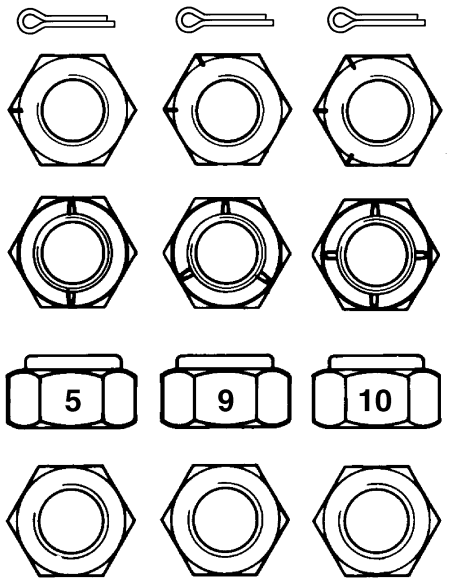
Yale®

Maintenance

METRIC AND INCH (SAE) FASTENERS



HM210064

Table 2. Studs and Nuts

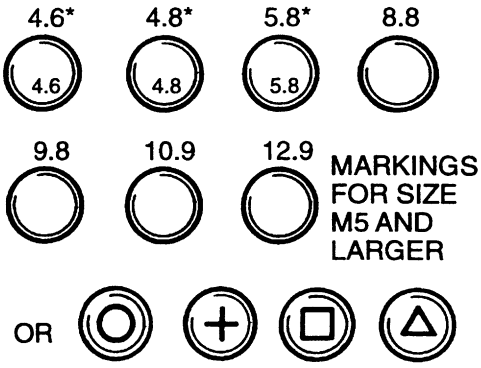
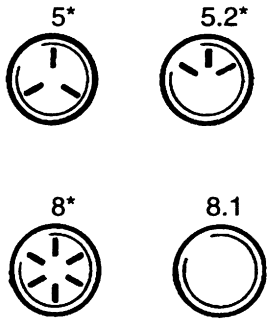
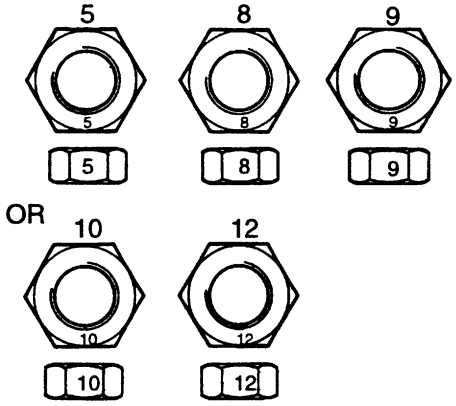
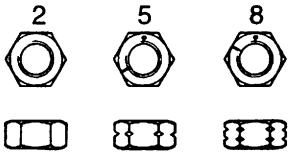
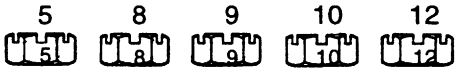
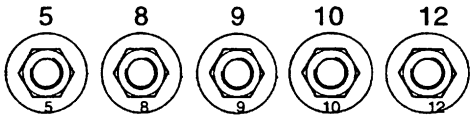
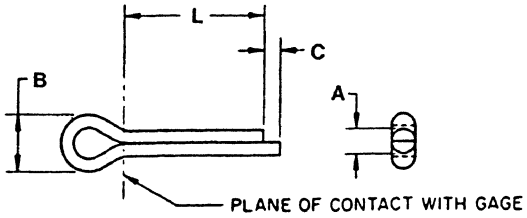
TYPE OF FASTENER	METRIC FASTENERS STRENGTH LEVELS: PROPERTY CLASS * MARKINGS NOT REQUIRED	INCH FASTENERS STRENGTH LEVELS: SAE GRADES * MARKINGS NOT REQUIRED
 STUDS		
 HEX NUTS		OR 
 HEX SLOTTED NUTS		MARKINGS NOT REQUIRED
 HEX FLANGE NUTS		MARKINGS NOT REQUIRED HM210067

Table 11. Cotter Pin Dimensional Data

Nominal Length L	Length Range		Nominal Size - Part Numbers	
	max	min	13.0 mm (0.500 in.)	16.00 mm (0.625 in.)
19.05 mm (0.750 in.)	20.5 mm (0.807 in.)	18.3 mm (0.720 in.)		
25.4 mm (1.00 in.)	26.9 mm (1.060 in.)	23.9 mm (0.940 in.)		
31.75 mm (1.250 in.)	33.3 mm (1.310 in.)	29.2 mm (1.150 in.)		
38.1 mm (1.500 in.)	40.9 mm (1.610 in.)	36.6 mm (1.440 in.)		
44.45 mm (1.750 in.)	46.0 mm (1.810 in.)	42.9 mm (1.690 in.)	0221889	
50.8 mm (2.000 in.)	52.3 mm (2.060 in.)	49.3 mm (1.940 in.)	0221890	
57.15 mm (2.250 in.)	58.7 mm (2.310 in.)	55.1 mm (2.170 in.)	0221891	
63.5 mm (2.500 in.)	65.0 mm (2.560 in.)	62.0 mm (2.440 in.)	0221892	
69.85 mm (2.750 in.)	72.1 mm (2.840 in.)	68.3 mm (2.690 in.)	0221893	0221895
76.2 mm (3.000 in.)	81.3 mm (3.200 in.)	74.7 mm (2.940 in.)	0015291	0221896
88.9 mm (3.500 in.)	91.4 mm (3.600 in.)	87.4 mm (3.440 in.)	0015292	0221897
101.6 mm (4.000 in.)	113.3 mm (4.460 in.)	98.8 mm (3.890 in.)	0015293	0221898
127.0 mm (5.000 in.)	128.5 mm (5.060 in.)	123.7 mm (4.870 in.)	0015295	0221899
152.4 mm (6.000 in.)	153.9 mm (3.060 in.)	138.7 mm (5.460 in.)	0015297	0221900



EXTENDED PRONG

HM211587

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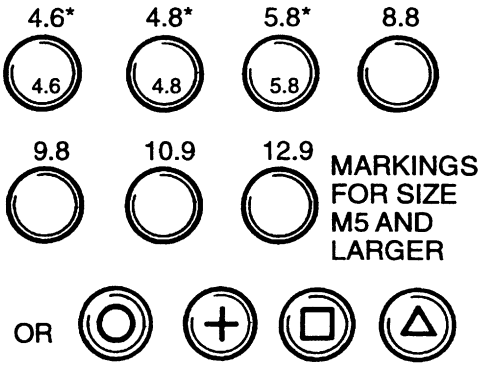
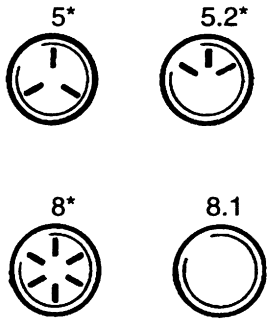
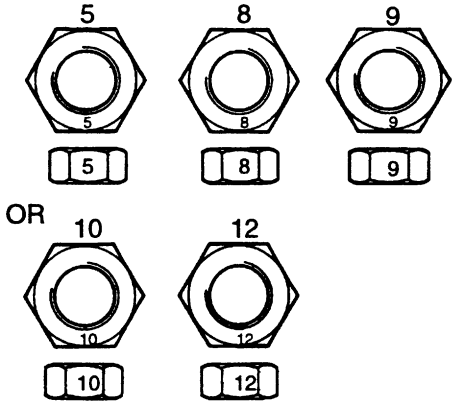
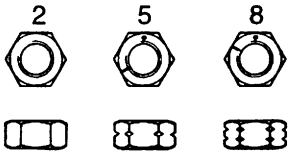
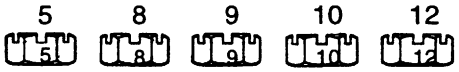
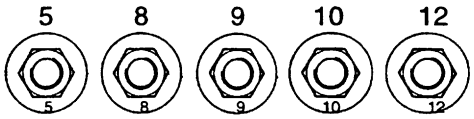
 STUDS		
 HEX NUTS		OR 
 HEX SLOTTED NUTS		MARKINGS NOT REQUIRED
 HEX FLANGE NUTS		MARKINGS NOT REQUIRED HM210067

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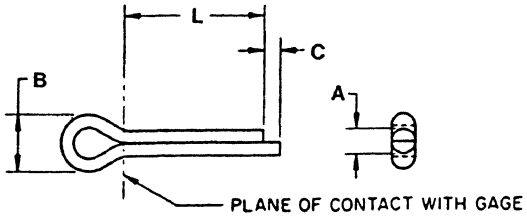


EXTENDED PRONG

HM211587

Legend for Figure 3

1. WIRE HARNESS
2. SLEEVE
3. NUT
4. LOCKWASHER
5. FLAT WASHER
6. BEARING CONE AND CUP ASSEMBLY
7. BEARING CONE
8. BEARING CUP
9. BEARING CUP
10. BEARING CONE
11. ALLEN-HEAD SCREW
12. SPINDLE
13. O-RING
14. BALL BEARING
15. SPACER
16. BRAKE ASSEMBLY
17. BRAKE HUB
18. KEY
19. KEY
20. DRIVE MOTOR
21. PIVOT BUSHING
22. WASHER
23. CAPSCREW
24. DRIVE TIRE AND WHEEL
25. MDU
26. DRIVE AXLE
27. BEARING CONE AND SEAL ASSEMBLY
28. BEARING CUP
29. PIN
30. DRIVE GEAR
31. NUT
32. BALL BEARING
33. GEAR AND PINION ASSEMBLY
34. GEAR AND PINION ASSEMBLY
35. NUT
36. GEAR
37. OIL SLINGER
38. CASTING
39. LOCKWASHER
40. CAPSCREW
41. FILL PLUG
42. ALLEN-HEAD SCREW
43. LOCKWASHER
44. COVER
45. ALLEN-HEAD SCREW
46. LOCKWASHER

DISASSEMBLE

Refer to Figure 3 for the following instructions.

NOTE: Total disassembly may not be necessary to repair the MDU. Do only the steps necessary to complete repairs.

The MDU can be removed from the lift truck to be completely disassembled. See Remove. However, certain components may be removed with the MDU installed in the truck. The drive motor, brake, drive wheel and tire assembly, and pivot bushing (21) may be removed with the MDU installed on the truck. The gear oil may also be changed with the MDU installed. Where partial disassembly of the MDU while installed is possible, assembly, cleaning, and inspection of the MDU is much easier when completely removed. The following steps refer to the disassembly of an MDU which has been removed from the drive unit compartment. See Figure 3.

1. Remove MDU from lift truck. Refer to Remove.

2. Place the MDU on a clean workbench.

3. Detach steering spindle by removing Allen-head screws (11) if necessary.

4. Remove pivot bushings (21) if necessary.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

5. Remove cover and drain oil:

a. Remove eight capscrews (40) and lockwashers (39).

b. Remove two Allen-head screws (42) and washers (43).

c. Using the slots provided, gently pry the top and bottom sides of cover alternately from the MDU.

d. Remove cover and place on a clean workbench.

e. Remove two pins (29) from MDU housing if necessary.

CAUTION

Use a hammer and a soft punch when removing bearings to avoid damage to bearings and/or casting.

6. Remove drive axle and bearings:

a. Remove nut (31) and gear (30).

b. Remove drive axle.

c. Remove bearing cone and seal assembly (27).

7. Remove gear and pinion assemblies and bearings:

a. Remove gear and pinion assemblies (33, 34) by hand.

b. Remove bearings (32) from casting and cover.

General

The control handle assembly is designed to perform several functions. The standard control handle includes the speed/direction control and buttons for the horn, traction reversing, and hydraulic functions. The control handle is connected to the Master Drive Unit (MDU) and is used to steer the truck as it turns the MDU. Move the control handle left or right to turn the drive/steer tire and steer the truck. Controls mounted in the handle are linked to the control panel by a wiring harness that passes through the center of the handle. The brake is applied when the handle is in the full up or down position.

A bottom-mounted control handle assembly is used on the MSW020/025-E, MSW025/030-F, MPB040-E, MPW045-E, and MPW050-E. The handle is designed to be used while the operator is walking beside the lift truck.

