

SERVICE REPAIR

MANUAL

Hyster D264 (N45ZR2, N35ZDR2) Forklift

HYSTER

ELECTRICAL SYSTEM

**N35ZDR2, N45ZR2 [D264];
N30ZDR2, N35-40ZR2 [E470];
N30ZDRS2, N35-40ZRS2 [B265]**

HYSTER

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.

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This section is for the following models:

(N35ZDR2, N45ZR2) [D264];
(N30ZDR2, N35-40ZR2) [E470];
(N30ZDRS2, N35-40ZRS2) [B265]

General



WARNING

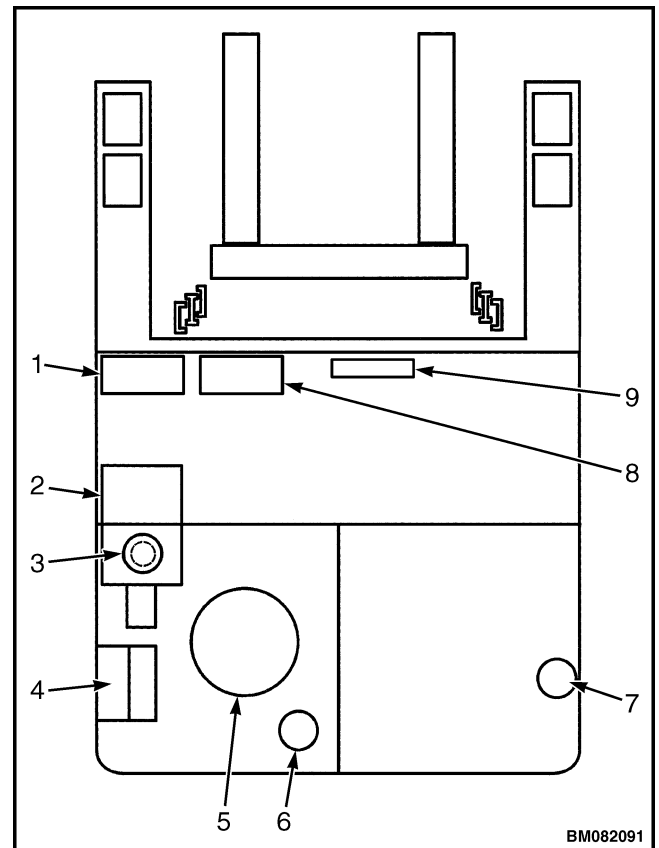
This electrical system utilizes capacitors that maintain a charge on the electrical system even after the battery is disconnected. Damage to the truck components and injury from electrical shock may occur if the capacitors are not properly discharged prior to servicing the electrical systems. Refer to Discharging the Internal Capacitors in this section.



CAUTION

Electrical components on this truck are polarity sensitive and may be damaged if wired incorrectly. Make sure each electrical wire connection is tagged and properly identified before removal or installation. If the proper location for connection is unclear, consult the wiring diagram for the truck. Make sure testing meters have adequate voltage and current capacities to handle the output of the electrical components they are used to check. Never wire aftermarket components to this truck without factory approval.

The electrical system is an alternating current (AC) system. DC current from the battery is converted into AC current by a series of transistor motor controllers to power each AC induction motor. See Figure 1. Other components of this system include battery connectors and cables, cooling fans, main contactor, CAN I/O, display unit, integrated fuse board (IFB), horn, lights, multifunction control handle, emergency battery disconnect switch, key or lever switch, and wiring harnesses.



1. TRACTION CONTROLLER
2. LIFT MOTOR
3. AUX HYDRAULIC MOTOR (BELOW) (N35ZDR, N45ZR, N30ZDR, N35-40ZR ONLY)
4. CAN I/O AND STEERING CONTROLLERS
5. TRACTION MOTOR
6. STEERING MOTOR
7. CASTER MOTOR (OPTIONAL)
8. HYDRAULIC CONTROLLER
9. INTEGRATED FUSE BOARD (IFB)

Figure 1. Electrical System General Arrangement

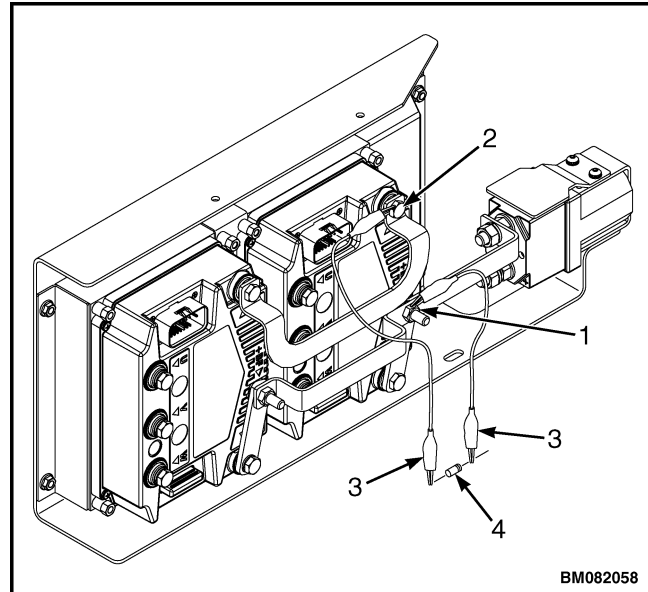
DISCHARGING THE INTERNAL CAPACITORS

When working with the electrical systems of the truck, it is necessary to discharge the internal capacitors of the controllers associated with each circuit affected.

WARNING

Capacitors inside the controllers can hold an electrical charge after the battery is disconnected. Discharge the internal capacitors before servicing the electrical system to prevent injury or electronic damage.

