SERVICE REPAIR

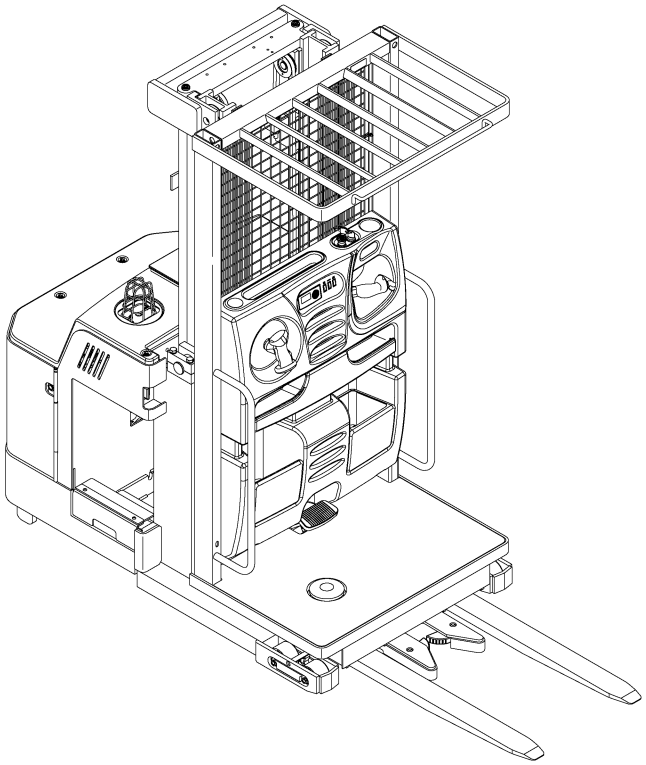
MANUAL

Hyster E174 (R30XMS3) Forklift

HYSTER

ELECTRICAL SYSTEM [E174 (R30XMS3)]

R30XMS3 [E174]



HYSTER

PART NO. 4031797

2200 SRM 1467

SAFETY PRECAUTIONS
MAINTENANCE AND REPAIR

- The Service Manuals are updated on a regular basis, but may not reflect recent design changes to the product. Updated technical service information may be available from your local authorized Hyster® dealer. Service Manuals provide general guidelines for maintenance and service and are intended for use by trained and experienced technicians. Failure to properly maintain equipment or to follow instructions contained in the Service Manual could result in damage to the products, personal injury, property damage or death.
- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury and property damage.

On the lift truck, the WARNING symbol and word are on orange background. The CAUTION symbol and word are on yellow background.

TABLE OF CONTENTS

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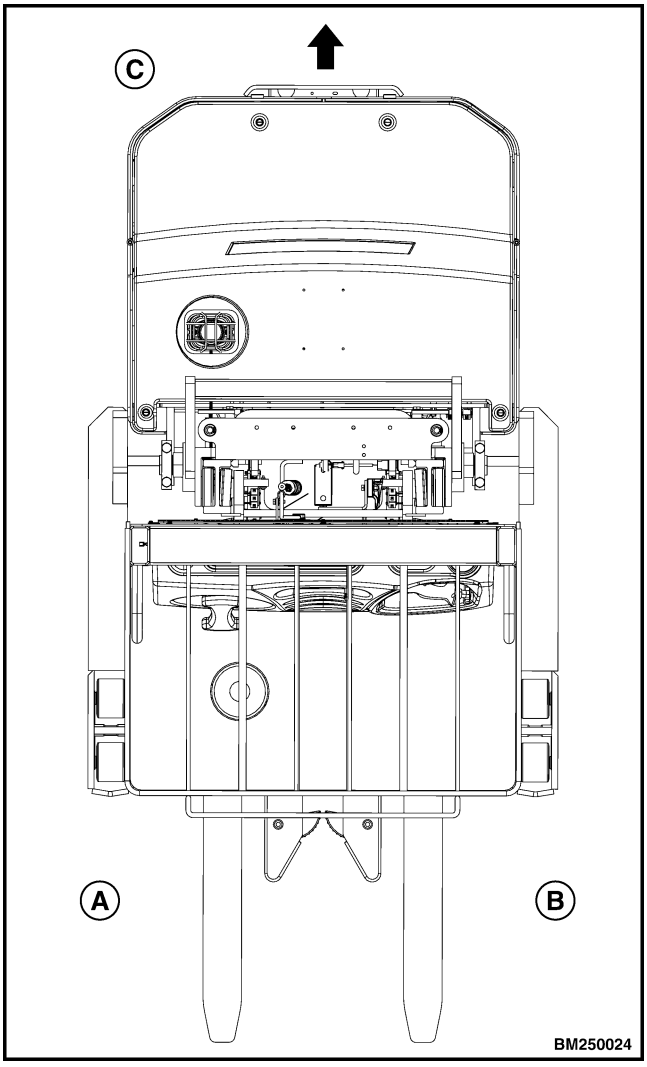
This section is for the following models:

(R30XMS3) [E174]

General

This section applies to the R30XMS3. This section has the checks, adjustments, and repair procedures for parts of the electrical system. Throughout this section, forward will refer to an operator standing in the truck facing the steer tire with the forks trailing. Left and right will be determined by the point of view of an operator situated in the operator compartment and facing the steer tire. See Figure 1.



A. LEFT SIDE
B. RIGHT SIDE
C. FORWARD TRAVEL

Figure 1. Truck Orientation

WARNING

DO NOT operate a lift truck that needs adjustments or repairs. Report the need for adjustments or repairs immediately. If adjustment or repair is necessary, attach a DO NOT OPERATE tag to the control handle. Remove the key from the key switch. Some of the checks and adjustments are done with the battery connected. Never have any metal on your fingers, arms, or neck. These metal items can accidentally make an electrical connection and cause injury.

WARNING

To avoid injury and prevent electrical shock, perform the following steps before doing any troubleshooting, adjustments, connecting, or disconnecting a handset or PC:

1. **Block the lift truck so that the drive wheels are off the floor. See the Operator's Manual.**
2. **Turn the key switch to the OFF position and disconnect the battery.**
3. **Discharge the capacitors in the controllers. See Discharging the Capacitors. DO NOT short across the motor controller terminals with a screwdriver or jumper wire. Remove the 200-ohm, 2-watt resistor before reconnecting the battery.**

CAUTION

To avoid controller damage:

1. **ALWAYS disconnect the battery when servicing the controllers.**
2. **ALWAYS discharge the capacitors using the proper procedure before performing any service. See Discharging the Capacitors.**
3. **NEVER put power to the controller with any power wire disconnected or loose.**
4. **NEVER short any controller terminal or motor terminal to battery (+), battery (−), or the frame.**

CAUTION

Correct meter polarity is necessary for some checks. Meter correct positive is indicated as (+). Meter correct negative is indicated as (−).

Use a digital meter with a minimum rating of 20,000 ohms per volt to make accurate measurements.

DISCHARGING THE CAPACITORS

WARNING

DO NOT make repairs or adjustments unless you have been properly trained and authorized to do so. Improper repairs and adjustments can create dangerous operating conditions. DO NOT operate a lift truck that needs repairs. Report the need for repairs to your supervisor immediately. If repair is necessary, attach a DO NOT OPERATE tag on the steering wheel and disconnect the battery.

Disconnect the battery and allow the capacitors to discharge before opening any compartment covers or inspecting or repairing the electrical system. DO NOT place tools on top of the battery. If a tool causes a short circuit, the high current flow from the battery can cause personal injury or property damage.