Special Precautions

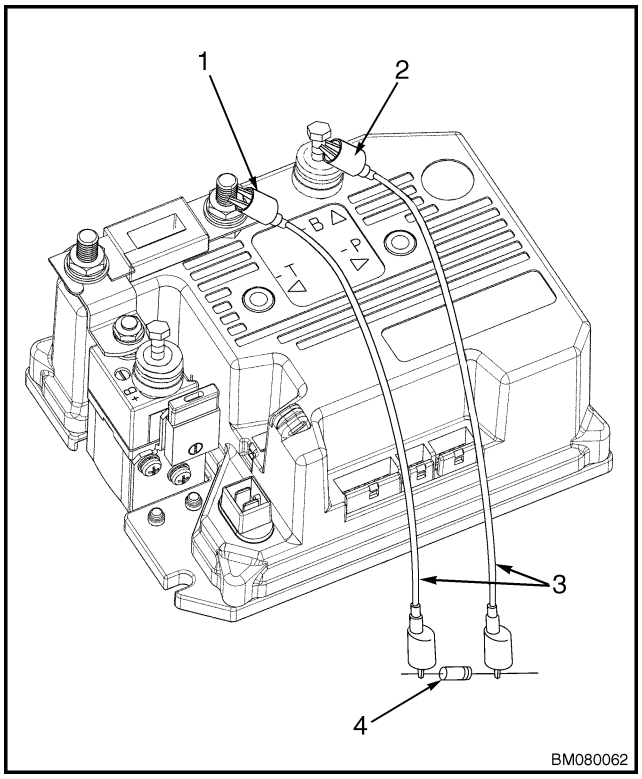
WARNING

To avoid personal injury and prevent electrical shock, perform the following steps before troubleshooting or adjusting and before connecting or disconnecting a handset or personal computer.

CAUTION

To avoid controller damage, always disconnect the battery, discharge the capacitor, and never put power to the controller while any power wires are disconnected. Never short any controller terminal or motor terminal to the battery. Make sure to use the proper procedure when servicing the controller.

1. Turn the key switch to the **OFF** position and disconnect the battery.
2. Discharge the capacitors in the controllers by connecting a 200-ohm, 2-watt resistor across the controller's B+ and B− terminals. **DO NOT** short across the motor controller terminals with a screwdriver or jumper wire. See Figure 1 and Figure 2.
3. Remove the 200-ohm, 2-watt resistor before reconnecting the battery.



1. POSITIVE CONNECTION
2. NEGATIVE CONNECTION
3. INSULATED JUMPER WIRES
4. 200-OHM, 2-WATT RESISTOR

Figure 1. Discharging Controller - MPB040-E

TABLE OF CONTENTS

This section is for the following models:

MSW020/025-E [A895];
MSW025/030-F [B895];
MPB040-E [B827];
MPW045-E [B802];
MPW050-E [C802]

Special Precautions

WARNING

DO NOT make repairs or adjustments unless you have both authorization and training. Repairs and adjustments that are not correct can create dangerous operating conditions. DO NOT operate a lift truck that needs repairs. Report the need for repairs to your supervisor immediately. If repair is necessary, attach a DO NOT OPERATE tag to the control handle.

WARNING

Disconnect the battery and separate the connector before opening the drive unit compartment cover or inspecting or repairing the electrical system. If a tool causes a short circuit, the high current flow from the battery can cause personal injury or property damage.

WARNING

Some checks and adjustments are done with the battery connected. DO NOT connect the battery until the procedure tells you to do so. Never have any metal on your fingers, arms, or neck. Metal items can accidentally make an electrical connection and cause injury.

WARNING

Before doing any tests or adjustments, raise the vehicle off the ground and block the lift truck to prevent unexpected movement. See the section Periodic Maintenance 8000YRM1048, Periodic Maintenance 8000YRM1009, or Periodic Maintenance 8000YRM1379 for your lift truck. Refer to How to Put a Lift Truck on Blocks.

WARNING

The capacitor in the transistor controller can hold an electrical charge after the battery is disconnected. To prevent an electrical shock and personal injury, discharge the capacitor before inspecting or repairing any component in the drive unit compartment. Wear safety glasses. Make certain that the battery has been disconnected.

CAUTION

To avoid controller damage, always disconnect the battery, discharge the capacitor, and never put power to the controller while any power wires are disconnected. Never short any controller terminal or motor terminal to the battery. Make sure to use proper procedure when servicing the controller.

1. Block load wheels to prevent lift truck from moving. See the section **Periodic Maintenance** 8000YRM1048, **Periodic Maintenance** 8000YRM1009, or **Periodic Maintenance** 8000YRM1379 for your lift truck.
2. Turn the key switch to the **OFF** position and disconnect the battery.
3. Discharge the capacitors in the controllers by connecting a 200-ohm, 2-watt resistor across the controller's B+ and B- terminals. **DO NOT** short across the motor controller terminals with a screwdriver or jumper wire. See Figure 3 or Figure 4.
4. Remove the 200-ohm, 2-watt resistor before reconnecting the battery.

Fuses

WARNING

Before checking or changing any fuses, make certain the battery has been disconnected.

Always wear safety glasses. Block the tires, remove the key from the key switch, disconnect battery, and discharge the capacitors before making checks or repairs in the drive unit compartment. See Special Precautions.

MPB040-E

The MPB040-E 24-volt motorized hand trucks have two fuses. They are:

1. 175-amp (FU 1) protects both the lift pump motor and the drive motor
2. 5-amp (FU 2) protects the control circuits

MPW045/050-E

The MPW045-E and MPW050-E 24-volt lift trucks have two fuses. They are:

1. 250-amp (FU 1) protects both the lift pump motor and the drive motor.
2. 5-amp (FU 2) protects the control circuits.

The MPW045-E and MPW050-E 12-volt lift trucks have three fuses. They are:

1. 250-amp (FU 1) protects both the lift pump motor and the drive motor.
2. 5-amp (FU 2) protects the control circuits.
3. 5-amp (FU 3) protects the 12-volt DC to 24-volt DC converter circuit.

MSW020/025-E

The MSW020/025-E 24-volt lift trucks have two fuses. They are:

1. 250-amp (FU 1) protects both the lift pump motor and the drive motor.
2. 5-amp (FU 2) protects the control circuits.

If it cannot be determined visually that any of the fuses have failed, check for continuity using an ohmmeter. To replace FU 1, loosen retaining capscrews. Install a new fuse and tighten capscrews. FU 2 is retained by a fuse holder. Make certain that any replacement fuse is of the right amperage before installation.

MSW025/030-F

The MSW025/030-F 24-volt lift trucks have three fuses. They are:

1. FU 1 protects both the lift pump motor and the drive motor.
2. FU 2 protects the control circuits.
3. FU 3 protects the control circuits.

If it cannot be determined visually that any of the fuses have failed, check for continuity using an ohmmeter. To replace FU 1, loosen retaining capscrews. Install a new fuse and tighten capscrews. FU 2 or FU 3 are retained by a fuse holder. Make certain that any replacement fuse is of the right amperage before installation.

SWITCHES (ON/OFF AND PROPORTIONAL)

Remove

NOTE: It is not always necessary to remove and disassemble all the components that make up the control section of the steering handle to replace a damaged part. Do only the steps necessary to replace the damaged parts. See Figure 16.

1. Move lift truck to a safe, level area and block the drive wheel to prevent movement of the lift truck.
2. Turn the key switch to the **OFF** position and disconnect battery.
3. Discharge the capacitor. See Special Precautions.

NOTE: The handle is comprised of two molded-plastic halves and is held together by three capscrews.

4. Remove the three capscrews retaining upper half of control handle to lower half.
5. Disengage hooks under the auto-reverse switch. Slide upper half off the lower half using a gentle rocking motion while lifting and pulling upper half away from lower half. See Figure 16.
6. Unplug handle wiring harness from control handle card.
7. Place upper half of handle upside down on a secure, level work surface so the internal parts are facing up.
8. Refer to the wiring diagram, or draw a sketch of where the failed push button switch is plugged into the control handle card. Unplug failed switch from control handle card.

NOTE: Both ON/OFF and proportional switches use three tabs to keep the switches attached to the upper half of the control handle.

9. Remove the switch by pressing the three tabs toward the switch and pushing the switch through upper half of cover.
10. **Replace ON/OFF Switch**:
    a. Separate the button from the switch by spreading the four tabs to allow the switch to slide out of the button.
    b. To assemble, slide the ON/OFF switch into the ON/OFF button. Verify that the switch assembly locks into position.

Install

1. Install the switch assembly into the control handle. Verify that the switch assembly locks into position in the control handle.
2. Connect the switch assembly wiring to the control handle card.
3. Plug handle wiring harness into control handle card.

CAUTION

DO NOT force the upper half onto the lower half as this will cause damage to the retaining hooks of the upper half.

4. Install upper half of handle onto the lower half:
    a. Tip the upper half up and align the hooks under the auto-reverse switch.
    b. Lower the upper half onto the lower half.
5. Install three capscrews to retain upper half of control handle to lower half.
6. Connect battery cable and test control handle operation.

NOTE: If adding optional proportional switches for the first time, make sure to perform Control Handle Card (Old Style).

If the charger begins the charge cycle, but stops before it is complete and an error light comes on, this usually indicates a problem with the batteries.

NOTE: The charger has an electronic safety timer that will detect if the batteries are not responding to the charge within the prescribed time period. The charger will shut itself down if it determines there is a problem with the batteries.

1. If the charger is unable to raise the battery voltage above 1.7 volts/cell (20.4 volts total) within one minute after start up, it will stop charging and a constant red LED will light up.

2. If the charger is unable to raise the battery voltage above 2.05 volts/cell (24.6 volts total) within one hour after start up, it will stop charging and a constant red LED will light up.

3. If the charger is unable to raise the battery voltage above 2.42 volts/cell (29.0 volts total) within 10 hours after start up, it will stop charging and a constant red LED will light up.

4. If at any time during the charge cycle the transformer overheats, the charger will stop, the yellow LED will stay on, and the red LED will flash. This may appear to be a charger issues, but it is caused by the batteries. If the battery voltage does not rise as it should, the charger output current will increase, which raises the transformer temperature. Eventually, it will become too hot, causing the charger to shut down to protect itself. The charger will restart itself and begin charging again after the transformer has cooled down, but the same situation may occur again. If this happens within one hour after start up, the one hour timer will expire and shut the charger down as described in item 2 above.

All of the cases above are indicative of a set of batteries that are not responding properly to the charger due to one or more weak or failing cells.

When any one of these situations occur, it is best to unplug the charger and inspect the batteries for one or more bad cells. This can be done with a load tester or a specific gravity test. If the variation between the highest and lowest specific gravity reading between the three cells in any one battery is 0.050 (50 gravity points) or more, there is a reason to suspect a weak or failing cell.

If a battery has a bad cell, it must be replaced. To improve battery life, and to get the maximum amount of run time out of each charge cycle, it is best to replace all four batteries at the same time.

If all the above steps have been taken and the charger still does not function properly, the charger should be replaced.

Battery Charger (Accusense® 20A)

DESCRIPTION

Lift trucks equipped with Accusense® battery chargers can be distinguished by the battery charger label. See Figure 31 for lift trucks manufactured before May, 2013. See Figure 32 for lift trucks manufactured after May, 2013. Accusense 20A chargers are self contained, 120 volt, AC powered chargers. Each charger comes equipped with a short lead plug to allow connection to the 120 volt AC outlet using a 20 amp rated extension cord. The charger will operate from any wall outlet capable of supplying 108 to 126 volts AC protected by a 20 amp circuit breaker.

NOTE: Chargers can be identified by the MFR MOD number on the charger label. If the first two digits of the MFR MOD number read 1Q or 2Q, the equipment is a Gen IV Q-Series charger.

For the Gen IV chargers, refer to Accusense® Gen IV Charger **2200YRM2030**. For other charger models, use this manual.

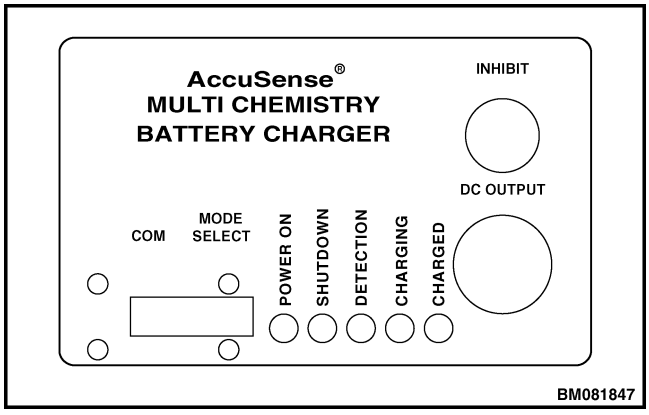


Figure 31. Accusense 20A Chargers, Manufactured Before May, 2013

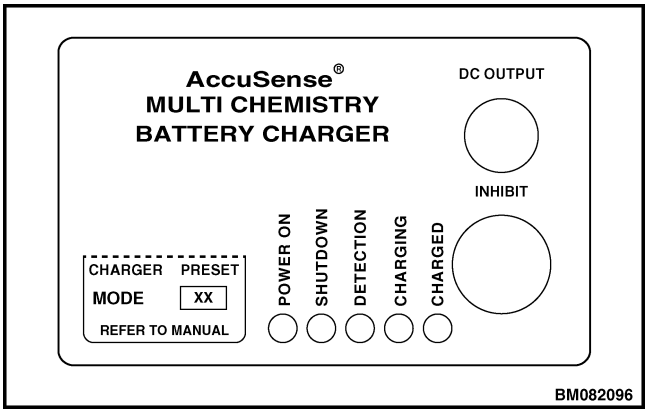


Figure 32. Accusense 20A Chargers, Manufactured After May, 2013

NOTE: Some markets use a special 230 volt AC charger which require connection to a 230 volt AC outlet. Users with 230 volt AC chargers should substitute 230 volts AC in the place of 120 volts AC when instructed to connect the charger to a power source.

