SERVICE REPAIR

MANUAL

Hyster D476 (T5ZAC) Forklift Service Repair Manual

HYSTER

CONTROLLER DIAGNOSTICS

C80ZHD [A282];
T5ZAC [C476/D476];
T7ZAC [C477]; C605ZHD, C80ZHD [A373]

HYSTER

PART NO. 4096004 **9000 SRM 1657**

SAFETY PRECAUTIONS
TROUBLESHOOTING PROCEDURES

- 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 condition that can cause immediate death or injury!

CAUTION

Indicates a condition that can cause 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:

(C80ZHD) [A282];
(T5ZAC) [C476/D476];
(T7ZAC) [C477];
(C605ZHD, C80ZHD) [A373]

How To Use This Troubleshooting Manual

GENERAL INSTRUCTIONS AND SAFETY INFORMATION

WARNING

DO NOT add to or modify the lift truck. Any modification that affects the safe operation of the truck cannot be undertaken without written authorization of the Hyster company.

Any change to the lift truck, the tires, or its equipment can change the lifting capacity. The lift truck must be rated as equipped and the nameplate must show the new rating capacity.

WARNING

The technician must be aware of, and follow, all general safety precautions that are published in the Operating Manual and that are posted as Safety Decals on and in the lift truck.

Before starting, the technician should be familiar with certain policies, requirements, and instructions used in the troubleshooting procedures. Using the troubleshooting procedures correctly helps the technician to perform the procedure safely and prevents damage to the machine and support equipment.

HOW TO USE DIAGNOSTIC TROUBLESHOOTING MANUAL

Manual Layout:

Section: This manual consists of one section which is further divided into groups.

- 9030 – Electrical System

Groups: The 9030 Electrical System is divided into two groups that identify specific electrical troubleshooting procedures.

- 03 – General Maintenance/Diagnostic Data
  The General Maintenance and Diagnostic Data group includes general troubleshooting, discharging the capacitors, basic electrical troubleshooting, multiplexing, User Iterface, and status codes and descriptions.
- 20 – Diagnostic Trouble Codes
  The Diagnostic Trouble Codes group includes all troubleshooting procedures for status codes reported by a given Node or system.

For a listing of all Diagnostic Trouble Codes and descriptions, see the Status Codes and Descriptions section of this manual.

GENERAL INSTRUCTIONS

1. Become familiar with the content, layout, and access provisions of data in this manual. This will improve your efficiency and decrease the time required to resolve the problems.
2. Once you begin a troubleshooting procedure, do not skip steps.
3. If you reach the end of a procedure without resolving the problem and you are not directed to another procedure contact Resident Service Engineering through the Contact Management System.
4. Do not limit yourself, remember to apply your own experience and knowledge to assist in resolving the problems, but do not compromise safety in doing so.
5. Most of the cross-reference data in the manual will be electronically linked for rapid and easy access. Use the links wherever the cursor highlights an item as a linkable option.

SECTION 9030

ELECTRICAL SYSTEMS

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Group 03

General Maintenance and Diagnostic Data

GENERAL TROUBLESHOOTING

In the event the lift truck does not operate correctly, a status code is displayed on the display panel. Once the status code is obtained, follow the procedures outlined in this manual only after reviewing the following information regarding the truck's unique electrical system and troubleshooting procedures.

NOTE: Due to the interaction of the Combination controller with all truck functions, almost any status code or controller fault could be caused by an internal failure of the Combination controller. After all other status code procedures have been followed and no problem is found, the Combination controller should be tested and replaced as the last option to correct the problem.

The onboard diagnostic system employed on the vehicle can assist in the troubleshooting process. Read and be familiar with the instructions for accessing and using the display's diagnostic system in **User Interface Service Technician** 2200SRM1631 .

Prior to troubleshooting systems and components on the vehicle, ensure the battery voltage is correct and within specifications. Make sure the battery connector contacts are clean of corrosion and the battery polarity within the connector is correct. Inspect that all fuses are correct and are not the cause of component failure. Ensure the key switch is in the ON position when conducting voltage checks or verifying the operation of a component. Make sure the brake switch and the operator presence switch, if equipped, are functioning properly and are closed.

Many faults noted by lift truck's electrical system may be the result of loose wiring connections and/or broken or shorted wiring within the lift truck. Begin the troubleshooting process by carefully inspecting the wiring involving the device or devices noted by the onboard diagnostic system. .

The controllers are sealed units with no serviceable components. Troubleshooting is usually limited to accessing status codes and following the diagnostic procedure provided for each status code.

Use standard testing procedures to verify inputs and outputs when necessary.

CAUTION

Never attempt to probe through the back of the connector plugs of the motor controller. These plugs are special sealed plugs. Probing through the back of the plugs will destroy the seal and can cause a short circuit. If a circuit must be tested for voltage, check for voltage at an amp-type plug, a switch, or component. If a circuit is suspect, check the circuit for continuity by disconnecting the plug and testing continuity from the front (pin end) of the plug.

Standard probes are too large to be inserted into the center of female pins (sockets) of the special sealed plugs and can damage or expand the pins. Expanded pins will not provide good connections once the plug is reconnected. The connectors are shaped to allow the insertion of a small flat-blade screwdriver into the connector. After inserting the screwdriver into the connector, attach probes with alligator clips to the shank of the screwdriver to obtain readings. An additional method would be to use Breakout Kit #1397311 .

Refer to **8000 SRM 1643** for wiring diagrams and additional circuit information.

DISCHARGING THE CAPACITORS

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

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 to the control handle and disconnect the battery.

Disconnect the battery and discharge the internal or external capacitors 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 jewelry or other metallic items on your fingers, arms, or neck when working near electrical components. 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.

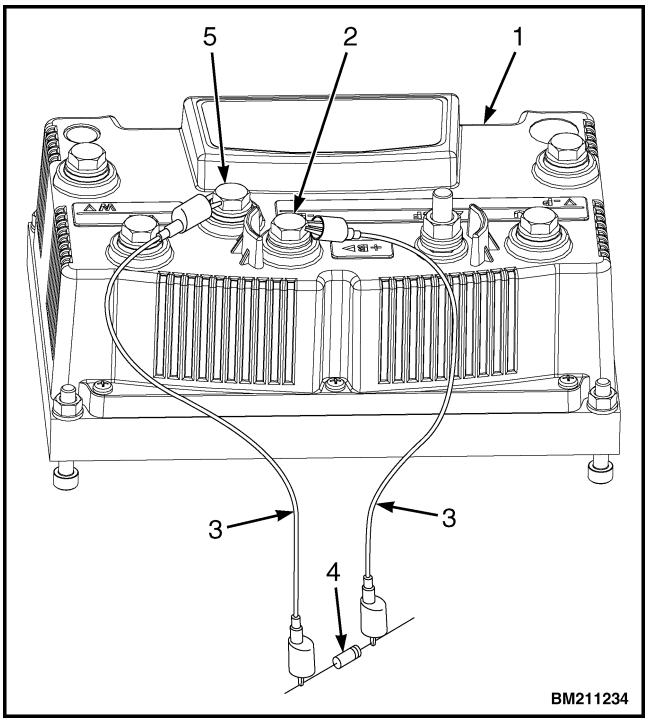
The capacitors in the transistor controllers can hold an electrical charge after the battery is disconnected. To prevent an electrical shock and personal injury, discharge the internal or external capacitors before inspecting or repairing any component in the electrical compartments. Make certain that the battery has been disconnected.