1. Move the lift truck to a safe, level area and completely lower the mast. Turn the key switch to the **OFF** position and attach a **DO NOT OPERATE** tag to the control handle. Block the drive wheel to prevent unexpected movement.
2. Disconnect the battery power cable connector from the truck connector located on the right side of the frame. Pull the battery cable connector handle to separate the battery connector from the truck connector.
3. Remove the operator compartment cover.
4. Discharge the internal capacitor in the controllers by connecting a 200-ohm, 2-watt resistor across the controller B+ and B- terminals of the motor controller for 10 seconds. Remove the resistor after discharging the capacitors. See Figure 2.



1. POSITIVE CONNECTION (B+)
2. NEGATIVE CONNECTIONS (B-)
3. INSULATED JUMPER WIRES
4. 200-OHM, 2-WATT RESISTOR

Figure 2. Discharging the Internal Capacitors

STATIC STRAP

The static strap is a rubber strap molded with non-sparking metal inside. It is mounted to the frame of the lift truck near the lower mast mounting plate. See Figure 3. Static electricity builds during operation of the lift truck. The tires of the lift truck isolate the metal components of the truck from the floor. The strap allows limited conductivity between the lift truck frame and the floor to disperse the static charge. If the static strap is removed or damaged, the static charge may build. This can cause damage to electronic components of the lift truck and may discharge with a spark when the forks or other parts of the lift truck frame contact items that permit grounding to the floor. Sparks caused by static electricity can cause an explosion when it occurs near flammable materials or around batteries which vent flammable gasses during normal operation. Check that the static strap is present and is in good working condition before operating the lift truck. Replace the strap if necessary.

Inspect

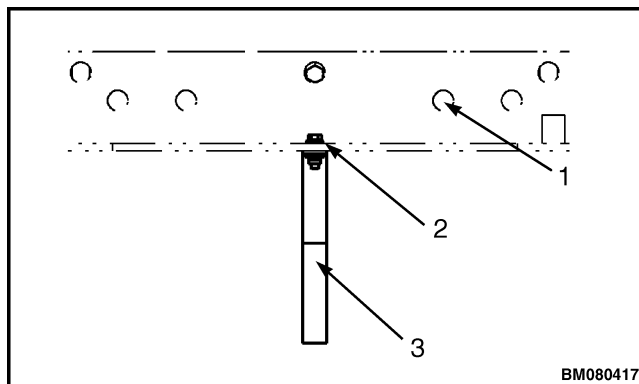
Check that the static strap is present and is in good working condition before operating the lift truck. Inspect the static strap for wear, cracks, tears, or missing length. Inspect the strap for cleanliness and clean if necessary with a mild, soapy detergent if dirty or oily. Replace the strap as necessary. See Replace.

Replace

1. Raise the carriage approximately 915 mm (36 in.). Safety chain the reach carriage assembly in place. Refer to **Periodic Maintenance** 8000SRM1617 for instructions on safety chaining the mast. Turn the key switch to the **OFF** position and disconnect the battery. Attach a **DO NOT OPERATE** tag to the control handle.

NOTE: Access the static strap from the front of the lift truck.

2. Remove the hardware securing the old static strap to the frame. See Figure 3. Clean the contact surface area near the mounting hole of any rust and paint to ensure the static strap makes good frame contact. See Figure 3.



1. MAST MOUNTING HOLES
2. HARDWARE
3. STATIC STRAP

Figure 3. Static Strap

3. Install the new static strap using the hardware as removed.
4. Reconnect the battery, remove the tag from the control handle, and turn the key switch to the **ON** position. Remove the safety chains from the mast. Refer to **Periodic Maintenance** 8000SRM1617.

Battery Connection

The battery cables supply power from the battery terminals through the battery cable connectors and then to the connections of the motor controllers and main contactor in the truck.

INSPECT

Inspect the battery cables for cuts or damage to the insulation. Inspect for abrasions of the insulation or burned insulation or connector ends. Inspect the battery connectors for worn or damaged cable ends or cracked housings. Overheated cables or heat affected terminal lug ends are signs of cable damage, loose connections, or improper battery charging or maintenance. Replace any damaged cables and repair or replace damaged battery connectors.

REPLACING CABLES



WARNING

Making repairs with the battery connected can cause a short circuit. Disconnect the battery by separating the battery to truck connectors before inspecting or repairing the electrical system.

Be careful using tools near the battery terminals. Contact between terminals can cause a short circuit. High current flow during a short circuit can result in injury or parts damage.

NOTE: Never lubricate the battery terminal connector with grease or other lubricants. The battery SB connector is designed to self-clean when it is disconnected and reconnected.

1. Move the lift truck to a safe, level area and completely lower the mast. Turn the key switch to the **OFF** position and attach a **DO NOT OPERATE** tag to the control handle. Block the drive wheel to prevent unexpected movement.
2. Pull the connector (battery side) from the fixed connector (truck side) to separate the battery cable connectors. See Figure 4.