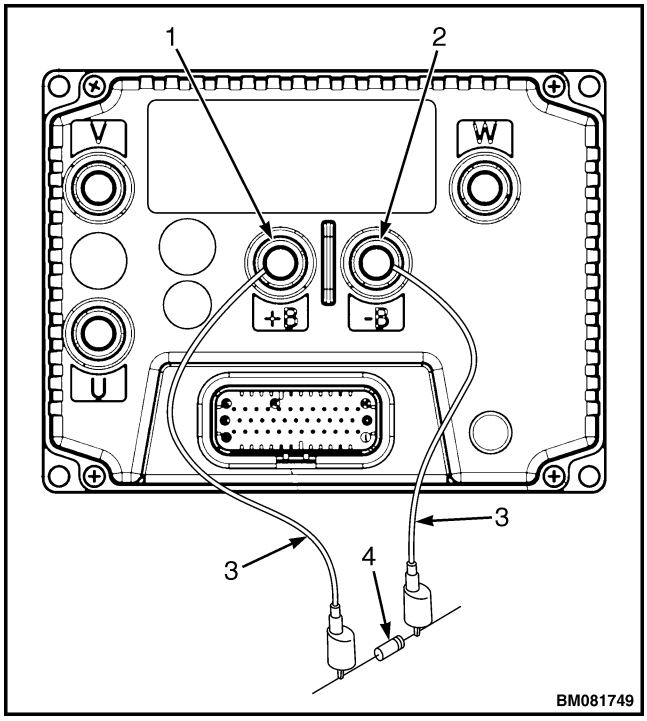
Some checks and adjustments are performed with the battery connected. DO NOT connect the battery until the procedure instructs you to do so. Never wear any metallic items on your fingers, arms, or neck. Metal items can accidentally make an electrical connection and cause injury.

Before performing any tests or adjustments, block the lift truck to prevent unexpected movement.

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

DO NOT short across the motor controller terminals with a screwdriver or jumper wire.

1. To avoid injury and prevent electrical shock, perform the following steps (Step 2 through Step 6 below) to discharge the capacitors before troubleshooting, making adjustments or repairs, or connecting or disconnecting a PC service tool:
2. Turn the key or keyless switch to the **OFF** position and **DISCONNECT THE BATTERY**.
3. Block the lift truck so the drive wheels are off the floor to prevent lift truck from moving.
4. Remove the electrical compartment cover to access the lift controller.
5. Discharge the capacitors in the controllers by connecting a 200-ohm, 2-watt resistor across the lift controller's negative (B−) and positive (B+) terminals. Wait at least 20 seconds to be sure that the capacitors are fully discharged. See Figure 2.
6. Remove the resistor from the controller(s) and reinstall the covers before returning the lift truck to service.



1. B+ TERMINAL
2. B− TERMINAL
3. JUMPER LEADS
4. 200-OHM, 2-WATT RESISTOR

Figure 2. Traction Controller

Major Electrical System Features

- Keep It Simple philosophy - a simple hardware design with fewer parts - better reliability
- Programmable setup of the truck with operator controls and dash display
- Noncontact encoders that give position of lift, steering input, and steer drive tire angle
- Variable Hall effect sensor for throttle
- On-board diagnostics with text display
- AC traction motor and controller
- Regenerative braking for minimal wear of park brake
- Control Area Network (CAN) bus digital data link
- Alphanumeric multifunction display
- Continuous height sensing (encoder)
- Height, steer angle, and travel speed relationships
- Battery discharge indication adjustable for regular or maintenance-free batteries

INTEGRATED SYSTEM

This orderpicker uses a CANbus, two-wire, twisted pair, serial communications network bus to connect several electronic subsystems together to form one integrated system.

CANBUS ADVANTAGES

- Increased reliability
- Substantial reduction in connections and wiring complexity
- Extensive function monitoring capability
- Serial bus simplicity (two wires)
- Easy information exchange between subsystems

CANBUS COMMUNICATIONS

Electronic controllers connected by the CANbus data link are as follows:

- CAN I/O
- ACE0
- EPS
- ECO Smart Dash Display
- Forward Antenna
- Reverse Antenna

The two-wire, twisted pair, CANbus carries the following data:

- Traction throttle
- Traction direction
- Horn
- Lift/Lower
- Steering position and steering rate
- Status information and diagnostic information.

Electric Steering

The electric steering is accomplished using an AC Induction Motor connected to a 50:1 gear reduction unit. This AC motor and gear reduction unit is supplied complete and is called the Steer Unit Assembly. The AC Induction Motor is powered by a 3-Phase AC Induction Motor Controller. The AC Induction Controller accepts steering commands via the CANbus from the CAN I/O unit located under the dash.

Centering Proximity Sensor

CAUTION

It is very important that the proximity sensor be connected to the harness and that the sensor air gap is set correctly prior to key-on. If the proximity sensor is not in place and not able to sense the target plate, then the steer system will hit the mechanical stops at key-on. If the steer system hits the mechanical stops, then the steer motor and gear reduction assembly must be replaced.

Every time the key switch is turned on the steering system centers the drive wheel. The steering system uses the feedback from a proximity sensor mounted next to the drive unit assembly. The proximity sensor senses a target plate that establishes the drive wheel center position.

Traction

Traction is provided by an AC motor and a controller. The controller is connected to the CANbus communications link over which it receives commands and reports faults and status information. It also has auxiliary transistor outputs that control the traction main contactor, lift pump contactor, lower solenoid valve, brake coil, and horn.

CAN I/O

The CAN I/O connects the following devices to the CANbus network.

Input Devices

- Throttle Hall Sensor - three wires, battery negative, positive 5 volts, and the variable output having an approximate range of 1.0 volt (full reverse command) to 4.0 volts (full forward command), with 2.5 volts at neutral.
- Lift and Lower switches - connect to two digital inputs on the CAN I/O. Used on small chassis trucks, not on large chassis trucks.
- Lift and Lower Hall effect sensor - used on large chassis trucks, not on small chassis trucks.
- Horn switch - connects to one digital input on the CAN I/O.
- Foot switch - connects to one digital input on the CAN I/O.

NOTE: The foot switch, side gate switches, and the slack chain switches are sourced from wire 202. Wire 202 is connected to pin 9 of the CAN I/O. Pin 9 is at battery positive voltage.

- Side gate switches - both in series, connect to one digital input on the CAN I/O.
- Slack chain switches - both in series, connect to one digital input on the CAN I/O.
- Steering analog input for Return-to-Center - a dual Hall Effect device is utilized connected to a 5 volt supply. There are two complementary outputs with a voltage range of 0.5 to 4.5 volts. The voltages are converted to a digital signal. This information is then sent over the CANbus to provide the steer motor speed and direction. See Figure 3.

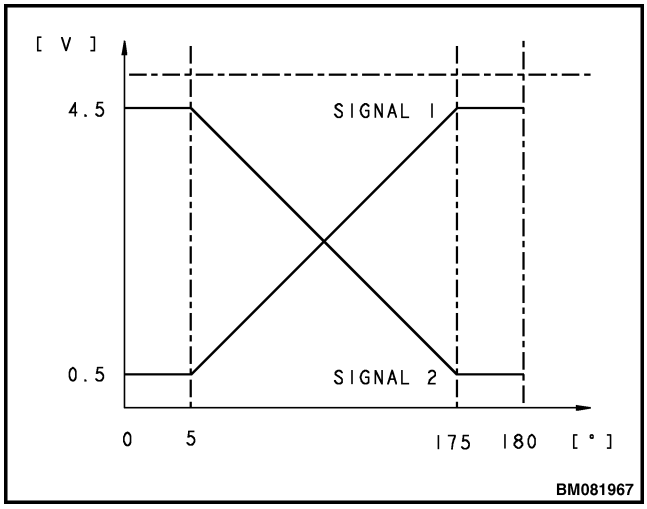


Figure 3. Rotary Hall Effect Sensor Signal

- Steering input for Multiturn Steering - a stepper motor is used as a generator to provide the steer motor direction and speed control. The stepper motor supplies two quadrature sine waves that are converted to digital signals. This information is then sent over the CANbus to provide the steer motor speed and direction.
- Height encoder - a digital output device with two bits each with 128 pulses per revolution (256 total). It is powered by the 5-volt source from the CAN I/O.

