENCA	Phase A of the traction motor encoder.
A#15	CPOTTR	Accelerator potentiometer wiper.
A#16	DI10	Digital input DI10.
A#17	DI8	Digital input DI8.
A#18	DI11	Digital input DI11.
A#19	DI5	Digital input DI5.
A#20	DI1	Input of the switch DI1.
A#21	DI12	Digital input DI12.
A#22	THMOT	Traction motor thermal sensor input.
A#23	EVP2	Driving output for the second PWM current-controlled electrovalve (driving to -B).
A#24	LOWER EVP1	Negative of the lower proportional electrovalve driver (driving to -Batt).
A#25	PENC	Positive supply for external devices (encoder, potentiometers, etc.) +12 /+5 V, 150 mA maximum.
A#26	HORN	Driving output for the horn electrovalve (driving to -B).
A#27	CANL	Low-level CAN bus line.
A#28	CANH	High-level CAN bus line.
A#29	DI9	Digital input DI9.
A#30	CPOTL/NPOT	Lift/Lower potentiometer wiper input.
A#31	DI4	Digital input DI4.
A#32	DI3	Digital input DI3.
A#33	EV3	Driving output for the PWM voltage-controlled electrovalve EV3 (driving to -B).
A#34	EV4	Driving output of the on/off electrovalve EV4 (driving to -B).
A#35	DI7	Digital input DI7.

Terminal stud		
Pin No.	Signal Name	Description
-	-B	Negative battery termination.
-	+B	Positive battery termination.
-	U, V, W	Connection bars of the three motor phases; follow this sequence and the indication on the motor.
-	-P	Negative terminal of pump DC motor (COMBIAC0 only).

ELECTRICAL SYSTEM

9.2 Fuse

Function		Status							
		Fuse 1	Fuse 2	Fuse 3	Fuse 4	Fuse 5	Fuse 6	Power fuse	
Fuse 1	5A	×	○	○	○	○	○	○	○
Fuse 2	10A	○	×	○	○	○	○	○	○
Fuse 3	5A	○	○	×	○	○	○	○	○
Fuse 4	10A	○	○	○	×	○	○	○	○
Fuse 5	5A	○	○	○	○	×	○	○	○
Fuse 6	5A	○	○	○	○	○	×	○	○
Power fuse 350A		○	○	○	○	○	○	○	×
1	Drive	×	○	○	○	×	×	×	×
2	Hydraulic Action	×	○	○	○	×	×	×	×
3	Steering	×	×	○	○	×	×	×	×
4	Instrument	×	○	○	○	○	○	○	×
5	Turn Signal/Warning Light	○	×	○	○	○	○	○	×
6	Horn	○	○	×	○	○	○	○	×
7	Headlight	○	○	○	○	○	○	○	×
8	Reversing Light	×	○	○	×	○	○	○	×
9	Buzzer	○	○	○	○	○	○	○	×
10	Brake Light	○	○	×	○	×	○	○	×
11	Fan	×	×	○	○	○	○	○	×

× : Failure

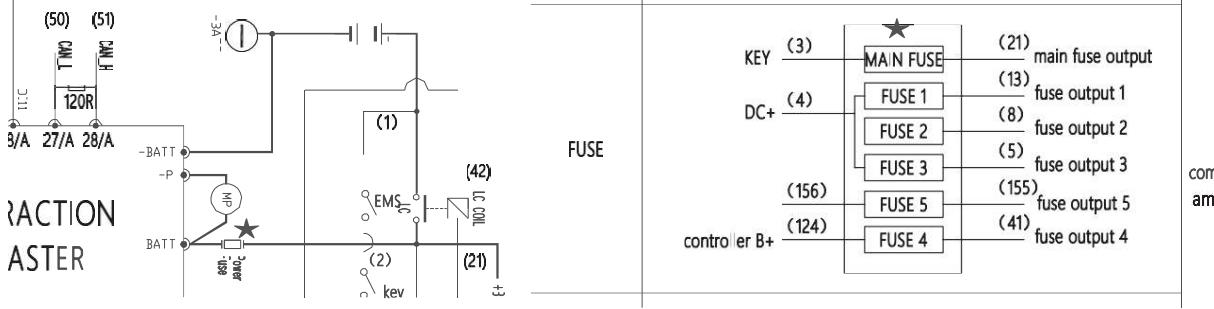
○ : Normal

9.2.1 Location of Fuses

Main fuse and Fuse 1-6: installed in fuse box.

Power fuse 350A: installed in electrical plate.

★ Fuse position in electrical schematic diagram



9.2.2 Checking and Testing

Checking

- Check the fuses for damage, check the connectors at terminal lugs for loosening or poor connection of leads.

Testing

- Turn the key switch to 'OFF', remove key; pull out the battery plug and disconnect the power supply.
- Set the multimeter to resistance measurement: with black probe (-) connected to one end of the fuse; red probe (+) connected to another end of the fuse.
- Identify if the fuse is normal according to the multimeter resistance readings as shown in the following table:

Resistance Measurement	Judgment
0 Ω	Normal
∞ Ω	Failure (replace the fuse)

ELECTRICAL SYSTEM

9.3 Main Contactor

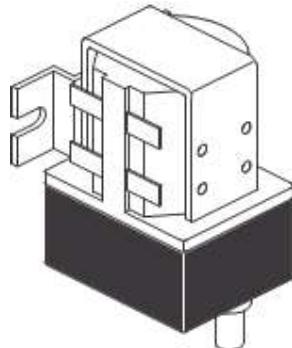


Fig1221-50008SM

This truck uses DC contactors with normally-open contacts. And the ON/OFF of the contactors is controlled through controller, to achieve the control of ON/OFF of the vehicle.

When the contactor coil is energized, the coil current will create a magnetic field, making the static stator core produce a steady magnetic force to absorb the core and drive the contactor actions: normally-opened contact connected, so the circuit is disconnected.

When the contactor coil is powered off, the magnetic force disappears, the pressure plate is released along with the release of spring, and the contact recovers: normally-opened contact disconnected, so the circuit is disconnected.

9.3.1 Removal and Installation

Main contactor is installed on the chassis.

- See Section 9.1.1.

9.3.2 Faults and Causes

	Fault	Contact adhesion or slow release
1	Cause	a. Contact fusion welding. b. Contact spring pressure is too low. c. Mechanical moving parts blocked, shaft rusted or crooked. d. Anti-force spring damaged.
		Fault Contact not absorbed or not fully absorbed
2	Cause	a. Insufficient voltage of battery. b. Main contactor coil open circuit. c. Mechanical moving parts blocked, shaft rusted or crooked. d. Control contact poor contact.

9.3.3 Checking and Testing Visual

Inspection

- Check the surface and appearance of contactor.
- Visually check the surface of contactor for scratches, damage, and stains.
- If any of the above case is found, replace with new contactor.

Coil Checks

- Disconnect the cables on the contactor.
- Check the resistance of the coil with a multimeter: measurement method is as shown in Fig1221-50009SM.
- Identify if the contactor is normal according to the readings of resistance on the multimeter. As shown in the following table:

Resistance Measurement	Judgment
Approx. 145 Ω	Normal
0 Ω	Coil shorting (replace the contactor)
∞ Ω	Coil breaking (replace the contactor)

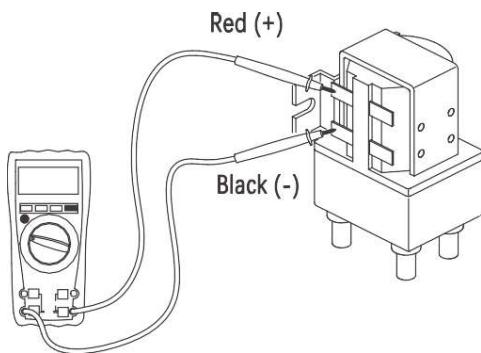


Fig1221-50009SM

Contact Checks

- Check if the surface of contact surface is smooth and symmetrical.
- Separately provide the contact with a voltage of 48V to observe if the contact can engage.
- If the surface is uneven or the contact does not engage, replace the main contactor.

9.3.4 Control Circuit Troubleshooting

Main Contactor Control Circuit (Fig3112-50003SM)

Check if the circuit is broken by using a multi- meter:

- Set the multimeter to ON-OFF.
- Check if #21/#42 circuit (circuit between contactor and controller) is conducted.

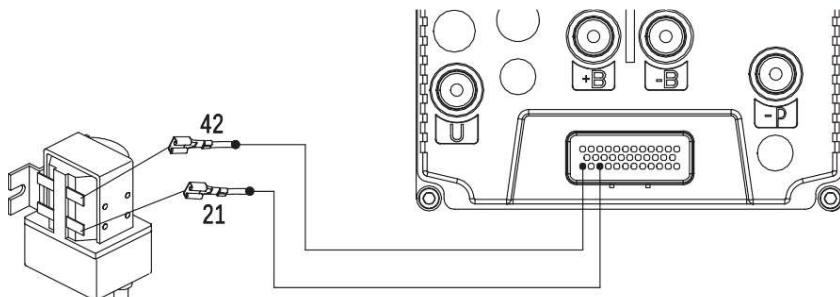


Fig3112-50003SM

ELECTRICAL SYSTEM

9.4 DC-DC Converter

48V DC-DC converter provides converted voltage, Working performance: 48V DC to 12V.

9.4.1 Removal and Installation

DC-DC converter is installed on the chassis.

- See Section 9.1.1.

9.4.2 Faults and Causes

	Fault	Turn on switches, the lights won't light up and horn does not sound
1	Cause	a. 48v DC-DC converter failure. b. 48v DC-DC converter circuit not conducted.

9.4.3 Checking and Testing

Checking

- Check if the appearance of converter and its wiring harness are in good condition, and if the connectors are connected securely.

Testing (48V DC-DC Converter)

- Check if the converter circuit is conducted.
- Provide a voltage of 48V between converter interfaces 3 and 18:
 - If there is voltage output of 12V between interfaces 4 and 17, the converter is working properly.
 - If the output voltage is not 12V, the converter needs to be replaced.

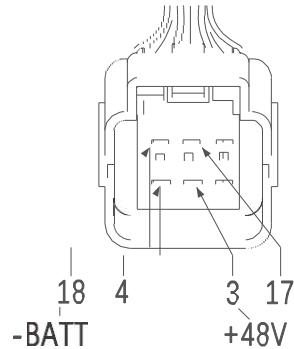


Fig3131-50021SM

- Check if the converter circuit is conducted.
- Provide a voltage of 48V between converter interfaces 21 and 18:
 - If there is voltage output of 12V between interfaces 155 and 156, the converter is working properly.
 - If the output voltage is not 12V, the converter needs to be replaced.

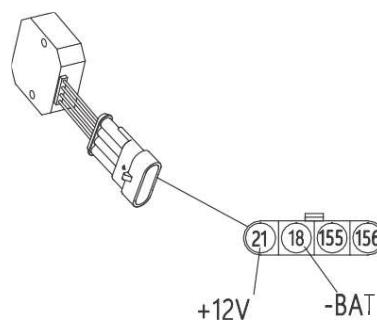


Fig3112-50015SM

9.4.4 Control Circuit Troubleshooting

48V DC-DC Converter Control Circuit

Check if the circuit is broken by using a multimeter:

- Set the multimeter to ON-OFF.
- Check if #3/#4/#17/#18 circuit is conducted.

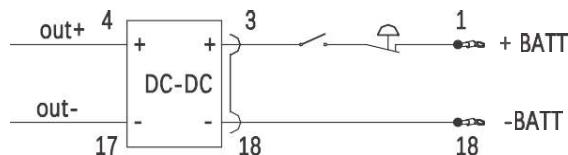


Fig3131-50022SM

12V DC-DC Converter Control Circuit

Check if the circuit is broken by using a multimeter:

- Set the multimeter to ON-OFF.
- Check if #18/#21/#155/#157 circuit is conducted.

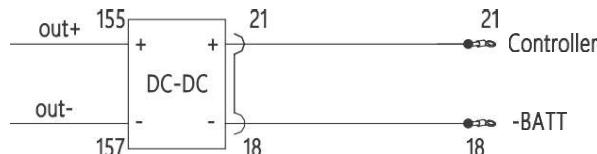


Fig3112-50014SM

ELECTRICAL SYSTEM

9.5 Combination Light / Headlight

This truck is equipped with two combination lights and two headlights.

See Section 3.1.

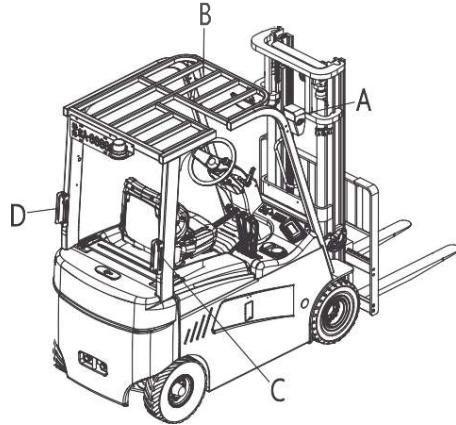
9.5.1 Removal and Installation

Removal

- Disconnect the combination light/headlight connector.
- Remove the combination light/headlight from the vehicle.

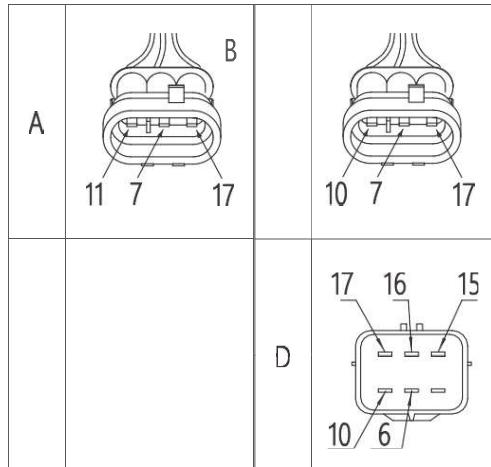
Installation

- Install in the reverse order of removal.



9.5.2 Faults and Causes

	Fault	Operate the switch, but combination light/headlight won't turn on.
1	Cause	<ul style="list-style-type: none">a. Combination light / headlight failure.b. Combination light / headlight circuit not conducted.



9.5.3 Checking and Testing

Checking

- Check if the appearance of combination warning light / front headlight and its wiring harness are in good condition, and if the connectors are connected securely.

Testing

- Check if combination warning light / front headlight circuit is conducted.
- Energize the combination warning light / front headlight with a voltage of 12V:
 - If the light is on, then it is normal.
 - If the light is not lit, then the light is faulty.

9.5.4 Control Circuit Troubleshooting

Light Control Circuit (Fig3131-50026SM)

Check if the circuit is broken by using a multimeter:

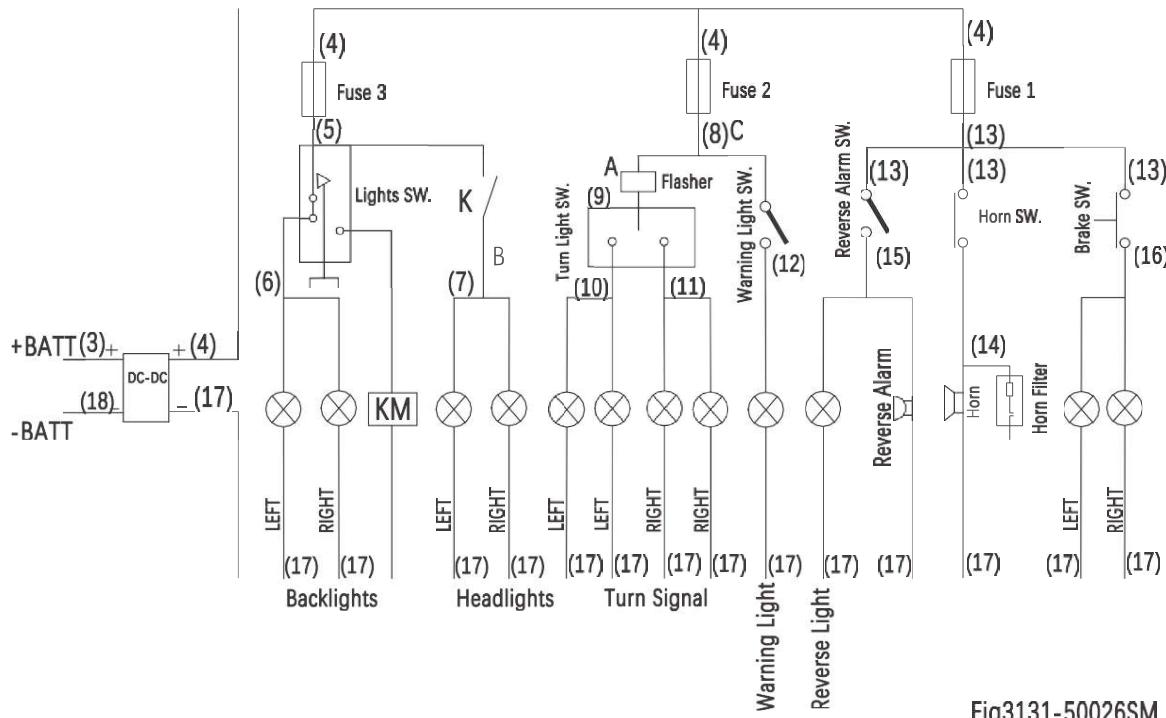


Fig3131-50026SM

ELECTRICAL SYSTEM

9.6 Seat Switch

Seat switch is mounted under the seat.

9.6.1 Removal and Installation

Removal

- Disconnect the connections between seat switch and main wiring harness.
- Remove the seat; (see Section 4.4)
- Remove the seat switch under the seat.

Installation

- Install in the reverse order of removal.

9.6.2 Faults and Causes

	Fault	Seat switch not triggered; the vehicle still can travel
1	Cause	a. Seat switch failure. b. Seat switch shorted . (short circuit)
	Fault	Seat switch triggered; the vehicle cannot travel
2	Cause	a. Seat switch failure. b. Seat switch with broken circuit.

9.7.3 Checking and Testing

Checking

Check if the appearance of the seat switch and its wiring harness are in good condition, and if the connectors are connected securely.

- Repeatedly press the seat switch to check if it can reset properly.

Testing

- Enter TESTER Menu to check the status of the switch:
- Press the seat switch if the display does not change, then it indicates the seat switch or its circuit failure. (see Section 9.8)
- Check if the seat switch circuit is conducted.
- Carry out ON/OFF test to seat switch with a multimeter: Reset the seat switch (original position), the circuit is disconnected; press the seat switch, the circuit is conducted.