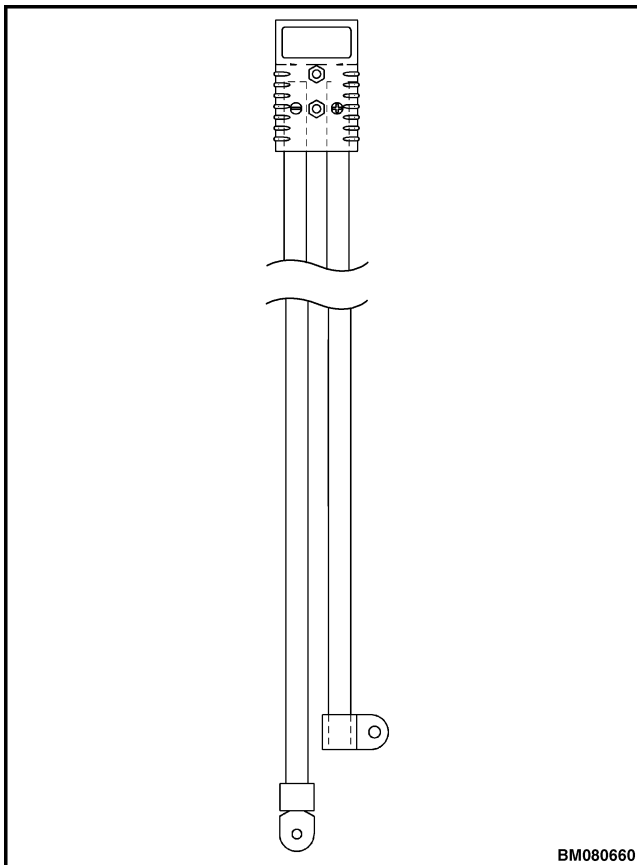


Figure 4. Battery Connector and Cables

3. If the power cables or connector (battery side) are damaged, replace the cables:
 - a. Remove the battery from the lift truck.
 - b. Disconnect the cables from the battery terminals.

- c. Install new cables.
 - d. Reinstall the battery to the lift truck.
 - e. Connect the battery connectors.
4. If the power cables or connector (truck side) are damaged, replace the cables:
 - a. Remove the cover(s) from the operator compartment to access the main contactor.
 - b. Discharge the capacitors in the motor controllers. Refer to Discharging the Internal Capacitors.

NOTE: Make note of position of cables for proper reinstallation.

- c. Remove the nuts securing the cables to the terminals of the main contactor and bus bar. Remove the cables from the terminals.
 - d. Remove the two clamps securing cables to the frame inside the electrical compartment.
 - e. Remove the hardware securing the connector (truck side) to the frame.
 - f. Remove the power cables from the lift truck.
 - g. Route new cables into the electrical compartment.
 - h. Secure the connector to the frame using two capscrews and attaching hardware.
 - i. Position the power cables onto the terminals as removed. Secure the cables to the terminals of the main contactor and bus bar using the attaching hardware.
 - j. Install the two clamps securing power cables to the frame inside the electrical compartment as removed.
 - k. Install the plastic covers to the operator compartment as removed.

Key Switch

WARNING

The key switch does not remove electrical power from the main contactor and controllers of the lift truck. Before servicing the truck, disconnect the battery and discharge the capacitors. See Discharging the Internal Capacitors.

WARNING

Making repairs with the battery connected can cause a short circuit. Disconnect the battery by separating the connectors before opening the electrical compartment covers or inspecting/repairing the electrical system. High current flow during a short circuit can cause injury or parts damage.

The key switch is used to power **ON** and **OFF** the lift truck operating systems including the dash display and integrated fuse board.

REPLACE

CAUTION

Check the electrical connections to the key switch before replacing. Loose connections of key switch wiring can cause malfunctions similar to those caused by a faulty switch.

NOTE: Some models have lever switches in the place of key switches. The lever switch operates identical to the key switch other than there is no key to be removed.

In the following instructions, both key switches and lever switches will be referred to as key switches. See Figure 5 and Figure 6.

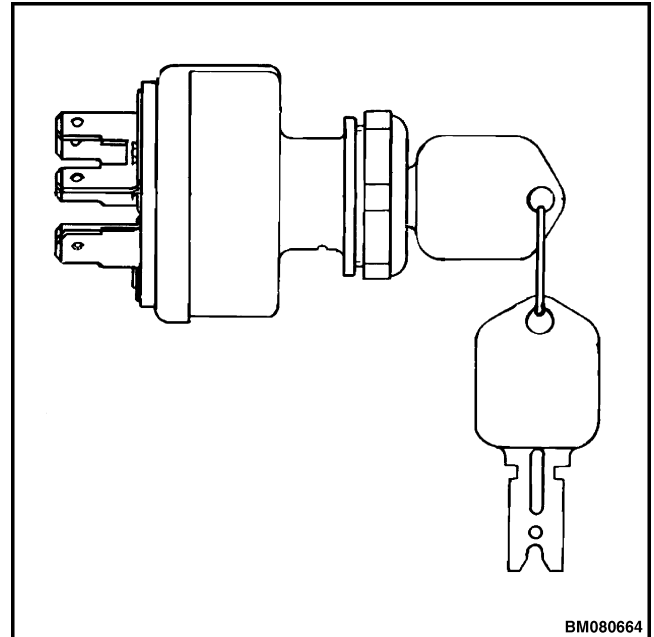


Figure 5. Key Switch

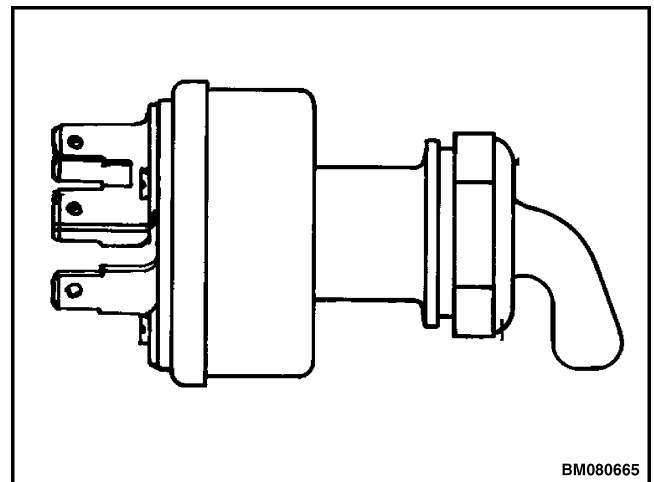


Figure 6. Lever-Type Switch

1. Move the lift truck to a safe, level area, and completely lower the mast. Turn the key switch to the **OFF** position and remove the key. Attach a **DO NOT OPERATE** tag to the control handle and block the drive wheels to prevent unexpected movement.
 2. Disconnect the battery power cable connector from the truck connector located on the right side of the frame. Pull the battery cable connector handle to separate the battery connector from the truck connector.
 3. Discharge the capacitors. See Discharging the Internal Capacitors.
 4. Access the key switch wiring:
 - a. Remove the plastic cover from the operator compartment on fore/aft stance models.