Output Devices

- Piezo beeper - driven by one digital output, pull-down transistor.

ENCODER INTEGRITY

Steering and height encoders are tested continuously for current draw. If the total current draw from the two encoders and the Hall effect sensor is too high or too low, a fault will be generated and truck operation will be inhibited. Additional software continuously checks the output bit sequence activity of the steering input encoder to ensure that both bits are operating.

TEST ENCODERS

NOTE: This procedure applies to the height encoder and the AC motor speed encoders. The height encoder operates from a 5 volt supply and the AC motor speed encoders operate from a 12 volt supply.

Conventional means can be used to diagnose the encoders as follows. Using a voltmeter, determine if 5 or 12 volts and battery negative are going to each encoder by back-probing the connector. If good, then connect to one output channel and battery negative, and rotate the encoder very slowly to see if the input goes on/off/on (0 then 5 volts from the height encoder) when the encoder is rotated slowly. Check the other bit also. If they are both outputting, the encoder is OK. See Setup.

PROXIMITY SWITCHES

These are noncontact devices which sense the presence of steel. They have three wires going to them: battery negative, supply voltage, and an output signal. See Table 1. They also have a built-in indicator light that lights the collar where the wires enter the proximity switch. These devices can be checked by looking at the indicator light and by testing the output with a voltmeter to see that it changes with and without the steel in front of it.

KEY SWITCH

Battery positive is connected to the key switch, through the Over-the-Mast cable, when the battery disconnect switch is closed and 10 amp fuse, FUSE1, is in place. The output side of the key switch, wire 10, powers the logic for the traction controller, the steer controller, and the AC hoist controller option when preset. The key switch also directly powers the main contactor coil, the mast prox sensor, and the strobe light. The CAN I/O unit and display are powered from the key switch through a 2.7 amp PTC, labeld PTC1. The PTC, Positive Temperature Coefficient Thermister, is built into the harness.

MULTIFUNCTION DISPLAYS

The Ecosmart™ display is connected to the system via the CANbus. It has a graphic LCD display with back lighting. During operation the graphics show battery charge, throttle percent, travel speed, steer angle, truck hours, and the selected performance mode. When in setup mode or if a fault condition occurs, the LCD will change from the normal graphics to an alphanumeric message stating specific codes and parameter values. Five LED status indicators are provided with symbols (left to right): battery, wrench, thermometer, operator presence, and one extra LED for optional use. There are five buttons used for entering passwords, changing performance modes, and navigating the service menu.

BDI

The battery state of charge is determined in the traction controller circuitry and software. The battery voltage is sensed at the traction controller. There are 10 steps shown on the left of the display. Flooded cell and maintenance-free battery types can be accommodated by changing the setup parameters. In the Setup Menu, choose Battery Type; Flooded Cell or Maintenance Free. Check with your battery manufacturer for recommended settings.

SPEED

The traction throttle command is shown by 8 step bars at the top of the display. The actual speed is shown below in km/h or mph, selectable by a parameter in the setup menu.

Table 1. Proximity Switches

Device	Supply Voltage (Sensing Metal)	Output Voltage (Sensing Metal)	Indicator Light (Sensing Metal)	PNP or NPN
Mast Proximity Switch	B+ (Wire 10)	B+	ON	PNP Sourcing
MDU Proximity Switch	+12 Volts	+12 Volts	ON	NPN Sourcing

STEER ANGLE

The actual steer wheel angle is shown as a graphic bar, this will display straight (0°) to full left and right (±90°).

TRUCK HOURS

The Truck Hours are displayed in the lower right corner by default.

OPERATIONAL MODE

The current operating mode being used is indicated by numbers 1 to 4 in the upper right corner. These correspond to modes 1 through 4. Mode 1 being "Turtle" mode and Mode 4 being "Rabbit" or Hi-performance mode.

Setup

NOTE: For additional information on the menu system, refer to the section **User Interface Service-Level Functions =>S/N A169N02999L =>S/N A185N02999L =>S/N H118N02999L =>S/N E174N02999L** 2200SRM1470 or **User Interface Supervisor Functions =>S/N A169N02999L =>S/N A185N02999L =>S/N H118N02999L =>S/N E174N02999L** 2200SRM1469.

The setup menu can be entered at any time by pressing the "Enter" (#5 button) twice. To exit the setup menu, press the left (#4 button) several times or turn the key switch to the **OFF** position, and then back to the **ON** position.

SETUP INSTRUCTIONS

1. Move the lift truck to a safe, level area.
2. Block the drive wheels to prevent movement of the lift truck. See **Periodic Maintenance** 8000SRM1472 - How To Put A Lift Truck On Blocks.
3. Remove the front cover to gain access to controllers.

ACE0 Traction Control Unit

NOTE: For all the display examples shown below, x's represent numerical values which will vary with parameter adjustments.

If the Traction Controller is replaced, perform the following procedure immediately after installation.

1. Connect all electrical connections prior to initial startup of the Traction Controller. During initial startup, the Traction Controller senses system devices to determine option configuration and initial calibrations.

   Check that the multifunction handle is in the neutral position and the brake pedal is up during initial startup.
2. When a controller is replaced then the truck CDF file is to be downloaded with the Field Service Tool
3. Check and ensure all parameters are set to the default values. After reviewing and adjusting all setup parameters, refer to **Steering System** 1600SRM1462 for the Steer Calibration procedure.

NORMAL OPERATION

Display

Password Access

Following truck startup, if the Operator Password feature is enabled, the operator will be prompted to enter their operator password. The display will show five empty placeholders. The operator then must enter the five-digit operator-level password. The number of possible password combinations range from 11111 to 55555. Pressing a display button will result in the corresponding digit being shown on the LCD display from left to right. After the 5th password digit is entered, the display will proceed with approval of the password. If the code is correct, the display will revert to normal operation, and the vehicle is enabled. If the code is incorrect, the truck will remain disabled until the correct operator password is entered (multiple attempts are allowed).

Startup Checklist

If the Startup Checklist feature has been enabled, the operator will be prompted to complete the Startup Checklist. The Startup Checklist will consist of items that the operator must complete each time the key switch is turned **ON**.

1. The display presents a series of questions to the operator.
2. The operator must respond to each question by either pressing the Up Arrow button (#1) for "Yes" or the Down Arrow button (#3) for "NO." There must be an answer to each request before the next request is shown on the display. All requests must be performed before the truck can begin operation.
3. When this feature is enabled, the following items will show on the display each time the key is turned ON. Display button 1 (Up Arrow) is used to answer "OK." Display button 3 (Down Arrow) is used to answer "NOT OK."
    - Chck Display
    - Chck Multif Handl
    - Chck Hyd Oil Lvl
    - Chck Lights
    - Chck Horn
    - Chck Back Alarm
    - Chck Brakes
    - Chck for Leaks
    - Chck Steering
    - Chck Battery
    - Chck Devals
    - Chck Forks
    - Chck Plaft/Chain
    - Chck Restraint
    - Chck Lift Chains
    - Chck OVHD Guard
    - Chck Static Straps
    - Chck Tire and Wheel
    - Chck Load Wheels

NOTE: If "NOT OK" is selected for any of the check list items, "**Service Required, No lift Permitted**" will be displayed. The operator must re-key to re-enter the check list.