OPERATION

LED Display

The charger has five colored LEDs located on the top of the charger. The LEDs are used to indicate the status of the charger during operation. The order of the LEDs may vary with models, but are labeled to identify their function. See Table 6.

STEERING PUMP MOTOR

NOTE: Some electrical trucks use a steering pump motor. Refer to your truck model's service manual for instructions on removal and installation of steering pump motors.

1. Disconnect battery connector. Remove floor plate from lift truck for access to steering pump motor. Open hood for access to motor. Remove screws that hold two brush cover plates to motor housing.
2. Inspect brushes and commutator as described in previous paragraphs for traction and hydraulic pump motors. The brush replacement procedure is also the same, although there are only two brushes for the steering pump motor. See Table 3.
3. Install brush covers and screws. Install floor plate or close hood and connect battery connector.

NORMAL COMMUTATOR SURFACE

A commutator that has been in service will have a smooth and polished surface with a darker brown color where it rotates under the brushes. See Table 1. A variation of color on the commutator surface between light brown and darker brown is normal. This surface condition is the lubrication between the commutator and the brushes. The brushes will wear rapidly if this surface condition does not develop during the first 6 to 10 hours of operation after a commutator with a new surface is installed.

COMMUTATOR PROBLEMS

Commutator and motor problems and are shown in Table 2.

Motors Repair

DISASSEMBLE

See the **Master Drive Unit** section or the **Frame** section for your lift truck for instructions on the removal and installation of the traction motor.

See the **Hydraulic System** section for instructions to remove and install the hydraulic pump and motor.

See the Brush and Commutator Inspection and Brush Replacement in this section for more information on these components of the motor.

Traction Motor and Hydraulic Pump Motor

NOTE: It is recommended that the bearings and the seal be replaced every 3,000 hours or 36 months, whichever comes first.

1. Clean outside surfaces of motor before disassembly. See Figure 8, Figure 9, and Figure 10. Put motor on its commutator (brush) end on a bench. On hydraulic motor assemblies, make index marks on pump and motor. Make index marks on end frames of motor and field frame so correct assembly is possible.

2. On hydraulic motor assemblies, remove two capscrews that fasten pump to pump motor. See Figure 11 or Figure 12. Remove pump. Put an index mark on armature shaft at the position of the coupler hub for correct assembly. Remove coupler hub from armature shaft by loosening setscrew and sliding hub off shaft and key. Do not lose key.

3. Remove brush cover. Remove brushes and spring assemblies.

4. Remove hex head screws from commutator end of motor. Carefully slide end frame from motor and armature shaft. Do not damage parts. A puller is frequently necessary to separate end frame from field frame.

CAUTION

The drive end frame and the armature are heavy components. Work carefully so the field coils, pole pieces, and armature are not damaged during disassembly and assembly.

5. Remove screws that fasten drive end frame to field frame. Remove end frame and armature. Use a plastic or rubber hammer as necessary to loosen end frame.

Brush Alignment, Traction and Hydraulic Motors

NOTE: The brush holder in these motors can be rotated for timing of the brush alignment with the commutator. This process normally requires special equipment and training. A special repair service for electric motors is required to align the bushes for the correct timing with the commutator. If the brushes are not timed correctly with the commutator, the motor will have a low power output. The procedures for timing an electric motor are not described in this section. Do not rotate the brush holder from its original position.

If the brush holder must be loosened or removed from the end frame for repairs, the brush holder must be installed again in the same position. See Figure 7. Make alignment marks between brush holder and end frame before brush mounting plate is released. The brush holder must be installed again in the same position.

If a new brush holder must be installed, there will not be an alignment mark on the new brush holder. Make an alignment mark on end frame with a reference point on brush holder that must be removed. Install new brush holder so the reference point and the alignment mark are aligned. The new brush holder must be installed in the same position as the old holder so the timing will be correct.

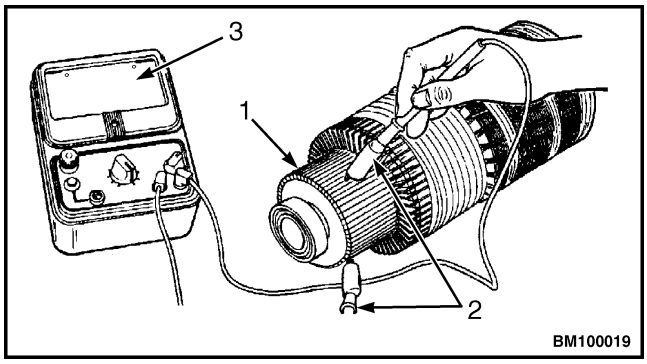
Tests for Damaged Field and Armature

The tests described in the following paragraphs are to help a service person check a motor for damage and to determine if it must be sent to a repair service for rebuilt motors. The resistance checks will not normally indicate a short circuit in a motor winding. A resistance greater than 1 to 2 ohms can indicate a damaged winding. The motor must be removed from the lift truck and disassembled as shown in the illustrations before the tests can be done.

TEST FOR AN OPEN CIRCUIT IN ONE ARMATURE WINDING

The armature windings in large electric motors normally have less than 1 ohm of resistance. The two commutator bars for a winding are found 180 degrees apart on the commutator. If an ohmmeter (R × 1 scale) is used to check the resistance between the two commutator bars of the winding, a resistance of more than 1 ohm indicates a problem in that winding. A resistance of infinity (∞) indicates an open (damaged) winding. See Figure 14.

If the armature has an open circuit, there will normally be two burned commutator bars on opposite sides of the commutator. These burned areas will cause the brushes to wear rapidly. When the motor operates, large electric sparks and arcs occur as the damaged commutator bars rotate under each brush. See Table 2.



1. COMMUTATOR BARS
2. TEST PROBES AT 90-DEGREE SEPARATION
3. RESISTANCE SHOULD BE LESS THAN 1 OHM

Figure 14. Test for an Armature Open Circuit

TEST FOR SHORT CIRCUIT IN ONE ARMATURE WINDING

A short circuit in a motor winding is difficult to test because of the normal low resistance (less than 1 ohm) of a good armature. Special equipment is necessary to check for a short circuit in a motor winding. A motor with a short circuit in an armature winding will have a different sound when it begins to operate, but a service person must have experience to hear and understand the difference in sound. A winding with a short circuit will also run hotter than a good winding and can have indications of heat damage. A winding that shows heat damage when the other windings are normal can have a short circuit. See Figure 15.

WARNING

Installing improper electrical accessories or installing an electrical accessory incorrectly can increase the risk of equipment damage, personal injury and fire. DO NOT install electrical accessories to the truck unless you have been trained and authorized to do so. Personnel installing the electrical accessories must document the changes made to the truck. DO NOT install accessories which affect the truck's compliance with standard EN 1175:2020.

WARNING

California Proposition 65 - Operating, servicing and maintaining a powered industrial truck can expose you to chemicals including engine exhaust, carbon monoxide, phthalates, and lead, which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information, go to www.P65Warnings.ca.gov.

Battery Maintenance

Battery maintenance must include the following items:

- A good battery charger
- A clean battery
- Keep the electrolyte at the correct level (see Figure 13)
- Keep a record of the battery
- An Equalization Charge once a month

SAFETY PROCEDURES

1. Wear a rubber apron, gloves, boots, and goggles or a face shield when doing maintenance on batteries.

2. Batteries generate hydrogen gas when they are being charged. Keep open fire away from batteries. Do not check the electrolyte level with a match or a lighter. Do not smoke and do not create sparks.

3. Lift batteries correctly with a crane or equipment designed for the job. Always use a spreader bar designed and adjusted for the battery. Move batteries with a lift truck or a conveyor or rollers designed for that purpose. If the battery does not have a cover, a rubber mat or insulating material must be put over the top of the battery to prevent a short circuit with other equipment. Make sure the lifting equipment has enough capacity for the job. Do not use chain or wire rope slings.

4. Never put metal materials or tools on a battery.

5. Disconnect battery from lift truck before doing maintenance or repairs.

6. When maintenance on the battery or the battery charger is required, disconnect both the AC and DC power. If the battery connectors must be replaced, make sure the positive and negative terminals and cables are kept separate and insulated from each other. Even a momentary short circuit can cause an explosion and damage the battery.

7. Keep water readily available to flush spilled electrolyte. Electrolyte in the eyes must be flushed with water immediately, and then quickly get medical attention. Special showers and eye wash systems are required in areas where battery maintenance is done.

8. If electrolyte is spilled on a work surface or the floor, flush area with water, use a solution of soda (sodium bicarbonate) to make the acid neutral.

9. Only trained persons are permitted to do maintenance on batteries and battery chargers. Make sure the regulations by government safety agencies, government insurers, private insurers, and private organizations are followed when doing maintenance on batteries.

MAINTENANCE RECORDS

NOTE: Follow the same sequence when you record the cell number. Always begin the record with a positive cell. Follow a sequence so the last cell is always the cell for the negative cable.

Record the beginning ampere reading of the charger each time the battery is charged. Any difference in the daily ampere reading can indicate a problem with the battery or the charger.

NEW BATTERY

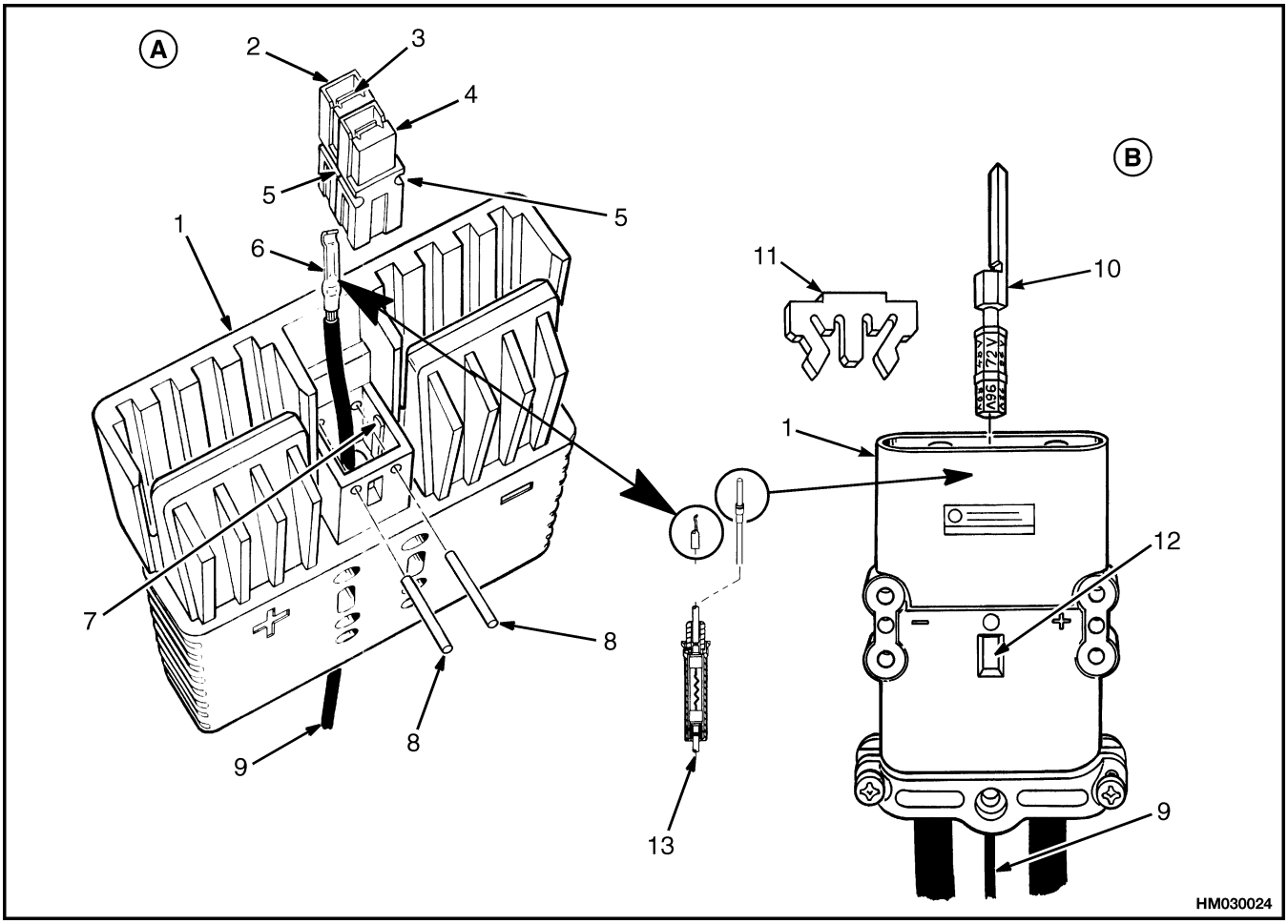
CAUTION

Always use a spreader bar and slings that lift vertically on the lifting eyes of the battery. DO NOT use a chain or sling without a spreader bar or you will damage the battery case.

