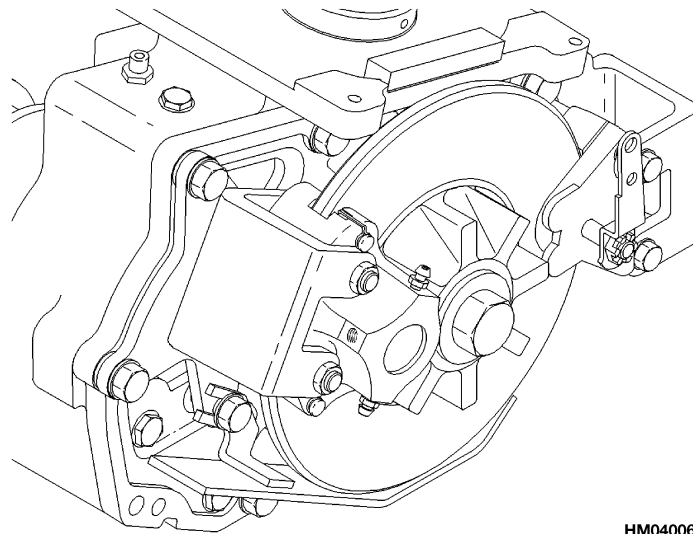


# **BRAKE SYSTEM**

**J30-40XMT [C160]; J1.60-2.00XMT [G160];  
J30-40XMT<sub>2</sub> [H160]**



HM040065

# ***HYSTER***

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- Remove the clamp retaining the hose to the master cylinder from the reservoir and disconnect the hose.
- Wipe the exterior of the master cylinder to remove any surface dirt.

## INSTALL

- Align the master cylinder with the block and install the washers and the capscrew. Note that one washer should be positioned on each side of the block.
- Align the fork end of the master cylinder with the pedal and install the clevis pin, washer, and a new cotter pin.
- Install the hose from the reservoir on the master cylinder. Install the clamp to retain the hose.
- Remove the plugs from the brake line and the service brake. Attach the brake line to the service brake.
- Fill the brake reservoir with brake fluid. The brake fluid used for the service brakes shall meet the requirements of SAE J1703 and Federal Motor Vehicle Safety Standard-FMVSS 116 (DOT 3). The capacity of the reservoir is 1.1 liter (37 oz).
- Remove the air from the brake system. See Brake System Air Removal.
- Install the floor plates.
- Connect the battery. Remove the safety chains and lower the carriage. Remove the blocks from the tires.

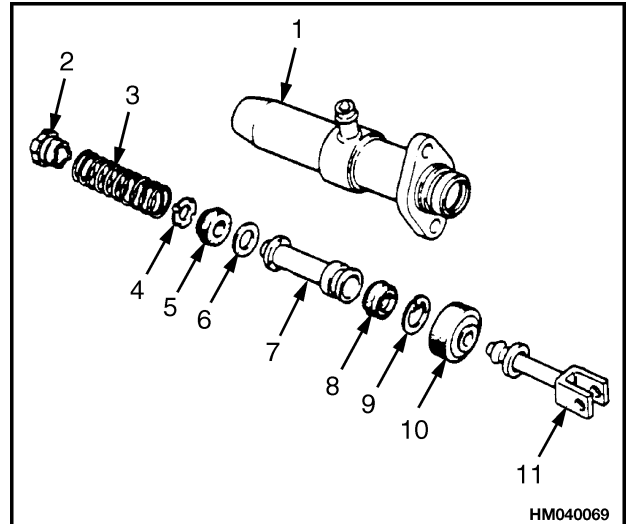
## DISASSEMBLE



### WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal and installation.

- Pull back on the rubber boot and using snap ring pliers, remove the snap ring from the cylinder body. Remove the push rod and fork end. See Figure 4.



- |                  |                  |
|------------------|------------------|
| 1. CYLINDER BODY | 7. PISTON        |
| 2. VALVE         | 8. SECONDARY CUP |
| 3. SPRING        | 9. SNAP RING     |
| 4. RETAINER      | 10. RUBBER BOOT  |
| 5. MAIN CUP      | 11. FORK END     |
| 6. WASHER        |                  |

*Figure 4. Master Cylinder*

- Remove the secondary cup, piston, washer, main cup, spring retainer, spring, and valve from the cylinder body.
- Discard the valve, main cup, washer, secondary cup, and boot.



### WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the recommendations of the manufacturer. Wear eye protection.



### CAUTION

DO NOT use an oil solvent to clean the brake caliper. Use a solvent approved for cleaning of brake parts. Do not permit oil or grease in the brake fluid or on the brake components or the brake pads.

- Wash all metal components in clean brake fluid and dry using a clean, regulated compressed air supply.
- Inspect the cylinder body bore for scoring or pitting. Replace the complete assembly if the body is defective.

*Legend for Figure 7*

- |                            |                       |
|----------------------------|-----------------------|
| 1. CAPSCREW                | 20. PLATE, MOUNTING   |
| 2. LOCKWASHER              | 21. CAPSCREW          |
| 3. WASHER                  | 22. WASHER            |
| 4. PLATE, COVER            | 23. RESISTOR ASSEMBLY |
| 5. LABEL                   | 24. DIODE ASSEMBLY    |
| 6. SWITCH                  | 25. WASHER            |
| 7. STANDOFF                | 26. CAPSCREW          |
| 8. CAPSCREW                | 27. WIRE              |
| 9. LOCKWASHER              | 28. TERMINAL, PUSH-ON |
| 10. CONTROL MODULE         | 29. TERMINAL, RING    |
| 11. PLATE, MOUNTING        | 30. NUT               |
| 12. CAPSCREW               | 31. WASHER            |
| 13. NUT                    | 32. CAPSCREW          |
| 14. FUSE BLOCK             | 33. COVER, SOLENOID   |
| 15. FUSE, 30 AMP           | 34. LABEL             |
| 16. CAPSCREW               | 35. CAPSCREW          |
| 17. WASHER, EXTERNAL TOOTH | 36. COVER, FRONT COWL |
| 18. RELAY                  | 37. COWL WELDMENT     |
| 19. TERMINAL BLOCK         |                       |

5. Align the solenoid on the mounting bracket and install the capscrews and lockwashers. Make certain that the two electrical wires extend through the cowl to the control module.
6. Apply sealant 501702904 to the upper threads of the guide rods and install them in the base of the solenoid.
7. Install the cover on the control box using the three capscrews and washers.
8. Remove the blocks from the wheels. Connect the battery.

**TERMINAL BLOCK****Remove**

1. Park the lift truck in a level area, then block the wheels. Disconnect the battery.
2. Open the rear compartment cover.
3. Tag and identify the wires to the relay. Remove the wires. Remove the capscREW and external tooth washer retaining the relay to the mounting plate.
4. Remove the resistor assemblies and the diode assembly.

5. Remove the capscrews and washers retaining the terminal strip to the mounting plate.
6. Remove the mounting plate by removing the three capscrews and washers retaining the mounting plate to the panel.

**Install**

1. Install the mounting plate on the panel using the three capscrews and washers.
2. Install the terminal strip on the mounting plate using the capscrews and washers.
3. Install the diode assembly and the resistor assemblies on the terminal block. Refer to the wiring diagrams and schematics.
4. Install the relay on the mounting plate using the capscREW and external tooth washer. Connect the wires to the relay.
5. Close the rear compartment cover.
6. Remove the blocks from the wheels. Connect the battery.

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This section is for the following models:

J30-40XMT [C160];  
 J1.60-2.00XMT [G160];  
 J30-40XMT<sub>2</sub> [H160]

**INSTALL****WARNING**

**Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers and wear eye and face protection during removal and installation.**

1. On the early production models, install the bellcrank on the mounting bracket using the washer and snap ring. On the later production models install the self-lubed washer, shims (as required), washer, and capscrew. Install the brake rods in the bellcrank and install the washers and nuts.
2. Install the switch plate assembly to the park brake lever assembly.
3. Align the park brake lever assembly with the mounting bracket on the cowl. Install the capscrews, lockwashers, plain washers, and nuts to retain the brake assembly to the mounting bracket.

**NOTE:** Position the three plain washers on the lower capscrew, between the park brake assembly and the switch plate assembly for use as a spacer.

4. Install the park brake switch and insulator on the plate assembly using the two nuts. Connect the wires to the proper terminals on the switch.

5. Install the brake cable through the bracket welded to the cowl. Position the spring on the brake cable and install the ball stud on the cable end. Install the ball stud in the bellcrank and secure using the nut.
6. Position the clevis pin halfway through the park brake lever assembly. Align and install the brake cable end. Push the clevis pin completely through the park brake lever assembly and install the cam block, washer, and a new cotter pin.
7. Install the brake release lever in the mounting bracket. Align the end of the lever with the hole in the park brake lever assembly and install the washer and a new cotter pin. Align the bracket with the leg of the cowl and the overhead guard and install the capscrew, washers, and nuts. Tighten the nuts to 134 N•m (99 lbf ft).
8. Adjust the park brakes. See Park Brake Adjustment.
9. Connect the battery. Remove the safety chains and lower the carriage. Remove the blocks from the wheels.

*Legend for Figure 8*

- |                            |                        |
|----------------------------|------------------------|
| 1. CAPSCREW                | 24. SCREW              |
| 2. LOCKWASHER              | 25. LOCKWASHER         |
| 3. WASHER                  | 26. WASHER             |
| 4. PLATE                   | 27. SCREW              |
| 5. PARK BRAKE BUTTON LABEL | 28. SCREW              |
| 6. SWITCH                  | 29. WASHER             |
| 7. STANDOFF                | 30. FRONT COVER        |
| 8. SCREW                   | 31. SCREW              |
| 9. LOCKWASHER              | 32. WASHER             |
| 10. CONTROL MODULE         | 33. CAPSCREW           |
| 11. MOUNTING PLATE         | 34. LOCKWASHER         |
| 12. CAPSCREW               | 35. WASHER             |
| 13. NUT                    | 36. NUT                |
| 14. FUSE BLOCK             | 37. COVER              |
| 15. 30A FUSE               | 38. NUT                |
| 16. MOUNTING PLATE         | 39. SPACER             |
| 17. TERMINAL BLOCK         | 40. CAPSCREW           |
| 18. RELAY                  | 41. COWL               |
| 19. TERMINAL               | 42. COWL               |
| 20. WIRE                   | 43. CAPSCREW           |
| 21. RING TERMINAL          | 44. INSTRUCTIONS LABEL |
| 22. DIODE                  | 45. COWL COVER         |
| 23. 2W 150 OHM RESISTOR    |                        |

## Park Brake Adjustment

The park brake must hold the truck with a rated load on a 15 percent grade using the park brake pedal actuation only.



### WARNING

**To access the park brakes, the mast and carriage must be raised and a safety chain installed. Follow the instructions in *Periodic Maintenance 8000 SRM 528* or *8000 SRM 584*, *Safety Procedures When Working Near the Mast*.**

The park brake may be adjusted in three different locations. Before making any adjustments, park the lift truck in a level area and block the wheels. Release the park brake. Check to make certain that the brake pads are contacting the brake caliper evenly. If the pads are not contacting the caliper evenly, the park brake must be adjusted. Remove the cotter pin and the yoke end pin. Adjust the park brake caliper using the following steps:

1. Lubricate the push pins, the bore of the caliper body caliper lever, and the caliper lever washer using antiseize Hyster P/N 316865 or equivalent. See Figure 3 for component identification. Refer to **Periodic Maintenance 8000 SRM 528** or **8000 SRM 584**.
2. Coat all other mating surfaces of the brake linkage with multipurpose grease. See Figure 5 or Figure 6. Refer to **Periodic Maintenance 8000 SRM 528** or **8000 SRM 584**.
3. Remove the cotter pins from the castle nuts. Tighten the castle nuts to 1.5 N•m (13 lbf in).
4. Back off on the castle nut by four flats (240 degrees).
5. Check the clearance between the brake pad and brake disc. The clearance between the brake pad and disc must be 0.30 to 0.38 mm (0.012 to 0.015 in.).
6. Install new cotter pins to retain the castle nuts. If the nut must be moved to provide access to install the cotter pin, the castle nut should be tightened.
7. Install the yoke end pins to attach the yokes to the cam levers. Install new cotter pins to retain the yoke end pins.

## General

This manual has a description and the repair procedure for the main control valve.

## Description

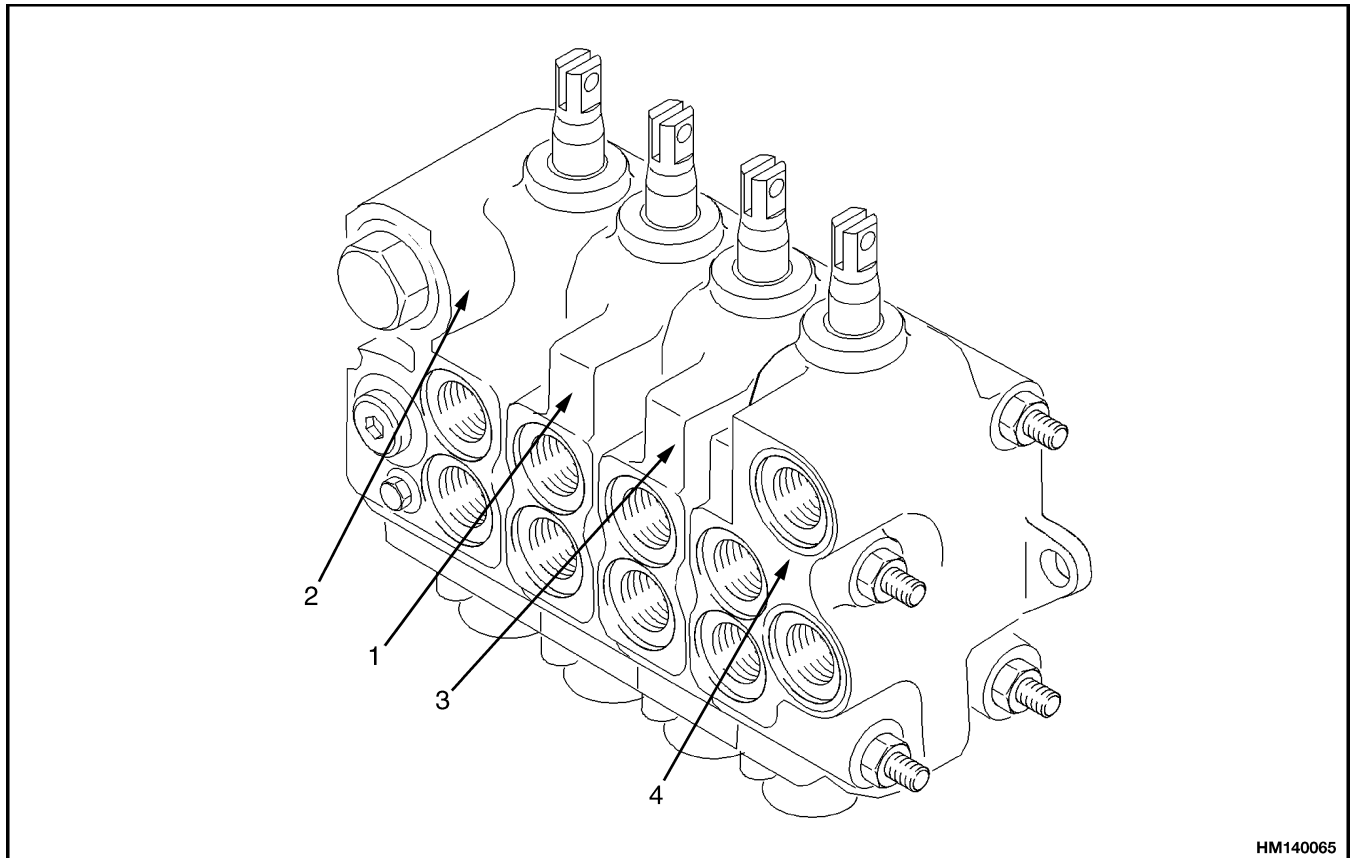
The main control valve is a manually actuated valve that controls the operation of the lift, tilt, and auxiliary cylinders. See Figure 1. The main control valve is installed to the right of the operator's seat. It is fastened to a bracket on the frame of the lift truck. The main control valve has the following sections:

- Operating inlet and lift section
- Tilt section
- Auxiliary section(s)

The sections are held together with through bolts.

Each function of the main control valve is made as a separate section having a spool and valve body. The outer section body castings are the same, as are the center section body castings. The control spools are different for each function. Additional sections may be added between the outer sections and the center section to control optional auxiliary functions.

Each spool has a spring that returns the spool to the neutral position when the control lever is released. Each valve section has a check valve in the valve body.



HM140065

1. AUXILIARY SECTION 2
2. AUXILIARY SECTION 1

3. TILT SECTION
4. OPERATING INLET AND LIFT SECTION

**Figure 1. Main Control Valve**

**Legend for Figure 6**

- |                                     |                      |
|-------------------------------------|----------------------|
| 1. OUTLET AND AUXILIARY SECTION 2   | 5. AUXILIARY SPOOL 2 |
| 2. AUXILIARY SECTION 1              | 6. AUXILIARY SPOOL 1 |
| 3. TILT SECTION                     | 7. TILT SPOOL        |
| 4. OPERATING INLET AND LIFT SECTION | 8. LIFT SPOOL        |

**ASSEMBLE**

**NOTE:** Coat all the parts with clean hydraulic oil to facilitate assembly and to provide initial lubrication. Petroleum jelly may be used to hold the O-rings in place during assembly.

1. If the plug and O-ring were removed from the operating inlet and lift section, install the plug and a new O-ring in the new section.
  2. Install the poppet, spring, O-ring, and cap in the outer auxiliary section. Install the relief valve, spring, O-ring, and plug in the other port.
  3. Install the poppet, spring, and relief seat in the center section(s). Install a new O-ring, backup ring, and plug in the port. Install the retainer to lock the plug in position. Make certain that the retainer is seated in the groove in the port.
  4. Assemble the C-washers, springs, quad rings, O-rings, sleeves, and retainers on the spools.
- Install the spools in the proper sections. Align the dust cover and install the capscrews to retain the covers to the sections.
5. Align the sections and install the springs, O-rings, retainers, and balls between the sections.
  6. Install the tie rods. All the tie rods are 9.6 mm (0.38 in.) in diameter. Assemble the nuts on the tie rods and use a torque wrench to tighten the nuts. Tighten the nuts to 38 to 41 N•m (28 to 30 lbf ft).
  7. Check the relief valves for proper adjustment. The relief valve pressure for the tilt and lift functions should open at 17.92 MPa (2600 psi) to protect the lift and tilt system. The secondary relief valve for the auxiliary functions should open at 14 MPa (2000 psi) to protect the auxiliary system.

**Relief Valve Check**

1. Install a tee in the inlet line to the main control valve. Install a pressure gauge in the tee.
2. Check the operation of the relief valve as follows:
  - a. Run the pump at normal operating speed, so that the pump is developing the proper flow and has reached operating temperature.
  - b. Operate the tilt spool of the control valve until the tilt cylinder is at the end of its stroke long enough to get a pressure reading on the gauge.
3. Check the pressure reading with the recommended pressure.
4. Remove the pressure gauge and the tee from the inlet line.

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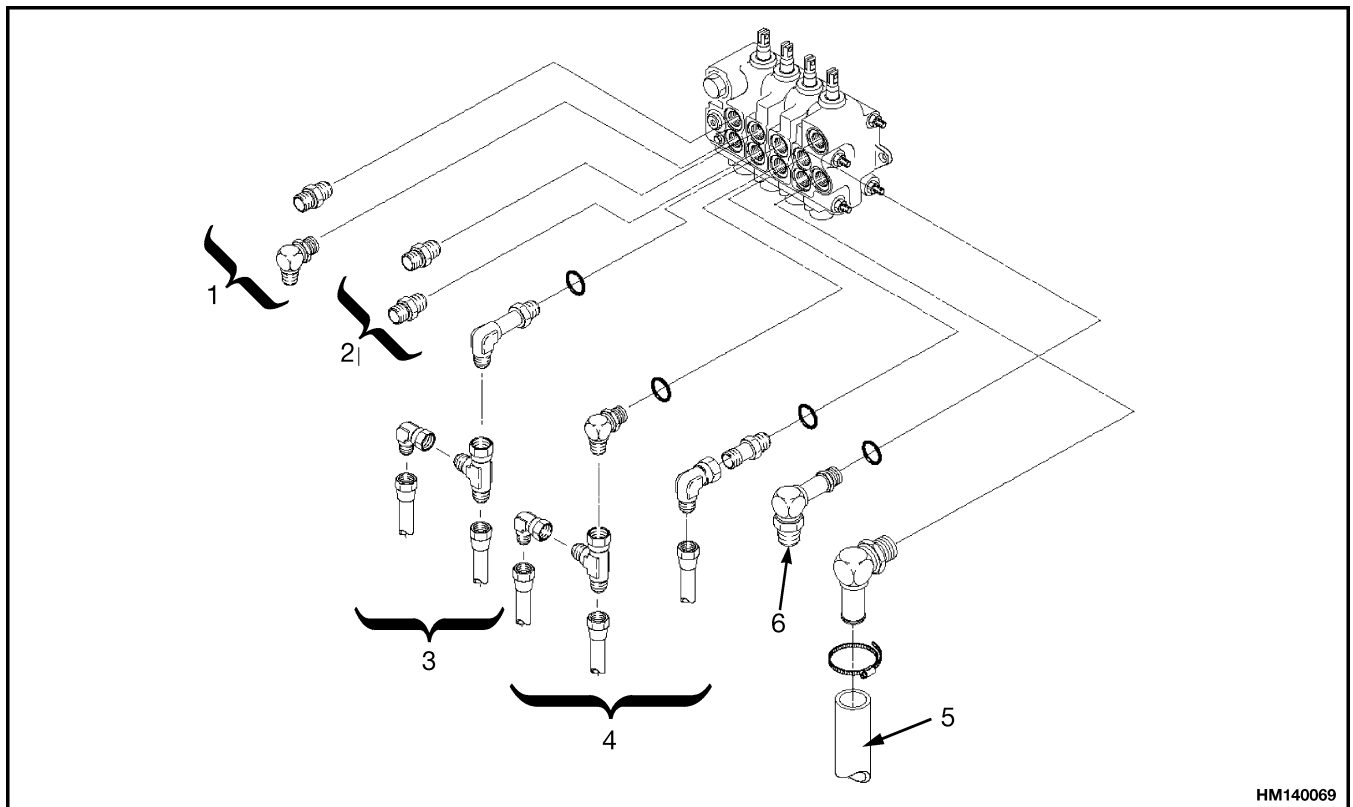
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This section is for the following models:

J30-40XMT [C160];  
J30-40XMT<sub>2</sub> [H160];  
J1.60-2.00XMT [E160]

*Legend for Figure 4*

- |                            |                    |
|----------------------------|--------------------|
| 1. COVER                   | 21. LOCKWASHER     |
| 2. SCREW                   | 22. NUT            |
| 3. LINKAGE FRAME           | 23. LOCKOUT STRAP  |
| 4. LIFT HAND LEVER         | 24. CAPSCREW       |
| 5. TILT HAND LEVER         | 25. WASHER         |
| 6. 3RD FUNCTION HAND LEVER | 26. LOCKWASHER     |
| 7. 4TH FUNCTION HAND LEVER | 27. NUT            |
| 8. CAPSCREW                | 28. PIN            |
| 9. WASHER                  | 29. SPRING         |
| 10. LOCKWASHER             | 30. CRANK          |
| 11. NUT                    | 31. PIVOT          |
| 12. STANDOFF               | 32. CRANK          |
| 13. STANDOFF               | 33. SPACER         |
| 14. CAPSCREW               | 34. LINK           |
| 15. KNOB                   | 35. COTTER PIN     |
| 16. PIN                    | 36. PIN            |
| 17. LATCH ROD              | 37. ROCKER ARM     |
| 18. LATCH                  | 38. SNAP RING      |
| 19. CAPSCREW               | 39. PIVOT PIN      |
| 20. WASHER                 | 40. FLANGE BEARING |

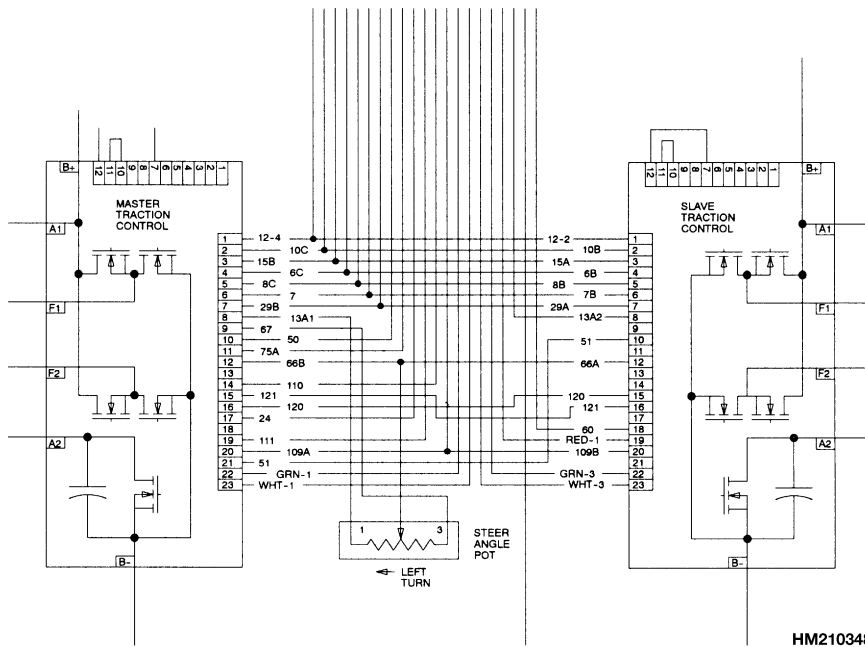


- |                |                   |
|----------------|-------------------|
| 1. AUXILIARY 2 | 4. LIFT           |
| 2. AUXILIARY 1 | 5. TO FILTER      |
| 3. TILT        | 6. FEED FROM PUMP |