OR
 - b. Remove the plastic cover from the bottom of the arm rest console on sidestance models. See Figure 20.
- NOTE:** Make note of the position of the key switch before removal.
5. Remove the nut retaining the key switch to the mounting bracket and remove the key switch with the wiring attached.
 6. Tag and disconnect the electrical wiring from the key switch. See Figure 7.
 7. Install the electrical wiring to the new key switch as removed.
 8. Position the switch into the mounting hole as removed.
 9. Install the jam nut onto the key switch as removed.
 10. Install the plastic cover(s) to the operator compartment as removed.
 11. Engage the battery cable connectors. Install the key and turn the key switch to the **ON** position. Test for proper operation.
 12. Remove the blocks from the drive wheels and the **DO NOT OPERATE** tag from the control handle.

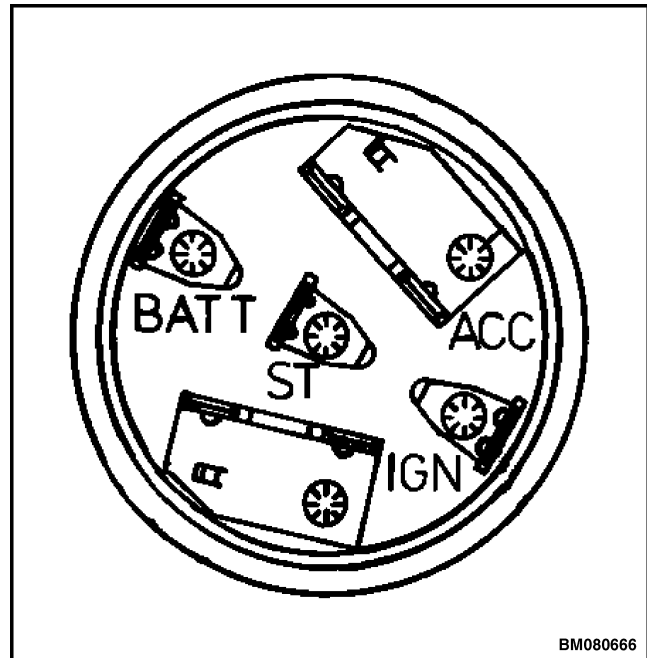


Figure 7. Electrical Connections

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
- Non-contact 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 truck 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:

- Display
- Traction
- Steer
- Steer Caster (Optional)
- Pump
- Auxiliary Pump (Americas Only)
- Handle
- Impact Module (Optional)
- CAN I/O
- Remote Module (Americas Only)

The CANbus carries the following data:

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

Electric Steering / Steer Caster (Optional)

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. If the optional steered caster is installed, the truck also centers the caster wheel using its proximity sensor.

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. The traction controller 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

- Proximity Sensor - The Proximity Sensor is a sourcing PNP sensor that provides a voltage input signal to the CAN I/O when the sensor senses ground.
- Height Encoder - The Height Encoder is a hall effect sensor that provides the CAN I/O with a two-channel digital input signal.
- Pressure Sensor - The Pressure Sensor is a three-wire pressure transducer that provides the CAN I/O a linear 0 to 5 Vdc signal proportional to hydraulic pressure.
- Main Steer Status - The CAN I/O receives a hardwired input signal from the Main Steer Controller when steering is active.
- Caster Steer Status - The CAN I/O receives a hardwired input signal from the Caster Steer Controller when the caster is active.

Output Devices

The following CAN I/O outputs are low-side driver controlled, meaning the CAN I/O Controller will provide a device ground when requested.

- Load Hold/Lift Coil
- Lower Coil
- Auxiliary Steer Coil
- Side-Shift Coil
- Tilt Coil
- Extend/Retract Coil
- Controller Fan
- Component Fan
- Backup Alarm
- Horn
- Strobe light (Relay)

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 channel goes on/off/on (0 then 5 volts from the height encoder) when the encoder is rotated slowly. Check the other output channel as well. If they are both outputting the proper LED signal or voltage then 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 and Figure 52. 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. Proximity switches may also be used to perform signal inputs for speed reduction mast cushion reset and battery interlock functions.

Table 1. Proximity Switches

Device	Supply	Output Voltage (Sensing Metal)	Indicator Light	PNP or NPN
Mast Proximity	Constant B(-) supplied	Sources battery voltage to Lift Pump Controller	ON	PNP Sourcing
Reach Proximity	Ground supplied by EXT/RET Coil when energized	Sources battery voltage to CAN I/O	ON	PNP Sourcing
Height Proximity	Constant B(-) supplied	Sources battery voltage to Remote CAN (If equipped)	ON	PNP Sourcing
MDU Proximity	B(+)	Main Steer Controller ground signal provided to Main Steer Controller input	ON	NPN Sinking
Caster Proximity	B(+)	Caster Controller ground signal provided to Caster Controller input	ON	NPN Sinking

KEY SWITCH

The key switch receives battery voltage provided by the Integrated Fuse Board and is protected by a 10 amp fuse. The truck's E-Stop switch is also located in series with the key switch's battery input circuit. When the power disconnect is up and the key switch is turned to the IGN position, battery voltage is supplied to the Integrated Fuse Board KEY SW RUN IN circuit, pin 7. When the key switch is turned to the ST position, battery voltage is supplied to the Integrated Fuse Board KEY SW RUN IN circuit, pin 10.