Use the correct blocks or spacers to hold the battery in position in the lift truck. Make sure the battery compartment is clean and dry. All vent caps must be in position when the battery is in service. If the vent caps are not installed, the electrolyte will leak, causing corrosion on the battery case and in the battery compartment.

Inspect a new battery for damage. Make sure the electrolyte in each of the cells is at the correct level. Charge the battery for 6 hours or until the specific gravity is correct. Make sure the battery is correctly installed in the lift truck. Use a spreader bar with slings designed for the battery to lift and move the battery. See Figure 10.

Always complete the Battery Inspection Report and the Daily Battery Report. See Figure 11 and Figure 12.



NOTE: INDICATOR INSERT (2). GREEN - FOR BATTERY WITH CELL CAPS. GRAY - FOR BATTERY WITH SEALED CELLS.

NOTE: CONNECTOR BODY COLOR [ANDERSON SBE CONNECTOR ONLY (1)]. GRAY - 36-VOLT BATTERY. BLUE - 48-VOLT BATTERY. GREEN - 72-VOLT BATTERY. BLACK - 80-VOLT BATTERY.

A. ANDERSON SBE OR SBX CONNECTOR

B. FEM OR DIN CONNECTOR

1. HALF OF CONNECTOR SET
2. RED HOUSING FOR +12 VOLT "BATTERY TAP"
3. LOCK SPRING (TIP OF CONTACT MUST LOCK OVER TOP OF LOCK SPRING)
4. BLACK CONNECTOR HOUSING (ASSEMBLED ON RED HOUSING WITH SLOTS FOR LOCK PINS ALIGNED AS SHOWN - NO WIRE OR CONTACT IN HOUSING)
5. SLOT FOR LOCK PIN
6. CONTACT FOR CONNECTOR OF +12 VOLT BATTERY TAP
7. KEY [RED (2) AND BLACK (4) CONNECTORS ALIGN ON KEY]
8. LOCK PINS FOR +12 VOLT CONNECTOR (MUST INSTALL FROM FRONT OF CONNECTOR THROUGH RED AND BLACK CONNECTORS)
9. +12 VOLT WIRE TO TRUCK (TRUCK HALF) OR TO BATTERY (BATTERY HALF)
10. INDICATOR INSERT FOR BATTERY VOLTAGE AND BATTERY TYPE [ROTATE FOR CORRECT VOLTAGE IN WINDOW (12); COLOR SHOWS BATTERY TYPE]
11. LOCK FOR ALL CABLE TERMINALS AND INDICATOR
12. WINDOW SHOWING BATTERY VOLTAGE
13. IN-LINE FUSE ASSEMBLY AND CONTACT FOR +12 VOLT CONNECTOR (TRUCK HALF OF BATTERY CONNECTOR ONLY) (SBE/SBX CONTACT SHOWN)

Figure 23. Detail of Battery Connectors With +12 Volt Tap

General

This section describes how to select and do the maintenance for large batteries used in electric lift trucks. This information is for service personnel that must do the maintenance on large lead-acid batteries. Battery repair requires special training and equipment. Do not try to repair a battery unless you have the correct tools, equipment, and experience. Most battery repairs are done by a special repair service. Some batteries have a nameplate attached to the face of the battery cover. This nameplate communicates specific information about the battery including the name of the battery manufacturer, battery type, serial number, nominal voltage, capacity in amperes at the five-hour rate, and service mass (with ballast if used to compensate for lack of battery mass).

Battery Type

LEAD-ACID BATTERIES

A lead-acid battery converts chemical energy into electrical energy. See Figure 1. Chemical changes within the battery give the electrical energy. When the chemical reaction has occurred so the battery will not give its rated voltage and current, the battery is discharged. A reverse chemical action must occur so the battery can be used again. The batteries described in this section can be charged again by an electric voltage and current from an outside source so there is a reverse chemical action. The lead-acid chemicals store the electric energy until the electric energy is needed to operate an electric device.

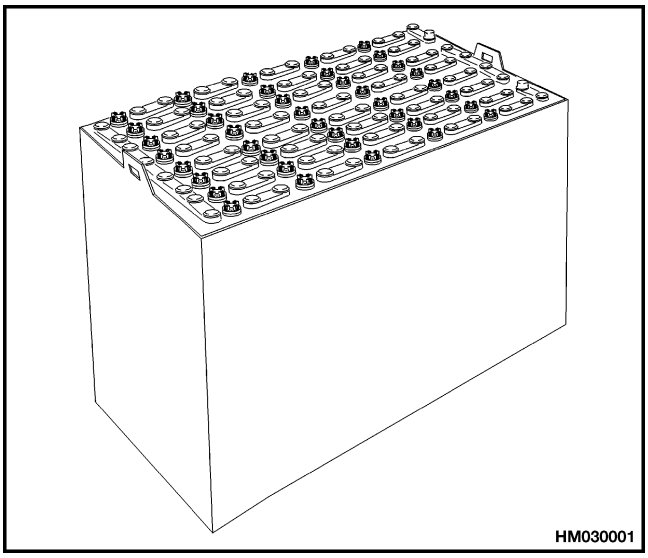
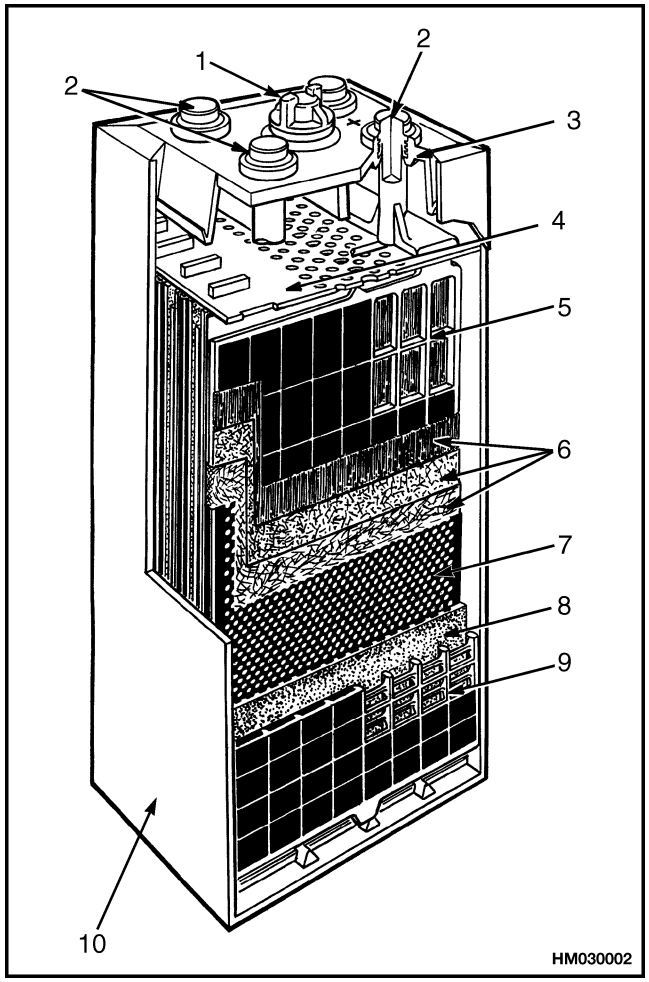


Figure 1. Lead-Acid Industrial Battery

A lead-acid battery is made from several lead-acid batteries called cells. Each cell has positive and negative plates with dielectric spacers between each plate. All of the plates are within a solution of electrolyte. See Figure 2.



1. VENT AND FILL CAP
2. POST
3. POST SEAL
4. PLATE PROTECTOR (SHIELD)
5. POSITIVE PLATE
6. EXPANSION MATS
7. RETAINER
8. SEPARATOR
9. NEGATIVE PLATE
10. BATTERY JAR

Figure 2. Battery Cell

Legend for Figure 14.

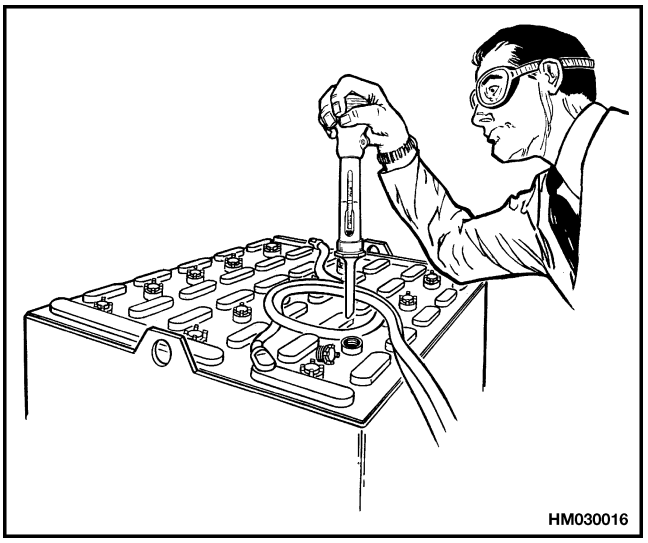
1. HIGH FLOAT MEANS HIGH SPECIFIC GRAVITY.
2. LOW FLOAT MEANS LOW SPECIFIC GRAVITY.
3. CORRECT METHOD OF READING HYDROMETER: EYE LEVEL EVEN WITH SURFACE OF ELECTROLYTE.

BATTERY TEMPERATURE

The temperature of the electrolyte will change the reading of the specific gravity. When the temperature increases approximately 6°C (10°F), the specific gravity will decrease by 0.003 point. See Figure 15 for making specific gravity corrections. If the hydrometer you are using does not have a temperature correction, you will have to use a thermometer. Special battery thermometers are available that will indicate the correction factor directly and add or subtract the correct number of points. See Figure 16.

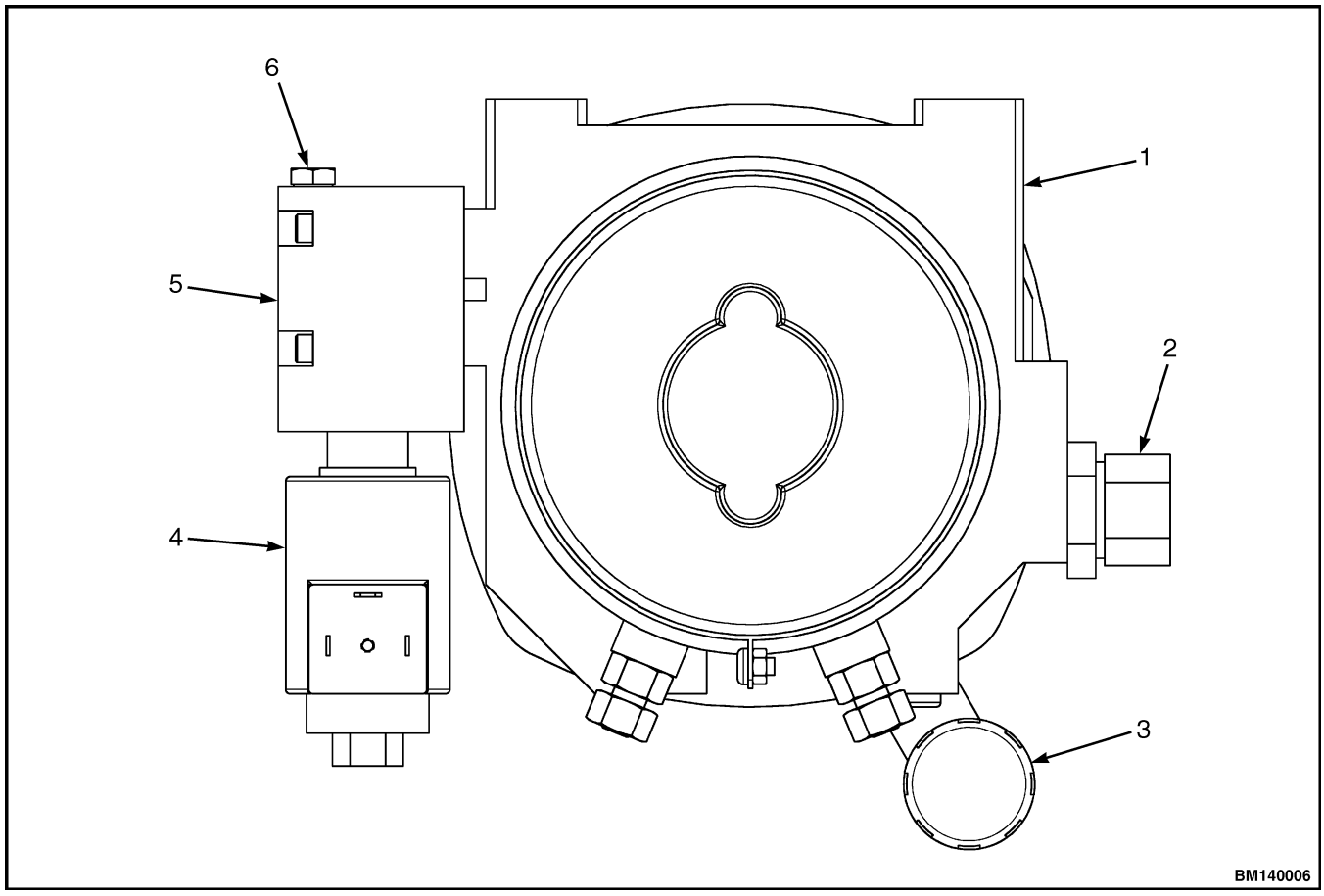
NEVER charge a battery at a rate that will raise the electrolyte temperature above 49°C (120°F). NEVER let a battery stay discharged for long periods. A temperature above this amount will damage the battery. The cells in the center of the battery are normally at the highest temperature. If the battery temperature is too hot, make sure the ventilation of the battery is increased and make sure the charge or discharge rate is not too high. A recommendation for a battery in service is 8 hours of use (discharge), followed by 8 hours of charging, followed by 8 hours of cooling.