9.7.4 Control Circuit Troubleshooting

Seat Switch Control Circuit

Check if the circuit is broken by using a multimeter:

- Set the multimeter to ON-OFF.
- Check if #21/#23 circuit (circuit between seat switch and master controller) is conducted.

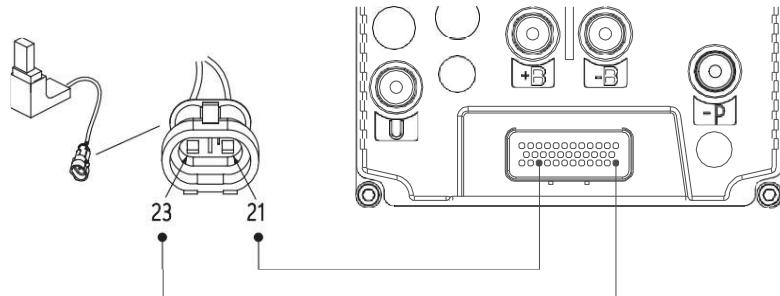


Fig3112-50008SM

ELECTRICAL SYSTEM

9.7 Display / Battery Discharge Indicator (BDI)

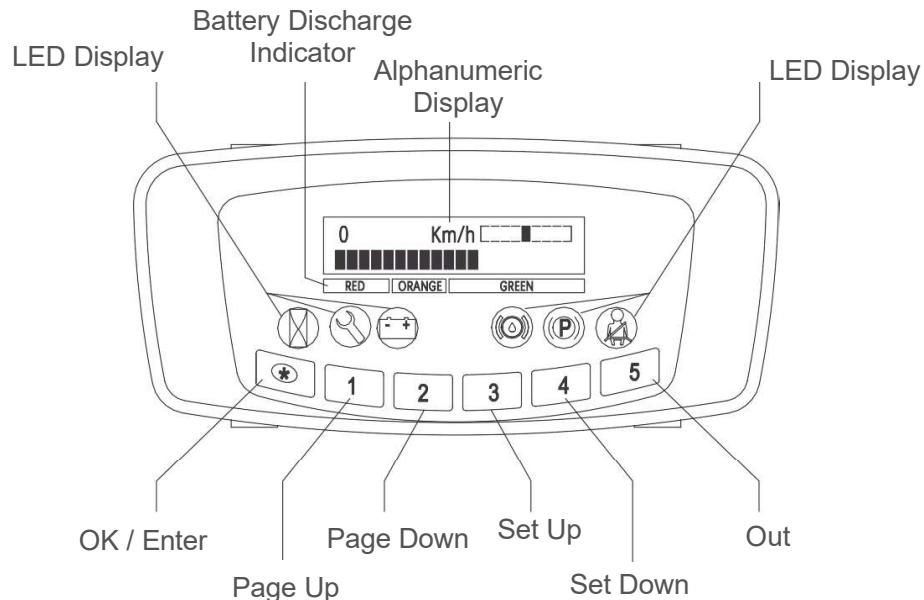


Fig3530-50019SM

Power

Only lights when power supply is OK.



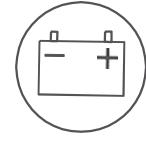
Wrench

When there is an operation failure, an error code will display on the dashboard and led lights.



Low Battery

The LED lights when the measured battery voltage is equal to or less than 20% nominal battery voltage.



Thermometer

This led lights when one truck's controller is in alarm due to IMS high temperature.



Handbrake

This led lights on when pulling on the parking brake lever.



Safety belt

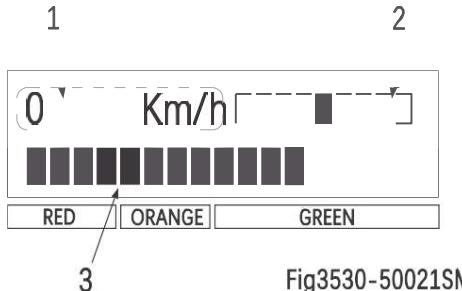
This LED illuminates when the safety belt is off.



Fig3530-50020SM

ELECTRICAL SYSTEM

Alphanumeric Display (7)



i NOTE

The display will act like a Zapi digital console.



Fig3530-50022SM

No.	Name
1	Speed
2	Wheel position and running direction / Hour meter
3	Battery's state of charge

BUTTON * = ENTER

BUTTON 1 = ROLL UP

BUTTON 2 = ROLL DOWN

BUTTON 3 = SET UP

BUTTON 4 = SET DOWN

BUTTON 5 = OUT

* See "Handheld Unit Operation Manual" for detailed operations

9.7.1 Instrument Operation Schematics

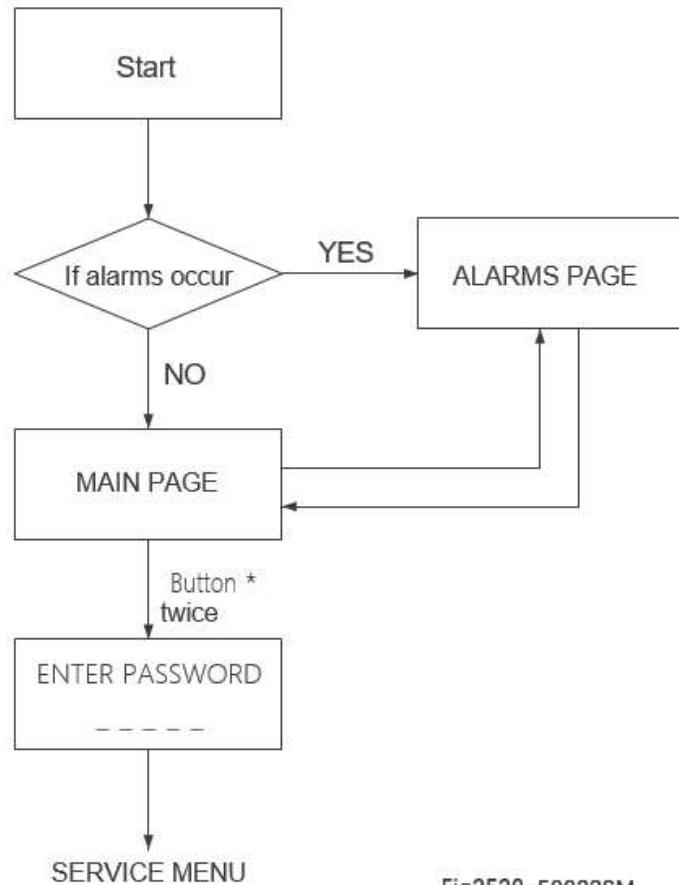


Fig3530-50023SM

9.7.2 Parameter Settings



CAUTION

It is strictly prohibited to change any of the parameters in "PARAMETER SET" without the written permission of equipment manufacturer or its agent.

NO.	Parameter	Setting
P1	Speed Proportion	
P2	Steer Enable	
P3	Speed Unit	
P4	SPE Mode Option	
P5	Start Speed	
P6	Start ACC	
P7	Language	
P8	Key Beep	
P9	Display System	
P10	Truck Type	

ELECTRICAL SYSTEM

9.8 Controller Error Message

Electrical faults are mainly caused by electrical components failure or electrical circuit failure. Wherein, when some components failures which may not affect the ON/OFF of control circuit occur, the instrument won't display fault

code (see Chapter 10 - Troubleshooting); while the when the components failures which may affect the ON/OFF of control circuit occur to the electrical circuit, the controller will sound an alarm for error, and fault information will be displayed on the instrument.

9.8.1 Controller (COMBIAC0 Master_uc)

Error Message		Possible cause	Fault elimination
Error	Error text		
8	WATCHDOG	This is a safety related test. It is a self-diagnosis test that involves the logic between master and supervisor microcontrollers.	This alarm could be caused by a CAN bus malfunctioning, which blinds master-supervisor communication.
17	LOGIC 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.	The failure lies in the controller hardware. Replace the controller
18	LOGIC FAILURE #2	Fault in the hardware section of the logic board which deals with voltage feedbacks of motor phases.	The failure lies in the controller hardware. Replace the controller.
19	LOGIC FAILURE #1	This fault is displayed when the controller detects an undervoltage condition at the KEY input. Undervoltage threshold depends on the nominal voltage of the controller	1-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 removing such loads. 2-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. 3-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.

ELECTRICAL SYSTEM

Error Message		Possible cause	Fault elimination
Error	Error text		
28	PUMP VMN LOW	The pump motor output is lower than expected, considering the PWM duty cycle applied.	<p>A) If the problem occurs at start up (the LC does not close at all), check:</p> <ul style="list-style-type: none"> - Motor internal connections. - Motor power cables connections. - If the motor connection are OK, the problem is inside the controller. <p>B) If the problem occurs after closing the LC (the LC closes and then opens back again), check:</p> <ul style="list-style-type: none"> - 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. <p>C) If the alarm occurs during motor running, check:</p> <ul style="list-style-type: none"> - 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	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.	<ul style="list-style-type: none"> -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.

ELECTRICAL SYSTEM

Error Message		Possible cause	Fault elimination
Error	Error text		
30	VMN LOW	<p>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.</p> <p>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.</p>	<p>If the problem occurs at start up (the LC does not close at all), check:</p> <ul style="list-style-type: none"> - motor internal connections (ohmic continuity). - motor power-cables connections. - if the motor connections are OK, the problem is inside the controller, replace it. <p>If the alarm occurs while the motor is running, check:</p> <ul style="list-style-type: none"> - 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.
31	VMN HIGH	<p>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.</p> <p>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.</p>	<p>A) If the problem occurs at start-up (the LC does not close), check:</p> <ul style="list-style-type: none"> - motor internal connections (ohmic continuity); - motor power cables connections. - if the motor connections are OK, the problem is inside the controller. Replace it. <p>B) If the alarm occurs while the motor is running, check:</p> <ul style="list-style-type: none"> - 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	<p>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.</p>	<p>It is suggested to verify the power contacts of LC; if they are stuck, is necessary to replace the LC.</p>

ELECTRICAL SYSTEM

Error Message		Possible cause	Fault elimination
Error	Error text		
38	CONTACTOR OPEN	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.	LC contacts are not working. Replace the LC.
52	PUMP I=0 EVER	While the pump motor is running, the current feedback is constantly stuck to zero.	1-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; 2-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	In standby, the sensor detects a current value different from zero.	The current sensor or the current feedback circuit is damaged. Replace the controller.
60	CAPACITOR CHARGE	When the key is switched on, the inverter tries to charge the power capacitors through the series of a PTC and a power resistance, checking if the capacitors are charged within a certain timeout. If the capacitor voltage results less than a certain percentage of the nominal battery voltage, the alarm is raised and the main contactor is not closed.	1-Check if an external load is 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. 2- 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. 3- The charging circuit has a failure or there is a problem in the power section. Replace the controller.

ELECTRICAL SYSTEM

Error Message		Possible cause	Fault elimination
Error	Error text		
62	TH. PROTECTION	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.	<p>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.</p> <p>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.</p>
65	MOTOR TEMPERAT.	This warning occurs when the temperature sensor is open (if digital) or if it has overtaken the MAX. MOTOR TEMP. threshold (if analog) (see paragraph 8.2.3).	<ol style="list-style-type: none"> 1- Check the temperature read by the thermal sensor inside the motor through the MOTOR TEMPERATURE reading in the TESTER function. 2- Check the sensor ohmic value and the sensor wiring. 3- If the sensor is OK, improve the cooling of the motor. 4- If the warning is present when the motor is cool, replace the controller.
66	BATTERY LOW	Parameter BATTERY CHECK is other than 0 (SET OPTION) and battery charge is evaluated to be lower than BATT.LOW TRESHLD (ADJUSTMENTS).	<ol style="list-style-type: none"> 1- Check the battery charge and charge it if necessary 2- If the battery is charged, measure the battery voltage through a voltmeter and compare it with the BATTERY VOLTAGE reading in the TESTER function. If they are different, adjust the ADJUST BATTERY parameter (ADJUSTMENTS list) with the value measured through the voltmeter. 3- If the problem is not solved, replace the logic board.

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Error Message		Possible cause	Fault elimination
Error	Error text		
74	DRIVER SHORTED	The driver of the LC coil is shorted.	1- Check if there is a short or a low impedance pull-down between NMC (A12) and -B. 2- The driver circuit is damaged; replace the logic board. 3-the SET POSITIVE PEB parameter is not correct
75	CONTACTOR DRIVER	The LC coil driver is not able to drive the load. The device itself or its driver circuit is damaged.	This type of fault is not related to external components; replace the logic board.
78	VACC NOT OK	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 above the minimum value acquired during the PROGRAM VACC procedure.	1- Check the wirings. 2- Check the mechanical calibration and the functionality of the accelerator potentiometer. 3- Acquire the maximum and minimum potentiometer value through the PROGRAM VACC function. 4- If the problem is not solved, replace the logic board.
79	INCORRECT START	Incorrect starting sequence. Possible reasons for this alarm are: 1- A travel demand active at key-on. 2- Man-presence sensor active at key on.	1- Check wirings. 2- Check microswitches for failures. 3- Through the TESTER function, check the states of the inputs are coherent with microswitches states. 4- If the problem is not solved, replace the logic board.
80	FORW + BACK	This alarm occurs when both the travel requests (FW and BW) are active at the same time.	1- Check that travel requests are not active at the same time. 2- Check the FW and BW input states through the TESTER function. 3- Check the wirings relative to the FW and BW inputs. 4- Check if there are failures in the microswitches. 5- If the problem is not solved, replace the logic board.

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Error Message		Possible cause	Fault elimination
Error	Error text		
82	ENCODER ERROR	This fault occurs when the frequency supplied to the motor is higher than 30 Hz and the signal feedback from the encoder has a too high jump in few tens of milliseconds. This condition is related to an encoder failure.	1- Check the electrical and the mechanical functionality of the encoder and the wires crimping. 2- Check the mechanical installation of the encoder, if the encoder slips inside its housing it will raise this alarm. 3- Also the electromagnetic noise on the sensor can be the cause for the alarm. In these cases try to replace the encoder. 4- If the problem is still present after replacing the encoder, the failure is in the controller
86	PEDAL WIRE KO	—	—
104	SHELF WR. IN:100	"MAXIMUM HEIGHT M" parameter out of range (under 1m or above 25.5m)	Adjust this parameter into allowed range values
105	AGV PLC E-STOP	PLC device has opened the Main Contactor and the Electric Brake coils (and the A19-DI5 input is closed to key)	This problem is due to PLC device (MIR)
106	AGV WAIT BOOT XX	Zapi controller is waiting the right behavior of the A19-DI5 input (driven by the PLC) to close the Main Contactor: "XX" = 1 --> From the key on event to "BOOT TIME A19 LO" the controller checks if the A19-DI5 input is open to key. "XX" = 2 --> From the end of the above check the controller wait "BOOT TIME TOL LO" the closing to key of the A19-DI5 input. "XX" = 3 --> From the end of the above check the controller check if the A19-DI5 input is closed to key for at least "BOOT TIME A19 HI" ; "XX" = 10 --> A19-DI5 input closed to key at the key on event; "XX" = 11 --> Check failed on point "XX" = 1; "XX" = 12 --> Check failed on point "XX" = 2; "XX" = 13 --> Check failed on point "XX" = 3;	This problem is due to PLC device (MIR)

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Error Message		Possible cause	Fault elimination
Error	Error text		
117	CAN SHELF SELEC.	CAN message timeout of the shelf selector messages between traction and pump controller.	Check can wiring
123	LIFT LIMIT ERROR	Limit SW in alarm	check the lift limit switch perform a reset of the switch (lift above the SW and lower below the SW)
125	WRONG INV. MODEL	Model TYPE and Inverter Type do not match with the HW	Check the coherence between the HW and the parameter settings
129	WRONG CONFIG	wrong set of controller type and model type	1-check the parameter controller type in ""special adjustment"" menu 2-check the parameter model type in ""special adjustment"" menu
130	REACH OUT OF RNG	reach pot out of the normal range	1-do the teaching again 2-check the wiring of the reach pot
131	VACC REACH NOTOK	the output of reach pot is present, but the enable switch is not active	1-check the reach pot 2-check the wiring

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Error Message		Possible cause	Fault elimination
Error	Error text		
132	ALL ACQU. REACH	do the wrong way of reach pot teaching	do the teaching in correct way
133	TLT OUT OF RANGE	tilt pot out of the normal range	1-do the teaching again 2-check the wiring of the tilt pot
134	VACC TILT NOT OK	the output of tilt pot is present, but the enable switch is not active	1-check the tilt pot 2-check the wiring
135	SFT OUT OF RANGE	side shift pot out of the normal range	1-do the teaching again 2-check the wiring of the side shift pot
136	VACC SHFT NOT OK	the output of side shift pot is present, but the enable switch is not active	1-check the side shift pot 2-check the wiring
137	ALL ACQU. TILT	do the wrong way of tilt pot teaching	do the teaching in correct way
138	ALL ACQU. SHIFT	do the wrong way of side shift pot teaching	do the teaching in correct way
139	NO CAN TILL EP	the controller lost the communication with EP tiller at least once when the truck is using	1-check the wiring of can cable 2-try to replace the EP tiller 3-replace the controller

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Error Message		Possible cause	Fault elimination
Error	Error text		
140	WAIT TILL EP	wait the EP tiller CAN-BUS communication when key-on	1-check the wiring of can cable 2-try to replace the EP tiller 3-replace the controller
141	NO CAN BRAKE EP	if set the PEDAL BRK TYPE is optio#1,but the controller can't get the can message from brake, the alarm occurs	1-check the wiring of can-brake 2-check if the can-brake is broken 3-try to set the PEDAL BRK TYPE=NONE
142	WAIT ACTIVATION	if download a SW with activation function, but haven't do any activation before, the alarm occurs	do activation with EP TOOLS
143	WRONG PASSWORD	if the EP PASSWORD function is active but haven't enter the correct password, the alarm occurs	1-enter the correct password 2-disable the password function
144	NO CAN DISP EP	When the truck is running, if the DISPLAY TYPE=5, but the controller lose the communication with EP DISPLAY, this alarm occurs	1-check the communication wiring between EP DISPLAY and controller 2-check if the EP DISPLAY is broken
145	WAIT DISP EP	if the DISPLAY TYPE=5, but the controller can't get message from EP DISPLAY when the truck start, this alarm occurs	1-check the communication wiring between EP DISPLAY and controller 2-check if the EP DISPLAY is broken 3-try to set the DISPLAY TYPE into a correct value
146	RENTAL TIMEOUT	if the rental function is activated, but the rental enable time is run out, this alarm occurs	1-check the rental hour left in TESTER menu 2-use EP TOOLS to disable the rental function

