SERVICE MANUAL SECTION

CF 500, CF 600 — Electrical

Truck Model: CF 500
Truck Model: CF 600
Unit Code: 08GEV
Unit Code: 08MGB
Unit Code: 08MEZ
Unit Code: 08WNH
Unit Code: 08000
Unit Code: 16HBA
Unit Code: 16HBB
Unit Code: 16XAL

S08307

11/02/2005

Table of Contents

Safety Information

NOTE: Read the following before starting the service procedure.

The information contained in this International Service Manual Section was current at the time of printing and is subject to change without notice or liability.

You must follow your company safety procedures when you service or repair equipment. Be sure to understand all of the procedures and instructions before you begin work on the unit.

International uses the following types of notations to give warning of possible safety problems and to give information that will prevent damage to the equipment being serviced or repaired.

WARNING: A warning indicates procedures that must be followed exactly. Personal injury or possible death can occur if the procedure is not followed.

CAUTION: A caution indicates procedures that must be followed exactly. If the procedure is not followed, damage to equipment or components can occur.

NOTE: A note indicates an operation, procedure or instruction that is important for correct service.

Some procedures require the use of special tools for safe and correct service. Failure to use these special tools when required can cause injury to service personnel or damage to vehicle components.

This service manual section is intended for use by professional technicians, NOT a "**do-it-yourselfer**." It is written to inform these technicians of conditions that may occur on some vehicles, or to provide information that could assist in the proper service of a vehicle. Properly trained technicians have the equipment, tools, safety instructions, and know-how to do a job properly and safely. If a condition is described, DO NOT assume that the service section applies to your vehicle. See your International Truck Dealer for information on whether this service section applies to your vehicle.

Speed Control

Description and Operation

The speed control system is controlled by the engine control module (ECM). The speed control system is designed to maintain a constant road speed with cruise control. The speed control system is controlled by the instrument panel-mounted switches (CRUISE/RPM, RESUME +/SET-) and the brake switch. The instrument panel-mounted switches are hardwired to the ECM.

The speed control functions:

- turn on the vehicle speed control system.
- set and maintain the desired vehicle speed.
- accelerate the vehicle speed.
- coast down to a lower vehicle speed.
- resume the prior vehicle speed.
- turn off the vehicle speed control system.

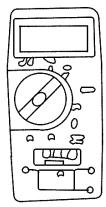
The speed control system consists of the following components:

- Speed control switches
- ECM
- Brake switch

Diagnosis and Testing

Refer to Wiring Diagrams, Speed Control for schematic and connector information.

Table 1 Special Tools

 ST1137-A	Automotive Meter ZTSE4357
	EZ-Tech III

Principles of Operation

Speed Control

Pressing the CRUISE/RPM switch turns the speed control system on. Pressing and releasing the SET - switch while the vehicle is traveling at the desired speed activates the speed control system.

Tapping the RESUME +/SET - switch while in the set mode respectively, increases or decreases the maintained vehicle speed by 1.6 km/h (1 mph) per tap. If the respective button is pressed and held, the vehicle speed continues to accelerate or decelerate until the button is released.

Pressing the CRUISE/RPM switch, or turning the ignition switch to the OFF position, turns the speed control system off. Applying the brake puts the speed control system into the STANDBY mode. Pressing the RESUME + button, when the speed control system is in the STANDBY mode causes the vehicle to accelerate to the last set speed. Resume does not function if the OFF button is pressed, the ignition switch is in the OFF position or if the current vehicle speed is below the minimum operational speed, 48 km/h (30 mph).

NOTE: When the brake pedal is applied, an electrical signal on circuit 2233 (OR-YL) from the brake switch to the ECM deactivates the system.

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical and electrical damage.
3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. Verify the speedometer operates correctly without speed control by test driving the vehicle. If the speedometer does not operate correctly, refer to Instrument Cluster.
5. Verify the brake lamps are operating correctly. If the brake lamps are not operating correctly, refer to Exterior Lighting.
6. If the cause is not visually evident, connect the diagnostic tool to the data link connector (DLC) and carry out the diagnostic tool data link test. The ECM monitors the speed control system for proper voltages and sets DTC 221 if incorrect.

Pinpoint Tests

Table 2 PINPOINT TEST A: DTC 221 THE SPEED CONTROL IS INOPERATIVE

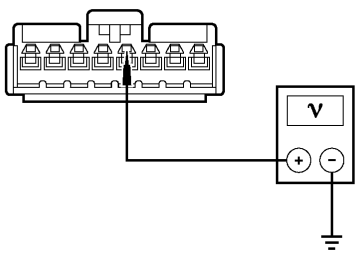
Test Step	Result / Action to Take
A1 CHECK FOR DTCS • Review the recorded DTCs from the engine control module (ECM) self-test. • **Are any ECM DTCs recorded with DTC 221?**	**Yes** Refer to EGES-305, Engine Diagnostics Manual and the ECM Diagnostic Trouble Code (DTC) Index. **No** GO to A2.
A2 CHECK CIRCUIT 298 (VT/OG) AT THE CRUISE/RPM SWITCH FOR AN OPEN • Key in OFF position. • Remove the CRUISE/RPM switch and the RESUME +/SET - switch from the instrument panel. For additional information, refer to Speed Control Switch in this section. • **Disconnect:** CRUISE/RPM Switch C2178 • Key in ON position. • Measure the voltage between CRUISE/RPM switch C2178 pin 4, circuit 298 (VT/OG), harness side and ground.  N0024642 **Is the voltage greater than 10 volts?**	**Yes** GO to A3. **No** Verify the power distribution center (PDC) fuse F46 is OK, REPAIR circuit 298 (VT/OG). CLEAR the DTCs. REPEAT the self-test.

Table 2 PINPOINT TEST A: DTC 221 THE SPEED CONTROL IS INOPERATIVE (cont.)

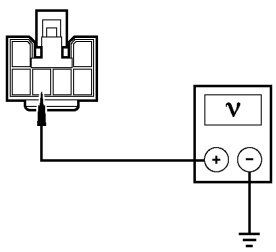
Test Step	Result / Action to Take
A3 CHECK CIRCUIT 248 (TN-OR) AT THE RESUME +/SET - SWITCH FOR AN OPEN • Key in OFF position. • **Disconnect:** Resume +/Set - Switch C2177 • Key in ON position. • Measure the voltage between RESUME +/SET - switch C2177 pin D, circuit 248C (TN-OR), harness side and ground.  N0024643 **Is the voltage greater than 10 volts?**	**Yes** Go to A4. **No** Verify the power distribution center (PDC) fuse F46 is OK, REPAIR circuit 248 (TN-OR). CLEAR the DTCs. REPEAT the self-test.

Table 2 PINPOINT TEST A: DTC 221 THE SPEED CONTROL IS INOPERATIVE (cont.)

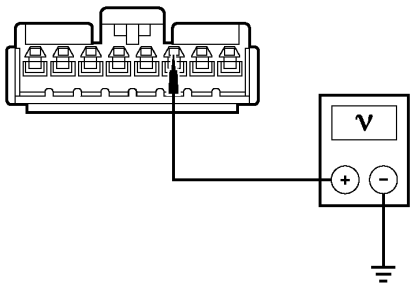
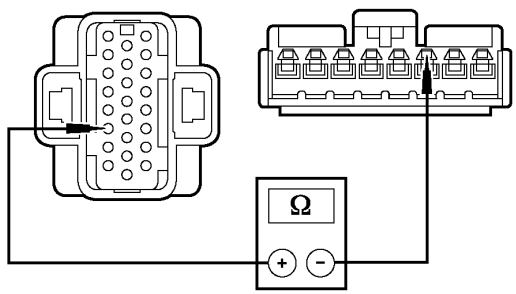
Test Step	Result / Action to Take
A4 CHECK CIRCUIT 248 (TN/OG) FOR A SHORT TO VOLTAGE • Key in OFF position. • **Disconnect:** ECM C175a • Key in ON position. • Measure the voltage between CRUISE/RPM switch C2178 pin 3, circuit 248B (TN/OG), harness side and ground.  N0024644 **Is the voltage less than 0.2 volt?**	**Yes** GO to A5. **No** REPAIR circuit 248 (TN/OG). CLEAR the DTCs. REPEAT the self-test.
A5 CHECK CIRCUIT 248 (TN/OG) FOR AN OPEN • Key in OFF position. • Measure the resistance between ECM C175a pin 6, circuit 248 (TN/OG), harness side and CRUISE/RPM switch C2178 pin 3, circuit 248 (TN/OG), harness side.  N0024645 **Is the resistance less than 0.5 ohm?**	**Yes** GO to A6. **No** REPAIR circuit 248 (TN/OG). CLEAR the DTCs. REPEAT the self-test.

Table 2 PINPOINT TEST A: DTC 221 THE SPEED CONTROL IS INOPERATIVE (cont.)

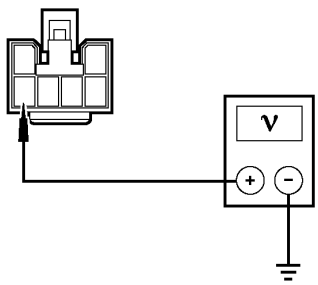
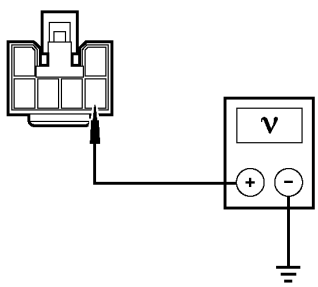
Test Step	Result / Action to Take
A6 CHECK CIRCUIT 5133 (WH) FOR A SHORT TO VOLTAGE • **Disconnect:** ECM C175b • Key in ON position. • Measure the voltage between RESUME +/SET - switch C2177 pin B, circuit 5133 (WH), harness side and ground.  N0024646 **Is the voltage less than 0.2 volt?**	**Yes** GO to A7. **No** REPAIR circuit 5133 (WH). CLEAR the DTCs. REPEAT the self-test.
A7 CHECK CIRCUIT 133 (BK) FOR A SHORT TO VOLTAGE • Measure the voltage between RESUME +/SET - switch C2177 pin H, circuit 133 (BK), harness side and ground.  N0024647 **Is the voltage less than 0.2 volt?**	**Yes** GO to A8. **No** REPAIR circuit 133 (BK). CLEAR the DTCs. REPEAT the self-test.

Table 2 PINPOINT TEST A: DTC 221 THE SPEED CONTROL IS INOPERATIVE (cont.)

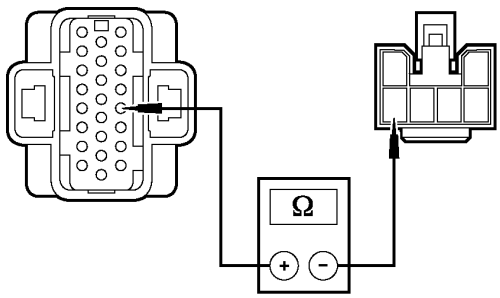
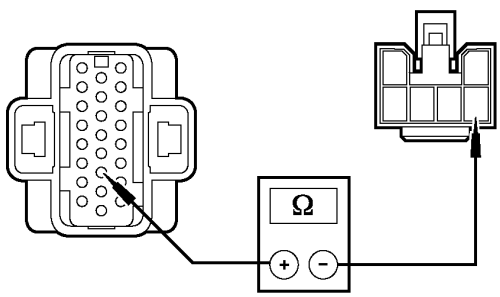
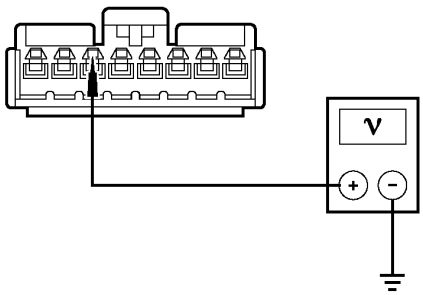
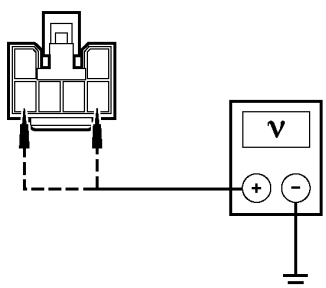
Test Step	Result / Action to Take
A8 CHECK CIRCUIT 5133 (WH) FOR AN OPEN • Key in OFF position. • Measure the resistance between RESUME +/SET - switch C2177 pin B, circuit 5133 (WH), harness side and ECM C175b pin 21, circuit 5133 (WH), harness side.  N0024648 **Is the resistance less than 0.5 ohm?**	**Yes** GO to A9. **No** REPAIR circuit 5133 (WH). CLEAR the DTCs. REPEAT the self-test.
A9 CHECK CIRCUIT 133 (BK) FOR AN OPEN • Measure the resistance between RESUME +/SET - switch C2177 pin H, circuit 133 (BK), harness side and ECM C175b pin 14, circuit 133 (BK), harness side.  N0024649 **Is the resistance less than 0.5 ohm?**	**Yes** GO to A10. **No** REPAIR circuit 133 (BK). CLEAR the DTCs. REPEAT the self-test.

Table 2 PINPOINT TEST A: DTC 221 THE SPEED CONTROL IS INOPERATIVE (cont.)

Test Step	Result / Action to Take
A10 CHECK THE CRUISE/RPM SWITCH • **Connect:** CRUISE/RPM Switch C2178 • Key in ON position. • Measure the voltage between CRUISE/RPM switch C2178 pin 3, circuit 248B (TN/OG), back probe and ground.  N0024650 **Is the voltage greater than 10 volts?**	**Yes** GO to A11. **No** REPLACE the CRUISE/RPM switch. CLEAR the DTCs. REPEAT the self-test.
A11 CHECK THE RESUME +/SET - SWITCH • Key in OFF position. • **Connect:** RESUME +/SET - Switch C2177 • Key in ON position. • While depressing the RESUME + switch, measure the voltage between RESUME +/SET - switch C2177 pin B, circuit 5133 (WH), back probe, and ground; and while depressing the SET - switch, measure the voltage between RESUME +/SET - switch C2177 pin H, circuit 133 (BK), back probe, and ground.  N0024651 **Are the voltages greater than 10 volts?**	**Yes** INSTALL a new ECM. REFER to the Engine Operation and Maintenance Manual. CLEAR the DTCs. REPEAT the self-test. **No** INSTALL a new CRUISE/RPM switch or RESUME +/SET - switch. CLEAR the DTCs. REPEAT the self-test.

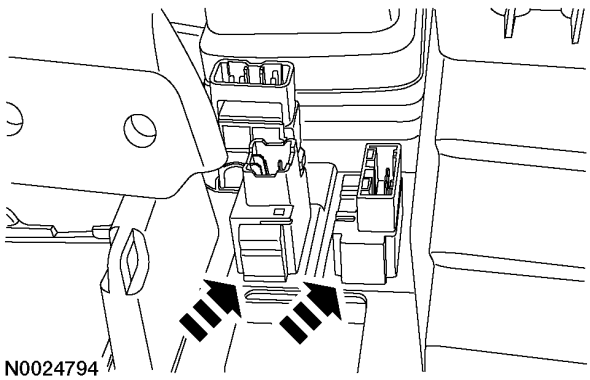
Removal and Installation

Speed Control Switch

1. Remove the instrument cluster module. For additional information, refer to Instrument Cluster.

NOTE: Instrument panel removed for clarity.

2. Squeeze the affected switch retaining clips and push the switch out of its mounting location in the instrument panel.



3. Disconnect the affected switch electrical connector.
4. To install, reverse the removal procedure.

Instrument Cluster and Panel Illumination

Description and Operation

Instrument Panel Illumination

The instrument cluster and the panel lighting system consists of both dimmable and non-dimmable (fixed) illumination sources. The instrument cluster and panel lighting system is powered through the instrument panel dimmer switch. The dimmable lighting illumination intensity is controlled by the output of the instrument panel dimmer switch.

When the main light switch is in the PARK LAMPS or HEADLAMPS position, the instrument cluster looks for an input from the dimmer switch. If no input is found, the instrument cluster backlighting is commanded to maximum.

Dimmable Instrument Cluster and Panel Lighting

The instrument cluster and panel lighting system provides dimmable backlighting to the following components:

- Climate control assembly
- Instrument cluster
- Cruise set switch
- Cruise enable switch
- Ashtrays
- Hazard switch
- PRNDL indicator

Non-Dimmable (Fixed) Instrument Cluster and Panel Lighting

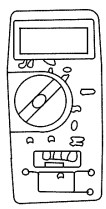
The non-dimmable (fixed) lighting system consists of the following component:

- Audio unit
- Warning lights

Diagnosis and Testing

Refer to Wiring Diagrams, Instrument Illumination for schematic and connector information.

Table 3 Special Tool

 ST1137-A	Automotive Meter ZTSE4357

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of electrical damage.

Table 4 Visual Inspection Chart

Electrical
• Bulbs
• Circuitry open/shorted
• Dimmer
• Hazard, cruise set/enable or A/C switch
• Climate control
• Instrument cluster

3. If the concern is not visually evident, verify the symptom. GO to Symptom Chart.

Table 5

Condition	Possible Sources	Action
One or more illumination source(s) is inoperative	• Circuitry open. • Instrument panel dimmer.	Go to Pinpoint Test A.
The audio system illumination is inoperative	• Audio unit	INSTALL a new audio unit. For additional information, refer to Audio Unit in S16031.
The instrument panel illumination does not dim	• Circuitry shorted. • Instrument panel dimmer.	Go to Pinpoint Test B.

Pinpoint Tests

Pinpoint Test A: One Or More Illumination Source(s) Is Inoperative

Normal Operation

Under normal operation, when the headlamp switch is in the PARK LAMPS or HEADLAMPS position, voltage is fed from the headlamp switch to the instrument panel dimmer through circuit 14 (BN). The voltage is then lowered to the desired brightness by the dimmer and the lowered voltage is sent to the instrument panel lamps through circuit 19 (LB/RD). The instrument panel lamps are grounded through circuit 57 (BK).

Possible Causes

- An open in circuit 14 (BN), 19 (LB/RD) or 57 (BK)
- An open in the headlamp ground circuit
- Instrument panel dimmer
- Hazard, cruise set/enable or A/C switch
- Climate control
- Instrument cluster
- Bulb

Table 6 PINPOINT TEST A: ONE OR MORE ILLUMINATION SOURCE(S) IS INOPERATIVE

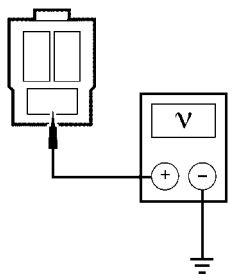
Test Step	Result / Action to Take
A1 CHECK INSTRUMENT PANEL ILLUMINATION • Place the headlamp switch in the PARK LAMPS position. • **Is all instrument panel illumination inoperative?**	**Yes** GO to A2. **No** GO to A4.
A2 CHECK CIRCUIT 14 (BN) FOR VOLTAGE • Place the headlamp switch in the OFF position. • **Disconnect:** Instrument Panel Dimmer C2298 • Place the headlamp switch in the PARK LAMPS position. • Measure the voltage between instrument panel dimmer C2298–A, circuit 14 (BN) and ground.  N0023965 **Is the voltage greater than 10 volts?**	**Yes** GO to A3. **No** REPAIR circuit 14 (BN) for an open. TEST the system for normal operation.