**Figure 5. Hydraulic Line Arrangement**

# DIAGRAMS

## J30-40XMT2 [H160]



# HYSTER

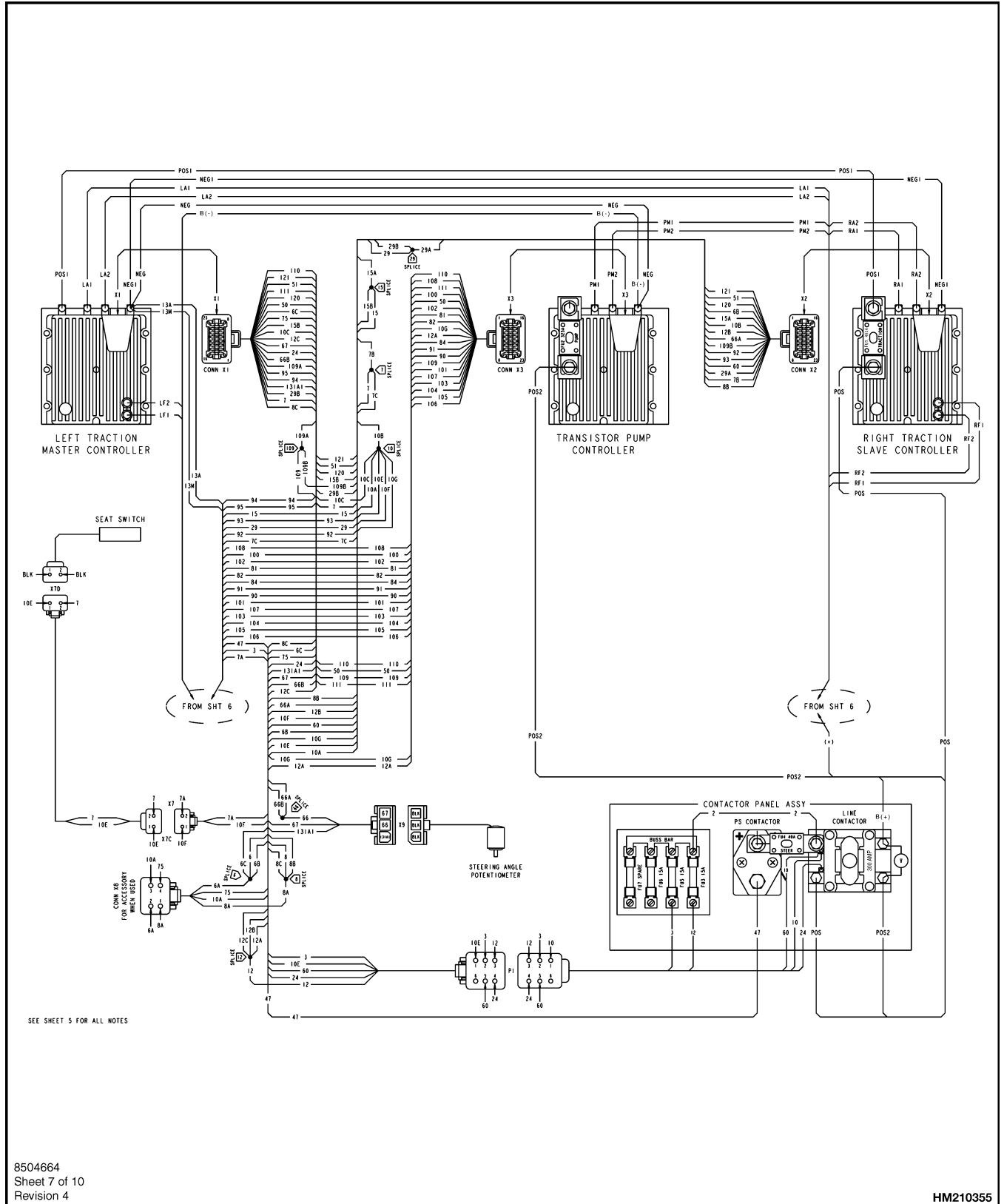


Figure 7. Wiring Diagram-Rear Compartment With Transistor Lift Pump Control



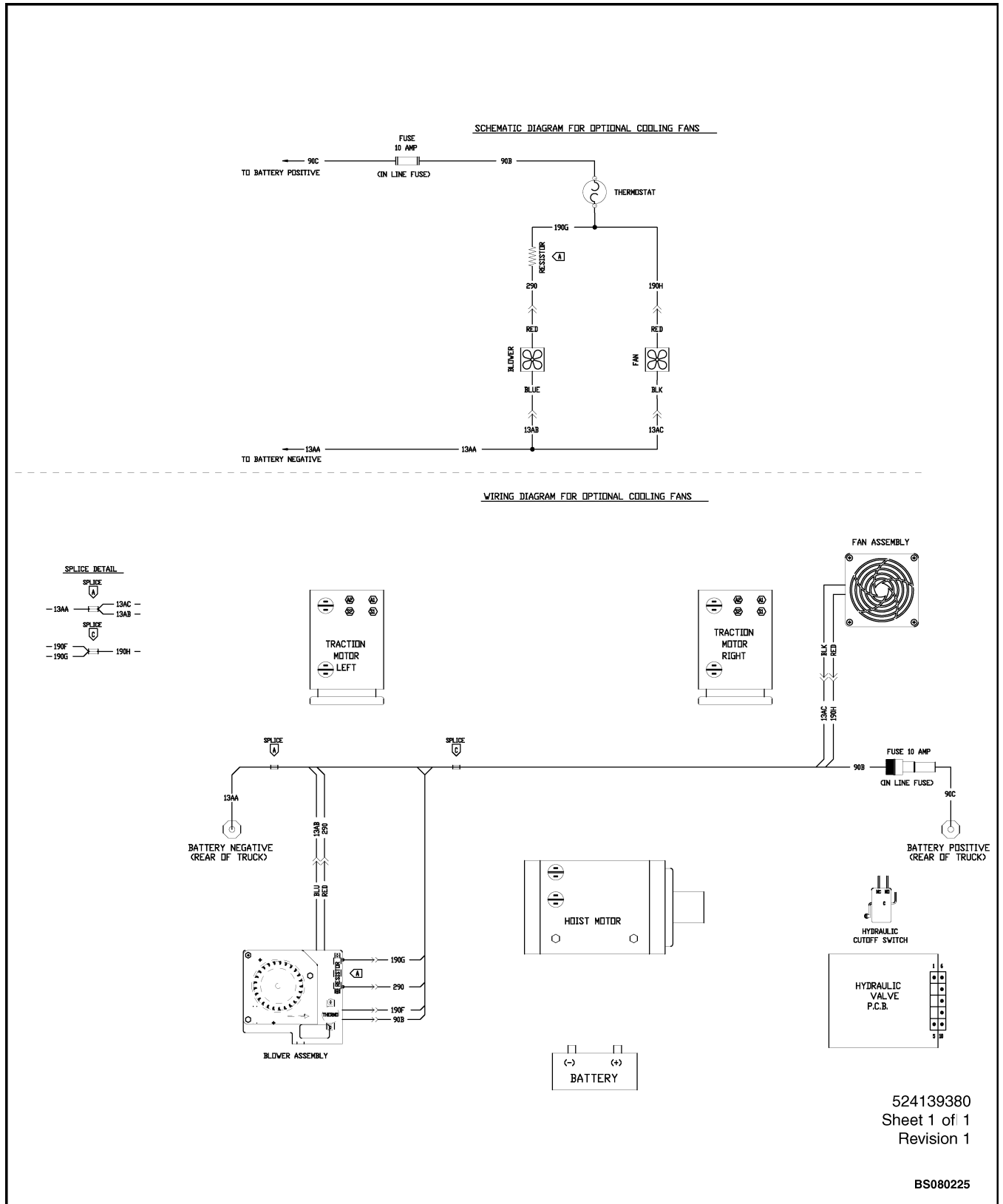


Figure 27. Cooling Fan Wiring Diagram



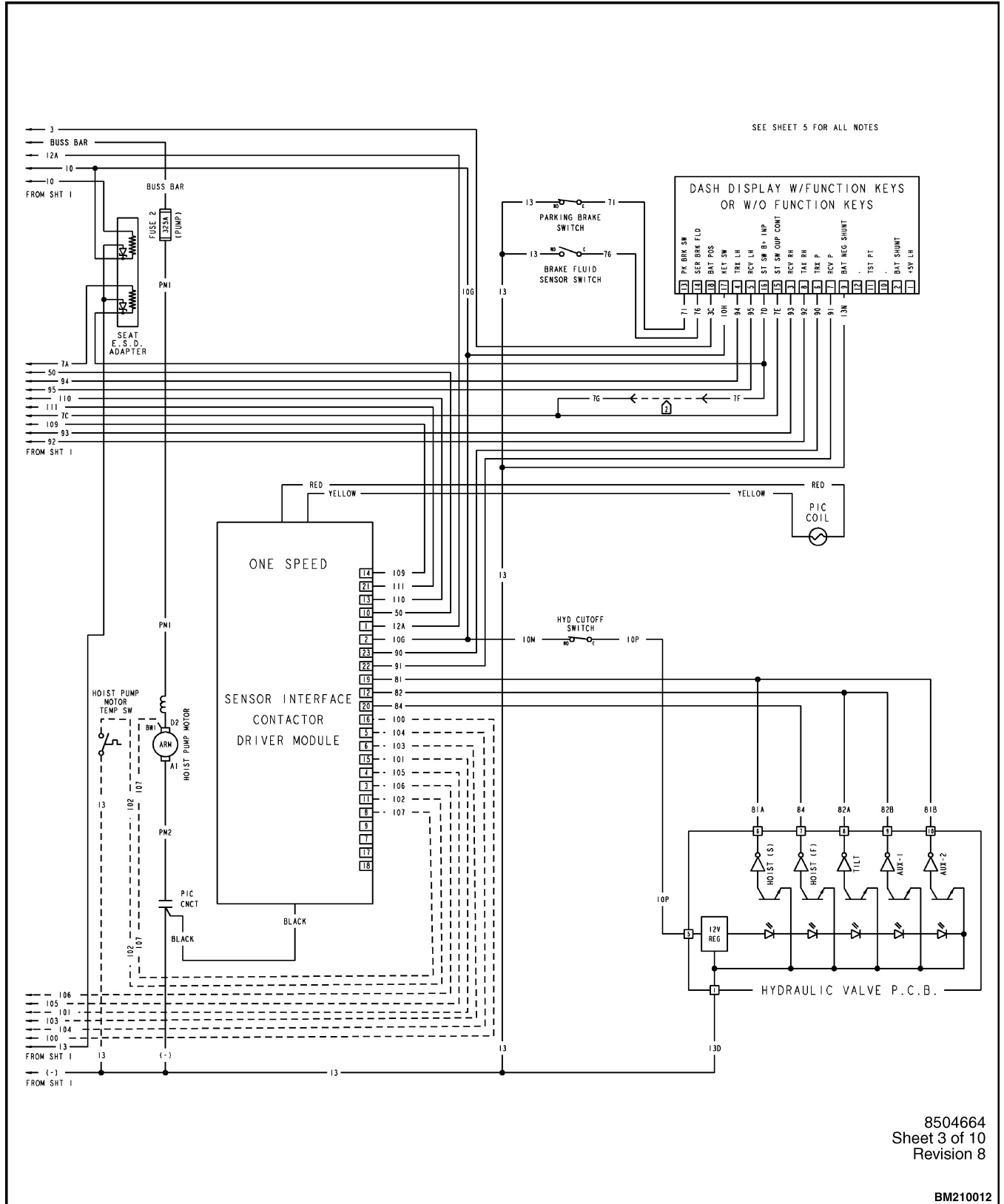


Figure 13. Wiring Schematic-1-Speed Lift Pump Control

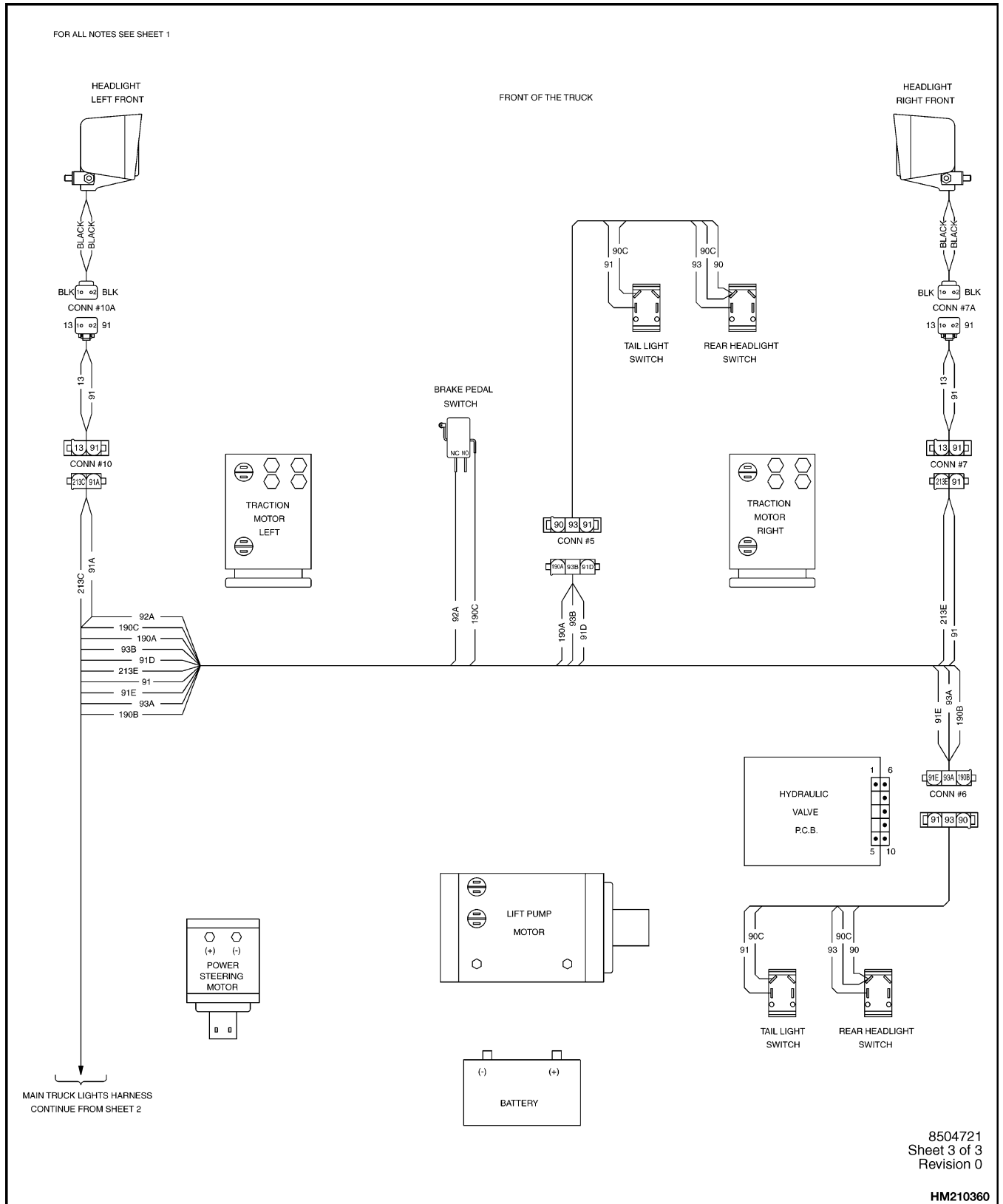


Figure 23. Wiring Diagram (Front Compartment)

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        Replace ..... 33

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        Replace ..... 34

    Brake Fluid Switch..... 34

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        Check..... 35

        Replace ..... 35

    Stop Light Switch ..... 36

        Check..... 36

        Replace ..... 36

## POSITIONING STEER TIRE FOR STRAIGHT TRAVEL

The steer tire must be positioned so the truck travels in a straight line within 152 mm (6 in.) over a distance of 9 m (30 ft) before adjustments are made to the steer angle potentiometer. The following procedure is used to verify that the truck travels in a straight line for 9 m (30 ft). If the truck does not travel straight within the tolerance allowed, the steer tire should be repositioned using the steering wheel until the truck can be operated in a straight line as described, within the specified tolerance. The steer tire must be exactly positioned for straight travel before adjustments can be properly made to the steer angle potentiometer.

**NOTE:** This procedure requires a section of floor that is smooth and level for approximately 30 m (100 ft).

1. Move the steering wheel so the steer tire is positioned for straight travel. Operate the lift truck slowly, without touching the steering wheel, for 9 m (30 ft). The steer tire is in the proper position when the lift truck will travel in a straight line within 152 mm (6 in.) in 9 m (30 ft). Check that the lift truck moves in a straight line as follows:
  - a. Install a pointer on the outside of the lift truck, forward of the counterweight. The pointer should be positioned so it does not touch the floor. A ty-wrap can be fastened to the frame with duct tape to serve as a pointer.
  - b. Mark the floor under the point of the pointer.
  - c. Operate the lift truck slowly for 5 m (15 ft). The operator should not move the steering wheel while travelling and the lift truck should coast to a stop. Mark the floor under the point of the pointer.
  - d. Operate the lift truck slowly in the same direction for another 5 m (15 ft). The operator should not move the steering wheel while travelling and the lift truck should coast to a stop. Mark the floor under the point of the pointer.
  - e. Draw a straight line between the first and last marks. The center mark must be within 76 mm (3 in.) of the line. If the center mark is not within 76 mm (3 in.), the steer tire is positioned incorrectly. Reposition the steer tire with the steering wheel and repeat this

procedure until the steer tire is correctly positioned.

- f. Remove the pointer.

2. When the steer tire has been correctly positioned, the steer angle potentiometer can be adjusted. Refer to Adjust.

## ADJUST



### WARNING

**Before troubleshooting, adjusting, or connecting/disconnecting the handset, perform the following steps, unless specifically instructed to do otherwise:**

1. **Block the lift truck so the drive wheels are off the floor. See the section Periodic Maintenance 8000 SRM 772. Refer to HOW TO PUT THE LIFT TRUCK ON BLOCKS.**
2. **Turn the key switch to the OFF position and unplug the battery.**
3. **Discharge the capacitors by connecting a 200-ohm, 2-watt resistor across the controller's POS and NEG terminals (outer two power cable terminals). See Figure 1 or Figure 2.**

The steer angle potentiometer can be centered using one of two methods. Due to variations in voltmeters and the accuracy required in adjusting the steer angle potentiometer to the center point, the handset method is recommended.

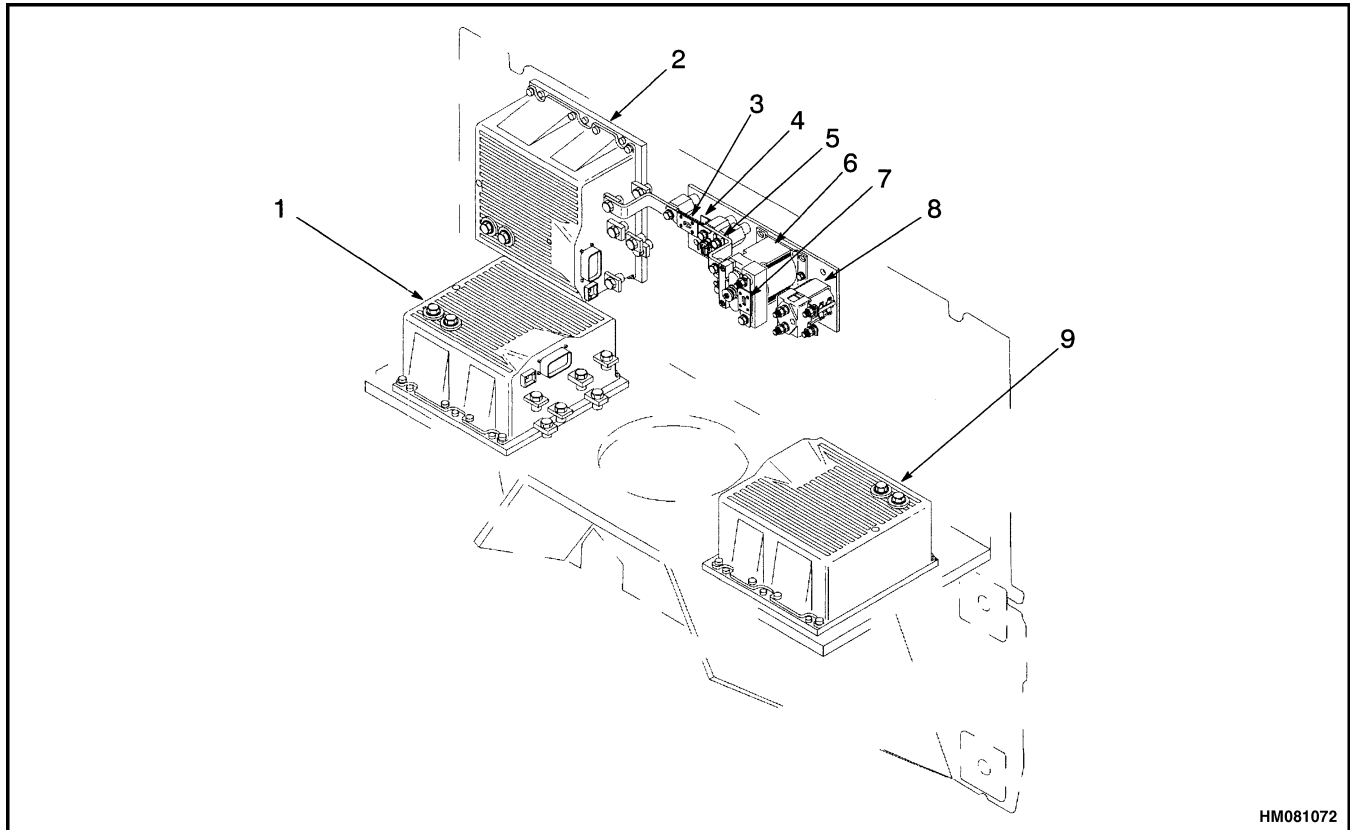
**NOTE:** Failure to properly center the potentiometer can result in overheating of the traction motor or traction motor controller. The fault code may occur immediately or intermittently.

## Handset Method

1. Position the steer tire for straight travel. Refer to Positioning Steer Tire for Straight Travel.

**NOTE:** Do not move the steer tire or steering wheel after the steer tire has been positioned for straight travel.

2. Block the drive wheels. Do not raise the wheels off the ground. Turn the key switch to the **OFF** position, disconnect the battery, and discharge the capacitors.
3. Plug the handset into the left motor controller.



HM081072

- |   |                                    |
|---|------------------------------------|
| 1. LEFT TRACTION MOTOR CONTROLLER                           | 5. TRACTION MOTOR FUSE             |
| 2. LIFT PUMP MOTOR CONTROLLER                               | 6. MAIN CONTACTOR                  |
| 3. LIFT PUMP MOTOR FUSE                                     | 7. POWER STEER PUMP MOTOR FUSE     |
| 4. KEY SWITCH, TRACTION CONTROLLERS, AND<br>AUXILIARY FUSES | 8. POWER STEERING CONTACTOR        |
|   | 9. RIGHT TRACTION MOTOR CONTROLLER |

**Figure 14. Electrical Compartment With Transistor-Controlled Lift Pump (Early Models)**

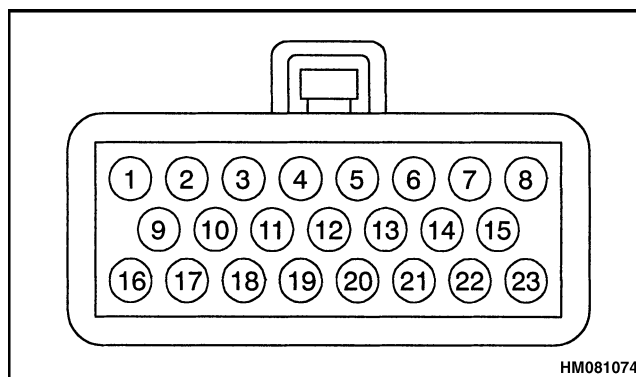


Figure 20. J-12 Plug

## Other Control Components

### WARNING

Before troubleshooting, adjusting, or connecting/disconnecting the handset, perform the following:

1. Turn the key switch to the OFF position and unplug the battery.
2. Discharge the capacitors by connecting a 200-ohm, 2-watt resistor across the controller's POS and NEG terminals (outer two power cable terminals). See Figure 1 or Figure 2.

Following is a short description of the other control components and their function:

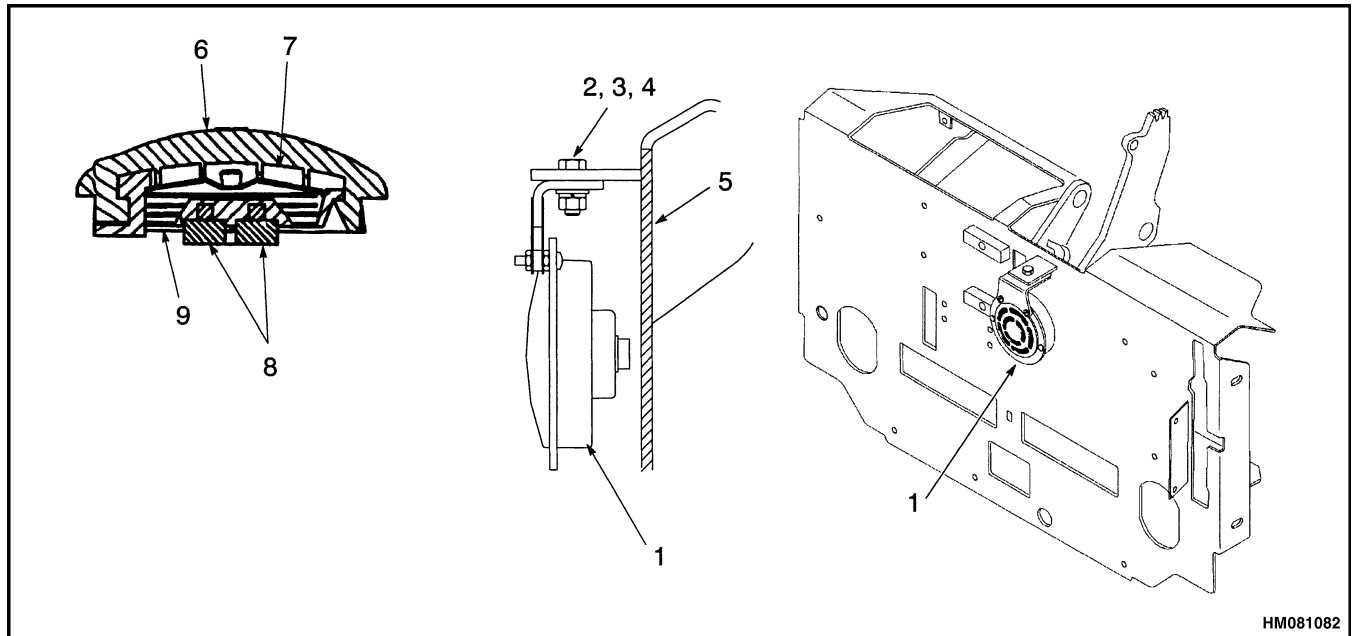
- Key switch is in the housing of the instrument panel and connects battery voltage to all of the control circuits, except the horn.
- Seat switch is inside the seat and is open if the operator is not on the seat. The seat switch sends a signal to the traction controllers to enable the controllers and the power steering.
- Parking brake switch operates if the parking brake is applied. The parking brake switch is fastened near the linkage for applying the parking brake. The switch sends a signal to the instrument panel to illuminate the parking brake indicator.

The parking brake switch and the instrument panel are used to operate an alarm. The alarm sounds if the operator leaves the seat of the lift truck when the key is in the ON position and the parking brake is not applied.

- Accelerator switch assembly is actuated by the MONOTROL® pedal or accelerator pedal and is part of the SRO circuit. If the accelerator switch assembly is closed before the seat switch, the controller will not permit the lift truck to move.
- Direction control switches in the MONOTROL pedal or steering column send signals to the traction controllers to select the forward or reverse direction.
- Brake fluid switch sends voltage to the indicator light in the instrument panel when the fluid in the brake master cylinder is low.
- The hydraulic cutoff switch prevents operation of the hydraulic controls if the hood is not closed and latched.

The following control components are offered as options on this lift truck:

- The optional stop light switch is actuated by the brake pedal to energize the optional stop lights on the rear legs of the overhead guard.
- Optional motor temperature switches cause the indicator light on the instrument panel to illuminate when either the lift pump or the traction motor is too hot.
- Optional brush wear indicators cause the indicator light on the instrument panel to illuminate when the brushes of the lift pump, steer pump motor, or traction motors are worn.



1. HORN
2. HEXAGON HEAD BOLT
3. WASHER
4. NUT
5. LIFT TRUCK COWL

6. COVER
7. CONTACT PLATE
8. CONTACT SET AND SETSCREW
9. SPRING

*Figure 30. Horn and Horn Button*

### Horn Button, Replace

The Horn Switch and Cover (button) is in the center of the steering wheel. See Figure 30. Replace the horn button assembly as follows:

1. Disconnect the battery and remove the key.
2. Carefully lift the cover and horn button assembly up off the steering wheel. Lift the assembly far enough for access to the setscrews that fasten the horn wires. There is some extra length of the horn wires, but the assembly will not come up very far. If necessary for additional clearance, the cover, contact plate, and spring can be removed from the contact set.
3. Loosen the setscrews that fasten the contact set to the horn wires.
4. Pull the horn wires out of the contact set and remove the assembly.

### WARNING

**If the steering wheel has been removed, make sure the steering wheel nut has been tightened. The correct torque is 40 to 54 N•m (30 to 40 lbf ft).**

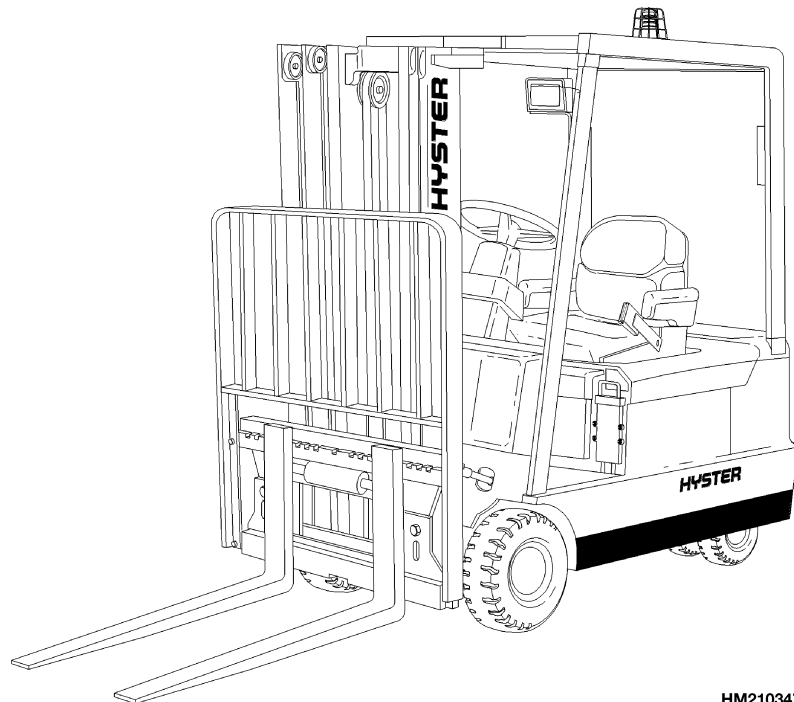
5. Put the replacement assembly in position over the steering wheel and install the wires in the contacts. Tighten the setscrews to fasten the wires.

**NOTE:** If the contact set, spring, contact plate, and cover are separated, make sure they are installed and aligned correctly.

6. Carefully push the wires into the shaft bore as far as possible. Align the horn button assembly and press down on the edges of the cover to install it in the steering wheel.
7. Connect the battery.

# ELECTRICAL SYSTEM

J30-40XMT2 [H160]



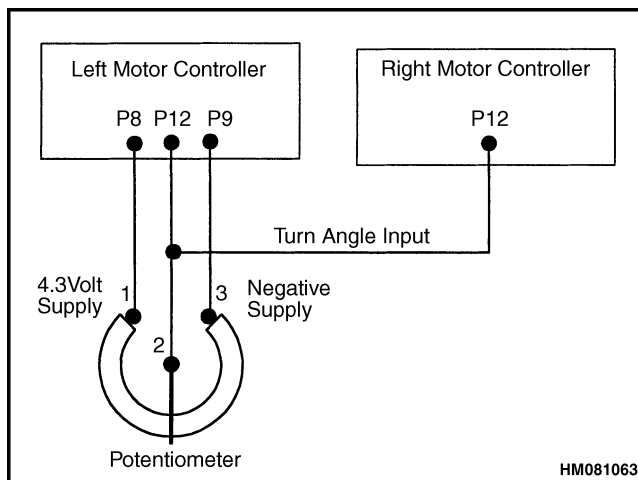
HM210347

# **HYSTER**

## Steer Angle Potentiometer

### GENERAL

The steer angle potentiometer measures the position of the steer tire. The steer angle potentiometer is a 10,000 ohm, 320 degree pot and is located in the rear compartment. The potentiometer shaft is attached to the top of the rotary actuator by a coupler. The steer angle potentiometer provides a voltage divider circuit that conveys the turn angle of the steer tire to the left and right traction motor controllers. The potentiometer is connected to the two controls as shown in Figure 6. The steer angle potentiometer must be properly adjusted. A status code is displayed when the potentiometer is greatly out of adjustment. The absence of this status code does NOT indicate that the potentiometer is properly adjusted.



**Figure 6. Steer Angle Potentiometer Connection Points**

### OPERATION

When properly adjusted and operating correctly, the input voltages measured at P12 on the left and right traction motor controllers are identical and correspond to the turn angle of the steer wheel. When the steer wheel is straight ahead (0 degree turn angle), the input voltage at each controller should be 2.15  $\pm$ 0.01 volts. As the lift truck is turned left, the input voltages decrease; as the lift truck is turned right,

the input voltages increase. Refer to Figure 7 for the correlation between the turn angles of the steer tire and the input voltages and actions of the controllers.

### Example

The following series of events takes place in a left turn from the zero to 90 degree steer wheel position.

In the first 25 degrees of travel (2.15 to 1.81 wiper volts), there is no change to the wheel speed on the inside of the turn (left wheel).

Between 25 degrees (1.81 wiper volts) and 66 degrees (1.10 wiper volts), the left motor reduces speed proportionally from top speed at 25 degrees to creep speed at 66 degrees.

Beyond 32 degrees the maximum lift truck speed is reduced. The maximum lift truck speed is reduced from full speed at 32 degrees to the value set by Function 11 at 90 degrees.

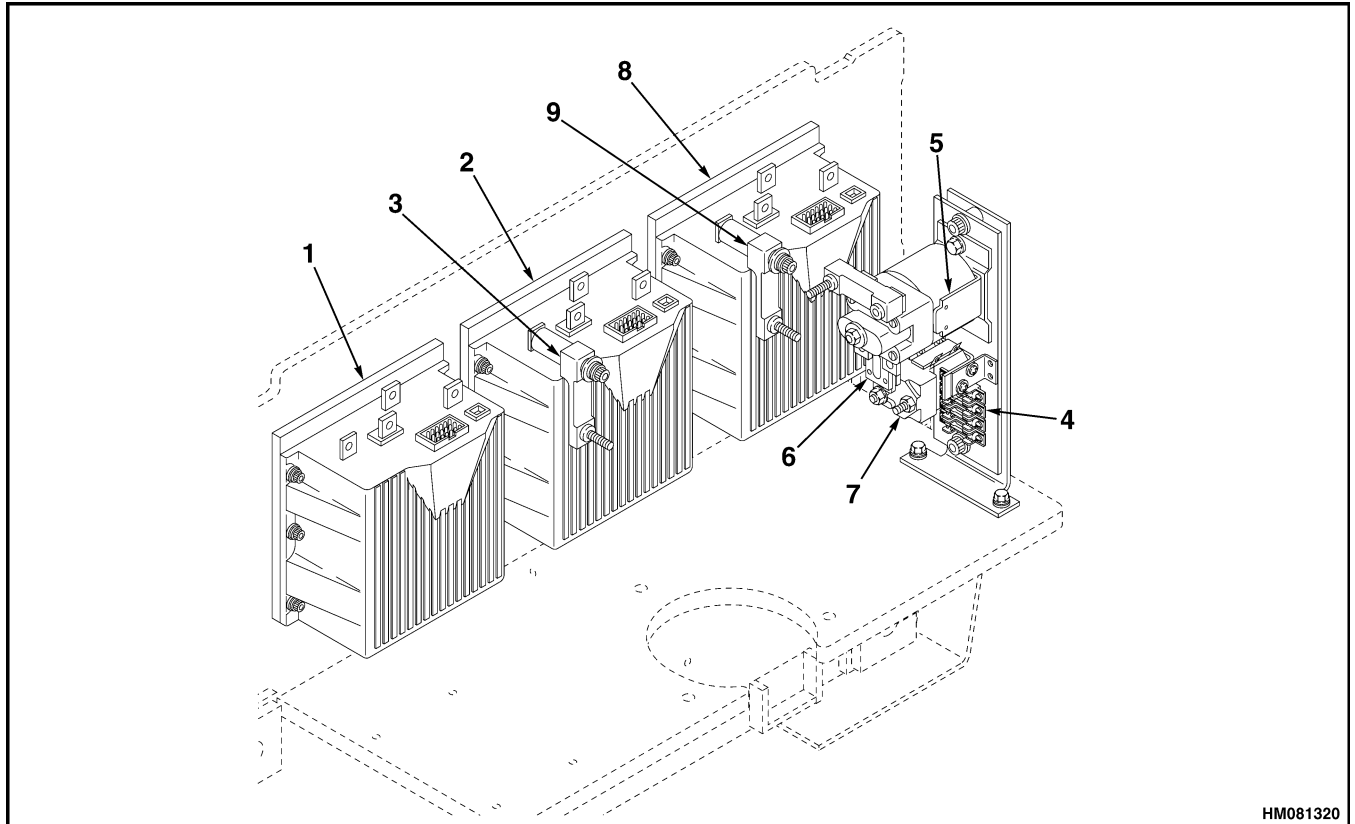
Between 66 degrees and 71 degrees, the left wheel is in a free-wheel mode.