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

CAUTION

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

1. Move the lift truck to a safe, level area and completely lower the forks. 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 top-left 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 or external capacitors in the controllers by connecting a 200-ohm, 2-watt resistor across the controller B(+) and B(-) terminals of the combination controller. Remove the resistor after discharging the capacitors. See Figure 9030-03-1.



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

Figure 9030-03-1. Discharging the Internal Capacitors

ELECTRICAL TEST EQUIPMENT

Before beginning intrusive circuit checks, verify the vehicle battery state of charge. Visually inspect suspected connectors for loose, damaged, or corroded terminals. Check for blown fuses and inspect circuits for cause of overcurrent conditions. Physically check mechanical operation to ensure a switch, relay, or solenoid is not sticking or damaged.

NOTE: Measuring continuity between two terminals of a switch while operating the switch will determine its functionality.

PC Service Tool

The PC Service Tool is a Windows based service application that is used to communicate with the truck's electrical control system. It can be used to monitor the status and condition of various systems. With this capability, the PC Service Tool can be used to monitor component operation, or determine if abnormal events have occurred in the truck, and assist with diagnostics and troubleshooting.

Breakout Kit #1397311

The Breakout Kit allows the technician to perform circuit input and output checks at the controllers' connectors. The Breakout kits primary function allows the technician to diagnose circuit faults while the vehicle's circuits are connected and operating. This is done by installing the breakout kit in series with the controller and its circuits.

Digital Multimeter (DMM)

Digital multimeters provide several measurement functions in one tool. A DMM should be capable of accurately measuring voltage, amperage, and resistance. Ensure that the multimeter used in troubleshooting procedures is accurate and that the test leads do not have excessive resistance. A faulty meter or damaged test leads will cause inaccurate readings and incorrect electrical diagnoses.

Jumper Wires, Test Leads, and Test Lights

When using jumper wires, test leads, and test lights, take care not to force tips into connector sockets. Use appropriate clips and adapters to prevent damage to connectors. Expanded or damaged sockets can cause poor continuity between connections.

Jumper wires allow testing across a suspected open in the circuit. Jumper wires can be used for located opens, shorts, and performing voltage drops. If a circuit operates correctly with the jumper wire in place, and is faulty when the jumper wire is removed, a fault can be found in the bypassed location.

Jumper wires can also be used to eliminate sections of the circuit to diagnose either power or grounds. Using the jumper wire to provide a component a known good ground can help reduce the amount of checks needed to diagnose a circuit.

Jumper wires can be used to bypass components such as switches. If a faulty switch is suspected, removing it from the circuit with a jumper wire can determine if a switch or component is at fault.

Jumper wires can be used to check for open or faulty relay contacts which are often sealed and can take additional steps to properly diagnose.

Test lights can be used when quick voltage or ground checks are necessary. Many features operate on switched voltage, and using a test light as a load device may be helpful. The test light may also be used to verify continuity to B-. Discretion should be used when troubleshooting a circuit using a test light, as the light may illuminate even though there may be an excessive amount of resistance on the ground circuit or when a low voltage or amperage situation exists.

Basic Electrical Troubleshooting

ELECTRICAL CHECKS

The following electrical checks are used to diagnose circuit and component faults on trucks. Review the following information so that it may be applied when diagnosing a fault or status code.

Voltage Checks

Voltage is electrical pressure or force that pushes current through a circuit. The force is measured in volts.

Low voltage to a load device will cause the device to be inoperative or operate poorly. This can be caused by a low battery source, high circuit resistance, poor connections, or an open circuit; the resistance of poor connections or poor ground acts as an additional load in the circuit, causing low voltage pushing current, or amperage, through a device.

A voltmeter is used to perform:

- Measurement of force

- Presence of voltage
- Voltage drops

When using a voltmeter to determine if voltage is present and capable of operating a device, connect the positive meter lead to the power circuit of a device's connector and connect the negative meter lead to the negative battery terminal.

Measuring the voltage drop is performed by connecting the positive test lead to the positive side of the device while simultaneously connecting the negative meter lead to the negative side of the device. The test can also be performed across a section of wire that is faulty and suspected of having excessive resistance. A voltage drop must be performed while the device is operating. In a circuit with a single load device, the device will drop the total voltage of the circuit. If the device drops less than battery voltage, it can be assumed that the circuits are using the remaining voltage as a source of excessive resistance or a poor connection exists, assuming the battery state-of-charge is correct.

Amperage Checks

An ammeter is used to measure amperage or current flow through a circuit. An ampere is the measurement of electron flow, which can be used to measure the amount of electrons that are flowing through a circuit. Ohm's Law states that current flow in a circuit is equal to the circuit voltage divided by total circuit resistance, known as the potential difference. Since amperage is the current in the circuit, increasing voltage also increases the current, or amperage levels.

Measuring amperage is always performed by placing the ammeter in series with the device or circuit. This will cause all current to flow through the protected meter. The circuit must be operating in order to measure amperage. Never measure amperage on high amperage circuits or in parallel to a circuit, this can result in the damage of the meter and the electrical system.

Resistance Checks

The ohmmeter is used to measure a circuit or device's resistance in ohms. Ohmmeters use low internal voltage and current which flow through an isolated circuit or device being tested. The voltage of the meter battery and the amount of current flow in the circuit are used to calculate the circuit's resistance. It is necessary to disconnect or isolate the circuit being test so not to damage the vehicle's electrical system or the ohmmeter.

An ohmmeter is used to perform:

- Resistance of a load device
- Resistance of conductors
- Value of resistors
- Operation of variable resistors
- CANbus termination resistors
- Continuity

Contactor and Contactor Coil Checks

1. Measure voltage between the coil's positive terminal and B(-).

NOTE: Key in ON position.

Is voltage same as truck's battery voltage?

YES- Proceed to Step 2.

NO- Inspect the Coil's battery B(+) input circuit for open or short.

2. Disconnect coil's ground control circuit. Measure resistance between ground circuit terminal and B(-).

NOTE: Actuate coil ground control.

Is resistance <1 ohm?

YES- Proceed to Step 3.

NO- Inspect ground control circuit. Verify that controller is receiving device input signal.

3. Measure battery voltage between main contactor's battery B(+) terminal and B(-).

NOTE: Key in ON position.

Is voltage same as truck's battery voltage?

YES- Repair or replace faulty contactor.

NO- Inspect main contactor battery cable for loose, damaged, or corroded connections.

Multiplexing

MULTIPLEXING AND THE CANBUS

Controller Area Network (CAN) Bus communication allows multiple modules to communicate with each other using the same digital data on a shared network, this method of communication is known as multiplexing. The CANbus is a pair of twisted insulated wires that interconnect all the modules on the network. The data transmitted is a digital encoded format. Digital means only two states are used to transmit data, High/On and Low/Off. This eliminates the need for each module to be hard wired to each sensor. Using Multiplexing, sensor information that may be received by one module, can then be shared with all other modules. The information is sent out over the CANbus in an encoded form and any other module that requires the information can pick it out from the data stream.

Troubleshooting the CANbus

NOTE: Refer to the latest Diagram SRM for the most current circuit information.

When the CANbus is active and modules are communicating, CAN HI and CAN LO voltage will be approximately 5 volts when added together. If both CAN HI and CAN LO have consistent 2.5 volt, there is no communication on the CANbus.