Table 6 PINPOINT TEST A: ONE OR MORE ILLUMINATION SOURCE(S) IS INOPERATIVE (cont.)

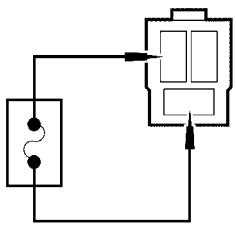
Test Step	Result / Action to Take
A3 CHECK CIRCUIT 19 (LB/RD) FOR AN OPEN • Place the headlamp switch in the OFF position. • **Disconnect:** Instrument Panel Dimmer C2298 • Connect a fused jumper between instrument panel dimmer C2298–A, circuit 14 (BN) and instrument panel dimmer C2298–C, circuit 19 (LB/RD).  N0023966 **Do all the intrument panel lamps illuminate brightly?**	**Yes** INSTALL a new instrument panel dimmer. TEST the system for normal operation. **No** REPAIR circuit 19 (LB/RD) for an open. TEST the system for normal operation.

Table 6 PINPOINT TEST A: ONE OR MORE ILLUMINATION SOURCE(S) IS INOPERATIVE (cont.)

Test Step	Result / Action to Take
A4 CHECK CIRCUIT 57 (BK) FOR AN OPEN • Place the headlamp switch in the OFF position. • Measure the resistance between ground and inoperative illumination source: — PRNDL indicator C3245–F, circuit 57 (BK). — hazard switch C2039–9, circuit 57 (BK). — ashtray lamp C2014–2, circuit 57 (BK). — ashtray lamp C2246–2, circuit 57 (BK). — cruise set switch C2177–G, circuit 57 (BK). — cruise enable switch C2178–7, circuit 57 (BK). — climate control C294d–2, circuit 57 (BK). — A/C switch C294a–1, circuit 57 (BK). — instrument cluster C220b–1, circuit 57 (BK). — instrument cluster C220b–2, circuit 57 (BK). — instrument cluster C220b–3, circuit 57 (BK). • **Is the resistance less than 5 ohms?**	**Yes** GO to A5. **No** REPAIR circuit 57 (BK). TEST the system for normal operation.
A5 CHECK CIRCUIT 19 (LB/RD) FOR VOLTAGE • Place the headlamp switch in the PARK LAMPS position. • Turn the instrument pannel dimmer to the FULL BRIGHT setting. • Measure the resistance between ground and inoperative illumination source: — PRNDL indicator C3245–E, circuit 19 (LB/RD). — hazard switch C2039–8, circuit 19 (LB/RD). — ashtray lamp C2014–1, circuit 19 (LB/RD). — ashtray lamp C2246–1, circuit 19 (LB/RD). — cruise set switch C2177–A, circuit 19 (LB/RD). — cruise enable switch C2178–6, circuit 19 (LB/RD). — climate control C294d–1, circuit 19 (LB/RD). — A/C switch C294a–6, circuit 19 (LB/RD). — instrument cluster C220b–9, circuit 19 (LB/RD). • **Is the voltage greater than 10 volts?**	**Yes** For ashtray lamps, INSTALL a new bulb. For all others, INSTALL a new switch, component or assembly. **No** REPAIR circuit 19 (LB/RD) for an open. TEST the system for normal operation.

Pinpoint Test B: The Instrument Panel Illumination Does Not Dim

Normal Operation

Under normal operation, when the headlamp switch is in the PARK LAMPS or HEADLAMPS position, voltage is fed from the headlamp switch to the instrument panel dimmer through circuit 14 (BN). The voltage is then lowered to the desired brightness by the dimmer and the lowered voltage is sent to the instrument panel lamps through circuit 19 (LB/RD). The instrument panel lamps are grounded through circuit 57 (BK).

Possible Causes

- A short to voltage in circuit 19 (LB/RD)
- Instrument panel dimmer

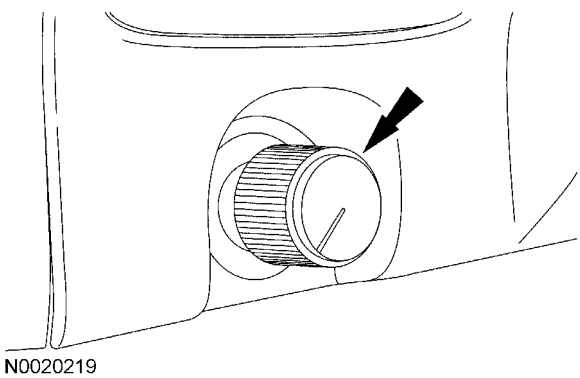
Table 7 PINPOINT TEST B: THE INSTRUMENT PANEL ILLUMINATION DOES NOT DIM

Test Step	Result / Action to Take
B1 CHECK INSTRUMENT PANEL DIMMER • **Disconnect:** Instrument Panel Dimmer C2298 • Observe the instrument panel illumination. **Is the instrument panel illumination OFF?**	**Yes** INSTALL a new instrument panel dimmer. TEST the system for normal operation. **No** REPAIR circuit 19 (LB/RD) for a short to voltage. TEST the system for normal operation.

Removal and Installation

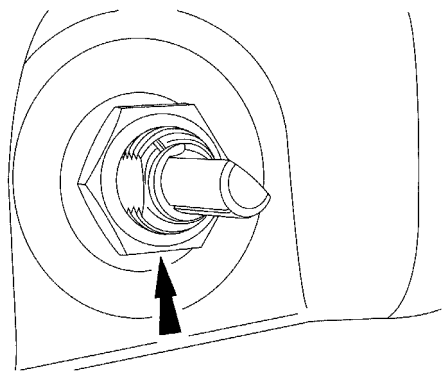
Instrument Panel Dimmer Switch

1. Remove the instrument panel dimmer knob.



N0020219

2. Remove the instrument panel dimmer retaining nut.



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3. Remove the instrument panel dimmer.
4. Disconnect the electrical connector.

5. To install, reverse the removal procedure.

Instrument Cluster

Description and Operation

Instrument Cluster

The instrument cluster contains gauges, indicator lamps, warning lamps and a message center that are designed to provide the driver with system statuses and to alert the driver that certain conditions exist in the vehicle. Gauges provide information to the driver indicating the status of systems.

The gauges include:

- vehicle speed.
- engine rpm.
- fuel level.
- engine coolant temperature.

Indicator lamps provide information to the driver of conditions that exist in the vehicle.

The indicator lamps include:

- turn signal.
- high beam.
- wait to start.
- tow/haul.
- PTO.

Warning indicator lamps provide information to the driver of conditions that could potentially alter vehicle performance.

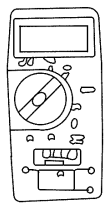
The warning indicators include:

- charging.
- safety belt.
- park brake.
- transmission.
- check electrical.
- transmission oil temperature.
- water in fuel.
- stop engine.
- engine.
- change oil.
- brake fluid level.
- ABS.

Diagnosis and Testing

Refer to Wiring Diagrams, Instrument Cluster for schematic and connector information.

Table 8 Special Tools

 ST1137-A	Automotive Meter ZTSE4357
	EZ-Tech III

Principles of Operation

Instrument Cluster

The instrument cluster is a hybrid electronic cluster (HEC) that contains a microprocessor, gauges, indicator lamps and internal circuitry. The instrument cluster is non-repairable.

The instrument cluster carries out a display prove-out to verify that the warning/indicator lamps and monitored systems are operating correctly. When the ignition switch is turned to the ON position with the engine off, the following indicators illuminate for 3 seconds:

- Brake fluid level
- Check transmission
- Transmission temperature
- Check electrical system

- ABS
- Wait to Start (this indicator may stay on longer if the ECM determines that glow plugs will be required to start the engine)

Odometer Display

This Liquid Crystal Display (LCD) module provides the odometer and trip odometer information.

Gauges

Speedometer

The instrument cluster receives a vehicle speed signal from the engine control module (ECM) through the communication network. The instrument cluster monitors this input from the ECM and commands a corresponding movement of the speedometer pointer.

Tachometer

The tachometer is electrically operated and indicates the engine speed in revolutions per minute (rpm). The tachometer range is 0 to 4,000 rpm. The tachometer receives the signal through the communication network from the ECM. If the rpm information sent to the instrument cluster is invalid or missing, the instrument cluster defaults the tachometer to 0 rpm.

Odometer

The odometer is tamper-resistant and accumulates and registers up to one million kilometers in metric mode or one million miles in English mode, based upon rolling count data sent from the ECM over the communication network. The trip odometer is resettable and accumulates and registers up to 999.9 kilometers (999.9 miles).

Fuel Gauge

The instrument cluster is hardwired to the fuel sending unit, which is a variable resistor controlled by the action of a float arm. When the fuel level is low, resistance in the unit is low. When the fuel level is high, the resistance is high. The instrument cluster uses the input from the fuel sender and commands the fuel gauge indication according to the fuel level data. The fuel gauge has an integrated low fuel warning indicator.

Engine Coolant Temperature Gauge

The instrument cluster monitors the engine coolant temperature data received from the ECM over the communication network, and commands the temperature gauge indication with a corresponding movement of the pointer. The engine coolant temperature gauge has an integrated temperature warning indicator.

Warning Indicator Lamps

Anti-Lock Brake System (ABS) Warning Indicator

The ABS warning indicator is used to indicate an ABS concern or deactivation of the ABS. The instrument cluster, upon receipt of the ABS message from the ABS module through the communication network, turns on the ABS warning indicator.

Brake Fluid Level

The instrument cluster brake fluid level warning indicator illuminates when there is a low brake fluid level. The brake fluid level switch is hardwired to the instrument cluster. The brake fluid level switch provides a ground to the instrument cluster when the brake fluid level is low or when the electrical connector is disconnected.

Park Brake

The instrument cluster park brake warning indicator illuminates when the parking brake is applied. The parking brake switch is hardwired to the instrument cluster. The parking brake switch provides a ground to the instrument cluster when the parking brake switch is applied.

Charging System Warning Indicator

Internal circuitry in the voltage regulator provides a ground path to the instrument cluster and the indicator illuminates. When the generator builds up enough voltage to energize the voltage regulator, voltage is applied to the ground side of the indicator effectively removing the ground path and turning the indicator off.

Safety Belt Warning Indicator

The safety belt warning indicator is powered through the instrument cluster and is grounded through the safety belt switch. When the safety belt is buckled, the switch opens and the instrument cluster turns off the safety belt warning indicator. When the safety belt is unbuckled, the switch closes and provides a ground to the instrument cluster to illuminate the safety belt warning indicator.

Transmission Warning Indicator

The instrument cluster receives data from the transmission control module (TCM) over the communication network. The TCM communicates to the instrument cluster to illuminate the transmission warning indicator if a DTC is set by the TCM.

Transmission Oil Temperature Warning Indicator

The instrument cluster receives data from the TCM over the communication network. The TCM communicates to the instrument cluster to illuminate the transmission warning indicator if the transmission oil is above the calibrated temperature.

Water In Fuel Warning Indicator

The instrument cluster receives data from the ECM over the communication network. The ECM communicates to the instrument cluster to illuminate the water-in-fuel indicator when the fuel system water collector is full.

Change Oil Warning Indicator

The instrument cluster receives data from the ECM over the communication network. The ECM communicates to the instrument cluster to illuminate the change oil indicator when the ECM determines an oil change is necessary.

Check Electrical System Warning Indicator

The instrument cluster will illuminate the indicator continuously when there is a loss of communication between the instrument cluster and the ECM, TCM or ABS module. The indicator will flash if the instrument cluster determines that the ABS indicator is not functional.

Low Fuel Warning Indicator

The fuel gauge has an integrated low fuel warning indicator. This indicator will illuminate when the fuel level is below 1/8 of the tank.

Engine Coolant Temperature Warning Indicator

The instrument cluster will illuminate the indicator continuously when the engine coolant temperature is above 110°C (230°F). The indicator will flash if the instrument cluster does not receive coolant temperature information from the ECM.

Indicator Lamps

High Beam Indicator

The instrument cluster provides a ground for the high beam indicator. When the high beam headlamps are turned ON, the multifunction switch provides a power signal to the instrument cluster through hardwired circuitry and illuminates the high beam indicator.

RH and LH Turn Indicators

The instrument cluster provides a ground for the RH and LH turn indicators. When the multifunction switch is in the RH or LH turn position, power is supplied to the instrument cluster through hardwired circuitry and the RH or LH turn indicators flash ON and OFF. The indicators will operate when the hazard switch is ON, regardless of the key position.

Wait to Start Indicator

The wait to start signal is transmitted to the instrument cluster over the communication network from the ECM. The wait to start indicator illuminates when the ignition switch is in the ON position with the engine OFF indicating that the glow plugs are heating.

Tow/Haul Indicator

The tow/haul indicator illuminates when the tow/haul button is pressed on the transmission range (TR) selector lever. When the vehicle is in the tow mode, the indicator is illuminated by a signal from the ECM to inform the operator that the vehicle will not shift into overdrive. When the indicator is illuminated, the vehicle also provides engine braking and early transmission downshifts when braking on downhill grades.

Power Take-Off (PTO) Indicator

The PTO indicator illuminates when a signal from the TCM tells the instrument cluster that the PTO unit is in use.

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical and electrical damage.

Table 9 Visual Inspection Chart

Mechanical	Electrical
• Engine oil filter • Engine oil level • Engine coolant level • Coolant thermostat • Fuel tank • Low fuel • Fuel tank(s)	• Circuitry open/shorted • Fuel level sender • Instrument cluster

3. If the fault is not visually evident, determine the symptom and GO to the Symptom Chart.

Table 10 Symptom Chart

Condition	Possible Sources	Action
Incorrect fuel gauge indication	• Circuitry open. • Fuel level sender. • Instrument cluster.	Go to Pinpoint Test A.
The speedometer, tachometer or temperature gauge is inoperative.	• Circuitry open. • Instrument cluster.	Go to Pinpoint Test B.
The park brake warning indicator is never on	• Circuitry open. • Instrument cluster. • Parking brake switch.	Go to Pinpoint Test C.
The park brake warning indicator is always on	• Circuitry shorted. • Parking brake switch. • Instrument cluster.	Go to Pinpoint Test D.
The brake fluid level warning indicator is never on	• Circuitry open. • Instrument cluster. • Brake fluid level switch.	Go to Pinpoint Test E.
The brake fluid level warning indicator is always on	• Circuitry shorted. • Brake fluid level switch. • Instrument cluster.	Go to Pinpoint Test F.
The charging system indicator is never on	• Circuitry open. • Alternator control. • Instrument cluster.	Go to Pinpoint Test G.

Table 10 Symptom Chart (cont.)

Condition	Possible Sources	Action
The charging system indicator is always on	• Circuitry shorted. • Alternator control. • Instrument cluster.	Go to Pinpoint Test H.
The high beam indicator is never on	• Circuitry open. • Instrument cluster.	Go to Pinpoint Test I.
The LH or RH turn indicator is never on	• Circuitry open. • Instrument cluster.	Go to Pinpoint Test J.
The instrument cluster is inoperative	• Circuitry. • Instrument cluster.	Go to Pinpoint Test K.
The low fuel or coolant temperature warning indicator is inoperative/always on	• Instrument cluster.	• If the fuel or coolant temperature gauge operates correctly, INSTALL a new instrument cluster. For additional information, refer to Instrument Cluster Removal and Installation in this section. TEST the system for normal operation.
The ABS, transmission warning, transmission temp warning, tow/haul, PTO, wait-to-start, water-in-fuel, stop engine warning, engine warning, or change oil indicator is inoperative/always on.	• Instrument cluster.	• INSTALL a new instrument cluster. Refer to Instrument Cluster Removal and Installation in this section. TEST the system for normal operation.

Pinpoint Tests

Pinpoint Test A: Incorrect Fuel Gauge Indication

Normal Operation

Under normal operation, the fuel level sender is grounded through circuit 57 (BK). The instrument cluster reads a variable voltage from the fuel level sender through circuit 29 (YE/WH).

Possible Causes

- An open in circuit 29 (YE/WH) or 57 (BK)
- A short to ground in circuit 29 (YE/WH)
- Fuel level sender
- Instrument cluster

Table 11 PINPOINT TEST A: INCORRECT FUEL GAUGE INDICATION

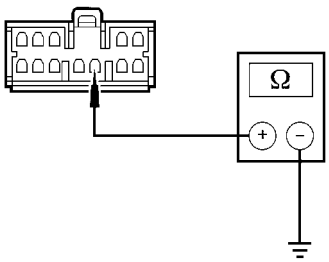
Test Step	Result / Action to Take
A1 CHECK FUEL LEVEL SENDER • Estimate the fuel level. • **Disconnect:** Instrument Cluster C220a • Measure the resistance between ground and instrument cluster C220a-10, circuit 29 (YE/WH).  N0025263 Compare the resistance to the levels below. Tank Level: **Above Full** — Sensor Resistance: **157–163** Ohms Tank Level: **Full** — Sensor Resistance: **142–148** Ohms Tank Level: **3/4** — Sensor Resistance: **112–118** Ohms Tank Level: **1/2** — Sensor Resistance: **82–88** Ohms Tank Level: **1/4** — Sensor Resistance: **54–56** Ohms Tank Level: **Empty** — Sensor Resistance: **24–26** Ohms Tank Level: **Below Empty** — Sensor Resistance: **14–16** Ohms **Does the measured resistance match the resistance above?**	**Yes** INSTALL a new instrument cluster. REFER to Instrument Cluster, Removal and Installation in this section. TEST the system for normal operation. **No** If the resistance is greater than 160 ohms, GO to A2. If the resistance is less than 15 ohms, GO to A4. If the resistance is 15-160 ohms, INSTALL a new fuel level sender. For additional information, refer to Fuel Tank and Lines in S15002. TEST the system for normal operation.

Table 11 PINPOINT TEST A: INCORRECT FUEL GAUGE INDICATION (cont.)

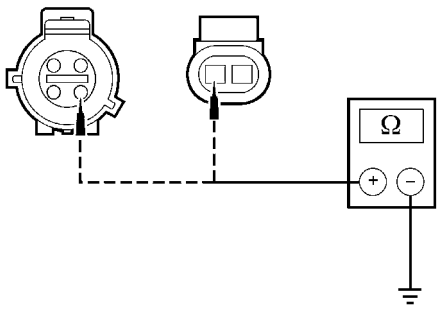
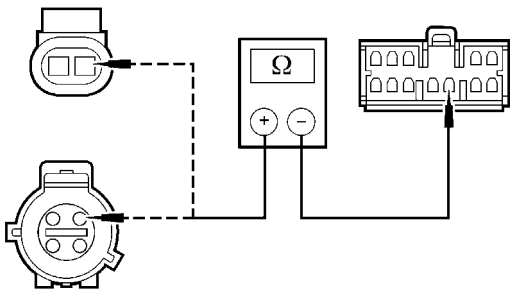
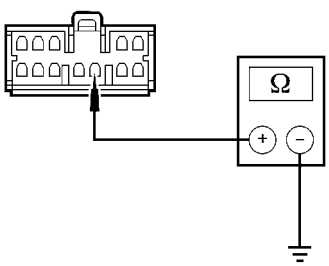
Test Step	Result / Action to Take
A2 CHECK CIRCUIT 57 (BK) FOR AN OPEN • **Disconnect:** Fuel Level Sender C3262 • Measure the resistance between ground and fuel level sender C3262-A or C3261-4, circuit 57 (BK).  N0025264 **Is the resistance less than 5 ohms?**	**Yes** GO to A3. **No** REPAIR circuit 57 (BK) for an open. TEST the system for normal operation.