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Error Message		Possible cause	Fault elimination
Error	Error text		
147	NO CAN BMS EP	if the communication between BMS and controller is out of time, this alarm occurs	1-check the communication wiring between BMS and controller 2-there's a fault on BMS can device, replace the BMS
148	EP BMS MC OPEN	if the battery charge level is to low, the BMS require the main contactor open, this alarm occurs	1-check the battery charge level 2-check if the battery is ok 3-replace the BMS
149	EP BMS TRAC CTB	if the battery charge level is too low, the BMS require the controller to reduce the traction speed, this alarm occurs	1-check the battery charge level 2-check if the battery is ok 3-replace the BMS
150	EP BMS LIFT STOP	if the battery charge level is to low, the BMS require the controller to stop the lift function, this alarm occurs	1-check the battery charge level 2-check if the battery is ok 3-replace the BMS
151	EP BMS TRAC STOP	if the battery charge level is to low, the BMS require the controller to stop the traction function, this alarm occurs	1-check the battery charge level 2-check if the battery is ok 3-replace the BMS
153	OFFSET SPD. SENS.	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.	Perform the teaching procedure: in OPTIONS, select ABS SENS. ACQUIRE.
154	SIXSTEP ERROR	—	—
155	WAIT MOTOR STILL	The controller is waiting for the motor to stop rotating. This warning can only appear in controllers for brushless motors	—

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Error Message		Possible cause	Fault elimination
Error	Error text		
161	RPM HIGH	This alarm occurs in Gen. Set versions when the speed exceeds the threshold speed.	—
170	WRONG KEY VOLT.	The measured key voltage is not the right one for the inverter.	<p>1- Check if the SET KEY VOLTAGE parameter in the ADJUSTMENTS list is set in accordance with the key voltage.</p> <p>2- Check if the key voltage is ok using a voltmeter, if not check the wiring.</p> <p>3- In case the problem is not solved, replace the logic board.</p>
177	COIL SHOR. EB.	This alarm occurs when an overload of the EB driver occurs.	<p>1- Check the connections between the controller outputs and the loads.</p> <p>2- Collect information about characteristics of the coil connected to the driver and ask for assistance to a EP technician in order to verify that the maximum current that can be supplied by the hardware is not exceeded.</p> <p>3- In case no failures/problems have been found, the problem is in the controller, which has to be replaced.</p>

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Error Message		Possible cause	Fault elimination
Error	Error text		
178	MOTOR TEMP. STOP	The temperature sensor has overtaken the threshold defined by STOP MOTOR TEMP.	<p>1- Check the temperature read by the thermal sensor inside the motor through the MOTOR TEMPERATURE reading in the TESTER function.</p> <p>2- Check the sensor ohmic value and the sensor wiring.</p> <p>3- If the sensor is OK, improve the cooling of the motor.</p> <p>4- If the warning is present when the motor is cool, replace the controller.</p>
179	STEER SENSOR KO	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	<p>1- 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.</p> <p>2- If the problem is not solved, replace the logic board.</p>
180	OVERLOAD	The motor current has overcome the limit fixed by hardware.	<p>If the alarm condition occurs again, ask for assistance to a EP technician.</p> <p>The fault condition could be affected by wrong adjustments of motor parameters.</p>
181	WRONG ENC SET	Mismatch between parameters ENCODER PULSES 1 and ENCODER PULSES 2	Set the two parameters with the same value, according to the adopted encoder
182	EVP2 COIL OPEN	No load is connected between the EVP2 output and the electrovalve positive terminal.	<p>1- Check the EVP2 condition.</p> <p>2- Check the EVP2 wiring.</p> <p>3- If the problem is not solved, replace the logic board.</p>

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Error Message		Possible cause	Fault elimination
Error	Error text		
183	EVP2 DRIV. SHORT	1- The EVP2 driver is shorted. 2- The microcontroller detects a mismatch between the valve set-point and the feedback of the EVP2 output.	1- Check if there is a short circuit or a low-impedance conduction path between the negative of the coil and -B. 2- 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 EP in order to verify that the software diagnoses are in accordance with the type of coil employed. 3- If the problem is not solved, it could be necessary to replace the controller.
184	EVP2 DRIVER OPEN	The EVP2 driver is not able to drive the EVP2 coil. The device itself or its driving circuit is damaged.	This fault is not related to external components. Replace the logic board.
186	WAIT MOT.P STILL	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 because 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.	1- If the motor connected to -P is still moving, just wait for it to be still. 2- If not, in 30 seconds the alarm PUMP VMN NOT OK will appear.

ELECTRICAL SYSTEM

Error Message		Possible cause	Fault elimination
Error	Error text		
187	MANY PUMP REQ.	if there's more than one pump function request, e.g. lift + tilt, the alarm occurs	1-check the microswitches status 2-check the wiring of pump functions 3-disconnect the wire on the controller side 4-If the problem is not solved, replace the logic board.
188	PUMP VACC NOT OK	The minimum voltage of the lift potentiometer is not correctly set.	1-It is suggested to repeat the acquiring procedure of MIN LIFT and MAX LIFT 2-check the wiring of the lift pot 3-check if it's the lift pot fault
189	PUMP INC START	Man-presence switch is not enabled at pump request	1- Check wirings. 2- Check microswitches for failures. 3- Through the TESTER function, check the states of the inputs are coherent with microswitches states. 4- If the problem is not solved, replace the logic board.
190	PUMP VMN NOT OK	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 HYDRO SETTINGS). If the voltage is too low, this alarm occurs.	1- 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. 2- Motor internal connections 3- Motor power cables connections 4- Motor leakage to truck frame 5- 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	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.	This type of fault is not related to external components; replace the controller.

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Error Message		Possible cause	Fault elimination
Error	Error text		
192	PUMP VACC RANGE	For COMBIAC0 and COMBIACX, it means the output of lift pot is out of the normal range	
193	SMARTDRIVER KO	There is a hardware problem in the smart driver circuit. The driver is set to be ON but the output voltage does not increase	<p>1- Verify that the EB coil is connected correctly between pin A2 and pin A4.</p> <p>2- Verify that the parameter POSITIVE E.B. is set in accordance with the actual configuration (see paragraph 8.2.5). The software, in fact, depending on specific parameter value, makes a proper diagnosis; a wrong configuration of this parameter could generate a false fault.</p> <p>3- In case no failures/problems have been found, the problem is in the controller, which must be replaced.</p>
194	AUX BATT. SHORT.	<p>For the versions where the smart driver is not installed (36/48V and 80V), it is possible to decide where the positive supply for pin A2 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:</p> <ul style="list-style-type: none"> - 0 = PEB is managed by the smart driver (available for 24V version only). - 1 = PEB comes from the TILLER input (A1). - 2 = PEB comes from PEV (A3). PEV must be connected to terminal +B of the controller. This is the default configuration for 36/48V and 80V version. <p>This alarm can only appear if POSITIVE E.B. is set as 1 TILLER/SEAT.</p>	<p>1- Verify that the parameter POSITIVE E.B. is set in accordance with the actual coil positive supply (see paragraph 8.2.5).</p> <p>2- In case no failures/problems have been found, the problem is in the controller, which must be replaced.</p>

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Error Message		Possible cause	Fault elimination
Error	Error text		
195	POS. EB. SHORTED	The voltage on pin A2 is high even if the smart driver is turned OFF	1- Verify that the parameter POSITIVE E.B. is set in accordance with the actual coil positive supply 2- Check if there is a short or a low impedance path between pin A2 and +B. If no failures/ problems have been found, the problem is in the controller, which must be replaced.
196	MOT.PHASE SH.	Short circuit between two motor phases. The hexadecimal value "XX" identifies the shorted phases: 36: U – V short circuit 37: U – W short circuit 38: V – W short circuit	1- Verify the motor phases connection on the motor side. 2- Verify the motor phases connection on the inverter side. 3- Check the motor power cables. 4- Replace the controller. 5- If the alarm does not disappear, the problem is in the motor. Replace it.
197	WRONG SLAVE VER.	Wrong software version on supervisor uC.	Upload the correct software version
198	M/S PAR CHK MISM	At start-up there is a mismatch in the parameter checksum between the master and the supervisor microcontrollers.	Restore and save again the parameters list.
199	PARAM TRANSFER	Master uC is transferring parameters to the supervisor.	Wait until the end of the procedure. If the alarm remains longer, re-cycle the key.
200	VDC OFF SHORTED	The logic board measures a voltage value across the DC-link that is constantly out of range, above the maximum allowed value	1- Check that the battery has the same nominal voltage of the inverter. 2- Check the battery voltage. If it is out of range replace the battery. 3- If the battery voltage is ok, replace the logic board.
201	TORQUE PROFILE	There is an error in the choice of the torque profile parameters.	Check in the HARDWARE SETTINGS list the value of those parameters

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Error Message		Possible cause	Fault elimination
Error	Error text		
202	VDC LINK OVERV.	<p>This fault is displayed when the controller detects an overvoltage condition. Overvoltage threshold depends on the nominal voltage of the controller.</p> <p>Nominal voltage 24V 36/48V 72/80V 96V</p> <p>Ovvervoltage threshold 35V 65V 115V 130V</p> <p>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:</p> <ul style="list-style-type: none"> - High voltage Overvoltage condition - Low/normal voltage Undervoltage condition 	If the alarm happens during the brake release, check the line contactor contact and the battery power-cable connection.
203	HW FAULT MC	the Mcu and the Scu check the status of the main contactor is different from each other.	This type of fault is related to internal components. Replace the logic board.
204	BRAKE RUN OUT	The CPOT BRAKE input read by the microcontroller is out of the range defined by parameters SET PBRK. MIN and SET PBRK. MAX	<ol style="list-style-type: none"> 1- Check the mechanical calibration and the functionality of the brake potentiometer. 2- Acquire the minimum and maximum potentiometer values. 3- If the alarm is still present, replace the logic board.
205	EPS RELAY OPEN	The controller receives from EPS information about the safety contacts being open.	Verify the EPS functionality

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Error Message		Possible cause	Fault elimination
Error	Error text		
206	INIT VMN HIGH	Before closing the LC, the software checks the power-bridge voltage without driving it. The software expects the voltage to be in a "steady state" value. If it is too high, this alarm occurs. The hexadecimal value "XX" identifies the faulty phase: 81: phase U 82: phase V 83: phase W	1- Check the motor power cables. 2- Check the impedance between U, V and W terminals and -B terminal of the controller. 3- Check the motor leakage to truck frame. 4- 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	Before closing the LC, the software checks the power-bridge voltage without driving it. The software expects the voltage to be in a "steady state" value. If it is too low, this alarm occurs. The hexadecimal value "XX" identifies the faulty phase: 01: phase U 02: phase V 03: phase W	1- Check the motor power cables. 2- Check the impedance between U, V and W terminals and -B terminal of the controller. 3- Check the motor leakage to truck frame. 4- 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	the connection of the EEPROM is not ok	This type of fault is related to internal components. Replace the logic board.
209	PARAM RESTORE	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.	1- A travel demand or a pump request does cancel the alarm. 2- If the alarm appears at key-on without any CLEAR EEPROM performed, replace the controller.
210	WRONG RAM MEM.	The algorithm implemented to check the main RAM registers finds wrong contents: the register is "dirty". This alarm inhibits the machine operations.	Try to switch the key off and then on again, if the alarm is still present replace the logic board.

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Error Message		Possible cause	Fault elimination
Error	Error text		
211	STALL ROTOR	The traction rotor is stuck, or the encoder signal is not correctly received by the controller	<p>1- Check the encoder condition.</p> <p>2- Check the wiring.</p> <p>3- 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.</p> <p>4- If the problem is not solved, replace the logic board.</p>
212	POWER MISMATCH	The error between the power setpoint and the estimated power is out of range.	Ask for assistance from an EP technician about the correct adjustment of the motor parameters.
213	POSITIVE LC OPEN	The positive voltage of LC is different from expected.	<p>1- Verify LC coil is properly connected.</p> <p>2- Verify CONF. POSITIVE LC parameter is set in accordance with the actual coil positive supply (see paragraph 8.2.5). Software, depending on the parameter value, makes a proper diagnosis; a mismatch between the hardware and the parameter configuration could generate a false fault.</p> <p>3- In case no failures/problems have been found, the problem is in the controller, which must be replaced.</p>
214	EVP COIL OPEN	No load is connected between the EVP output (A24) and the electrovalve positive terminal.	<p>1- Check the EVP condition.</p> <p>2- Check the EVP wiring.</p> <p>3- If the problem is not solved, replace the logic board.</p>

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Error Message		Possible cause	Fault elimination
Error	Error text		
215	EVP DRIV. SHORT.	1- The EVP driver (output A24) is shorted. 2- The microcontroller detects a mismatch between the valve set-point and the feedback of the EVP output.	1- Check if there is a short circuit or a low-impedance conduction path between the negative of the coil and -B. 2- Collect information about: o the voltage applied across the EVP coil, o the current in the coil, o features of the coil. Ask for assistance to EP 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.
216	EB. COIL OPEN	This fault appears when no load is connected between the NEB output (A4) and the EB positive terminal PEB (A2)	1- Check the EB coil. 2- Check the wiring. 3- If the problem is not solved, replace the logic board.
217	PEV NOT OK	Terminal PCOM is not connected to the battery, or the voltage is different from that defined by parameter SET POSITIVE PEB (see the ADJUSTMENTS list, paragraph 8.2.3). This alarm can occur if output NAUX1 is present (and the related setting is active) or the AUX OUT function is active.	1- Check PCOM terminal: it must be connected to the battery voltage (after the main contactor). 2- Set the nominal PCOM voltage in parameter SET POSITIVE PEB in ADJUSTMENTS list (see paragraph 8.2.3).
218	SENS MOT TEMP KO	The output of the motor thermal sensor is out of range.	1- Check if the resistance of the sensor is what expected measuring its resistance. 2- Check the wiring. 3- If the problem is not solved, replace the logic board.
219	PEB-PEVP NOT OK	only for AC3 and ACE3, the PEB and PEV voltage is not match the parameter setting	1- Check PCOM terminal: it must be connected to the battery voltage (after the main contactor). 2- Set the nominal PCOM voltage in parameter SET POSITIVE PEB in ADJUSTMENTS list.

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Error Message		Possible cause	Fault elimination
Error	Error text		
220	VKEY OFF SHORTED	At key-on, the logic board measures a voltage value of the KEY input that is constantly out of range, below the minimum allowed value.	<p>1- Check that the battery has the same nominal voltage of the inverter.</p> <p>2- Check the battery voltage if it is out of range replace the battery.</p> <p>3- If the battery voltage is ok, replace the logic board.</p>
221	HANDBRAKE	Handbrake input is active.	<p>1- Check that handbrake is not active by mistake.</p> <p>2- Check the SR/HB input state through the TESTER function.</p> <p>3- Check the wirings.</p> <p>4- Check if there are failures in the microswitches.</p> <p>5- If the problem is not solved, replace the logic board.</p>
222	SEAT MISMATCH	This alarm can appear only in a Traction + Pump configuration or in a multi-motor one. There is an input mismatch between the traction controller and the pump controller relatively to the TILLER/SEAT input (A1): the two values recorded by the two controllers are different.	<p>"1- Check if there are wrong connections in the external wiring.</p> <p>2- Using the TESTER function, verify that the seat inputs are in accordance with the actual state of the external switch.</p> <p>3- In case no failures/problems have been found, the problem is in the controller, which must be replaced.</p>
223	COIL SHOR. MC (For Combi AC0/ Combi ACX and ACE4) MC-EF COIL SHOR. (For ACE2, ACE3)	This alarm occurs when an overload of the MC driver	<p>1- Check the connections between the controller outputs and the loads.</p> <p>2- Collect information about characteristics of the coil connected to the driver and ask for assistance from a certified technician to verify that the maximum current that can be supplied by the hardware is not exceeded.</p> <p>3- In case no failures/problems have been found, the problem is in the controller, which must be replaced.</p>

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Error Message		Possible cause	Fault elimination
Error	Error text		
224	WAITING FOR NODE	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.	Check if any other device on the CAN bus is in fault condition.
225	CURRENT SENS. KO	the current sensor of the controller cannot be driven or always 0	This type of fault is related to internal components. Replace the logic board.
226	VACC OUT RANGE	1- The CPOT input read by the microcontroller is not within the MIN VACC ÷ MAX VACC range, programmed through the PROGRAMM VACC function. 2- The acquired values MIN VACC and MAX VACC are inconsistent.	1- 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. 2- If the problem is not solved, replace the logic board.
227	HW FAULT	At start-up, some hardware circuit intended to enable and disable the power bridge, or the LC driver (output A12) is found to be faulty. The hexadecimal value "XX" facilitates EP technicians debugging the problem.	This type of fault is related to internal components. Replace the logic board.
228	TILLER OPEN	Tiller/seat input has been inactive for more than 120 seconds.	1- Activate the tiller/seat input. 2- Check the tiller/seat input state through the TESTER function. 3- Check the wiring. 4- Check if there are failures in the microswitches. 5- If the problem is not solved, replace the logic board.
229	HW FAULT EB.	At start-up, the hardware circuit dedicated to enable and disable the EB driver (output A4) is found to be faulty. The hexadecimal value "XX" facilitates EP technicians debugging the problem.	This type of fault is not related to external components. Replace the logic board.

ELECTRICAL SYSTEM

Error Message		Possible cause	Fault elimination
Error	Error text		
230	LC COIL OPEN	This fault appears when no load is connected between the NMC output A12 and the positive voltage (for example the KEY voltage).	<p>1- Check the wiring, to verify if LC coil is connected to the right connector pin and if it is not interrupted.</p> <p>2- If the alarm is still present, then the problem is inside the logic board; replace it.</p>
232	CONT. DRV. EV	AUX valve driver is not able to drive the load.	The device or its driving circuit is damaged. Replace the controller.
233	POWERMOS SHORTED	The DC-link voltage drops to zero when a high-side or low-side MOSFET is turned on.	<p>1- Check that motor phases are correctly connected.</p> <p>2- Check that there is no dispersion to ground for every motor phases.</p> <p>3- In case the problem is not solved, replace the controller.</p>
234	DRV. SHOR. EV	AUX valve driver is shorted.	<p>1- Check if there is a short circuit or a low impedance path between the negative terminal of the coils and -B.</p> <p>2- If the problem is not solved, replace the logic board.</p>
235	CTRAP THRESHOLD	it is a controller internal check fault	Check the parameter DUTY PWM CTRAP is correct. If the alarm is still, Ask for assistance from a certified technician
236	CURRENT GAIN	The maximum current gain parameters are at the default values, which means that the maximum current adjustment procedure has not been carried out yet.	Ask for assistance to a EP technician in order to do the adjustment procedure of the current gain parameters.