To charge the battery, a direct current must pass through the cells in the opposite direction to the discharging current. The ampere-hours must be equal to the discharging ampere-hours plus the energy lost as heat. This additional amount of charge will vary according to the battery and the temperature, but the average additional charge is 12 percent. When the battery is nearly charged, the final charging must be at a low rate. A charging rate that is too high will cause heating in the battery and a high loss of water from the electrolyte. The charging of the battery must be done correctly, or the service life of the battery will be decreased.



Specific Gravity Reading	Electrolyte Temp.	Correction Points	Correct Value
1.210	31°C (88°F)	+0.003	1.213
1.210	27°C (81°F)	+0.001	1.211
1.210	25°C (77°F)	0.000	1.210
1.210	18°C (64°F)	−0.004	1.206
+0.001 or −0.001 for each 2 degrees C from the 25-degree base value.			

Figure 15. Specific Gravity Check



1. PUMP HOUSING
2. RELIEF VALVE
3. OIL FILL
4. PROPORTIONAL VALVE AND COIL
5. LOWERING VALVE BLOCK
6. MANUAL LOWERING SCREW (RETIGHTEN AFTER USE)

Figure 2. Manual Lowering Screw (Early Model MSW020/025-E)

5. Remove the lower, then upper drive unit compartment covers.
6. Discharge the capacitor. See Special Precautions.
7. Tag and disconnect the power wires to obtain adequate clearance to tilt the lift pump and motor assembly away from the frame.
8. Remove the two nuts and washers attaching the mounting bracket to the isolators and tilt the lift pump and motor assembly away from the frame.
9. Slowly loosen the relief valve cartridge to relieve pressure.
10. Remove the relief valve cartridge.
11. If necessary, remove the check valve cartridge using a 90 mm (3.5 in.) long M8 bolt. Thread the bolt into the cartridge to pull it from the housing.

Install

1. Verify that the O-rings on the valve cartridges are not damaged. Replace as needed.
2. Verify that the valve cartridges and pump housing are clean and not damaged.
3. Lubricate the relief valve cartridge threads and the O-rings on both valve cartridges with clean hydraulic oil.
4. If removed, install the check valve cartridge.
5. Install the relief valve cartridge and torque to 32 N•m (23.5 lbf ft).
6. Install the two nuts and washers connecting the mounting bracket and isolators. Torque the nuts to 15 N•m (11 lbf ft).
7. Connect the power wires to the lift pump motor with the two nuts and washers. Torque the nuts to 4.0 N•m (35 lbf in).
8. Connect battery and turn key switch to **ON** position.
9. Remove blocks from wheels.
10. Operate the lift and lower function several times to purge the air from the hydraulic circuit.
11. Bleed air from hydraulic system. See Bleed Hydraulic System.
12. Check hydraulic oil level in reservoir and fill to **FULL** level.
13. Verify that the relief valve setting is correct. See Relief Valve Adjustment.

Relief Valve Adjustment

WARNING

DO NOT make repairs or adjustments unless you have been properly trained and authorized to do so. Improper repairs and adjustments can create dangerous operating conditions. DO NOT operate a lift truck that needs repair. Report the problem to your supervisor immediately. If repairs are necessary, turn the key switch to the OFF position, attach a DO NOT OPERATE tag to the control handle, and disconnect the battery.

1. Check hydraulic oil level in reservoir when oil is at room temperature. Remove breather cap and add recommended hydraulic oil to proper level, if required. See Hydraulic Reservoir **DO NOT OVERFILL**. Oil will leak from breather/filler cap if too full.
2. Operate lift truck until hydraulic oil reaches operating temperature.
3. Lower forks completely to relieve pressure from hydraulic system. Remove key from switch and disconnect battery.
4. Remove the upper drive unit compartment cover.
5. Remove the lower drive unit compartment cover.
6. Turn key switch to **OFF** position and disconnect battery.
7. Block load wheels to prevent lift truck from moving. Refer to the section **Periodic Maintenance** 8000 YRM 1048 or **Periodic Maintenance** 8000 YRM 1379.
8. Discharge the capacitor. See Special Precautions.

TABLE OF CONTENTS

This section is for the following models:

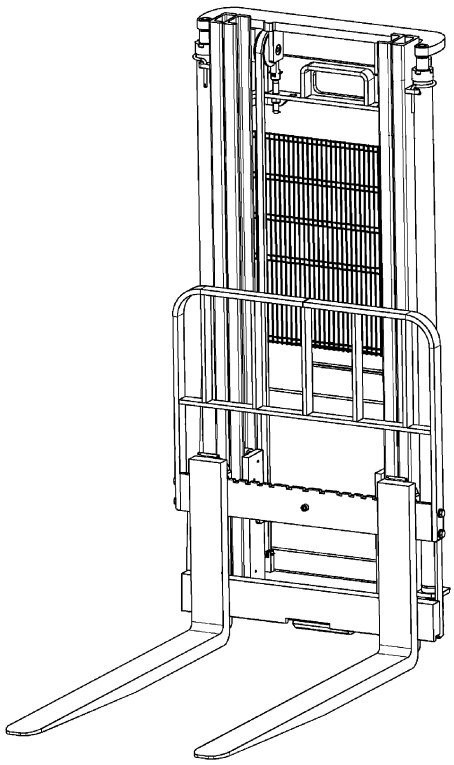
MSW020/025-E [A895]

Yale

Maintenance

MAST REPAIRS

MSW020/025-E [A895]



PART NO. 524175627

4000 YRM 1046

Legend for Figure 7

1. LIFT CYLINDER
2. SNAP RING
3. SHIM
4. WASHER
5. O-RING
6. SPACER
7. CHAIN PIN
8. COTTER PIN
9. CHAIN ANCHOR
10. LOCK NUT
11. OUTER WELDMENT
12. SCREW
13. DAMPER
14. WASHER
15. CYLINDER RETAINER
16. BRACKET (LH)
17. NUT
18. SCREW
19. WEAR STRIP
20. SHIM
21. SNAP RING
22. WASHER
23. LOAD ROLLER (INNER)
24. SNAP RING
25. WASHER
26. OPERATOR GUARD
27. BRACKET (RH)
28. LOCKWASHER
29. SCREW
30. PIN
31. COTTER PIN
32. WASHER
33. SHEAVE
34. WASHER
35. CHAIN
36. INNER WELDMENT

INSTALL

The following instructions describe the proper procedure for installing the mast to the frame of the lift truck. Always read and follow **ALL** warnings and directions.

WARNING

Do not make repairs or adjustments unless specifically authorized to do so. Repairs and adjustments must be performed by trained service technicians.

WARNING

Mast parts are heavy and may shift. Distances between parts are small. Serious injury can result if part of the body is hit by parts of the mast or carriage. A lifting device must be used to support or lift the mast components.

WARNING

Never allow anyone under a raised carriage. Do not put any part of your body in or through the lift mechanism unless all parts of the mast are completely lowered and the battery is disconnected.

WARNING

Use only lifting devices with a capacity greater than the weight of the object being lifted.

Always wear protective clothing and eye protection.

1. Attach overhead crane or hoist to mast at hook point. Refer to Figure 4.

CAUTION

Check that crossmember is completely seated before removing overhead lifting device.

2. Raise mast to a vertical position directly in front of truck using overhead crane or hoist. Place back of mast against front of truck and lower crossmember of mast into receiver on frame.
3. Center mast using mast set screws and install mast mounting capscrews.
4. Torque mast mounting capscrews to 225 N•m (166 lbf ft). See Figure 4.
5. Install hydraulic supply hose to tubing assembly. See Figure 2.
6. Tighten mast setscrews. Tighten jam nut until it touches frame and then tighten one half turn to secure setscrews.
7. Check hydraulic oil level and fill to the **FULL** mark if necessary.
8. Install carriage. See Carriage Repair.

CAUTION

The air must be bled from the hydraulic system before the truck is put into operation.

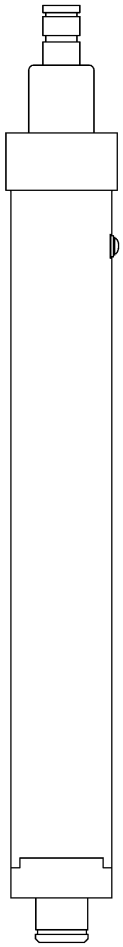
9. Bleed air from hydraulic system:
   - **a.** Connect battery and turn key switch to **ON** position.
   - **b.** Fully extend and then lower mast several times to purge air from the hydraulic system.
   - **c.** Loosen bleed screws near top of cylinders.
   - **d.** Briefly press and release **LIFT** button. Repeat until hydraulic oil flows from bleed screws without bubbling.
   - **e.** Retighten bleed screws.
   - **f.** Clean up spilled hydraulic oil.

Yale

Maintenance

LIFT CYLINDERS

MSW020/025-E [A895]



Legend for Figure 5

1. TUBE
2. ROD
3. WIPER
4. ROD SEAL
5. BACK-UP RING
6. O-RING
7. SEAL
8. BLEED SCREW
9. WEAR RING
10. GLAND
11. FLOW CONTROL VALVE

ASSEMBLE

Refer to Figure 5 for the following procedures.

1. Install flow control valve and hydraulic fitting to bottom of cylinder tube.

2. Install **NEW** rod seal and wiper into gland.

3. Install **NEW** back-up ring and O-ring above threads on outside of gland.

4. Apply a thin coat of hydraulic oil to cylinder rod and wear ring.

5. Place wear ring on cylinder rod and install into tube.

6. Install gland onto end of rod and slide down to tube. Turn gland by hand to start threads and tighten hand tight.

NOTE: Secure cylinder tube in a vise to torque gland. Be careful not to damage tube with vise.

7. Torque gland to 375 N•m (276 lbf ft).

INSTALL

1. Attach one end of a sling to lift cylinder (approximately halfway between center of cylinder assembly and gland) and other end to a hoist or overhead crane. Raise cylinder to a vertical position.

2. Carefully position lift cylinder into place. Be sure pin on bottom of cylinder assembly is lined up with hole in mounting surface.

3. Secure lift cylinder with cylinder retainer and remove sling from cylinder.

4. Install washer and snap ring to hydraulic fitting located on bottom of cylinder.

5. Connect the tube assembly to hydraulic fittings on the bottom of the lift cylinders.

6. Install spacer and O-ring to top of cylinder rod.

7. Connect battery and turn key switch to **ON** position.

8. Press **LIFT** button to raise cylinder rod into place in top plate of inner weldment.

9. Install washer, shim, and snap ring to top of cylinder rod above top plate.

10. Lower the mast:

a. Raise the inner weldment off of hardwood blocks. Remove the hardwood blocks from under the mast or remove and lower the mast completely.

or

b. Raise the inner weldment until safety chain becomes loose. Remove the safety chains and lower the mast completely.