Following successful completion of the startup checklist, the display will revert to the normal screen and the truck will become operational.

Truck Operation Mode

The dash display button 1 through 4 are used for mode selection during key switch **ON**. When the display is in normal operation, the respective Mode number will be displayed at the top right of the screen.

- The modes are numbered 1, 2, 3, and 4. Mode 1 corresponds to slowest performance mode and 4 corresponds to most aggressive performance mode.
- Modes are selected using the corresponding numbered display buttons (1 through 4).
- To change the operating mode, the lift truck **MUST BE** stopped with the control handle in the neutral position.
- The last mode selected will be retained and will be displayed on the dash even after the key has been recycled.

If the Operator Password feature is enabled, each password has a maximum mode programmed with it. This will be the highest mode level allowed for that particular operator. The operator may select lesser modes.

DIAGNOSTICS

Several levels of diagnostics are utilized. Internal tests are performed at every truck startup. Run-time diagnostic information is available through the display. This would include controller temperatures, motor speeds, and motor AC line current. The units for the motor AC line current is amps RMS. There are also non-run-time diagnostics. Input interlock switches can be cycled and checked, such as the slack chain switches and the foot switch. If the operator is on the foot switch at the Key-ON, then the operator must lift their foot to the open condition, then close the foot switch to begin operation. If the operator is off the foot switch at Key-ON then depressing the foot switch allows for truck operation. Also available are the output voltages of the analog input sensors such as the hydraulic throttle for the large chassis, straddle, and furniture trucks. See **User Interface Service-Level Functions =>S/N A169N02999L =>S/N A185N02999L =>S/N H118N02999L =>S/N E174N02999L** 2200SRM1470 for more details. During truck operations, fault conditions detected by any of the controllers are logged in the fault log. For fault codes and display messages, see **AC Motor Controller** 2200SRM1466.

Power-On Self-Test

The power-on self-test is completed upon every truck startup. During the power-on self-test, the traction controller will check for the presence of the brake coil, the main contactor coil, and the valve coils. All AC controllers will check for the presence of their associated AC motor windings. The CAN I/O unit will check for the presence of the traction throttle, hydraulic throttle, and the steer input sensors. At power-on controllers must begin transmitting the correct messages on the CANbus before truck operation is allowed. If any of these items are missing, then specific fault codes will be noted on the display.

Interlocks

After startup, the following controls and switches must be in the noted positions to allow truck operation:

1. Traction throttle, hoist throttle, and the RTC must be all in there neutral positions. This is commonly referred to as Static Return of Off (SRO).
2. The side gate switches and slack chain switches must be closed. When an interlock switch is not set, the display the "Wrench Icon" will blink and the alarm message will be noted on the display.
3. The foot switch must be cycled to allow traction and hoist function. The display "Man Icon" is illuminated when the brake switch is open. The message "Foot SW Open" is noted on the display when traction is selected and the foot switch is open.
4. When installed, the optional service key switch must be closed.

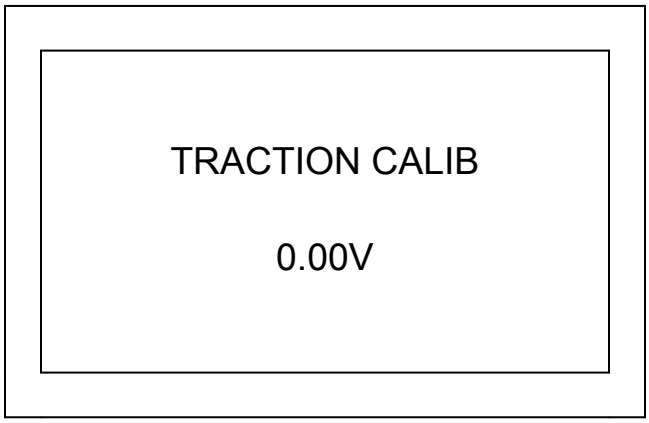
Setup Menu Diagnostics

Enter the Service menu by turning the key to the **ON** position and pressing the display button #5 (Enter) twice. The display screen will indicate "Enter Password." Use the five display buttons to enter the five digit service-level password. (The middle button (Enter) is used to enter the number 5.) If the wrong password is entered, the screen will indicate "Incorrect Password" and then return to the primary graphic mode. Once the service-level password is correctly entered, the first menu item appears. To view the next menu item, press the display button #3 (Down Arrow). Repeat this until the desired menu item has been reached. The Setup and Diagnostic menus are now available. Refer to **User Interface Service-Level Functions =>S/N A169N02999L =>S/N A185N02999L =>S/N H118N02999L =>S/N E174N02999L** 2200SRM1470 for more information on the Setup Menu.

Calibration

TRACTION THROTTLE

1. Enter the Setup menu.
2. Scroll to TRACT SETTINGS and press 2 to enter.
3. Press button 1 or 3 to scroll to TRACTION CALIBR.
4. The Traction Throttle must now be in the neutral position.
5. Press button 2 to enter and wait for 2 seconds.
6. Display reads:

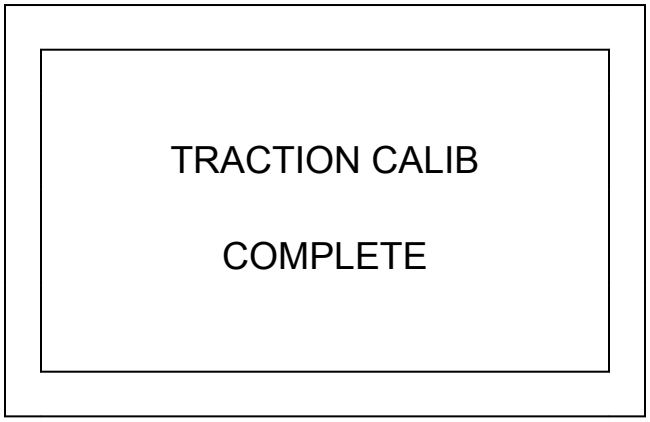


NOTE: "0.00V" should be 2.50V ± 0.50V when the traction throttle is in neutral position. 2.50V ± 0.50V is the recommended throttle neutral position voltage after the throttle is mechanically in position.

7. Move the Traction Throttle fully forward to the mechanical stop and hold for 2 seconds.
8. Move the Traction Throttle fully reverse to the mechanical stop and hold for 2 seconds. Release the traction throttle back to neutral.
9. Press button 5 to save Neutral, Max and Min value. Display should read the following for 2 seconds.

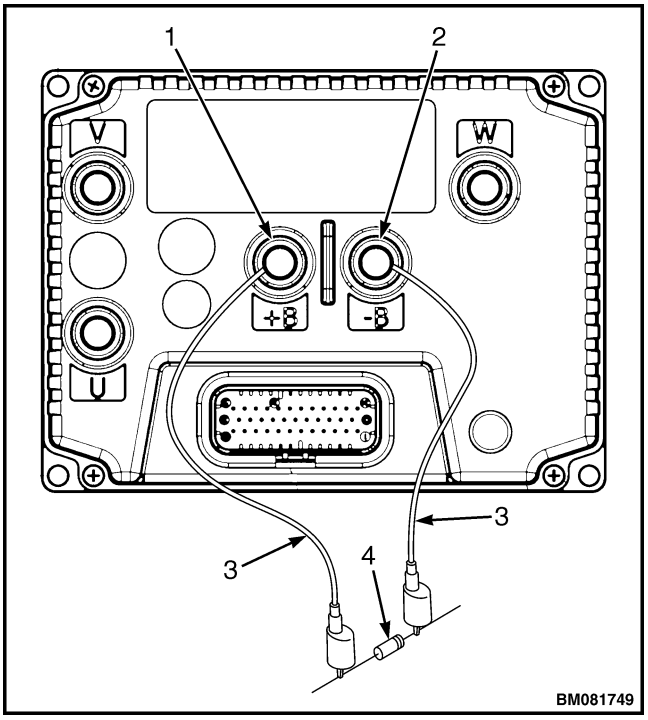
NOTE: Press button 4 to cancel calibration during Step 6 to Step 8.