ELECTRICAL SYSTEM

Error Message		Possible cause	Fault elimination
Error	Error text		
237	ANALOG INPUT	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.	If the problem occurs permanently, it is necessary to replace the logic board.
238	HW FAULT EV.	At start-up, the hardware circuit dedicated to enable and disable the EV drivers is found to be faulty. The hexadecimal value "XX" facilitates EP technicians debugging the problem.	This type of fault is not related to external components. Replace the logic board.
239	CONTROLLER MISM.	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.	1- Upload the correct firmware. 2- Ask for assistance to a EP technician in order to verify that the firmware is correct.
240	EVP DRIVER OPEN	The EVP driver is not able to drive the EVP coil. The device itself or its driving circuit is damaged.	This fault is not related to external components. Replace the logic board.
241	COIL SHOR. EVAUX	This alarm occurs when an overload of the EV drivers occurs.	1- Check the connections between the controller outputs and the loads. 2- Collect information about characteristics of the coils connected to the drivers and ask for assistance to a EP 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 must be replaced.

ELECTRICAL SYSTEM

Error Message		Possible cause	Fault elimination
Error	Error text		
242	OPEN COIL EV.	"This fault appears when no load is connected between one or more EV outputs and the positive terminal PEV (pin A3). For the meaning of code "XX", refer to paragraph 10.5 EVP1=BIT 0 EV1=BIT 1 EV2=BIT 2 EV3=BIT 3 EVP2=BIT 4 EV4=BIT 5 EV5=BIT 7 HORN=BIT 6"	1- Check the coils. 2- Check the wiring. 3- If the problem is not solved, replace the logic board.
243	THROTTLE PROG.	A wrong profile has been set in the throttle profile.	Set properly the throttle-related parameters
244	WARNING SLAVE	Warning on supervisor uC.	Connect the Console to the supervisor uC and check which alarm is present.
245	IQ MISMATCHED	The error between the Iq (q-axis current) setpoint and the estimated Iq is out of range.	Ask for assistance from an EP technician in order to do the correct adjustment of the motor parameters.
246	EB. DRIV.OPEN	The EB coil driver is not able to drive the load. The device itself or its driving circuit is damaged.	This type of fault is not related to external components. Replace the logic board.
247	DATA ACQUISITION	Controller in calibration state.	The alarm ends when the acquisition is done.
248	NO CAN MSG.	CANbus communication does not work properly. The hexadecimal value "XX" identifies the faulty node.	1- Verify the CANbus network (external issue). 2- Replace the logic board (internal issue).
249	CHECK UP NEEDED	This is a warning to point out that it is time for the programmed maintenance.	Turn on the CHECK UP DONE option after that the maintenance service.

ELECTRICAL SYSTEM

Error Message		Possible cause	Fault elimination
Error	Error text		
250	THERMIC SENS. KO	The output of the controller thermal sensor is out of range.	This kind of fault is not related to external components. Replace the controller.
251	WRONG SET BAT.	At start-up, the controller checks the battery voltage (measured at the KEY input A10) and it verifies that it is within a range of $\pm 20\%$ around the nominal value.	<p>1- Check that the SET BATTERY parameter inside the ADJUSTMENTS list matches the battery nominal voltage.</p> <p>2- If the battery nominal voltage is not available for the SET BATTERY parameter inside the ADJUSTMENTS list, record the value stored as HARDWARE BATTERY RANGE parameter in the SPECIAL ADJUST. list and contact an EP technician.</p> <p>3- Through the TESTER function, check that the KEY VOLTAGE reading shows the same value as the key voltage measured with a voltmeter on pin A10. If it does not match, then modify the ADJUST BATTERY parameter according to the value read by the voltmeter.</p> <p>4- Replace the battery.</p>
253	FIELD ORIENT. KO	The error between the Id (d-axis current) setpoint and the estimated Id is out of range.	Ask for assistance from an EP technician in order to do the correct adjustment of the motor parameters.
254	EB. DRIV.SHRT.	1- The EB driver is shorted. 2- The microcontroller detects a mismatch between the valve setpoint and the feedback at the EB output.	<p>1- Check if there is a short or a low impedance path between the negative coil terminal and -B.</p> <p>2- Check if the voltage applied is in accordance with the parameter's settings.</p> <p>3- If the problem is not solved, replace the controller.</p>

ELECTRICAL SYSTEM

8.9.2 Controller (COMBIAC0 SLAVE uc)

Error Message		Possible Cause	Fault Elimination
Error	Error Text		
17	LOGIC 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.	The failure lies in the controller hardware. Replace the controller
19	LOGIC FAILURE #1	This fault is displayed when the controller detects an undervoltage condition at the KEY input. Undervoltage threshold depends on the nominal voltage of the controller	<p>1-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 removing such loads.</p> <p>2-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.</p> <p>3-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.</p>
195	WRONG CONFIG	wrong set of controller type and model type	<p>1-check the parameter controller type in "special adjustment" menu</p> <p>2-check the parameter model type in "special adjustment" menu</p>
196	NO CAN TILL EP	the controller lost the communication with EP tiller at least once when the truck is using	<p>1-check the wiring of can cable.</p> <p>2-try to replace the EP tiller.</p> <p>3-replace the controller</p>
197	NO CAN DISP EP	When the truck is running, if the DISPLAY TYPE=5, but the controller loses communication with EP DISPLAY, this alarm occurs	<p>1-check the communication wiring between EP DISPLAY and controller.</p> <p>2-check if the EP DISPLAY is broken</p>

ELECTRICAL SYSTEM

Error Message		Possible cause	Fault elimination
Error	Error text		
200	STEER SENSOR KO	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	1- 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. 2- If the problem is not solved, replace the logic board.
201	WRONG ENC SET	Mismatch between parameters ENCODER PULSES 1 and ENCODER PULSES 2	Set the two parameters with the same value, according to the adopted encoder
202	VDC LINK OVERV.	This fault is displayed when the controller detects an overvoltage condition. Overvoltage threshold depends on the nominal voltage of the controller. Nominal voltage 24V 36/48V 72/80V 96V Overvoltage threshold 35V 65V 115V 130V 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 Overvoltage condition - Low/normal voltage Undervoltage condition	If the alarm happens during the brake release, check the line contactor contact and the battery power- cable connection.
208	EEPROM KO	the connection of the EEPROM is not ok	This type of fault is related to internal components. Replace the logic board.

ELECTRICAL SYSTEM

Error Message		Possible cause	Fault elimination
Error	Error text		
209	PARAM RESTORE	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.	1- A travel demand or a pump request does cancel the alarm. 2- If the alarm appears at key-on without any CLEAR EEPROM performed, replace the controller.
210	WRONG RAM MEM.	The algorithm implemented to check the main RAM registers finds wrong contents: the register is "dirty". This alarm inhibits the machine operations.	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	the slave controller find the status of the main contactor is different between hardware and CAN-BUS	This type of fault is related to internal components. Replace the logic board.
213	INPUT MISMATCH	the slave controller find the status of the input is different between hardware and CAN-BUS	This type of fault is related to internal components. Replace the logic board.
227	OUT MISMATCH XX	the slave controller find the status of the output is different between hardware and CAN-BUS	This type of fault is related to internal components. Replace the logic board.
229	NO CAN WR MSG.XX	CANbus communication does not work properly. The hexadecimal value "XX" identifies the faulty node.	1- Verify the CANbus network (external issue). 2- Replace the logic board (internal issue).
230	SOFTWARE ERROR	it means the software of the slave controller is wrong	This type of fault is related to internal components. Replace the logic board.

ELECTRICAL SYSTEM

Error Message		Possible cause	Fault elimination
Error	Error text		
237	ANALOG INPUT	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.	If the problem occurs permanently, it is necessary to replace the logic board.
239	CONTROLLER MISM.	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.	1- Upload the correct firmware. 2- Ask for assistance to a EP technician in order to verify that the firmware is correct.
240	OUT MISMATCH PU	This is a safety related test. Supervisor µC has detected that master µC is driving the pump motor in a wrong way (not corresponding to the operator request).	1- Checks the matching of the parameters between Master and Supervisor. 2- Ask for assistance from an EP technician. 3- If the problem is not solved, replace the logic board.
241	SP MISMATCH PUMP	This is a safety related test. The supervisor µC has detected a mismatch in the DC-pump speed setpoint with respect to the master µC.	1- Check the matching of the parameters between master and supervisor. 2- Ask for assistance from an EP technician. 3- If the problem is not solved, replace the logic board.
242	SP MISMATCH XX	This is a safety related test. The supervisor µC has detected a mismatch in the speed setpoint with respect to the master µC. The hexadecimal value “XX” facilitates EP technicians debugging the problem.	1- Check the matching of the parameters between master and supervisor. 2- Ask for assistance from a certified technician. 3- If the problem is not solved, replace the logic board.
248	NO CAN MSG. XX	CANbus communication does not work properly. The hexadecimal value “XX” identifies the faulty node.	1- Verify the CANbus network (external issue). 2- Replace the logic board (internal issue).

9.9 Electrical Schematic Diagrams

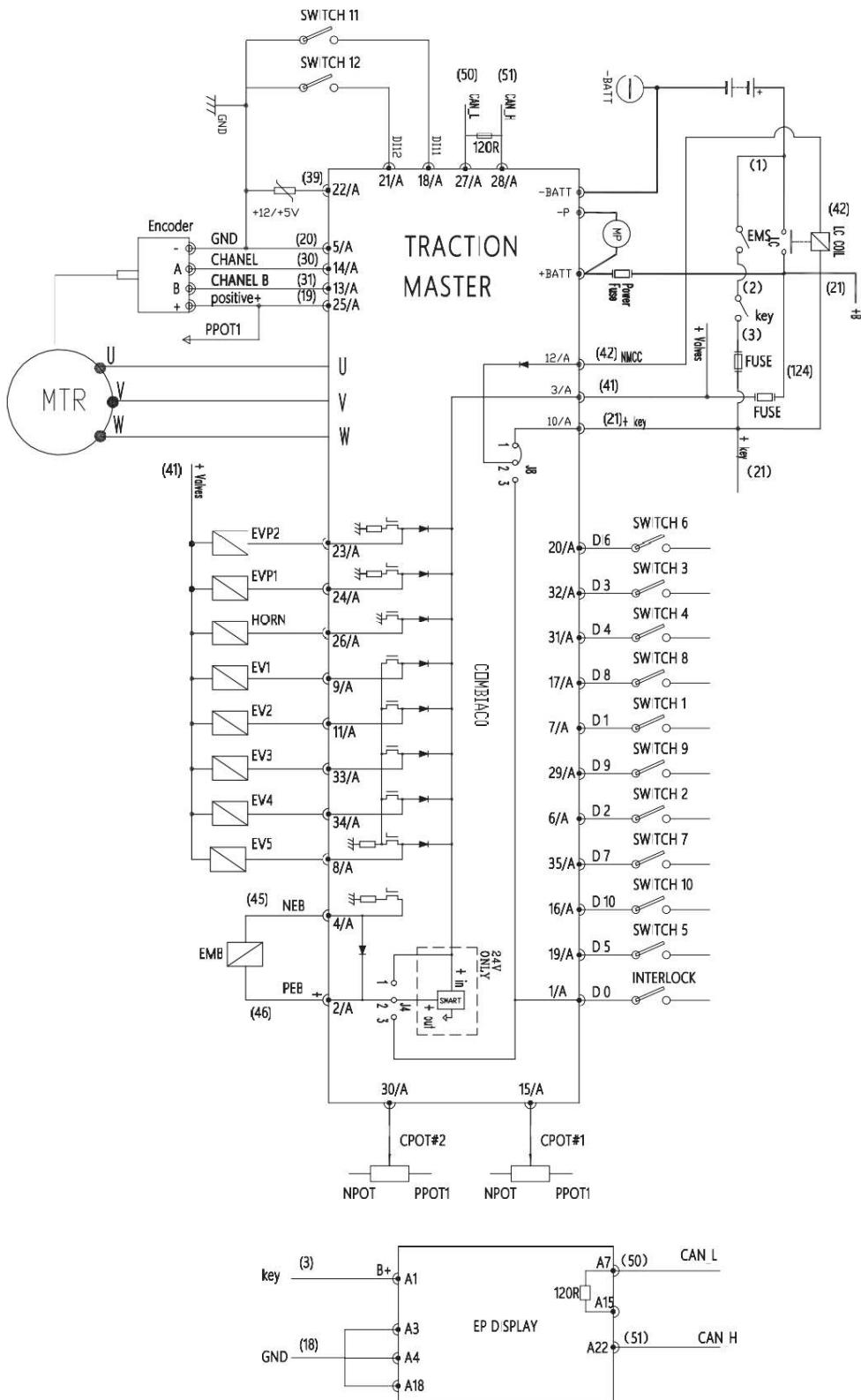
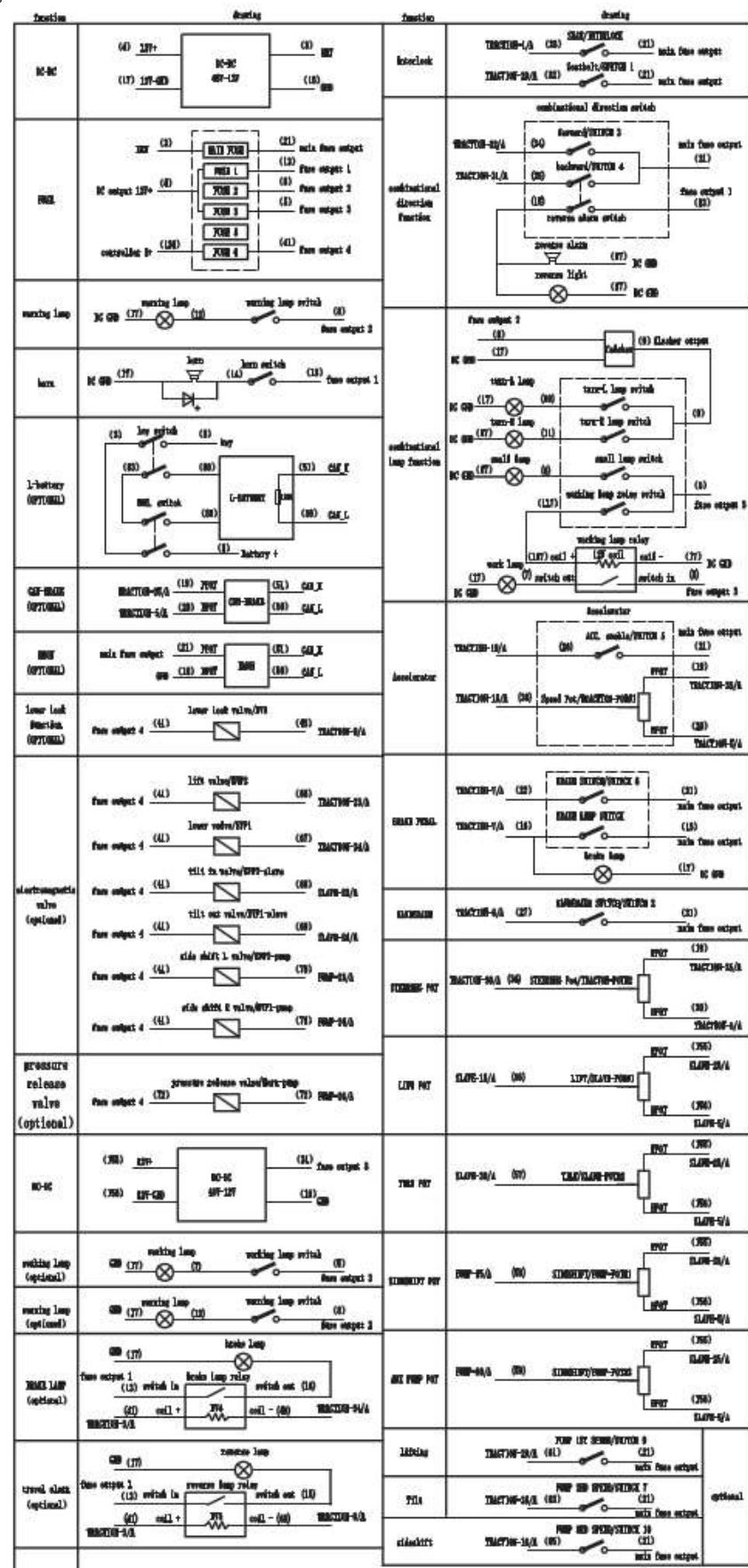


Fig 3112-50009SM

ELECTRICAL SYSTEM



9.10 Cable Wiring Diagrams

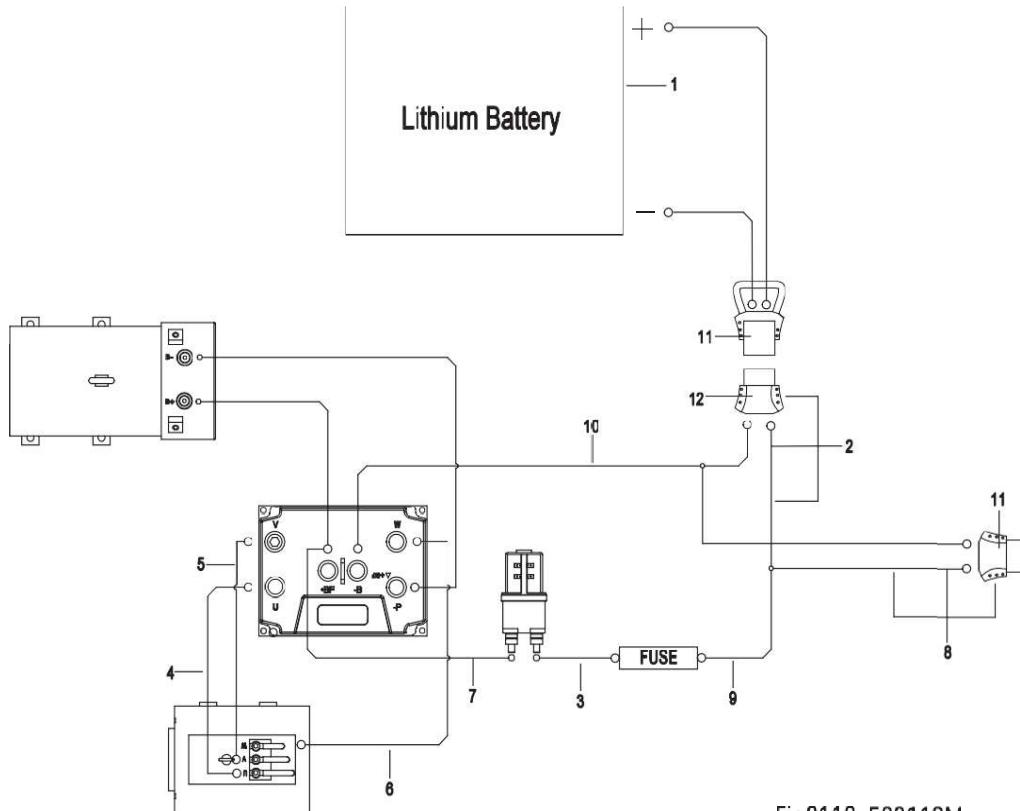


Fig3112-50011SM

No.	Name
1	Lithium Battery
2	Power Cable Assembly
3	T+ Cable
4	TU Cable
5	TV Cable
6	TW Cable