⚠ CAUTION

The air must be bled from the hydraulic system before the truck is put into operation.

11. Bleed air from hydraulic system:
- **a.** Connect battery and turn key switch to **ON** position.
- **b.** Fully extend and then lower the mast several times to purge air from the hydraulic system.
- **c.** Loosen bleed screw near top of cylinder.
- **d.** Briefly press and release **LIFT** button repeatedly until hydraulic oil flows from bleed screw without bubbling.
- **e.** Retighten bleed screw.
- **f.** Raise and lower mast to check for proper operation.
- **g.** Repeat procedures for bleeding hydraulic system if necessary.

12. Check cylinders and hydraulic system for leaks.

HOW TO PUT THE LIFT TRUCK ON BLOCKS

WARNING

DO NOT put the lift truck on blocks if the surface is not solid, even, and level. Make sure that any blocks used to support the lift truck are solid, one-piece units. Put a block in front and back of the tires touching the ground to prevent movement of the lift truck.

DO NOT raise the lift truck by attaching an overhead lifting device to areas that can be damaged. Some of these points are not designed to support the weight of the lift truck. The lift truck can be damaged or it can fall, causing serious injury. Attach the chain or sling to a support structure of the lift truck frame.

DO NOT make repairs or adjustments unless specifically authorized to do so. Repairs and adjustments must be performed by trained service technicians.

How to Raise the Drive/Steer Tire

1. Put blocks on both the front and back sides of the load wheels to prevent movement of the lift truck. Refer to Figure 2.

   Use a special low-clearance hydraulic jack, crane, or another lift truck to raise the drive tire. Make sure that the jack, crane, or other lift truck has the correct capacity rating. The capacity must equal at least 2/3 the weight of the lift truck, including the battery. See the nameplate for the lift truck weight.

2. Raise the lift truck enough to suspend the drive tire. Install additional blocks under the frame near the drive tire.

How to Raise the Load Wheels

WARNING

Never raise the base arms any higher than necessary to change the load wheels. Always raise both base arms at the same time. Raising the base arms too high can make the lift truck tip over and cause damage or possible injury.

1. Put blocks on both the front and back sides of the drive tire to prevent movement of the lift truck. Refer to Figure 2.

2. Use an overhead lifting device and web sling under the base arms at the mast to raise the load wheels. Another lift truck can also be used to raise the base arms. Make sure the overhead lifting device and web sling or other lift truck has a capacity of at least 2/3 the total weight of the lift truck including the battery. See the nameplate for the lift truck weight.

3. Raise the base arms enough to suspend the wheels. Install blocks under the base arms at the rear of the wheels to support the lift truck.

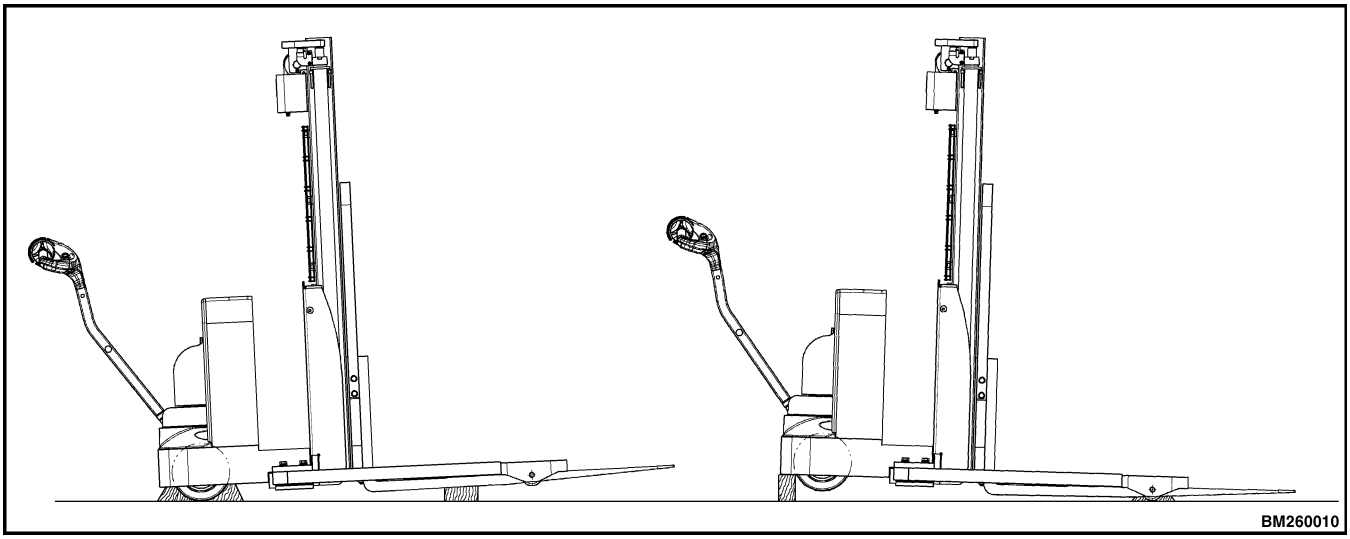
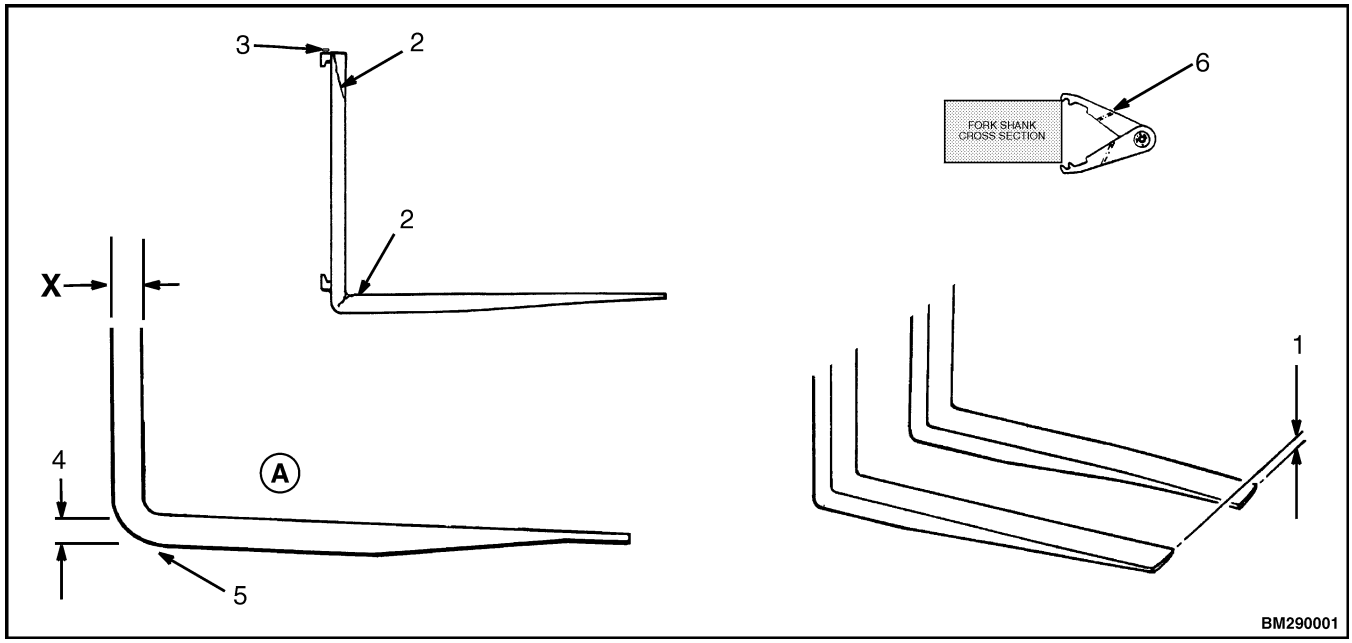


Figure 2. Putting Lift Truck on Blocks



Fork Tip Alignment	
Length of Forks	**3% Dimension**
0914 mm (36 in.)	27.00 mm (1.10 in.)
1067 mm (42 in.)	32.00 mm (1.26 in.)
1220 mm (48 in.)	37.00 mm (1.46 in.)
1371 mm (54 in.)	40.00 mm (1.57 in.)
1524 mm (60 in.)	46.00 mm (1.81 in.)

1. TIP ALIGNMENT (MUST BE WITHIN 3% OF FORK LENGTH)
2. CRACKS
3. LATCH DAMAGE
4. THICKNESS OF BOTTOM OF FORK (MUST BE 90% OF DIMENSION X)
5. FORK BLADE (BOTTOM OF FORK)
6. FORK TOOL 150114750

Figure 9. Check the Forks

2. Remove the drive unit compartment cover(s).
3. Discharge the capacitors.
4. Remove fill plug.
5. Remove eight capscrews and lockwashers.
6. Remove two Allen-head screws and washers.
7. Place a drip pan under the drive unit. Gently pry top and bottom of cover where the housing is notched, until cover comes off drive unit. Drain oil into drip pan and dispose of properly.
8. Clean cover, pins, and mounting flange on housing of all old sealant, dirt, and oil.
9. Apply Loctite® 510 in a continuous ring completely around mounting face of cover. Pass ring **AROUND** bolt holes on cover to the inside.
10. Install eight capscrews through the MDU cover. Torque to 23 N•m (17 lbf ft).
11. Install two Allen-head screws. Torque to 10 N•m (7 lbf ft).
12. Fill the MDU with gear oil until oil begins to flow out of oil fill hole.
13. Install fill plug and torque to 40 N•m (30 lbf ft).
14. Install drive unit compartment cover(s).
15. Remove blocks from drive tire, reconnect battery, and test for proper operation.

Welding Repairs

WARNING

Disconnect the battery connector and remove the battery before welding. Welding can cause a fire and/or an explosion. Make sure there is no fuel, oil, or grease near the weld area. Make sure the area is well ventilated.

Forklift truck frames and components may have polyurethane paint. Welding, burning, or other heat sufficient to cause thermal decomposition of the paint may release isocyanates. These chemicals are allergic sensitizers to skin and respiratory tract and overexposure may occur without odor warning. When performing work, utilize good industrial hygiene practices, including removal of all paint (prime and finish coats) to the metal around the area to be welded. Use local ventilation, and/or supplied-air respiratory protection.

CAUTION

Always disconnect the battery connector to prevent damage to circuit components when welding. Connect the welding ground clamp as close to the weld area as possible to prevent welding current from damaging bearings.

Observe the previous **WARNING** and **CAUTION** before performing any welding repairs.

General Repairs

LOAD WHEELS

Check each load wheel bearing for smooth operation. If the bearing operation is not smooth, the bearing must be replaced. The load wheels have lube fittings for lubrication. See Figure 16. Lubricate all load wheels every 350 hours. See Maintenance Schedule.

Remove

1. Remove load from forks and move lift truck to a safe, level area.
2. Lower mast and forks completely.
3. Turn the key switch to the **OFF** position and disconnect battery.
4. Block drive tire so it cannot move and block load wheels off the floor.

NOTE: Refer to Figure 16 for the following instructions.

5. Remove pin from shaft.

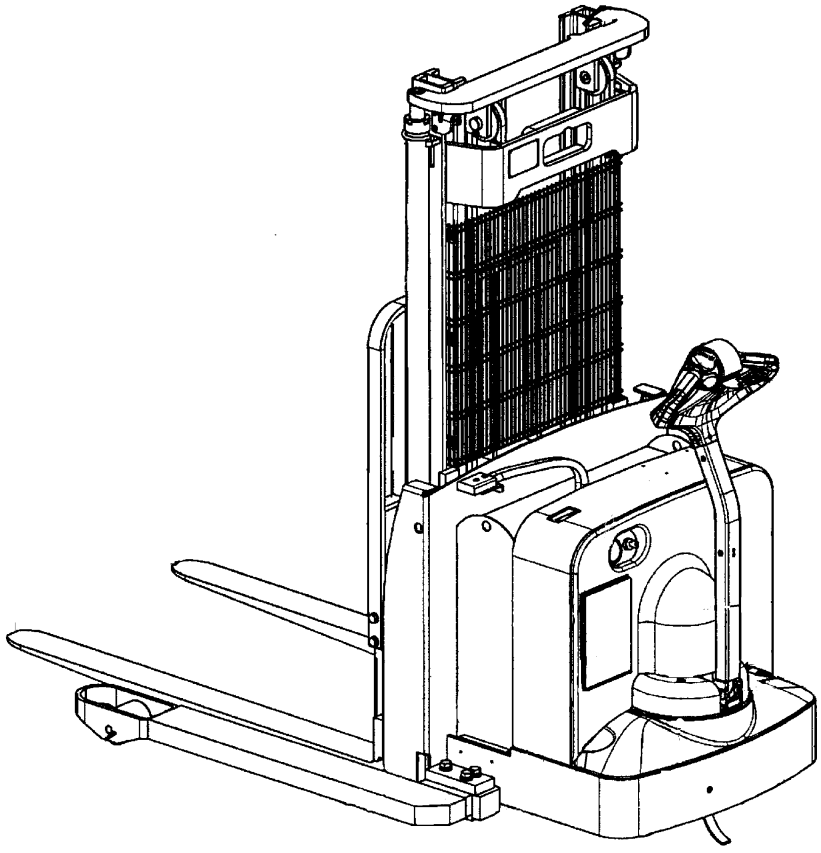
NOTE: When removing the shaft from the basearm, the shims and washers may fall out. Use one hand to pull on the shaft and the other to catch the shims and washers while supporting the load wheel.