Table 11 PINPOINT TEST A: INCORRECT FUEL GAUGE INDICATION (cont.)

Test Step	Result / Action to Take
A3 CHECK CIRCUIT 29 (YE/WH) FOR AN OPEN • Measure the resistance between fuel level sender C3262-B or C3261-2, circuit 29 (YE/WH) and instrument cluster C220a-10, circuit 29 (YE/WH).  N0025265 **Is the resistance less than 5 ohms?**	**Yes** INSTALL a new fuel level sender. For additional information, refer to Fuel Tank and Lines in S15002. TEST the system for normal operation. **No** REPAIR circuit 29 (YE/WH) for an open. TEST the system for normal operation.
A4 CHECK CIRCUIT 29 (YE/WH) FOR A SHORT TO GROUND • **Disconnect:** Fuel Level Sender C3262 • Measure the resistance between ground and instrument cluster C220a-10, circuit 29 (YE/WH).  N0025263 **Is the resistance greater than 10,000 ohms?**	**Yes** INSTALL a new fuel level sender. For additional information, refer to Fuel Tank and Lines in S15002. TEST the system for normal operation. **No** REPAIR circuit 29 (YE/WH) for a short to ground. TEST the system for normal operation.

Pinpoint Test B: The Speedometer, Tachometer Or Temperature Gauge Is Inoperative

Normal Operation

Under normal operation, the instrument cluster receives voltage through circuit 489 (PK/BK). The instrument cluster is grounded through circuit 57 (BK).

Possible Causes

- An open in circuit 57 (BK) or 489 (PK/BK)
- Instrument cluster

Table 12 PINPOINT TEST B: THE SPEEDOMETER, TACHOMETER OR TEMPERATURE GAUGE IS INOPERATIVE

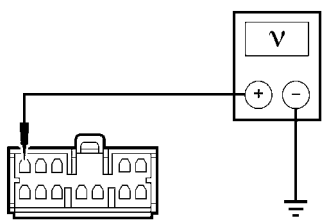
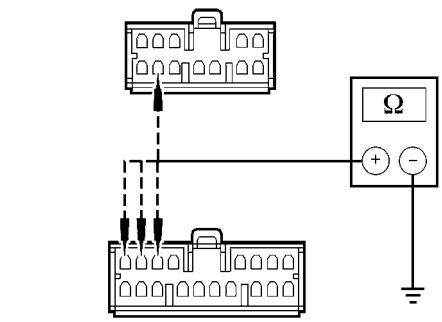
Test Step	Result / Action to Take
B1 CHECK GAUGE OPERATION • Observe speedometer, tachometer or temperature gauge operation. **Are all 3 gauges inoperative?**	**Yes** GO to B2. **No** GO to B4.
B2 CHECK VOLTAGE TO THE INSTRUMENT CLUSTER • **Disconnect:** Instrument Cluster C220a • Key in ON position. • Measure the voltage between ground and instrument cluster C220a-1, circuit 489 (PK/BK).  N0025266 **Is the voltage greater than 10 volts?**	**Yes** GO to B3. **No** REPAIR circuit 489 (PK/BK) for an open. TEST the system for normal operation.

Table 12 PINPOINT TEST B: THE SPEEDOMETER, TACHOMETER OR TEMPERATURE GAUGE IS INOPERATIVE (cont.)

Test Step	Result / Action to Take
B3 CHECK GROUND TO THE INSTRUMENT CLUSTER • Key in OFF position. • Measure the resistance between ground and instrument cluster: — C220a-7, circuit 57 (BK). — C220b-1, circuit 57 (BK). — C220b-2, circuit 57 (BK). — C220b-3, circuit 57 (BK).  N0025267 **Is the resistance less than 5 ohms?**	**Yes** INSTALL a new instrument cluster. Refer to Instrument Cluster, Removal and Installation in this section. TEST the system for normal operation. **No** REPAIR circuit 57 (BK) for an open. TEST the system for normal operation.
B4 CHECK THE ECM PIDS • Key in START position. • Enter the following diagnostic mode on the diagnostic tool: Vehicle Speed, Engine Speed or Coolant Temperature ECM PID. • Test drive the vehicle. **Did the vehicle speed, engine speed or coolant temperature change?**	**Yes** INSTALL a new instrument cluster. Refer to Instrument Cluster, Removal and Installation in this section. TEST the system for normal operation. **No** REFER to the engine manual EGES-305.

Pinpoint Test C: The Park Brake Warning Indicator Is Never On

Normal Operation

Under normal operation, the park brake switch is grounded through circuit 57 (BK). When the park brake is applied, the park brake switch is closed and ground is provided to the instrument cluster park brake warning indicator through circuit 162 (LG/RD).

Possible Causes

- An open in circuit 57 (BK) or 162 (LG/RD)
- Park brake switch
- Instrument cluster

Table 13 PINPOINT TEST C: THE PARK BRAKE WARNING INDICATOR IS NEVER ON

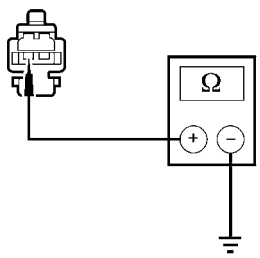
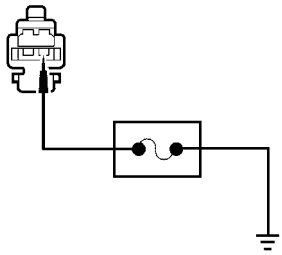
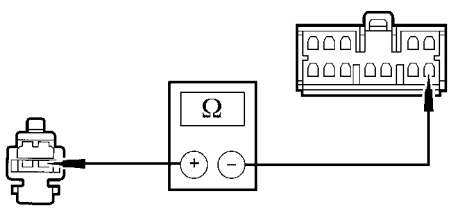
Test Step	Result / Action to Take
C1 CHECK THE PARKING BRAKE SWITCH GROUND • **Disconnect:** Parking Brake Switch C306. • Measure the resistance between ground and parking brake switch C306-A, circuit 57 (BK).  N0025260 **Is the resistance less than 5 ohms?**	**Yes** Go to C2. **No** REPAIR circuit 57 (BK) for an open. TEST the system for normal operation.

Table 13 PINPOINT TEST C: THE PARK BRAKE WARNING INDICATOR IS NEVER ON (cont.)

Test Step	Result / Action to Take
C2 CHECK THE PARKING BRAKE SWITCH Connect a fused jumper wire between ground and parking brake switch C306–B, circuit 162 (LG/RD).  N0025261 • Key in ON position. • **Does the brake warning indicator illuminate?**	**Yes** INSTALL a new parking brake switch. TEST the system for normal operation. **No** Go to C3.
C3 CHECK CIRCUIT 162 (LG/RD) FOR AN OPEN • Key in OFF position. • **Disconnect:** Instrument Cluster C220a • Measure the resistance between instrument cluster C220a-12, circuit 162 (LG/RD) and parking brake switch C306-B, circuit 162 (LG/RD).  N0025268 **Is the resistance less than 5 ohms?**	**Yes** INSTALL a new instrument cluster. Refer to Instrument Cluster, Removal and Installation in this section. TEST the system for normal operation. **No** REPAIR circuit 162 (LG/RD) for an open. TEST the system for normal operation.

Pinpoint Test D: The Park Brake Warning Indicator Is Always On

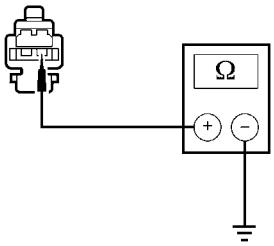
Normal Operation

Under normal operation, the park brake switch is grounded through circuit 57 (BK). When the park brake is applied, the park brake switch is closed and ground is provided to the instrument cluster park brake warning indicator through circuit 162 (LG/RD).

Possible Causes

- A short to ground in circuit 162 (LG/RD)
- Park brake switch
- Instrument cluster

Table 14 PINPOINT TEST D: THE PARK BRAKE WARNING INDICATOR IS ALWAYS ON

Test Step	Result / Action to Take
D1 CHECK THE PARKING BRAKE SWITCH • **Disconnect:** Parking Brake Switch C306 • Key in ON position. • Observe the brake warning indicator. **Is the brake warning indicator OFF?**	**Yes** INSTALL a new parking brake switch. TEST the system for normal operation. **No** Go to D2.
D2 CHECK CIRCUIT 162 (LG/RD) FOR AN OPEN • Key in OFF position. • **Disconnect:** Instrument Cluster C220a • Measure the resistance between ground and parking brake switch C306-B, circuit 162 (LG/RD).  N0025269 **Is the resistance greater than 10,000 ohms?**	**Yes** INSTALL a new instrument cluster. For additional information, refer to Instrument Cluster, Removal and Installation in this section. TEST the system for normal operation. **No** REPAIR circuit 162 (LG/RD) for a short to ground. TEST the system for normal operation.

Pinpoint Test E: The Brake Fluid Level Warning Indicator Is Never On

Normal Operation

Under normal operation, the brake fluid level switch is grounded through circuit 57 (BK). When the fluid level is low, the brake fluid level switch is closed and ground is provided to the instrument cluster brake fluid level warning indicator through circuit 128 (VT/YE).

Possible Causes

- An open in circuit 57 (BK) or 128 (VT/YE)
- Brake fluid level switch
- Instrument cluster

Table 15 PINPOINT TEST E: THE BRAKE FLUID LEVEL WARNING INDICATOR IS NEVER ON

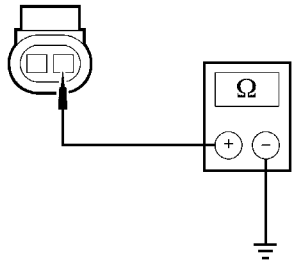
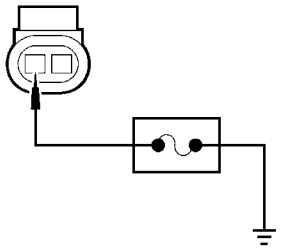
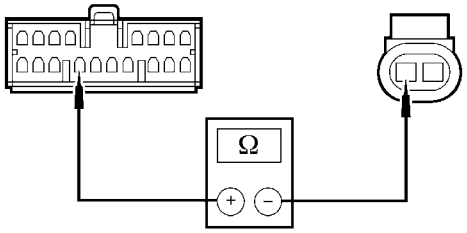
Test Step	Result / Action to Take
E1 CHECK THE BRAKE FLUID LEVEL SWITCH GROUND • **Disconnect:** Brake Fluid Level Switch C124 • Measure the resistance between ground and brake fluid level switch C124-B, circuit 57 (BK).  N0025270 **Is the resistance less than 5 ohms?**	**Yes** Go to E2. **No** REPAIR circuit 57 (BK) for an open. TEST the system for normal operation.

Table 15 PINPOINT TEST E: THE BRAKE FLUID LEVEL WARNING INDICATOR IS NEVER ON (cont.)

Test Step	Result / Action to Take
E2 CHECK THE BRAKE FLUID LEVEL SWITCH • Connect a fused jumper wire between ground and brake fluid level switch C124-A, circuit 128 (VT/YE).  N0025271 • Key in ON position. • **Does the brake fluid level warning indicator illuminate?**	**Yes** INSTALL a new brake fluid level switch. TEST the system for normal operation. **No** Go to E3.
E3 CHECK CIRCUIT 128 (VT/YE) FOR AN OPEN • Key in OFF position. • **Disconnect:** Instrument Cluster C220b • Measure the resistance between instrument cluster C220b-12, circuit 128 (VT/YE) and brake fluid level switch C124-A, circuit 128 (VT/YE).  N0025272 **Is the resistance less than 5 ohms?**	**Yes** INSTALL a new instrument cluster. For additional information, refer to Instrument Cluster, Removal and Installation in this section. TEST the system for normal operation. **No** REPAIR circuit 128 (VT/YE) for an open. TEST the system for normal operation.

Pinpoint Test F: The Brake Fluid Level Warning Indicator Is Always On

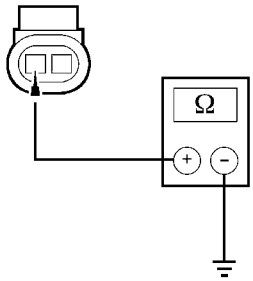
Normal Operation

Under normal operation, the brake fluid level switch is grounded through circuit 57 (BK). When the fluid level is low, the brake fluid level switch is closed and ground is provided to the instrument cluster brake fluid level warning indicator through circuit 128 (VT/YE).

Possible Causes

- A short to ground in circuit 128 (VT/YE)
- Brake fluid level switch
- Instrument cluster

Table 16 PINPOINT TEST F: THE BRAKE FLUID LEVEL WARNING INDICATOR IS ALWAYS ON

Test Step	Result / Action to Take
F1 CHECK THE BRAKE FLUID LEVEL SWITCH • **Disconnect:** Brake Fluid Level Switch C124 • Key in ON position. • Observe the brake fluid level warning indicator. • **Is the brake fluid level warning indicator OFF?**	**Yes** INSTALL a new brake fluid level switch. TEST the system for normal operation. **No** Go to F2.
F2 CHECK CIRCUIT 128 (VT/YE) FOR AN OPEN • Key in OFF position. • **Disconnect:** Instrument Cluster C220b • Measure the resistance between ground and brake fluid level switch C124-1, circuit 128 (VT/YE).  N0025273 **Is the resistance greater than 10,000 ohms?**	**Yes** INSTALL a new instrument cluster. For additional information, refer to Instrument Cluster, Removal and Installation in this section. TEST the system for normal operation. **No** REPAIR circuit 128 (VT/YE) for a short to ground. TEST the system for normal operation.

Pinpoint Test G: The Charging System Indicator Is Never On

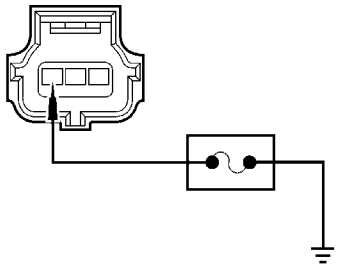
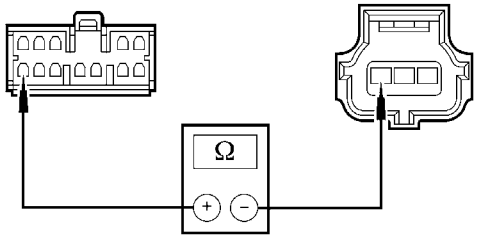
Normal Operation

Under normal operation, when voltage is low, the alternator control provides ground to the instrument cluster charging indicator through circuit 1818 (WH/BK)/904 (LG/RD).

Possible Causes

- An open in circuit 1818 (WH/BK)/904 (LG/RD)
- Instrument cluster
- Alternator control

Table 17 PINPOINT TEST G: THE CHARGING SYSTEM INDICATOR IS NEVER ON

Test Step	Result / Action to Take
G1 CHECK THE CHARGING SYSTEM WARNING INDICATOR OPERATION • **Disconnect:** Alternator Control C102a • Connect a fused jumper wire between ground and alternator control C102a-1, circuit 1818 (WH/BK).  N0025274 • Key in ON position. • **Does the charging system warning indicator illuminate?**	**Yes** INSTALL a new alternator control. REFER to Generator and Regulator. TEST the system for normal operation. **No** Go to G2.
G2 CHECK CIRCUIT 904 (LG/RD)/1818 (WH/BK) FOR AN OPEN • Key in OFF position. • **Disconnect:** Instrument Cluster C220a • Measure the resistance between instrument cluster C220a-6, circuit 904 (LG/RD) and alternator control C102a-1, circuit 1818 (WH/BK).  N0025275 **Is the resistance less than 5 ohms?**	**Yes** INSTALL a new instrument cluster. For additional information, refer to Instrument Cluster, Removal and Installation in this section. TEST the system for normal operation. **No** REPAIR circuit 904 (LG/RD)/1818 (WH/BK) for an open. TEST the system for normal operation.

Pinpoint Test H: The Charging System Indicator Is Always On

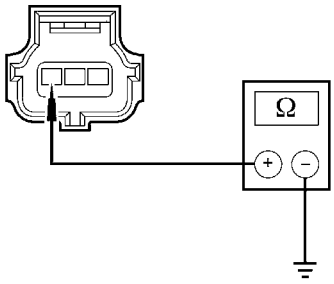
Normal Operation

Under normal operation, when voltage is low, the alternator control provides ground to the instrument cluster charging indicator through circuit 1818 (WH/BK)/904 (LG/RD).

Possible Causes

- A short to ground in circuit 1818 (WH/BK)/904 (LG/RD)
- Instrument cluster
- Alternator control

Table 18 PINPOINT TEST H: THE CHARGING SYSTEM INDICATOR IS ALWAYS ON

Test Step	Result / Action to Take
H1 CHECK THE CHARGING SYSTEM WARNING INDICATOR OPERATION • **Disconnect:** Alternator Control C102a • Key in ON position. • Observe the charging system warning indicator. • **Does the charging system warning indicator continue to illuminate?**	**Yes** Go to H2. **No** INSTALL a new alternator control. REFER to Generator and Regulator. TEST the system for normal operation.
H2 CHECK CIRCUIT 904 (LG/RD)/1818 (WH/BK) FOR A SHORT TO GROUND • Key in OFF position. • **Disconnect:** Instrument Cluster C220a • Measure the resistance between ground and alternator control C102a-1, circuit 1818 (WH/BK).  N0025276 **Is the resistance greater than 10,000 ohms?**	**Yes** INSTALL a new instrument cluster. For additional information, refer to Instrument Cluster, Removal and Installation in this section. TEST the system for normal operation. **No** REPAIR circuit 904 (LG/RD)/1818 (WH/BK) for a short to ground. TEST the system for normal operation.

Pinpoint Test I: The High Beam Indicator Is Never On

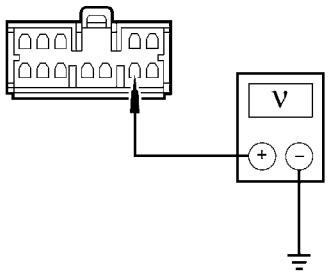
Normal Operation

Under normal operation, when the high beams are on, voltage is provided to the instrument cluster high beam indicator through circuit 1718 (RD/PK).