If CAN HI is shorted to B(-) or CAN LO is shorted to battery voltage, network communication will stop.

If you measure battery voltage on the data link, there is a short to power in the circuit.

If you measure 0 volts while the CANBus is active, there is a short to B(-) or an open in the circuit.

Internal control module failures can stop the entire network from communicating. If there are no harness problems, disconnect control modules one at a time until CANbus communication returns.

With both 120 ohm termination resistors connected to the CANbus, resistance between the two circuits should read 60 ohms.

If CANbus resistance is 120 ohms, there is an open circuit or a termination resistor is missing.

If resistance is 0 ohms, the two circuits are shorted together.

1. Measure voltage between the diagnostic connector, socket A and B(-).

NOTE: Key in ON position.

Is voltage approximately 2.5 volts?

YES- Proceed to Step 2.

NO- Inspect CAN HI circuit for open or short; if voltage is 0 volts, the CAN HI circuit is shorted to B(-) or open. If voltage is above 5 volts, the CAN HI is shorted to power.

2. Measure voltage between the diagnostic connector, socket B and B(-).

NOTE: Key in ON position.

Is voltage approximately 2.5 volts?

YES- Disconnect the battery and proceed Step 3.

NO- Inspect the CAN LO circuit for open or short; If voltage is 0 volts, the CAN LO circuit is shorted to B(-) or open. If voltage is above 5 volts, the CAN LO is shorted to power.

3. Measure resistance between the diagnostic connector, socket A and socket B.

Is resistance 60 ± 6 ohms?

YES- CANbus communication is operating correctly.

NO- If resistance is 120 ohms; the CANbus has an open circuit, missing, or damaged termination resistor. If resistance is 0 ohms, the CANbus circuits are shorted together. If resistance is open; the CAN HI and/or CAN LO connection to the diagnostic port may be open. Use the wiring diagrams to detect and correct open circuit.

User Interface

USER INTERFACE, SETUP, AND TROUBLESHOOTING

The dash display has a LCD screen for displaying truck system information. The display has five indicator lights for truck function status. There are five number keys for password. Number keys 1-4 are also used for navigating the on-board setup and service menus. The dash display also contains a battery state-of-charge indicator and is equipped to allow operator selectable drive modes.

Button Keypad

The button keypad is located on the right side of the display. It consists of four buttons arranged in a circle with a fifth button in the center. The buttons are numbered 1 through 5, starting with button 1 at the top and continuing clockwise and ending with button 5 situated in the center of the keypad.

LED Indicator Lights

The LED indicator lights are located on the display below the LCD screen and to the left of the button keypad. The lights illuminate to notify the operator of certain conditions. The function of each light (in order from left to right) is as follows:

- Battery Indicator
- Wrench Indicator
- Temperature Indicator
- Operator Symbol
- Warning Indicator

LCD Screen

The LCD screen displays the following when the key is in the ON position:

1. Indicator symbols will illuminate from left to right.
2. The truck horn will beep.
3. The battery state-of-charge will illuminate.
4. Performance mode will be displayed.
5. Steer angle indicator will be displayed.
6. Truck speed indicator will be displayed.
7. Truck hours will be displayed.

Dash Display Access

The operator passwords are a series of five-digit numbers. Each of the five number digits can be the numbers 1 through 5. If enabled, the password number series must be entered into the memory by a technician or supervisor and assigned to an operator. A certified dealer technician can use a personal computer (PC), connected to the lift truck, to check and assign passwords.

After the key is moved to the ON position, the LCD screen will show ENTER PASSWORD, if this function is enabled. Use the numbered push buttons to enter the five-digit password. The password can be entered as many times as needed. If the password is entered incorrectly, the message PASSWORD ERROR will appear and the operator will be prompted to ENTER PASSWORD again.

Refer to the appropriate User Interface manual for further information regarding the Supervisor or Service Level application.

Status Code Toggling

This feature allows the operator to toggle the display from the normal screen display to the status code screen. Pressing the 2 button will cause the display to switch from the normal display screen to the status code screen. Pressing the 4 button will cause the display to return from the status code screen to the normal display.

Automatic Diagnostics

This feature allows for immediate access to diagnostics associated with status codes. To use this feature, press the 5 button while viewing the status code screen. If diagnostics are available with the code, the diagnostics will be immediately entered.

Status Code Indication

This feature indicates if a status code is available when in the normal screen. If a status code is present, the mode indicator will display “!”.

Status Codes and Descriptions

STATUS CODES

Status codes give an indication to the operator that a possible malfunction or incorrect truck use has occurred. Status codes are a code number of a symptom or malfunction. The wrench symbol will flash and the status code number will be shown on the LCD screen if an incorrect truck use or malfunction occurs during operation. Have an authorized service person check and repair the lift truck if a status code number appears. The symptoms for each status code are shown in this manual. This manual also provides in-depth troubleshooting procedures for each fault broken down into the following system or node:

NODE 10: DISPLAY

NODE 32: COMBI

Status Codes are displayed as four lines. Line one consist of the Node and Code number. The second line consists of the Node name while lines three and four contain code descriptions. For example, Status Code 32003 is shown in the Status Code Structure Table 9030-03-1. This Status Code is set when a lower coil circuit fault is detected by the combination controller.

Table 9030-03-1. Status Code Structure

LINE NUMBER	LINE DESCRIPTION
LINE 1	32003
LINE 2	Combination
LINE 3	Lower Coil
LINE 4	Circuit

STATUS CODE DESCRIPTIONS

Status Codes can be reported by any Node that detects a fault.

Table 9030-03-2. Node 10 Status Codes

NODE	STATUS	DESCRIPTION
10	099	*The Display has detected an Internal Fault. **
10	100	The Display has detected a loss of CAN communication with the Combination Controller.
10	106	The Display has detected a loss of CAN communication with the Handle.
10	109	The Display is not communicating on the CANBus.
**Any Node or system that detects an internal fault is capable of reporting a 099 Status Code. Refer to the xx099 Status Code troubleshooting procedures for all Internal Fault Codes regardless of what Node has reported the fault.*		

Table 9030-03-3. Node 32 Status Codes

NODE	STATUS	DESCRIPTION
32	003	The Combination Controller has detected a fault in the Lower Coil circuit.
32	004	The Combination Controller has detected a short in the Lower Coil circuit.
32	005	The Combination Controller has detected a fault in the Load Hold Coil circuit.
32	006	The Combination Controller has detected a short in the Load Hold Coil circuit.