Yale

Maintenance

CAPACITIES AND SPECIFICATIONS

MSW020/025-E [A895]



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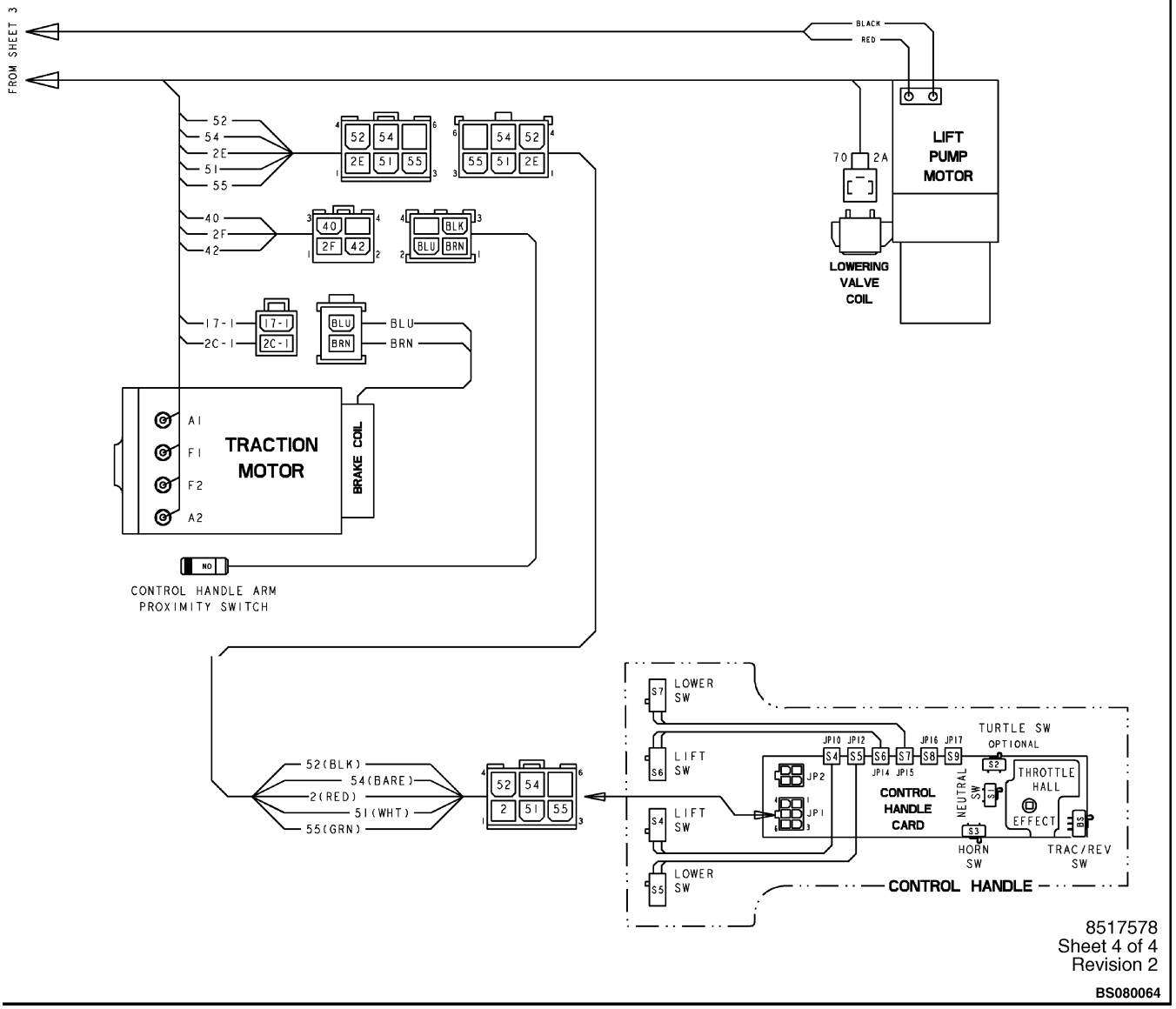


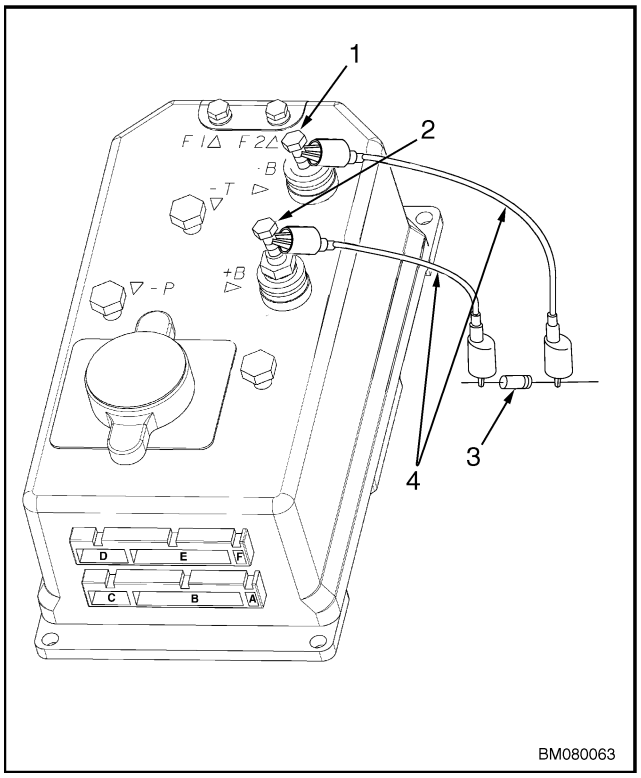
Figure 2. Wiring Diagram

Controller Safety

WARNING

The ZAPI™ controllers can hold an electrical charge for several minutes after the key switch has been turned OFF. To prevent injury, discharge the controllers by connecting a 200-ohm, 2-watt resistor between the battery positive connector and battery negative connector on the controller and hold there for 5 seconds.

See Figure 2.



1. NEGATIVE CONNECTION
2. POSITIVE CONNECTION
3. 200-OHM, 2-WATT RESISTOR
4. INSULATED JUMPER WIRES

Figure 2. Discharging Controller

Controller Adjustments

The ZAPI™ transistor motor controller can store and display Error Codes (Alarms). It is also possible to modify the controller Setup for individual preferences. Communication with the controller is possible by four methods:

1. **LED** - An LED (light emitting diode) can be installed in trucks that do not use a display. The LED flashes error codes to the technician for diagnosis. The LED would be installed on the bottom of the ZAPI™ controller at connector port D. See Figure 1.

2. **Dash Display** - Some trucks are equipped with an optional dash display or MDI. Error codes are shown on the LCD (liquid crystal display) when the wrench symbol and red light are lit. The format is AL XX where XX is the error code. The software version is displayed on startup.

3. **ZAPI™ Handset** - A diagnostic handset is available through your Yale dealer. The handset makes it possible to diagnose faults and modify controller settings. See Programming, in this section.

4. **Personal Computer** - The controller can also be connected to a personal computer (PC) equipped with special software and cables. The PC can read, store, and change settings on the controller.

Proper use of these four methods and a list of diagnostic codes are explained in Troubleshooting, in this section.

6. Cycle the key switch to start the lift truck in the normal mode. Operate the lift truck until the alarm code reoccurs (faults out). Then, go back to the Alarm Code menu and write down the alarm codes which are now present. These alarms should be investigated first to isolate the most prominent malfunctions.

NOTE: If the THERMAL PROTECTION alarm codes are generated, use the Tester Function = Temperature. If the controller sees 75°C (175°F) or below −10°C (14°F), it will reduce electrical current to the motors and regular performance of the lift truck will slow down.

You can operate the truck with the Tester Function activated and monitor the controller's internal temperature in real time. For additional heat dissipation, fold up several layers of aluminum foil and place it between the controller mounting base and the mounting plate to fill any air pockets in the mating surfaces which will impede conductivity and prevent the heat from flowing from the controller heat sink into the mounting plate of the controllers. The use of ''conductivity paste' is not recommended.

CAUTION

If the battery has been disconnected and reconnected with the key switch in the ON position, a voltage spike can cause corruption of the Zapi controller EPROM.

Remember to use the "Tester" function to check switch input from the control handle to the controller. This procedure will also alert you if the controller has been changed but the control handle card has not been reprogrammed.

Zapi controller menu items:

- ACCELERATOR = Volts Percent % = Shows Variable Voltage From Traction Thumbwheel (FWD or REV)
- FORWARD AND BACKWARD SWITCH = "OFF to "ON"
- LIFTING CONTROL = Volts Percent % = Lifting and Lowering = Proportional Switches (Control Handle Card Must be Calibrated)
- LIFTING AND LOWERING SWITCH = "OFF" to "ON"
- BELLY, HORN, SNAIL SWITCHES = "OFF" to "ON"
- SW8 = Gray Button for Alt Functions = "OFF" to "ON" (Reach and Counterbalance)
- ETC.

Dash Display	Controller LED	Handset or PC
AL01	1 Flash	BATTERY CHARGING

CONDITION

Controller waits in standby mode while a battery charger is connected.

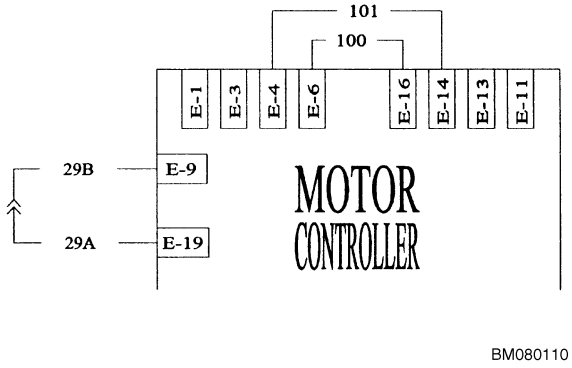
TRUCK RESPONSE

Traction and hoist functions disabled.

POSSIBLE CAUSES AND TEST PROCEDURES

- Connector E is loose at base of controller or defective.

  Inspect connector E. Check wire 100 between position E6 and E16 for continuity.



BM080110

LOGIC

Controller inputs indicate a battery charger is connected.

Dash Display	Controller LED	Handset or PC
AL02	2 Flashes	CONTACTOR CLOSED

CONDITION

Main contactor circuit is damaged.

TRUCK RESPONSE

Traction and hydraulic functions disabled.

POSSIBLE CAUSES AND TEST PROCEDURES

- Main contactor tips are welded closed.

  Disconnect power leads at contactor. Use meter to confirm open circuit across power terminals.

  If short circuit is measured, replace contactor.

- Problem in motor field circuit.

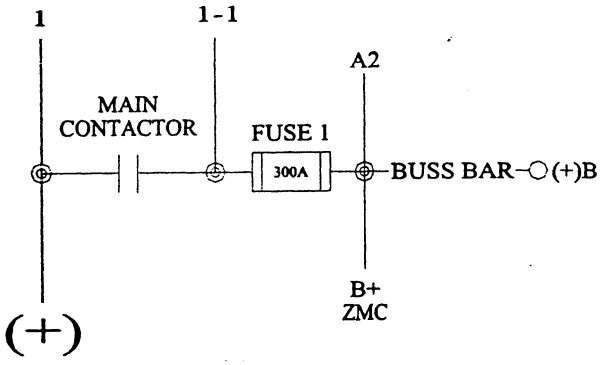
  Verify electrical connections between motor field and controller.

  Check motor field for shorts to chassis. See Traction Motor Test.

- Controller is damaged.

  Replace controller.

Refer to the section **Electrical System** 2200YRM1026 or **Electrical System** 2200YRM1007 for more information on troubleshooting electrical system circuits and components.



BM080100

LOGIC

Occurs when the controller detects a short in the main contactor circuit.

Dash Display	Controller LED	Handset or PC
AL10	LED ON (No Flashing)	VFIELD NOT OK

CONDITION

Voltage measured at field connections is not correct.

TRUCK RESPONSE

Traction and hydraulic functions disabled.