Possible Causes

- An open in circuit 1718 (RD/PK)
- Instrument cluster

Table 19 PINPOINT TEST I: THE HIGH BEAM INDICATOR IS NEVER ON

Test Step	Result / Action to Take
I1 CHECK HIGH BEAM VOLTAGE TO THE INSTRUMENT CLUSTER • **Disconnect:** Instrument Cluster C220a • Place the multifunction switch in the HEADLAMPS position. • Activate the high beams. • Measure the voltage between ground and instrument cluster C220a-11, circuit 1718 (RD/PK).  N0028781 **Is the voltage greater than 10 volts?**	**Yes** INSTALL a new instrument cluster. For additional information, refer to Instrument Cluster, Removal and Installation in this section. TEST the system for normal operation. **No** REPAIR circuit 1718 (RD/PK) for an open. TEST the system for normal operation.

Pinpoint Test J: The LH Or RH Turn Indicator Is Never On

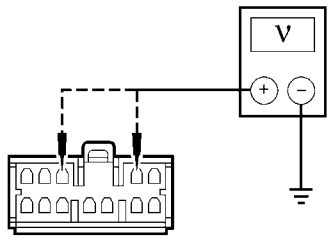
Normal Operation

Under normal operation, when the LH or RH turn signals are on, voltage is provided to the instrument cluster LH or RH turn indicator through circuit (LH) 1719 (GY/BK) or (RH) 1720 (DB/OG).

Possible Causes

- An open in circuit 1719 (GY/BK) or 1720 (DB/OG)
- Instrument cluster

Table 20 PINPOINT TEST J: THE LH OR RH TURN INDICATOR IS NEVER ON

Test Step	Result / Action to Take
J1 CHECK LH OR RH TURN SIGNAL VOLTAGE TO THE INSTRUMENT CLUSTER • **Disconnect:** Instrument Cluster C220a • Activate the hazard lamps. • Measure the voltage between ground and instrument cluster: — C220a-3, circuit 1719 (GY/BK). — C220a-4, circuit 1720 (DB/OG).  N0028780 **Is the voltage pulse from 0 volts to greater than 10 volts?**	**Yes** INSTALL a new instrument cluster. For additional information, refer to Instrument Cluster, Removal and Installation in this section. TEST the system for normal operation. **No** REPAIR circuit 1719 (GY/BK) or 1720 (DB/OG) for an open. TEST the system for normal operation.

Pinpoint Test K: The Instrument Cluster Is Inoperative

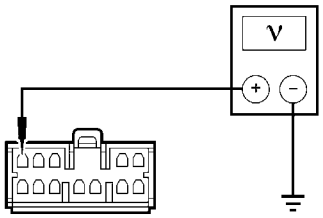
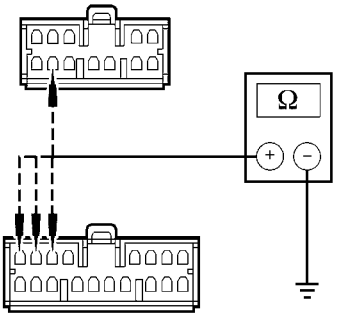
Normal Operation

Under normal operation, the instrument cluster receives voltage through circuit 489 (PK/BK). The instrument cluster is grounded through circuit 57 (BK).

Possible Causes

- An open in circuit 57 (BK) or 489 (PK/BK)
- Instrument cluster

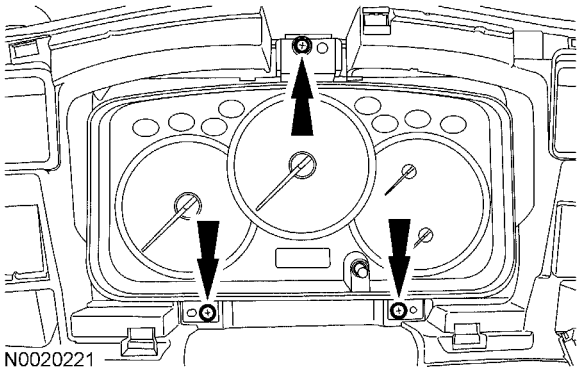
Table 21 PINPOINT TEST K: THE INSTRUMENT CLUSTER IS INOPERATIVE

Test Step	Result / Action to Take
K1 CHECK VOLTAGE TO THE INSTRUMENT CLUSTER • **Disconnect:** Instrument Cluster C220a • Key in ON position. • Measure the voltage between ground and instrument cluster C220a-1, circuit 489 (PK/BK).  N0025266 **Is the voltage greater than 10 volts?**	**Yes** GO to K2. **No** REPAIR circuit 489 (PK/BK) for an open. TEST the system for normal operation.
K2 CHECK GROUND TO THE INSTRUMENT CLUSTER • Key in OFF position. • **Disconnect:** Instrument Cluster C220b • Measure the resistance between ground and instrument cluster: — C220a-7, circuit 57 (BK). — C220b-1, circuit 57 (BK). — C220b-2, circuit 57 (BK). — C220b-3, circuit 57 (BK).  N0025267 **Is the resistance less than 5 ohms?**	**Yes** INSTALL a new instrument cluster. For additional information, refer to Instrument Cluster, Removal and Installation in this section. TEST the system for normal operation. **No** REPAIR circuit 57 (BK) for an open. TEST the system for normal operation.

Removal and Installation

Instrument Cluster

1. Lower the steering wheel tilt adjustment.
2. Remove the instrument cluster bezel.
3. Remove the 3 screws and position the instrument cluster away from the instrument panel.



4. Disconnect the electrical connectors.
5. To install, reverse the removal procedure.

Horn

Specifications

Table 22 Torque Specifications

Description	Nm	lb-in.
Horn assembly nut	9	80

Description and Operation

Horn

Horn components include the following items:

- Clockspring
- Horn relay
- Horns
- Steering wheel pad horn switch

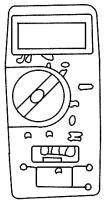
Horn Switches

The horn switches are in the steering wheel. The switches are powered through the clockspring and grounded through the steering column.

Diagnosis and Testing

Refer to Wiring Diagrams for schematic and connector information.

Table 23 Special Tool

 ST1137-A	Automotive Meter ZTSE4357

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Table 24 Visual Inspection Chart

Mechanical	Electrical
• Horn • Horn switch • Horn relay	• Power distribution center (PDC) fuse 14 (15A) • Wiring harness • Loose or corroded connections • Clockspring

3. If the concern is not visually evident, verify the symptom. GO to Symptom Chart.

Table 25

Condition	Possible Sources	Action
The horn is inoperative	• Fuse. • Circuitry open. • Horn relay. • Horn switch. • Horn.	Go to Pinpoint Test A.
The horn is always on	• Circuitry shorted. • Horn relay. • Horn switch.	Go to Pinpoint Test B.

Pinpoint Tests

Pinpoint Test A: The Horn Is Inoperative

Normal Operation

Under normal operation, voltage is fed from the power distribution center (PDC) fuse 14 (15A) to the horn relay through circuit 460 (YE/LB). When the horn switch is pressed, ground is provided to the horn relay coil through the multifunction switch and circuit 6 (YE/LG). When the relay is energized, voltage is sent to the horn through circuit 1 (DB). The horn is grounded through circuit 57 (BK).

Possible Causes

- An open in circuit 1 (DB), 6 (YE/LG), 57 (BK) or 460 (YE/LB)
- An open fuse
- Horn
- Horn relay
- Horn switch
- Multifunction switch
- Clockspring

Table 26 PINPOINT TEST A: THE HORN IS INOPERATIVE

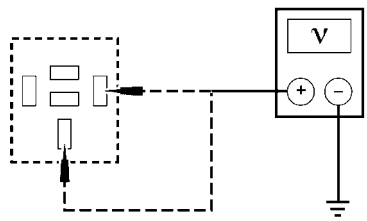
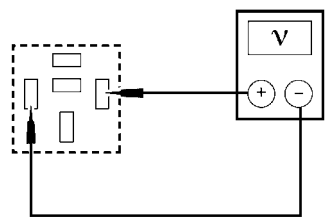
Test Step	Result / Action to Take
A1 CHECK CIRCUIT 1 (DB) FOR A SHORT TO VOLTAGE • **Disconnect:** Horn Relay. • Measure the voltage between ground and horn relay socket pin: — 30, circuit 460 (YE/LB). — 86, circuit 460 (YE/LB).  N0024006 **Are the voltages greater than 10 volts?**	**Yes** GO to A2. **No** If there is no voltage present on one pin, REPAIR circuit 460 (YE/LB) for an open. TEST the system for normal operation. If there is no voltage present on both pins, VERIFY the power distribution center (PDC) fuse 14 (15A) is OK. If OK, REPAIR circuit 460 (YE/LB) for an open. TEST the system for normal operation.
A2 CHECK THE HORN SIGNAL CIRCUIT • While pressing the horn switch, measure the voltage between horn relay socket pin 86, circuit 460 (YE/LB) and pin 85, circuit 6 (YE/LG).  N0024007 **Is the voltage greater than 10 volts?**	**Yes** GO to A3. **No** GO to A6.

Table 26 PINPOINT TEST A: THE HORN IS INOPERATIVE (cont.)

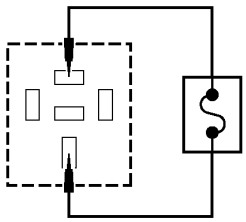
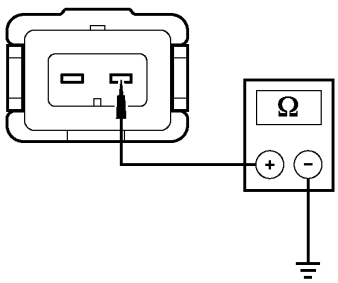
Test Step	Result / Action to Take
A3 CHECK THE HORN RELAY • Connect a fused jumper wire between horn relay socket pin 30, circuit 460 (YE/LB) and pin 87, circuit 1 (DB).  A0032587 **Does the horn sound?**	**Yes** INSTALL a new horn relay. TEST the system for normal operation. **No** GO to A4.
A4 CHECK CIRCUIT 57 (BK) FOR AN OPEN • **Disconnect:** Horn C131. • Measure the resistance between horn C131, circuit 57 (BK) and ground.  N0024009 **Is the resistance less than 5 ohms?**	**Yes** GO to A5. **No** REPAIR circuit 57 (BK) for an open. TEST the system for normal operation.

Table 26 PINPOINT TEST A: THE HORN IS INOPERATIVE (cont.)

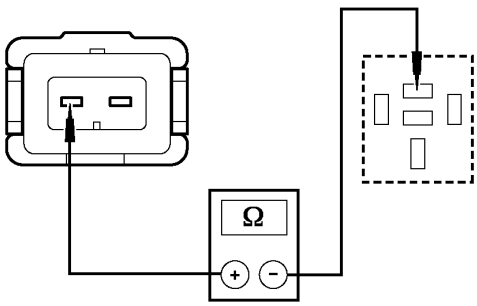
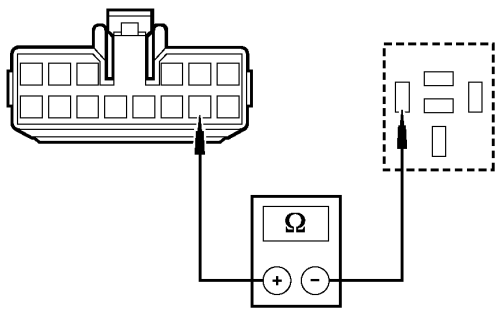
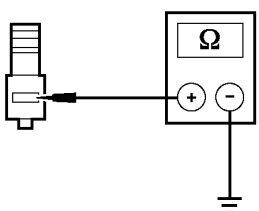
Test Step	Result / Action to Take
A5 CHECK CIRCUIT 1 (DB) FOR AN OPEN • Measure the resistance between horn C131, circuit 1 (DB) and horn relay socket pin 87, circuit 1 (DB).  N0031826 **Is the resistance less than 5 ohms?**	**Yes** INSTALL a new horn. TEST the system for normal operation. **No** REPAIR circuit 1 (DB) for an open. TEST the system for normal operation.

Table 26 PINPOINT TEST A: THE HORN IS INOPERATIVE (cont.)

Test Step	Result / Action to Take
A6 CHECK CIRCUIT 6 (YE/LG) FOR AN OPEN • **Disconnect:** Multifunction Switch C202b. • Measure the resistance between multifunction switch C202b-13, circuit 6 (YE/LG) and horn relay socket pin 85, circuit 6 (YE/LG).  N0024011 **Is the resistance less than 5 ohms?**	**Yes** GO to A7. **No** REPAIR circuit 6 (YE/LG) for an open. TEST the system for normal operation.
A7 CHECK THE HORN SWITCH CIRCUITRY • Remove the horn pad. • **Disconnect:** Horn Switch. • While pressing and releasing each of the 4 horn contacts of the horn switch, measure the resistance between the horn switch wire and ground.  N0024012 **Is the resistance less than 5 ohms with each horn contact pressed and greater than 10,000 ohms with each horn contact released?**	**Yes** CARRY OUT the multifunction switch component test. Refer to Wiring Diagrams for component testing. If OK, INSTALL a new clockspring. TEST the system for normal operation. **No** INSTALL a new horn switch. TEST the system for normal operation.

Pinpoint Test B: The Horn Is Always On

Normal Operation

Under normal operation, voltage is fed from the power distribution center (PDC) fuse 14 (15A) to the horn relay through circuit 460 (YE/LB). When the horn switch is pressed, ground is provided to the horn relay coil through the multifunction switch and circuit 6 (YE/LG). When the relay is energized, voltage is

sent to the horn through circuit 1 (DB). The horn is grounded through circuit 57 (BK).

Possible Causes

- A short to ground in circuit 6 (YE/LG)
- A short to voltage in circuit 1 (DB)
- Horn relay
- Horn switch
- Multifunction switch

Table 27 PINPOINT TEST B: THE HORN IS ALWAYS ON

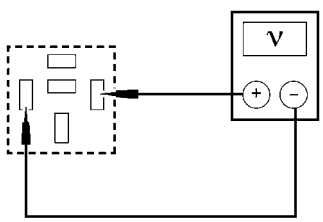
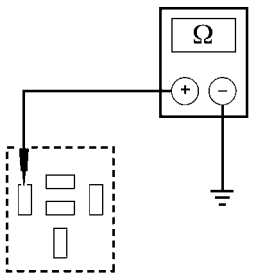
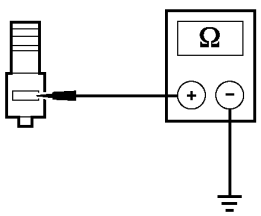
Test Step	Result / Action to Take
B1 CHECK CIRCUIT 1 (DB) FOR A SHORT TO VOLTAGE • **Disconnect:** Horn Relay. **Is the horn OFF?**	**Yes** GO to B2. **No** REPAIR circuit 1 (DB) for a short to voltage. TEST the system for normal operation.
B2 CHECK THE HORN RELAY • Measure the voltage between horn relay socket pin 86, circuit 460 (YE/LB) and pin 85, circuit 6 (YE/LG).  N0024007 **Is voltage present?**	**Yes** GO to B3. **No** INSTALL a new horn relay. TEST the system for normal operation.

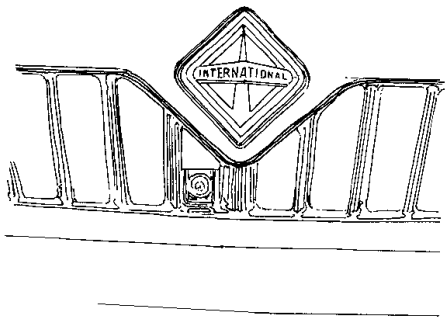
Table 27 PINPOINT TEST B: THE HORN IS ALWAYS ON (cont.)

Test Step	Result / Action to Take
B3 CHECK CIRCUIT 6 (YE/LG) FOR A SHORT TO GROUND • **Disconnect:** Multifunction Switch C202b • Measure the resistance between ground and horn relay socket pin 85, circuit 6 (YE/LG).  N0024013 **Is the resistance greater than 10,000 ohms?**	**Yes** GO to B4. **No** REPAIR circuit 6 (YE/LG) for a short to ground. TEST the system for normal operation.
B4 CHECK THE HORN SWITCH CIRCUITRY • Remove the horn pad. • **Disconnect:** Horn Switch. • Measure the resistance between horn switch wire and ground.  N0024012 **Is the resistance greater than 10,000 ohms?**	**Yes** INSTALL a new multifunction switch. For additional information, refer to Steering Column Switches in S05017. TEST the system for normal operation. **No** INSTALL a new horn switch. TEST the system for normal operation.

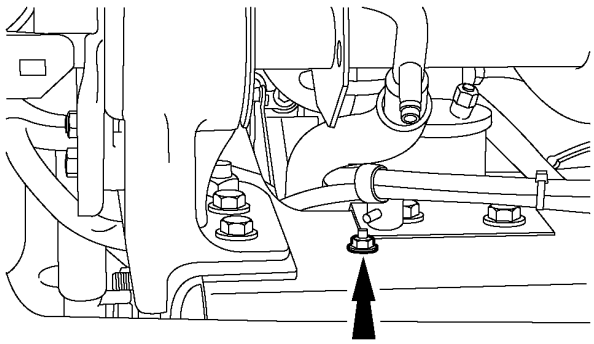
Removal and Installation

Horn

1. Remove the radiator grille retaining screw.



2. Remove the radiator grille.
3. Remove the horn assembly nut.
   • To install, tighten to 9 Nm (80 lb-in).

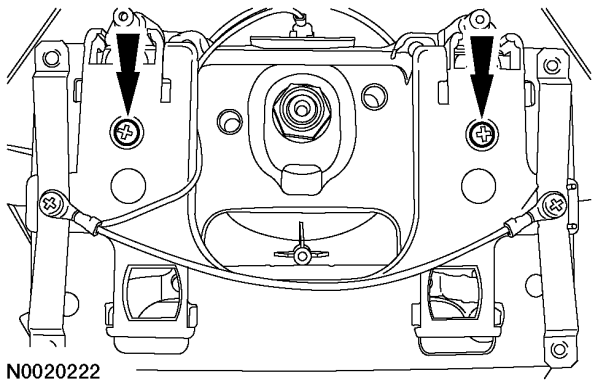


N0020223

4. Remove the horn assembly.
5. Disconnect the electrical connector.
6. To install, reverse the removal procedure.

Horn Switch

1. Remove the horn pad.
2. Disconnect the electrical connector.
3. Remove the 2 horn switch retaining screws.



N0020222

4. Remove the horn switch.
5. To install, reverse the removal procedure.

Warning Devices

Description and Operation

Warning Devices

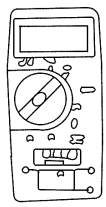
The warning device system consists of the following:

- Safety belt warning lamp switch
- Door ajar switch
- Instrument cluster
- Key-in-ignition warning switch
- Headlamp on warning

Diagnosis and Testing

Refer to Wiring Diagrams for schematic and connector information.