As the steer angle reaches the 71 degree point, the left wheel begins to turn in the opposite direction and accelerate proportionally.

Beyond 86 degrees, the steer angle potentiometer is outside the normal range of travel.

### INSTALL

1. Position the steer tire in approximately the straight travel position.
2. Position the steer angle potentiometer in approximately the midrange position.
3. Install the potentiometer through the bracket, washer, and nut while guiding the potentiometer shaft into the coupling. Position the potentiometer so the wires are in line with the potentiometer mounting bracket. Fasten the potentiometer to the bracket using the lockwasher and nut.



HM081320

- |   |                                    |
|---|------------------------------------|
| 1. LEFT TRACTION MOTOR CONTROLLER                           | 5. LINE CONTACTOR                  |
| 2. LIFT PUMP MOTOR CONTROLLER                               | 6. POWER STEER PUMP MOTOR FUSE     |
| 3. LIFT PUMP MOTOR FUSE                                     | 7. POWER STEERING CONTACTOR        |
| 4. KEY SWITCH, TRACTION CONTROLLERS, AND<br>AUXILIARY FUSES | 8. RIGHT TRACTION MOTOR CONTROLLER |
|   | 9. TRACTION FUSE                   |

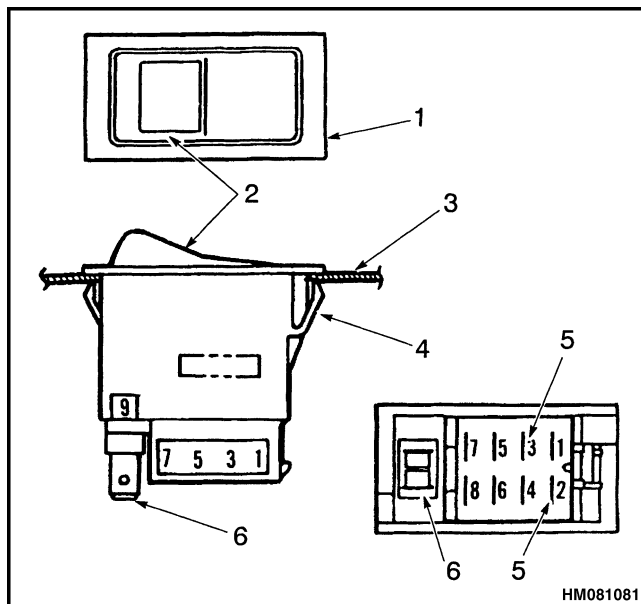
**Figure 12. Electrical Compartment With One-Speed Lift Pump (Early Models)**

See Table 7 for additional information.

**Table 7. SICDM Connections/Descriptions/Status Codes**

	<b>Pin Number</b>	<b>Description</b>	<b>Wire Number</b>	<b>Status Code</b>
<b>P P L U G</b>	P1	Battery Volts	12	-
	P2	Battery Volts from Key Switch	10	-
	P3	Power Steering Motor Brush Wear Indicator Input	106	93
	P4	Power Steering Motor Brush Wear Indicator Input	105	93
	P5	Left Traction Motor Brush Wear Indicator Input	104	94
	P6	Right Traction Motor Brush Wear Indicator Input	103	94
	P7	NOT USED	-	-
	P8	Lift Pump Motor Brush Wear Indicator Input	107	95
	P9	Lift Pump Motor Brush Wear Indicator Input	108	95
	P10	+12 Volt Pump Enable Signal Input from Left Traction Controller (Left Traction Controller with Lift Interrupt feature)	50	-
	P11	Lift Pump Motor Temperature Input	102	91
	P12	Speed Limit 1 Input (Tilt and Auxiliary 1)	82	-
	P13	Brush Wear Indicator Output to Traction Controller	110	-
	P14	Motor Overtemperature Output to Traction Controller	109	-
	P15	Right Traction Motor Temperature Input	101	92
	P16	Left Traction Motor Temperature Input	100	90
	P17	NOT USED	-	-
	P18	NOT USED	-	-
	P19	Speed Limit 2 Input (Slow Lift and Auxiliary 2)	81	-
	P20	Speed Limit 3 Input (Fast Lift)	84	-
	P21	+5 Volt Power Supply Input from Left Traction Controller	111	-
	P22	NOT USED*	-	-
	P23	NOT USED*	-	-

\*Pin is wired, but not used by the SICDM. (SICDM provides no input or output.)



1. SWITCH ASSEMBLY
2. LENS AND FUNCTION SYMBOL (NOT ON ALL SWITCHES)
3. INSTRUMENT PANEL
4. RETAINER CLIP
5. SWITCH LIGHT AND OTHER TERMINALS
6. POWER TERMINALS

**Figure 28. Rocker Switch**

4. Remove the switch and install the replacement switch in the panel. Make sure the switch is in the correct position for reading by the operator.
5. Connect the wires or wire harness to the electrical terminals on the switch as removed during removal.



### CAUTION

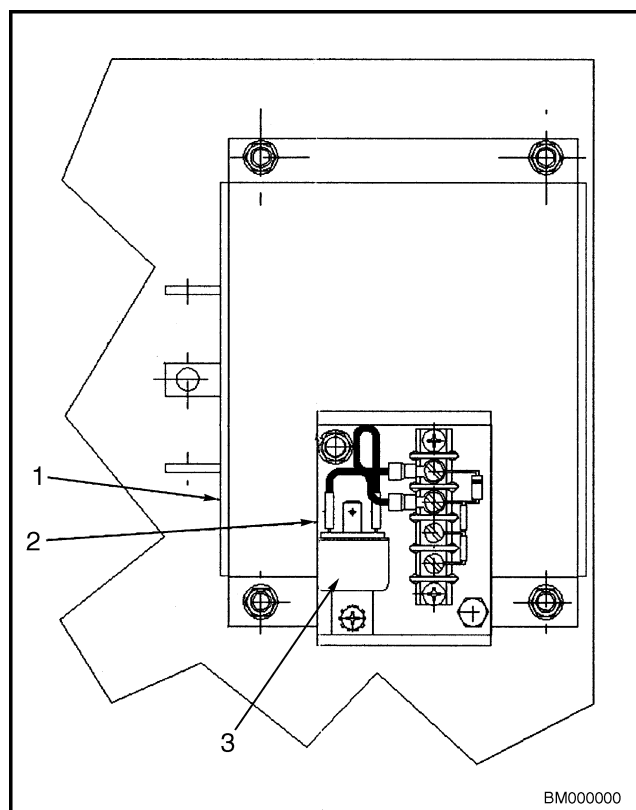
**Make sure wire connectors do not touch other switch or metal terminal wire connectors, metal brackets, or the bracket mounting nuts. Make sure there is no tension on the wires or connectors.**

6. Install the cover under the instrument panel and connect the battery.

### DC-TO-DC CONVERTER

The DC-to-DC Converter, when used, is mounted on the steering support plate in the rear compartment. See Figure 29. The DC-to-DC converter is optional and can be furnished when lights are used on the lift truck. A 12-volt battery tap is also available as an

option. The DC-to-DC converter is used to convert 36-48 VDC to 12 VDC for the lights. The converter has an inline 15 amp fuse.



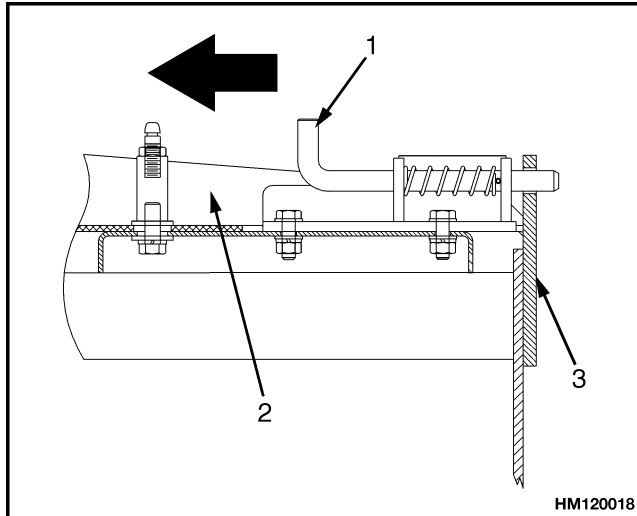
1. DC-TO-DC CONVERTER
2. BACKUP LIGHT RELAY PANEL
3. LIGHT SWITCH RELAY

**Figure 29. DC-to-DC Converter and Backup Light Relay Panel**

Replace the DC-to-DC converter as follows:

1. Disconnect the battery and remove the key.
2. Remove the rear compartment cover.
3. Tag the wires to the converter. Disconnect the wires from the converter.
4. Remove the screws, lockwashers, and washers retaining the converter to the support plate and remove the converter.
5. Clean the plate surface beneath the converter and fill all voids with silicone grease, P/N 1198757. The contact surface between the converter and the frame must be 90% covered with the grease.





- |                               |          |
|-------------------------------|----------|
| 1. SLIDING LATCH<br>MECHANISM | 2. HOOD  |
|                               | 3. FRAME |

**Figure 6. Latch Mechanism**

The latch mechanism must operate correctly before the lift truck can be operated. The latch must not be worn and must fully engage the frame. The hood must be locked in the closed position when the lift truck is operated. If the latch mechanism does not lock the hood in the closed position, the hydraulic linkage and covers will not close and the lift truck hydraulic system will not operate.

The latch at the front of the hood fastens the hood to the frame, and two hinges at the back of the hood fasten to the hood to brackets attached to the counterweight. A double-dampened, gas-controlled strut holds the hood in the open position. A handle to disconnect the battery is fastened to the hood at the right side of the seat assembly. This handle is an emergency disconnect that permits the operator to quickly disconnect the battery while on the seat of the lift truck.

The hood, seat belt, hip restraint brackets, seat, and seat mount are all parts of the operator restraint system. Checks and adjustments for the operator restraint system are described in the **Operating Manual**, Part No. 1463779, and the section **Periodic Maintenance** 8000 SRM 772.

The seat assembly slides on seat rails that are fastened to the hood by four capscrews. A lever at the left front side of the base controls the adjustment of the seat to the forward and backward positions.

An optional seat can be installed that has a back cushion which tilts backward 5 to 20 degrees. A handle on the right side of the seat back controls the angle of tilt.

All seats have a seat switch installed in the bottom cushion that senses pressure. When the operator is not on the seat, the seat switch opens and stops the operation of the lift truck.

To raise the hood and seat assembly, move the seat as far to the rear as possible. Release the latch and move the steering column to the most forward position. Release and raise the hydraulic linkage and covers. Pull back on the latching mechanism to release and raise the hood.

## REMOVE

1. Disconnect the battery connector.
2. Disconnect the electrical connector to the seat switch.

**NOTE:** The seat assembly does not have to be removed from the hood to remove the hood from the lift truck. To remove the seat, remove the four capscrews that fasten the seat base to the hood. Lift the seat assembly from the hood. If the seat is not being removed, raise the hood.

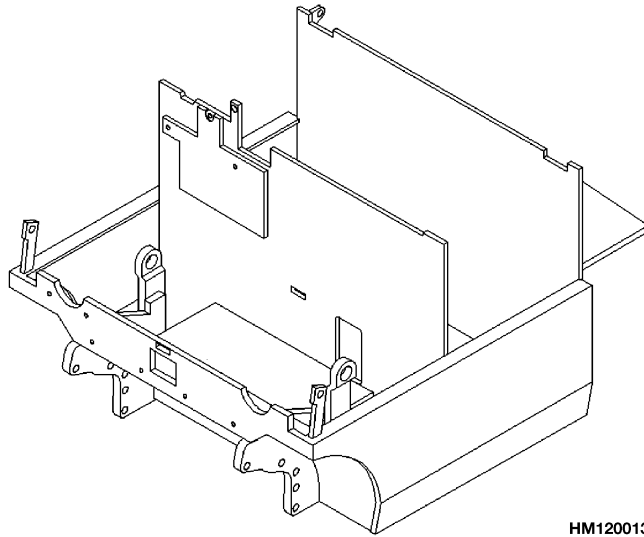
3. Disconnect the double-dampened, gas-controlled strut by removing the locking clip retaining the truck to the frame. Move the hood to the closed position.
4. Remove the four capscrews, washers, and nuts retaining the hood bracket to the hood. Make certain not to lose any of the shims.

## INSTALL

1. With the aid of an assistant, install the hood on the hinges. Put the hood in the closed position.
2. Tighten the capscrews to 86 N•m (63 lbf ft). The minimum clearance between the hood and the front plate of the frame is 3.5 mm (0.14 in.). If necessary, add or remove shims to obtain the proper clearance. If the seat assembly has been removed, install the seat assembly on the hood.
3. Raise the hood. Align and install the gas-filled strut. Install the locking clip to retain the strut to the frame. Connect the electrical connector for the seat switch.

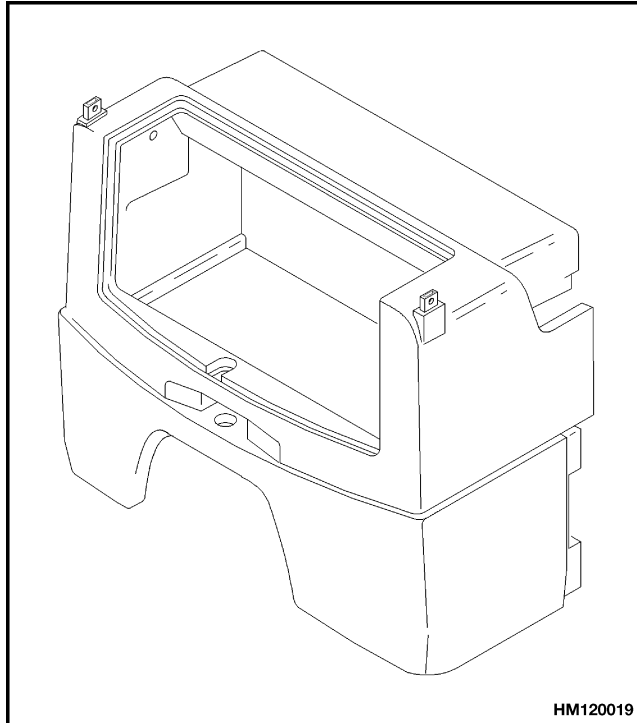
# FRAME

J30/35/40XMT2 [H160]



HM120013

# ***HYSTER***



**Figure 7. Counterweight**

## INSTALL

### **WARNING**

The counterweight is very heavy. Make sure the sling, chain, eyebolts, and crane or lifting device have the capacity to lift the counterweight.

1. Use a crane to lift the counterweight into position. The lift points for the counterweight are at the center of gravity of the counterweight. Some assistance will be required to align the counterweight and the frame.
2. Install the four M20 × 2.5 × 60 capscrews and hardened flat washers that hold the counterweight to the frame. Tighten the capscrews to 435 N•m (321 lbf ft).
3. Disconnect the sling or chain. Remove the eyebolts from the counterweight.
4. Install the battery platform and the acid tray in the battery compartment.
5. Install the overhead guard as described in the Overhead Guard Repair. Install the hood and seat assembly.
6. Install the battery.

## Hydraulic Tank Repair

### INSPECT

Make a visual inspection of all sides of the tank. Inspect the welds for cracks and leakage. Check for wet areas, accumulation of dirt, and loose or missing paint caused by leakage. Areas of the tank that are not easily seen can be checked with an inspection mirror and a light that is approved for locations with flammable vapors.

### SMALL LEAKS, REPAIR

Use the following procedure to repair small leaks:

### **WARNING**

Do not use tools that can make sparks, heat, or static electricity. The vapors in the tank can cause an explosion.

1. Use steam to clean the area around the leak. Remove all paint and dirt around the leak.
2. Apply Hyster part number 251099 Loctite® 290 to the leak. Follow the instructions of the manufacturer.

### LARGE LEAKS, REPAIR

1. Use one of the procedures described in Clean to clean and prepare the tank for repairs.
2. Contact your dealer for Hyster lift trucks for welding instructions.
3. Use acceptable welding practices to repair the tank. See the American National Standard *Safety in Welding and Cutting* AWS Z 49.1 - 1999.

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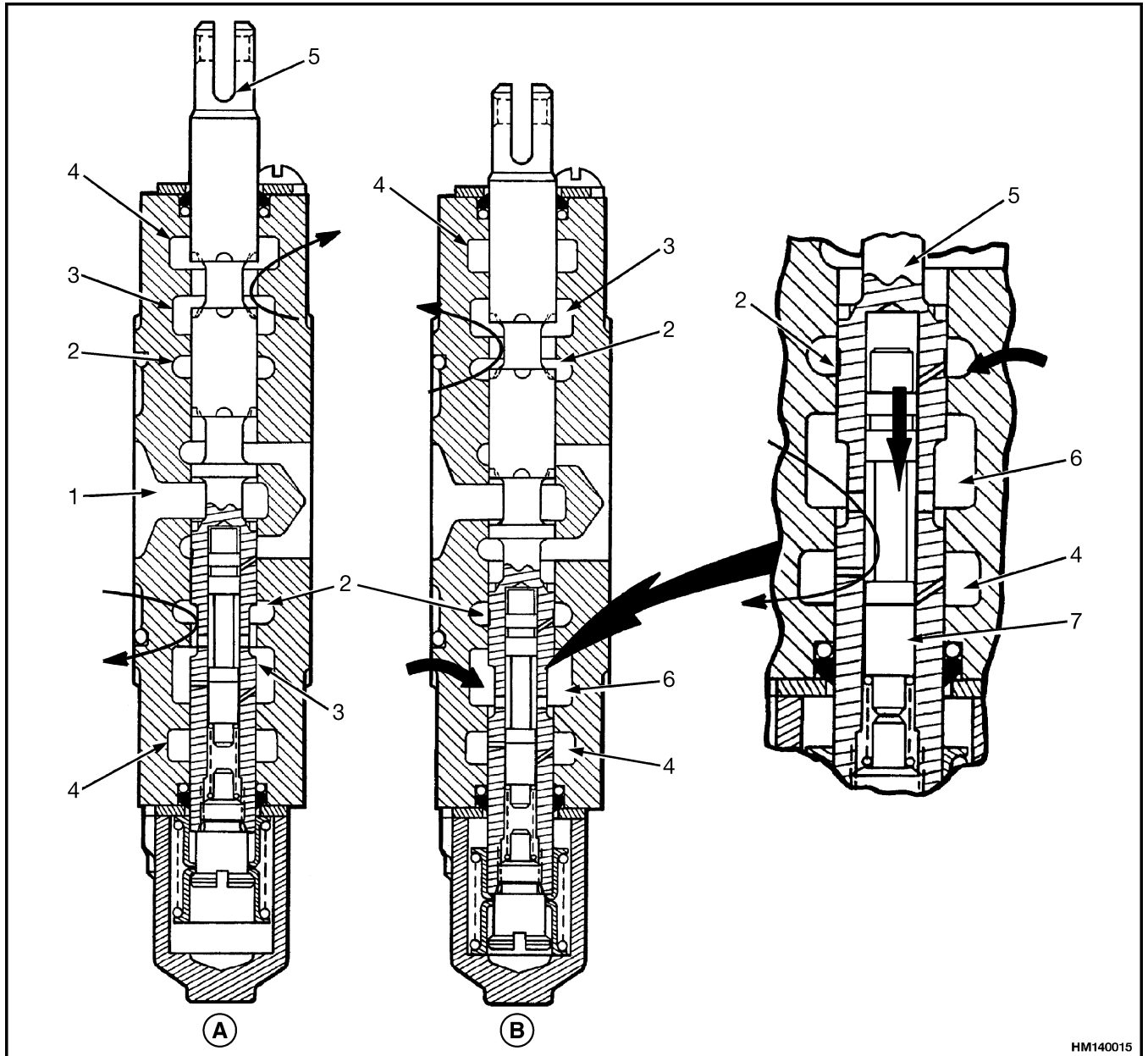
This section is for the following models:

J30-35-40XMT2 [H160]

*Legend for Figure 6*

- |                  |                    |
|------------------|--------------------|
| 1. SCREW         | 27. LOCKWASHER     |
| 2. LOWER COVER   | 28. NUT            |
| 3. STANDOFF      | 29. BRACKET        |
| 4. STANDOFF      | 30. CAPSCREW       |
| 5. CAPSCREW      | 31. WASHER         |
| 6. VANE-LIFT     | 32. LOCKWASHER     |
| 7. VANE-PUMP     | 33. NUT            |
| 8. CAPSCREW      | 34. PC BOARD       |
| 9. WASHER        | 35. CAPSCREW       |
| 10. LOCKWASHER   | 36. WASHER         |
| 11. NUT          | 37. LOCKWASHER     |
| 12. LINK         | 38. NUT            |
| 13. COTTER PIN   | 39. BRACKET        |
| 14. PIN          | 40. CAPSCREW       |
| 15. PIN          | 41. WASHER         |
| 16. SNAP RING    | 42. LOCKWASHER     |
| 17. WASHER-SHIMS | 43. NUT            |
| 18. PIN          | 44. RUBBER CHANNEL |
| 19. SPRING       | 45. RUBBER CHANNEL |
| 20. NUT          | 46. CONTROL VALVE  |
| 21. LOCKWASHER   | 47. CAPSCREW       |
| 22. STUD         | 48. WASHER         |
| 23. PIN-WELDMENT | 49. LOCKWASHER     |
| 24. SPACER       | 50. NUT            |
| 25. SWITCH       | 51. VALVE BRACKET  |
| 26. SCREW        |                    |





**A. TILT BACKWARD**

- 1. OPEN CENTER PASSAGE
- 2. SUPPLY CAVITY
- 3. TO/FROM PISTON END OF TILT CYLINDERS
- 4. DRAIN CAVITY

**B. TILT FORWARD**

- 5. TILT SPOOL
- 6. TO/FROM ROD END OF TILT CYLINDERS
- 7. TILT CONTROL SPOOL

*Figure 4. Tilt Spool Operation*

## Pressure Relief Valve Check and Adjustment

**NOTE:** The main control valve has two relief valves: a primary relief valve and a secondary relief valve. The primary relief valve is in the inlet section of the control valve. The secondary relief valve is in the lift/lower section of the control valve.

### PRIMARY RELIEF VALVE

#### 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 key switch is OFF.

1. Connect a 25 MPa (3500 psi) gauge to the test port at the inlet section of the control valve. See Figure 10.
2. Loosen the jam nut.
3. Operate the hydraulic system to warm the oil temperature to 55 to 65°C (131 to 149°F).

#### CAUTION

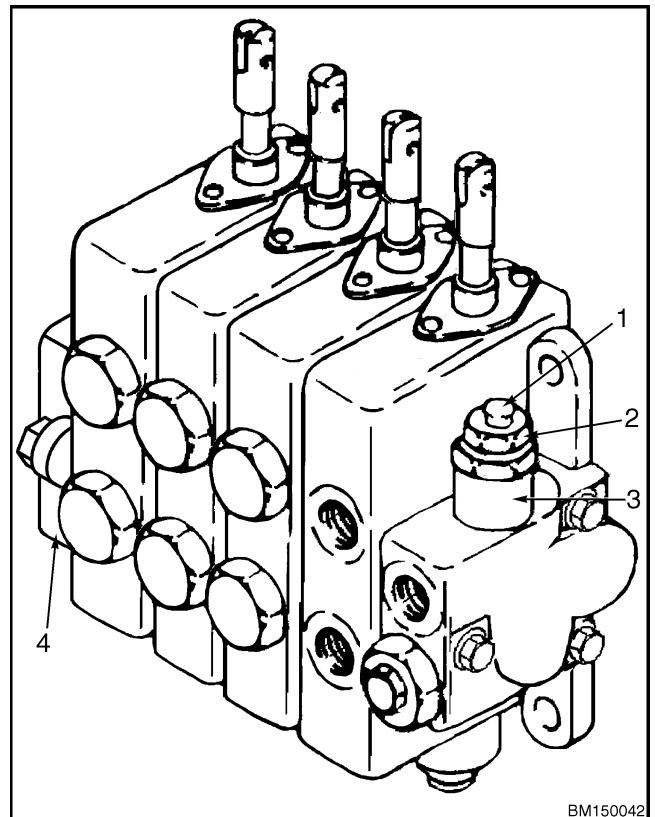
During this test, the mast must be fully extended. Make sure there is enough overhead clearance in the building or do the test outdoors.

4. Raise the mast until it stops. Hold the lever and check the reading of the gauge when the relief valve opens. Turn the adjustment screw as necessary to change the setting. For J30-35-40XMT2, the correct setting is 19.3 MPa (2800 psi). Tighten the jam nut when the adjustment is correct.
5. Remove the gauge when the checks are complete.

### SECONDARY RELIEF VALVE

1. Connect a 20 MPa (3000 psi) gauge to the test port at the inlet section of the control valve. See Figure 10.
2. Loosen the jam nut on the relief valve.

3. Operate the hydraulic system to warm the oil temperature to 55 to 65°C (131 to 149°F).
4. Tilt the mast backward until it stops. Hold the lever and check the reading of the gauge when the relief valve opens. Turn the adjustment screw as necessary to change the setting. For J30-35-40XMT2, the correct setting is 13.7 MPa (2000 psi). Tighten the jam nut when the adjustment is correct.
5. Remove the gauge when the checks are complete.



1. ADJUSTMENT SCREW
2. JAM NUT
3. PRIMARY RELIEF VALVE
4. SECONDARY RELIEF VALVE

*Figure 10. Relief Valve Locations*

## General

When turning the key switch to the **ON** position, the Brush Wear Indicator and Motor Temperature Indicator will illuminate. Contact your dealer if the Brush Wear Indicator and Motor Temperature Indicator will not illuminate when turning the key switch to the **ON** position.

This manual contains a Maintenance Schedule and the instructions for maintenance and inspection. The Maintenance Schedule has time intervals for inspection, lubrication, and maintenance. The time intervals are based on a normal operation. A normal operation is considered to be one 8-hour shift per day in a relatively clean environment on an improved surface. Multiple shifts, dirty operating conditions, etc., will require a reduction in the recommended time periods in the Maintenance Schedule.



### WARNING

**Do not make repairs or adjustments unless you have both authorization and training. Repairs and adjustments that are not correct can make a dangerous operating condition.**

**Do not operate a lift truck that needs repairs. Report the need for repairs to your supervisor immediately. If repair is necessary, put a DO NOT OPERATE tag on the control handle. Remove the key from the key switch.**

Your Hyster lift truck dealer has the facilities and trained personnel to do the maintenance. A complete program of inspection, lubrication, and maintenance will help your lift truck perform efficiently and operate over a longer period of time.

Some users have service personnel and facilities to do the items listed in the Maintenance Schedule. Workshop manuals are available from your Hyster lift truck dealer to help users who do their own maintenance.

Do not make repairs or adjustments unless specifically authorized to do so.

Put the lift truck on a level surface. Lower the carriage and forks, apply the parking brake, and turn the key switch to **OFF**. Open the access panels and inspect for leaks and conditions that are not normal. Clean any oil spills. Make sure that lint, dust, paper,

and other materials are removed from the compartments.

## HOW TO MOVE DISABLED LIFT TRUCK

### How to Tow Lift Truck



### WARNING

**Use extra care when moving a lift truck during the following conditions:**

- Brakes do not operate correctly.
- Steering does not operate correctly.
- Tires are damaged.
- Traction conditions are bad.
- The lift truck must be moved on a steep grade.

**If the steering pump motor does not operate, steering control of the lift truck can be slow. This can make the control of the lift truck difficult. If there is no electrical power, steering can be difficult. Do not tow the lift truck if there is no power. Poor traction can cause the disabled lift truck or towing vehicle to slide. Steep grades will require additional brake force to stop the lift truck.**

**Never carry a disabled lift truck unless the lift truck MUST be moved and cannot be towed. The lift truck used to carry the disabled lift truck MUST have a rated capacity equal to or greater than the weight of the disabled lift truck. The capacity must be for a load center equal to half the width of the disabled lift truck. See the Nameplate of the disabled lift truck for the approximate total weight. The forks must extend the full width of the disabled lift truck. Center the weight of the disabled lift truck on the forks and be careful not to damage the under side of the lift truck.**

1. The towed lift truck must have an operator.
2. Tow the lift truck slowly.
3. Raise the carriage and forks approximately 30 cm (12 in.) from the surface. Install a chain to prevent the carriage and mast channels from moving.

## SAFETY PROCEDURES WHEN WORKING NEAR MAST

The following procedures must be used when inspecting or working near the mast. Additional precautions and procedures can be required when repairing or removing the mast.



### WARNING

**Mast parts are heavy and can move. Distances between parts are small. Serious injury or death can result if part of the body is hit by parts of the mast or the carriage.**

- **Never put any part of the body into or under the mast or carriage unless all parts are completely lowered or a safety chain is installed. Also make sure that the power is off and the key is removed. Put a DO NOT OPERATE tag in the operator's compartment. Disconnect the battery on electric lift trucks and put a tag or lock on the battery connector.**
- **Be careful of the forks. When the mast is raised, the forks can be at a height that could cause an injury.**
- **Do NOT climb on the mast or lift truck at any time. Use a ladder or personnel lift to work on the mast.**
- **Do NOT use blocks to support the mast weldments nor to restrain their movement.**
- **Mast repairs require disassembly and removal of parts and can require removal of the mast or carriage. Follow the repair procedures in the correct Service Manual section for the mast.**

### WHEN WORKING NEAR THE MAST, ALWAYS:

1. Lower the mast and carriage completely. Push the lift/lower control lever forward and make sure there is no movement in the mast. Make sure all parts of the mast that move are fully lowered.