10. Press button 4 several times to exit set up.



AC Traction Motor Controller

The ACE0 traction controller delivers smooth, silent control of motor speed and torque. Three-phase winding control stage provides solid-state motor control and full regenerative braking without additional relays or contactors. See Figure 4. There are no serviceable parts in the ACE0 controller. No attempt should be made to open, repair, or modify the controller.



1. BATTERY POSITIVE
2. BATTERY NEGATIVE
3. JUMPER WIRES
4. 200-OHM 2 WATT RESISTOR

Figure 4. ACE0 Controller

The controller checks the following functions:

- Checks the temperature and gives both low- and high-temperature thermal protection to the controller.
- Electronically checks the traction circuit for malfunctions and prevents traction motor operation if a failure occurs.
- Regulates the current in the motor circuit and automatically reduces the current and prevent damage.
- Checks for incorrect battery usage.
- Checks for and protects from stall conditions.

CONTROLLER REMOVAL

1. Move lift truck to a safe, level area. Turn the key switch to the **OFF** position and remove the key. Attach a DO NOT OPERATE tag to the multifunction control handle. Put blocks under drive wheels to keep lift truck from moving. See **Periodic Maintenance** 8000SRM1472 - How To Put A Lift Truck On Blocks.

WARNING

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

2. Disconnect and separate battery connector. Remove the cover and discharge the capacitors. Refer to Discharging the Capacitors in this section.
3. Unplug connector from traction motor controller. Tag and disconnect wires to terminals.
4. Remove four capscrews and lockwashers and carefully remove controller from the truck frame.

INSTALL

1. Make certain the mounting surface for controller is clean. There should be no dirt between the frame and the controller. Apply heat-conductive grease to bottom of controller. Align controller in lift truck with holes and install lockwashers and capscrews. Tighten the Traction Controller mounting capscrews to 7 to 8 N•m (62 to 71 lbf in).

LOW-VOLTAGE PROTECTION FUNCTION

This function protects the controller and the battery. The controller will not operate correctly if there is less than 18 volts from the battery. The battery current drain increases as the battery voltage decreases. The battery may still operate the lift truck to move it for battery charging or replacement.

Contactor and Electrical Panel Checks

WARNING

DO NOT operate a lift truck that needs adjustment or repairs. Report the need for adjustment or repairs immediately. If adjustment or repair is necessary, put a DO NOT OPERATE tag on the instrument panel. Remove the key from the key switch.

WARNING

Some of the checks are done with the battery connected. Never have any metal on your fingers, arms, or neck. These metal items can accidentally make an electrical connection and cause a personal injury.

CAUTION

Correct multimeter polarity is necessary for some checks. Meter positive is indicated as (+). Meter negative is indicated as (−).

Use a multimeter with a minimum rating of 20,000 ohms per volt to make measurements. Most digital voltmeters are acceptable.

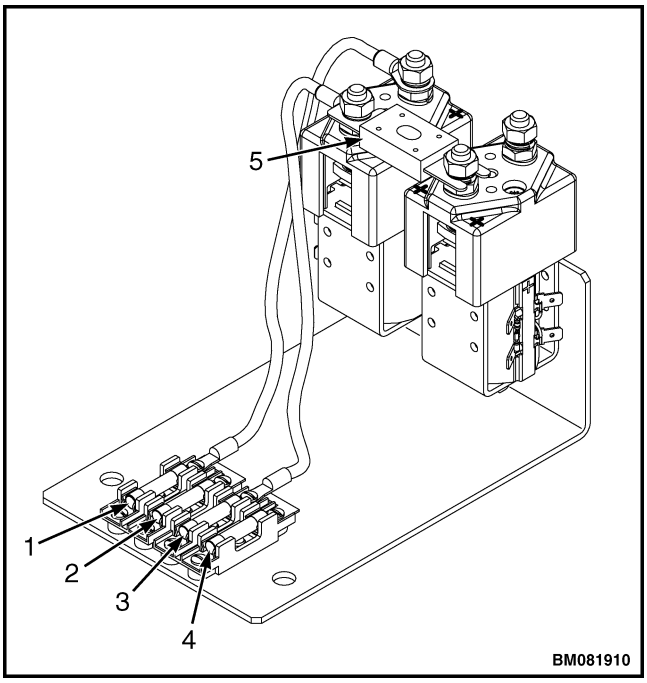
NOTE: To perform the following component tests or to replace any of the components, the drive unit compartment doors must be opened and the drive unit compartment cover must be removed.

FUSES

All the fuses are located in the electrical compartment. See Figure 5. Remove cover over electrical compartment for access. The condition of some fuses can be checked by looking at them. Other fuses do not change in looks and must be checked with an ohmmeter to determine continuity. Disconnect battery and remove a fuse before checking the fuse.

All fuses are on the contactor panel. Ratings of the fuses are as follows:

Fuses	Circuit	Rating
FU 1	Platform Key Switch	10A
FU 2	Fans, Lights, Heater	10A
FU 3	Valve Coils, Horn, Back-Up Alarm, Hydraulic Pump Contactor Coil	10A
FU 4	Spare	10A
FU 5	Hydraulic Pump	300A



1. FU 1
2. FU 2
3. FU 3
4. FU 4
5. FU 5

Figure 5. Fuse Locations

CONTACTORS

General

With the key switch turned **OFF**, the main contactor coil is not connected to either battery positive or battery negative. When the key switch is turned **ON**, battery positive is connected to the main contactor coil. After passing the power-on self-test the traction controller will turn on a transistor that will connect the low side of the main contactor to ground. The main contactor is activated providing power to all controllers and valve coils.

On trucks with DC hoist, the main contactor tips must be closed prior to applying battery voltage to the hydraulic pump contactor tips. The CAN I/O unit processes a lift command and transmits a CANbus message to the traction controller. The traction controller will turn on a low side driver transistor that energizes the pump contactor coil and in turn closes the pump contactor tips. Battery positive is then applied to the pump motor to initiate lift.

Test

WARNING

Parts of this procedure require working on the truck with full electric current present. To prevent personal injury or property damage, DO NOT wear a watch, rings, or jewelry while working around the contactor panel. Whenever manually closing a contactor with the power connected, use a properly insulated tool.

1. Check condition of battery. If it is not fully charged, recharge or replace battery with a fully charged battery before continuing.

2. Raise drive wheel of truck so it is clear of the floor. Block chassis in this position and remove lifting device.

3. Visually check to see if contactor closes when circuit is energized. If contactor closes, proceed to Step 5. If contactor does not close, proceed to Step 4.

4. Check for battery voltage at contactor coil.

   No voltage: Open circuit in control circuit wiring to contactor.

   Low voltage: High resistance in control circuit wiring to contactor.

   Full battery voltage: No problem with control circuit. Problem is probably in contactor. Proceed with test.