No.	Name
7	C1 Cable
8	Power Cable Assembly
9	Power Cable +
10	Power Cable -
11	Plug Head Male
12	Plug Head

ELECTRICAL SYSTEM

9.11 Wiring Harness and Connectors

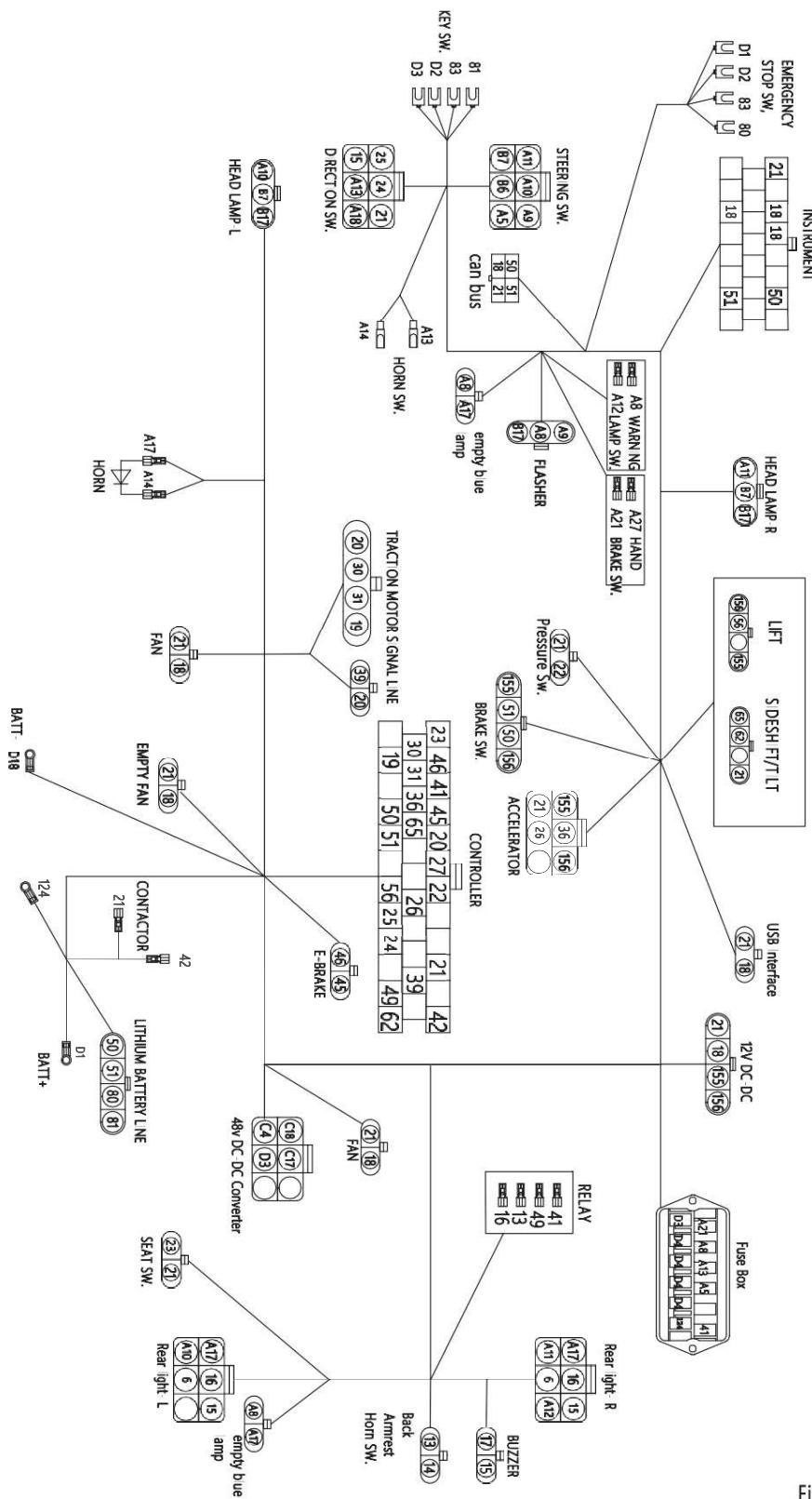


Fig3112-50012SM

TROUBLESHOOTING

10.1 Preparation Before Troubleshooting

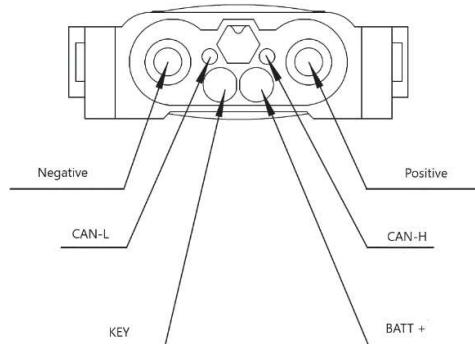
- Park the truck on level ground and block the wheels with wooden wedges.
- Fully lower the forks and press the emergency stop switch.
- Turn off the key switch.
- Open the cover and check the controller.



CAUTION

- Controllers are still energized when key is off.
- Before checking or repairing the controllers, unplug the battery plug and be sure the electrical circuit is disconnected.

10.1.1 Check the Voltage of Battery



- Measure resistance between CAN-L and CAN-H pins. The resistance should be approximately 60 ohms or 120 ohms. This means the CAN Bus is not damaged.
 - Measure the DC voltage between KEY and BATT+. The voltage should be higher than 45V otherwise, the battery may have been over-discharged.
 - If the truck's display does not turn ON, BMS or BDI may have issues. Check the wiring harness and connections.
- Identify if the battery voltage is normal according to the measured voltage.

Determine if the battery voltage is normal according to the measured voltage.
Reference the following table:

Battery	Voltage	Judgment
48V	Greater than 48V	Normal
	Less than 48V	Needs to be charged



CAUTION

If the battery voltage is still abnormal after being charged: open the battery compartment, check the voltage of each battery and its connection circuit respectively:

- 1) Check if the voltage of single battery is normal.
(See Service Manual - Storage Battery)
 - 2) Check if the cables for connections between each battery are normal, check for open circuit and if the connection between connectors is secure.
- Battery leakage check: disconnect the battery connection, black probe (-) connected to (-) terminal of battery plug; red probe (+) connected to the chassis. Read the voltage reading on the meter.
- No voltage (0V): normal.
With voltage: battery leakage (remove battery compartment, check each battery and cables).



NOTE

Enter TESTER menu to check the battery voltage. (See Section 9.8).

10.2 Troubleshooting Solutions of Common Faults

Table 10.1 lists the common faults that may occur and handling methods. Mainly consists of the following items:

Table 10.1 Troubleshooting of Common Faults			
Fault	Fault Symptom	Troubleshooting Order *	Troubleshooting Measures
Power supply failure	1. Whole vehicle power outage	a. Power supply failure b. Fuse failure c. Emergency stop switch or circuit failure d. Key switch or circuit failure	1. Check the voltage of storage battery (see Section 10.1.1) 2. Check the fuses (see Section 9.2) 3. Check key switch and its circuit (see Section 6.5) 4. Check emergency stop switch and its circuit (see Section 6.7)
Travel Fault	1. Forward and reverse moving failures of the vehicle, but other functions are normal	a. Parking brake switch and seat switch or its circuit connection failure b. Gearbox failure c. Travel switch or its circuit connection failure d. Drive motor or its circuit connection failure e. Controller failure	Controller failure error, carry out troubleshooting according to the fault code information on the instrument (see Section 9.9). 1) Check if parking brake switch and seat switch or the connection of its circuit is normal;(See Section 6.7 and Section 9.7) 2) Check the gearbox; (see Section 5.3) 3) Check the travel switch and its connection circuit. (see Section 6.3) 4) Check the drive motor and its connection circuit. (see Section 5.2) 5) Replace the controller.
	2. The vehicle can travel at low speed, but cannot travel at high speed	Failures due to external factors: a. Motor bearing blocked b. Gearbox bearing blocked Failures due to internal factors: a. Drive motor speed encoder failure b. Controller failure	Controller failure error, carry out troubleshooting according to the fault code information on the instrument (see Section 8.14). 1) Check if the motor rotation is normal. 2) Check the speed encoder and its connection circuit. (see Section 5.2) 4) Remove the gearbox, check if the gear rotation is smooth and if there is blocking. (see Section 5.3) 5) Replace the controller

* Carry out trouble shooting in the order listed in the table, it can help quickly identify problems and resolve accordingly.

Table 9.1 Troubleshooting of Common Faults (continued)

Fault	Fault Symptom	Troubleshooting Order *	Troubleshooting Measures
Hydraulic Failure	1. The vehicle cannot lift	1. Pump motor does not work: a. Parking brake switch and seat switch or its circuit connection failure b. Pump motor or its circuit connection failure c. Control switch or its circuit connection failure d. Controller failure 2. Pump motor works: a. Overload b. Insufficient hydraulic oil c. Hydraulic pipeline leakage d. Pump motor reverse rotation e. Cylinder failure (blocked) f. Solenoid valve blocked and cannot reset g. Valve body failure: excessive wear of gear pump, serious internal leaks, insufficient pressure of relief valve or blocked, check valve blocked	1. Pump motor does not work: 1) Check if parking brake switch and seat switch or the connection of its circuit is normal;(See Section 6.7 and Section 9.7); 2) Check the pump motor and its connection circuit. (see Section 7.3) 3) Check the control button and its connection circuit. (see Section 6.9 or 6.10) 4) Replace the controller. 2. Pump motor works: 1) Refer to the rated capacity marked on the nameplate. 2) Lower the mast to the bottom, check if the amount of oil in the oil tank can meet the requirements (see Section 2.2.3). 3) Check the pipe and hydraulic components for oil leaks. 4) Check the pump motor wiring. 5) Check the cylinder for damage or deformation, remove the cylinder to check for wear or aged seals inside. (see Section 7.7) 6) Wash or replace the solenoid spool (see Section 7.5) 7) Wash or replace the valve body (see Section 7.4 or 7.4)
	2. The vehicle cannot be lowered	a. Solenoid valve (or manual valve) or its circuit connection failure b. Lowering switch or its circuit connection failure c. Valve failure. d. Cylinder deformation or blocked e. Explosion-proof valve blocked	1) Check the lowering button and its connection circuit. (see Section 6.9 or 6.10) 2) Check the solenoid valve and its connection circuit. (see Section 7.5) 3) Check the cylinder for deformation, remove the cylinder to check if the internal assembly is normal (see Section 7.7) 4) Clean or replace the valve; (see Section 7.4 or 7.4) 5) Replace the explosion-proof valve.

* Carry out trouble shooting in the order listed in the table. It can help quickly identify problems and resolve them accordingly.

Table 9.1 Troubleshooting of Common Faults (continued)

Fault	Fault Symptom	Troubleshooting Order *	Troubleshooting Measures
Lift Failure	3. Slow Lifting of Vehicle	a. Overload b. Hydraulic pipeline leakage c. Valve failure: Gear pump wear, internal leakage occurs Insufficient relief valve pressure or blocked	1) Refer to the rated capacity marked on the nameplate. 2) Check the pipe and hydraulic components for oil leaks. 3) Wash or replace the valve body (see Section 7.4 or 7.4)
	4. Slow Lowering of Vehicle	a. Solenoid valve blocking b. Valve body failure: throttle valve failure or blocked	1) Wash or replace the solenoid spool (see Section 7.5) 2) Wash or replace the valve body (see Section 7.4 or 7.4)
	5. Unstable Lifting / Lowering of Vehicle	a. Chain loosening. b. Poor lubrication between steel channel and rollers. c. Improper adjustment of rollers or blocked.	1) Adjust the chain tension; (see Appendix A1-1.1) 2) Check if the steel channel grease is normal, clean and relubricate steel channel and rollers. 3) Adjust the side roller spacing through roller screw; or replace the roller.
<p>* Under the circumstances of normal lifting and lowering, if failure occurs to any of other hydraulic actions (forward/backward shifting, forward/backward tilting and left/right shifting), perform troubleshooting to the corresponding control switch and its control circuit.</p>			
Steering Fault	1. The vehicle cannot be steered (the vehicle can travel)	a. Steering potentiometer or its circuit connection failure b. Redirector or the tubing connection failure c. Steering bridge or the tubing connection failure d. Pump motor failure e. Gear pump failure f. Pump controller failure	Controller failure error, carry out troubleshooting according to the fault code information on the instrument (see Section 9.9). 1) Check the steering potentiometer or its connection circuit; (see Section 8.2) 2) Check if the mechanical connection between steering wheel and redirector is solid; (see Section 6.1) 3) Check the redirector or the tubing connection. (see Section 7.6) 4) Check the steering bridge or the tubing connection. (see Section 8.1) 5) Check the pump motor or its connection circuit. (see Section 7.3) 6) Check the pump; (see Section 7.5) 7) Replace the controller.

Table 9.1 Troubleshooting of Common Faults (continued)

Fault	Fault Symptom	Troubleshooting Order *	Troubleshooting Measures
Other Failures	1. Lights do not light	a. Light failure or circuit not conducted b. Lighting combination switch or its circuit connection failure c. Fuse failure d. DC-DC converter failure	1) Check the light and its circuit connection; (see Section 9.6) 2) Check Lighting combination switch and its connection circuit; (see Section 6.4) 3) Check fuse and its connection circuit; (see Section 9.2) 4) Check DC-DC converter and its connection circuit. (see Section 9.5)
	2. Horn does not sound	a. Horn switch or its circuit connection failure b. Horn failure c. Fuse failure d. DC-DC converter failure	1) Check the horn button and its connection circuit. (see Section 6.2) 2) Check the horn and its connection circuit; (see Section 6.2) 3) Check fuse and its connection circuit; (see Section 9.2) 4) Check DC-DC converter and its connection circuit. (see Section 9.5)

* Carry out trouble shooting in the order listed in the table. It can help quickly identify problems and resolve them accordingly.

APPENDIX

A SERVICE MANUAL - MAST

A

A3 Three-stage Full Free Mast

A3-1 Removal and Installation

Removal

- Disconnect the connections between lifting - lowering tubing, left shifting tubing and right shifting tubing and mast tubing.
- Wrap the sling (4) around the upper beam of inner and outer masts, slightly lift the mast with crane.
- Remove the shafts (1) between the outer mast and tilt cylinders (A and B).

- Unscrew the bolts (2) and remove the fixed plate (3) between the outer mast and chassis (C and D).
- Remove the mast from the truck.

Installation

- Install in the reverse order of removal.

WARNING

Make sure the lifting equipment is solid and secure, and the load capacity should be greater than the total weight of the vehicle.

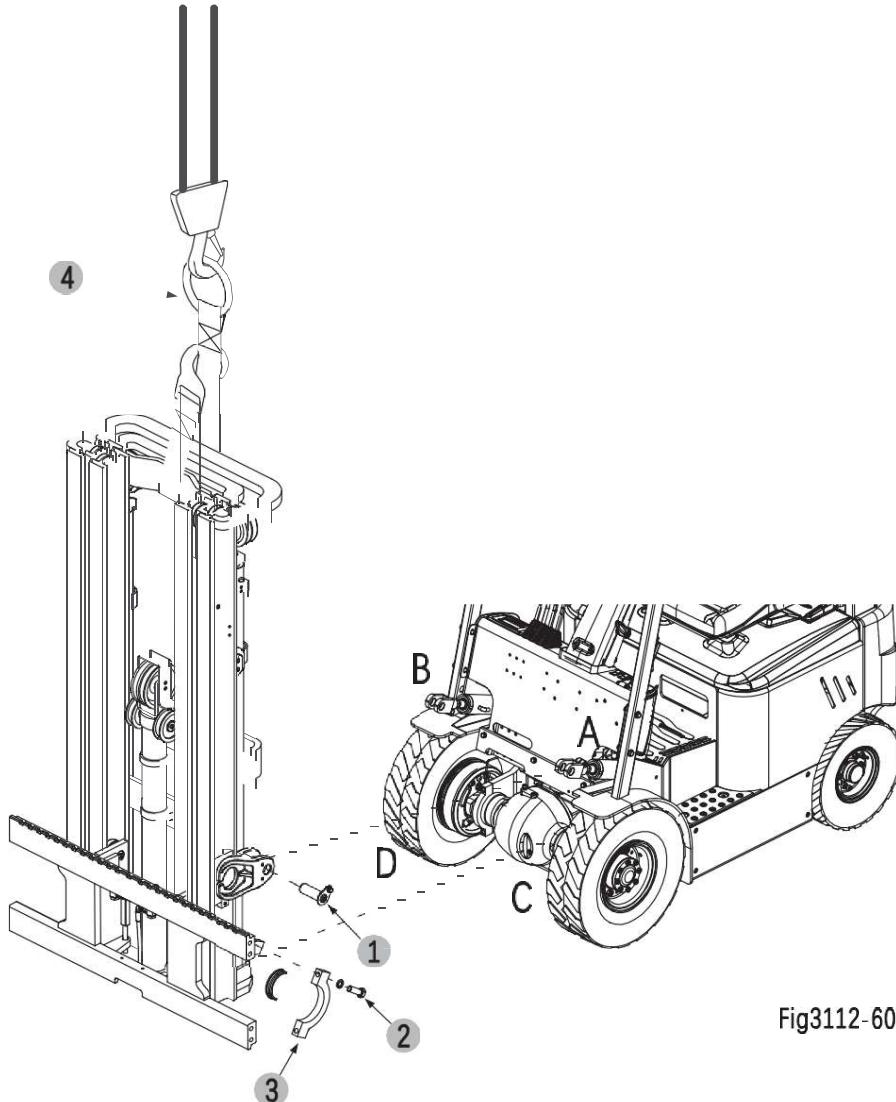


Fig3112-60003SM

A3-2 Lifting Chains

A3-2.1 Chain Adjustment

- Lower the mast to the bottom.
- Press the emergency stop switch and disconnect the key switch.