**OR**

2. If parts of the mast must be in raised position, install a safety chain to restrain the moving parts of the mast. Connect moving parts to a part that does not move. Follow these procedures:
  - a. Put the mast in a vertical position.
  - b. Raise the mast to align the bottom cross-member of the weldment that moves in the outer weldment with a crossmember on the outer weldment. On the two-stage and free-lift masts, the moving part is the inner weldment. On the three-stage mast, it is the intermediate weldment. On the four-stage mast, it is the first intermediate weldment. See Figure 6.
  - c. Use a 3/8-inch minimum safety chain with a hook to fasten the crossmembers together so the movable member cannot lower. Put the hook on the back side of the mast. Make sure the hook is completely engaged with a link in the chain. Make sure the safety chain does not touch lift chains or chain sheaves, tubes, hoses, fittings, or other parts on the mast.
  - d. Lower the mast until there is tension in the safety chain, and the free-lift cylinder (free-lift and three-stage masts only) is completely retracted. If the engine is running, stop the engine. Apply the parking brake. Install a **DO NOT REMOVE** tag on the safety chain(s).
  - e. Install another safety chain (3/8 inch minimum) between the top or bottom crossmember of the carriage and a crossmember on the outer weldment.
3. Apply the parking brake. After lowering or restraining the mast, shut off the power and remove the key. Put a **DO NOT OPERATE** tag in the operator's compartment. Disconnect the battery on electric lift trucks and put a tag or lock on the battery connector.

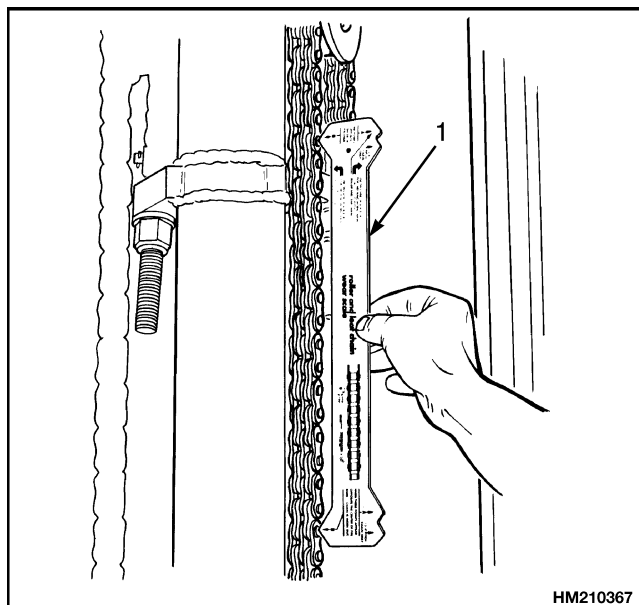
### LIFT CHAINS

**WARNING**

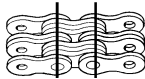
When working on or near the mast or carriage, see **Safety Procedures When Working Near Mast** located in **Maintenance Procedures Every 8 Hours or Daily**.

**Do not work under a raised carriage. Lower the carriage or use a safety chain to prevent the carriage from lowering when doing maintenance on the mast and lift chains.**

1. Lubricate the lift chains with 30W engine oil. The best procedure is to remove the chains from the lift truck and soak them in oil.
2. If a section of chain is 3 percent longer than a similar section of new chain, the chain is worn and must be replaced. If a chain scale is available, check the lift chains as shown in Figure 15. If a chain scale is not available, measure 20 links of chain. Measure from the center of a pin to the center of another pin 20 pitches away. Compare the length with the chart in Figure 15. Replace the chain if the length of 20 links of the worn section is more than the maximum wear limit.



HM210367

<b>Pitch</b> 	<b>Total length of 20 links (pitch) of new chain</b>	<b>Wear Limit The maximum length of 20 links.</b>
12.7 mm (0.50 in.)	254.0 mm (10.0 in.)	261.6 mm (10.3 in.)
15.9 mm (0.63 in.)	317.5 mm (12.5 in.)	327.0 mm (12.9 in.)
19.1 mm (0.75 in.)	381.0 mm (15.0 in.)	392.4 mm (15.4 in.)
25.4 mm (1.00 in.)	508.0 mm (20.0 in.)	523.3 mm (20.6 in.)
31.8 mm (1.25 in.)	635.0 mm (25.0 in.)	654.1 mm (25.75 in.)
44.5 mm (1.75 in.)	889.0 mm (35.0 in.)	915.7 mm (36.05 in.)
50.8 mm (2.00 in.)	1016.0 mm (40.0 in.)	1046.5 mm (41.2 in.)

**NOTE:** THE INSTRUCTIONS FOR MEASURING CHAIN WEAR ARE SHOWN ON THE CHAIN WEAR SCALE.

1. CHAIN WEAR SCALE

*Figure 15. Lift Chains Check*

When the oil has drained, install the drain plug. Fill the hydraulic tank with the oil described in the Maintenance Schedule.

## BRAKES

Check the brake pads and discs for wear. Minimum thickness of service brake pads is 0.76 mm (0.03 in.). Minimum thickness of cam side parking brake pad is 6.60 mm (0.26 in.). Minimum thickness of brake disc is 3.6 mm (0.142 in.).

Check the operation of the service brakes and the parking brake. See the repair procedures described in the section **Brake System** 1800 SRM 570.

There is no adjustment for the service brakes.

Replace the parking brake cable. See the repair procedures described in the section **Brake System** 1800 SRM 570.

### Parking Brake, Adjust



#### WARNING

**To access the parking brakes, the mast and carriage must be raised and a safety chain installed. See Safety Procedures When Working Near Mast.**

**NOTE:** The parking brake calipers must be adjusted before any other brake adjustments are made.

The parking brake may be adjusted in three different locations. Before making any adjustments, park the lift truck in a level area and block the wheels. Release the parking brake lever.

1. Check to make certain that the brake pads are contacting the brake disc evenly. If the brake pads are not contacting the disc evenly, remove the cotter pin and tighten the castle nut until the brake pads just contact the brake disc. Back off on the castle nut until the cotter pin can be installed. Adjust the parking brake caliper as follows:
  - a. Lubricate the pushpins, the bore of the caliper body, caliper lever, and caliper lever washer using antiseize Hyster P/N 251979 or equivalent. See Figure 24. Refer to Maintenance Schedule.
  - b. Coat all other mating surfaces of the brake linkage with multipurpose grease. See Figure 25.

- c. Remove the cotter pins from the castle nuts. Torque the castle nuts to 1.5 N•m (13 lbf in).
- d. Back off on the castle nut by four flats (240 degrees).
- e. Check the clearance between the brake pad and brake disc. The clearance between the brake pad and disc must be 0.30 to 0.38 mm (0.012 to 0.015 in.).
- f. Install new cotter pins to retain the castle nuts. If the nut must be moved to provide access to install the cotter pin, the castle nut should be tightened.
- g. Install the yoke end pins to attach the yokes to the cam levers. Install new cotter pins to retain the yoke end pins.

2. The length of the brake cable can be adjusted at the end of the cable connected to the bracket located at the bottom of the cowl. To adjust the length of the cable, remove the jam nut retaining the ball stud to the brake bracket. Loosen the jam nut on the end of the ball stud retaining the ball stud. Turn the ball stud clockwise to decrease the length of the brake cable. Turn the ball stud counterclockwise to increase the length of the cable. Decreasing the cable length will increase the brake pressure. When increasing the cable length, the minimum thread engagement of the cable into the ball stud is 12 mm (0.47 in.).
3. The other adjustment can be made by removing the cotter pin and the clevis pin, retaining the rod ends to the brake levers. Lengthen or shorten the rod ends as required. Turn the rod ends clockwise to shorten the length of the rod end and to increase the braking capability. Install the clevis pin and the cotter pin after the proper adjustment has been made. Both rod ends should be adjusted equally.
4. Test the operation of the parking brake. The parking brake, when in good condition and correctly adjusted, will hold a lift truck with a capacity load on a 15 percent grade [a slope of 1.5 m in 10 m (1.5 ft in 10 ft)].

## TRANSAXLE

Each transaxle has its separate oil supply. See Figure 12. Raise the mast and safety chain to access the transaxle assemblies. Place a pan with at least a 3.8 liter (1 gal) capacity under the transaxles.

## Install Tire on Wheel

### WARNING

Wheels can explode and cause injury or death if the following procedures are not followed:

- Clean and inspect all parts of the wheel before installing the tire. Paint any parts that have rust or corrosion.
- Do NOT use any damaged or repaired wheel parts.
- Make sure that all parts of the wheel are the correct parts for that wheel assembly. Make sure the rim is the correct size for the tire. Lubricate the part of the wheel that contacts the bead and flap.
- Do NOT mix parts between different types or manufacturers of wheels.
- Do NOT mix types of tires, type of tire tread, or wheel assemblies of different manufacturers on any one lift truck.
- Do NOT use a steel hammer on the wheel. Use a rubber, lead, plastic, or brass hammer to put parts together. Make sure that the side ring is in the correct position. The ends of the side ring must not touch. The clearance at the ends of the lock ring will be approximately 13 to 25 mm (0.5 to 1.0 in.) after it is installed. If the clearance is wrong, the wrong part has been used.
- Apply a rubber lubricant or a soap solution to the tire bead and tube.

Do not lubricate the tire bead with antifreeze or petroleum-based liquid. Vapors from these liquids can cause an explosion during inflation or use.

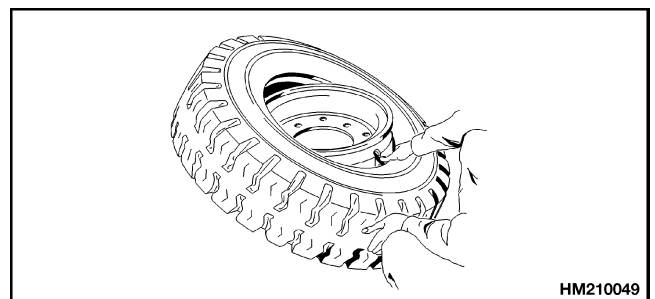
#### STEP 1.

Install the inner tube and the rubber flap in the tire.



#### STEP 2.

Install the wheel rim in the tire. Make sure the stem of the inner tube is aligned with the slot in the rim.



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## Battery



### WARNING

Make sure the key switch is **OFF** and the park brake is set before connecting the battery.

If the lift truck was operated with a discharged battery, check all contactors for welded tips before a charged battery is connected.



### WARNING

Do not put tools on the battery.

The acid in the electrolyte can cause injury. If the electrolyte is spilled, use water to flush the area. Make the acid neutral with a solution of sodium bicarbonate (baking soda). Acid in the eyes must be flushed with water immediately.

Batteries generate explosive fumes. Keep the vents in the caps clean. Keep sparks or open flames away from the battery area. Do not make a spark from the battery connections. Disconnect the battery when doing maintenance.

The battery must fit the battery compartment so the battery restraint will operate correctly. Use spacers to prevent the battery from moving more than 13 mm (0.5 in.) in any direction.

Check the hydraulic oil level when the oil is at operating temperature, the carriage is lowered, and the key switch is **OFF**. Add hydraulic oil only as needed. If more hydraulic oil is added than the **FULL** level, hydraulic oil will leak from the breather during operation.

Make sure the battery weight is within the maximum and minimum weight shown on the Nameplate.

Keep the battery case, top cover, and the area for the battery clean and painted. Leakage and corrosion from the battery can cause a malfunction in the electric controls of the lift truck. Use a water and sodium bicarbonate solution (baking soda) to clean the battery and the battery area. Keep the top of the battery clean, dry, and free of corrosion.

Make sure the battery is charged and has the correct voltage and ampere-hour rating for the lift truck as shown on the Nameplate.

Inspect the battery case, connector, and cables for damage, cracks, or breaks. See the battery dealer

in the area to repair any damage. Check the level of the electrolyte daily on a minimum of one cell. The correct level is halfway between the top of the plates and the bottom of the fill hole. Add only distilled water.

## Battery Restraint System

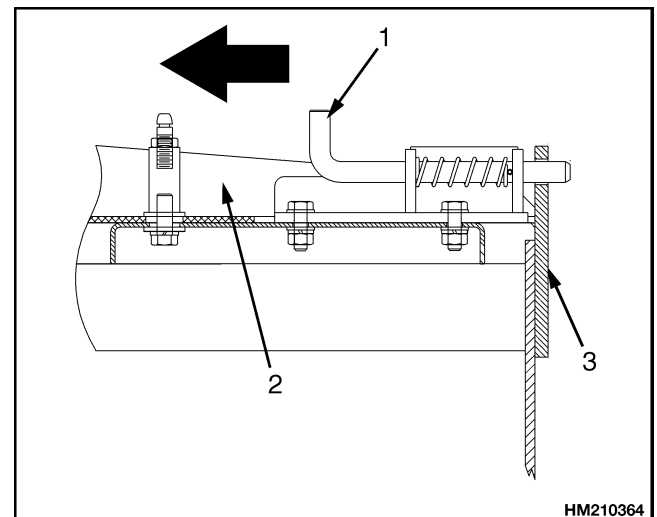


### WARNING

The battery restraint and its latch mechanism must operate correctly before the lift truck is operated. See Figure 4.

The hood assembly is also a battery restraint. The function of the battery restraint, when the hood is correctly locked to the frame, is to hold the battery in the battery compartment if the lift truck tips over. A sliding latch mechanism on the front of the hood locks the hood to the frame. The sliding latch unlocks the hood from the frame so the hood can be raised to the open position for access to the battery. The hood is also the support for the seat. A spring brace holds the seat and hood assembly in the open position.

Make sure the latch mechanism operates correctly. Check that the latch is not worn and fully engages the frame. The hood must be locked in the closed position when the lift truck is operated. Try to raise the seat and hood when the hood is locked in the closed position. If the latch mechanism does not lock the hood in the closed position, do not operate the lift truck.



- |                            |          |
|----------------------------|----------|
| 1. SLIDING LATCH MECHANISM | 2. HOOD  |
|                            | 3. FRAME |

**Figure 4. Battery Restraint Latch Mechanism**

## LIFT SYSTEM OPERATION



### WARNING

When working on or near the mast or carriage, see **Safety Procedures When Working Near Mast** located in **Maintenance Procedures Every 8 Hours or Daily**.

Lower the lift mechanism completely. 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 key switch is OFF.

Do not try to locate hydraulic leaks by putting hands on pressurized hydraulic components. Hydraulic oil can be injected into the body by pressure.

1. Check for leaks in the hydraulic system. Check the condition of the hydraulic hoses and tubes.

**NOTE:** Parts of the mast move at different speeds during raising and lowering.

2. Slowly raise and lower the mast several times without a load. The mast components must raise and lower smoothly in the correct sequence. The carriage raises first, then the inner weldment and the intermediate weldment (three-stage masts only).
3. The inner weldment(s) and the carriage must lower completely.
4. Raise the mast 1 m (3 ft), with a capacity load. The inner weldment(s) and carriage must raise smoothly. Lower the mast. All moving components must lower smoothly.
5. With the load lowered, tilt the mast backward and forward. The mast must tilt smoothly and both tilt cylinders must stop evenly.
6. Check that the controls for the attachment operate the functions of the attachment. (See symbols by each of the controls.) Make sure all of the hydraulic lines are connected correctly and do not leak.

## MAST



### WARNING

When working on or near the mast or carriage, see **Safety Procedures When Working Near Mast** located in **Maintenance Procedures Every 8 Hours or Daily**.

Do not work under a raised carriage. Lower the carriage or use a safety chain to prevent the carriage from lowering when doing maintenance on the mast and lift chains.

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the recommendations of the manufacturer.

Be careful when cleaning with steam. Steam can cause serious burns. Wear protective clothing, eye protection, and gloves. Never expose your skin to steam.



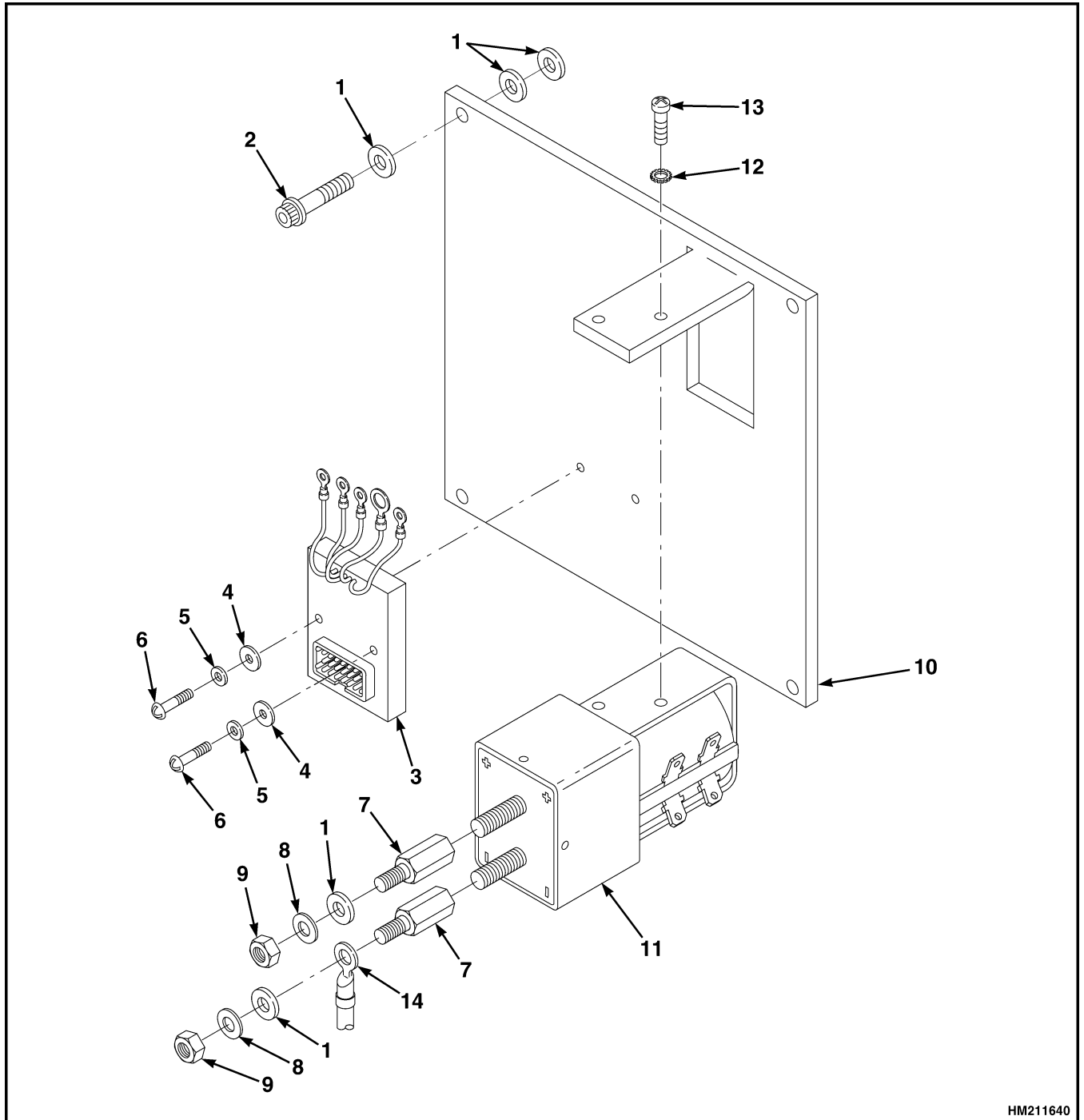
### CAUTION

**DO NOT use steam or high-pressure water to clean the load rollers or the lift chains. Steam and high-pressure water can remove the lubrication from the bearings in the load rollers. Water in the bearings of the sheaves and the link pins of chains can also shorten the service life of these parts.**

1. Lubricate the sliding surfaces and the load roller surfaces along the full length of the channels as shown in Figure 13 and Figure 14. Apply lubricant only to the indicated surfaces.

**NOTE:** The load rollers and sheaves have sealed bearings that do not need additional lubrication.

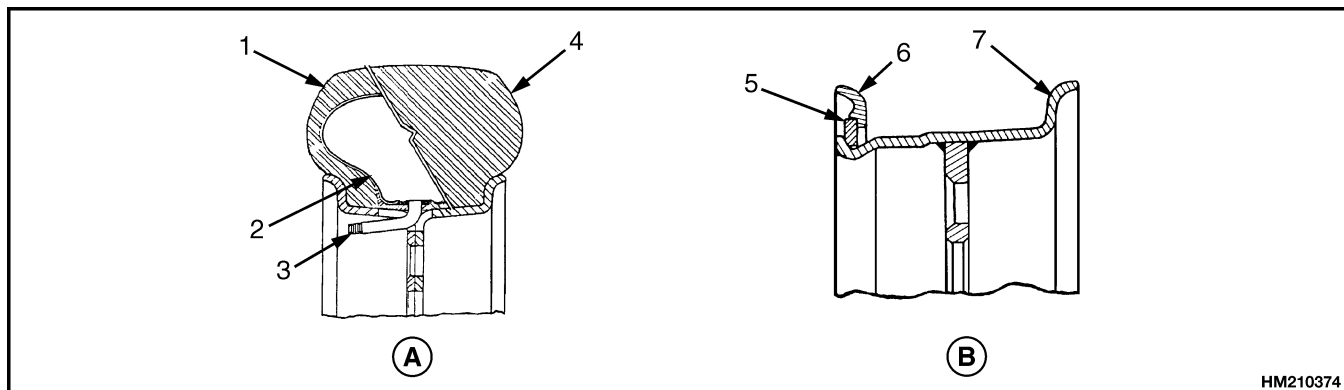
2. Lubricate the mast pivots with multipurpose grease at the grease fittings on the pivot pins.



HM211640

- |                            |                 |
|----------------------------|-----------------|
| 1. LOCKWASHER              | 8. LOCKWASHER   |
| 2. CAPSCREW                | 9. NUT          |
| 3. CONTACTOR DRIVER MODULE | 10. BASEPLATE   |
| 4. LOCKWASHER              | 11. CONTACTOR   |
| 5. WASHER                  | 12. WASHER      |
| 6. SCREW                   | 13. SCREW       |
| 7. STUD                    | 14. POWER CABLE |

**Figure 23. Pump Contactor Panel, EE**



**A. PNEUMATIC TIRE AND PNEUMATIC-SHAPED SOLID TIRES**

- 1. PNEUMATIC TIRE
- 2. FLAP
- 3. VALVE WASHER
- 4. PNEUMATIC-SHAPED SOLID TIRE

**B. THREE-PIECE WHEEL**

- 5. LOCK RING
- 6. SIDE FLANGE
- 7. WHEEL RIM

Figure 28. Types of Wheels



**WARNING**

Make sure all of the air pressure is removed from the tire before a wheel is disassembled. Air pressure in the tires can cause the tire and rim parts to explode, causing serious injury or death. Keep tire tools in firm contact with the wheel parts. If the tool slips, it can move with enough force to cause an injury.

- 2. Remove the air from the tire. Remove the valve core to make sure that all of the air is out of the inner tube. Push a wire through the valve stem to make sure that the valve stem does not have a restriction.



**WARNING**

The lifting and carrying of pneumatic tires is not recommended because their weight could be in excess of 45 kg (100 lb). Where applicable, use a wheel or tire dolly to assist in the removal and installation of the wheel.

- 3. Remove the wheel lug nuts, and remove the wheel and tire from the lift truck. Lift truck tires and wheels are heavy.

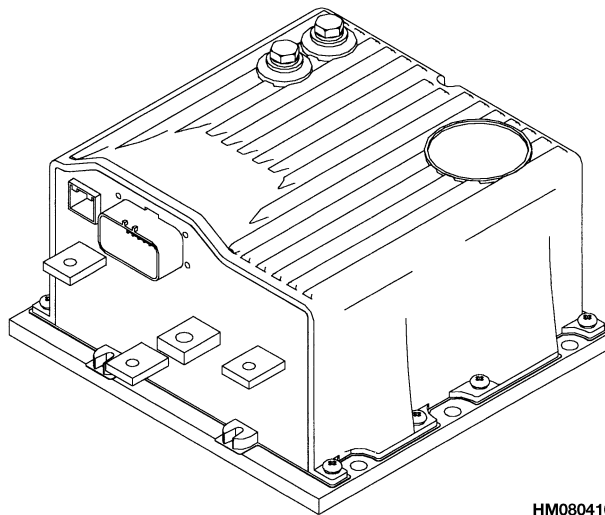
**Tire Sizes and Pressures**

J30XMT2 and J35XMT2	Tire Size	kPa	psi
DRIVE TIRES			
Pneumatic	18 × 7-8 (16PR)	1000	145
Pneumatic-Shaped Solid	18 × 7-8	NA	NA
STEER TIRES			
Pneumatic	15 × 4.5 × 8 (12PR)	1000	145
Pneumatic-Shaped Solid	15 × 4.5 × 8	NA	NA

J40XMT2	Tire Size	kPa	psi
DRIVE TIRES			
Pneumatic-Shaped Solid	200/50 × 10	NA	NA
STEER TIRES			
Pneumatic-Shaped Solid	15 × 4.5 × 8	NA	NA

# **SX/SR TRANSISTOR MOTOR CONTROLLERS AND HANDSET**

**ALL ELECTRIC LIFT TRUCKS THAT HAVE A SX  
OR SR TRANSISTOR MOTOR CONTROLLER**



HM080410

# ***HYSTER***

## CONTROLLER FEATURES

### General

The controller has an on-time range of approximately 0 to 100 percent. The SX and SR controllers operate at a constant frequency, and the percent on time is controlled by the pulse width of the voltage/current applied to the motor circuits.

### Creep Speed

With the accelerator at maximum volts (approximately 4.2 to 3.5 volts), creep speed can be adjusted by Function 2. At creep speed, the ON time can decrease to approximately 5 percent, with the OFF time at approximately 95 percent. At full transistor operation, this condition will be reversed (short OFF time, long ON time). This variation of ON and OFF time of the oscillator varies the voltage applied to the motor, thereby varying the speed of the motor for a given load.

### Controlled Acceleration

This feature allows for adjustment of the time it takes for the controller to accelerate to 100 percent applied battery voltage to the motor on hard acceleration. Controlled acceleration is adjustable from 0.1 to 22 seconds. Controlled acceleration is adjusted using Function 3 (standard instrument panel) or Functions 48, 52, 56, and 60 (premium instrument panel).

### Current Limit

This circuit monitors motor current by utilizing sensors in series with the armature and field windings. The information is used to maintain maximum currents at a preset value. If heavy load currents are detected, this circuit overrides the oscillator and limits the average current to a value set by Function 4 and Function 8. The C/L setting is based on the maximum thermal rating of the controller. Because of the flyback current, the motor current is usually greater than battery current, except at 100 percent ON time.

## BRAKING

### Regenerative Braking to Zero Speed

Slowdown is accomplished when reversing direction by providing a small amount of retarding torque for

deceleration. If the lift truck is moving, and the directional lever is moved from one direction to the other, the regenerative braking signal is initiated. Once the regenerative braking signal has been initiated, the field current is increased. Armature current is regulated to the regenerative braking current limit as set by Function 9. As the lift truck slows down, the field current continues to increase, and transistor Q5 begins to turn on and off. See Figure 7. The field current will increase until it reaches a preset value set by Function 10, and transistor Q5 ON time will increase until it reaches 100 percent ON time. Once both of the above conditions have been met, and the regenerative braking current limit can no longer be maintained, the braking function is canceled. The fields will then reverse, and the controller reverts back to motoring.

Part of the energy produced by the motor during regenerative braking is returned to the battery, and part is converted to heat in the drive motor.

Function 9, Regen Current Limit, is user adjustable and will alter the distance the lift truck requires to reach zero speed. Function 10, Regen Field Current, is not normally adjusted in the field.

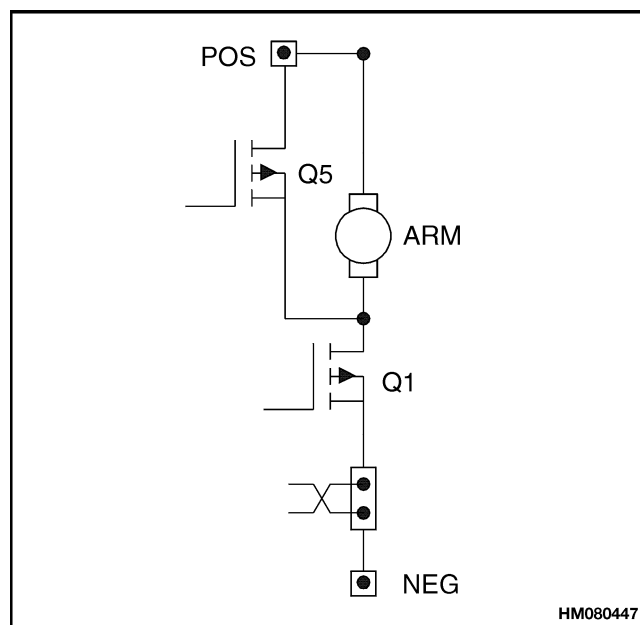


Figure 7. Regenerative Braking Circuit

alert hourmeter reading is reached, or if an optional temperature sensor determines that a motor is overheated.

The traction controller will set a status code if an optional brush wear indicator detects a worn brush.

The maintenance alert hourmeter reading is programmed into the traction controller using Function 19 and Function 20.

**NOTE:** The brush wear and motor temperature inputs to the traction controller are received from the lift pump controller (transistor lift pump control) or the sensor interface/contact driver module (contactor lift pump control). See the section **Electrical System** 2200 SRM 698 (G160 trucks) or **Electrical System** 2200 SRM 774 (H160 trucks) for additional information on the SICDM.

**Interactive Instrument Panel Modes**

Premium instrument panels allow the operator to select the best lift truck performance for different

conditions. There are four modes that can be selected by depressing a push button on the instrument panel.

From the instrument panel, the operator may select any of four preset interactive modes.

**TRACTION CONTROLLER**

- (4) Controlled acceleration levels
- (4) Field-weakening levels (FW Start and FW Ratio)
- (4) Speed limits

**LIFT PUMP CONTROLLER**

- (4) Controlled acceleration levels
- (4) Speed Limit 2 levels (Slow Lift, Auxiliary 2)
- (4) Speed Limit 3 levels (Fast Lift)

**NOTE:** Traction controller Functions 3, 24, 6, and 12 are disregarded when using the premium instrument panel with mode selection. See Table 3.

**NOTE:** Lift pump controller Functions 3, 12, and 13 are disregarded when using the premium instrument panel with mode selection. See Table 3.

*Table 3. Instrument Panel Function Number Correlation*

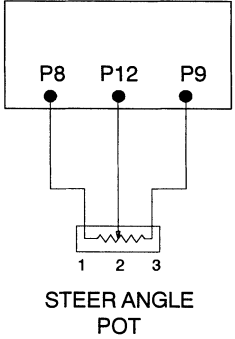
	Function Description	Standard Dash Function Number (Without mode selection)	Premium Dash Function Number			
			Mode 1	Mode 2	Mode 3	Mode 4
<b>Traction Controller</b>	Controlled Acceleration	3	48	52	56	60
	FW Start	24	49	53	57	61
	FW Ratio	6	50	54	58	62
	Maximum Armature % On	12	51	55	59	63
<b>Lift Pump Controller</b>	Controlled Acceleration	3	48	52	56	60
	Speed Limit 2	12	49	53	57	61
	Speed Limit 3	13	50	54	58	62

These interactive modes are preset using function numbers:

	Handset	PC
Traction Controller	48 to 63	97 to 112
Lift Pump Controller	48 to 62	97 to 111

Table 4 outlines the normal logic flow for presetting the interactive traction modes.