Table 9030-03-3. Node 32 Status Codes (Continued)

NODE	STATUS	DESCRIPTION
32	033	The Combination Controller has detected a fault in the Main Contactor Coil circuit.
32	034	The Combination Controller has detected a short in the Main Contactor Coil circuit.
32	037	The Combination Controller has detected a fault in the Audible Alarm circuit.
32	038	The Combination Controller has detected a short in the Audible Alarm circuit.
32	039	The Combination Controller has detected a fault in the Visible Alarm circuit.
32	040	The Combination Controller has detected a short in the Visible Alarm circuit.
32	052	The Combination Controller has detected a Throttle Sensor fault.
32	060	The Combination Controller has detected a fault in the Traction Motor or Traction Motor circuit.
32	061	The Combination Controller has detected a short in the Traction Motor or circuit.
32	062	The Combination Controller has detected a Motor Encoder fault.
32	067	The Combination Controller has detected that the Main Contactor is stuck closed or has welded tips.
32	068	The Combination Controller has detected that the Main Contactor is not closed or stuck open.
32	069	The Combination Controller has detected a fault in Capacitor charge.
32	085	The Combination Controller has detected low key input voltage or a fault in the key input circuit.
32	086	The Combination Controller has detected Low DC Bus Voltage or a fault in the DC Bus circuit.
32	087	The Combination Controller has detected High DC Bus Voltage or a fault in the DC Bus circuit.
32	200	The Combination Controller has detected a Lift/Lower Switch release fault.
32	201	The Combination Controller has detected a Throttle release fault.
32	216	The Combination Controller has detected a Rabbit Switch release fault.
32	227	The Combination Controller has detected that the Traction Motor has stalled.

Table 9030-03-4. Warning Codes

CODE TYPE	NODE	STATUS	DESCRIPTION	SYMPTOM
Thermal	XX	080	*Motor Cutback**	A controller has begun to reduce power to the motor in attempt to manage increased temperatures that may damage the motor. Motor cutback is initiated at 140°C (284°F). Truck performance will be reduced until temperature lowers to an acceptable level. Motor temperature input can be monitored in menu D2.32.6.
	XX	081	*Motor Overheated**	Motor cutback (XX080) was unsuccessful. Motor cutback is initiated at 160°C (320°F). The truck will severely limit performance until the motor temperature returns to normal. Motor temperature input can be monitored in menu D2.32.6
	XX	082	*Controller Cutback**	A controller has begun to reduce power in attempt to manage increased temperatures that may damage internal components. Controller cutback is initiated at 90°C (194°F). Truck performance will be reduced until temperature lowers to an acceptable level. Controller temperature input can be monitored in menu D2.32.5.
	XX	083	*Controller Overheated**	Controller cutback (XX082) was unsuccessful. Controller cutback is initiated at 110°C (230°F). The truck will severely limit performance until the motor temperature returns to normal. Motor temperature input can be monitored in menu D2.32.5.
	XX	248	*Low Temp**	A controller has detected low temperature conditions. Move truck to a warmer ambient condition an allow sufficient time to warm.
(XX) Any Node or system that detects a thermal fault is capable of reporting a Status Code.				

NOTES

Group 20
Diagnostic Trouble Codes

DTC xx099
Internal - Fault

POSSIBLE CAUSE

A. INTERNAL FAULT

COMPONENT OPERATIONAL CHECK

NOTE: Always check battery condition and state of charge before performing electrical troubleshooting. A faulty or low charged battery will cause electrical features to not operate as designed and give incorrect readings while performing electrical tests.

PROCEDURE OR ACTION:

1. Conduct a visual inspection of all connectors/wiring associated with the fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate **Electrical System** SRM.
   NO: Proceed to Step 2.
2. Re-key the vehicle.
   Is the code still present?
   YES: Proceed to Cause A.
   NO: Problem may be intermittent.

CAUSE A - INTERNAL FAULT

PROCEDURE OR ACTION:

1. Replace faulty controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

END FAULT

DTC xx100
CANBus Communications - Combi

POSSIBLE CAUSE

A. CANBUS COMMUNICATION FAULT

B. COMBINATION WIRING FAULT

C. FAULTY COMBINATION CONTROLLER

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

NOTE: Always check battery condition and state of charge before performing electrical troubleshooting. A faulty or low charged battery will cause electrical features to not operate as designed and give incorrect readings while performing electrical tests.

PROCEDURE OR ACTION:

1. Conduct a visual inspection of all connectors/wiring associated with the fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate **Electrical System** SRM.
   NO: Proceed to Step 2.
2. Re-key the vehicle.
   Is the code still present?
   YES: Proceed to Step 3.
   NO: Problem may be intermittent.
3. Locate input diagnostics (D2.10) and verify Combination controller communication (D2.10.32).
   Is the Combination controller online?
   YES: Fault may be intermittent.
   NO: Proceed to Step 4.
4. Using input diagnostics (D2.10), determine if other nodes are offline.
   Are other nodes offline?
   YES: Suspect short to frame.
   NO: Proceed to Cause A.

CAUSE A - CANBUS COMMUNICATION FAULT

PROCEDURE OR ACTION:

NOTE: Perform Step 1 and Step 3 with key in ON position.

1. Disconnect the Combination controller connector CPS005 and measure voltage between socket 28 and B(-).
   Is CAN HI voltage approximately 2.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect CAN HI circuit for open or short. If voltage is 0 volts, the CAN HI circuit is shorted to ground or open. If voltage is above 5 volts, the CAN HI circuit is shorted to power.
2. Measure voltage between the Combination controller connector CPS005, socket 27 and B(-).
   Is CAN LO voltage approximately 2.5 Vdc?
   YES: Disconnect battery and proceed to Step 3.

DTC xx100 (Cont)
CANBus Communications - Combi

NO: Inspect CAN LO circuit for open or short. If voltage is 0 volts, the CAN LO circuit is shorted to ground or open. If voltage is above 5 volts, the CAN LO circuit is shorted to power.

3. Measure resistance between the Combination controller connector CPS005, socket 27 and socket 28.
   Is resistance 60 ± 6 ohms?
   YES: No communication faults are present, connect battery and proceed to Cause B.
   NO: If resistance is 120 ohms, the CANbus has an open circuit or a missing or damaged termination resistor. If resistance is 0 ohms, the CANbus circuits are shorted together.

CAUSE B - COMBINATION WIRING FAULT

PROCEDURE OR ACTION:

NOTE: Perform Step 1 and Step 2 with key in ON position.

1. Measure voltage between the Combination controller B(+) terminal and B(-).
   Is voltage 24 ± 2.5 Vdc / 36 ± 3.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect B(+) cable for damage or loose connections.
2. Measure resistance between the Combination controller B(-) terminal and B(-).
   Is resistance ≤ 1 ohm?
   YES: Proceed to Step 3.
   NO: Inspect B(-) cable for damage or loose connections.
3. Measure voltage between the Combination controller, socket 10 and B(-).
   Is voltage 24 ± 2.5 Vdc / 36 ± 3.5 Vdc?
   YES: Proceed to Cause C.
   NO: Inspect circuit 010-A for open or short.