CAUTION

Switch off the power supply before any adjustments or operations!

- Loosen the upper and lower lock nuts (2) on chain bolt.
- Through screwing upward the adjusting nut (9) in the middle, the chain will slowly tension.
- When the chain is adjusted to be tensioned with no obvious loosening, fasten the upper and lower lock nuts.

CAUTION

When the adjustment is completed, there should be an adjustable distance of at least three pitches over the chain bolts.

- Pull out emergency stop switch and turn on the key switch.
- Through repeatedly lifting/lowering the mast to test if the chain has tension. If the chain is still loose, repeat the steps above.

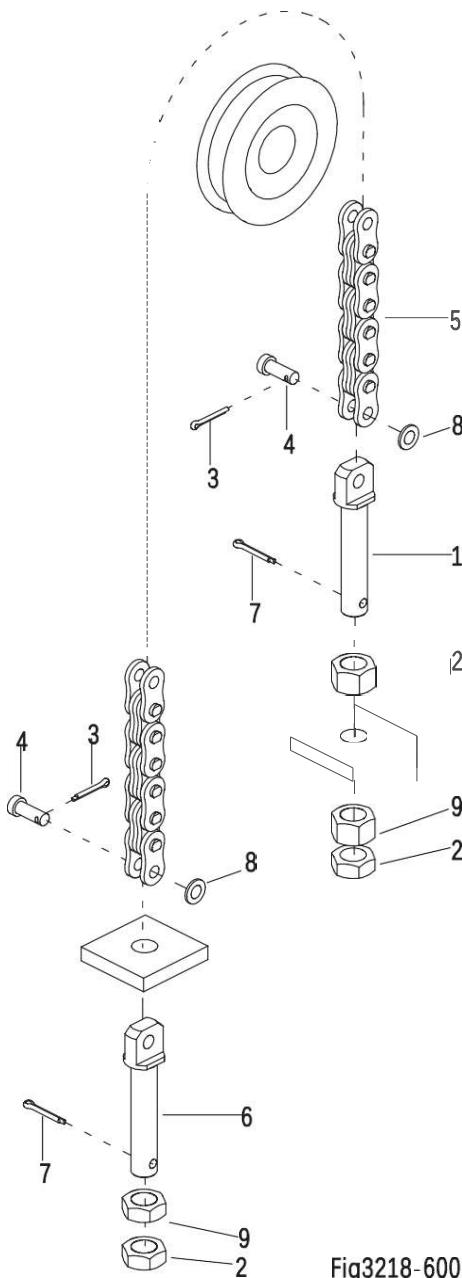


Fig3218-60016SM

A3-2.2 Chain Replacement

A3-2.2.1 Mast Chains

- Block the truck wheels with wooden wedges, raise the inner mast (2, Fig3218-60017SM) 20in, insert wooden block between inner mast and the ground for support.



Place support under the inner mast to prevent it from falling, resulting in personal injury.

- Remove the cotter pin (7, Fig3218-60016SM) and unscrew the lock nut (2) and adjusting nut (9) from the chain joint (1) and chain joint (6).
- Remove the chain assembly from the chain sprocket (20, Fig3218-60017SM).
- Remove the cotter pin (3, Fig3218-60016SM) and flat washer (8), pull out the pin shaft (4), separate the chains (5) from the chain joint (1) and chain joint (6).
- Replace with new chains and hang the new chain assembly onto the chain sprocket.
- Put the chain connector (6) through the inner mast chain-hanging plate, screw the adjusting nut (9) and lock nut (2).
- Put the chain connector (1) through the outer mast chain-hanging plate, screw the adjusting nut (9) and lock nut (2).
- Adjust the chains according to Section A3- 2.1.

A3-2.2.2 Fork Carriage Chains

- Block the truck wheels with wooden wedges, raise the fork carriage 20in, insert wooden block between inner mast and the ground for support.



Place support under the inner mast to prevent it from falling, resulting in personal injury.

- Remove the cotter pin (7, Fig3218-60016SM) and unscrew the lock nut (2) and adjusting nut (9) from the chain joint (1) and chain joint (6).
- Remove the chains from the chain sprocket (17, Fig3218-60017SM).
- Remove the cotter pin (3, Figure 90603) and flat washer (8), pull out the pin shaft (4), separate the chains (5) from the chain joint (1) and chain joint (6).
- Replace with new chains and hang the new chain assembly onto the chain sprocket.
- Put the chain connector (6) through the fork carriage chain-hanging plate, screw the adjusting nut (9) and lock nut (2).
- Put the chain connector (1) through the middle cylinder chain-hanging plate, screw the adjusting nut (9) and lock nut (2).
- Adjust the chains according to Section A3- 2.1.

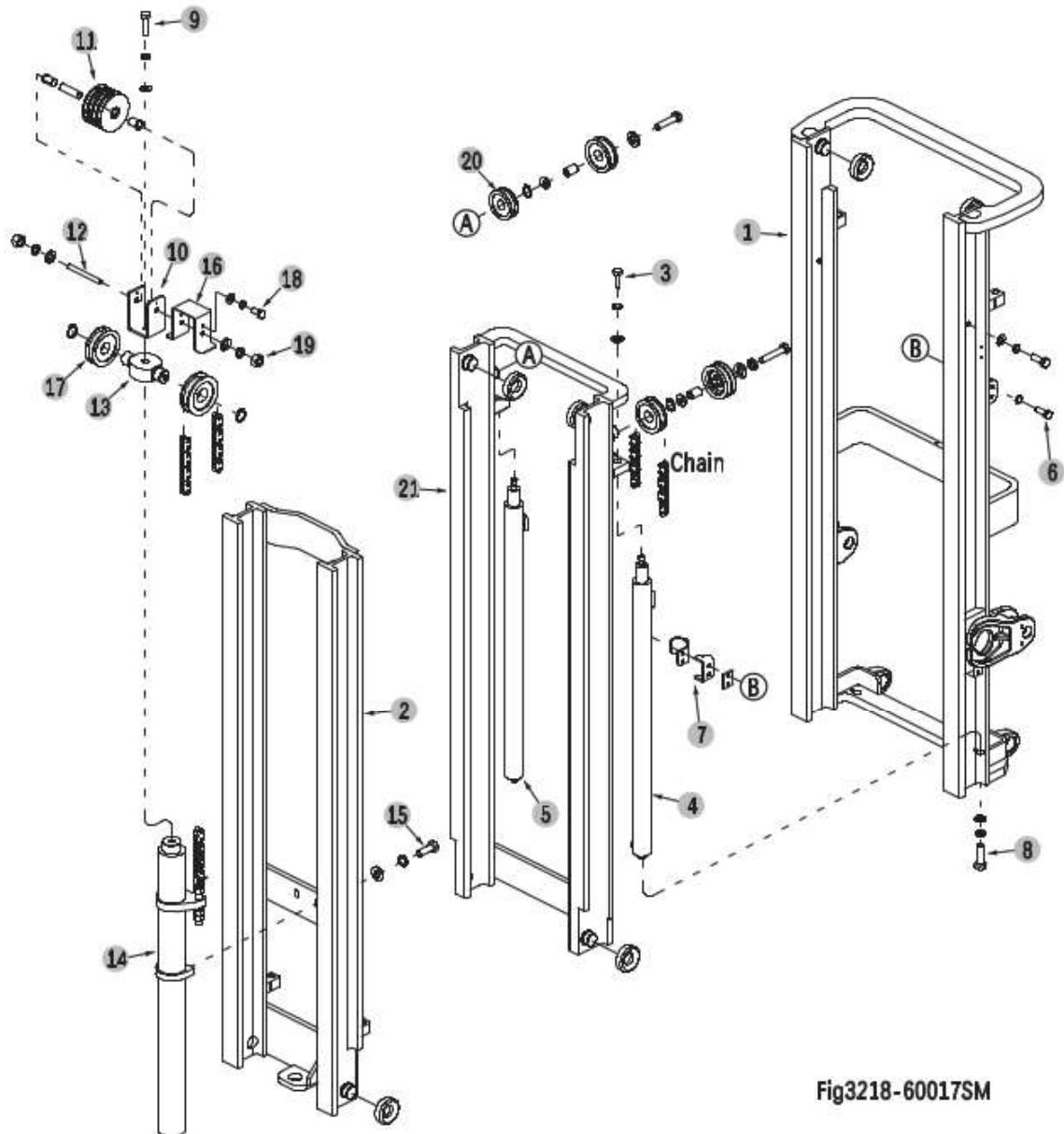


Fig3218-60017SM

A3-3 Mast Tubing

Code	Description
A1	Lifting / Lowering Mast Tubing

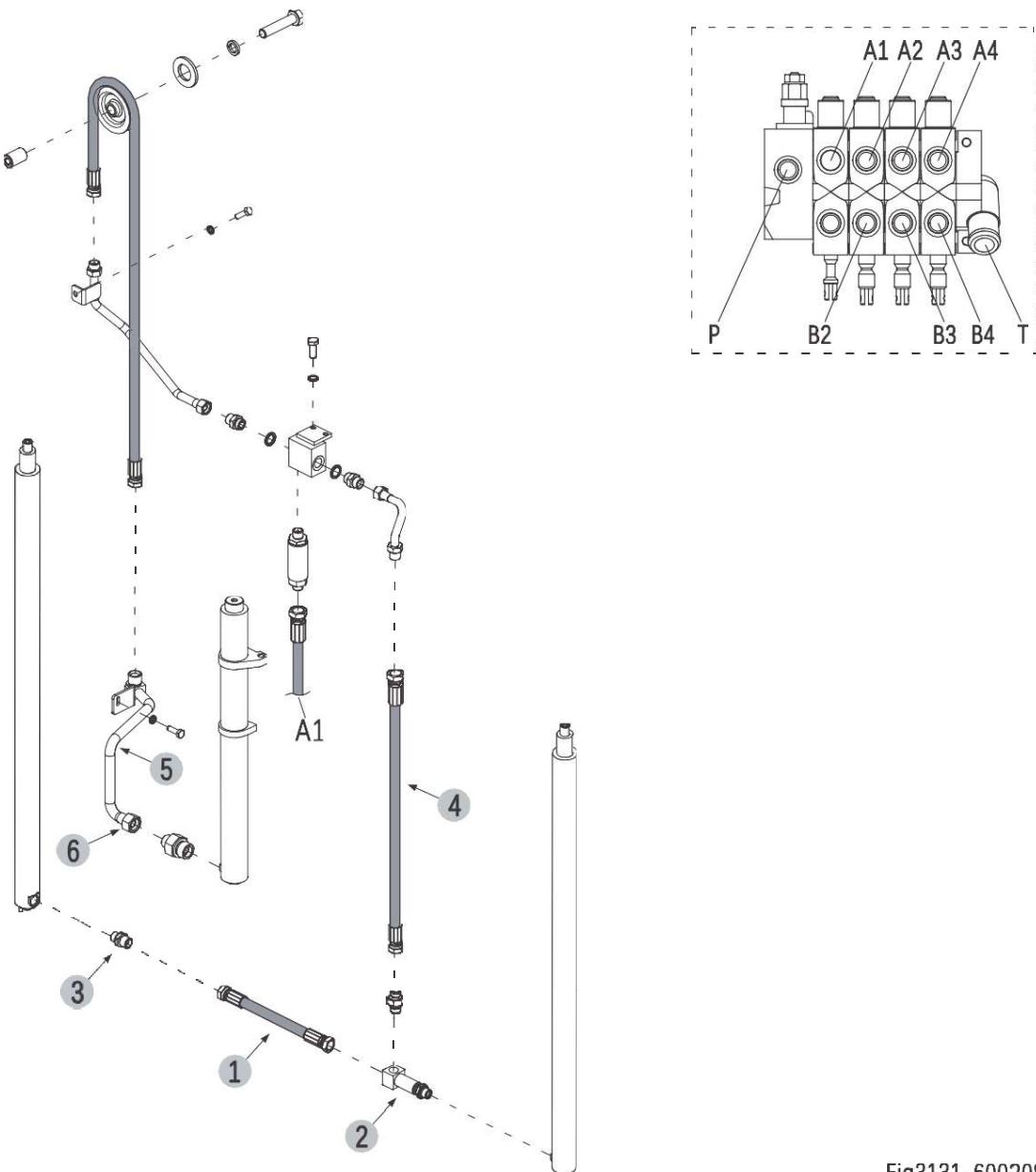


Fig3131-60020SM

Code	Description
A3	Right Shift Mast Tubing
B3	Left Shift Mast Tubing

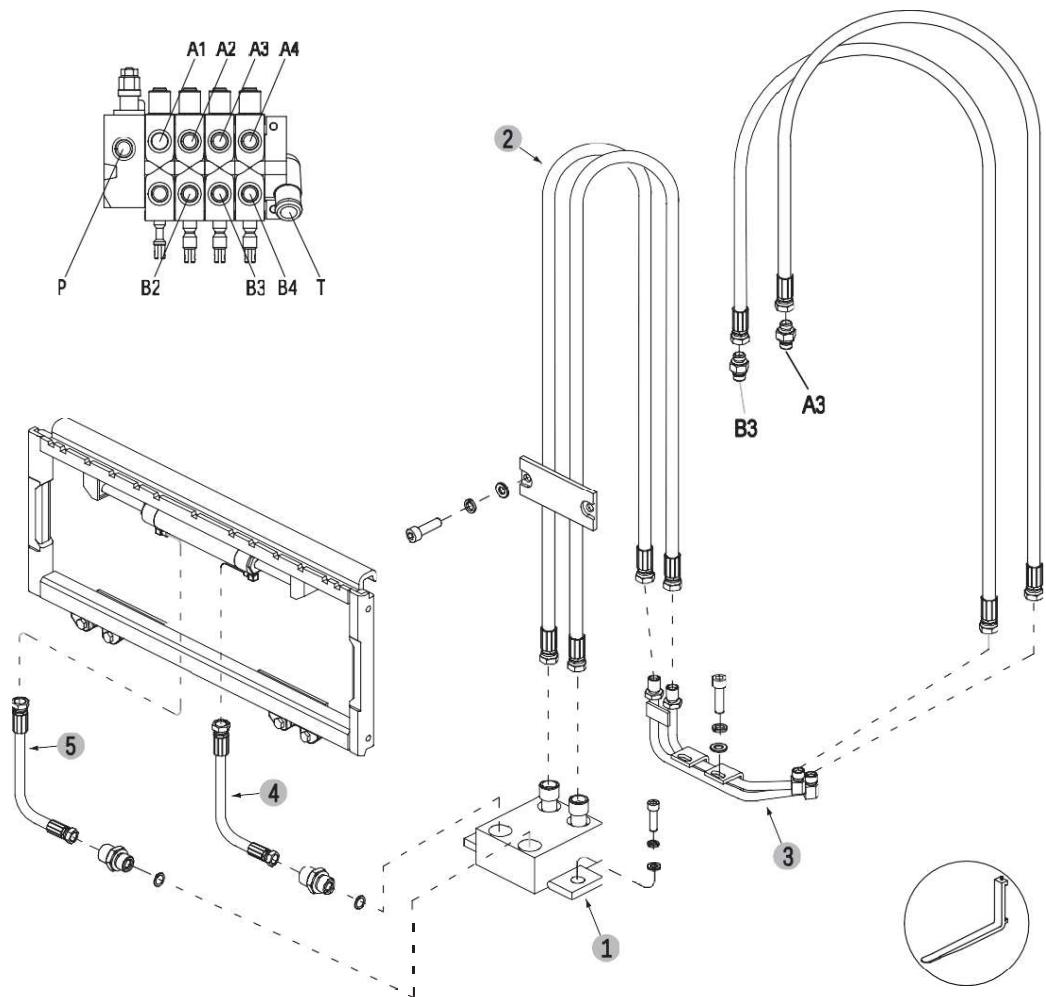


Fig3218-60010SM

A3-4 Lift Cylinder

A

A3-4.1 Cylinder Removal

Left Cylinder Removal (with mast down)

- Remove the mast from the chassis according to Section A3-1.
- Lay down the mast with lifting tools (with outer mast underneath the inner mast), place sleepers at both ends for supporting.
- Disconnect the connections between the tubing (1, Fig 3131-60020SM) and three-pass assembly (2).
- Remove the tubing (4) from the three-pass component (2);

CAUTION

Hydraulic oil may damage truck parts and contaminate the environment. When removing joints or tubing, place a clean container under it for discharge of hydraulic oil.

- Unscrew the bolt (6, Fig3218-60017SM) and remove the cylinder clamp (7).

CAUTION

Before going on with the next step, please fix the cylinder properly first. Be sure to avoid the falling of cylinder during removal, resulting in personal injury.

- Unscrew the mounting bolt (8) from the bottom of the cylinder.
- Unscrew bolt (3) and remove the cylinder (4) from the mast.
- Remove the three-pass component (2) from the right cylinder.

Right Cylinder Removal (with mast down)

- Remove the mast from the chassis according to Section A3-1.
- Lay down the mast with lifting tools (with outer mast underneath the inner mast), place sleepers at both ends for support.
- Remove the tubing (1, Fig3131-60020SM) to make it separate from the direct coupling (3).

CAUTION

Hydraulic oil may damage truck parts and contaminate the environment. When removing joints or tubing, place a clean container under it for discharge of hydraulic oil.

- Unscrew the bolt (6, Fig3218-60017SM) and remove the cylinder clamp (7).

CAUTION

Before going on with the next step, please fix the cylinder properly first. Be sure to avoid the falling of cylinder during removal, resulting in personal injury.

- Unscrew the mounting bolt (8) from the bottom of the cylinder.
- Unscrew bolt (3) and remove the cylinder (5) from the mast.

Full Free Middle Cylinder (with mast on the vehicle)

- Lower the mast to the bottom, press the emergency stop switch and disconnect the key switch.
- Remove retaining shelf (see Section A1-5.1).
- Block the truck wheels with wooden wedges, raise the fork carriage to 20in with lifting tools, insert wooden block between it and the ground for support.

CAUTION

Hydraulic oil may damage truck parts and contaminate the environment. When removing joints or tubing, place a clean container under it for discharge of hydraulic oil.

- Loosen the joints (6, Fig3131-60020SM) to separate the middle cylinder and rigid pipe assembly (5).
- Disconnect the connections between the tubing (2, Figure 60619) around the middle cylinder and rigid pipe assembly (3).
- Remove the fork carriage chains according to Section A3-2.2.2.