Table 28 Special Tools

 ST1137-A	Automotive Meter ZTSE4357
	EZ-Tech III

Principles of Operation

Safety Belt Warning Chime

The safety belt warning chime warns that the safety belt is not fastened. The safety belt warning chime sounds when the driver safety belt is not fastened and the ignition switch is turned to the ON or START position.

The safety belt warning chime stops sounding when:

- the safety belt is fastened.
- the ignition switch is turned to the OFF or ACC position.

The safety belt warning chime inputs are:

- the ignition switch ON position.
- the driver safety belt switch.

The output is the instrument cluster chime.

Key-In-Ignition Warning Chime

The key-in-ignition chime warns that the key is in the ignition lock cylinder when the driver door is ajar. The key-in-ignition warning chime sounds when all the following conditions are met:

- The driver door is ajar
- The key is in the ignition lock cylinder
- The ignition switch is in the OFF or ACC position

The key-in-ignition warning chime stops sounding when:

- the driver door is closed.
- the key is removed from the ignition lock cylinder.
- the ignition switch is turned to the ON position.

The key-in-ignition warning chime inputs are:

- the ignition switch.
- the key-in-ignition switch.
- the LH door ajar switch.

The output is the instrument cluster chime.

Headlamp On Warning Chime

The headlamp on warning chime warns that the headlamps are on while the driver or passenger door is ajar. The headlamp on warning chime sounds when all the following conditions are met:

- The driver or passenger door is ajar
- The multifunction switch is in the PARKLAMPS or HEADLAMPS position
- The ignition switch is in the OFF position

The headlamp on warning chime stops sounding when any one of the conditions above are removed.

The headlamp on warning chime inputs are:

- the ignition switch is in the OFF position.
- the multifunction switch.
- the driver and passenger door ajar switch.
- the key-in-ignition switch.

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Table 29 Visual Inspection Chart

Mechanical	Electrical
• Key-in-ignition warning switch • Door ajar switch • Driver safety belt switch • Multifunction switch	• Circuitry open/shorted • Instrument cluster

3. If the concern is not visually evident, verify the symptom. GO to Symptom Chart.

Table 30 Symptom Chart

Condition	Possible Sources	Action
All chimes are inoperative	• Instrument cluster.	Install a new instrument cluster. REFER to Instrument Cluster.
The safety belt warning chime/ indicator is inoperative/ always on	• Circuitry open. • Safety belt switch. • Instrument cluster.	Go to Pinpoint Test A.
A chime is inoperative — key-in-ignition (with the door ajar)	• Circuitry open. • Key-in-ignition switch. • Instrument cluster.	Go to Pinpoint Test B.
A chime is inoperative — head/parking lamps ON (with the door ajar)	• Circuitry open. • Multifunction switch. • Instrument cluster.	Go to Pinpoint Test C.
A chime is always on (with the door ajar)	• Circuitry shorted. • Instrument cluster.	Go to Pinpoint Test D.

Pinpoint Tests

Pinpoint Test A: The Safety Belt Warning Chime/Indicator is Inoperative/Always On

Normal Operation

Under normal operation, the safety belt switch is grounded through circuit 57 (BK). When the driver safety belt is not fastened, the safety belt switch is closed and provides ground to the instrument cluster through circuit 85 (BN/YE). When the instrument cluster receives ground from the safety belt switch (not fastened) and the ignition switch is turned to the ON or START position, the safety belt warning indicator will illuminate and the instrument cluster will chime.

Possible Causes

- An open in circuit 57 (BK) or 85 (BN/YE)
- Safety belt switch
- Instrument cluster

Table 31 PINPOINT TEST A: THE SAFETY BELT WARNING CHIME/INDICATOR IS INOPERATIVE/ALWAYS ON

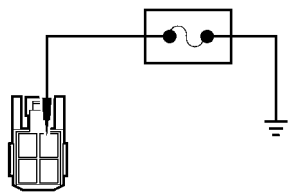
Test Step	Result / Action to Take
A1 CHECK THE INDICATOR STATUS • Key in ON position. • Unlatch the driver safety belt. • Observe the safety belt indicator lamp. **Is the safety belt warning indicator inoperative?**	**Yes** GO to A2. **No** GO to A4.
A2 CHECK THE DRIVER SAFETY BELT SWITCH • Key in OFF position. • **Disconnect:** Safety Belt Switch C323 • Key in ON position. • Connect a fused jumper wire between ground and safety belt switch C323–2, circuit 85 (BN/YE).  N0025249 **Does the safety belt warning indicator illuminate?**	**Yes** INSTALL a new safety belt buckle. For additional information, refer to Safety Belt System in S16032. TEST the system for normal operation. **No** GO to A3.

Table 31 PINPOINT TEST A: THE SAFETY BELT WARNING CHIME/INDICATOR IS INOPERATIVE/ALWAYS ON (cont.)

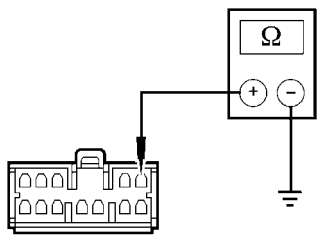
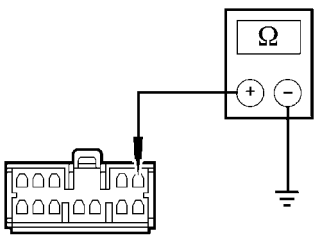
Test Step	Result / Action to Take
A3 CHECK CIRCUIT 85 (BN/YE) FOR AN OPEN • Key in OFF position. • **Connect:** Safety Belt Switch C323. • **Disconnect:** Instrument cluster C220a. • Key in ON position. • Unlatch the driver safety belt. • Measure the resistance between ground and instrument cluster C220a-5, circuit 85 (BN/YE).  N0025250 **Is the resistance less than 5 ohms?**	**Yes** INSTALL a instrument cluster. For additional information, refer to Instrument Cluster. TEST the system for normal operation. **No** REPAIR circuit 85 (BN/YE) for an open. TEST the system for normal operation.

Table 31 PINPOINT TEST A: THE SAFETY BELT WARNING CHIME/INDICATOR IS INOPERATIVE/ALWAYS ON (cont.)

Test Step	Result / Action to Take
A4 CHECK THE DRIVER SAFETY BELT SWITCH • Key in OFF position. • **Disconnect:** Safety Belt Switch C323. • Key in ON position. • Observe the safety belt indicator lamp. **Does the safety belt warning indicator illuminate?**	**Yes** GO to A5. **No** INSTALL a new safety belt buckle. For additional information, refer to Safety Belt System in S16032. TEST the system for normal operation.
A5 CHECK CIRCUIT 85 (BN/YE) FOR A SHORT TO GROUND • Key in OFF position. • **Disconnect:** Instrument Cluster C220a. • Key in ON position. • Measure the resistance between ground and instrument cluster C220a-5, circuit 85 (BN/YE).  N0025250 **Is the resistance greater than 10,000 ohms?**	**Yes** INSTALL a instrument cluster. For additional information, refer to Instrument Cluster. TEST the system for normal operation. **No** REPAIR circuit 85 (BN/YE) for a short to ground. TEST the system for normal operation.

Pinpoint Test B: A Chime Is Inoperative — Key-In-Ignition (With The Door Ajar)

Normal Operation

Under normal operation, the key-in-ignition switch is supplied voltage from the power distribution center (PDC) fuse 15 (10A) through circuit 3049 (BK/LG). When the key is placed in the ignition cylinder, the key-in-ignition switch is closed and provides voltage to the instrument cluster through circuit 1414 (LG/VT). When the instrument cluster receives voltage from the key-in-ignition switch and the driver or passenger door is ajar, the instrument cluster will chime.

Possible Causes

- An open in circuit 1414 (LG/VT) or 3049 (BK/LG)
- Fuse
- Key-in-ignition switch
- Instrument cluster

Table 32 PINPOINT TEST B: A CHIME IS INOPERATIVE — KEY-IN-IGNITION (WITH THE DOOR AJAR)

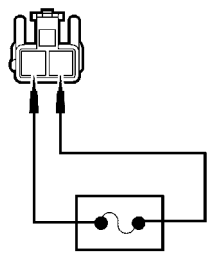
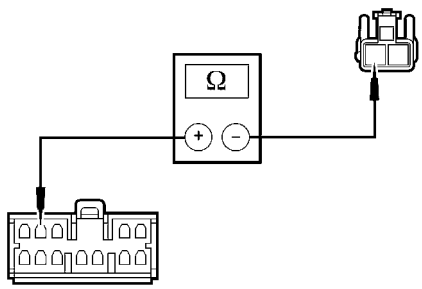
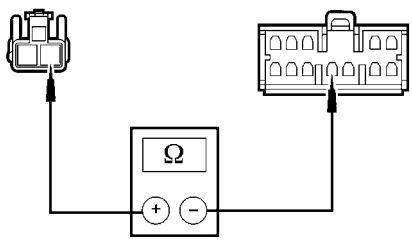
Test Step	Result / Action to Take
B1 CHECK THE KEY-IN-IGNITION SWITCH • **Disconnect:** Key-In-Ignition Switch C2112 • Open the driver and passenger side door. • Connect a fused jumper between key-in-ignition switch C2112-1, circuit 3049 (BK/LG) and key-in-ignition switch C2112-2, circuit 1414 (LG/VT).  N0025251 **Does the key-in-ignition chime sound?**	**Yes** INSTALL a new key-in-ignition switch. REFER to Key-In-Ignition switch, Removal and Installation in this section. TEST the system for normal operation. **No** GO to B2.

Table 32 PINPOINT TEST B: A CHIME IS INOPERATIVE — KEY-IN-IGNITION (WITH THE DOOR AJAR) (cont.)

Test Step	Result / Action to Take
B2 CHECK CIRCUIT 3049 (BK/LG) FOR AN OPEN • **Disconnect:** Instrument Cluster C220a • Measure the resistance between instrument cluster C220a-2, circuit 3049 (BK/LG) and key-in-ignition switch C2112-1, circuit 3049 (BK/LG).  N0025252 **Is the resistance less than 5 ohms?**	**Yes** GO to B3. **No** INSPECT power distribution center (PDC) fuse 15 (10A) for an open. If OK, REPAIR circuit 3049 (BK/LG) for an open. TEST the system for normal operation.
B3 CHECK CIRCUIT 1414 (LG/VT) FOR AN OPEN • Measure the resistance between instrument cluster C220a-9, circuit 1414 (LG/VT) and key-in-ignition switch C2112-2, circuit 1414 (LG/VT).  N0025253 **Is the resistance less than 5 ohms?**	**Yes** INSTALL a instrument cluster. For additional information, refer to Instrument Cluster. TEST the system for normal operation. **No** REPAIR circuit 1414 (LG/VT) for an open. TEST the system for normal operation.

Pinpoint Test C: A Chime Is Inoperative — Head/Parking Lamps ON (With The Door Ajar)

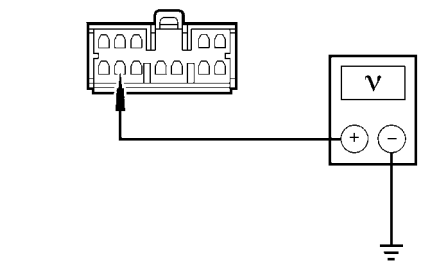
Normal Operation

Under normal operation, when the multifunction switch is in the HEADLAMPS or PARKLAMPS position, voltage is provided to the instrument cluster through circuit 19 (LB/RD). When the instrument cluster receives voltage from the multifunction switch and the driver or passenger door is ajar, the instrument cluster will chime.

Possible Causes

- An open in circuit 19 (LB/RD)
- Instrument cluster

Table 33 PINPOINT TEST C: A CHIME IS INOPERATIVE — HEAD/PARKING LAMPS ON (WITH THE DOOR AJAR)

Test Step	Result / Action to Take
C1 CHECK THE HEAD/PARKING LAMPS INPUT • **Disconnect:** Instrument Cluster C220a • Place the multifunction switch in the PARKLAMPS position. • Measure the voltage between ground and instrument cluster C220a-7, circuit 19 (LB/RD).  N0025254 **Is the voltage greater than 10 volts?**	**Yes** INSTALL a instrument cluster. For additional information, refer to Instrument Cluster. TEST the system for normal operation. **No** REPAIR circuit 19 (LB/RD) for an open. TEST the system for normal operation.

Pinpoint Test D: A Chime Is Always ON (With The Door Ajar)

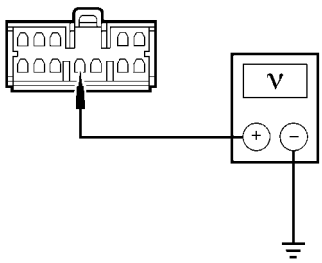
Normal Operation

Under normal operation, when the key is placed in the ignition cylinder, the key-in-ignition switch is closed and provides voltage to the instrument cluster through circuit 1414 (LG/VT). When the instrument cluster receives voltage from the key-in-ignition switch and the driver or passenger door is ajar, the instrument cluster will chime.

Possible Causes

- A short to voltage in circuit 1414 (LG/VT)
- Key-in-ignition switch
- Instrument cluster

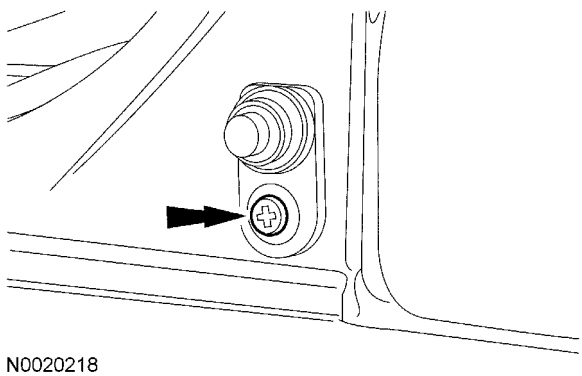
Table 34 PINPOINT TEST D: A CHIME IS ALWAYS ON (WITH THE DOOR AJAR)

Test Step	Result / Action to Take
D1 CHECK THE KEY-IN-IGNITION SWITCH • **Disconnect:** Key-In-Ignition Switch C2112 • Open the driver or passenger side door. **Does the key-in-ignition chime sound?**	**Yes** GO to D2. **No** INSTALL a new key-in-ignition switch. REFER to Key-In-Ignition Switch, Removal and Installation in this section. TEST the system for normal operation.
D2 CHECK CIRCUIT 1414 (LG/VT) FOR A SHORT TO VOLTAGE • **Disconnect:** Instrument Cluster C220a • Key in ON position. • Measure the voltage between ground and instrument cluster C220a-9, circuit 1414 (LG/VT).  N0025255 **Is any voltage present?**	**Yes** REPAIR circuit 1414 (LG/VT) for a short to voltage. TEST the system for normal operation. **No** INSTALL a instrument cluster. For additional information, refer to Instrument Cluster. TEST the system for normal operation.

Removal and Installation

Door Ajar Switch

1. Open the driver or passenger door.
2. Remove the door ajar switch retaining screw.

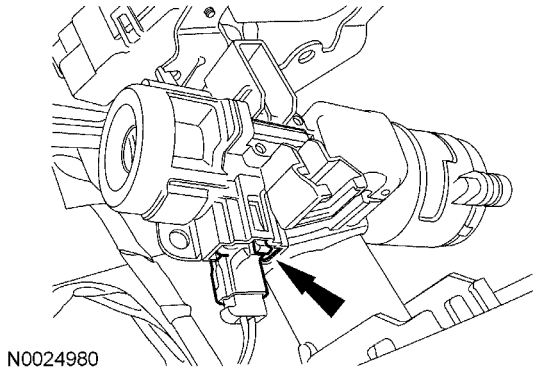


N0020218

3. Disconnect the electrical connector.
4. To install, reverse the removal procedure.

Key-In-Ignition Warning Switch

1. Remove the upper column shroud.
2. Press the key-in-ignition switch retaining tab.



3. Remove the key-in-ignition switch.
4. Disconnect the electrical connector.
5. To install, reverse the removal procedure.

Charging System — General Information

Specifications

Table 35 Generator General Specifications

Item	Specification
Voltage	80
Generator	130 amps

Description and Operation

Charging System

The charging system is a negative ground system consisting of the following:

- Generator
- Electronic rear-mounted voltage regulator
- Charging system warning indicator
- Storage batteries
- Necessary wiring and cables

Generator

The generator is belt-driven by the engine accessory drive system.

The generator is mounted on the top right of the engine and is a 130-amp generator with a 3.21:1 pulley ratio.

With the key in the ON position, voltage is supplied through the instrument cluster warning indicator I circuit to the voltage regulator. The regulator grounds this circuit and the charging system warning indicator is illuminated. When the engine is started, the regulator removes the ground on this circuit and the warning indicator turns off.

Battery

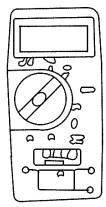
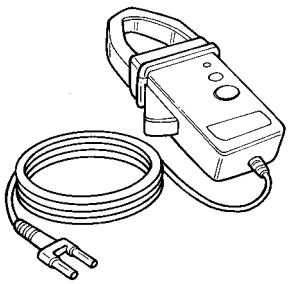
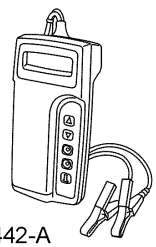
The batteries are a 12-volt direct current source connected in a negative ground system. The batteries have 3 major functions:

- Engine cranking power source
- Voltage stabilizer for the electrical system
- Temporary power when electrical loads exceed the generator output current

Diagnosis and Testing

Refer to Wiring Diagrams, Charging System for schematic and connector information.

Table 36 Special Tools

 ST1137-A	Automotive Meter ZTSE4357
	Amp Clamp ZTSE4575
 ST2442-A	MCR700 Digital Battery Analyzer

Principles of Operation

Functionality

With the key in the ON position, voltage is applied through the warning indicator I circuit to the voltage regulator. This turns the regulator on, allowing current to flow from battery sense A circuit to the generator field coil. When the engine is started, the generator begins to generate alternating current (AC) which is internally converted to direct current (DC). This current is then supplied to the electrical system through the output terminal (B+) of the generator.

Once the generator begins generating current, a voltage signal is taken from the generator stator and fed back to the regulator internally. This voltage feedback signal (typically one-half of the battery voltage) is used to turn off the warning indicator.

With the system functioning normally, the generator output current is determined by the voltage of the A circuit. This A circuit voltage (battery sense circuit) is compared to a set voltage internal to the regulator, and the regulator controls the generator field current to maintain correct generator output.

The generator system consists of the generator mounted on the top right of the engine. The generator system uses a 130-amp generator with a 3.21:1 pulley ratio.

Positive Battery Output Circuit 36 (B+) (RD)

The generator output is supplied through the battery positive output (B+) terminal on the rear of the generator to the battery and the electrical system.

I Circuit — Single Generator

The I (ignition) circuit is used to turn on the voltage regulator. This circuit is powered up when the key is in the ON position. Voltage is supplied from the instrument cluster and through the charge warning indicator (battery icon) to the generator. This circuit is also used to turn the charging system warning indicator on if there is a fault in the charging system operation.