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.

STEER ANGLE

The actual steer wheel angle is shown as a graphic bar, this will display straight (0°) to full left and right (±90°). Actual drive wheel movement is 75° to 105° of center due to the MDU offset location in the frame.

TRUCK HOURS

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

OPERATIONAL MODE

The factory programmed modes are 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. The dealer technician can also program these modes if required.

Setup

NOTE: For additional information on the menu system, refer to the section **User Interface Service Technician** 2200SRM1614 or **User Interface Supervisor Functions** 2200SRM1613.

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** 8000SRM1617 - How To Put A Lift Truck On Blocks.
3. Remove the front cover to gain access to controllers.

NOTE: If hydraulics disabled is displayed on the lift truck, press and hold buttons 3 and 4 simultaneously for 4 seconds. Press the 4 button to exit the enable hydraulics screen.

ACE2 / ACE3 Traction and Hydraulic Controllers

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

NOTE: Controllers and dash displays should not be exchanged between other trucks for periods of longer than 10 hours for testing purposes. Controller nodes may acquire higher hours from a donor truck if this practice is used and the original truck hour meter readings cannot be recovered to lower hour level readings. Additionally non-programmed devices may assume the truck serial number that they are installed in.

If the Traction or Hydraulic Controllers are replaced, perform the following procedure immediately after installation.

1. Connect all electrical connections prior to initial startup of the Traction or hydraulic Controller. During initial startup, the Traction and Hydraulic Controllers sense the 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 Common Control System (CCS) Service Tool (See CDF File Importation and Set-up Procedure).
3. Check and ensure all parameters are set to the default values. After reviewing and adjusting all setup parameters, refer to **Steering System** 1600SRM1610 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 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 factory performance 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 foot switch or slack chain if equipped. 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 of various sensors. See **User Interface Service Technician 2200SRM1614** 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 **Controller Diagnostics 9000SRM1622**.

Calibrations

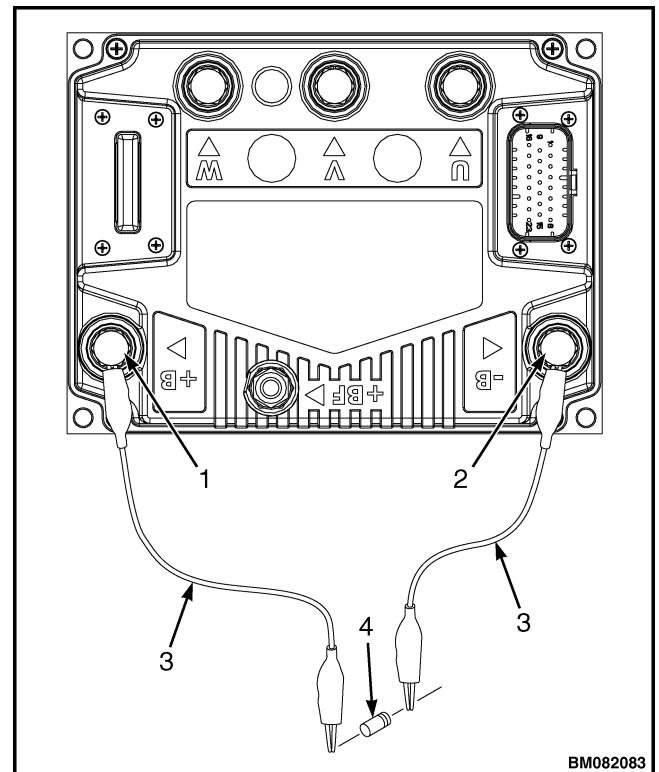
Refer to **User Interface Service Technician** 2200SRM1614 for calibration of the steering, rear handle and mast tare weight calibration procedures. Not all calibrations may be required. Trucks with steered caster may require both steer calibrations to be performed. The throttle handle calibration is only required on trucks with the Aft Handle Option. Any time a truck is updated with a Configuration Data File with the Aft Handle Option. Any time a truck is updated with a Configuration Data File (cdf), the calibrations must be performed.

NOTE: Steering calibrations must be performed with the operator brake switch in the activated condition.

AC Motor Controllers

The ACE 2 / 3 traction or hydraulic controllers deliver 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 8. There are no serviceable parts in the ACE 2 / 3 traction or hydraulic controllers. No attempt should be made to open, repair, or modify the controller.

NOTE: Controllers and dash displays should not be exchanged between other trucks for periods of longer than 10 hours for testing purposes. Controller nodes may acquire higher hours from a donor truck if this practice is used and the original truck hour meter readings cannot be recovered to lower hour level readings. Additionally non-programmed devices may assume the truck serial number that they are installed in.



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

Figure 8. ACE 2 / 3 Traction or Hydraulic 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 8000SRM1617 - 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.

NOTE: Controllers and dash displays should not be exchanged between other trucks for periods of longer than 10 hours for testing purposes. Controller nodes may acquire higher hours from a donor truck if this practice is used and the original truck hour meter readings cannot be recovered to lower hour level readings. Additionally non-programmed devices may assume the truck serial number that they are installed in.