Table 5 outlines the normal logic flow for presetting the interactive lift pump modes.

Status Code	Description	Memory Recall	Circuit
<b>-10</b>	Steer angle potentiometer voltage is too high.	Yes	Traction
<p style="text-align: center;"><b>Symptom</b> Traction is disabled.</p> <p style="text-align: center;"><b>Possible Causes and Test Procedures</b></p> <ul style="list-style-type: none"> <li>• Steer angle potentiometer out of adjustment. Verify that the steer angle potentiometer is adjusted properly. See the section <b>Electrical System</b> 2200 SRM 698. Refer to ,AdjustSteer Angle Potentiometer.</li> <li>• Steer angle potentiometer defective. Check the steer angle potentiometer for proper operation. See the section <b>Electrical System</b> 2200 SRM 698. Refer to ,TestSteer Angle Potentiometer.</li> <li>• Loose or missing connections at P8, P12, or P9. Disconnect the P plug and the potentiometer and check continuity: Between P8 and pot terminal 1 Between P12 and pot terminal 2 Between P9 and pot terminal 3</li> <li>• Malfunctioning controller. Replace controller.</li> </ul> <p><b>NOTE:</b> Input voltage at P12 should be less than 3.9 volts at all times.</p>		<div style="text-align: center;">  </div> <p style="text-align: center;"><b>Cause</b> This status code is displayed when P12 is greater than 3.9 volts.</p>	

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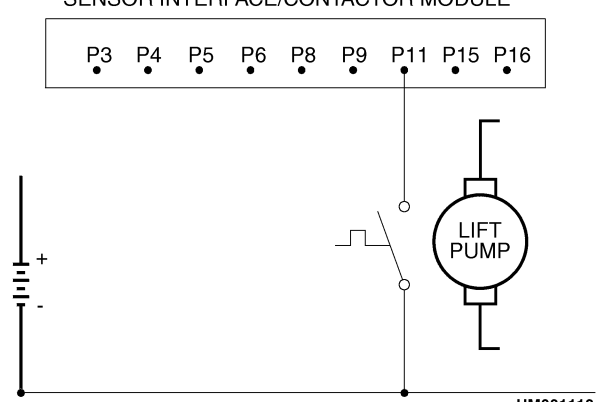


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Status Code	Description	Memory Recall	Circuit
<b>-43</b>	Motor armature offset voltage is too low.	No	Traction
<p><b>Symptom</b> Maximum travel speed is reduced or traction is disabled.</p> <p><b>Possible Causes and Test Procedures</b></p> <ul style="list-style-type: none"> <li>• Controller is defective. Replace the traction controller.</li> </ul>		<p style="text-align: right;">HM081110</p>	
		<p><b>Cause</b> This status code is displayed when the voltage at the current sensor input is less than 2.4 volts with no current flowing in the motor circuit.</p>	

Status Code	Description	Memory Recall	Circuit
<b>-44</b>	Armature transistor did not turn off properly.	Yes	Traction
<p><b>Symptom</b> Traction is disabled.</p> <p>Line contactor may open, close, and then open again. Line contactor can then only be closed by opening and closing the key switch.</p> <p><b>Possible Causes and Test Procedures</b></p> <ul style="list-style-type: none"> <li>• Malfunctioning controller. Replace the traction controller.</li> </ul>		<p style="text-align: right;">HM081110</p>	
		<p><b>Cause</b> This status code is displayed when, during controller operation, the armature transistor fails to turn off. This will result in a PMT condition.</p>	

Status Code	Description	Memory Recall	Circuit
<b>-91</b>	Lift pump motor temperature too high.	No	Traction and Pump
<p style="text-align: center;"><b>Symptom</b></p> <p style="text-align: center;">Status code flashes on and off. Maximum travel speed is reduced.</p> <p style="text-align: center;"><b>Possible Causes and Test Procedures</b></p> <ul style="list-style-type: none"> <li>• Lift pump motor is too hot. Allow lift pump motor to cool. If problem recurs, determine reason for overheating lift pump motor and correct.</li> <li>• P11 is shorted to battery negative. Locate and repair short.</li> <li>• Lift pump motor temperature sensor is shorted or defective. Replace temperature sensor.</li> <li>• Defective lift pump controller. (SR transistor-controlled lift pump only.) Replace the lift pump controller.</li> <li>• Defective sensor interface/contact driver module. (Contactor-controlled lift pump only.) Replace the sensor interface/contact driver module.</li> </ul> <p><b>NOTE:</b> Function 13, speed limit 3 is enabled by this status code.</p>		<p style="text-align: center;">PUMP CONTROLLER OR SENSOR INTERFACE/CONTACTOR MODULE</p>  <p style="text-align: right; font-size: small;">HM081112</p> <p style="text-align: center;"><b>Cause</b></p> <p style="text-align: center;">This status code is displayed when the voltage at terminal P11 of the SR lift pump controller or the sensor interface/contact driver module is at zero volts.</p>	

Status Code	Description	Memory Recall	Circuit
<b>-151</b>	Capacitor volts are low before the line contactor closes (internal controller function during precharge).	No	Pump
<p><b>Symptom</b> Lift and auxiliary hydraulic functions are disabled. Controller capacitor does not precharge. Line contactor may not close.</p> <p><b>Possible Causes and Test Procedures</b></p> <ul style="list-style-type: none"> <li>Failed key switch fuse. Replace key switch fuse.</li> <li>Open key switch circuit. Repair key switch circuit.</li> <li>Defective lift pump controller. Replace lift pump controller.</li> <li>Accessory or component other than controllers connected to load side of line contactor. Verify that the traction and lift pump controllers are the only components on the load side of the line contactor.</li> </ul> <p><b>NOTE:</b> Repeated charging/discharging of the capacitors during troubleshooting can cause status code 151.</p>		<p style="text-align: right;">HM081118</p>	
		<p><b>Cause</b> This status code is displayed during "key on" when the internal capacitor voltage is less than 85 percent of battery voltage at initial key switch on.</p>	

Status Code	Description	Memory Recall	Circuit
<b>-157</b>	Controller motor current sensor input voltage polarity check.	No	Pump
<p><b>Symptom</b> Lift and auxiliary hydraulic functions are disabled.</p> <p><b>Possible Causes and Test Procedures</b></p> <ul style="list-style-type: none"> <li>Defective lift pump controller. Replace lift pump controller.</li> </ul>		<p style="text-align: right;">HM080410</p>	
		<p><b>Cause</b> This status code is displayed when the voltage input to the internal motor current sensor is of the wrong polarity.</p>	

**Function 06****FW Ratio**

(Push 6)

**WARNING**

Function 06 is not normally adjusted in the field. Adjusting Function 06 between the minimum and maximum values will not alter lift truck performance.

This setting represents the ratio of field current to armature current.

**NOTE:** This FW ratio is in effect when the standard instrument panel is used.

**Function 07****Minimum Field Current**

(Push 7)

This function allows the adjustment of the field weakening level to set the top speed of the motor.

Minimum Current	Maximum Current	Controller Set Range	Resolution (per set unit)
0 amps	40 amps	51 to 255	0.185 amp
Example: Function 07 set at 71 equals 3.7 amps.			
$(71 - 51) \times 0.185 \text{ amp} = 3.7 \text{ amps}$			
<ul style="list-style-type: none"> <li>Higher settings can decrease speed.</li> <li>Lower settings can increase speed.</li> </ul>			
<b>NOTE:</b> Settings less than 51 will result in 0 amps.			

**Function 08****Maximum Field Current**

(Push 8)

**WARNING**

Function 08 is not normally adjusted in the field. Adjusting Function 08 between the minimum and maximum values will not alter lift truck performance.

This function adjusts the maximum field current to obtain the maximum torque of the motor.

**Function 09****Regenerative Braking Current Limit**

(Push 9)

This function adjusts the regen braking current limit.

Minimum Current	Maximum Current	Controller Set Range	Resolution (per set unit)
52 amps	468 amps	0 to 255	1.63 amps
Example: Function 09 set at 110 equals 231.3 amps.			
$(110 \times 1.63 \text{ amps}) + 52 \text{ amps} = 231.3 \text{ amps}$			
<ul style="list-style-type: none"> <li>Higher settings decrease stopping distance.</li> <li>Lower settings increase stopping distance.</li> </ul>			

**Function 10****Field Current for Regenerative Braking**

(Push 10)

**WARNING**

Function 10 is not normally adjusted in the field. Adjusting Function 10 between the minimum and maximum values will not alter lift truck performance.

This function adjusts the field current to be used during the regen braking mode.

**Function 11****Turn Speed Limit**

(Push 11)

This function allows for the adjustment of the maximum lift truck speed (maximum battery volts to the motor) available when the steer angle potentiometer signal indicates the steer angle is 32 degrees or greater.

Maximum Volts	Minimum Volts	Controller Set Range	Resolution (per set unit)
100%	0%	51 to 180	0.78%
Example: Function 11 set at 71 equals 84.4% B.V.			
$100\% - [(71 - 51) \times 0.78\%] = 84.4\%$			
<ul style="list-style-type: none"> <li>Higher settings decrease speed.</li> <li>Lower settings increase speed.</li> </ul>			

and the number shown in the following instructions at the same time.

**NOTE:** The key switch must be in the **ON** position to access Functions 48 to 62.

**Function 48**  
**Mode 1 (Turtle) - Controlled Acceleration**  
 (Push CONT 1)

This function allows for the adjustment of the time it takes for the controller to accelerate to 96 percent applied battery voltage to the motor on hard acceleration.

Minimum Time	Maximum Time	Controller Set Range	Resolution (per set unit)
0.1 sec	5.5 secs	0 to 255	0.021 sec
Example: Function 48 set at 20 equals 0.52 second.			
$(20 \times 0.021 \text{ sec}) + 0.1 \text{ sec} = 0.52 \text{ sec}$			
<ul style="list-style-type: none"> <li>Higher settings provide slower acceleration.</li> <li>Lower settings provide faster acceleration.</li> </ul>			

**NOTE:** This controlled acceleration is in effect when mode 1 is selected on the premium instrument panel.

**Function 49**  
**Mode 1 (Turtle) - Speed Limit 2 (SL2)**  
 (Push CONT 1)

This function allows for the adjustment of the speed limit (maximum battery volts to the motor) when the SL2 limit switch input signal is received by the controller. SL2 limit switch is a normally open switch connected to battery negative; the switch closing enables speed limit.

Minimum Volts	Maximum Volts	Controller Set Range	Resolution (per set unit)
0%	100%	0 to 255	0.375 volt
Example: Function 50 set at 50 equals 18.75 volts.			
$50 \times 0.375 \text{ volt} = 18.75 \text{ volts}$			
<ul style="list-style-type: none"> <li>Higher settings increase speed.</li> <li>Lower settings decrease speed.</li> </ul>			

**NOTE:** This speed limit 2 is in effect when mode 1 is selected on the premium instrument panel.

**Function 50**  
**Mode 1 (Turtle) - Speed Limit 3 (SL3)**  
 (Push CONT 3)

This function allows for the adjustment of the speed limit (maximum battery volts to the motor) when the SL3 limit switch input signal is received by the controller. SL3 limit switch is a normally open switch connected to battery negative; the switch closing enables speed limit.

Minimum Volts	Maximum Volts	Controller Set Range	Resolution (per set unit)
0%	100%	0 to 255	0.375 volt
Example: Function 50 set at 50 equals 18.75 volts.			
$50 \times 0.375 \text{ volt} = 18.75 \text{ volts}$			
<ul style="list-style-type: none"> <li>Higher settings increase speed.</li> <li>Lower settings decrease speed.</li> </ul>			

**NOTE:** This speed limit 3 is in effect when mode 1 is selected on the premium instrument panel.

**Function 52**  
**Mode 2 - Controlled Acceleration**  
 (Push CONT 5)

Same as Function 48.

**NOTE:** This controlled acceleration is in effect when mode 2 is selected on the premium instrument panel.

**Function 53**  
**Mode 2 - Speed Limit 2 (SL2)**  
 (Push CONT 6)

Same as Function 49.

**NOTE:** This speed limit 2 is in effect when mode 2 is selected on the premium instrument panel.

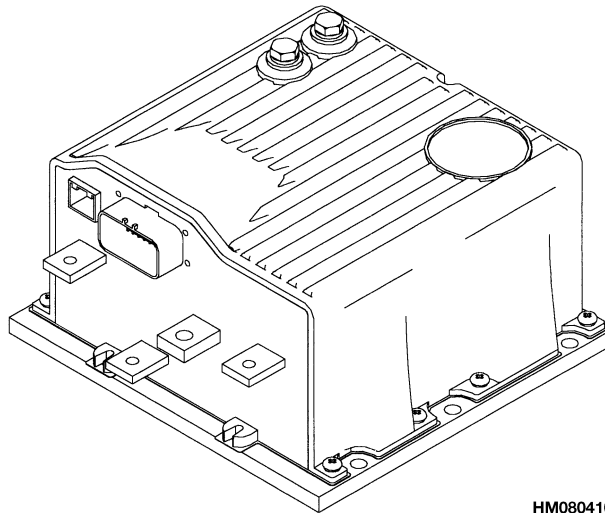
**Function 54**  
**Mode 2 - Speed Limit 3 (SL3)**  
 (Push CONT 7)

Same as Function 50.

**NOTE:** This speed limit 3 is in effect when mode 2 is selected on the premium instrument panel.

# **SX/SR TRANSISTOR MOTOR CONTROLLERS AND HANDSET**

**ALL ELECTRIC LIFT TRUCKS THAT HAVE A SX  
OR SR TRANSISTOR MOTOR CONTROLLER**



HM080410

# ***HYSTER***

## CONTROLLER FEATURES

### General

The controller has an on-time range of approximately 0 to 100 percent. The SX and SR controllers operate at a constant frequency, and the percent on time is controlled by the pulse width of the voltage/current applied to the motor circuits.

### Creep Speed

With the accelerator at maximum volts (approximately 4.2 to 3.5 volts), creep speed can be adjusted by Function 2. At creep speed, the ON time can decrease to approximately 5 percent, with the OFF time at approximately 95 percent. At full transistor operation, this condition will be reversed (short OFF time, long ON time). This variation of ON and OFF time of the oscillator varies the voltage applied to the motor, thereby varying the speed of the motor for a given load.

### Controlled Acceleration

This feature allows for adjustment of the time it takes for the controller to accelerate to 100 percent applied battery voltage to the motor on hard acceleration. Controlled acceleration is adjustable from 0.1 to 22 seconds. Controlled acceleration is adjusted using Function 3 (standard instrument panel) or Functions 48, 52, 56, and 60 (premium instrument panel).

### Current Limit

This circuit monitors motor current by utilizing sensors in series with the armature and field windings. The information is used to maintain maximum currents at a preset value. If heavy load currents are detected, this circuit overrides the oscillator and limits the average current to a value set by Function 4 and Function 8. The C/L setting is based on the maximum thermal rating of the controller. Because of the flyback current, the motor current is usually greater than battery current, except at 100 percent ON time.

## BRAKING

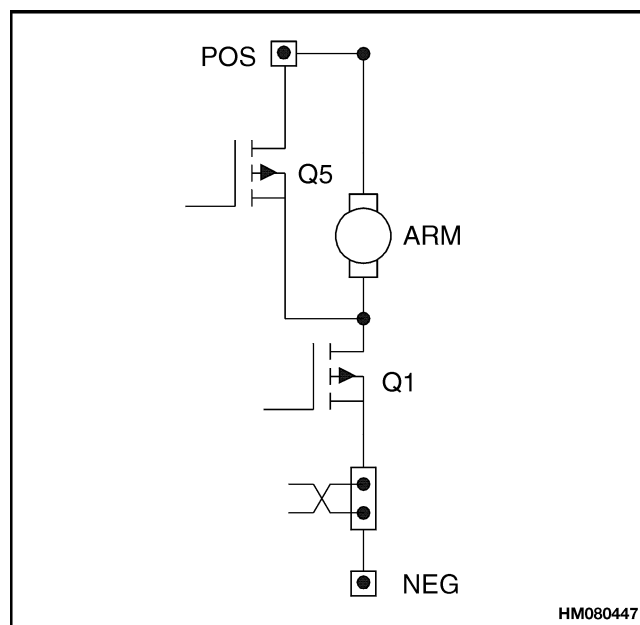
### Regenerative Braking to Zero Speed

Slowdown is accomplished when reversing direction by providing a small amount of retarding torque for

deceleration. If the lift truck is moving, and the directional lever is moved from one direction to the other, the regenerative braking signal is initiated. Once the regenerative braking signal has been initiated, the field current is increased. Armature current is regulated to the regenerative braking current limit as set by Function 9. As the lift truck slows down, the field current continues to increase, and transistor Q5 begins to turn on and off. See Figure 7. The field current will increase until it reaches a preset value set by Function 10, and transistor Q5 ON time will increase until it reaches 100 percent ON time. Once both of the above conditions have been met, and the regenerative braking current limit can no longer be maintained, the braking function is canceled. The fields will then reverse, and the controller reverts back to motoring.

Part of the energy produced by the motor during regenerative braking is returned to the battery, and part is converted to heat in the drive motor.

Function 9, Regen Current Limit, is user adjustable and will alter the distance the lift truck requires to reach zero speed. Function 10, Regen Field Current, is not normally adjusted in the field.



*Figure 7. Regenerative Braking Circuit*

alert hourmeter reading is reached, or if an optional temperature sensor determines that a motor is overheated.

The traction controller will set a status code if an optional brush wear indicator detects a worn brush.

The maintenance alert hourmeter reading is programmed into the traction controller using Function 19 and Function 20.

**NOTE:** The brush wear and motor temperature inputs to the traction controller are received from the lift pump controller (transistor lift pump control) or the sensor interface/contact driver module (contactor lift pump control). See the section **Electrical System** 2200 SRM 698 (G160 trucks) or **Electrical System** 2200 SRM 774 (H160 trucks) for additional information on the SICDM.

**Interactive Instrument Panel Modes**

Premium instrument panels allow the operator to select the best lift truck performance for different

conditions. There are four modes that can be selected by depressing a push button on the instrument panel.

From the instrument panel, the operator may select any of four preset interactive modes.

**TRACTION CONTROLLER**

- (4) Controlled acceleration levels
- (4) Field-weakening levels (FW Start and FW Ratio)
- (4) Speed limits

**LIFT PUMP CONTROLLER**

- (4) Controlled acceleration levels
- (4) Speed Limit 2 levels (Slow Lift, Auxiliary 2)
- (4) Speed Limit 3 levels (Fast Lift)

**NOTE:** Traction controller Functions 3, 24, 6, and 12 are disregarded when using the premium instrument panel with mode selection. See Table 3.

**NOTE:** Lift pump controller Functions 3, 12, and 13 are disregarded when using the premium instrument panel with mode selection. See Table 3.

*Table 3. Instrument Panel Function Number Correlation*

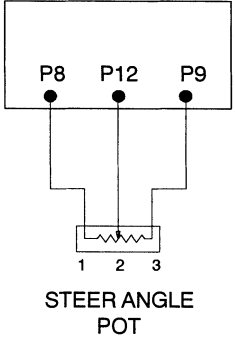
	Function Description	Standard Dash Function Number (Without mode selection)	Premium Dash Function Number			
			Mode 1	Mode 2	Mode 3	Mode 4
<b>Traction Controller</b>	Controlled Acceleration	3	48	52	56	60
	FW Start	24	49	53	57	61
	FW Ratio	6	50	54	58	62
	Maximum Armature % On	12	51	55	59	63
<b>Lift Pump Controller</b>	Controlled Acceleration	3	48	52	56	60
	Speed Limit 2	12	49	53	57	61
	Speed Limit 3	13	50	54	58	62

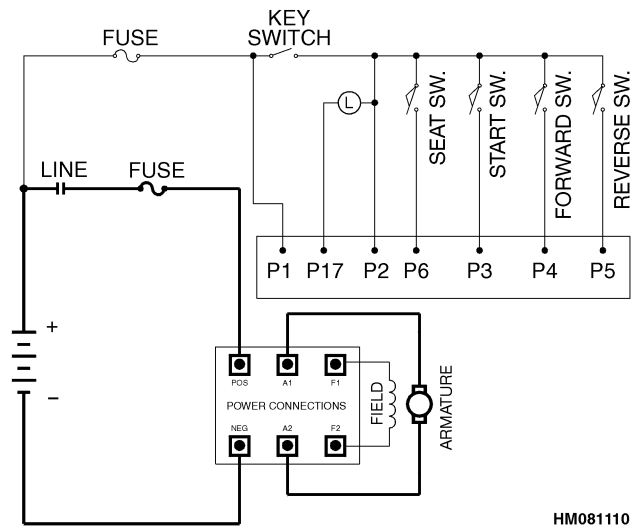
These interactive modes are preset using function numbers:

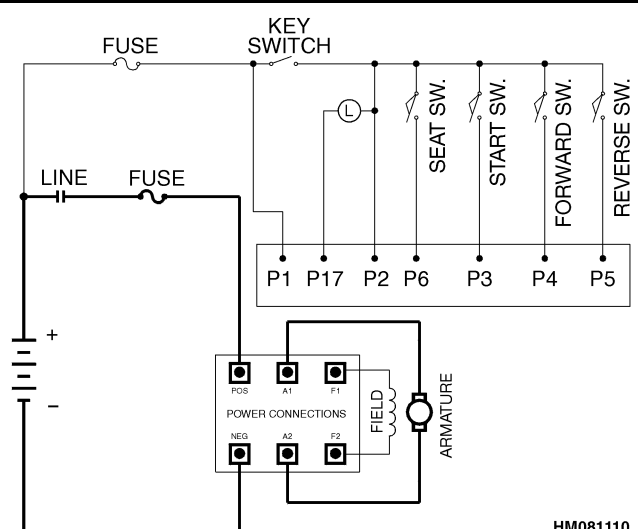
	Handset	PC
Traction Controller	48 to 63	97 to 112
Lift Pump Controller	48 to 62	97 to 111

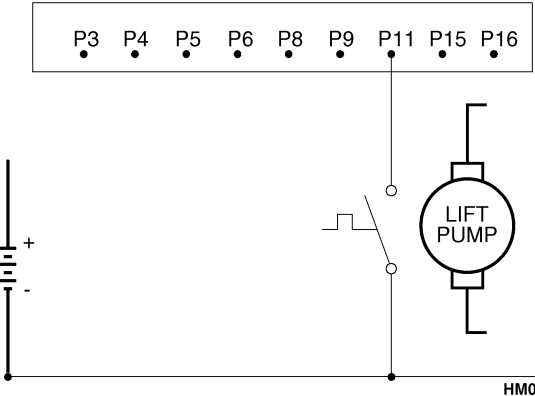
Table 4 outlines the normal logic flow for presetting the interactive traction modes.

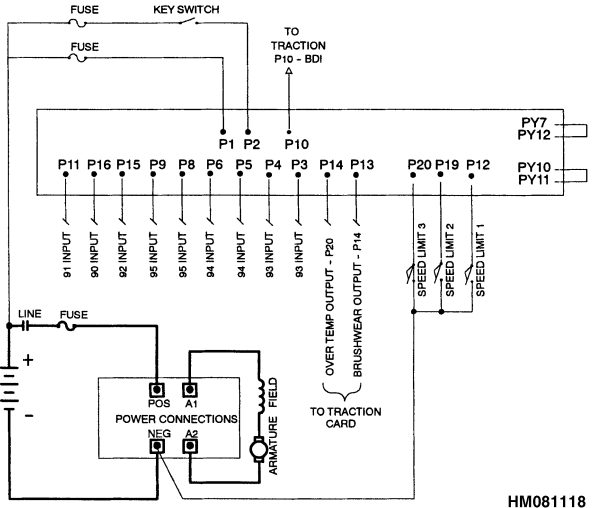
Table 5 outlines the normal logic flow for presetting the interactive lift pump modes.

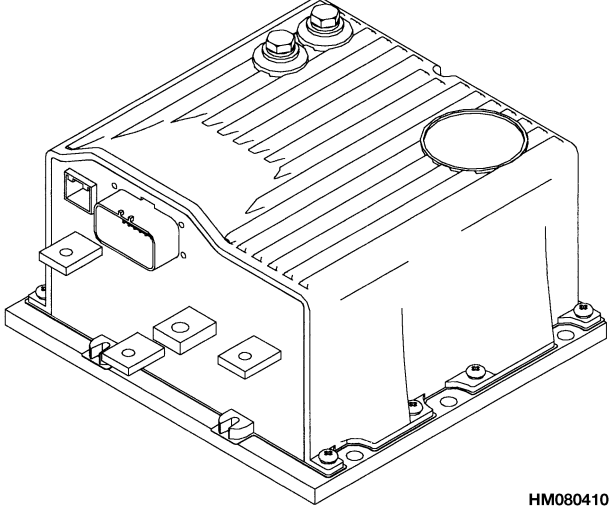
Status Code	Description	Memory Recall	Circuit
<b>-10</b>	Steer angle potentiometer voltage is too high.	Yes	Traction
<p style="text-align: center;"><b>Symptom</b> Traction is disabled.</p> <p style="text-align: center;"><b>Possible Causes and Test Procedures</b></p> <ul style="list-style-type: none"> <li>• Steer angle potentiometer out of adjustment. Verify that the steer angle potentiometer is adjusted properly. See the section <b>Electrical System</b> 2200 SRM 698. Refer to ,AdjustSteer Angle Potentiometer.</li> <li>• Steer angle potentiometer defective. Check the steer angle potentiometer for proper operation. See the section <b>Electrical System</b> 2200 SRM 698. Refer to ,TestSteer Angle Potentiometer.</li> <li>• Loose or missing connections at P8, P12, or P9. Disconnect the P plug and the potentiometer and check continuity: Between P8 and pot terminal 1 Between P12 and pot terminal 2 Between P9 and pot terminal 3</li> <li>• Malfunctioning controller. Replace controller.</li> </ul> <p><b>NOTE:</b> Input voltage at P12 should be less than 3.9 volts at all times.</p>		<div style="text-align: center;">  <p style="text-align: center;">STEER ANGLE POT</p> <p style="text-align: right;">HM081108</p> </div> <p style="text-align: center;"><b>Cause</b> This status code is displayed when P12 is greater than 3.9 volts.</p>	

Status Code	Description	Memory Recall	Circuit
<b>-43</b>	Motor armature offset voltage is too low.	No	Traction
<p><b>Symptom</b> Maximum travel speed is reduced or traction is disabled.</p> <p><b>Possible Causes and Test Procedures</b></p> <ul style="list-style-type: none"> <li>• Controller is defective. Replace the traction controller.</li> </ul>		 <p style="text-align: right;">HM081110</p>	
		<p><b>Cause</b> This status code is displayed when the voltage at the current sensor input is less than 2.4 volts with no current flowing in the motor circuit.</p>	

Status Code	Description	Memory Recall	Circuit
<b>-44</b>	Armature transistor did not turn off properly.	Yes	Traction
<p><b>Symptom</b> Traction is disabled.</p> <p>Line contactor may open, close, and then open again. Line contactor can then only be closed by opening and closing the key switch.</p> <p><b>Possible Causes and Test Procedures</b></p> <ul style="list-style-type: none"> <li>• Malfunctioning controller. Replace the traction controller.</li> </ul>		 <p style="text-align: right;">HM081110</p>	
		<p><b>Cause</b> This status code is displayed when, during controller operation, the armature transistor fails to turn off. This will result in a PMT condition.</p>	

Status Code	Description	Memory Recall	Circuit
<b>-91</b>	Lift pump motor temperature too high.	No	Traction and Pump
<p style="text-align: center;"><b>Symptom</b></p> <p style="text-align: center;">Status code flashes on and off. Maximum travel speed is reduced.</p> <p style="text-align: center;"><b>Possible Causes and Test Procedures</b></p> <ul style="list-style-type: none"> <li>• Lift pump motor is too hot. Allow lift pump motor to cool. If problem recurs, determine reason for overheating lift pump motor and correct.</li> <li>• P11 is shorted to battery negative. Locate and repair short.</li> <li>• Lift pump motor temperature sensor is shorted or defective. Replace temperature sensor.</li> <li>• Defective lift pump controller. (SR transistor-controlled lift pump only.) Replace the lift pump controller.</li> <li>• Defective sensor interface/contact driver module. (Contactor-controlled lift pump only.) Replace the sensor interface/contact driver module.</li> </ul> <p><b>NOTE:</b> Function 13, speed limit 3 is enabled by this status code.</p>		<p style="text-align: center;">PUMP CONTROLLER OR SENSOR INTERFACE/CONTACTOR MODULE</p>  <p style="text-align: right; font-size: small;">HM081112</p> <p style="text-align: center;"><b>Cause</b></p> <p style="text-align: center;">This status code is displayed when the voltage at terminal P11 of the SR lift pump controller or the sensor interface/contact driver module is at zero volts.</p>	

Status Code	Description	Memory Recall	Circuit
<b>-151</b>	Capacitor volts are low before the line contactor closes (internal controller function during precharge).	No	Pump
<p style="text-align: center;"><b>Symptom</b></p> <p>Lift and auxiliary hydraulic functions are disabled. Controller capacitor does not precharge. Line contactor may not close.</p> <p style="text-align: center;"><b>Possible Causes and Test Procedures</b></p> <ul style="list-style-type: none"> <li>• Failed key switch fuse.     Replace key switch fuse.</li> <li>• Open key switch circuit.     Repair key switch circuit.</li> <li>• Defective lift pump controller.     Replace lift pump controller.</li> <li>• Accessory or component other than controllers connected to load side of line contactor.     Verify that the traction and lift pump controllers are the only components on the load side of the line contactor.</li> </ul> <p><b>NOTE:</b> Repeated charging/discharging of the capacitors during troubleshooting can cause status code 151.</p>		 <p style="text-align: right;">HM081118</p>	
<p><b>Cause</b></p> <p>This status code is displayed during "key on" when the internal capacitor voltage is less than 85 percent of battery voltage at initial key switch on.</p>			

Status Code	Description	Memory Recall	Circuit
<b>-157</b>	Controller motor current sensor input voltage polarity check.	No	Pump
<p style="text-align: center;"><b>Symptom</b></p> <p>Lift and auxiliary hydraulic functions are disabled.</p> <p style="text-align: center;"><b>Possible Causes and Test Procedures</b></p> <ul style="list-style-type: none"> <li>• Defective lift pump controller.     Replace lift pump controller.</li> </ul>		 <p style="text-align: right;">HM080410</p>	
<p><b>Cause</b></p> <p>This status code is displayed when the voltage input to the internal motor current sensor is of the wrong polarity.</p>			

**Function 06****FW Ratio**

(Push 6)

**WARNING**

Function 06 is not normally adjusted in the field. Adjusting Function 06 between the minimum and maximum values will not alter lift truck performance.

This setting represents the ratio of field current to armature current.

**NOTE:** This FW ratio is in effect when the standard instrument panel is used.

**Function 07****Minimum Field Current**

(Push 7)

This function allows the adjustment of the field weakening level to set the top speed of the motor.