5. Check at the contactor for loose, broken, or corroded connections.

6. Visually check the condition of the tips for pitting, burning, or wear.

7. Check ohm value of contactor coil. Disconnect leads from one side of the coil and connect an ohmmeter across coil. Reverse ohmmeter leads and check in the opposite polarity (since spike suppressors on some coils make them polarity sensitive). Compare ohm reading against ohm value for the type contactor. Use the highest rating. See Table 2.

Table 2. Coil Resistance

Device	Location	24v Coil Resistance @ 21°C (70°F)	Notes
Truck main contactor	Contactor panel	44 ohms ±8 ohms	Test coil both ways. Use highest reading.
Lift pump contactor	Contactor panel	17 ohms ±4 ohms	Test coil both ways. Use highest reading.
Lower solenoid valve	On pump assembly	40 ohms ±10 ohms	Test coil both ways. Use highest reading.
Load hold relay	Under chassis cover near the top of the drive motor	320 ohms ±65 ohms	Terminals 85 and 86 are the coil.
Brake coil	On top of drive motor	12 ohms ±4 ohms	

Tips

When replacing tips, make sure the new tips have the same ampere carrying capacity and are direct replacements for the original tips.

A high-voltage drop (2 volts or more) across the tips indicates poor contact or high resistance. Check for burned or worn tips, incorrect size or mismatched tips, and proper gap settings when open.

Disassemble and Assemble

WARNING

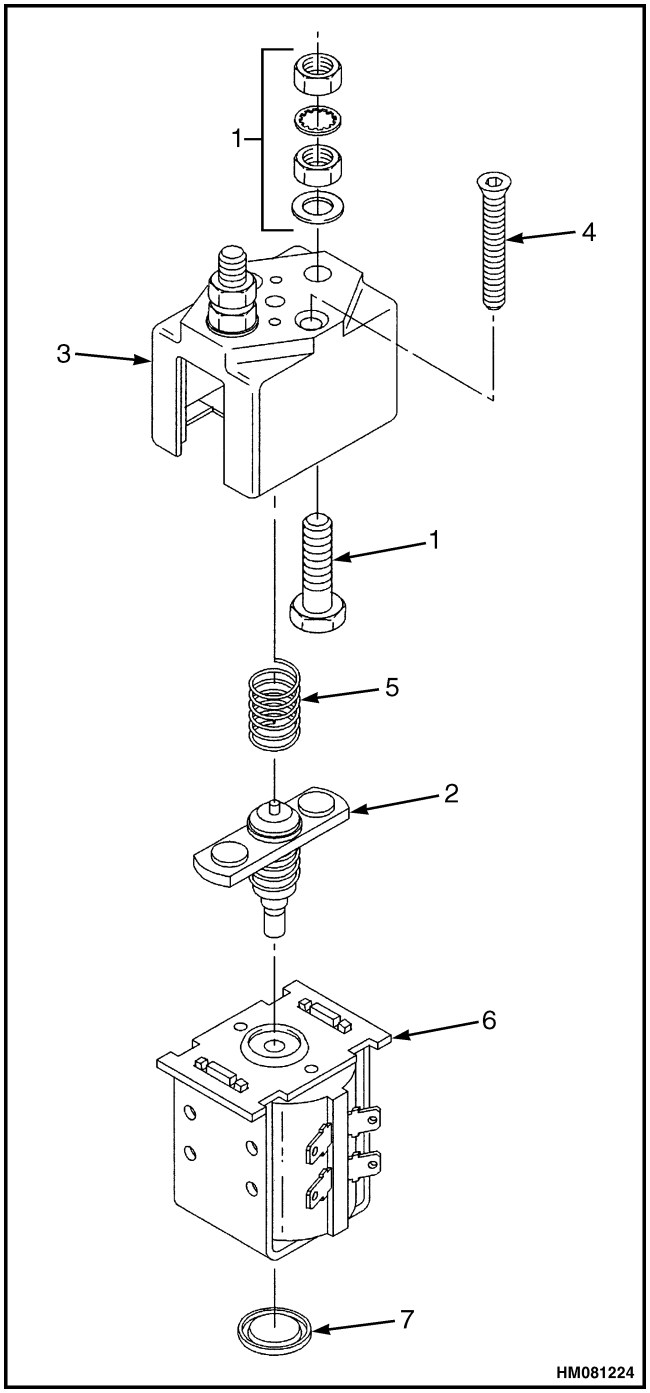
Disconnect the battery and separate the connector before opening the drive unit and compartment and inspecting or repairing the electrical system. If a tool causes a short circuit, the high-current flow from the battery can cause a personal injury or property damage.

NOTE: If both the contacts and coil of a contactor will be replaced, replace the complete contactor as described in Replacing the Contactor. Do only the parts of the procedure necessary to replace the defective parts being replaced.

NOTE: All of the contacts for each contactor must be replaced at the same time if any contact requires replacement.

The contactor contacts are made of special silver alloy. The contacts may look black and rough from normal operation. This condition does not cause problems with the operation of the lift truck. Cleaning is not necessary. **DO NOT** USE A FILE ON THE CONTACTS. **DO NOT** LUBRICATE THE CONTACTS. Replace contacts when the silver alloy is worn away to the base support metal. Replace contactor parts as follows:

1. Make an identification of the buss bars for correct installation. Remove nuts that fasten fixed contacts.
2. Remove two screws that fasten covers for each contactor. See Figure 6. Remove cover of each contactor. **DO NOT** lose plunger springs.



1. FIXED CONTACT
2. MOVING CONTACT
3. TOP COVER
4. SCREW - TOP COVER
5. RETURN SPRING
6. COIL AND FRAME
7. END CAP

Figure 6. Contactor

3. Replace two fixed contacts in contactor covers.
4. Remove plunger assembly and movable contact and replace fixed contact bar. Replace contact of plungers.
5. If a coil will be replaced, remove cover base. Remove screws that fasten coil frame to mount bracket. Remove coil and frame. Remove bushing part of plunger and armature cap from coil. Install these parts on the replacement coil.
6. Install coil and frame on mount bracket.
7. Install cover base, fixed contact bar, and plunger on coil frame. Make sure spring is on plunger.
8. Install covers and electrical bars on covers as removed during disassembly.
9. Install contactor assemblies on the lift truck.

Traction Throttle Sensor Removal and Installation

WARNING

The operator platform can move abruptly and can cause personal injury when any lift or lower buttons are accidently pushed. Fully lower the operator platform and remove the key from the key switch, disconnect the battery, and install a DO NOT OPERATE tag on the instrument panel.