2. Disconnect and separate battery connector. Remove the cover and discharge the capacitors. Refer to **Discharging the Internal Capacitors.**
3. Unplug connectors from traction or hydraulic motor controller. Tag and disconnect wires to terminals.
4. Remove four cap screws and lock washers and carefully remove the necessary controller from the aluminum heat sink plate.

INSTALL

1. Make certain the mounting surface for the controllers are clean. There should be no dirt between the frame and the controllers. Align the controllers in lift truck with holes and install lock washers and cap screws. Tighten the Traction or Hydraulic Controller mounting cap screws to 7 to 8 N·m (62 to 71 lbf in). If mounting the aluminum heat sink for either pump or traction controllers to the frame, tighten screws to 10 to 12 N·m (89 to 106 lbf in). Refer to **A/C Motor Repair S/N A169N03000L=> S/N A185N03000L=> S/N H118N03000L=> S/N E174N03000L=> 0620SRM1621** for phase cable torque specifications.

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.

CDF File Installation Procedure

NOTE: Installation of a CDF file requires the CCS Field Tool from HYPASS or Access. A CDF file download is required whenever a controller or other module device is replaced or a new option feature is added to the truck. A CDF file may also be used to recover factory settings if parameters have been changed. After Installing the CDF file or replacing any controller node the following calibrations may be required (See CALIBRATIONS):

- Steering and caster steering (if installed)
- Mast tare weight
- Aft handle throttle (if installed)
- Lift cushion (Americas only)
- Optional sensors or reading systems (if installed) including: reach sensor, return to set til, lift limit, and shelf height selector.

1. Use the truck serial number in Hypass or Access and open the truck software section and locate the Configuration Data File (CDF). Each file is serial number specific so if there are multiple trucks all files must be obtained and downloaded. The files can be renamed if desired, however never change the file number extension (.hex). It is recommended the files be saved to the computer desktop (default location) or another file directory where it can be easily located.
2. Connect to the truck with the IFAK cable. With the truck powered On, open the CCS Software Update Tool program on the laptop. When the tool opens, select the truck model type and type in the truck serial number.
3. Select IMPORT CDF.
4. Select PROGRAM.



Figure 9. Configuration Data File

5. The program will automatically load and update any necessary files. (Note: not all trucks get all the listed files). When the programming is complete it will say “programming complete”
6. Whenever a CDF file is downloaded it requires that the truck steering, (caster steering if equipped), and mast Tare up and mast Tare down calibrations be performed using the dash display. See **User Interface Service Technician 2200SRM1614**.

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.

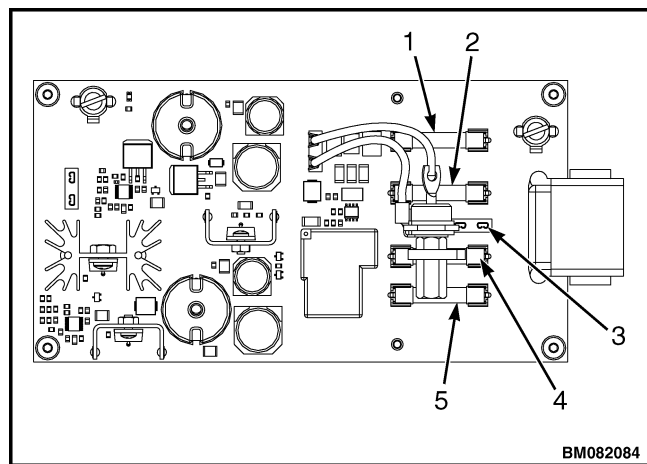
NOTE: To perform the following component tests or to replace any of the components, the drive unit compartment doors must be opened and the drive unit compartment cover must be removed.

FUSES

All the fuses are located in the electrical compartment. See Figure 10. 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 10	Key Switch E-Stop Start	10A
FU 11	Battery Contact Coil Heater (Optional)	10A
JP1	(24V boards only)	7.5A
FU 12	Logic Power	10A
FU 13	Spare	10A



- 1. FU 10
- 2. FU 11
- 3. JP 1
- 4. FU 12
- 5. FU 13

Figure 10. 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.

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	32 ohms ± 3 ohms	Test coil both ways. Use highest reading.
Coil (Hydraulic control)	On pump assembly	40 ohms ± 4 ohms	Test coil both ways. Use highest reading.
Brake coil	On top of drive motor	12 ohms ± 1 ohm	