CAUSE C - FAULTY COMBINATION CONTROLLER

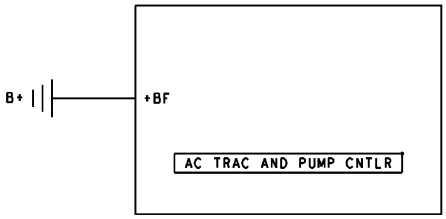
PROCEDURE OR ACTION:

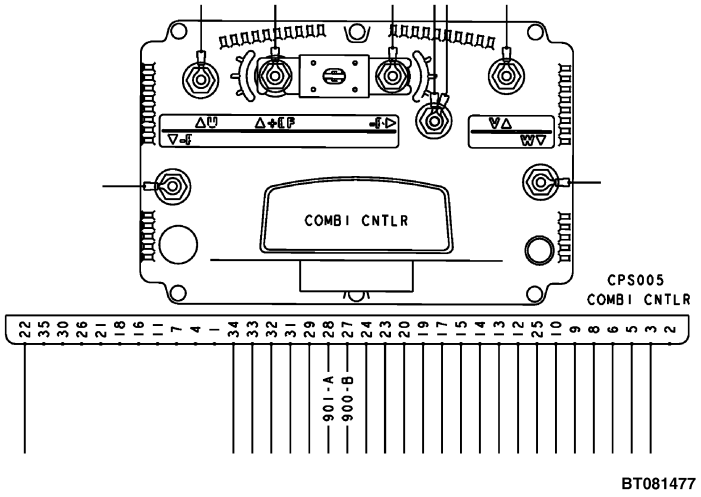
1. Replace faulty Combination controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DTC xx100 (Cont)
CANBus Communications - Combi

DTC XX100 CANBUS COMMUNICATIONS - COMBI DIAGRAMS





Troubleshooting Scenes

END FAULT

DTC xx109
CANBus Communications - Display

POSSIBLE CAUSE

A. CANBUS COMMUNICATION FAULT

B. DISPLAY WIRING FAULT

C. FAULTY DISPLAY

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

NOTE: Always check battery condition and state of charge before performing electrical troubleshooting. A faulty or low charged battery will cause electrical features to not operate as designed and give incorrect readings while performing electrical tests.

PROCEDURE OR ACTION:

1. Conduct a visual inspection of all connectors/wiring associated with the fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate **Electrical System** SRM.
   NO: Proceed to Step 2.
2. Re-key the vehicle.
   Is the code still present?
   YES: If display diagnostic menu is operational, proceed to Step 3. If display is inoperative, proceed to Cause A.
   NO: Problem may be intermittent.
3. Using input diagnostics (D2.10), determine if other nodes are offline.
   Are other nodes offline?
   YES: Verify CAN HI and CAN LO voltages of offline node(s).
   NO: Proceed to Cause A.

DTC xx109 (Cont)
CANBus Communications - Display

CAUSE A - CANBUS COMMUNICATION FAULT

PROCEDURE OR ACTION:

NOTE: Perform Step 1 and Step 2 with key in ON position.

1. Disconnect the display connector CRS060 and measure voltage between socket 3 and B(-).
   Is CAN HI voltage approximately 2.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect CAN HI circuit for open or short. If voltage is 0 volts, the CAN HI circuit is shorted to ground or open. If voltage is above 5 volts, the CAN HI circuit is shorted to power.
2. Measure voltage between the display connector CRS060, socket 4 and B(-).
   Is CAN LO voltage approximately 2.5 Vdc?
   YES: Disconnect battery and proceed to Step 3.
   NO: Inspect CAN LO circuit for open or short. If voltage is 0 volts, the CAN LO circuit is shorted to ground or open. If voltage is above 5 volts, the CAN LO circuit is shorted to power.
3. Measure resistance between the display connector CRS060, socket 3 and socket 4.
   Is resistance 60 ± 6 ohms?
   YES: No communication faults are present, connect battery and proceed to Cause B.
   NO: If resistance is 120 ohms, the CANbus has an open circuit or a missing or damaged termination resistor. If resistance is 0 ohms, the CANbus circuits are shorted together.

CAUSE B - DISPLAY WIRING FAULT

PROCEDURE OR ACTION:

1. Measure voltage between the display connector CRS060, socket 6 and B(-).
   Is voltage 24 ± 2.5 Vdc / 36 ± 3.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect circuit 010-H for open or short.
2. Measure voltage between the display connector CRS060, socket 6 and socket 1/2.
   Is voltage 24 ± 2.5 Vdc / 36 ± 3.5 Vdc?
   YES: Proceed to Cause C.
   NO: Inspect ground circuit 013-E and 102-C for open or short.

CAUSE C - FAULTY DISPLAY

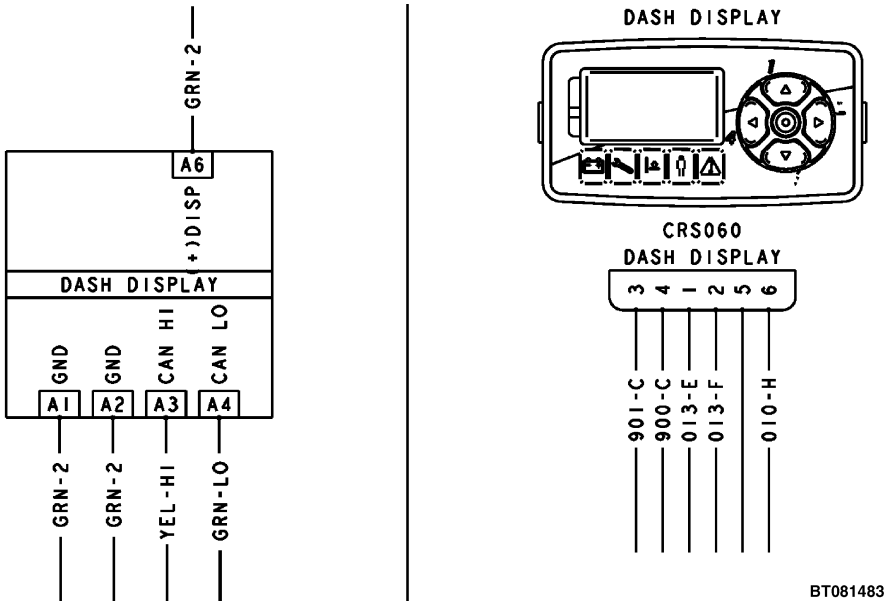
PROCEDURE OR ACTION:

1. Replace faulty display. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DTC xx109 (Cont)
CANBus Communications - Display

DTC XX109 CANBUS COMMUNICATIONS - DISPLAY DIAGRAMS



Troubleshooting Scenes

END FAULT

DTC xx106
CANBus Communications - Handle

POSSIBLE CAUSE

A. CANBUS COMMUNICATION FAULT

B. HANDLE WIRING FAULT

C. FAULTY HANDLE

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

NOTE: Always check battery condition and state of charge before performing electrical troubleshooting. A faulty or low charged battery will cause electrical features to not operate as designed and give incorrect readings while performing electrical tests.

PROCEDURE OR ACTION:

1. Conduct a visual inspection of all connectors/wiring associated with the fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate **Electrical System** SRM.
   NO: Proceed to Step 2.
2. Re-key the vehicle.
   Is the code still present?
   YES: Proceed to Step 3.
   NO: Problem may be intermittent.
3. Locate input diagnostics (D2.10) and verify handle communication (D2.10.60).
   Is the handle online?
   YES: Fault may be intermittent.
   NO: Proceed to Step 4.
4. Using input diagnostics (D2.10), determine if other nodes are offline.
   Are other nodes offline?
   YES: Suspect short to frame.
   NO: Proceed to Cause A.

DTC xx106 (Cont)
CANBus Communications - Handle

CAUSE A - CANBUS COMMUNICATION FAULT

PROCEDURE OR ACTION:

NOTE: Perform Step 1 and Step 2 with key in ON position.