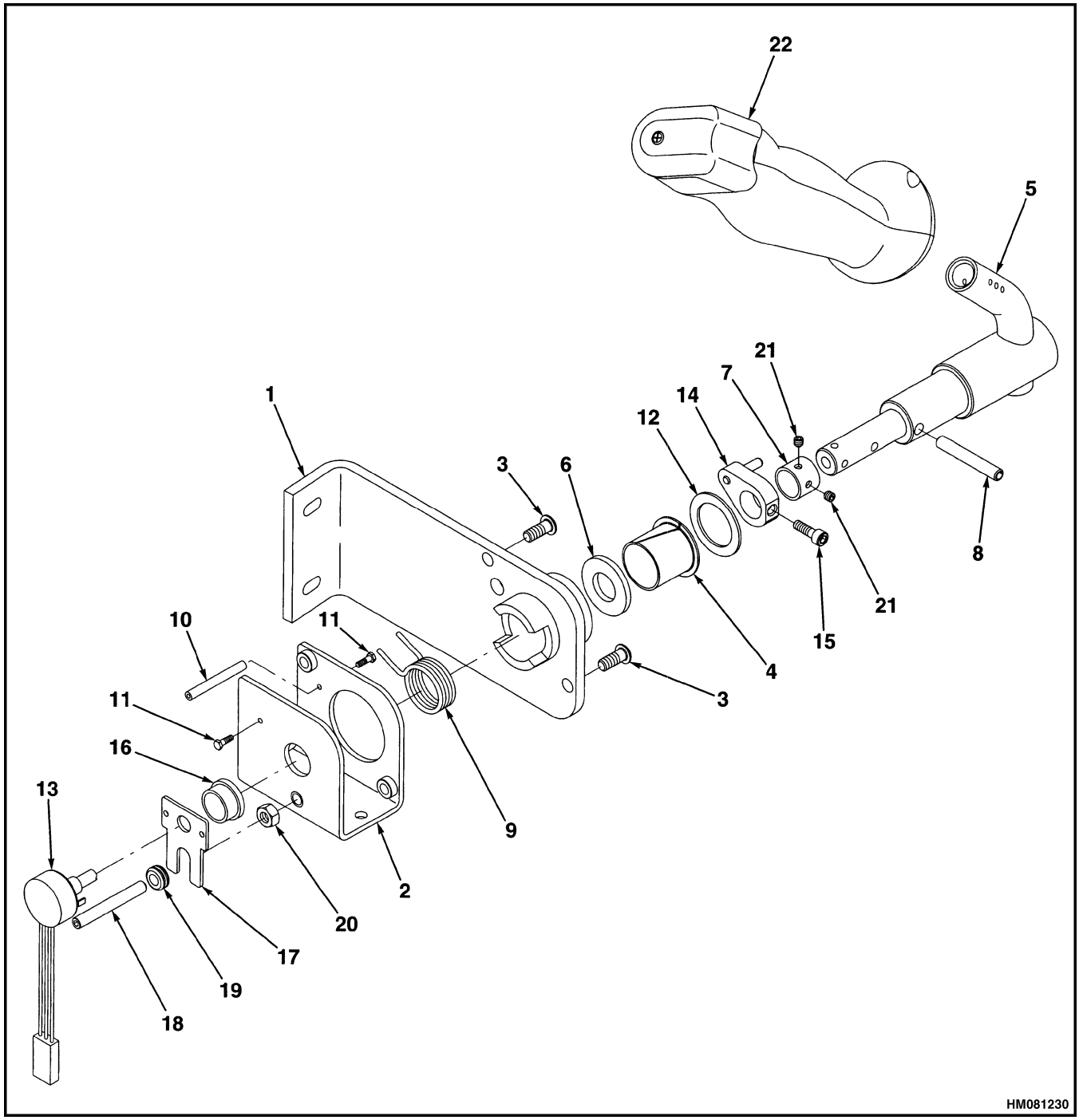
WARNING

The traction throttle sensor is a Hall effect device. The sensor provides a voltage output ratio (typically 5 volts) as a function of mechanical angle to the shaft as it rotates. The sensor operates on low supply voltage and is limited to short mechanical angles, requiring less than 180-degree rotation.

WARNING

Disconnect the battery connector to prevent operation of the hydraulic system or electrical shock and possible injury.

1. Disconnect battery.
2. Remove four capscrews that fasten console panel cover.
3. Disconnect electrical plug.
4. Remove nut that holds sensor on bracket. See Figure 7.
5. Loosen the two setscrews (21) that secure the Hall effect sensor stem to the inside of the control handle shaft.
6. Install new sensor into opening of bracket support. Align sensor on bracket and tighten nut.
7. Connect electrical plug. Once the plug is connected enter the SETUP menu. Scroll to NO RUN DIAGNOSTICS and enter the sub-menu. Now scroll to the TRAC JOYSTICK parameter. Approximately align the cross hatch on the end of the Hall Effect sensor stem with the tabs on the body of the Hall Effect sensor to achieve 2.50 volts. Tighten the setscrews and recheck the voltage at 2.50 volts in neutral.
8. Install instrument panel cover on cowl.
9. Reconnect the battery.
10. Calibrate the new sensor. See Traction Throttle in the Calibration section of this manual.



1. SUPPORT BRACKET
2. BRACKET ASSEMBLY
3. BUTTON HEAD SCREW
4. NYLON BEARING
5. SHAFT CONTROL HANDLE
6. WASHER
7. SPACER
8. ROLL PIN
9. RETURN SPRING
10. THREADED STANDOFF
11. SCREW
12. WASHER
13. HALL EFFECT SENSOR
14. CAM ASSEMBLY
15. CAPSCREW
16. BUSHING
17. HALL EFFECT SENSOR BRACKET
18. SCREW
19. RUBBER GROMMET
20. NUT
21. SETSCREW
22. HANDLE BODY

Figure 7. Control Handle Mechanism

Instrument Panel Removal and Installation

WARNING

Always disconnect the battery ground cable before making repairs to prevent possible damage and injury. Install a tag on the battery terminal so that no one connects the cable on the terminal.

1. Disconnect battery.
2. Remove four capscrews that fasten console panel cover.
3. Remove four screws that fasten instrument panel to console.
4. Align instrument panel on console and install capscrews.
5. Install instrument panel cover.
6. Connect battery.

Key Switch Removal and Installation

REMOVE

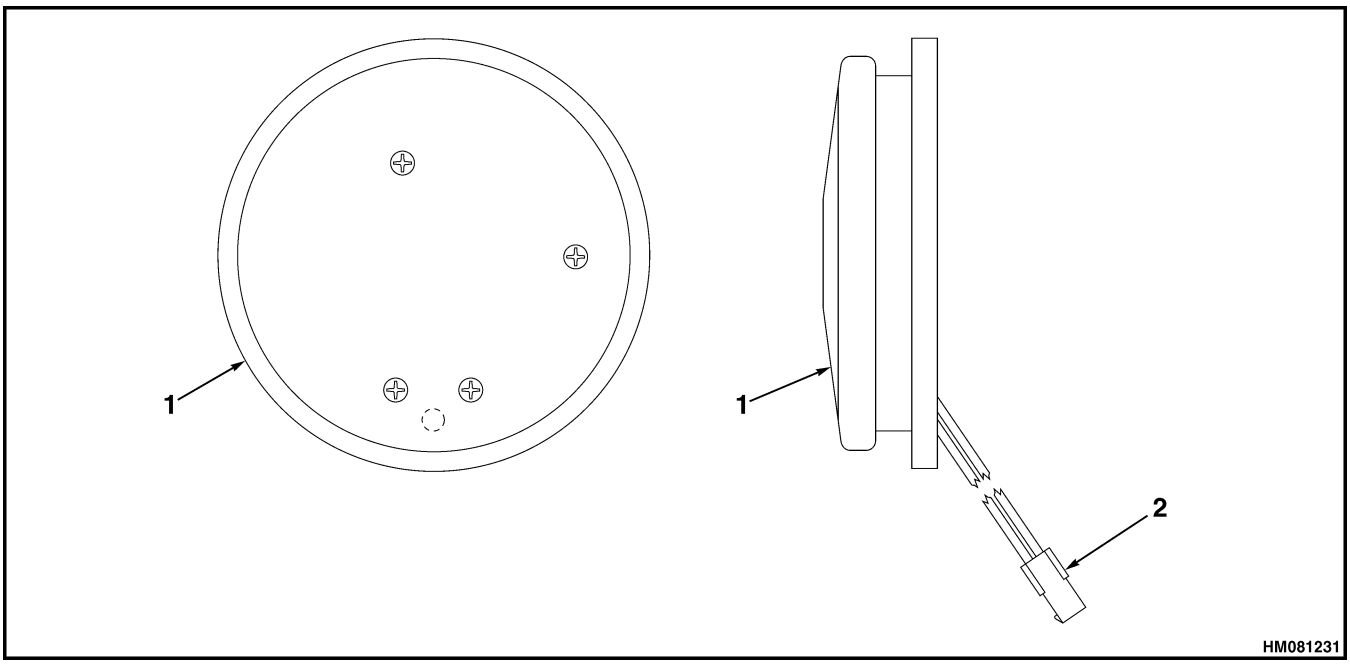
1. Move the lift truck to a safe, level area.
2. Block drive wheel to prevent truck from rolling.
3. Disconnect battery connectors and turn the key switch to the **OFF** position.
4. Remove instrument panel. See Instrument Panel Removal and Installation.
5. Remove cover.
6. Discharge the capacitors inside the controller.
7. Remove nut retaining the key switch to bracket.
8. Remove the key switch.
9. Identify and disconnect electrical wires to switch.