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**

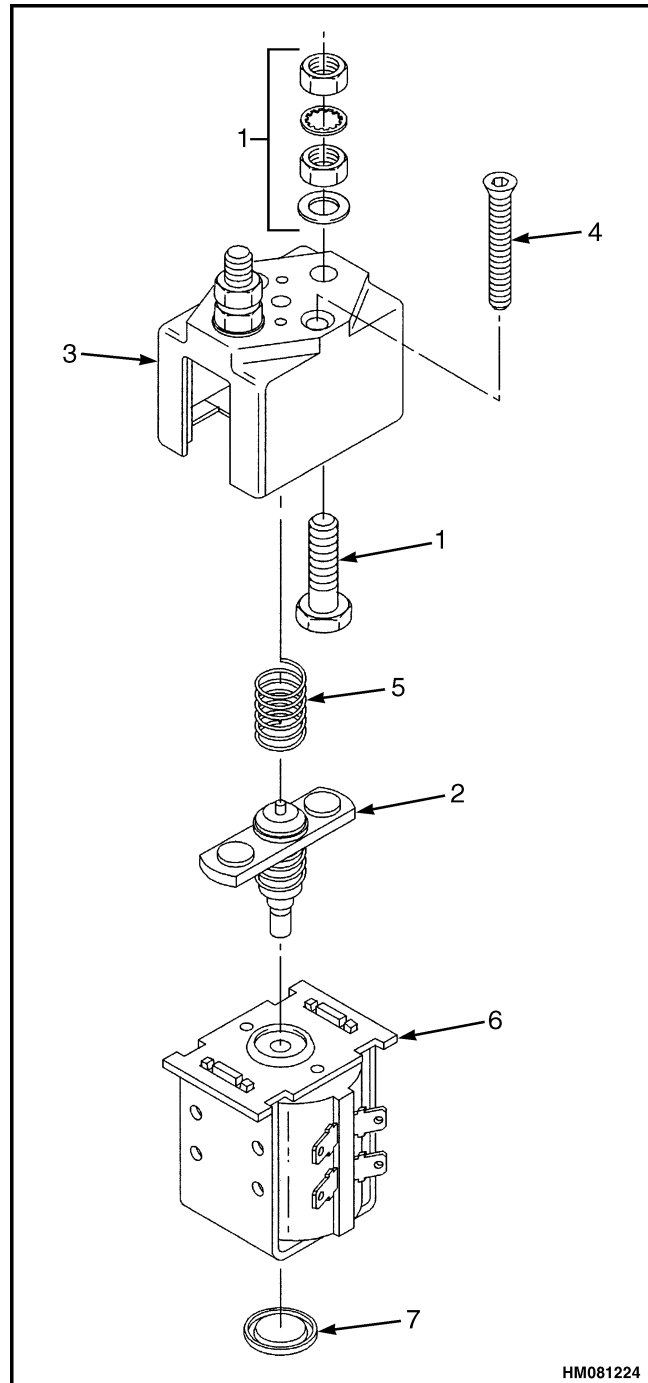
Disconnect the battery and separate the connector before opening the drive unit and compartment and inspecting or repairing the electrical system. If a tool causes a short circuit, the high-current flow from the battery can cause a personal injury or property damage.

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 11. Remove cover of each contactor. **DO NOT** lose plunger springs.
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.



HM081224

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

Figure 11. Contactor

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

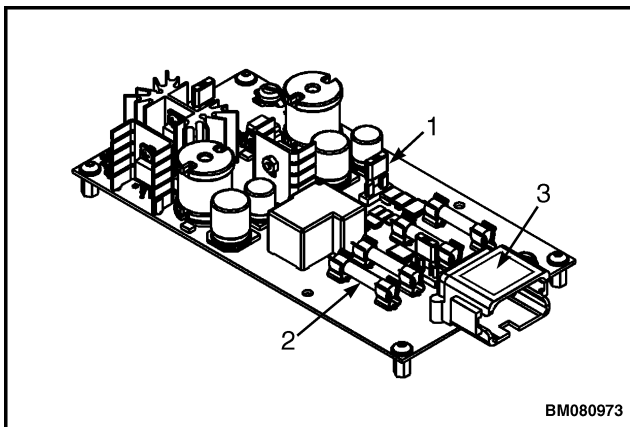
1. Connect wires to proper terminals.
2. Mount the key switch in bracket.
3. Install nut to retain the key switch. Make certain switch is properly aligned before tightening retaining nut.
4. Install instrument panel. See Instrument Panel Removal and Installation.
5. Connect battery connectors.
6. Test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

Integrated Fuse Board (IFB)

The Integrated Fuse Board (IFB) is located on the inside of the front frame wall, beside the traction and lift motor controllers. The IFB can be accessed by removing the operator compartment covers. See Figure 12. The IFB is used to pre-charge the power amplifiers in the motor controllers when the battery is connected to the lift truck. When the key switch is turned to the **ON** position, the IFB closes the K1 relay on the IFB to provide power to the lift truck logic circuits.

NOTE: The IFB is voltage specific to the lift truck. Though some are similar in appearance, not all IFBs are interchangeable. Refer to the **Parts Manual** when replacing the IFB for proper part selection.

The IFB also provides power for electrical components and optional equipment that may be installed on the lift truck. IFBs are specific for 24 volt and 36 volt lift trucks, and may be identified by the part number located on the IFB connector. See Figure 12. All IFBs for 36-volt units are equipped with a 24-volt regulator to power 24-volt accessories. An optional 12-volt regulator is available on both 24- and 36-volt IFBs depending on truck options.



1. 7.5 AMP FUSE (JP2)
2. 10 AMP FUSES (FOUR PLACES)
3. IDENTIFICATION LABEL ON CONNECTOR

Figure 12. Integrated Fuse Board (IFB)

NOTE: The integrated fuse board is not repairable. If damaged, it must be replaced. Check the IFB for signs of damaged or burned components. Fuses are the only replaceable component on the IFB.

Fuses



WARNING

Making repairs with the battery connected can cause a short circuit. Disconnect the battery by separating the connectors before opening the electrical compartment covers or inspecting/repairing the electrical system. High current flow during a short circuit can cause injury or parts damage.

The fuses are found on the IFB. See Figure 12. The condition of the fuses can often be checked visually. If unsure of condition, check fuses for continuity with an ohmmeter.

1. Completely lower the mast and park the lift truck in a safe, level location. Turn the key switch to the **OFF** position and disconnect the battery. Discharge the capacitors. See Discharging the Internal Capacitors.
2. Remove the two screws securing the plastic cover on the IFB for access to the fuses.
3. Test the fuses using an ohmmeter to check fuses:
 - a. Infinite Resistance = Defective Fuse
 - b. Continuity = Fuse Ok
4. Replace any defective fuse with a proper rated fuse. See Figure 12.