Minimum Current	Maximum Current	Controller Set Range	Resolution (per set unit)
0 amps	40 amps	51 to 255	0.185 amp
Example: Function 07 set at 71 equals 3.7 amps.			
$(71 - 51) \times 0.185 \text{ amp} = 3.7 \text{ amps}$			
<ul style="list-style-type: none"> <li>Higher settings can decrease speed.</li> <li>Lower settings can increase speed.</li> </ul>			
<b>NOTE:</b> Settings less than 51 will result in 0 amps.			

**Function 08****Maximum Field Current**

(Push 8)

**WARNING**

Function 08 is not normally adjusted in the field. Adjusting Function 08 between the minimum and maximum values will not alter lift truck performance.

This function adjusts the maximum field current to obtain the maximum torque of the motor.

**Function 09****Regenerative Braking Current Limit**

(Push 9)

This function adjusts the regen braking current limit.

Minimum Current	Maximum Current	Controller Set Range	Resolution (per set unit)
52 amps	468 amps	0 to 255	1.63 amps
Example: Function 09 set at 110 equals 231.3 amps.			
$(110 \times 1.63 \text{ amps}) + 52 \text{ amps} = 231.3 \text{ amps}$			
<ul style="list-style-type: none"> <li>Higher settings decrease stopping distance.</li> <li>Lower settings increase stopping distance.</li> </ul>			

**Function 10****Field Current for Regenerative Braking**

(Push 10)

**WARNING**

Function 10 is not normally adjusted in the field. Adjusting Function 10 between the minimum and maximum values will not alter lift truck performance.

This function adjusts the field current to be used during the regen braking mode.

**Function 11****Turn Speed Limit**

(Push 11)

This function allows for the adjustment of the maximum lift truck speed (maximum battery volts to the motor) available when the steer angle potentiometer signal indicates the steer angle is 32 degrees or greater.

Maximum Volts	Minimum Volts	Controller Set Range	Resolution (per set unit)
100%	0%	51 to 180	0.78%
Example: Function 11 set at 71 equals 84.4% B.V.			
$100\% - [(71 - 51) \times 0.78\%] = 84.4\%$			
<ul style="list-style-type: none"> <li>Higher settings decrease speed.</li> <li>Lower settings increase speed.</li> </ul>			

and the number shown in the following instructions at the same time.

**NOTE:** The key switch must be in the **ON** position to access Functions 48 to 62.

**Function 48**  
**Mode 1 (Turtle) - Controlled Acceleration**  
 (Push CONT 1)

This function allows for the adjustment of the time it takes for the controller to accelerate to 96 percent applied battery voltage to the motor on hard acceleration.

Minimum Time	Maximum Time	Controller Set Range	Resolution (per set unit)
0.1 sec	5.5 secs	0 to 255	0.021 sec
Example: Function 48 set at 20 equals 0.52 second.			
$(20 \times 0.021 \text{ sec}) + 0.1 \text{ sec} = 0.52 \text{ sec}$			
<ul style="list-style-type: none"> <li>Higher settings provide slower acceleration.</li> <li>Lower settings provide faster acceleration.</li> </ul>			

**NOTE:** This controlled acceleration is in effect when mode 1 is selected on the premium instrument panel.

**Function 49**  
**Mode 1 (Turtle) - Speed Limit 2 (SL2)**  
 (Push CONT 1)

This function allows for the adjustment of the speed limit (maximum battery volts to the motor) when the SL2 limit switch input signal is received by the controller. SL2 limit switch is a normally open switch connected to battery negative; the switch closing enables speed limit.

Minimum Volts	Maximum Volts	Controller Set Range	Resolution (per set unit)
0%	100%	0 to 255	0.375 volt
Example: Function 50 set at 50 equals 18.75 volts.			
$50 \times 0.375 \text{ volt} = 18.75 \text{ volts}$			
<ul style="list-style-type: none"> <li>Higher settings increase speed.</li> <li>Lower settings decrease speed.</li> </ul>			

**NOTE:** This speed limit 2 is in effect when mode 1 is selected on the premium instrument panel.

**Function 50**  
**Mode 1 (Turtle) - Speed Limit 3 (SL3)**  
 (Push CONT 3)

This function allows for the adjustment of the speed limit (maximum battery volts to the motor) when the SL3 limit switch input signal is received by the controller. SL3 limit switch is a normally open switch connected to battery negative; the switch closing enables speed limit.

Minimum Volts	Maximum Volts	Controller Set Range	Resolution (per set unit)
0%	100%	0 to 255	0.375 volt
Example: Function 50 set at 50 equals 18.75 volts.			
$50 \times 0.375 \text{ volt} = 18.75 \text{ volts}$			
<ul style="list-style-type: none"> <li>Higher settings increase speed.</li> <li>Lower settings decrease speed.</li> </ul>			

**NOTE:** This speed limit 3 is in effect when mode 1 is selected on the premium instrument panel.

**Function 52**  
**Mode 2 - Controlled Acceleration**  
 (Push CONT 5)

Same as Function 48.

**NOTE:** This controlled acceleration is in effect when mode 2 is selected on the premium instrument panel.

**Function 53**  
**Mode 2 - Speed Limit 2 (SL2)**  
 (Push CONT 6)

Same as Function 49.

**NOTE:** This speed limit 2 is in effect when mode 2 is selected on the premium instrument panel.

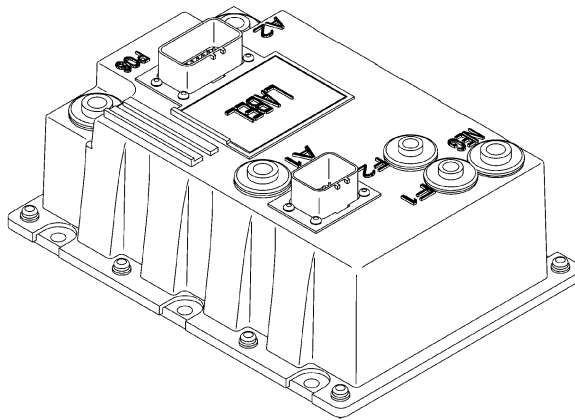
**Function 54**  
**Mode 2 - Speed Limit 3 (SL3)**  
 (Push CONT 7)

Same as Function 50.

**NOTE:** This speed limit 3 is in effect when mode 2 is selected on the premium instrument panel.

# **SR/SP TRANSISTOR MOTOR CONTROLLER AND HANDSET**

**ALL ELECTRIC LIFT TRUCKS WITH SR/SP  
TRANSISTOR MOTOR CONTROLLERS**



BM080069

# ***HYSTER***

the creep speed position. Maximum current is obtained with the accelerator in the top speed position.

### Auto Regenerative Braking

This feature is enabled by initiating a neutral position using either the directional switch or the accelerator switch. Once activated, auto regenerative braking operates similar to standard regenerative braking and is adjusted by Function 21.

### Conventional Plug Braking

Plug braking only occurs when the steer tire is at an angle of 65 degrees or greater. At steer angles less than 65 degrees, the truck is slowed by regenerative braking to zero speed.

During plug braking (when reversing direction), slowdown is accomplished by providing a small amount of retarding torque for deceleration. If the lift truck is moving, the steer tire is at an angle of 65 degrees or greater, and the directional lever is moved from one direction to the other, the plug signal is initiated. Once the plug signal has been initiated, the field is reversed, and the armature current is regulated to the plug current limit as set by Function 5. Armature current is regulated by increasing the field current as the lift truck slows down. Once the field current reaches a preset value, set by Function 10, and armature plug current can no longer be maintained, the braking function is canceled, and the controller reverts back to motoring.

All energy produced by the motor during plugging is converted to heat in the drive motor.

Function 5, Plugging Current Limit, is user adjustable and will alter the plugging distance. Function 10, Regen Field Current, is not normally adjusted in the field.

## AUXILIARY SPEED CONTROL

### Field Weakening

FW Ratio (Function 6) adjusts the field-weakening level to set the top speed of the motor. The FW Ratio is enabled when the armature current is less than the FW Start Current (Function 24) and the accelerator input voltage is less than 1 volt. Function 24 is used to optimize motor and controller performance.

**NOTE:** The FW Ratio has been determined by the factory. Function 6 is not normally adjusted in the field.

**NOTE:** FW Start, Functions 24, 49, 53, 57, and 61, is not normally adjusted in the field.

**NOTE:** Top speed can be reduced by increasing the value of Maximum Armature Percent On. Maximum Armature Percent On must never be adjusted to a value less than the factory minimum value. Maximum Armature Percent On is set using Function 12 (standard instrument panel) and Functions 41, 55, 59, and 63 (premium instrument panel).

### Speed Limits

This feature provides a means to control speed by limiting motor volts utilizing three adjustable speed limits. The lower motor volt limit always takes priority when more than one speed limit is activated. This motor volts limit regulates ON time of the transistor controller, but actual truck speed will vary at any set point depending on the loading of the lift truck. Each speed limit can be adjusted with the handset. Function 11 controls turn speed limit. Functions 12, 41, 55, 59, and 63 (Maximum Armature Percent On) control main speed limit, and Function 13 controls maintenance alert speed limit.

## RAMP OPERATION

### Ramp Start

This feature provides maximum control torque to restart a lift truck on an incline. The memory for this function is the directional switch. When stopping on an incline, the directional switch must be left in its original or neutral position to allow the controller to initiate full power when restarted. The accelerator potentiometer input will modulate ramp start current.

### Antirollback

This feature provides retarding torque to limit rollback speed in the nontravel direction when the accelerator pedal is released when stopping on a grade, or when the brake pedal is released when starting on a grade. This feature forces the lift truck to roll slowly down the grade when accelerator or brake is released. Because the lift truck cannot gain significant speed during rollback, the torque needed to restart on the ramp is lower than an unrestricted rollback speed.

**Table 3. Instrument Panel Function Number Correlation**

	Function Description	Standard Dash Function Number (Without mode selection)	Premium Dash Function Number			
			Mode 1	Mode 2	Mode 3	Mode 4
<b>Traction Controller</b>	Controlled Acceleration	3	48	52	56	60
	FW Start	24	49	53	57	61
	FW Ratio	6	50	54	58	62
	Maximum Armature Percent On	12	51	55	59	63
<b>Lift Pump Controller</b>	Controlled Acceleration	3	48	52	56	60
	Speed Limit 2	12	49	53	57	61
	Speed Limit 3	13	50	54	58	62

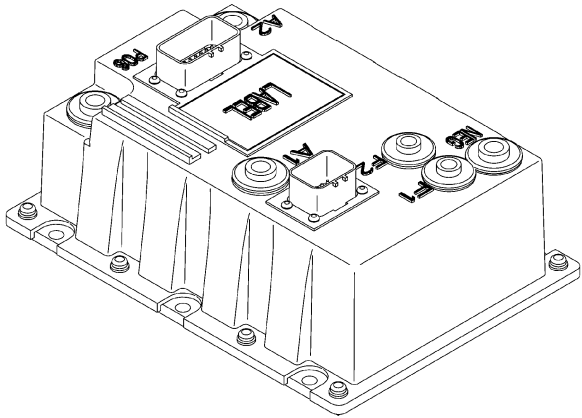
**NOTE:** Lift pump controller Functions 3, 12, and 13 are disregarded when using the premium instrument panel with mode selection. See Table 3.

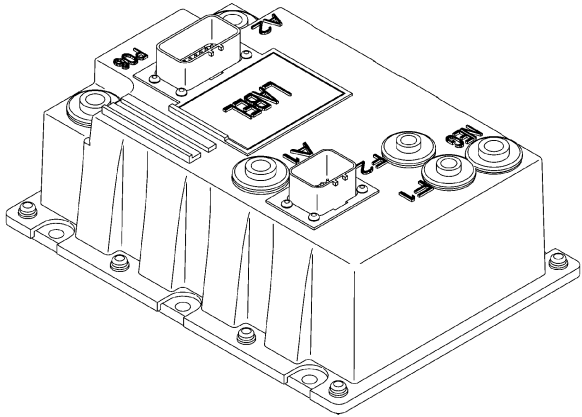
These interactive modes are preset using function numbers:

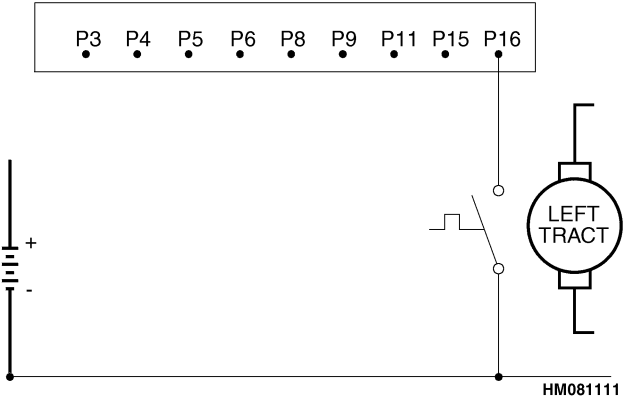
	Handset	PC
<b>Traction Controller</b>	48 to 63	97 to 112
<b>Lift Pump Controller</b>	48 to 62	97 to 111

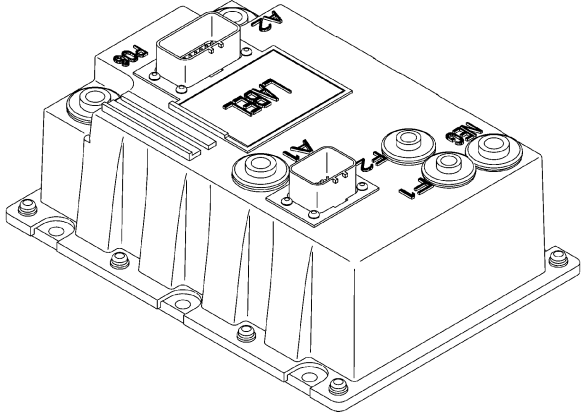
Status Code	Description	Memory Recall	Circuit
<b>-08</b>	Accelerator input voltage too low when key switch is initially closed.	No	Traction
<p><b>Symptom</b> Traction is disabled.</p> <p><b>Possible Causes and Test Procedures</b></p> <ul style="list-style-type: none"> <li>Accelerator speed control unit out of adjustment or defective. Input voltage at P7 should be more than 3.0 volts. Adjust or replace accelerator unit to ensure the voltage at P7 is more than 3.0 volts before depressing pedal.</li> <li>Short circuit between battery negative and P7 in accelerator input circuit. Disconnect wire from P7 and measure voltage at wire to negative. Voltage should be greater than 3.0 volts for solid-state accelerator speed control unit.</li> <li>Defective controller. Disconnect wire from P7. Measure voltage from P7 to negative. Voltage should be greater than 4.5 volts. If not, replace controller.</li> </ul> <p><b>NOTE:</b> Refer to status code -05 for accelerator speed control unit voltage specifications.</p>		<p style="text-align: right;">HM081241</p>	
		<p><b>Cause</b></p> <p>This status code is displayed when the accelerator input voltage at P7 is less than 3.0 volts and any of the following connections are opened and closed: battery plug, seat switch, or key switch.</p>	

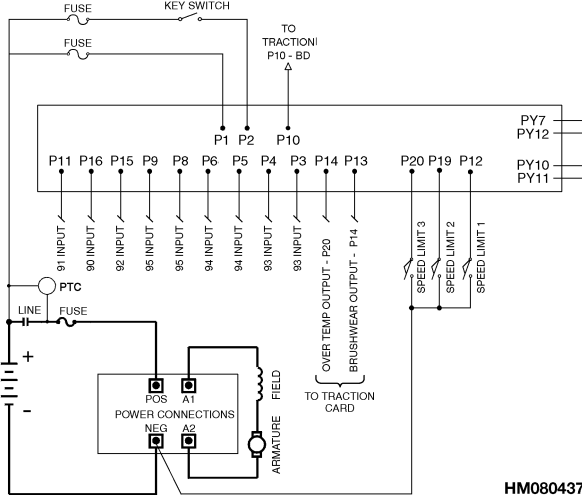
Status Code	Description	Memory Recall	Circuit
<b>-09</b>	Both the forward and reverse directional switches are closed at the same time.	No	Traction
<p><b>Symptom</b> Traction is disabled.</p> <p><b>Possible Causes and Test Procedures</b></p> <ul style="list-style-type: none"> <li>Forward or reverse directional switch is failed closed or out of adjustment (adjusted to be held closed). Replace or adjust directional switches to ensure they open when directional switch is returned to neutral.</li> <li>Short circuit between battery positive and P4 and/or P5. Disconnect wires from P4 and P5 and check wire for short circuit to positive side of directional switch.</li> <li>Malfunctioning controller. Disconnect wires and measure voltage at P4 and P5. Voltage should be less than 60 percent of battery volts.</li> </ul>		<p style="text-align: right;">HM080423</p>	
		<p><b>Cause</b></p> <p>This status code is displayed when P4 and P5 are greater than 60 percent of battery voltage at the same time.</p>	

Status Code	Description	Memory Recall	Circuit
<b>-41</b>	Open thermal protector (TP) or transistor overtemperature.	Yes	Traction
<p style="text-align: center;"><b>Symptom</b></p> <p>Maximum travel speed is reduced or traction is disabled.</p> <p style="text-align: center;"><b>Possible Causes and Test Procedures</b></p> <ul style="list-style-type: none"> <li>• Controller is in thermal cutback. [Controller heat sink (metal mounting base) temperature is in excess of 60°C (140°F).] Allow controller to cool; status code should disappear.</li> <li>• Internal thermal protector has failed. Measure the controller heat sink (metal mounting base) temperature during thermal cutback. Heat sink temperatures less than 60°C (140°F) during thermal cutback indicate a faulty thermal protector. Replace traction controller.</li> </ul>			
		<p><b>Cause</b></p> <p>This status code is displayed when the voltage at the internal thermal protector is greater than 0.8 volt.</p>	

Status Code	Description	Memory Recall	Circuit
<b>-42</b>	Motor armature offset voltage is too high.	No	Traction
<p style="text-align: center;"><b>Symptom</b></p> <p>Maximum travel speed is reduced or traction is disabled.</p> <p style="text-align: center;"><b>Possible Causes and Test Procedures</b></p> <ul style="list-style-type: none"> <li>• Controller is defective. Replace traction controller.</li> </ul>			
		<p><b>Cause</b></p> <p>This status code is displayed when the voltage at the internal current sensor input is greater than 2.6 volts with no current flowing in the motor circuit.</p>	

Status Code	Description	Memory Recall	Circuit
<b>-90</b>	Left traction motor temperature too high.	No	Traction and Pump
<p style="text-align: center;"><b>Symptom</b></p> <p style="text-align: center;">Status code flashes on and off. Maximum travel speed is reduced.</p> <p style="text-align: center;"><b>Possible Causes and Test Procedures</b></p> <ul style="list-style-type: none"> <li>• Left traction motor is too hot. Allow traction motor to cool. If problem recurs, determine reason for overheating traction motor and correct.</li> <li>• P16 is shorted to battery negative. Locate and repair short.</li> <li>• Left traction motor temperature sensor is shorted or damaged. Replace temperature sensor.</li> <li>• Defective lift pump controller. (SR transistor-controlled lift pump only.) Replace lift pump controller.</li> <li>• Defective sensor interface/contactactor driver module. (Contactor-controlled lift pump only). Replace sensor interface/contactactor driver module.</li> </ul> <p><b>NOTE:</b> Function 13, speed limit 3 is enabled by this status code.</p>		<p style="text-align: center;">PUMP CONTROLLER OR SENSOR INTERFACE/CONTACTOR MODULE</p>  <p style="text-align: right; font-size: small;">HM081111</p>	
		<p style="text-align: center;"><b>Cause</b></p> <p>This status code is displayed when the voltage at terminal P16 of the SR lift pump controller or the sensor interface/contactactor driver module is at zero volts.</p>	

Status Code	Description	Memory Recall	Circuit
<b>-145</b>	Power transistor (Q1) did not turn on properly.	Yes	Pump
<p><b>Symptom</b> Lift and auxiliary hydraulic functions are disabled.</p> <p><b>Possible Causes and Test Procedures</b></p> <ul style="list-style-type: none"> <li>Defective lift pump controller. Replace lift pump controller.</li> </ul>		 <p style="text-align: right;">BM080069</p>	
		<p><b>Cause</b> This status code is displayed when, during pump controller operation, the transistor fails to turn on.</p>	

Status Code	Description	Memory Recall	Circuit
<b>-146</b>	"Look Ahead" test for A2 volts less than 12 percent of battery voltage.	Yes	Pump
<p><b>Symptom</b> Lift and auxiliary hydraulic functions are disabled.</p> <p><b>Possible Causes and Test Procedures</b></p> <ul style="list-style-type: none"> <li>Check for short circuit from the motor armature to the frame of the lift truck.</li> <li>Defective lift pump controller. Replace lift pump controller.</li> </ul>		 <p style="text-align: right;">HM080437</p>	
		<p><b>Cause</b> This status code is displayed when the voltage at A2 is less than 12 percent of battery voltage.</p>	

 **CAUTION**

The ranges and values given in the following function descriptions are the ranges and the minimum and maximum values for the Motor Controller. The motor controller can be used on different models of lift trucks. Your lift truck may have specific settings or a different range of settings. Always refer to Capacities and Specifications for the correct factory values and the range of allowable settings for your lift truck.

**Function 01**  
**Auto Regen Enable Speed**  
 (Push 1)

 **WARNING**

Function 01 is not normally adjusted in the field. Adjusting Function 01 between the minimum and maximum values will not alter lift truck performance.

This setting adjusts the speed, below which the auto regen feature will not be enabled.

**Function 02**  
**Creep Speed**  
 (Push 2)

This function allows the adjustment of the creep speed (controller "on time") of the lift truck. Creep speed can be adjusted when an accelerator input voltage between 3.3 and 3.9 volts is provided to the controller or when an accelerator resistance value between 6.0K and 4.0K ohms is provided to the controller.

Min. On Time	Max. On Time	Controller Set Range	Resolution (per set unit)
2%	15%	0 to 225	0.05%
Example: Function 02 set at 20 equals 3% on time.			
$(20 \times 0.05\%) + 2\% = 3\%$			
<ul style="list-style-type: none"> <li>Higher settings increase creep speed.</li> <li>Lower settings decrease creep speed.</li> </ul>			

**Function 03**  
**Controlled Acceleration**  
 (Push 3)

This function allows for the adjustment of the time it takes for the controller to accelerate to 100 percent applied battery voltage to the motor on hard acceleration.

**NOTE:** This controlled acceleration is in effect when the standard instrument panel is used.

Min. Time	Max. Time	Controller Set Range	Resolution (per set unit)
0.025 sec	6.3 secs	0 to 255	0.025 sec
Example: Function 03 set at 20 equals 0.5 seconds.			
$(20 \times 0.025 \text{ secs}) + 0.025 \text{ secs} = 0.5 \text{ secs}$			
<ul style="list-style-type: none"> <li>Higher settings provide slower acceleration.</li> <li>Lower settings provide faster acceleration.</li> </ul>			

**Function 04**  
**Armature Current Limit**  
 (Push 4)

This function allows for the adjustment of the armature current limit of the controller. The rating of the controller will determine the range of adjustment for this function. See Figure 17 for the current limit curves. See Capacities and Specifications for the values for your lift truck.

Min. Current	Max. Current	Controller Set Range	Resolution (per set unit)
*	*	0 to 255	-
*See Figure 17 for the current limit curves.			
*See Capacities and Specifications for recommended values.			
<ul style="list-style-type: none"> <li>Higher settings increase armature current limit.</li> <li>Lower settings decrease armature current limit.</li> </ul>			

Min. Level	Max. Level	Controller Set Range	Resolution (per set unit)
0 amps	1325 amps	52 to 255	6.5 amps
Example: Function 02 set at 72 equals 130 amps.			
$(72 - 52) \times 6.5 \text{ amps} = 130 \text{ amps}$			
<ul style="list-style-type: none"> <li>• Higher settings = Function 16 at a higher current.</li> <li>• Lower settings = Function 16 at a lower current.</li> </ul>			

### Function 03 Controlled Acceleration (Push 3)

This function allows for the adjustment of the time it takes for the controller to accelerate to 96 percent applied battery voltage to the motor on hard acceleration.

Min. Time	Max. Time	Controller Set Range	Resolution (per set unit)
0.1 sec	5.5 secs	0 to 255	0.021 sec
Example: Function 03 set at 20 equals 0.52 second.			
$(20 \times 0.021 \text{ secs}) + 0.1 \text{ secs} = 0.52 \text{ secs}$			
<ul style="list-style-type: none"> <li>• Higher settings provide slower acceleration.</li> <li>• Lower settings provide faster acceleration.</li> </ul>			

**NOTE:** This controlled acceleration is in effect when the standard instrument panel is used.

### Function 04 Current Limit (Push 4)



**Function 04 is not normally adjusted in the field. Adjusting Function 04 between the minimum and maximum values will not alter lift truck performance.**

This function sets the adjustment of the current limit of the controller. The rating of the controller will determine the range of adjustment for this function.

Min. Current	Max. Current	Controller Set Range	Resolution (per set unit)
*	*	255 to 255	-
<ul style="list-style-type: none"> <li>• Higher settings increase current limit.</li> <li>• Lower settings decrease current limit.</li> </ul>			

### Function 07 Internal Resistance Compensation Rate (Push 7)

This function allows for the adjustment of the time it takes for the controller to add the internal resistance compensation voltage that is applied to the motor. This function will add 0.375 volt to the motor at the rate of time adjusted until the total internal resistance compensation voltage has been added.

**NOTE:** The internal resistance compensation voltage is set by Function 16, Speed/Torque Compensation.

Min. Time	Max. Time	Controller Set Range	Resolution (per set unit)
0.0015 sec	0.383 sec	0 to 255	0.0015 sec
Example: Function 07 set at 20 equals 0.032 second.			
$(20 \times 0.0015 \text{ secs}) + 0.0015 \text{ secs} = 0.032 \text{ secs}$			
<ul style="list-style-type: none"> <li>• Higher settings provide a slower compensation.</li> <li>• Lower settings provide a faster compensation.</li> </ul>			

For example, if you had selected 2.08 volts from Function 16 to be added to the motor, it would take 0.18 second to add a total of 2.08 volts.  
 $(2.08 \div 0.375) \times 0.032 = 0.18 \text{ seconds}$

### Function 11 Speed Limit 1 (SL1) (Push 11)

This function allows for the adjustment of the speed limit (maximum battery volts to the motor) when the SL1 limit switch input signal is received by the controller. SL1 limit switch is a normally open switch connected to battery negative; the switch closing enables speed limit.

Min. Volts	Max. Volts	Controller Set Range	Resolution (per set unit)
0%	100%	30 to 70	0.375 volt
Example: Function 11 set at 50 equals 18.75 volts.			
$0.375 \text{ volts} \times 50 = 18.75 \text{ volts}$			
<ul style="list-style-type: none"> <li>• Higher settings increase speed.</li> <li>• Lower settings decrease speed.</li> </ul>			

## Introduction to SEM

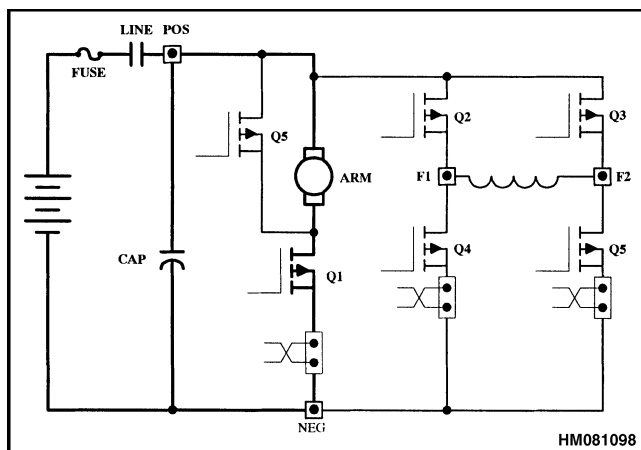
### ADVANTAGES OF TRANSISTORIZED SEM

Historically, most electric lift trucks have relied on series motor designs because of their ability to produce very high levels of torque at low speeds. As the demand for high-efficiency systems increases, shunt motors are now often being considered over series motors. In most applications, by independently controlling the field and armature currents in the separately excited motor, the best attributes of both the series- and the shunt-wound motors can be combined.

### FEATURES OF SEM

#### Solid-State Reversing

The direction of armature rotation on a shunt motor is determined by the direction in which current flows through the field windings. Because the shunt motor field only typically requires about 10 percent of the armature current at full torque, it is normally cost effective to replace the double-pole, double-throw, reversing contactor with a low-power transistor H-Bridge circuit. See Figure 1.



**Figure 1. Simplified Motor Circuit**

By energizing the transistors in pairs, current can be made to flow in either direction in the field. The field and armature control circuits typically operate at 12 kHz to 15 kHz, a frequency range normally above human hearing. This high frequency, coupled with the elimination of directional contactors, provides very quiet lift truck operation.

The line contactor is normally the only contactor required for the SEM traction circuit. This contactor is used for both precharge of the line capacitors and for shutdown of the motor circuit in the event of certain malfunctions. The line contactor is energized and de-energized by the key switch.

#### Performance and Efficiency

Because the SEM controller has the ability to control both the armature and field circuits independently, the system can normally be adjusted for maximum system efficiencies at certain operating parameters. Generally speaking, with the ability of independent field and armature control, the motor performance curve can be maximized through proper control application.

#### Field Weakening

Field weakening of a series-wound motor is accomplished by placing a resistor in parallel with the field windings of the motor. Bypassing some of the field current into the resistor causes the field current to be less or weakened, and motor speed can increase. To change the speed during field weakening, it is necessary to change the resistor value. In a separately excited motor, independent control of the field current provides for an infinite adjustment of field-weakened speeds, between motor base speed and maximum weak field. The transistorized control also eliminates the contactor and resistor required for field weakening with a series motor.

#### Regenerative Braking

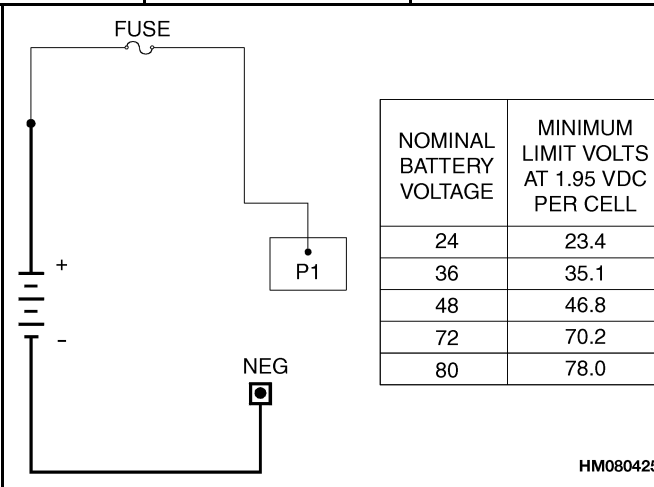
Regenerative braking (braking energy returned to the battery) may be accomplished completely with solid-state technology. The main advantage of regenerative braking is increased motor life. Motor current is reduced by 50 percent or more during braking while maintaining the same braking torque as electrical braking with a diode clamp around the armature. The lower current translates into longer brush life and reduced motor heating. Solid-state regenerative braking also eliminates a power diode, current sensor, and contactor from the circuit.