A Circuit 36 (RD)

The A circuit or battery sense circuit is used to sense battery voltage. This voltage is used by the regulator to determine generator output. This circuit is also used to supply current to the generator field, which determines generator output.

Inspection and Verification

WARNING: Batteries contain sulfuric acid. Avoid contact with skin, eyes or clothing. Also, shield your eyes when working near batteries to protect against possible splashing of the acid solution. In case of acid contact with skin or eyes, flush immediately with water for a minimum of 15 minutes and get prompt medical attention. If acid is swallowed, call a physician immediately. Failure to follow these instructions may result in personal injury.

WARNING: Batteries normally produce explosive gases which can cause personal injury. Therefore, do not allow flames, sparks or lighted substances to come near the battery. When charging or working near a battery, always shield your face and protect your eyes. Always provide ventilation. Failure to follow these instructions may result in personal injury.

WARNING: When lifting a plastic-cased battery, excessive pressure on the end walls could cause acid to spew through the vent caps resulting in personal injury, damage to the vehicle or to the battery. Lift with a battery carrier or with your hands on opposite corners. Failure to follow these instructions may result in personal injury.

1. Verify the customer concern.
2. Inspect the charging system (battery, generator and cables, harness connectors, connections) to determine if any obvious mechanical or electrical concerns exist. If found, repair as necessary and test the system for normal operation. Refer to the following tables:

Table 37 Visual Inspection Chart

Mechanical	Electrical
• Battery box, posts, hold-down clamp, cables and connections for damage • Generator drive (serpentine) belt for condition and tension to make sure there is no slip between the belt and the pulley. For additional information, refer to the Engine Operation and Maintenance Manual. • Generator pulley	• Charging system warning indicator • Battery charge • Circuitry • Cables

3. Check the operation of the charging system warning indicator in the instrument cluster. Normal operation is as follows:
   - With the key off, the charging system warning indicator should be off.
   - With the key on and the engine off, the charging system warning indicator should be on.
   - With the engine running, the charging system warning indicator should be off.
4. Verify the battery condition. For additional information, refer to Battery, Mounting and Cables.

NOTE: When testing the I circuit with the engine running, make certain to load the charging system by turning the blower motor to the HIGH position and the headlamps on high beam.

Table 38 Normal Charging System Voltages and Charging System Warning Indicator Operation

Key Position	I Circuit 1818 (WH/BK)	A Circuit 36 (RD)	Generator B+ Circuit 36 (RD)	Battery	Engine to Battery Ground	Charging System Warning Indicator Operation
OFF	0 volts	12 volts	12 volts	12 volts	0 volts	Off
ON — engine off	1–3 volts	12 volts	12 volts	12 volts	0 volts	Illuminated
ON — engine running	8–9 volts	13–15 volts	13–15 volts	13–15 volts	0 volts	Off

5. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
6. If the cause is not visually evident, verify the symptom and GO to the Symptom Chart.

Table 39 Symptom Chart

Condition	Possible Sources	Action
The battery is discharged or battery voltage is low	• Corroded terminal(s). • Loose connection(s). • High key-off current drain(s). • Battery. • Generator.	Go to Pinpoint Test A.
The charging system warning indicator is ON with the engine running (the charging system voltage does not increase)	• Circuitry. • Generator.	Go to Pinpoint Test B.
The charging system overcharges (battery voltage is greater than 15.5 volts)	• Circuitry. • Generator.	Go to Pinpoint Test C.
The charging system warning indicator is ON with the engine running and the battery increases voltage	• Circuitry. • Instrument cluster. • Generator.	Go to Pinpoint Test D.
The charging system warning indicator is OFF with the ignition switch in the ON position and the engine OFF	• Bulb. • Circuitry. • Instrument cluster. • Generator.	Go to Pinpoint Test E.
The charging system warning indicator lamp flickers or is intermittent	• Fuse(s). • Circuitry. • Corroded terminals. • Generator.	Go to Pinpoint Test F.
The generator is noisy	• Bolts or brackets. • Drive belt. • Generator or pulley.	Go to Pinpoint Test G.
Radio interference	• Generator. • Circuitry. • In-vehicle entertainment system.	Go to Pinpoint Test H.

Pinpoint Tests

Pinpoint Test A: The Battery Is Discharged Or Battery Voltage Is Low

Normal Operation

With the key in the ON position, voltage is applied through the warning indicator I circuit to the voltage regulator. This turns the regulator on, allowing current to flow from battery sense A circuit to the generator field coil. When the engine is started, the generator begins to generate alternating current (AC) which

is internally converted to direct current (DC). This current is then supplied to the electrical system through the output terminal (B+) of the generator. Once the generator begins generating current, a voltage signal is taken from the generator stator and fed back to the regulator internally. This voltage feedback signal (typically one-half of the battery voltage) is used to turn off the warning indicator. With the system functioning normally, the generator output current is determined by the voltage of the A circuit. This A circuit voltage (battery sense circuit) is compared to a set voltage internal to the regulator, and the regulator controls the generator field current to maintain correct generator output.

Possible Causes

- Corroded terminal(s)
- Loose connection(s)
- High key-off current drain(s)
- Battery
- Generator

CAUTION: Do not make jumper connections except as directed. Incorrect connections may damage the voltage regulator test terminals, fuses or fusible links.

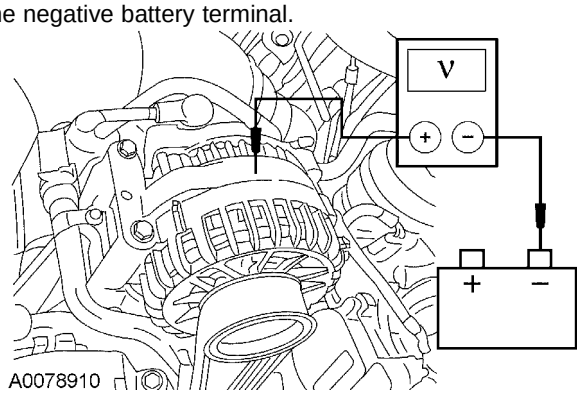
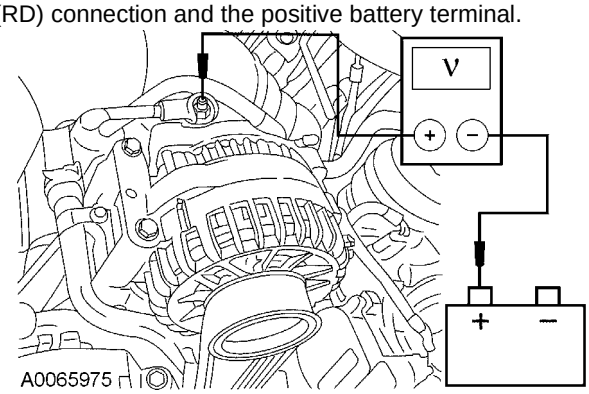
CAUTION: Do not allow any metal object to come in contact with the generator housing and/or internal diode cooling fins. A short circuit may result and burn out the diodes.

NOTE: All voltage measurements are referenced to the negative (-) battery post unless otherwise specified.

Table 40 PINPOINT TEST A: THE BATTERY IS DISCHARGED OR BATTERY VOLTAGE IS LOW

Test Step	Result / Action to Take
A1 CHECK THE BATTERY CONDITION • Carry out the Battery — Condition Test to determine if the battery can hold a charge and is OK for use. Refer to Battery, Mounting and Cables. **Does the battery pass the condition test?**	**Yes** GO to A2. **No** INSTALL a new battery. REFER to Battery, Mounting and Cables. TEST the system for normal operation.
A2 CHECK THE GENERATOR OUTPUT • Carry out the Generator On-Vehicle Load Test and No Load Test. Refer to the Component Tests in this section. **Does the generator pass the component tests?**	**Yes** GO to A3. **No** INSTALL a new generator. REFER to Generator and Regulator. TEST the system for normal operation.
A3 CHECK FOR CURRENT DRAINS • Carry out the Battery — Drain Testing. Refer to the Component Tests in this section. **Are any circuits causing excessive current drains?**	**Yes** REPAIR as necessary. TEST the system for normal operation. **No** GO to A4.

Table 40 PINPOINT TEST A: THE BATTERY IS DISCHARGED OR BATTERY VOLTAGE IS LOW (cont.)

Test Step	Result / Action to Take
A4 CHECK THE VEHICLE GROUNDS • Key in START position. • Measure the voltage drop between the generator housing and the negative battery terminal.  A0078910 **Is the voltage drop less than 0.1 volt?**	**Yes** GO to A5. **No** CHECK the engine ground, generator ground and the battery for corrosion. REPAIR as necessary. TEST the system for normal operation.
A5 CHECK THE VOLTAGE DROP IN B+ CIRCUIT 36 (RD) • Measure the voltage drop between generator B+ circuit 36 (RD) connection and the positive battery terminal.  A0065975 **Is the voltage drop less than 0.1 volt?**	**Yes** VERIFY if the customer left any component(s) on or if there is an intermittent excessive battery draw. TEST the system for normal operation. **No** CHECK for corrosion in the battery positive cable and/or connections. REPAIR as necessary. TEST the system for normal operation.

Pinpoint Test B: The Charging System Warning Indicator Is ON With The Engine Running (The Charging System Voltage Does Not Increase)

Normal Operation

With the key in the ON position, voltage is applied through the warning indicator I circuit to the voltage regulator. This turns the regulator on, allowing current to flow from battery sense A circuit to the generator field coil. When the engine is started, the generator begins to generate alternating current (AC) which is internally converted to direct current (DC). This current is then supplied to the electrical system through the output terminal (B+) of the generator. Once the generator begins generating current, a voltage signal is taken from the generator stator and fed back to the regulator internally. This voltage feedback signal (typically one-half of the battery voltage) is used to turn off the warning indicator. With the system functioning normally, the generator output current is determined by the voltage of the A circuit. This A circuit voltage (battery sense circuit) is compared to a set voltage internal to the regulator,

and the regulator controls the generator field current to maintain correct generator output.

Possible Causes

- Circuitry
- Generator

Table 41 PINPOINT TEST B: THE CHARGING SYSTEM WARNING INDICATOR IS ON WITH THE ENGINE RUNNING (THE CHARGING SYSTEM VOLTAGE DOES NOT INCREASE)

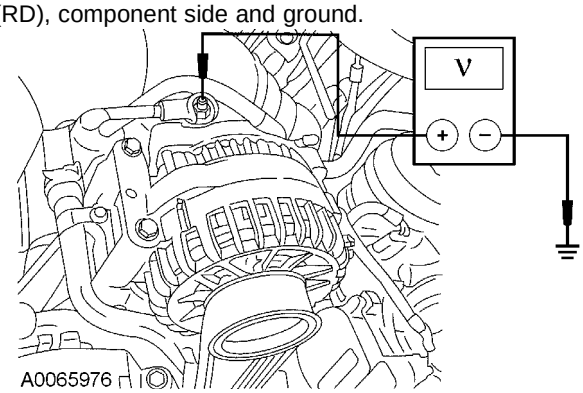
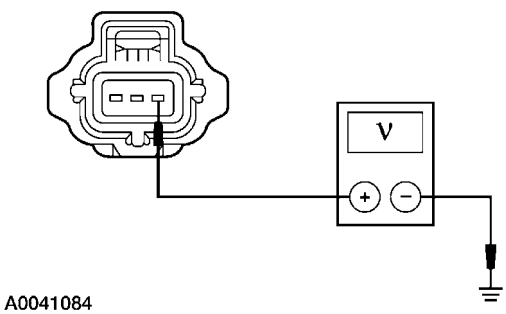
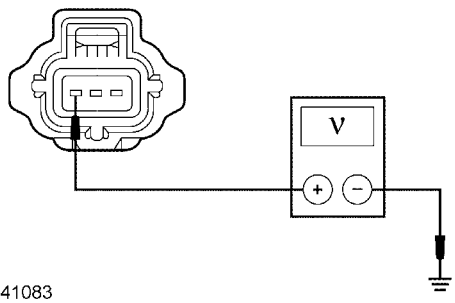
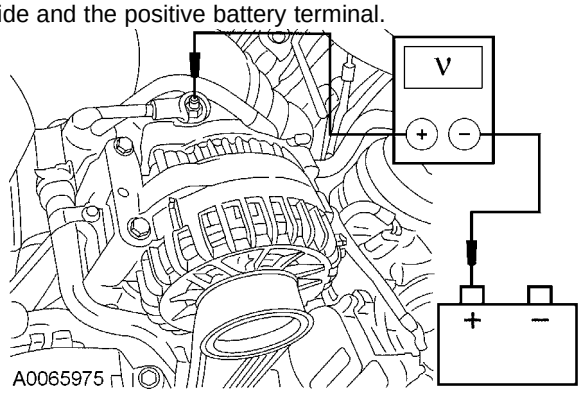
Test Step	Result / Action to Take
B1 CHECK THE GENERATOR B+ CIRCUIT 36 (RD) • Measure the voltage between generator B+ terminal, circuit 36 (RD), component side and ground.  **Is the voltage equal to battery positive voltage (B+)?**	**Yes** GO to B2. **No** REPAIR the circuit. TEST the system for normal operation.
B2 CHECK A CIRCUIT 36 (RD) FOR VOLTAGE • **Disconnect:** Generator C102a • Measure the voltage between generator C102a-3, circuit 36 (RD), harness side and ground.  **Is the voltage equal to battery positive voltage (B+)?**	**Yes** GO to B3. **No** REPAIR the circuit. TEST the system for normal operation.

Table 41 PINPOINT TEST B: THE CHARGING SYSTEM WARNING INDICATOR IS ON WITH THE ENGINE RUNNING (THE CHARGING SYSTEM VOLTAGE DOES NOT INCREASE) (cont.)

Test Step	Result / Action to Take
B3 CHECK I CIRCUIT 1818 (WH/BK) FOR AN OPEN • Key in ON position. • Measure the voltage between generator C102a-1, circuit 1818 (WH/BK), harness side and ground.  A0041083 **Is the voltage equal to battery positive voltage (B+)?**	**Yes** GO to B4. **No** REPAIR the circuit. TEST the system for normal operation.
B4 CHECK FOR VOLTAGE DROP IN B+ CIRCUIT 36 (RD) • Key in OFF position. • **Connect:** Generator C102a • Key in START position. • With the engine running, turn the headlamps on and the blower motor to the high position. • With the engine at 2,000 rpm, measure the voltage drop between the generator B+ terminal, circuit 36 (RD), component side and the positive battery terminal.  A0065975 **Is the voltage drop less than 0.5 volt?**	**Yes** INSTALL a new generator. REFER to Generator and Regulator. TEST the system for normal operation. **No** REPAIR the high resistance in the B+ circuit 36 (RD). TEST the system for normal operation.

Pinpoint Test C: The Charging System Overcharges (Battery Voltage Is Greater Than 15.5 Volts)

Normal Operation

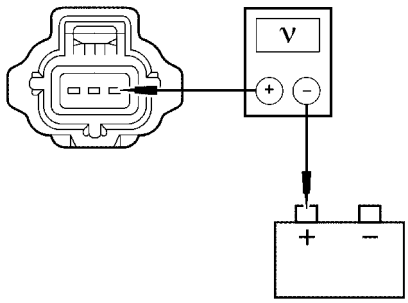
With the key in the ON position, voltage is applied through the warning indicator I circuit to the voltage regulator. This turns the regulator on, allowing current

to flow from battery sense A circuit to the generator field coil. When the engine is started, the generator begins to generate alternating current (AC) which is internally converted to direct current (DC). This current is then supplied to the electrical system through the output terminal (B+) of the generator. Once the generator begins generating current, a voltage signal is taken from the generator stator and fed back to the regulator internally. This voltage feedback signal (typically one-half of the battery voltage) is used to turn off the warning indicator. With the system functioning normally, the generator output current is determined by the voltage of the A circuit. This A circuit voltage (battery sense circuit) is compared to a set voltage internal to the regulator, and the regulator controls the generator field current to maintain correct generator output.

Possible Causes

- Circuitry
- Generator

Table 42 PINPOINT TEST C: THE CHARGING SYSTEM OVERCHARGES (BATTERY VOLTAGE IS GREATER THAN 15.5 VOLTS)

Test Step	Result / Action to Take
C1 CHECK FOR VOLTAGE DROP IN A CIRCUIT 36 (RD) • **Disconnect:** Generator C102a • Measure the voltage drop between generator C102a-3, circuit 36 (RD), harness side and the positive battery terminal.  N0024622 **Is the voltage drop less than 0.5 volt?**	**Yes** Go to C2. **No** REPAIR the high resistance in A circuit 36 (RD). TEST the system for normal operation.
C2 CHECK THE GENERATOR AND BATTERY GROUND CONNECTIONS • Key in OFF position. • Check the ground connections between the generator and the engine, and between the battery and the engine. • **Are all ground connections clean and tight?**	**Yes** INSTALL a new generator. REFER to Generator and Regulator. TEST the system for normal operation. **No** REPAIR the ground connections as necessary. TEST the system for normal operation.

Pinpoint Test D: The Charging System Warning Indicator Is ON With The Engine Running And The Battery Increases Voltage

Normal Operation

With the key in the ON position, voltage is applied through the warning indicator I circuit to the voltage regulator. This turns the regulator on, allowing current to flow from battery sense A circuit to the generator field coil. When the engine is started, the generator begins to generate alternating current (AC) which is internally converted to direct current (DC). This current is then supplied to the electrical system through the output terminal (B+) of the generator. Once the generator begins generating current, a voltage signal is taken from the generator stator and fed back to the regulator internally. This voltage feedback signal (typically one-half of the battery voltage) is used to turn off the warning indicator. With the system functioning normally, the generator output current is determined by the voltage of the A circuit. This A circuit voltage (battery sense circuit) is compared to a set voltage internal to the regulator, and the regulator controls the generator field current to maintain correct generator output.

Possible Causes

- Circuitry
- Instrument cluster
- Generator

Table 43 PINPOINT TEST D: THE CHARGING SYSTEM WARNING INDICATOR IS ON WITH THE ENGINE RUNNING AND THE BATTERY INCREASES VOLTAGE

Test Step	Result / Action to Take
D1 CHECK I CIRCUIT 1818 (WH/BK) FOR A SHORT TO GROUND • Key in OFF position. • **Disconnect:** Generator C102a • Key in ON position. • Check the charging system warning indicator. **Is the charging system warning indicator illuminated?**	**Yes** REPAIR I circuit 1818 (WH/BK). TEST the system for normal operation. **No** INSTALL a new generator. REFER to Generator and Regulator. TEST the system for normal operation.