1. Disconnect the control module connector B CRS115 and measure voltage between, socket 4 and B(-)
   Is CAN HI voltage approximately 2.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect CAN HI circuit for open or short. If voltage is 0 volts, the CAN HI circuit is shorted to ground or open. If voltage is above 5 volts, the CAN HI circuit is shorted to power.
2. Measure voltage between the control module connector B CRS115, socket 1 and B(-).
   Is CAN LO voltage approximately 2.5 Vdc?
   YES: Disconnect battery and proceed to Step 3.
   NO: Inspect CAN LO circuit for open or short. If voltage is 0 volts, the CAN LO circuit is shorted to ground or open. If voltage is above 5 volts, the CAN LO circuit is shorted to power.
3. Measure resistance between the control module connector B CRS115, socket 1 and socket 4.
   Is resistance 60 ± 6 ohms?
   YES: No communication faults are present, connect battery and proceed to Cause B.
   NO: If resistance is 120 ohms, the CANbus has an open circuit or a missing or damaged termination resistor. If resistance is 0 ohms, the CANbus circuits are shorted together.

CAUSE B - HANDLE WIRING FAULT

PROCEDURE OR ACTION:

NOTE: Perform Step 1 with key in ON position.

1. Measure voltage between the control module connector B CRS115, socket 3 and B(-).
   Is voltage 24 ± 2.5 Vdc / 36 ± 3.5 Vdc?
   YES: Proceed to Step 2.
   NO: Inspect circuit 010-G for open or short.
2. Measure resistance between the control module connector B CRS115, socket 2 and B(-)
   Is resistance ≤ 1 ohm?
   YES: Proceed to Cause C.
   NO: Inspect ground circuit 102-E for open or source of excessive resistance.

DTC xx106 (Cont)
CANBus Communications - Handle

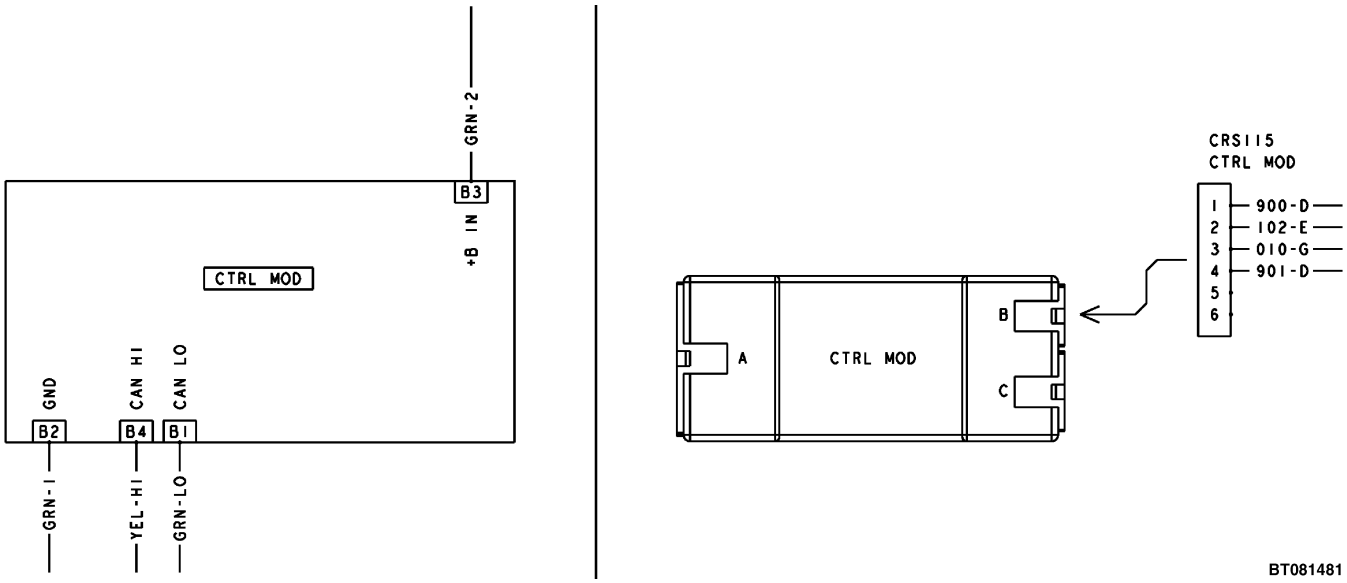
CAUSE C - FAULTY HANDLE

PROCEDURE OR ACTION:

1. Replace faulty handle. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DTC XX106 CANBUS COMMUNICATIONS - HANDLE DIAGRAMS



Troubleshooting Scenes

END FAULT

Lower Coil

CODES

DTC 32003 - Combi - Lower Coil - Circuit
DTC 32004 - Combi - Lower Coil - Short

POSSIBLE CAUSE

A. LOWER COIL WIRING FAULT

B. LOWER COIL FAULT

C. FAULTY COMBI CONTROLLER

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

NOTE: Always check battery condition and state of charge before performing electrical troubleshooting. A faulty or low charged battery will cause electrical features to not operate as designed and give incorrect readings while performing electrical tests.

PROCEDURE OR ACTION:

1. Conduct a visual inspection of all connectors/wiring associated with the fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate **Electrical System** SRM.
   NO: Proceed to Step 2.
2. Re-key the vehicle.
   Is the code still present?
   YES: Proceed to Step 3.
   NO: Problem may be intermittent.
3. Locate status menu (D1) and verify that lower coil is enabled (D1.7).
   Is lower enabled?
   YES: Proceed to Cause A.
   NO: Check that all interlocks have been met.

Lower Coil (Cont)

CAUSE A - LOWER COIL WIRING FAULT

PROCEDURE OR ACTION:

NOTE: Perform Step 1 with key in ON position.

1. Disconnect the lower coil connector CPS088 and measure voltage between socket 2 and B(-).
   Is voltage 24 ± 2.5 Vdc?
   YES: Disconnect battery and proceed to Step 2.
   NO: Inspect circuit 201-A for open or short.
2. Disconnect the Combination controller connector CPS005 and measure resistance between socket 24 and the lower coil connector CPS088, socket 1.
   Is resistance <1 ohm?
   YES: Proceed to Cause B.
   NO: Inspect ground control circuit 150 for open or source of excessive resistance.

CAUSE B - LOWER COIL FAULT

PROCEDURE OR ACTION:

1. Measure resistance between the lower coil's positive and negative terminals.
   Is resistance 40 ± 4.0 ohms?
   YES: Proceed to Cause C.
   NO: Replace faulty lower coil.

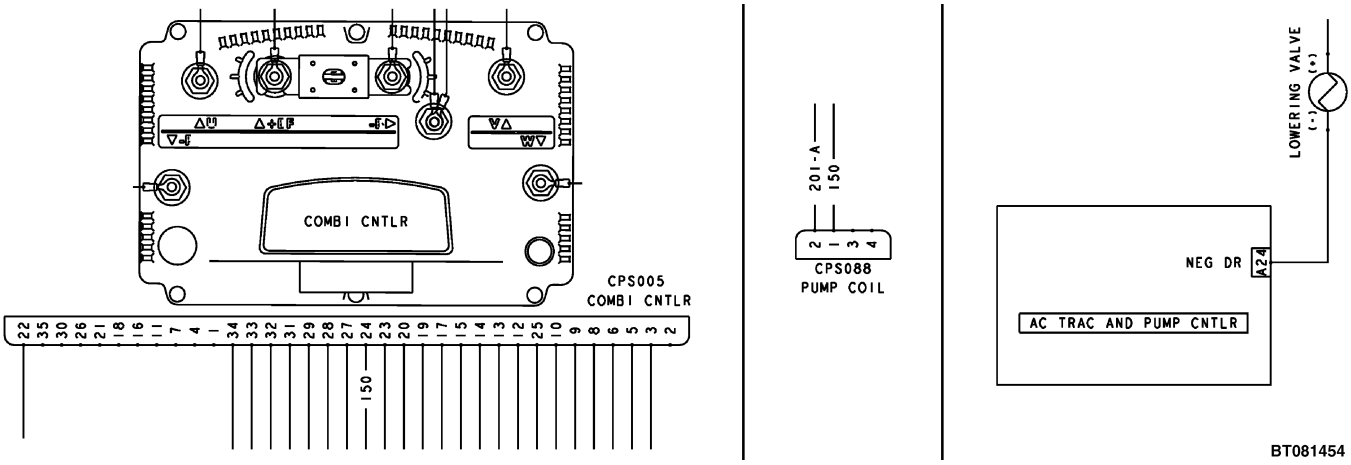
CAUSE C - FAULTY COMBI CONTROLLER

PROCEDURE OR ACTION:

1. If no faults are found, replace controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

Load Hold Coil

CODES

DTC 32005 - Combi - Load Hold - Circuit
DTC 32006 - Combi - Load Hold - Short

POSSIBLE CAUSE

A. LOAD HOLD COIL WIRING FAULT

B. LOAD HOLD COIL FAULT

C. FAULTY COMBINATION CONTROLLER

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

NOTE: Always check battery condition and state of charge before performing electrical troubleshooting. A faulty or low charged battery will cause electrical features to not operate as designed and give incorrect readings while performing electrical tests.

PROCEDURE OR ACTION:

1. Conduct a visual inspection of all connectors/wiring associated with the fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate **Electrical System** SRM.
   NO: Proceed to Step 2.
2. Re-key the vehicle.
   Is the code still present?
   YES: Proceed to Step 3.
   NO: Problem may be intermittent.

NOTE: Operate load hold coil.

3. Locate input diagnostics (D2.32) and verify lower switch activation (D2.32.27).
   Does the display indicate ON when lower switch is activated?
   YES: Proceed to Cause B.
   NO: Proceed to Step 4.
4. Locate output diagnostics (D3.32) and actuate load hold coil (D3.32.9).
   Does coil energize when actuated?
   YES: Fault may be intermittent.
   NO: Proceed to Cause A.

Load Hold Coil (Cont)

CAUSE A - LOAD HOLD COIL WIRING FAULT

PROCEDURE OR ACTION:

NOTE: Perform Step 1 with key in ON position.

1. Disconnect load hold coil connector CPS088 and measure voltage between socket 2 and B(-).
   Is voltage 24 ± 2.5 Vdc?
   YES: Disconnect battery and proceed to Step 2.
   NO: Inspect circuit 201-C for open or short.
2. Disconnect the Combination controller connector CPS005. Measure resistance between the combination connector CPS005, socket 24 and the load hold coil connector CPS088, socket 1.
   Is resistance <1 ohm?
   YES: Proceed to Cause B.
   NO: Inspect ground control circuit 150 for open or short.

CAUSE B - LOAD HOLD COIL FAULT

PROCEDURE OR ACTION:

1. Measure resistance between the load hold coil's positive and negative terminals.
   Is resistance 40 ± 4.0 ohms?
   YES: Proceed to Cause C.
   NO: Replace faulty load hold coil.

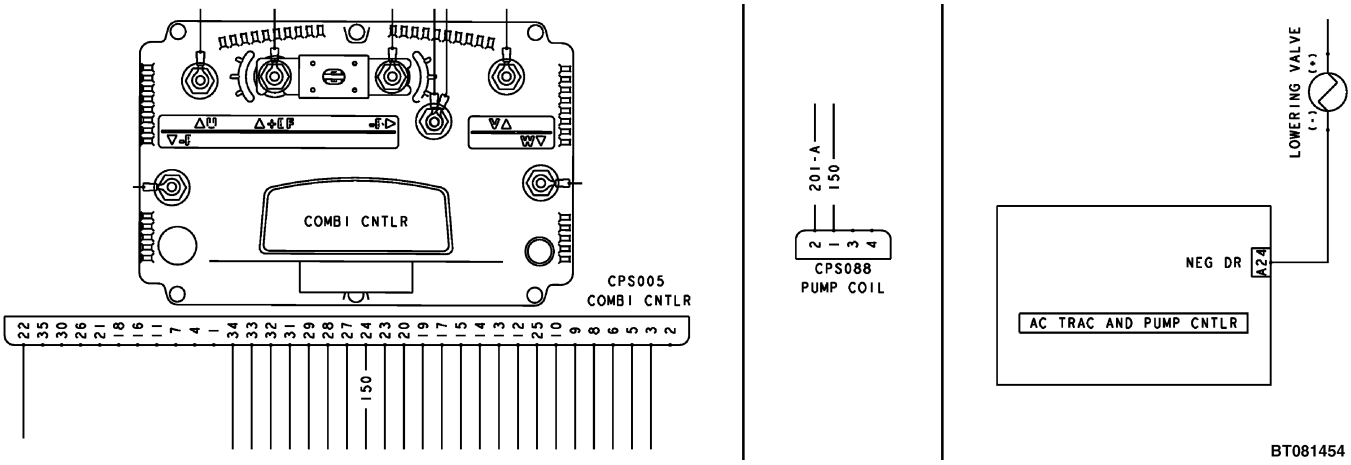
CAUSE C - FAULTY COMBINATION CONTROLLER

PROCEDURE OR ACTION:

1. If no faults are found, replace controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT

Main Contactor Coil

CODES

DTC 32033 - Combi - Main Cont Coil - Circuit
DTC 32034 - Combi - Main Cont Coil - Short

POSSIBLE CAUSE

A. MAIN CONTACTOR COIL WIRING FAULT
B. MAIN CONTACTOR COIL FAULT
C. FAULTY COMBINATION CONTROLLER

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

NOTE: Always check battery condition and state of charge before performing electrical troubleshooting. A faulty or low charged battery will cause electrical features to not operate as designed and give incorrect readings while performing electrical tests.

PROCEDURE OR ACTION:

1. Conduct a visual inspection of all connectors/wiring associated with the fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate **Electrical System** SRM.
   NO: Proceed to Step 2.
2. Re-key the vehicle.
   Is the code still present?
   YES: Proceed to Step 3.
   NO: Problem may be intermittent.
3. Locate input diagnostics (D1) and view the main contactor position (D1.2).
   Is the main contactor closed at correct time?
   YES: Fault may be intermittent.
   NO: Proceed to Cause A .

Main Contactor Coil (Cont)

CAUSE A - MAIN CONTACTOR COIL WIRING FAULT

PROCEDURE OR ACTION:

NOTE: Key in ON position.

1. Disconnect the main contactor coil's positive socket terminal TS003 and measure voltage between socket terminal TS003 and B(-).
   Is voltage 24 ± 2.5 Vdc?
   YES: Disconnect battery and proceed to Step 2.
   NO: Inspect circuit 010-E for open or short.

NOTE: Key in OFF position.

2. Disconnect combination controller connector CPS005 and the contactor coil's negative socket terminal TS004. Measure resistance between the main contactor coil negative socket terminal TS004 and the combination controller connector CPS005, socket 12.
   Is resistance <1 ohm?
   YES: Proceed to Cause B.
   NO: Inspect ground control circuit 079 for open or source of excessive resistance.