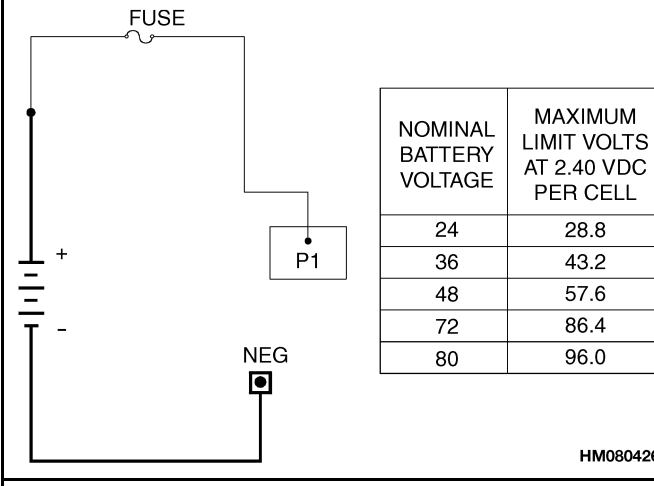
*Table 2. SP Lift Pump Controller Connections/Descriptions/Status Codes (Continued)*

	<b>Pin Number</b>	<b>Description</b>	<b>Wire Number</b>	<b>Status Code</b>
<b>PY  P L U G</b>	PY1	Clock (Out)	-	-
	PY2	Data (Out)	-	-
	PY3	Enable (Out)	-	-
	PY4	Negative	-	-
	PY5	+5 Volt Supply	-	-
	PY6	Cont/Store (In) (Handset)	-	-
	PY7	External Jumper to PY12	-	-
	PY8	Value	-	-
	PY9	Function	-	-
	PY10	External Jumper to PY11	-	-
	PY11	Serial Receive/Internal Connection to P22	-	-
	PY12	Serial Transmit/Internal Connection to P23	-	-

Status Code	Description	Memory Recall	Circuit
<b>NONE</b>	Segments do not illuminate on the instrument panel and/or the handset.	No	Traction and Pump
<p><b>Symptom</b> Display screen on instrument panel and/or handset is blank.</p> <p><b>Possible Causes and Test Procedures</b></p> <ul style="list-style-type: none"> <li>• Positive or negative controller voltage is not present. Ensure key switch is closed and voltage is present between P1 and battery negative (negative stand-off). Also, check for voltage between P2 and controller negative (B-).</li> <li>• Open circuit between controller PY plug and handset. Check for an open circuit or loose connection going from PY plug to handset.</li> <li>• Open circuit between controller P plug and the instrument panel. Check for an open circuit or loose connection going from P plug to instrument panel.</li> <li>• Defective instrument panel or handset. Replace instrument panel or handset.</li> </ul>		<p style="text-align: right;">HM080418</p>	
		<p><b>Cause</b> No input voltage to the controller or the display unit.</p>	

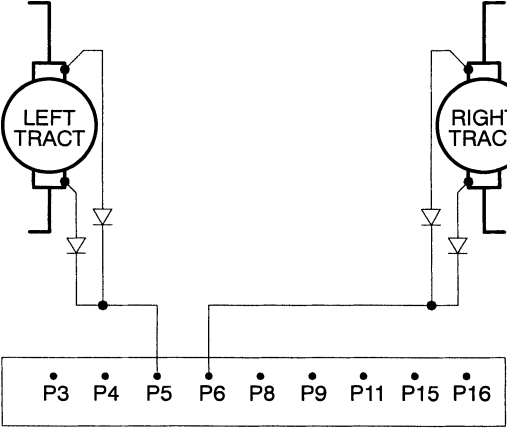
Status Code	Description	Memory Recall	Circuit
<b>-01</b>	No seat switch input.	No	Traction
<p><b>Symptom</b> Traction is disabled.</p> <p><b>Possible Causes and Test Procedures</b></p> <ul style="list-style-type: none"> <li>• Seat switch defective. Check to see that seat switch operates properly. Replace a failed switch.</li> <li>• Open circuit between battery positive and P6. Check for loose connections or broken wires:                     <ul style="list-style-type: none"> <li>Between seat switch and P6</li> <li>Between key switch and battery positive side of seat switch</li> </ul> </li> </ul>		<p style="text-align: right;">HM080419</p>	
		<p><b>Cause</b> This status code is displayed when P6 is less than 50 percent of battery voltage.</p>	

Status Code	Description	Memory Recall	Circuit												
<b>-15</b>	Battery voltage is too low or controller is adjusted to the wrong battery voltage.	No	Traction												
<p><b>Symptom</b> Traction is disabled.</p> <p><b>Possible Causes and Test Procedures</b></p> <ul style="list-style-type: none"> <li>• Discharged battery. Check battery for correct open circuit voltage. Correct voltages are listed on right. Charge battery, if required.</li> <li>• Defective battery. Check each battery cell for correct voltage (greater than 1.95 volts each cell). Replace or repair battery.</li> <li>• Incorrect controller adjustment. Check Function 15 for proper adjustment for battery being used. Adjust to proper settings. Refer to SR/SP Handset Instructions. See <b>Capacities and Specifications</b> for the Function 15 value for your lift truck.</li> <li>• Minimum battery volts not present between P1 and NEG. Check for battery volts between P1 and negative standoff. If battery volts are not present, check for a voltage drop between battery (+) and P1 and/or between battery (-) and negative standoff.</li> </ul>		 <table border="1"> <thead> <tr> <th>NOMINAL BATTERY VOLTAGE</th> <th>MINIMUM LIMIT VOLTS AT 1.95 VDC PER CELL</th> </tr> </thead> <tbody> <tr> <td>24</td> <td>23.4</td> </tr> <tr> <td>36</td> <td>35.1</td> </tr> <tr> <td>48</td> <td>46.8</td> </tr> <tr> <td>72</td> <td>70.2</td> </tr> <tr> <td>80</td> <td>78.0</td> </tr> </tbody> </table> <p style="text-align: right;">HM080425</p>		NOMINAL BATTERY VOLTAGE	MINIMUM LIMIT VOLTS AT 1.95 VDC PER CELL	24	23.4	36	35.1	48	46.8	72	70.2	80	78.0
NOMINAL BATTERY VOLTAGE	MINIMUM LIMIT VOLTS AT 1.95 VDC PER CELL														
24	23.4														
36	35.1														
48	46.8														
72	70.2														
80	78.0														
		<p><b>Cause</b> This status code is displayed when the battery volts are less than 1.95 volts per cell at initial key switch ON.</p>													

Status Code	Description	Memory Recall	Circuit												
<b>-16</b>	Battery voltage is too high or controller is adjusted to the wrong battery voltage.	No	Traction												
<p><b>Symptom</b> Traction is disabled.</p> <p><b>Possible Causes and Test Procedures</b></p> <ul style="list-style-type: none"> <li>• Incorrect controller adjustment. Check Function 16 for proper adjustment for battery being used. Adjust to proper setting. Refer to SR/SP Handset Instructions. See <b>Capacities and Specifications</b> for Function Number 15 value for your lift truck.</li> <li>• Battery overcharged or incorrect battery used. Check battery for correct open circuit voltage. Correct voltages are listed on right. If voltage is excessive, check battery charger for proper output voltage.</li> </ul>		 <table border="1"> <thead> <tr> <th>NOMINAL BATTERY VOLTAGE</th> <th>MAXIMUM LIMIT VOLTS AT 2.40 VDC PER CELL</th> </tr> </thead> <tbody> <tr> <td>24</td> <td>28.8</td> </tr> <tr> <td>36</td> <td>43.2</td> </tr> <tr> <td>48</td> <td>57.6</td> </tr> <tr> <td>72</td> <td>86.4</td> </tr> <tr> <td>80</td> <td>96.0</td> </tr> </tbody> </table> <p style="text-align: right;">HM080426</p>		NOMINAL BATTERY VOLTAGE	MAXIMUM LIMIT VOLTS AT 2.40 VDC PER CELL	24	28.8	36	43.2	48	57.6	72	86.4	80	96.0
NOMINAL BATTERY VOLTAGE	MAXIMUM LIMIT VOLTS AT 2.40 VDC PER CELL														
24	28.8														
36	43.2														
48	57.6														
72	86.4														
80	96.0														
		<p><b>Cause</b> This status code is displayed when the battery volts are greater than 2.4 volts per cell at key switch ON.</p>													

Status Code	Description	Memory Recall	Circuit
<b>-57</b>	Controller motor current sensor input too low during operation.	No	Traction
<p><b>Symptom</b> Maximum travel speed is reduced or traction is disabled.</p> <p><b>Possible Causes and Test Procedures</b></p> <ul style="list-style-type: none"> <li>Malfunctioning controller. Replace traction controller.</li> </ul>		<p style="text-align: right;">HM080428</p>	
		<p><b>Cause</b> This status code is displayed when the voltage input from the current sensor is too low during running.</p>	

Status Code	Description	Memory Recall	Circuit
<b>-64</b>	Line driver input (P2-17) is less than 12 percent of battery voltage.	No	Traction
<p><b>Symptom</b> Motor controller will not operate.</p> <p><b>Possible Causes and Test Procedures</b></p> <ul style="list-style-type: none"> <li>Open or loose connection to pin P17. Check for loose or broken wire at plug pin P17.</li> <li>Malfunction of driver transistor in motor controller. Replace motor controller.</li> </ul>		<p style="text-align: right;">HM080428</p>	
		<p><b>Cause</b> This status code is displayed when the controller detects that the line driver input (P2-17) is less than 12 percent of battery voltage with the key switch in the ON position.</p>	

Status Code	Description	Memory Recall	Circuit
<b>-94</b>	Left or right traction motor brushes are worn.	No	Traction and Pump
<p style="text-align: center;"><b>Symptom</b> Status code flashes on and off.</p> <p style="text-align: center;"><b>Possible Causes and Test Procedures</b></p> <ul style="list-style-type: none"> <li>• Left or right traction motor brushes are worn. A sensor has closed to battery positive. Replace traction motor brushes.</li> <li>• P5 and/or P6 is shorted to battery positive. Locate and repair short.</li> <li>• A traction motor brush wear sensor is shorted or defective. Locate and repair shorted sensor lead or replace traction motor brushes.</li> <li>• Defective pump controller. (SR transistor-controlled lift pump only.) Replace pump controller.</li> <li>• Defective sensor interface/contacter driver module. (Contactor-controlled lift pump only.) Replace sensor interface/contacter driver module.</li> </ul> <p><b>NOTE:</b> Status code 94 is only checked when a neutral signal is present (open start switch or open forward and reverse switches). The status code is then displayed when the controller is returned to the run mode.</p>		 <p style="text-align: center;">PUMP CONTROLLER OR SENSOR INTERFACE/CONTACTOR MODULE</p> <p style="text-align: right;">HM081115</p>	
		<p style="text-align: center;"><b>Cause</b></p> <p>This status code is displayed when the voltage at terminal P5 and/or terminal P6 of the SR lift pump controller or the sensor interface/contacter driver module is at battery volts.</p>	

## SR/SP Handset Instructions

### GENERAL FEATURES

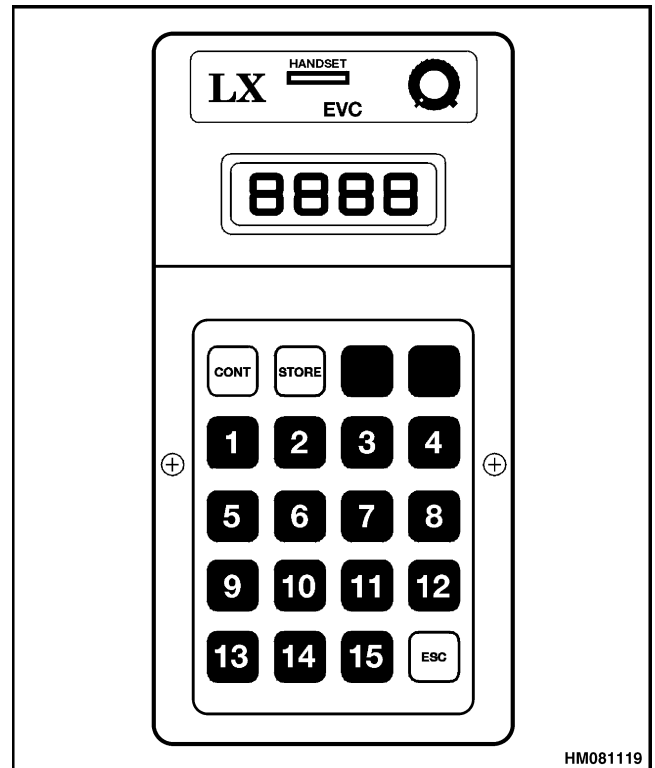
The GE handset is a multifunctional tool used with the LX, ZX, SR, and SP series GE solid-state controllers. See Figure 9. The handset consists of a light-emitting diode (LED) display and a keyboard for data entry. The handset is used for viewing, adjusting, and storing controller function settings (values) and for accessing status codes.

**NOTE:** The handset is the same for all GE controllers; however, the cable will change between some control types.

**NOTE:** Controllers can be programmed prior to installation using a 24-VDC power supply. See Figure 10 or Figure 11 for instructions on connecting the 24-VDC power supply.

See the section **Troubleshooting and Adjustments With a Computer Troubleshooting and Adjustments With a Computer, EV-100ZX, EV-T100, SR (SEM), and SP Motor Controllers** 2200 SRM 597 or **Troubleshooting and Adjustments With a Computer, For EV-100ZX, EV-T100, SR (SEM) and SP Motor Controllers (Windows Version)** 2200 SRM 947 for information on the use of a PC to troubleshoot and adjust the controllers.

The following outlines the procedures for viewing, adjusting, and storing controller function settings (values) and for accessing status codes.



*Figure 9. LX/ZX/SR/SP Handset*

**Function 15**  
**Battery Volts**  
(Push 15)

 **WARNING**

**Function 15 is not normally adjusted in the field. Adjusting Function 15 between the minimum and maximum values will not alter lift truck performance.**

This function allows for the adjustment of voltage range for controllers equipped with the battery discharge indicator function.

Factory Values - Function 15		
Left Traction Controller	36/48 volts with BDI	186
Right Traction Controller	No BDI	255

**NOTE:** The left traction controller is the primary controller and it controls the BDI feature. The left controller for a dual-motor proportioning system will be set differently than the right controller. See **Capacities and Specifications** for additional information.

Controller Set Range - Function 15	
Battery Volts	Set Units
24 volts	Between 0 and 31
36 volts	Between 32 and 44
48 volts	Between 45 and 69
72 volts	Between 70 and 80
80 volts	Between 81 and 183
36/48 volts	Between 184 and 250
No BDI feature	Between 251 and 255

**NOTE:** The following functions have function numbers larger than the numbers on the handset keyboard. To access these functions, push the **CONT** key and the number shown in the following instructions at the same time.

**NOTE:** The seat switch must be open to access Functions 16 to 28.

**Function 16**  
**Stall Trp Point Percent On-Time**  
(Push CONT 1)

This function sets the percent of on time for the FETs that the motor controller uses to determine a motor stall condition.

 **WARNING**

**Function 16 sets electrical limits to protect the motor from damage if stall occurs. Increasing the setting value can allow motor damage if a stall does occur.**

$$\text{Percent On Time} = (163 - \text{Set Point Value}) \times 0.892$$

If the Set Point Value is 163 or more, the percent On Time is zero. If the Set Point Value is 51 or less, the percent On Time is 100 percent.

**Function 17**  
**"Controller Type" Selection**  
(Push CONT 2)

 **WARNING**

**Function 17 is not normally adjusted in the field. Adjusting Function 17 between the minimum and maximum values will not alter lift truck performance.**

This function allows for the selection of the controller type used for your lift truck's application. The values listed below show the setting required for proper lift truck operation.

Factory Values - Function 17		
	W/Lift Interrupt	W/O Lift Interrupt
Left Traction Controller	57	53
Right Traction Controller	121	117

**NOTE:** The left traction controller is the primary controller. The left controller for a dual-motor proportioning system will be set differently than the right controller. See **Capacities and Specifications** for additional information.



**TRANSISTOR CONTROLLED 12CC/REV DISPLACEMENT PUMP**

Model	Lifting*				Lowering*			
	No Load		Rated Load		No Load		Rated Load	
	m/sec	ft/min	m/sec	ft/min	m/sec	ft/min	m/sec	ft/min
<b>Two-Stage Limited Free-Lift Mast</b>								
J30XMT2/36V	0.38	75	0.21	41	0.47	93	0.51	100
J35XMT2/36V	0.38	75	0.21	41	0.47	93	0.51	100
J40XMT2/36V	0.38	75	0.20	39	0.47	93	0.51	100
J30XMT2/48V	0.45	89	0.33	65	0.47	93	0.51	100
J35XMT2/48V	0.45	89	0.31	61	0.47	93	0.51	100
J40XMT2/48V	0.45	89	0.29	57	0.47	93	0.51	100
<b>Two-Stage Full Free-Lift Mast</b>								
J30XMT2/36V	0.37	73	0.21	41	0.37	73	0.47	93
J35XMT2/36V	0.37	73	0.21	41	0.37	73	0.47	93
J40XMT2/36V	0.37	73	0.20	39	0.37	73	0.47	93
J30XMT2/48V	0.44	87	0.33	65	0.37	73	0.47	93
J35XMT2/48V	0.44	87	0.31	61	0.37	73	0.47	93
J40XMT2/48V	0.44	87	0.29	57	0.37	73	0.47	93
<b>Three-Stage Full Free-Lift Mast</b>								
J30XMT2/36V	0.35	69	0.21	41	0.41	81	0.48	94
J35XMT2/36V	0.35	69	0.21	41	0.41	81	0.48	94
J40XMT2/36V	0.35	69	0.20	39	0.41	81	0.48	94
J30XMT2/48V	0.43	85	0.32	63	0.41	81	0.48	94
J35XMT2/48V	0.43	85	0.30	59	0.41	81	0.48	94
J40XMT2/48V	0.43	85	0.28	55	0.41	81	0.48	94
*Hydraulic Oil Temperature 62 to 73°C (144 to 163°F)								



## TRANSISTOR CONTROLLED 12CC/REV DISPLACEMENT PUMP

Model	Lifting*				Lowering*			
	No Load		Rated Load		No Load		Rated Load	
	m/sec	ft/min	m/sec	ft/min	m/sec	ft/min	m/sec	ft/min
<b>Two-Stage Limited Free-Lift Mast</b>								
J30XMT2/36V	0.38	75	0.21	41	0.47	93	0.51	100
J35XMT2/36V	0.38	75	0.21	41	0.47	93	0.51	100
J40XMT2/36V	0.38	75	0.20	39	0.47	93	0.51	100
J30XMT2/48V	0.45	89	0.33	65	0.47	93	0.51	100
J35XMT2/48V	0.45	89	0.31	61	0.47	93	0.51	100
J40XMT2/48V	0.45	89	0.29	57	0.47	93	0.51	100
<b>Two-Stage Full Free-Lift Mast</b>								
J30XMT2/36V	0.37	73	0.21	41	0.37	73	0.47	93
J35XMT2/36V	0.37	73	0.21	41	0.37	73	0.47	93
J40XMT2/36V	0.37	73	0.20	39	0.37	73	0.47	93
J30XMT2/48V	0.44	87	0.33	65	0.37	73	0.47	93
J35XMT2/48V	0.44	87	0.31	61	0.37	73	0.47	93
J40XMT2/48V	0.44	87	0.29	57	0.37	73	0.47	93
<b>Three-Stage Full Free-Lift Mast</b>								
J30XMT2/36V	0.35	69	0.21	41	0.41	81	0.48	94
J35XMT2/36V	0.35	69	0.21	41	0.41	81	0.48	94
J40XMT2/36V	0.35	69	0.20	39	0.41	81	0.48	94
J30XMT2/48V	0.43	85	0.32	63	0.41	81	0.48	94
J35XMT2/48V	0.43	85	0.30	59	0.41	81	0.48	94
J40XMT2/48V	0.43	85	0.28	55	0.41	81	0.48	94
*Hydraulic Oil Temperature 62 to 73°C (144 to 163°F)								



If necessary, remove latch knob from latch by removing two screws.

- Remove four hex head bolts retaining steering control unit to steering column bracket. Remove steering column from steering control unit and steering column bracket. Remove steering control unit. See the section **Steering Housing and Steering Control Unit** 1600 SRM 773 for information concerning repairs to the steering control unit.

 **WARNING**

**The spring (15, Figure 2) used between the steering column and the cowl mount has tension and can release with enough force to cause injury.**

- Loosen four hex head bolts retaining shaft, spring, plate, and steering column to cowl. Remove socket head bolt and nut that guides steering column through tilting positions from cowl bracket. Remove four hex head bolts, spring, and pin from cowl.

## INSTALL

 **WARNING**

**The spring (15, Figure 2) used between the steering column and the cowl mount has tension and can release with enough force to cause injury.**

- Align steering column with cowl mounting. See Figure 2. Install spring on shaft and plate. Align one end of spring in bracket on cowl and other end in steering column bracket. Install four hex head bolts and washers to retain steering column bracket, spring, and plate to cowl. Install socket head bolt through slot in steering column bracket. Apply Loctite No. 242 or equivalent on nut and install nut on inside of cowl. Tighten hex head bolts and nut to 25 N•m (18 lbf ft).
- Install splined end of steering column in steering control unit. Install unit and column in steering control bracket. Install four hex head bolts and washers to retain unit and column to steering column bracket.

 **WARNING**

**The spring (8, Figure 2) used to operate the latch for locking the steering column has tension and can release with enough force to cause injury.**

- Install latch on steering column bracket using clevis pin and new cotter pin. Install washer and spring on rod in steering column bracket. Then, using locking pliers on rod below spring and washer, raise rod and compress spring to seat rod in latch. Install latch knob using screws.
- Remove plugs from hydraulic connections and install hydraulic steering hoses to steering control unit. Tighten hose fittings to 25 to 29 N•m (18 to 21 lbf ft).
- If the optional directional switch is used, install directional switch assembly to steering column bracket using two shoulder head bolts, spring washers, and nuts.
- Identify and install electrical connections to directional switches.

 **WARNING**

**Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause eye injury. Always use the correct snap ring pliers and wear eye and face protection during removal and installation.**

- Install steering wheel on steering column shaft. Install steering wheel hex nut and tighten nut to 40 to 54 N•m (30 to 40 lbf ft). Install electrical leads for horn to base plate and retain leads using hex head bolts. Install base plate, retaining ring, and horn cover in steering wheel.

 **WARNING**

**The spring (23, Figure 2) used on the optical encoder has tension and can release with enough force to cause injury.**

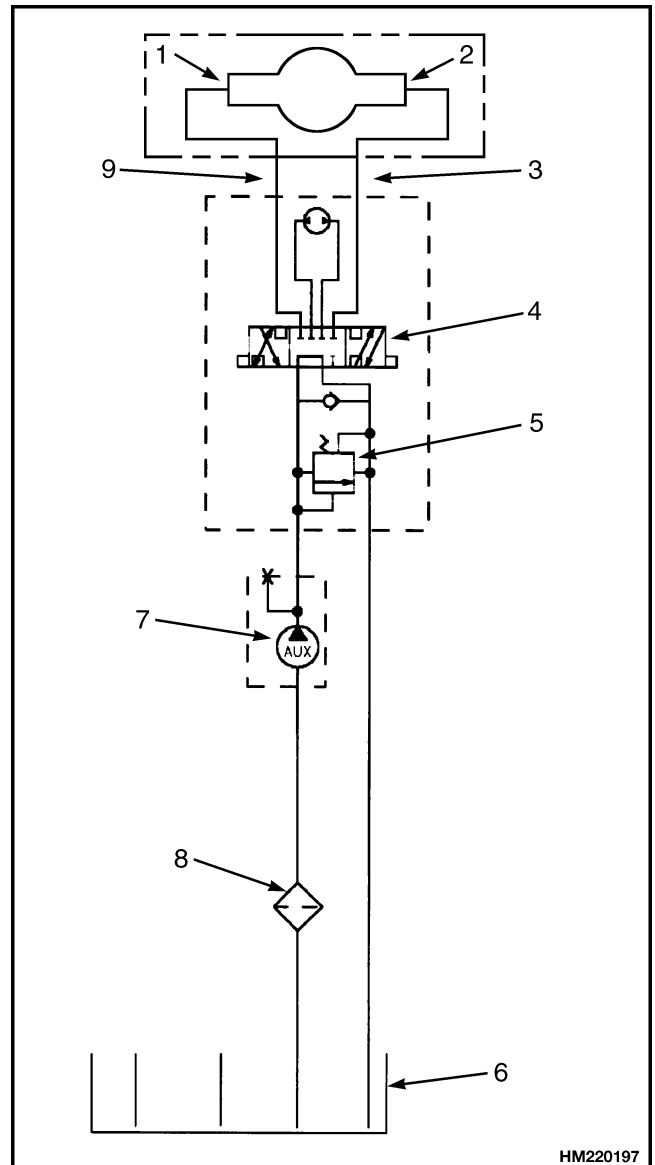
- Install optical encoder on steering column using spring to retain unit.
- Install key switch in bottom steering pod cover. Install electrical connections to key switch.

## Steering Pressure Check

**NOTE:** The correct relief valve pressure is  $7.7 \pm 0.34$  MPa (1100  $\pm$ 50 psi).

1. Install a pressure gauge in power steering pump discharge line (between pump and steering control unit). See Figure 9.
2. Operate steering pump and rotate steering wheel so relief valve (in steering control unit) operates. Check that maximum pressure is  $7.7 \pm 0.34$  MPa (1100  $\pm$ 50 psi).
3. If pressure is greater than 8.05 MPa (1150 psi), or less than 7.35 MPa (1050 psi), replace steering control unit.
4. When pressure checks are complete, remove pressure gauge.
5. Operate power steering system. Rotate trunnion to its stop in one direction, then rotate trunnion to its stop in the other direction. Check that steering turns trunnion smoothly. The face of the wheel should be approximately parallel to the frame plate at the back of the battery compartment when steering trunnion is rotated fully in each direction to its stops.

To check the operation of the printed circuit card that controls the steering, see the section **SX/SR Transistor Motor Controllers and Handset** 2200 SRM 774.



- |                             |                   |
|-----------------------------|-------------------|
| 1. LH                       | 6. HYDRAULIC TANK |
| 2. RH                       | 7. STEERING PUMP  |
| 3. R-PORT                   | 8. STRAINER       |
| 4. STEERING CONTROL UNIT    | 9. L-PORT         |
| 5. RELIEF 75 bar (1100 psi) |                   |

*Figure 9. Hydraulic Schematic*

## Troubleshooting

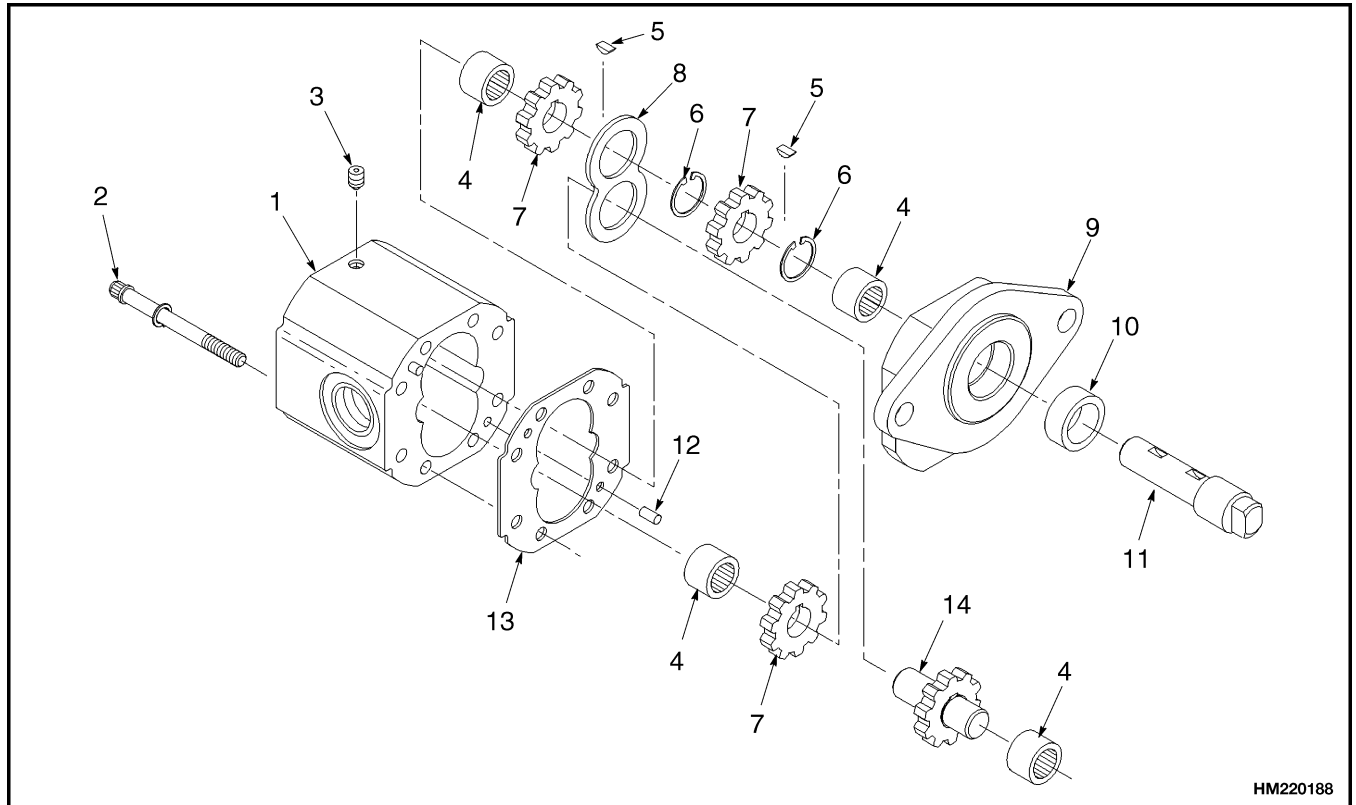
PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
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This section is for the following models:

J30-40XMT<sub>2</sub> [H160]



HM220188

- |                   |                          |
|-------------------|--------------------------|
| 1. HOUSING        | 8. SPACER                |
| 2. SCREW          | 9. COVER                 |
| 3. PLUG           | 10. OIL SEAL             |
| 4. NEEDLE BEARING | 11. DRIVE SHAFT          |
| 5. KEY            | 12. GUIDE PIN            |
| 6. SNAP RING      | 13. GASKET               |
| 7. GEAR           | 14. IDLER SHAFT AND GEAR |

**Figure 6. Power Steering Pump**

5. Clean and inspect needle bearings for damage. Inspect gears, idler shaft and gear, and drive shaft for erosion or damage. Replace all defective parts. Replace oil seal and joints.

## ASSEMBLE

Lubricate all components with clean hydraulic oil before assembly.



### WARNING

**Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers and wear eye and face protection during removal and installation.**

1. Install needle bearings in pump halves. Install snap rings to retain bearings.
2. Install spacer on shafts. Install remaining two gears on shafts.
3. Install oil seal in upper half of pump. Carefully install drive shaft through oil seal and needle bearing. Install keys on drive shaft.
4. Install idler shaft and gear in needle bearing of upper half of pump. Align and install gear on drive shaft and key so it mates with idler gear.
5. Ensure housing and cover are properly aligned and install gasket. Install eight capscrews and washers retaining housing and cover together.