Pinpoint Test E: The Charging System Warning Indicator Is OFF With The Ignition Switch In The On Position And The Engine OFF

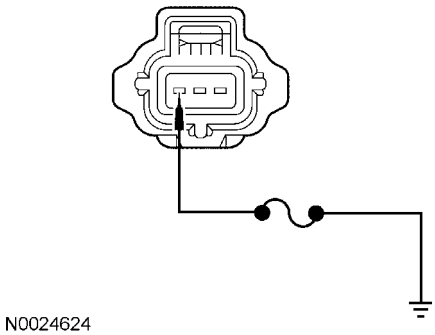
Normal Operation

With the key in the ON position, voltage is applied through the warning indicator I circuit to the voltage regulator. This turns the regulator on, allowing current to flow from battery sense A circuit to the generator field coil. When the engine is started, the generator begins to generate alternating current (AC) which is internally converted to direct current (DC). This current is then supplied to the electrical system through the output terminal (B+) of the generator. Once the generator begins generating current, a voltage signal is taken from the generator stator and fed back to the regulator internally. This voltage feedback signal (typically one-half of the battery voltage) is used to turn off the warning indicator. With the system functioning normally, the generator output current is determined by the voltage of the A circuit. This A circuit voltage (battery sense circuit) is compared to a set voltage internal to the regulator, and the regulator controls the generator field current to maintain correct generator output.

Possible Causes

- Bulb
- Circuitry
- Instrument cluster
- Generator

Table 44 PINPOINT TEST E: THE CHARGING SYSTEM WARNING INDICATOR IS OFF WITH THE IGNITION SWITCH IN THE ON POSITION AND THE ENGINE OFF

Test Step	Result / Action to Take
E1 CHECK THE CHARGING SYSTEM WARNING INDICATOR • Key in OFF position. • **Disconnect:** Generator C102a • Connect a fused (15A) jumper wire between generator C102a-1, circuit 1818 (WH/BK), harness side and ground.  N0024624 • Key in ON position. **Is the charging system warning indicator illuminated?**	**Yes** INSTALL a new generator. REFER to Generator and Regulator. TEST the system for normal operation. **No** REFER to Instrument Cluster for the diagnosis and testing of the instrument cluster.

Pinpoint Test F: The Charging System Warning Indicator Lamp Flickers Or Is Intermittent

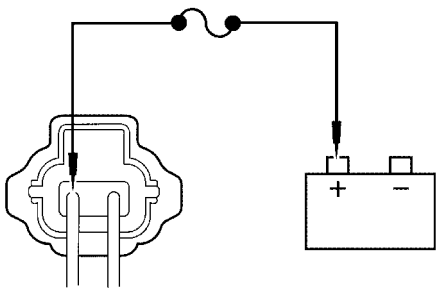
Normal Operation

With the key in the ON position, voltage is applied through the warning indicator I circuit to the voltage regulator. This turns the regulator on, allowing current to flow from battery sense A circuit to the generator field coil. When the engine is started, the generator begins to generate alternating current (AC) which is internally converted to direct current (DC). This current is then supplied to the electrical system through the output terminal (B+) of the generator. Once the generator begins generating current, a voltage signal is taken from the generator stator and fed back to the regulator internally. This voltage feedback signal (typically one-half of the battery voltage) is used to turn off the warning indicator. With the system functioning normally, the generator output current is determined by the voltage of the A circuit. This A circuit voltage (battery sense circuit) is compared to a set voltage internal to the regulator, and the regulator controls the generator field current to maintain correct generator output.

Possible Causes

- Circuitry
- Corroded terminal(s)
- Generator

Table 45 PINPOINT TEST F: THE CHARGING SYSTEM WARNING INDICATOR LAMP FLICKERS OR IS INTERMITTENT

Test Step	Result / Action to Take
F1 CHECK FOR LOOSE CONNECTIONS • Check all the generator, battery and power distribution connections for looseness, corrosion, loose or bent terminals, or loose eyelets. • **Are all the connections clean and tight?**	**Yes** Go to F2. **No** REPAIR as necessary. TEST the system for normal operation.
F2 CHECK A CIRCUIT 36 (RD) CONNECTIONS • Key in OFF position. • Connect a fused (15A) jumper wire between generator C102a-3, circuit 36 (RD) (back-probed), harness side and the positive battery terminal.  N0024623 • Key in START position. • With the engine running, note the charging system warning indicator operation. **Does the charging system warning indicator flicker?**	**Yes** INSTALL a new generator. REFER to Generator and Regulator. TEST the system for normal operation. **No** REPAIR the loose connection(s) in circuit 36 (RD). TEST the system for normal operation.

Pinpoint Test G: The Generator Is Noisy

Normal Operation

With the key in the ON position, voltage is applied through the warning indicator I circuit to the voltage regulator. This turns the regulator on, allowing current to flow from battery sense A circuit to the generator field coil. When the engine is started, the generator begins to generate alternating current (AC) which is internally converted to direct current (DC). This current is then supplied to the electrical system through the output terminal (B+) of the generator. Once the generator begins generating current, a voltage signal is taken from the generator stator and fed back to the regulator internally. This voltage feedback signal (typically one-half of the battery voltage) is used to turn off the warning indicator. With the system functioning normally, the generator output current is determined by the voltage of the A circuit. This A circuit voltage (battery sense circuit) is compared to a set voltage internal to the regulator, and the regulator controls the generator field current to maintain correct generator output.

Possible Causes

- Bolts or brackets
- Drive belt
- Generator or pulley

Table 46 PINPOINT TEST G: CHECK FOR ACCESSORY DRIVE BELT NOISE AND LOOSE MOUNTING BRACKETS

Test Step	Result / Action to Take
G1 CHECK THE CHARGING SYSTEM WARNING INDICATOR OPERATION • Key in OFF position. • Check the accessory drive belt for damage and correct installation. Refer to the Engine Operation and Maintenance Manual. • Check the accessory mounting brackets and generator pulley for looseness or misalignment. **Is the accessory drive OK?**	**Yes** Go to G2. **No** REPAIR as necessary. TEST the system for normal operation.
G2 CHECK THE GENERATOR FOR EXCESSIVE ELECTRICAL NOISE • **Disconnect:** Generator C102c • Key in START position. • With the engine running, determine if the generator is still noisy. **Is the noise still present?**	**Yes** GO to G3. **No** INSTALL a new generator. REFER to Generator and Regulator. TEST the system for normal operation.
G3 CHECK THE GENERATOR FOR MECHANICAL NOISE • Key in START position. • Turn all accessories off. With the engine running, use a stethoscope or equivalent listening device to probe the generator for unusual mechanical noise. **Is the generator the noise source?**	**Yes** INSTALL a new generator. REFER to Generator and Regulator. TEST the system for normal operation. **No** REFER to the Engine Operation and Maintenance Manual to diagnose the source of the engine noise.

Pinpoint Test H: Radio Interference

Normal Operation

With the key in the ON position, voltage is applied through the warning indicator I circuit to the voltage regulator. This turns the regulator on, allowing current to flow from battery sense A circuit to the generator field coil. When the engine is started, the generator begins to generate alternating current (AC) which is internally converted to direct current (DC). This current is then supplied to the electrical system through the output terminal (B+) of the generator. Once the generator begins generating current, a voltage signal is taken from the generator stator and fed back to the regulator internally. This voltage feedback signal (typically one-half of the battery voltage) is used to turn off the warning indicator. With the system functioning normally, the generator output current is determined by the voltage of the A circuit. This A circuit voltage (battery sense circuit) is compared to a set voltage internal to the regulator, and the regulator controls the generator field current to maintain correct generator output.

Possible Causes

- Generator
- Circuitry
- In-vehicle entertainment system

Table 47 PINPOINT TEST H: RADIO INTERFERENCE

Test Step	Result / Action to Take
H1 VERIFY THE GENERATOR IS THE SOURCE OF RADIO INTERFERENCE **NOTE:** If the original equipment manufactured (OEM) audio unit has been replaced with an aftermarket unit, the vehicle may not pass this test. Return the vehicle to OEM condition before following this pinpoint test. • Key in START position. • Tune the radio to a station where the interference is present. • Key in OFF position. • **Disconnect:** Generator C102c • Key in START position. • With the engine running, determine if the interference is still present. **Is the interference present with the generator disconnected?**	**Yes** REFER to Entertainment System in S16031 for the diagnosis and testing of the in-vehicle entertainment system. **No** INSTALL a new generator. REFER to Generator and Regulator. TEST the system for normal operation.

Component Tests: Battery — Drain Tests

NOTE: No production vehicle should have more than a 50 mA (0.050 amp) continuous draw.

Check for current drains on the battery in excess of 50 milliamps (0.050 amp) with all the electrical accessories off and the vehicle at rest. The current drains can be tested with the following procedure:

WARNING: Do not attempt this test on a lead-acid battery that has recently been recharged. Explosive gases can cause personal injury.

CAUTION: To prevent damage to the meter, do not crank the engine or operate accessories that draw more than 10A.

NOTE: Many modules draw 10 mA (0.010 amp) or more continuously.

NOTE: Use an in-line ammeter between the battery positive or negative post and its respective cable.

NOTE: Typically, a drain of approximately 1 amp can be attributed to an engine compartment lamp or glove compartment lamp staying on continually. Other component failures or wiring shorts may be located by selectively pulling fuses to pinpoint the location of the current drain. When the current drain is found, the meter reading will fall to an acceptable level. If the drain is still not located after checking all the fuses, it may be due to the generator.

NOTE: To accurately test the drain on a battery, an in-line digital ammeter must be used. Use of a test lamp or voltmeter is not an accurate method due to the number of electronic modules.

1. Make sure the junction box/fuse panels are accessible without turning on the interior or underhood lights.
2. Drive the vehicle at least 5 minutes and over 48 km/h (30 mph) to turn on and operate the vehicle systems.
3. Allow the vehicle to sit with the key OFF for at least 40 minutes to allow the modules to time out/power down.

4. Connect a fused (15A) jumper wire between the negative battery cable and the negative battery post to prevent modules from resetting and to catch capacitive drains.
5. Disconnect the negative battery cable from the post without breaking the connection of the jumper wire.

NOTE: It is very important that continuity is not broken between the battery and the negative battery cable when connecting the meter. If this happens, the entire procedure must be repeated.

6. Connect the tester between the negative battery cable and the post. The meter must be capable of reading milliamps and should have a 10-amp capability.

NOTE: If the meter settings need to be switched or the test leads need to be moved to another jack, the jumper wire must be reinstalled to avoid breaking continuity.

7. Remove the jumper wire.

NOTE: Amperage draw varies from vehicle to vehicle depending on the equipment package. Compare to a similar vehicle for reference.

NOTE: No production vehicle should have more than a 50 mA (0.050 amp) draw.

8. If the draw is found to be excessive, pull the fuses from the battery/central junction box one at a time and note the current drop. Do not reinstall the fuses until testing has been completed.
9. Check the wiring schematic in the wiring diagram for any circuits that run from the battery without passing through the battery/central junction box. Disconnect these circuits if the draw is still excessive.

Component Tests: Battery — Electronic Drains Which Shut Off When the Battery Cable is Disconnected

1. Repeat the steps of the battery drain testing.
2. Make sure all the doors are closed and all accessories are off. Without starting the engine, turn the key to ON for a moment and then OFF. Wait a few minutes for the illuminated entry lamps to turn off (if equipped).
3. Connect the ammeter and read the amperage draw.

The current reading (current drain) should be less than 50 mA (0.05 amp). If the current drain exceeds 50 mA (0.05 amp) after a few minutes, and if this drain did not show in previous tests, the drain is most likely caused by an inoperative electronic component. As in previous tests, remove the fuses from the battery/central junction box one at a time to locate the problem circuit.

Component Tests: Generator On-Vehicle Tests

CAUTION: To prevent damage to the generator, do not make jumper wire connections except as directed.

CAUTION: Do not allow any metal object to come in contact with the housing and the internal diode cooling fins with the key on or off. A short circuit will result and burn out the diodes.

NOTE: The battery posts and cable clamps must be clean and tight for accurate meter indications.

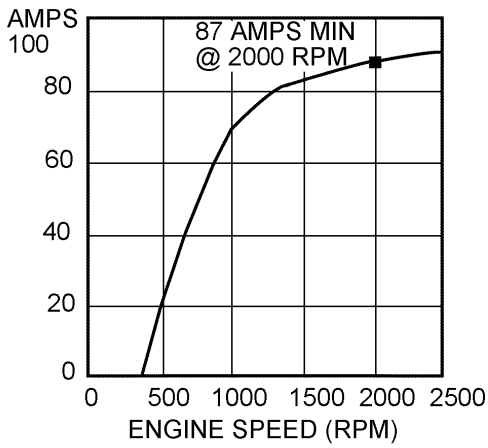
NOTE: Refer to the tester manual for complete directions for testing the charging system.

1. Turn off all lamps and electrical components.
2. Place the transmission in NEUTRAL and apply the parking brake.
3. Carry out the Load Test and No-Load Test according to the following component tests:

Component Tests: Generator On-Vehicle Tests — Load Test

1. Switch the tester to the ammeter function.
2. Connect the positive and negative leads of the battery tester to the corresponding battery terminals.

3. Connect the current probe to the generator B+ output terminal, circuit 36 (RD).
4. With the engine running at 2,000 rpm, adjust the tester load bank to determine the output of the generator. The generator output should be at least 87 amps.



A0006242

5. With the engine running, turn the A/C on, the blower motor on high speed and the headlamps on high beam.
6. Increase the engine speed to approximately 2,000 rpm. The voltage should increase a minimum of 0.5 volt above the base voltage.
   - If the voltage does not increase as specified, carry out the Generator On-Vehicle Tests — No Load Test, in this section.
   - If the voltage increases as specified, the charging system is operating normally.

Component Tests: Generator On-Vehicle Tests — No-Load Test

1. Switch the tester to the voltmeter function.
2. Connect the voltmeter positive lead to the generator B+ terminal and the negative lead to ground.
3. Turn all electrical accessories off.
4. With the engine running at 2,000 rpm, check the generator output voltage. The voltage should be between 13.0 and 15.0 volts. If not, refer to the Symptom Chart or back to the pinpoint test.

Battery, Mounting and Cables

Specifications

Table 48 Torque Specifications

Description	Nm	lb-ft.
Battery cable to terminal nuts	19	14
Starter solenoid cable nut	13	10

Description and Operation

Battery and Cables

This vehicle is equipped with a primary and secondary 12-volt maintenance-free battery.

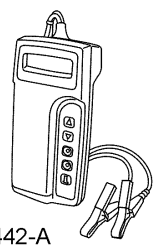
The battery and cable system consists of the following components:

- Primary battery
- Secondary battery
- Battery cable assembly
- Battery tray

International Truck and Engine Corporation strongly recommends that lead-acid batteries be returned to an authorized recycling facility for disposal.

Diagnosis and Testing

Table 49 Special Tool

 ST2442-A	MCR700 Digital Battery Analyzer

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Table 50 Visual Inspection Chart

Mechanical	Electrical
• Battery	• Battery cables
• Battery mounting	• Battery posts

3. If an obvious cause for a concern is found, correct (if possible) the cause before proceeding to the next step.
4. If the fault is not visually evident, proceed to the pinpoint test.

Pinpoint Tests

Table 51 PINPOINT TEST A: BATTERY CONDITION TEST

Test Step	Result / Action to Take
A1 TEST THE BATTERY CONDITION **NOTE:** No battery with a red test-eye should be replaced. The red eye only means the battery is discharged, not necessarily defective. **NOTE:** Failure to fully charge the battery before retesting may cause false readings. • Verify the battery condition using the Battery Analyzer. **Is the battery OK?**	**Yes** If the meter reads GOOD BATTERY, RETURN the battery to service. REFER to Charging System. If the meter reads GOOD-RECHARGE, CHARGE the battery and RETURN it to service. REFER to Charging System. If the meter reads CHARGE & RETEST, fully CHARGE and RETEST the battery. **No** If the meter reads REPLACE BATTERY, INSTALL a new battery. If the meter reads BAD CELL-REPLACE, INSTALL a new battery.

General Procedures

Battery Disconnect — Dual: Disconnect

WARNING: Batteries normally produce explosive gases which can cause personal injury. Therefore, do not allow flames, sparks or lighted substances to come near the battery, always shield your face and protect your eyes. Always provide ventilation. Failure to follow these instructions may result in personal injury.

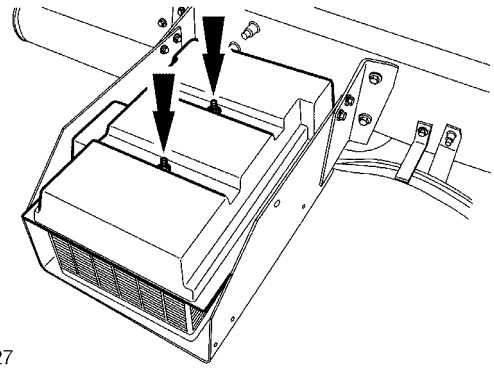
WARNING: When lifting a battery, excessive pressure on the end walls could cause acid to spew through the vent caps, resulting in personal injury. Lift with a battery carrier or with your hands on opposite corners. Failure to follow these instructions may result in personal injury.

WARNING: Keep out of the reach of children. Batteries contain sulfuric acid. Avoid contact with the skin, eyes or clothing. Also shield your eyes when working near the battery to protect against possible splashing of the acid solution. In case of acid contact with skin or eyes, flush immediately with water for a minimum of 15 minutes and get prompt medical attention. If acid is swallowed, call a physician immediately. Failure to follow these instructions may result in personal injury.

NOTE: When the battery is disconnected and reconnected, some abnormal drive symptoms may occur while the vehicle relearns its adaptive strategy. The vehicle may need to be driven to relearn its adaptive strategy.

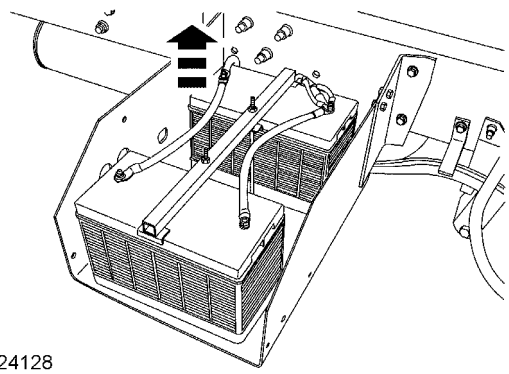
CAUTION: Be sure the battery cover is reinstalled to avoid premature battery failure.