CAUSE B - MAIN CONTACTOR COIL FAULT

PROCEDURE OR ACTION:

NOTE: Key in OFF position.

1. Measure resistance between the main contactor's coil terminals.
   Is resistance 32 ± 4.0 ohms?
   YES: Proceed to Cause C.
   NO: Replace faulty main contactor coil.

CAUSE C - FAULTY COMBINATION CONTROLLER

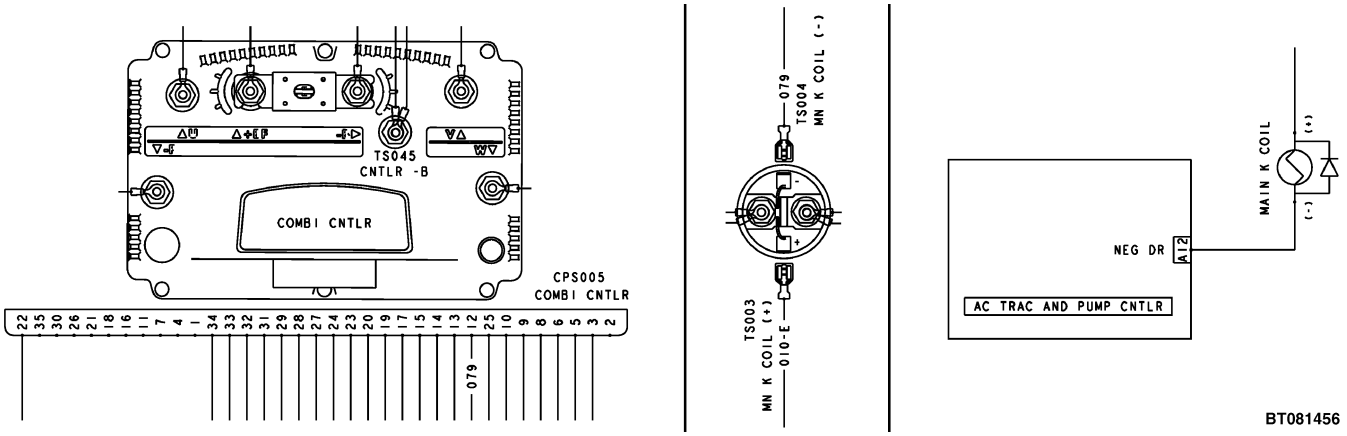
PROCEDURE OR ACTION:

1. If no faults are found, replace controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

Main Contactor Coil (Cont)

DIAGRAMS



Troubleshooting Scenes

END FAULT

Audible Alarm

CODES

DTC 32037 - Combi - Audible Alarm - Circuit
DTC 32038 - Combi - Audible Alarm - Short

POSSIBLE CAUSE

A. BACKUP ALARM WIRING FAULT
B. BACKUP ALARM FAULT
C. FAULTY COMBINATION CONTROLLER

NOTE

Please refer to the end of this procedure for supporting diagrams.

COMPONENT OPERATIONAL CHECK

NOTE: Always check battery condition and state of charge before performing electrical troubleshooting. A faulty or low charged battery will cause electrical features to not operate as designed and give incorrect readings while performing electrical tests.

PROCEDURE OR ACTION:

1. Conduct a visual inspection of all connectors/wiring associated with the fault code.
   Are any faults detected/observed?
   YES: Repair/replace connector or wiring associated with faults found. Refer to the appropriate **Electrical System** SRM.
   NO: Proceed to Step 2.
2. Re-key the vehicle.
   Is the code still present?
   YES: Proceed to Step 3.
   NO: Problem may be intermittent.
3. Locate output diagnostics (D3.32) and actuate audible alarm (D3.32.10).
   Does bakup alarm sound when actuated?
   YES: Fault may be intermittent.
   NO: Proceed to Cause A.

CAUSE A - BACKUP ALARM WIRING FAULT

PROCEDURE OR ACTION:

NOTE: Perform Step 1 with key in ON position.

1. Disconnect backup alarm connector CPS014 and measure voltage between socket 1 and B(-).
   Is voltage 24 ± 2.5 Vdc?
   YES: Disconnect battery and proceed to Step 2.
   NO: Inspect circuit 201-B for open or short.
2. Disconnect the Combination connector CPS005. Measure resistance between the Combination connector CPS005, socket 8 and the backup alarm connector CPS014, socket 2.
   Is resistance <1 ohm?
   YES: Connect Combination controller connector CPS005 and proceed to Cause B.
   NO: Inspect ground control circuit 603 for open or short.

Audible Alarm (Cont)

CAUSE B - BACKUP ALARM FAULT

PROCEDURE OR ACTION:

NOTE: Key in ON position.

NOTE: Operate backup alarm.

1. Measure continuity between the backup alarm connector CPS014, socket 2 and B(-).
   Is continuity present?
   YES: Replace faulty backup alarm.
   NO: Proceed to Cause C.

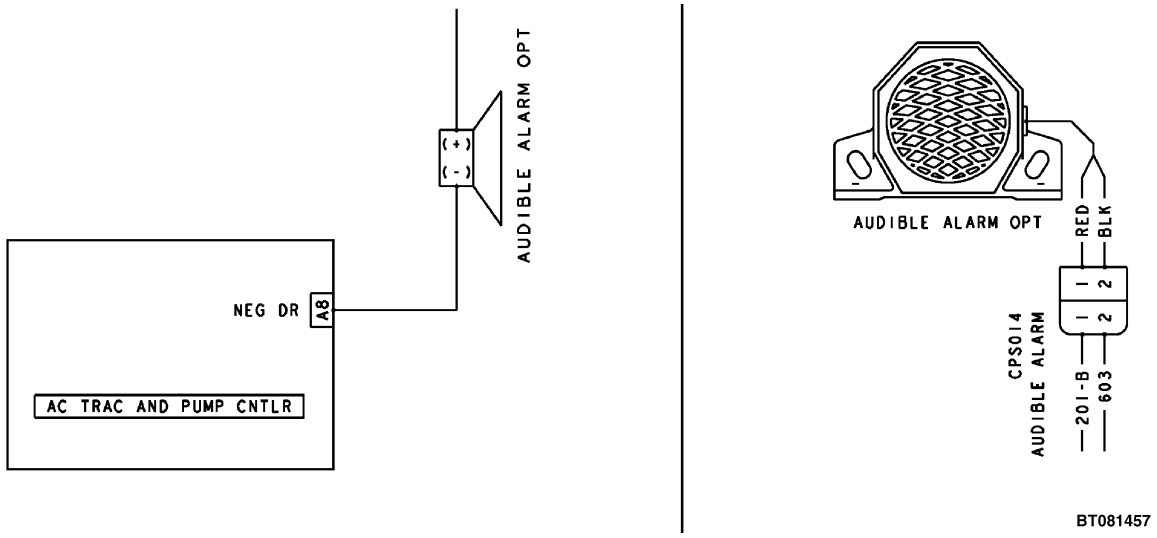
CAUSE C - FAULTY COMBINATION CONTROLLER

PROCEDURE OR ACTION:

1. If no faults are found, replace controller. Make sure to indicate the DTC code(s) on the warranty claim to include an accurate problem description leading to controller replacement.

END POSSIBLE CAUSES

DIAGRAMS



Troubleshooting Scenes

END FAULT