REPLACE

1. Move the lift truck to a safe, level area and completely lower the mast. Turn the key switch to the **OFF** position and attach a **DO NOT OPERATE** tag to the control handle. Block the drive wheel to prevent unexpected movement.

**WARNING**

Making repairs with the battery connected can cause a short circuit. Disconnect the battery by separating the connectors before opening the electrical compartment covers or inspecting/repairing the electrical system. High current flow during a short circuit can cause injury or parts damage.

2. Disconnect the battery power cable connector from the truck connector located on the right side of the frame. Pull the battery cable connector handle to separate the battery connector from the truck connector.
3. Remove the plastic cover from the operator compartment.
4. Discharge the capacitors. See Discharging the Internal Capacitors.
5. Tag and remove IFB wire connections. Remove the IFB from the mounting posts on the truck frame.
6. Install the electrical wiring to the IFB as removed.

**CAUTION**

Over tightening the attaching hardware can damage the IFB.

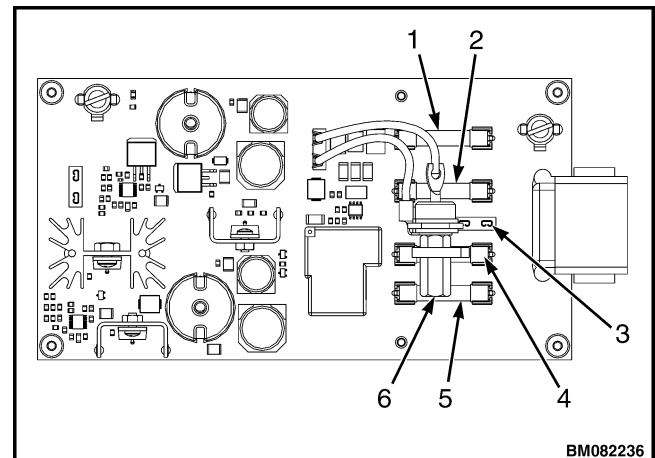
7. Position the IFB onto the mounting posts and secure as removed.
8. Install the plastic cover(s) to the operator compartment as removed.
9. Engage the battery cable connectors. Install the key and turn the key switch to the **ON** position. Test for proper operation. Remove the blocks from the drive wheels and the **DO NOT OPERATE** tag.

Most fuses are located in the electrical compartment. 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.

NOTE: Some fuses for accessories may be located in a separate fuse holder such as the heater option fuses. Trucks with camera options also have fuses located in the camera power module located on the front carriage.

Table 3. IFB Fuses

FUSES	CIRCUIT	RATING
FU10	Key Switch, E-Stop, Start	10A
FU11	Battery, Contact Coil, Heater (Optional)	10A
JP1	(24V boards only)	7.5A
FU12	Logic Power	10A
FU13	Spare	10A



- | | |
|---------|--------------------|
| 1. FU10 | 4. FU12 |
| 2. FU11 | 5. FU13 |
| 3. JP1 | 6. D6 DIODE (JP-2) |

Figure 13. Fuse & Diode Locations

DIODES

An internal IFB board diode (D6) and the external diode (D 5) are used to prevent fly-back voltage from the 24 volt and 12 volt circuits. The D6 diode is located under the IFB board fuse cover and is installed in the board fuse holder JP-2 location. The external D5 diode is located tied to the main har-

ness adjacent to the IFB board and is installed from the factory in the #3 pin location of the IFB board with the other side of the diode connecting to the 033A wire of the main harness. Before replacing an IFB board due to loss of 24 volt or 12 volt power, the Diode circuit should be checked for an open circuit or reversed wires or fuse terminal connections.

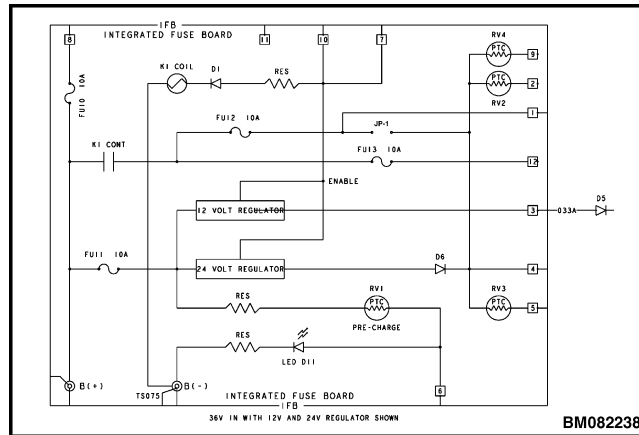


Figure 14. 36 Volt (24V / 12V Regulators) Internal Board Schematic

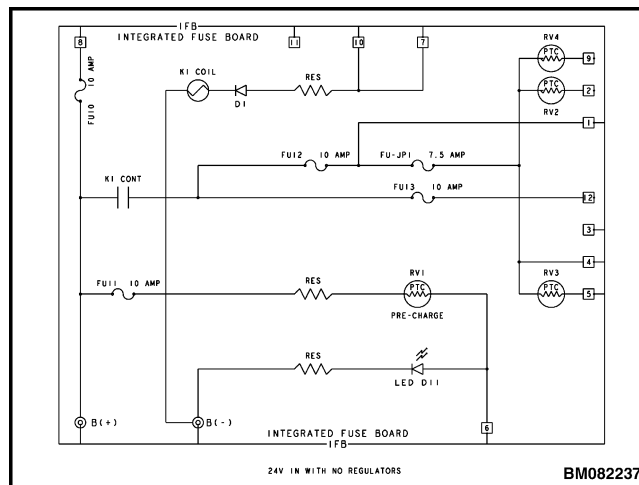


Figure 15. 24 Volt Internal Board Schematic