INSTALL

1. Connect wires to proper terminals.
2. Mount the key switch in bracket.
3. Install nut to retain the key switch. Make certain switch is properly aligned before tightening retaining nut.
4. Install instrument panel. See Instrument Panel Removal and Installation.
5. Connect battery connectors.
6. Test the key switch by turning it **ON** and **OFF**.
7. Install cover.

Foot Switch Removal and Installation

1. Remove nut from bottom of foot switch assembly. See Figure 8.
2. Unplug Molex™ switch so wires can be removed and connected during installation.
3. Remove screws that fasten switch in housing and remove switch.
4. Install new switch and wire connector. Install screw at bottom of plate and connect connector.



1. FOOT SWITCH ASSEMBLY
2. MOLEX™ CONNECTOR

Figure 8. Foot Switch

Slack Chain Switch Removal and Installation

WARNING

To replace the loose chain switches, the operator platform must be raised to provide access. The lowering of the operator platform can cause an injury. The operator platform must have a support or a chain to prevent the operator platform from lowering.

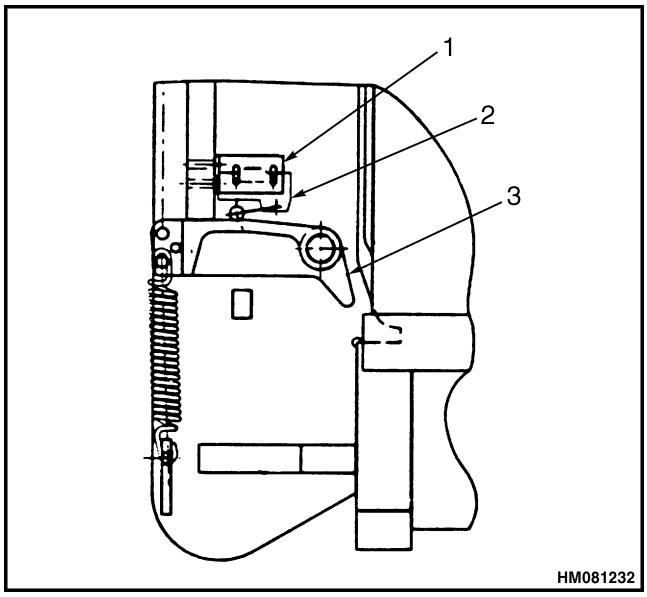
The loose chain switches are at the chain anchors on the mast side of the operator platform. See Figure 9.

1. Raise operator platform for access to loose chain switches. Block operator platform or use chains to prevent operator platform from lowering. The chains must be fastened to the operator platform and to a part of the mast that cannot move.

WARNING

Always disconnect the battery ground cable before making repairs to prevent possible damage and injury. Install a tag on the battery terminal so that no one connects the cable on the terminal.

2. Disconnect battery.
3. Install labels on wires for correct connection during installation. Remove wires from switch terminals.
4. Remove nuts that fasten switches to bracket and remove switches.
5. Install replacement switch on bracket. Attach switch to switch bracket. Adjust switch to provide proper contact of cam to chain anchor. Repeat operation for second switch.
6. Connect wires to switch terminals as marked during removal.



1. SWITCH BRACKET
2. SWITCH
3. CHAIN ANCHOR

Figure 9. Loose Chain Switch

Limit Switch Removal and Installation

WARNING

The operator platform can move abruptly and cause an injury when any lift or lower buttons are accidentally pushed. Fully lower the operator platform, Remove the key from the key switch and install a DO NOT OPERATE tag on the instrument panel.

1. Raise and block mast and operator platform high enough to gain access to the 24-inch limit switch located on a bracket welded to the bottom of the mast. See Figure 10.

2. Remove top cover and open compartment doors.

WARNING

Always disconnect the battery ground cable before making repairs to prevent possible damage and injury. Install a tag on the battery terminal so that no one connects the cable on the terminal.

3. Disconnect battery. Disconnect limit switch connector.

4. Loosen and remove nut retaining switch on front of bracket. Remove switch from bracket.

5. Reverse above procedure to assemble and install.

6. When installing limit switch, the distance between target and sensor should be 14 mm (0.55 in.).

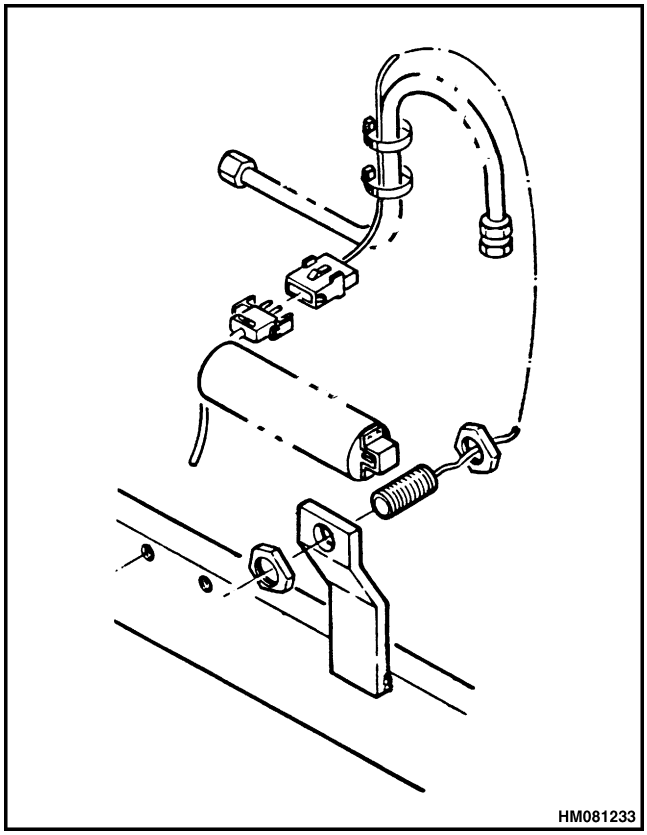


Figure 10. 24-Inch Limit Switch

DC to DC Converter

NOTE: The DC-to-DC Converter has no repairable parts. Check wiring and plug for proper voltages and connections. If converter is inoperative, it must be replaced.

The optional DC-to-DC converters provides 12 volts DC voltage to the lights and other optional equipment.

Replace the DC-to-DC Converter as follows:

1. Turn the key switch the **OFF** position and disconnect the battery.
2. Remove the electrical compartment cover and discharge the capacitors.
3. Disconnect the plug from the converter.
4. Remove the hardware retaining the converter to the platform and remove the converter from the lift truck.
5. Align the replacement converter and install the mounting hardware as removed.
6. Tighten the nuts to 1.7 N•m (15 lbf in).
7. Connect the plug to the converter.
8. Connect the battery and turn the lights **ON** to test functionality.
9. Install the electrical compartment cover.