POSSIBLE CAUSES AND TEST PROCEDURES

- Cable connection to motor field is loose or damaged.

  Verify connection of field wires to motor and controller.

- Motor field winding is shorted to chassis.

  Check motor field for shorts to chassis.

  Measure motor field resistance. Motor field should be approximately 0.5?.

- Check for traction motor malfunction.

  Perform traction motor test. See Traction Motor Test in this section.

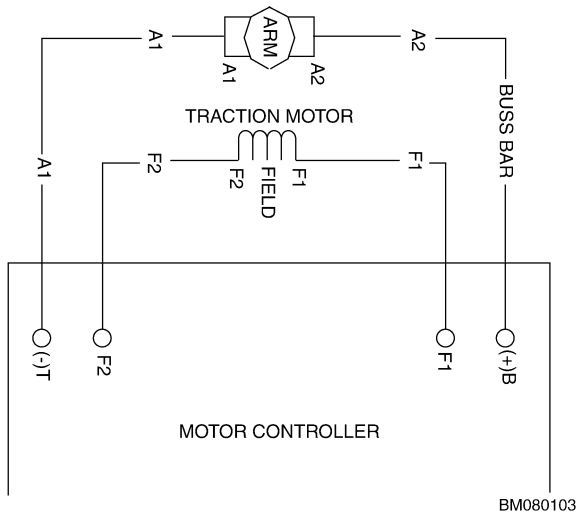
- Field current driver circuit has failed.

  Use a voltmeter to measure between F1 and B- and F2 and B- with battery connected and key **ON**. Voltage should measure 1/2 the voltage between B+ and B-.

  Replace controller.

- Field current drivers in controller are damaged.

  Replace controller Verify motor field cable connections.



LOGIC

This fault occurs when the voltage measured at the field connections is not the expected value.

Control Card Functional Test

Refer to Control Card Functional Test for the following procedures.

1. Follow all safety precautions as listed at the beginning of this section prior to performing any electrical checks.

2. Ensure Battery is fully charged.

a. Verify continuity between battery negative (at battery) and -B terminal (at controller).

3. Check for loose connections or damaged wiring between control card and controller.

a. Verify connection at the controller.

b. Very wire harness connection at the base of the steer handle.

4. Connect ZAPI handset and go to tester function. Refer to ZAPI™ PC Interface in this section.

NOTE: If ZAPI Handset cannot be connected, consult LED OFF. See Troubleshooting in this section.

5. With ZAPI Handset connected, check the following:

a. Look for battery voltage to be 25 ±0.5 volts.

b. Check for accelerator output to be 95% or more at full throttle, and to be at 0% and 0V on neutral position.

c. Check for lift switch, fork low switch, belly switch, and horn switch to alternate between on and off when switch is pressed and released. (Ensure belly switch is properly seated.)

(1) If ON-OFF lift/lower switches doesn't behave as expected, swap the On-Off switch with other On-Off switch available within tiller head to verify if problem follow the switch.

d. Check lifting control to be more than 90%.

(1) Output of proportional hydraulic controls should be less than 10% at neutral.

(2) If Proportional lift/lower switches doesn't behave as expected, swap the proportional switch with other proportional switch available within tiller head to verify if problem follow the switch.

6. If handset test are not passed, open tiller head and verify connection at control card:

a. Power off the forklift and measure continuity between pin 2, on JP2, on the control card and B- at the controller.

(1) If an open or high resistance is measured, trace problem source and refer to Troubleshooting in this section.

b. Power on the forklift and check for 7- segment LED to light on.

(1) If the LED is not lit then check to have power on JP2, between pin 1 and pin 2.

i. JP2 voltage reading shall be 14V or more, if not, then the tiller card is not receiving power from controller. Disconnect the connection at JP1 and verify the voltage between harness pins 1 and 2 is more than 14V.

a. Check the wiring between the controller and the tiller card, as well as the controller output.

b. Measure voltage at pin 5, on connector C, on the ZAPI controller. The voltage should be 12V with card disconnected and 3V to 9V with control card connected. If voltage is different, please refer to Troubleshooting, LED Off sections.

c. Measure voltage at pin 7, on connector C, on ZAPI controller. It should have 22V or greater with card disconnected. If voltage is different, please refer to Troubleshooting, LED Off sections.

Notice the CONNECTION STATUS while the file is downloaded into the controller. See Figure 19.

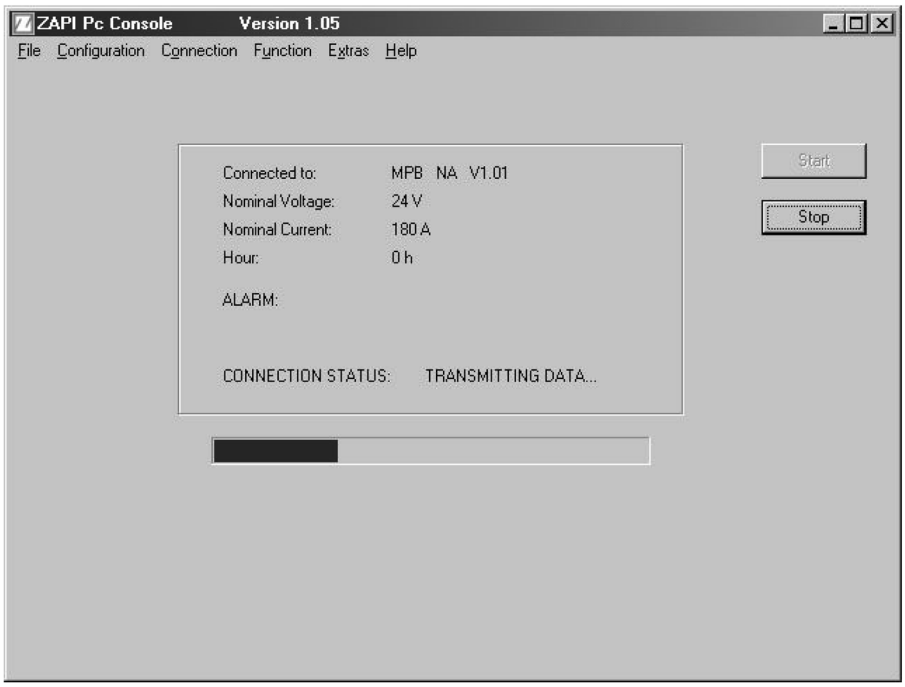


Figure 19. Connection Status

Memory Menu

If you wish to start all over with your adjustments prior to pressing the Store button, then you can select the Memory menu to see the screen in Figure 31.

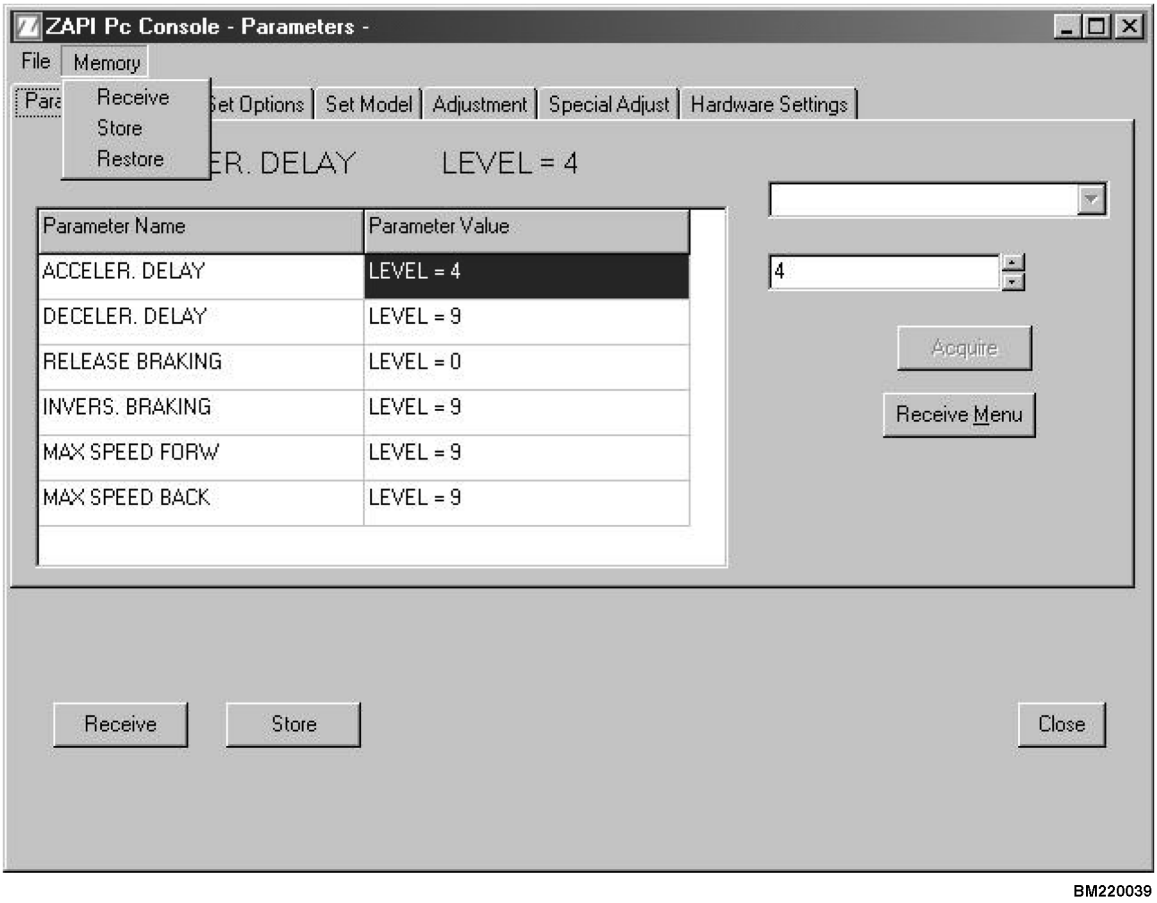


Figure 31. Memory Menu

This menu has three selections:

1. **Receive** - Same as Receive menu and Receive button.
2. **Store** - Same as Store button.
3. **Restore** - Will revert the parameter settings to what they were before adjustments were made. Note this will not work if the settings were stored before using this function.

The following list consists of possible alarms.

Alarms

1. **EVP NOT OK**
2. **BRAKE DRIVER KO**
3. **VFIELD NOT OK**
4. **PUMP VACC NOT OK**
5. **SERIAL ERROR #1**
6. **WATCHDOG**
7. **EEPROM KO**
8. **FORW + BACK**
9. **VMN NOT OK**
10. **CONTACTOR CLOSED**
11. **I=0 EVER**
12. **STBY I HIGH**
13. **HIGH FIELD CURRENT**
14. **NO FIELD CURRENT**
15. **CAPACITOR CHARGE**
16. **LOW BATTERY**
17. **THERMAL PROTECTION**
18. **CHARGING BATTERY**
19. **POWER FAILURE #1**
20. **DRIVER SHORTED**
21. **CONTACTOR DRIVER**
22. **VACC NOT OK**
23. **INCORRECT START**
24. **INPUT ERROR #2**
25. **INPUT ERROR #1**

PROGRAMMING TILT AND SIDESHIFT ON THE ZAPI CONTROLLER (LAPTOP)

1. Connect the laptop to the ZAPI Controller:

a. If equipped with sideshift, make sure controller connector "E" on the main wiring harness has a jumper wire installed between E3 to E13.

b. Turn the key switch to the **OFF** position. **SHUT DOWN** the laptop. Make certain the laptop was powered off as opposed to restarted or in standby mode.

c. Connect the laptop to the controller using the appropriate cables and connectors.

d. Turn the key switch to the **ON** position and then **POWER ON** the laptop.

e. Launch the ZAPI Laptop Software program from the desktop icon or the start menu.

2. ON the drop down menu, click on "Configuration," "COM Port."

a. Select the COM port "ComPort2."

b. Select the Baud Rate "1200 bps."

c. Click "OK" then "Start" in the console window.

d. Verify the connection status reads "CONNECTED."

CAUTION

This procedure will access High Level Programming of the ZAPI controller.

3. On the drop down menu, click on "Configuration," "Enter Password."

a. Enter the password **ZAPI** (in all capital letters). The password can only be entered if the Com Configuration was properly connected in the previous steps.

b. Click "OK."

4. On the drop down menu, click on "Function," "EEPROM Function."

a. Delete the value in the address box and enter **F000**.

b. Click "Start Write."

c. Verify that the new console window states "WRITE EEPROM CELL."

d. Delete the value in the address box and enter **F000**.

e. Click "Start Write" again.

f. Verify that the new console states "READ EEPROM CELL."

g. Click "Stop Write."

h. Delete the value in the "Value" box and enter **1234**.

i. Click "Start Write" again.