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
The power steer pump and motor is overheating (for 48-volt lift trucks).	Incorrect hydraulic pressure and current draw at idle, medium steering, and relief.	<p>Check the power steer pump and motor hydraulic pressures and current draws at idle, medium steering, and relief. The pressure and current draws should be as follows:</p> <p>Idle (pump running, no steering) - 0.28 to 0.42 MPa (40 to 60 psi) - 4 to 6 amps.</p> <p>Medium Steering and Relief - 5.60 to 5.95 MPa (800 to 850 psi) - 20 to 25 amps.</p> <p>Relief (turn wheel clockwise or counterclockwise to stop) - 7.7 MPa (1100 psi) - 30 to 35 amps.</p> <p><b>a.</b> If the momentary motor current draw at relief is 45 amps or above, replace the pump.</p> <p><b>b.</b> If the motor current draw at idle is 10 amps or more and the relief pressure is normal, check the entire hydraulic system for contamination. Replace or clean all filters and strainers, back flush the system (especially the steering control unit), and fill the hydraulic system with clean hydraulic oil. If high idle current draw still persists, check for kinked hoses before replacing the steering control unit or finally the power steer pump and motor assembly.</p>

- Remove the floor plates. Mark and disconnect the power cables from the traction motor.

**WARNING**

**The transaxle and traction motor assembly are heavy. Be sure that all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the transaxle and traction motor. The transaxle and traction motor can weigh approximately 111 kg (245 lb).**

- The traction motor has a M10 × 1.5 threaded hole for attaching a lifting eye. Either use a lifting eye and a hoist, or position a floor jack under the transaxle assembly. If a floor jack is used make certain that the transaxle rests firmly on the jack so it will not fall.
- Remove the five capscrews and washers retaining the transaxle to the frame. Use the floor jack or lifting device to lower the transaxle assembly from the frame. Make sure the cables and hoses do not cause interference when the transaxle assembly is removed from the lift truck.

**INSPECT****WARNING**

**Cleaning solvents can be flammable and toxic and can cause skin irritation. Wear protection when handling solvents and always follow the recommendations of the manufacturer.**

- Before assembling the transaxle, wash and thoroughly clean all parts in a suitable solvent and dry. Make certain that all gasket material or sealing compound has been removed from the housing and covers, and that all mating surfaces are smooth.
- Check housing for cracks. Check all threaded holes and wheel studs for damage. Check to see that the transaxle breather is not plugged.
- Check all bearings for excessive wear or flat spots. Dip clean bearings in new, clean gear oil and wrap in a clean, lint-free cloth until ready for assembly.
- Check all gears and shafts for excessive wear or damaged teeth.

On the S1 series transaxle only, check for damaged keyways. Check keys for rounded edges or

cracks. Check the keys for proper fit in the keyways of the shafts where they belong. If the keys do not fit properly, replace the key and/or shaft.

- Replace all worn or damaged parts. When assembling the transaxle, use all new stake nuts, O-rings, and seals. The pinion gear and ring gear must be replaced as a matched set.

**INSTALL****WARNING**

**The transaxle and traction motor assembly are heavy. Be sure that all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the transaxle and traction motor. The transaxle and traction motor can weigh approximately 111 kg (245 lb).**

- Position the transaxle assembly under the lift truck. Using a floor jack or hoist, raise the transaxle assembly high enough to install the capscrews and washers. Apply Loctite 271 (Hyster P/N 226414) or equivalent to the threads of the capscrews before installation. Tighten the capscrews to 256 N•m (189 lbf ft).
- Connect the power cables to the traction motor.
- Remove the plugs from the hydraulic brake lines and the service brake caliper. Attach the brake lines to the calipers.
- Install the clevis pin and attach the park brake linkage. Install a new cotter pin.
- Install the disc brake shield between the transaxle. Install the drive wheels. Tighten the wheel nuts to 170 N•m (125 lbf ft).
- Remove the lift truck from the blocks.
- Fill the transaxle with the recommended gear oil. Fill until oil starts to come out of the level plug opening. Install the plugs and tighten to 22 N•m (16 lbf ft).
- Install the floor plates.
- Check, adjust, and bleed the brakes if necessary. See the section **Brakes Brake System** 1800 SRM 570.
- Install the mast assembly and connect the battery. See the section **Masts Mast, Repairs** 4000 SRM 522 for installation information.

18. Install the traction motor on the transaxle, and install the capscrews and washers. Tighten the capscrews to 41 to 50 N•m (30 to 37 lbf ft).
19. Install the traction motor and transaxle assembly in the frame. Refer to Transaxle Repair, Install.

## S1 Series Transaxle

### DISASSEMBLE



#### WARNING

The transaxle and traction motor assembly is heavy. Be sure that all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the transaxle and traction motor. The transaxle and traction motor can weigh approximately 111 kg (245 lb). The traction motor alone weighs approximately 34.5 kg (76 lb).

1. Remove the four capscrews and washers retaining the traction motor to the transaxle. Remove the traction motor. The traction motor has an M10 × 1.5 threaded hole in the top of the motor to enable a lifting eye to be installed. See Figure 3.
2. Remove the service brake and the mounting bracket from the transaxle housing. See the section **Brake System** 1800 SRM 570.
3. Remove the park brake and park brake bracket from the transaxle housing. See the section **Brake System** 1800 SRM 570.
4. Remove the three capscrews and lockwashers retaining the cap to the housing. Remove the cap.
5. Remove the eight capscrews and lockwashers retaining the cover to the housing.
6. Straighten the staked portion of both nuts on the intermediate shaft. Remove the nut and plain washer from the brake rotor side of the shaft.
7. Remove the cover, service brake and park brake assemblies, and the brake rotor as one item from the housing. The spacer, oil seal, and bearing for the intermediate shaft will come off with the housing.
8. Remove the remaining nut and spacer from the intermediate shaft. Remove the intermediate shaft assembly from the housing.
9. Remove the ring gear and key from the shaft. Wire the shims together for use at assembly.

Remove the tapered roller bearings, shims, and spacers from the intermediate shaft.

10. Straighten the staked portion of the nut retaining the helical gear to the axle shaft. Remove the nut, washer, and the helical gear. Use a drift to remove the axle shaft from the housing. Remove the bearings from the housing.
11. Remove the tapered roller bearings and oil seal from the housing.
12. Remove the O-ring from the intermediate shaft.
13. If necessary, remove the pinion gear from the traction motor shaft by removing the nut. Remove the pinion gear and the shims. Wire the shims together for reuse at assembly.
14. Remove the O-ring from the traction motor.

### ASSEMBLE

1. Inspect the housing, cover, and internal components for wear or damage. Refer to Transaxle Repair, Inspect.
2. If the axle shaft wheel studs were removed, coat the threads of the studs with Loctite 271 (Hyster P/N 226414) or equivalent. Install the studs in the axle shaft until the studs are 32 mm (1.26 in.) above the face of the axle shaft.
3. Install the bearings in the transaxle housing for the axle shaft. Apply Loctite 515 (Hyster P/N 313022) or equivalent to oil seal and install oil seal into the housing. Carefully install the axle shaft into the housing. Install the helical gear on the axle shaft. Install the washer and nut on the axle shaft. Tighten the stake nut to 200 N•m (148 lbf ft) lubricated, while rotating the axle shaft to seat the bearings. Back off on the stake nut until the axle shaft rotates freely with no end play. Tighten the stake nut to 40 N•m (30 lbf ft). Stake the nut, using an 8 mm (0.31 in.) spherical end punch, until reaching the bottom of the slot in the axle shaft.

## General

This section describes disassembly and assembly procedures for the repair of transaxle assemblies used in J30XMT, J35XMT, and J40XMT or J1.60XMT, J1.80XMT, J2.00XMT, J30XMT<sub>2</sub>, J35XMT<sub>2</sub>, and J40XMT<sub>2</sub> lift trucks. This series of lift trucks can be equipped with either solid tires, pneumatic-shaped solid tires, or pneumatic tires. A description of the wheels and tires is included in the section **Periodic Maintenance** 8000 SRM 699 or **Periodic Maintenance** 8000 SRM 772.

The transmission/drive axle assembly is called a transaxle. There are two different transaxle assemblies used on the lift trucks. The S1 series was used from product introduction until mid 1996. Trucks manufactured after mid 1996 are equipped with the S2 series transaxle.

When servicing the transaxle, it is important to determine if it is an S1 series or S2 series assembly. See Table 1 and Table 2. Components and assemblies are not interchangeable. Different traction motors are used for the different transaxle assemblies. Left and right transaxles must always be of the same series.

The lift truck has a left and a right drive unit. Each of the two drive units consists of a transaxle and a

traction motor. Each transaxle assembly is attached to the truck frame. The traction motor is mounted directly on the transaxle. The torque of the traction motor is transmitted independently to each drive wheel by dual-reduction gearing in each transaxle assembly. The pinion gear engages the matched ring gear in the transaxle assembly. The traction motors normally turn in opposite directions to enable the drive wheels to turn in the same direction. When the steering angle of the steer tire reaches 60 degrees, power to the inside traction motor is removed. When the angle of the steer tire reaches 85 degrees, the inside traction motor is reversed. This arrangement permits this series of lift trucks to turn in a smaller than normal space.

The transaxle features a dual-reduction design utilizing both spiral bevel and helical gears. Left and right transaxle assemblies of each series are the same except for the housing, housing cover, service brake bracket, and park brake bracket. There are left and right assemblies for these components.

Disc brakes are connected to the intermediate shafts of the gear reduction system. Both the park and service brake use the same brake rotor.

**Table 1. Transaxle Identification**

S1 Series Transaxle	S2 Series Transaxle
Brake rotor retained with nut.	Brake rotor retained with bolt.
No grease fittings.	Grease fitting at top of case for pinion bearing lubrication.
Pinion gear is mounted on traction motor armature shaft.	Pinion gear is part of the transaxle assembly (integral).
Traction motor has upper and lower bearings.	Traction motor has upper (brush end) bearing only.

**Table 2. Transaxle Specifications**

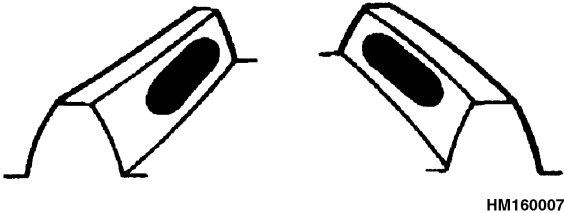
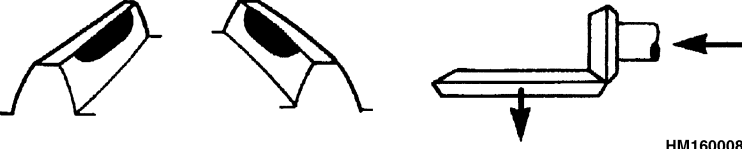

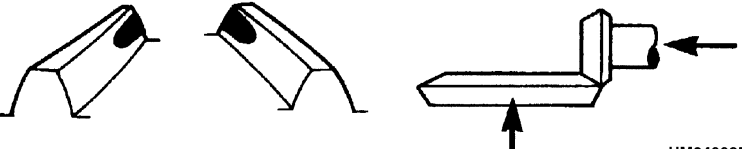
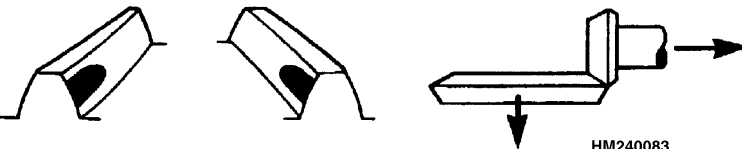
	S1 Series Transaxle	S2 Series Transaxle
Weight	80 kg (177 lb)	80 kg (177 lb)
Gear Ratio	15.87:1	15.61:1
Gear Oil Capacity	1.3 liter (0.34 gal)	1.7 liter (0.45 gal)

**NOTE:** As the pinion gear is moved in or out, the ring gear must be moved in the opposite direction approximately 1/4 of the distance the pinion gear has moved.

This adjustment factor is necessary due to the angle between the ring and pinion gears.

30. Repeat this procedure from Step 21.

**Table 3. Gear Teeth Contact Pattern**

<b>Adjustment of Correct Contact Pattern of Gear Teeth</b>	
<p><b>Correct Contact Pattern</b></p> 	<p><b>Step 1.</b> Apply gear marking compound to about 12 teeth of the ring gear.</p> <p><b>Step 2.</b> Apply a small amount of resistance to the drive wheel and rotate the pinion gear using a wrench. Rotate the pinion gear so the ring gear makes one revolution.</p> <p><b>Step 3.</b> Check the tooth contact pattern on the ring gear. Check the pattern on the side of the tooth where the pinion teeth apply the force.</p>
<b>Wrong Tooth Contact Pattern</b>	
<p><b>High Narrow Contact</b></p> 	<p>If the pattern shows the pinion gear is too far from the center of the ring gear, an adjustment in the direction of the arrows is necessary. Adjust the thickness of the shim sets as described in the assembly procedure.</p>
<p><b>Low Narrow Contact</b></p> 	<p>If the pattern shows the pinion gear is too close to the center of the ring gear, an adjustment in the direction of the arrows is necessary. Adjust the thickness of the shim sets as described in the assembly procedure.</p>
<p><b>Short Heel Contact</b></p> 	<p>If the pattern shows the pinion gear is too close to the center of the ring gear, an adjustment in the direction of the arrows is necessary. Adjust the shim sets at the ring gear as described in the assembly procedure.</p>
<p><b>Short Toe Contact</b></p> 	<p>If the pattern shows the pinion gear is too far from the center of the ring gear, an adjustment in the direction of the arrows is necessary. Adjust the shim sets at the spiral ring gear as described in the assembly procedure.</p>

# TROUBLESHOOTING AND ADJUSTMENTS WITH A COMPUTER

## For EV-100ZX, EV-T100, SR (SEM) And SP Motor Controllers

### COMPUTER SYSTEM

A Personal Computer (PC) can be used to set traction or pump motor functions, indicate status codes (possible faults) and make adjustments to the operating limits set in the control cards. The PC must have the following **minimum** configuration to program motor controllers:

- a. IBM® (or clone) Personal Computer (80286 or better) with 640 KB (512KB available) of RAM, a disk drive for a 3.5 inch diskette. A second disk drive or a hard disk is recommended for data storage.
- b. The GE SENTRY SOFTWARE® program will require an IBM 486DX/33 MHZ or faster compatible computer to operate Real Time diagnostics.
- c. One open serial Communications Port, either COM 1 or COM 2 on the PC.
- d. Shielded cable assembly, nine-pin DB-9 serial cable, male to female. [This cable assembly is a standard computer extension cable with straight-through wiring. Other cable lengths can be used that are within the serial cable limits of personal computers (recommendation is less than 10 meters (30 ft).] This cable assembly is normally available from vendors of computer equipment.
- e. Adapter cable for ZX controls. This cable has a female D-9 connector on one end and a Y-plug adapter on the other end. The cable can be constructed from individual parts. Cable connector pin assignments are shown in TABLE 1.
- f. Adapter cable for SR controls. This cable has a female DB-25 connector on one end and a 12-pin (Y-plug available for ZX controllers) adapter on the other end. The cable can be constructed from individual parts. Cable connector pin assignments are shown in TABLE 1.
- g. Some computers can require an adapter DB-25F (female) to DB-9 (male). Connector to connector pin assignments are shown in TABLE 2.
- h. HYTECH™ software diskette (Hyster Part No. 897702). This diskette has two main programs:

- a program to set traction or pump motor functions, indicate status codes (possible malfunctions) and make adjustments to the operating limits set in the control cards.
- a communications program that permits a remote computer to connect to a local computer through a telephone and modem connection. This communications program permits a service engineer at a remote location to run the local programs and make checks and adjustments to the lift truck.

TABLE 1. CABLE CONNECTIONS -  
COMPUTER TO CONTROL

<b>Model EV-100ZX and EV-T100 CONTROLS</b>	
<b>Computer Connector (9-Pin)</b>	<b>Controller Connector (14-Pin) Plug-Y</b>
Pin 2 (Receive)	Pin 14
Pin 3 (Transmit)	Pin 13
Pin 5 (Signal ground)	Pin 4
Pin 4 to pin 6 (Jumper)	
Pin 7 to pin 8 (Jumper)	
<b>Model SR and SP CONTROLS</b>	
<b>Computer Connector (9-Pin)</b>	<b>Controller Connector (12-Pin) Plug-Y</b>
Pin 2 (Receive)	Pin 12
Pin 3 (Transmit)	Pin 11
Pin 5 (Signal ground)	Pin 4
Pin 4 to pin 6 (Jumper)	
Pin 7 to pin 8 (Jumper)	

TABLE 2. ADAPTER PINS (DB25F to DB9)

<b>25-Pin Connector</b>	<b>9-Pin Connector</b>
Pin 2	Pin 3
Pin 3	Pin 2
Pin 4	Pin 7
Pin 5	Pin 8
Pin 6	Pin 6
Pin 7	Pin 5
Pin 8	Pin 1
Pin 20	Pin 4
Pin 22	Pin 9

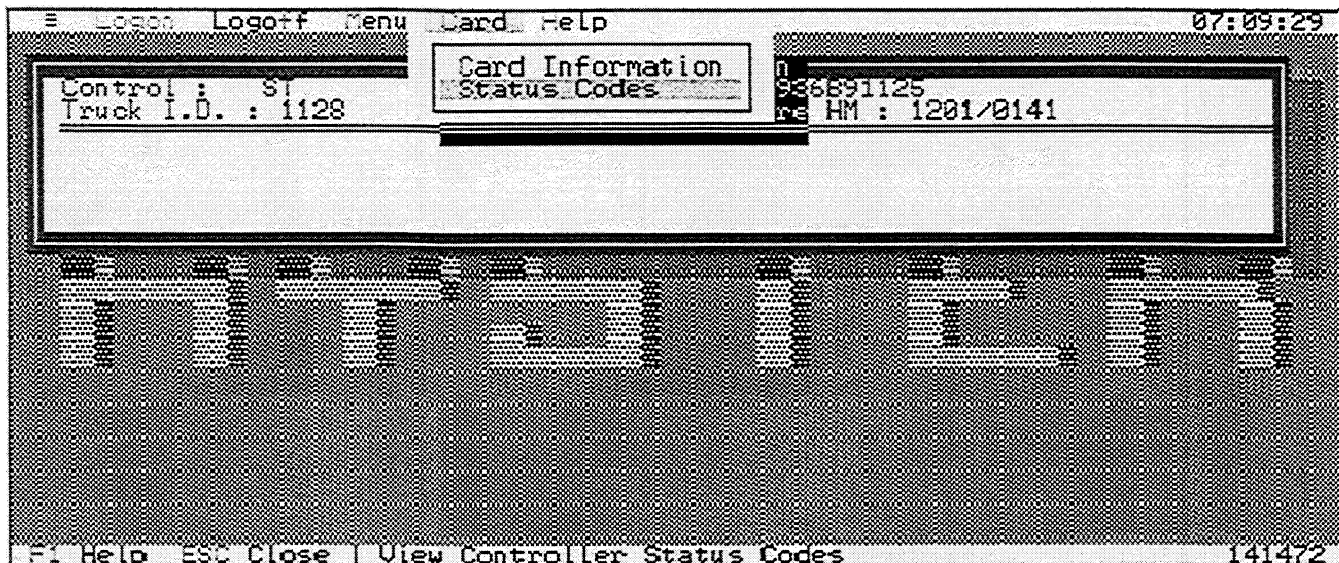


FIGURE 13. ACCESS TO THE STATUS CODE LIST

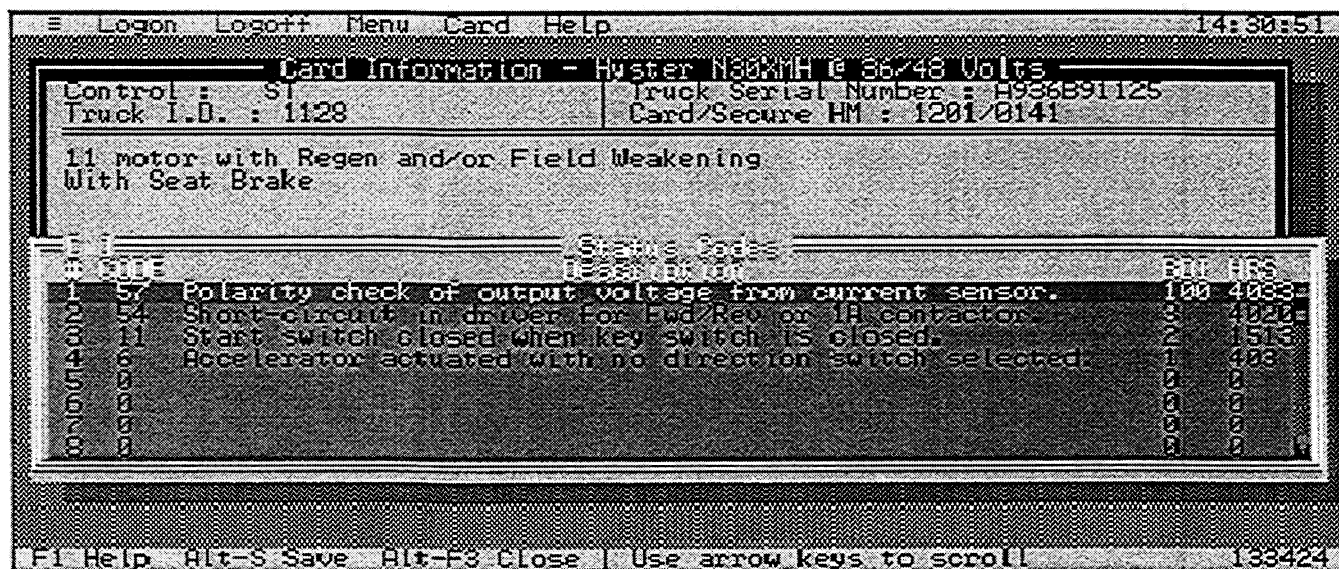


FIGURE 14. VIEWING THE STATUS CODE LIST

The columns show the following information:

# column indicates the Status Codes in the order they were sensed. The most recent Status Code is number 1.

Code indicates the Status Code (-01 through -181).

Description shows the title of the Status Code Chart.

BDI shows the battery charge at the time the Status Code was sensed. (Traction control cards only on lift trucks with a GE BDI.)

Hours shows the number of hours indicated by the Hourmeter when the status code was sensed.

### Saving The Status Code To Disk

After viewing the status codes, the data can be saved to the PC disk for reference or to make a hard copy. Pressing Alt-S displays the Status Codes dialogue box as shown in FIGURE 15. The Name field indicates a file extension for the Status Codes list. It is recommended that you do not change this extension. The standard convention for the file name, indicated by an asterisk (\*), is to use the truck number. The default file name extensions is: \*.stc. After the file name is entered, select OK. This saves the status codes to the disk and closes the Status Codes dialogue box.

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This section is for the following models:

J2.00-3.20XM (J40-60XM, J40-60XM<sub>2</sub>) [A216];  
 E1.25-2.00XM (E25-40XM, E25-40XM<sub>2</sub>) [D114];  
 E2.00-3.20XM (E45-65XM, E45-65XM<sub>2</sub>) [F108];  
 E3.50-5.50XL (E70-120XL, E70-120XL<sub>3</sub>) [C098];  
     J30-40XMT<sub>2</sub> [H160];  
     J1.6-2.0XMT<sub>2</sub> [G160];  
 N30XMH, N30XMH<sub>2</sub> [C210]

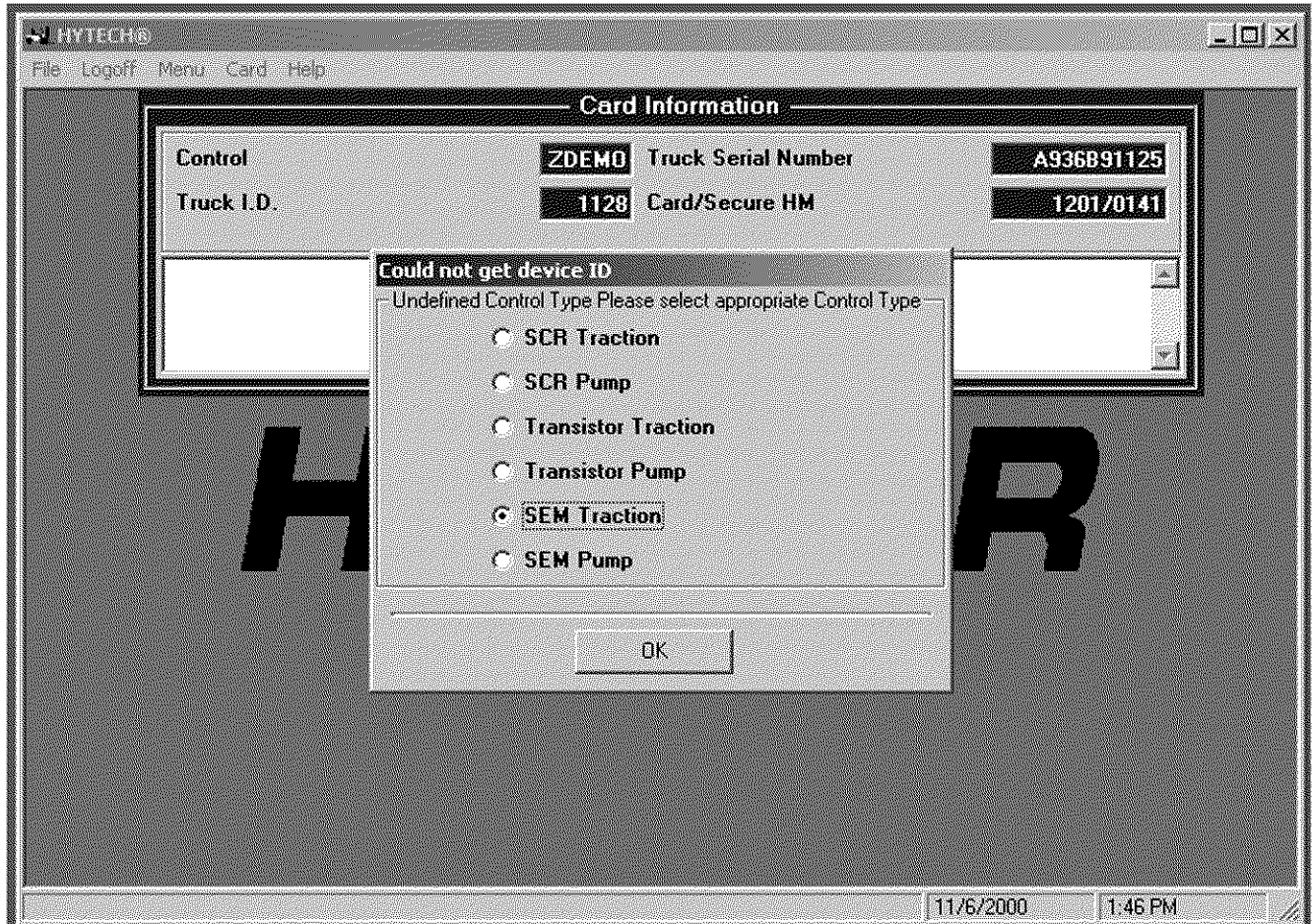
## SELECT LIFT TRUCK SERIES



### CAUTION

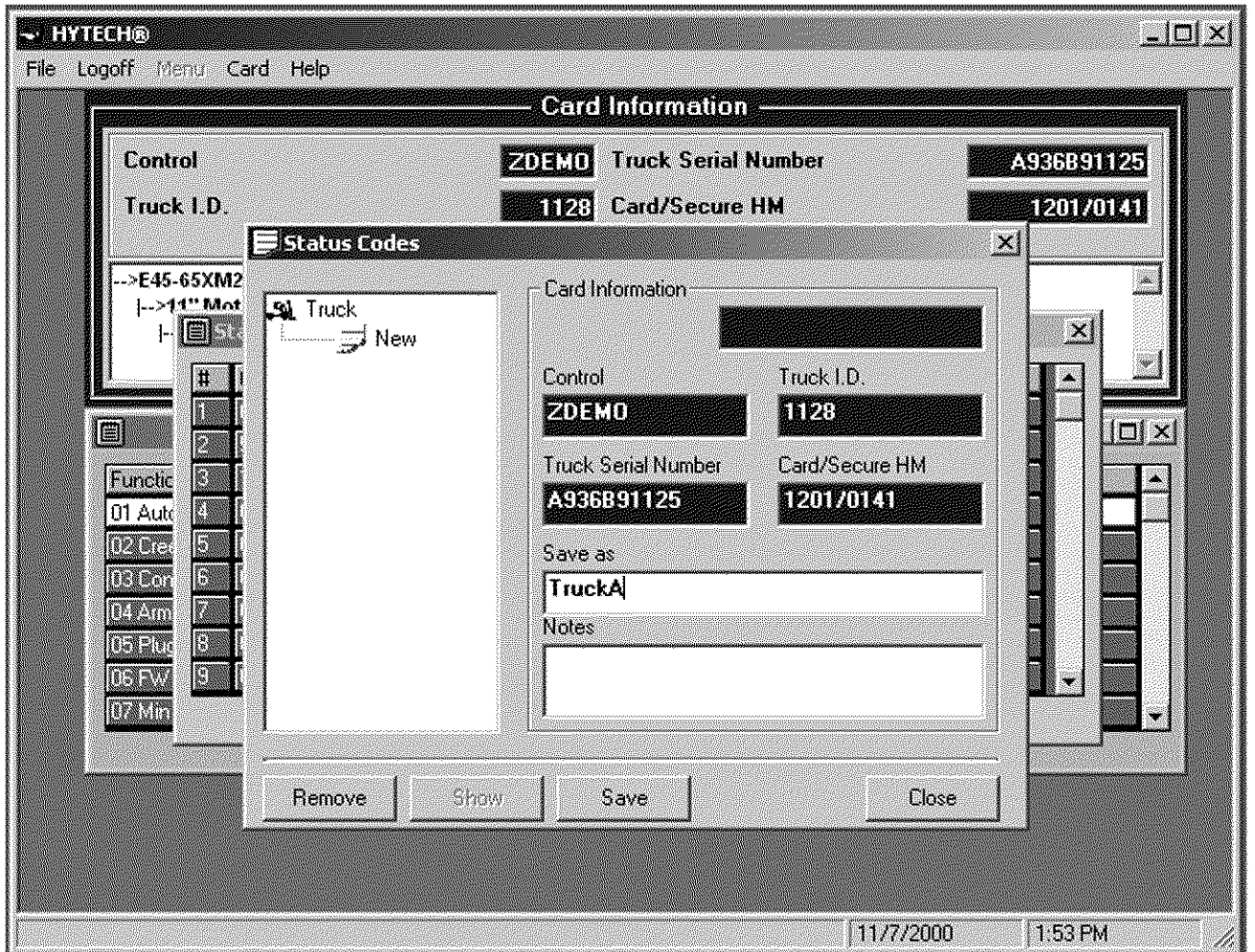
The Model Undefined option will permit the user to set Cards (parameter numbers) and values that can cause damage to the motor controller and the lift truck. Do not use this option without the instructions from a Hyster Company service engineer.

If the program recognizes the control type, a menu of the truck series using the control type is displayed. See Figure 7. The program also automatically determines if the control is a traction control or a hydraulic pump control. If the control type is not recognized, the screen shown in Figure 8 appears.



HM080879

*Figure 8. Undefined Controller Type*



HM080889

Figure 18. Saving Status Codes

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