- Unscrew bolt (18, Fig3218-60017SM) and remove the middle cylinder roller guard (16).
- Unscrew the nut (19), remove the middle cylinder tube shaft (12) and middle cylinder tube roller (11).
- Unscrew the bolt (9) and remove the middle cylinder fixing plate (10) and sprocket seat (13) from the cylinder (14).

 **CAUTION**

Before going on with the next step, fix the cylinder to prevent it falling during removal, resulting in personal injury.

- Unscrew the bolt (15), separate the cylinder (14) from the inner mast (2).
- Remove the cylinder (14) from the truck.

A-4.2 Cylinder Maintenance

Lifting Side Cylinder

 **CAUTION**

- Use suitable hose clamps to avoid cylinder deformation caused by severely tight hose clamp.
- Carry out the maintenance work in a clean environment to prevent impurities from entering into the cylinder, causing cylinder damage.
- During the installation, hydraulic oil of the same specifications must be used for cleaning or lubrication.
- Secure the cylinder to hose clamp and gently clamp the cylinder bottom.
- Unscrew the cylinder cap (4) with cylinder wrench.
- Remove the dust ring (1), seal (2) and O-ring (3) from the cylinder cap.
- Pull out the piston rod (6) from the cylinder tube (12).
- Remove the bushing (5) from the piston rod.
- Remove the support ring (7), cover plate (8)

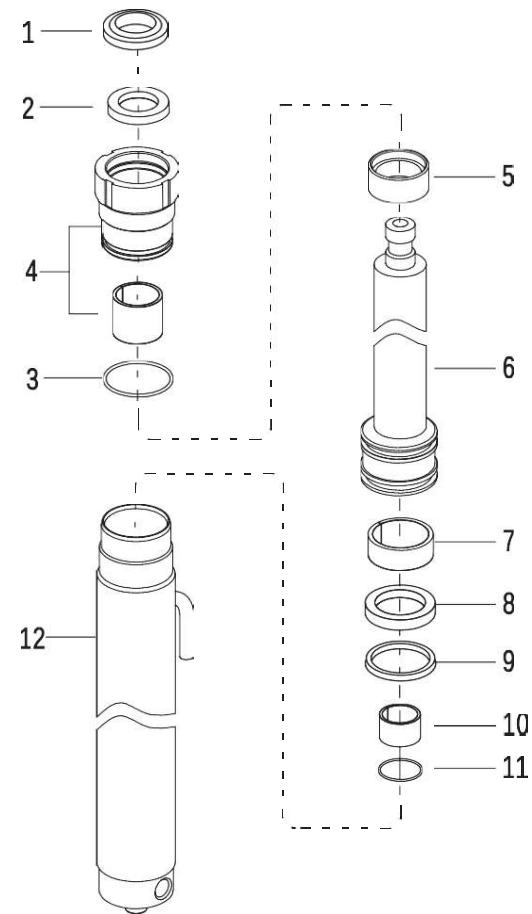


Fig3111-60008SM

and seal (9) from the piston rod.

- Unscrew the screw (11) from the piston (12) and remove the piston from the piston rod.
- Remove the snap ring (11) and sleeve (10) from the piston rod (6).
- Clean with hydraulic oil of the same specifications.
- Replace the problem parts and assemble in reverse steps.

 **CAUTION**

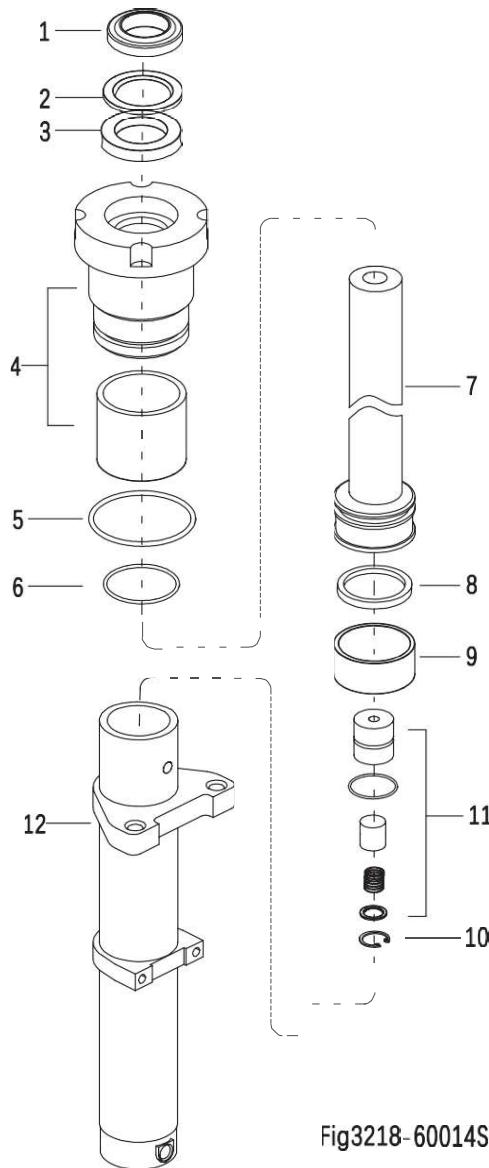
If the piston rod or cylinder tube is damaged, replace the entire cylinder.

If the seals are aged or damaged, replace the complete set of seals.

Full Free Middle Cylinder

A CAUTION

- Use suitable hose clamps to avoid cylinder deformation caused by severely tight hose clamp.
- Carry out the maintenance work in a clean environment to prevent impurities from entering into cylinder, causing cylinder damage.
- During the installation, hydraulic oil of the same specifications must be used for cleaning or lubrication.



- Secure the cylinder to hose clamp and gently clamp the cylinder bottom.
- Unscrew the cylinder cap (4) with cylinder wrench.
- Remove the dust ring (1), cover plate (2), seal (3), O-ring (5) and O-ring (6) from the cylinder cap.
- Pull out the piston rod (7) from the cylinder tube (12).
- Remove the support ring (9) and seal (8) from the piston rod.
- Remove the shaft ring (10) and the cushion assembly (11) from the piston rod.
- Clean with hydraulic oil of the same specifications.
- Replace the problem parts and assembly in reverse steps.

CAUTION

If the piston rod or cylinder tube is damaged, please replace the entire cylinder.

If the seals are aged or damaged, please replace the complete set of seals.

A3-4.3 Cylinder Installation

- Install the cylinder according to the reverse order of removal according to A3-4.1.
- Add hydraulic oil of the same specifications into the tank, see Section 2.2.3.
- Pull out emergency stop switch and turn on the key switch.
- Repeat Lift - Lower cylinder to discharge the air within the tubing and cylinder.
- Check the hydraulic oil level and make sure that the liquid is at standard level.

A3-5 Built-in Side Shifter

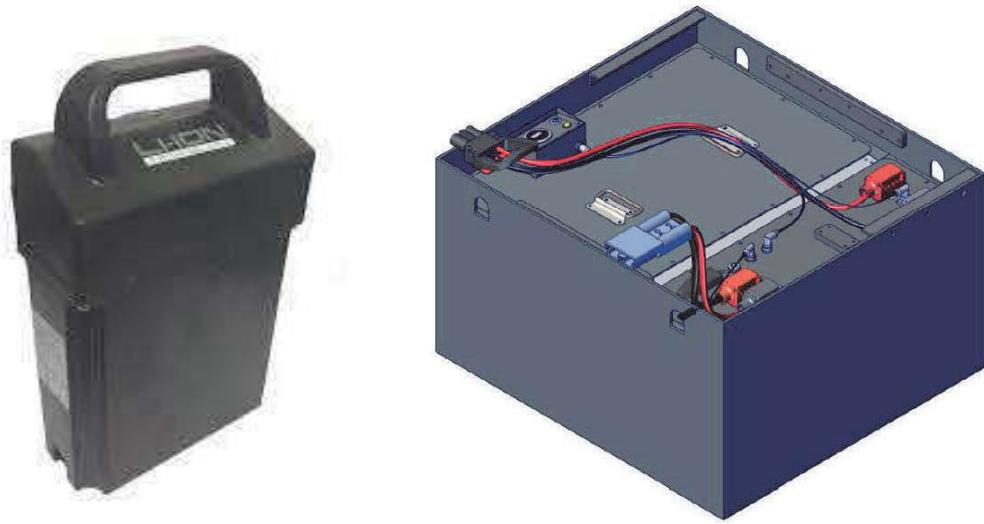
Reference Section A1-5.

A3-6 External Side Shifter

Reference Section A1-6.

Fig3218-60014SM

SERVICE MANUAL - BATTERY



Operation Manual

Lithium-ion Battery

Version 2.0

6/21/2023

Introduction

This manual is intended to provide information on correctly using the Li-ion battery and maximizing its productivity and longevity through preventive maintenance and safe operation. Operators should read through the manual before using the battery.

All the information, specifications, and illustrations in the manual are effective at time of print. The company maintains the right to modify the specification(s) or design(s) of the products at any time without prior notification.

Overview

Lithium-ion (Li-ion) batteries have many advantages over traditional lead acid and other types of batteries. Big Joe's Li-ion batteries are classified as LFP 'Lithium Iron Phosphate' or LiFePO₄. When stored, handled, and used properly, they also have a longer service life, a higher power density, don't need a cooling down period, and can be opportunity charged.

Big Joe's priority is safety, and establishing the following safety procedures for storing, handling and use of these batteries will help prevent fires and explosions.

Companies training employees to recognize the hazards of Li-ion and other types of batteries as well as how to handle, store and manage them properly will help to avoid damage to the batteries resulting in possible fires and explosions.

This battery should not be used at a very low SOC (state of charge) status. To ensure the battery life, the operator should avoid the discharge depth of more than 80% of the rated capacity of the battery. Whether it is partially discharged or fully discharged, the battery should be immediately charged.

Lithium batteries have a special charger and may not be charged with other types of battery chargers.

NOTE: A new battery from the factory should be fully charged before its initial use.

Getting Started

The lithium-ion battery unit is composed of battery cells in series or in parallel. It is equipped with battery management system (BMS) for monitoring and protecting the lithium-ion battery. The truck's key switch can control power supply of the battery. The circular meter shows various data including SOC (State of Charge), error code, total voltage, and temperature.

Safety & Warnings

- Always wear personal protective equipment (PPE) (e.g., safety goggles and safety gloves) when working on cells and batteries.
- Abide by the operation manual.
- Check the battery for leakage and mechanical damage before use and charging.
NOTE: **STOP** using the battery if leaking or damaged and follow the recycling instructions found in section 8.3 in this manual. We recommend the battery be recycled within 3 days.
- Inspect easy exchange batteries daily. See Appendix A for detailed daily inspection instructions for the pallet truck easy exchange batteries. If new or replacement visual inspection reminder decals are needed, they can be ordered via PN 056747.

WARNING

Visually inspect battery daily for cracks, bulges and leakage.
If damaged, remove from service and recycle immediately.
Refer to Li-Ion manual for further instructions.

- Check charger connectors and bracket for contamination daily, clean the bracket with a dry cloth if needed.
- All operations related to the battery must be implemented under the instruction of professionals.
- Do NOT smoke near the battery because it may cause fire.
- Do NOT place the battery near open flame, sparks, or energized wires as fire or explosion may occur.
- Avoid short-circuiting the battery, as fire or explosion is likely to occur.
- Keep the battery away from all fire sources, heat sources, and flammable or explosive materials.
- Don't knock over the battery, drop the battery, or expose it to abusive vibration applications.
- Use lifting and delivery devices as specified. Prevent the battery cell, interface, and connection cable from being damaged by the lifting hook.
- If the internal battery components start to leak out, do not inhale the fumes. Always wear PPE when in close contact with the battery.
- Wash hands after working on a battery.
- Use only insulated tools.
- Make sure the truck is turned off before connecting the battery.

- The metal part of the battery cell is electrified, don't place any external object or tool on the battery cell.
- Do NOT place the battery on top of conductive objects.
- Do NOT trample on the battery to prevent it from fierce shaking.
- Protect the battery from solar or other forms of heat radiation.
- Do NOT physically alter the battery, strike, crush, compress, notch, dent or modify it in any way.
- Do NOT open the battery without Big Joe Forklift's official authorization.
- Do NOT spray wash the battery with water.

Intended Use

- Discharge/Operational application temperatures: 32° F - 104° F
- Charging application temperatures: 41° F - 104° F.
- Humidity < 80%.
- The battery's maximum operation altitude is up to 6500ft (2000m).

NOTE:

- A high-rate recharging operation below 0°C may lead to battery damage, so the recommended charging temperature range is 41° F - 104° F.
- The discharging temperature range can be used in more extreme temperature conditions as follows -4° F - 131° F however, this isn't the recommended range for optimal life which is identified above. Also, the truck may not be rated for those extreme conditions or extended durations in a cold operating environment as that is truck and option dependent.
 - If used at low temperatures -4° F - 32° F, battery discharge capacity will be smaller compared with one in normal temperature conditions.
 - A battery used between 104° F - 131° F will accelerate the aging of the internal material which may shorten the service life of the battery, so is not recommended.

Battery Management System

The battery is permanently monitored by the Battery Management System (BMS). This provides communication with the truck.

The BMS continually monitors items such as the cell temperature, voltage, and charge status of the cells. It also functions as a safety cut-off device in case of overcharging, overcurrent, or overheating.

Potential Hazards

Hazards are not anticipated if the equipment is used correctly. Do not use the equipment for anything other than its intended purpose.

The following hazards can arise in the event of improper use:

Physical Damage:

This can occur if a battery falls or is deformed through pressure or high impact (e.g., truck forks penetrate the battery housing).

Physical damage includes cracks, breakage, splinters, or holes in the battery housing. This type of damage may be caused by a short circuit inside the battery, which may result in harmful materials leaking, fire or battery explosion.

Some physical damage may not show on the battery enclosure, but there may be damage to the internal cell pack, which could cause electrolyte leaking and short circuit. Always check for leakage before use and charging.

Short Circuits:

These may be caused by inadvertently creating a connection between the two battery terminals (e.g., battery immersed in water, battery leakage, contamination on the charger connector or battery connector).

Temperature Effects:

High temperatures caused by sunlight or being stored in warm locations (e.g., near ovens) can result in harmful material leakage and fire.

To avoid fire and leakage of harmful materials, a safe place for storing batteries must satisfy the following criteria:

- Do not store in places often frequented by personnel.
- Do not store in places where valuable objects (e.g., cars) are stored.
- Fire extinguishers must be available to put out any fires.
- Caution should be taken with fire or smoke detectors in the vicinity to ensure that an automatic fire detection system is only activated in the event of actual danger (e.g., naked flames).
- Small amounts of discharge from a single battery are not critical to the environment. Above-average natural ventilation is required in this case.
- No ventilation intake pipes should be in the vicinity, as discharged content could spread within a building.

Examples of where to store a non-functional battery:

- Covered area outdoors.
- Ventilated metal container.

- Covered box with pressure and smoke discharge option.

Fire Hazard

Physical damage, thermal effects, or incorrect storage in the event of a defect can result in fire. Please note that the battery materials can be flammable.

WARNING: Contact with combustion products can be hazardous. Fires produce combustion products. Combustion is a chemical process by which a flammable material combines with oxygen under heat and light (fire). The resulting combustion products can occur in the form of smoke, leaking fluids, escaping gases, debris, as well as decomposition products of certain chemicals. These combustion products are substances that enter the body through the respiratory tract and/or the skin and can cause serious health issues.

Avoid contact with combustion products and use personal protective equipment (PPE).

- Hydrogen fluoride (HF) Hydrofluoric acid = extremely corrosive
- Risk of toxic substances produced by pyrolysis
- Risk of highly flammable gas mixtures
- Other combustion products: Carbon monoxide & -dioxide, manganese, nickel, and cobalt oxides.

WARNING: If a lithium battery fire occurs, use a CO₂ (Class BC) or dry chemical (Class ABC) fire extinguisher. Lithium batteries do not have actual lithium metal so **DO NOT** use a Class D fire extinguisher.

Touch Voltage Hazard

Hazardous contact voltages only arise in the event of a technical or physical defect. The batteries are normally charged. There is still some residual voltage in a discharged battery. This must be considered a hazardous contact voltage.

Battery Storage

Proper storage prevents damage to batteries and prolongs their life expectancy. Follow these battery storage tips:

- Store in dry, well-ventilated areas
- Store in temperatures between 32° F and 104°F
- Store away from direct sunlight and heat sources
- Keep terminals covered when the battery is not in use
- Prevent terminals from touching each other
- Store separately from other types of batteries
- Keep the battery charged and do not store it for an extended period with a low state of charge (SOC) < 20%. It is recommended to maintain a charge level of 50% or greater.
- For long-term storage, the Li battery must be recharged every 2-3 months regardless of the SOC level. If a battery is stored longer than six months without charging, the cell may be damaged due to over-discharge. This can cause the cell to bulge and break the battery enclosure.

IMPORTANT: Monitor battery condition daily when in use and storage.

Battery Handling

Improper handling can cause damage to batteries, which may lead to overheating, fires, or explosions. Here are some tips for proper Li-ion battery handling:

- Remove batteries from devices that will not be used for an extended time.
- Keep batteries away from electromagnetic sources.
- Keep batteries intact.
- Keep batteries and charger in a clean location, do not expose battery or charger to water or other type of contaminations.
- Clean charger bracket and connector/pin with dry cloth if needed, since foreign material and contamination may accumulate in the bracket.
- DO NOT use batteries that show any signs of damage, they must be isolated.
- DO NOT modify the battery in any way.

WARNING: Damaged Li-ion batteries have the potential to leak electrolytes, so it's important to wear proper personal protective equipment (PPE) (goggles, gloves, apron, etc.) during handling.

Performance Data

Battery Nominal Data

Battery Cell

1	Cell material	LFP
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Battery System

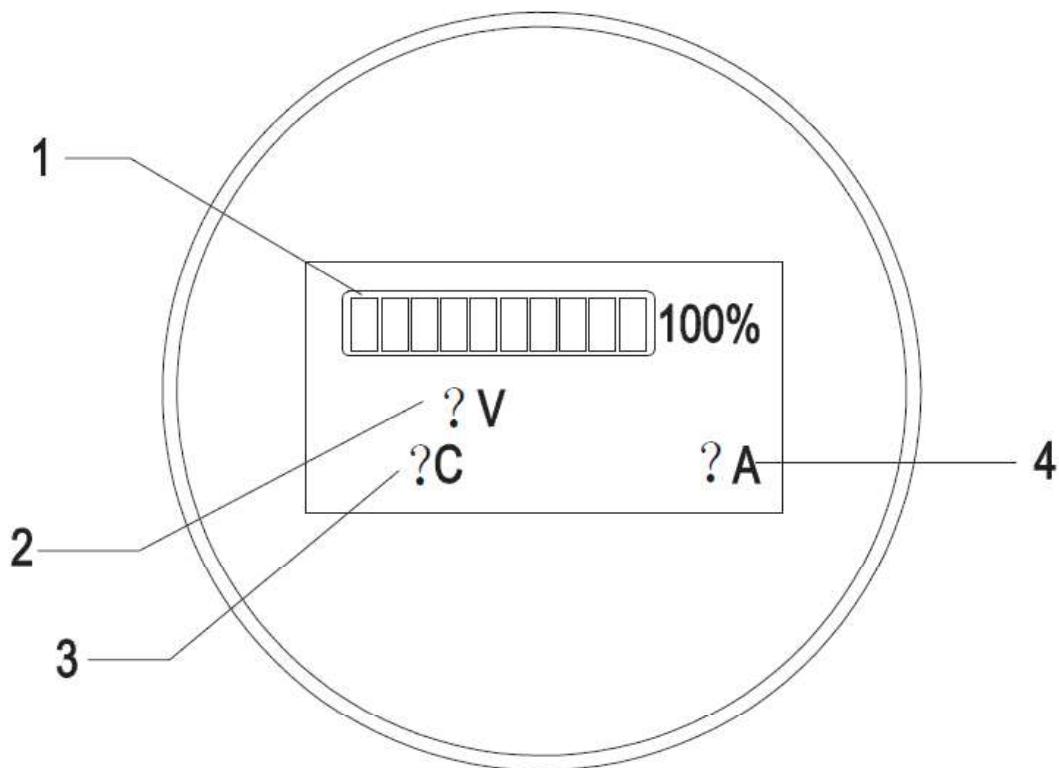
2	Burst mode	Parallel Circuit or Series Circuit
3	Ambient relative humidity	≤80%RH
4	Operational application temperature	32-104°F

BMS Nominal Data

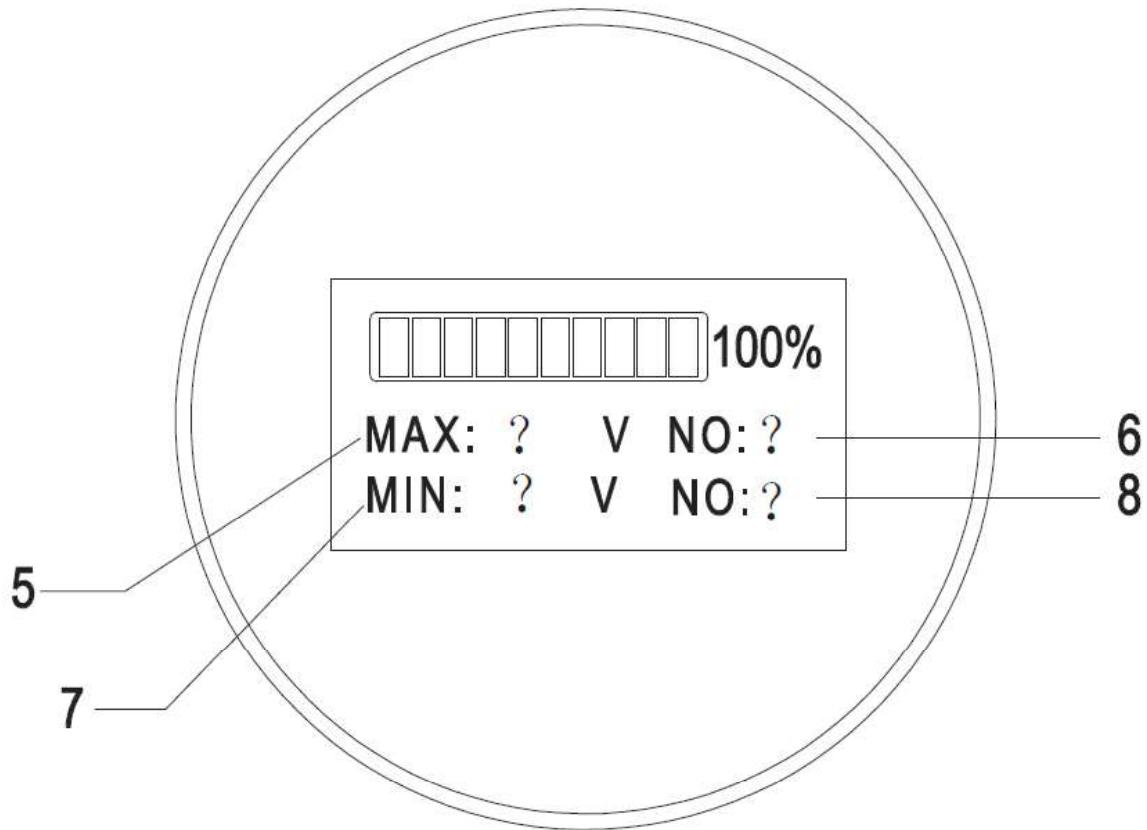
Battery Management System Function

No	Item	Function	Description
1	Inspection / Estimates	Monomer voltage detection	Accurate acquisition of all cell voltage data
2		Total voltage detection	Accurate acquisition of total voltage data
3		Temperature collecting	Accurate detection of battery temperature
4		Current inspection	Accurate detection of charge-discharge currents
5		SOC Estimate	Hall sensor is used to obtain the input and output current of the battery, and the SOC estimation of the battery is carried out by the method of ampere time integration
6	Communication Function	CAN communication	Communication and debugging
7	Protection Function	Short-circuit protection	Power circuit short circuit, contactor disconnect
8		Over current protection	Over-current occurs, contactor disconnect
9		Overcharging protection	Overcharge occurs, contactor disconnect
10		Over discharging protection	Over discharge occurs, contactor disconnect
11		Over temperature protection	Over temperature occurs, contactor disconnect
12	Sleep Wake	Sleep awakening function	Charge communication wake-up, Battery switch button wake-up

Battery Indicator



No	Name	Description
1	Energy Display	When the first cell and the second flash alternately, battery is low and must be charged. The battery remaining charge is displayed; "100%" indicates that the battery is fully charged.
2	Total Voltage	The sum of the total voltages of the lithium battery series
3	Temperature	Battery temperature
4	Charging Current	Current value when charging the lithium battery



No	Name	Description
5	Maximum Cell Voltage	Maximum value of cell voltage
6	Number of Cell	Identification number of the cell with maximum voltage
7	Minimum Cell Voltage	Minimum value of cell voltage
8	Cell Number of Minimum Cell Voltage	Identification number of the cell with minimum voltage

Transportation

Before transporting any lithium-ion battery, check the current regulations on the transport of dangerous goods. Comply with these when preparing the packaging and transport. Train authorized staff to dispatch lithium-ion batteries.

NOTE:

It is recommended that the original packaging is kept for any subsequent dispatch.

A lithium-ion battery is a special product.

Special precautions should be taken when:

- Transporting a truck equipped with a lithium-ion battery
- Transporting only the lithium battery

A class 9 danger label must be affixed to the packaging for transport.

Handling differs if the battery is transported on its own or in a truck. An example of a label appears in this supplement (see figure below). Refer to the latest current regulations before dispatch as the information might have changed since this manual was written.

Special documents must be sent with the battery. Refer to the applicable standards or regulations.

For UN3480	Lithium-ion Batteries	
For UN3481	Lithium-ion Batteries packed with Equipment or Lithium batteries built into Equipment	

Service

Lithium-ion batteries typically require no maintenance. If needed, only a certified technician should perform any service or maintenance.

Big Joe Forklifts recommends following the maintenance schedule below. Record all battery service, maintenance, and inspections to maximize the service life of your battery and lift truck.

No.	Maintenance Content	Method of Operation	Notes	Frequency
1	Check if battery capacity is too low	Check instrumentation SOC display	Make sure the battery is not stored without charge for a long period. If the battery system needs to be put on hold for a long period, keep the battery at a half power state and charge the battery every 3 months to ensure that the battery system remains in a half power state.	Everyday
2	The battery pack charge and discharge current	Check instrumentation display	Make sure battery pack charge and discharge current meet the operation manual requirements.	Everyday
3	Check connector pins at the bottom of the battery (if present)	Perform a visual inspection	If any ablation or deformation is found, replace the battery connector pins.	Everyday
4	Check if appearance is deformed, whether surface is oxidized, paint is peeling, the mounting position is offset or if cabinet is damaged	Perform a visual inspection	If deformed/damaged follow battery recycling procedure.	Everyday
5	Check the entire battery as well as the surface beneath it for signs of fluid leakage	Perform a visual inspection	If leaking, follow battery recycling procedure.	Everyday

No.	Maintenance Content	Method of Operation	Notes	Frequency
6	Check if battery and charger are clean	Perform a visual inspection Wear insulated gloves before performing cleaning	Clean the lithium battery and charger with a dry cloth or compressed air	Weekly

7	Check if external wiring harness has worn spots, imprints, creases, or exposed wire	Perform a visual inspection	Replace the wiring harness if damaged	Weekly
8	Check the surface of lithium-ion battery for cleanliness	No dust, water, corrosion, oxidation, rust, etc.	Clean the surface if dust, corrosion, oxidation, or rust is found. Use a dustless cloth or air compressor. Using water is strictly prohibited.	Weekly
9	Ensure outside battery screws are tight	Tighten screws if necessary		Weekly
10	Check for water or foreign material in the plug and socket. Check for rust or charring (if necessary)	Perform a visual inspection		Monthly
11	Check the cable for damages or loose joints (if necessary)	Perform a visual inspection		Monthly
12	Check the battery case for abnormalities such as cracks, deformation, and bulging	Perform a visual inspection	Stop using the battery if abnormalities are found	Monthly

NOTE: The manufacturer recommends using compressed air at less than 30psi (207kPa).

Troubleshooting & Recycling

During the use and maintenance of the lithium-ion battery, the battery or battery system may have one or more of the following abnormal conditions.

Only trained technicians are allowed to perform the necessary processing according to the instructions in this manual.

If there are any questions about the status or solutions, please contact Big Joe Forklifts dealers or after-sales service department of the company to obtain professional technical support.

- If the battery is found to have abnormal mechanical characteristics such as swelling, cracked casing, melted casing or distortion of the casing before and during installation, stop using the battery immediately, place it in open and well-ventilated space, and contact the after-sales service.
- If abnormalities such as looseness, cracks, cracks in the insulation layer, burn marks, etc. of the battery's pole pressing bolts, conductive strips, main circuit wires, and connectors are found before and during the installation, STOP using the battery immediately.
- If the polarity of the positive and negative terminals of the battery is found incorrect, STOP using the battery immediately and contact the after-sales service department to replace the battery or obtain other solutions.
- If the battery emits smoke; immediately STOP using the battery, use fire sand and an explosion-proof box for burial and isolation, wearing a respirator and fireproof gloves move the battery to a safe area, and notify the after-sales service department of the company for record and obtain technical support.

Damaged / Leaking Battery Handling

- Put on personal protective equipment (PPE), such as gloves, goggles/safety glasses, and a lab coat.
- Isolate and ventilate the area.
- Keep an appropriate fire extinguisher within reach.
- If batteries are showing evidence of overheating, use extreme care. Gases can be toxic and flammable.
- Disconnect the battery (if possible).
- Remove the battery from the equipment/device (if possible).
- Use inert, non-cellulose absorbents to clean up the spilled electrolyte.
- Place used absorbents and PPE in a sealed bag and contact your environmental or shipping container for proper disposal of the battery and absorbents.
- **DO NOT** place damaged batteries in regular trash or recycling containers.
- For safe storage while awaiting proper disposal, place the battery in a container of sand or another chemically inert cushioning material like vermiculite. There are damaged Li-ion battery kits commercially available for isolating a battery in a metal pail along with fire-proof media (such as sand, and vermiculite) to cover the battery with.

- If the electrolyte is leaking out, place the battery in a bucket of water for 7 days to effectively discharge the internal cells. This is the only time the battery should be exposed to water.
- Place the battery container away from combustibles.
- Contact the local fire department and ask for advice on how to proceed.

Charging

Designate a specific area for the purpose of charging lithium-ion batteries. When charging, make sure the battery charger is turned OFF before connecting the battery charging cables. Lithium-ion batteries allow for fast charging, if the battery does not charge completely in a normal period or if the battery management system (BMS) indicates a fault, then remove the battery from service. Big Joe Forklifts recommends the opportunity charge lithium-ion batteries. This is when the battery is recharged for short intervals during a shift period. It reduces or eliminates the need for long charging periods, changing batteries during a shift, and extending shift periods.

Please follow the guidelines below:

- Battery must be charged when the remaining charge is lower than 20%, avoid over-charging or over-discharging.
- Remaining charge should be higher than 60% during a short period of storage.
- Running the truck is prohibited in the case of a short circuit, low voltage, or high temperature.
- Perform charging, discharging test, and battery status inspection at least once per month, including total voltage, unit voltage, voltage difference, temperature, temperature difference, the value of insulation resistance, remaining charge, etc.
- Handle battery gently. DO NOT throw, roll, or allow to collide with other objects.

Recycling

Lithium-ion batteries must be disposed of according to the relevant environmental protection regulations. Big Joe Forklifts recommends researching battery recycling companies and choosing what is best for your situation. We have included two companies here with some information about each. This information is not guaranteed to be current, please contact the company for the most up-to-date information.

Note: The companies are not affiliated with Big Joe Forklifts and are considered third party.

Company:	<u>Battery Recyclers of America</u>	<u>Li-Cycle</u>
HQ:	Dallas TX	Toronto Canada
Years in Business: (as of 2023)	13 years	7 years
Recycling Process:	Smelting	Submerged
EPA Certified:	Yes	Yes
Refurb/Recycle:	Both	Recycle
Packaging Requirements:	Per DoT	Per DoT
Palletize Service:	Yes	No
Pickup:	Yes	Ship only
Logistics Support:	Yes	No
Min. Pickup Weight:	50 lbs.	N/A
Accept Mix of Lead and Li:	Yes	No

Appendix A: Daily Spot Check Record

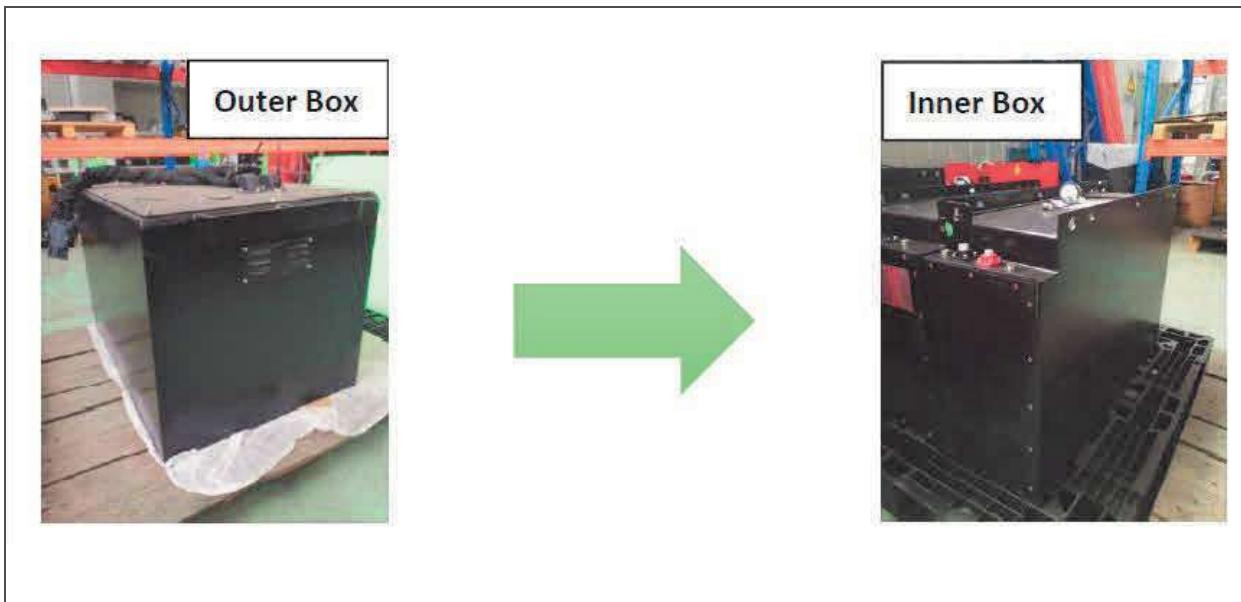
Daily Spot Check Record of Lithium Batteries (Easy Exchange)					
Routine Check Items	Leakage	Leakage	Box Damaged	Battery Bulge	Terminal Damage
Diagram of Routine Inspection Items					
Explanation	There is liquid leakage causing corrosion at the charging and discharging terminals on the bottom of the battery	There are traces of liquid leakage at the bottom of the battery, which caused stains around the positive and negative terminal ports	The box body is cracked and has pieces missing	The battery expands causing it to bulge	The terminal is deformed, discolored, blackened or there are traces of high temperature burning
Processing Method	Stop using, soak in water for 7 days to discharge and recycle according to local regulations	Stop using, soak in water for 7 days to discharge and recycle according to local regulations	Stop using and recycle according to local regulations	Stop using and recycle according to local regulations	Replace the terminal
Inspection Frequency	Daily	Daily	Daily	Daily	Daily
Inspection Method	Visual inspection	Visual inspection	Visual inspection	Visual inspection	Visual inspection
Date					
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
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23					
24					
25					
26					
27					
28					
29					
30					
31					

Note: All spot inspectors shall conduct a visual inspection prior to work every day. Mark "V" if they meet the requirements. If they do not meet the requirements, Mark "X" and report it to the proper personnel.

Place of use:	
Person in charge of spot inspection:	

Appendix B: Box Structure

Big Battery Box Structure – If equipped, only the inner box needs to be shipped with battery cells and BMS plate for repair/return.



C - SCHEDULE

Operator's Daily Checklist

Date _____ Operator _____

Truck No. _____ No. _____

Department _____

Runtime

Meter Reading_____

Daily Check Items	O.K.(✓)	Remark
Drive Wheel		
Steering Wheel		
Horn / Lights		
Lifting / Lowering Control Functions		
Optional Features		
Forward / Reverse Control Functions		
Steering control functions		
Braking Functions		
Check hydraulic system for leaks: cylinders, fittings, tubing, oil tank, etc.		



Big Lift LLC