1. Remove the battery cover.
   - Remove the battery cover nuts.
   - Remove the battery cover.



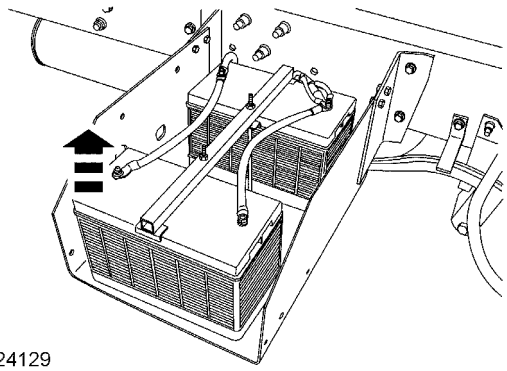
N0024127

2. Disconnect the primary battery ground cable (LH side of the battery tray).



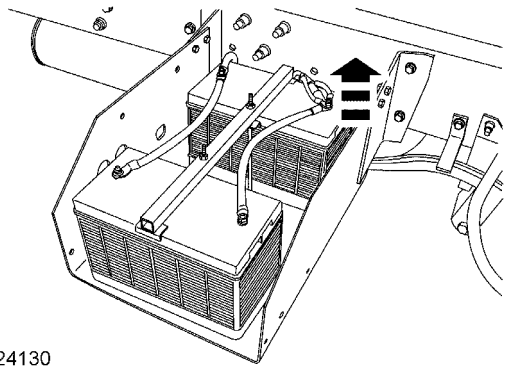
N0024128

3. Disconnect the secondary battery ground cable (RH side of the battery tray).



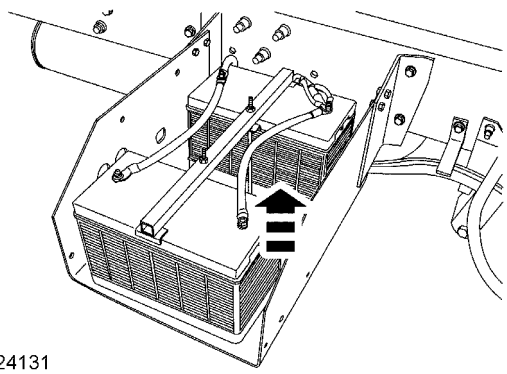
N0024129

4. Disconnect the primary battery positive cable (LH side of the battery tray).



N0024130

5. Disconnect the secondary battery positive cable (RH side of the battery tray).



N0024131

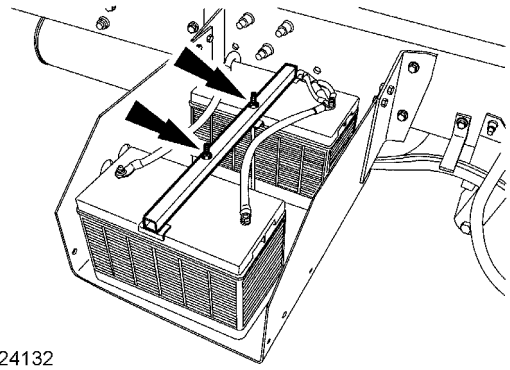
Battery Disconnect — Dual: Connect

1. To connect, reverse the disconnect procedure.

Removal and Installation

Battery

1. Disconnect the battery cables. For additional information, refer to Battery Disconnect — Dual above.
2. Remove the battery hold-down bracket nuts and battery hold-down bracket.



N0024132

WARNING: When lifting a battery, excessive pressure on the end walls could cause acid to spew through the vent caps, resulting in personal injury. Lift with a battery carrier or with hands on opposite corners. Failure to follow these instructions may result in personal injury.

3. Remove the battery.
4. To install, reverse the removal procedure.

Battery Tray

1. Remove the primary and secondary battery. For additional information, refer to Battery in this section.
2. Remove the battery tray.

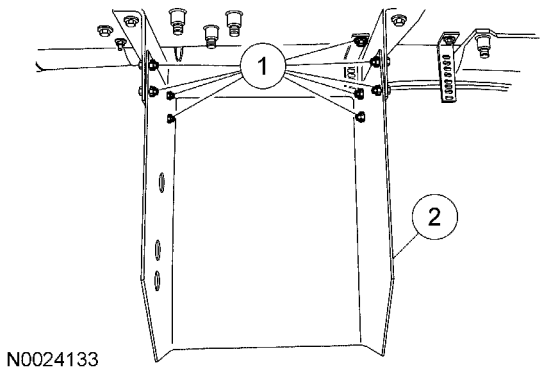
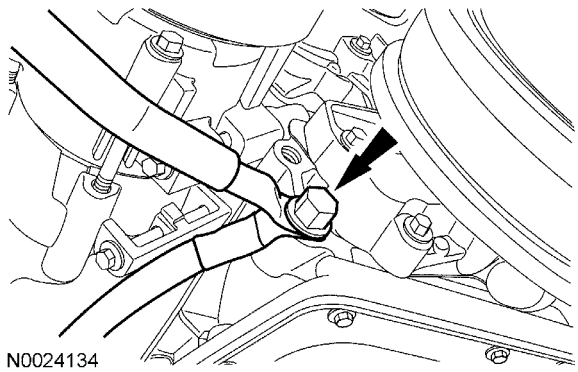


Figure 17
1. Remove the battery tray bolts.
2. Remove the battery tray.

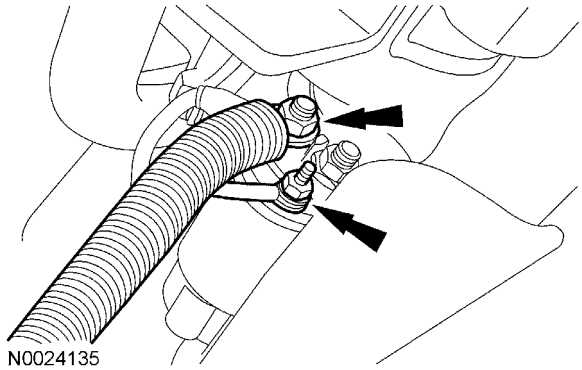
3. To install, reverse the removal procedure.

Battery Cables

1. Disconnect the primary and secondary battery. For additional information, refer to Battery Disconnect — Dual above.
2. Remove the battery negative ground cable bolt and remove the cable.



3. Disconnect the starter motor connections.
   - Remove the nut and disconnect the solenoid cable.
   - Remove the nut and disconnect the starter motor positive cable.



4. Remove the power distribution center cover.

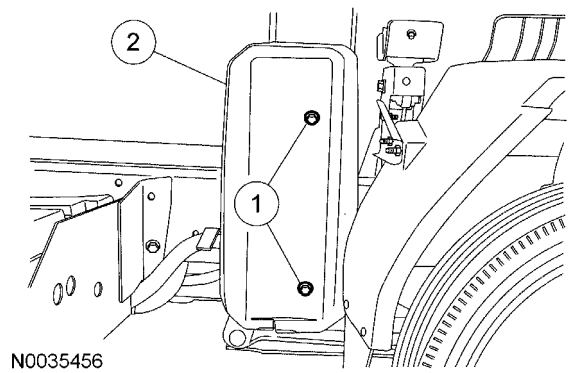
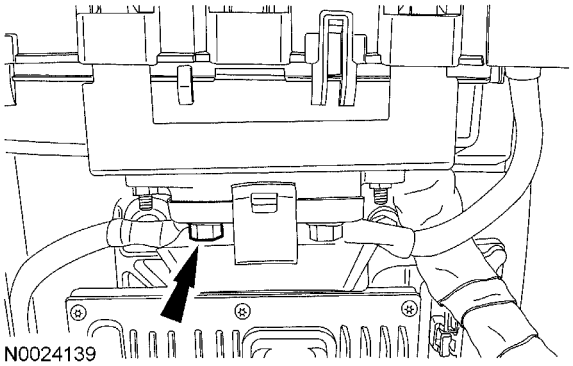


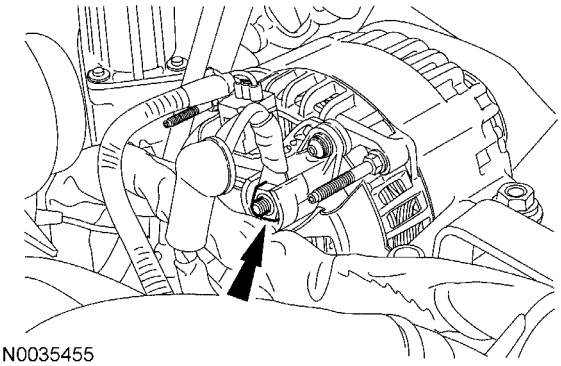
Figure 20
1. Remove the bolts.
2. Remove the power distribution center cover.

CAUTION: During re-assembly, make sure the battery cables attached to the mega-fuse are not in contact with the injector drive module (IDM).

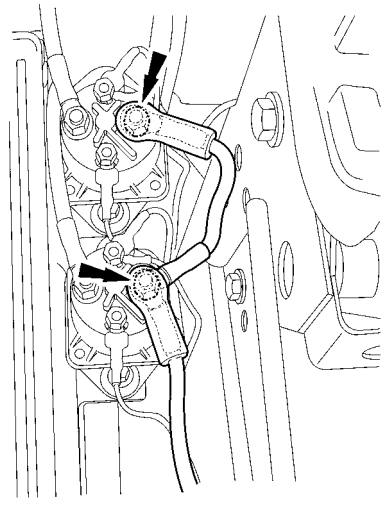
5. Remove the power distribution center cable nut.


N0024139

6. Remove the nut and position the generator B+ cable aside.


N0035455

7. Remove the glow plug relay cable nut and intake air heater aid relay cable nut.


N0035454

8. Remove the battery cable assembly.
9. To install, reverse the removal procedure.

Generator and Regulator

Specifications

Table 52 General Specifications

Item	Specification
Generator	
Rating	135 amp (max) @ 1,800-6,000 generator rpm, approximately 500-2,000 engine rpm
Pulley ratio	3.21:1
Voltage regulator type	Electronic rear mounted

Table 53 Torque Specifications

Description	Nm	lb-ft.	lb-in.
Generator B+ terminal nut	8	—	71
Generator mounting bolts	48	35	—

Description and Operation

Generator and Voltage Regulator

The charging system consists of the following components:

- Generator
- Electronic rear-mounted voltage regulator
- Generator warning lamp
- Associated wiring

The generator and voltage regulator:

- supply current to the electrical system.
- charge the battery.
- adjust the generator field current to increase or decrease the generator output.

- turn the generator warning lamp on when a problem is detected in the charging system.

Diagnosis and Testing

Generator

Refer to Charging System.

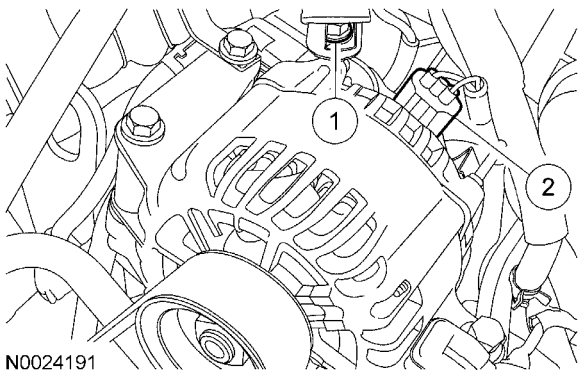
Removal and Installation

Generator

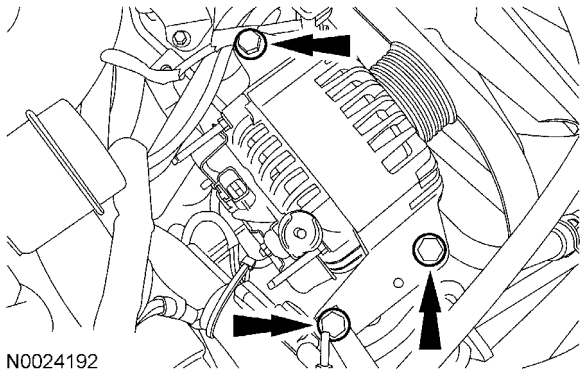
1. Disconnect the batteries. For additional information, refer to Battery, Mounting and Cables.
2. Release the accessory drive belt tension and remove the drive belt from the generator pulley.

CAUTION: When installing the generator, make sure to hand-start the generator battery positive cable nut to prevent cross-threading.

3. Disconnect the generator wire harness.
   a. Remove the nut and disconnect the battery positive cable.
      - To install, tighten to 8 Nm (71 lb-in).
   b. Disconnect the electrical connector and position the wire harness aside.



4. Remove the bolts and the generator.
   - To install, tighten to 48 Nm (35 lb-ft).



5. To install, reverse the removal procedure.

Exterior Lighting

Specifications

Table 54 Torque Specifications

Description	Nm	lb-in.
Cab marker lamp nuts	10	89

Description and Operation

Exterior Lighting

The exterior lighting system consists of the following components:

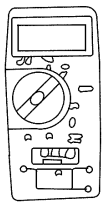
- Headlamps
- Rear lamps
- Fog lamps
- Parking lamps
- Turn signal lamps
- Side marker lamps
- Reversing lamp
- Center high mounted stoplamp
- Cab marker lamps
- Headlamp switch
- Multifunction switch
- Brake pedal position (BPP) switch
- Daytime running lamp (DRL) module

- Turn/hazard flash relay
- Headlamp relays

Diagnosis and Testing

Refer to Wiring Diagrams for schematic and connector information.

Table 55 Special Tools

 ST1137-A	Automotive Meter ZTSE4357

Inspection and Verification — Headlamps

1. Verify the customer concern by operating the headlamps.
2. Visually inspect the following for obvious signs of mechanical and electrical damage.

Table 56 Visual Inspection Chart

Mechanical	Electrical
• Headlamp switch • Multifunction switch	• Power distribution center (PDC) fuse 5 (30A) • Circuitry open/shorted • Headlamp bulbs • Headlamp relay • Headlamp high/low beam relay

3. If the concern is not visually evident, verify the symptom. GO to Symptom Chart.

Table 57 Symptom Chart

Condition	Possible Sources	Action
Both headlamps are inoperative	• Fuse. • Circuitry open. • Headlamp switch. • Multifunction switch. • Headlamp relay.	GO to Pinpoint Test A.
The low beams are inoperative	• Circuitry open. • Headlamp high/ low beam relay.	Go to Pinpoint Test B.
The high beams are inoperative	• Circuitry open. • Multifunction switch. • Headlamp high/ low beam relay.	Go to Pinpoint Test C.
One low beam headlamp is inoperative	• Circuitry open. • Headlamp bulb.	Go to Pinpoint Test D.
One high beam headlamp is inoperative	• Headlamp bulb. • Circuitry shorted.	INSPECT the bulb for an open. If OK, REPAIR circuit 12 (LG/BK) for an open. TEST the system for normal operation.
The headlamps are on continuously	• Circuitry shorted. • Headlamp relay. • Headlamp high/ low beam relay. • Multifunction switch.	GO to Pinpoint Test E.
The high and low beam headlamp is inoperative on one side	• Circuitry open.	REPAIR circuit 57 (BK). TEST the system for normal operation.
The flash-to-pass feature is inoperative	• Multifunction switch. • Circuitry open.	GO to Pinpoint Test F.

Pinpoint Tests — Headlamps

Pinpoint Test A: Both Headlamps Are Inoperative

Normal Operation

Under normal operation, when the multifunction switch is in the HEADLAMPS position, ground is fed from the multifunction switch to the headlamp relay coil through circuit 1708 (LG/BK). Battery voltage is supplied to the headlamp relay coil through circuit 1709 (BN). When the headlamp relay is energized voltage is sent to the headlamp high/low beam relay through circuit 1732 (BK/YE).

Possible Causes

- An open in circuit 1708 (LG/BK), 1709 (BN) or 1732 (BK/YE)
- Fuse
- Multifunction switch
- Headlamp relay

- Headlamp high/ low beam relay

Table 58 PINPOINT TEST A: BOTH HEADLAMPS ARE INOPERATIVE

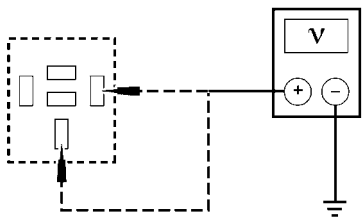
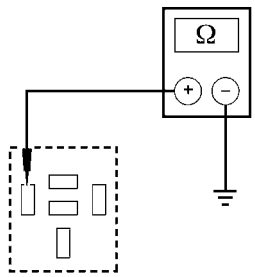
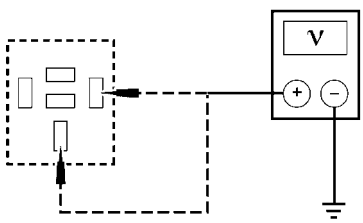
Test Step	Result / Action to Take
A1 CHECK FOR VOLTAGE TO THE HEADLAMP RELAY • **Disconnect:** Headlamp Relay. • Measure the voltage between ground and headlamp relay: — pin 30, circuit 1709 (BN). — pin 86, circuit 1709 (BN).  N0024006 **Are the voltages greater than 10 volts?**	**Yes** GO to A2. **No** VERIFY the power distribution center (PDC) fuse 5 (30A) is OK. If OK, REPAIR circuit 1709 (BN) for an open. TEST the system for normal operation.

Table 58 PINPOINT TEST A: BOTH HEADLAMPS ARE INOPERATIVE (cont.)

Test Step	Result / Action to Take
A2 CHECK CIRCUIT 1708 (LG/BK) FOR GROUND • Place the multifunction switch in the HEADLAMPS position. • Measure the resistance between ground and headlamp relay pin 85, circuit 1708 (LG/BK).  N0024013 **Is the resistance less than 5 ohms?**	**Yes** CARRY OUT the headlamp relay component test. Refer to the Wiring Diagrams for component testing. If OK, GO to A3. **No** CARRY OUT the multifunction switch component test. Refer to the Wiring Diagrams for component testing. If OK, REPAIR circuit 1708 (LG/BK) for an open. TEST the system for normal operation.
A3 CHECK CIRCUIT 1732 (BK/YE) FOR AN OPEN • **Connect:** Headlamp Relay • **Disconnect:** Headlamp High/Low Beam Relay • Measure the voltage between ground and headlamp high/low beam relay: — pin 30, circuit 1732 (BK/YE). — pin 86, circuit 1732 (BK/YE).  N0024006 **Are the voltages greater than 10 volts?**	**Yes** INSTALL a new headlamp high/low beam relay. TEST the system for normal operation. **No** REPAIR circuit 1732 (BK/YE) for an open. TEST the system for normal operation.

Pinpoint Test B: The Low Beams Are Inoperative

Normal Operation

Under normal operation, when the headlamp relay is energized voltage is sent to the headlamp high/low beam relay through circuit 1732 (BK/YE). Voltage is sent from the headlamp high/low beam relay to the headlamp bulbs through circut 13 (RD/BK). The headlamp bulbs are grounded through circuit 57 (BK).

Possible Causes

- An open in circuit 13 (RD/BK)

- Headlamp high/low beam relay

Table 59 PINPOINT TEST B: THE LOW BEAMS ARE INOPERATIVE

Test Step	Result / Action to Take
B1 CHECK THE HEADLAMP HIGH/LOW BEAM RELAY • **Disconnect:** Headlamp High/Low Beam Relay. • CARRY OUT the headlamp high/low beam relay component test. Refer to the Wiring Diagrams for component testing. **Does the relay test good?**	**Yes** REPAIR circuit 13 (RD/BK) for an open. TEST the system for normal operation. **No** INSTALL a new headlamp high/low beam relay. TEST the system for normal operation.

Pinpoint Test C: The High Beams Are Inoperative

Normal Operation

Under normal operation, when the headlamp relay is energized, voltage is sent to the headlamp high/low beam relay switch and coil through circuit 1732 (BK/YE). When the multifunction switch is in the HIGH beam position, ground is fed from the multifunction switch to the headlamp high/low beam relay coil through circuit 1708 (LG/BK). When the headlamp high/low beam relay is energized, voltage is sent from the headlamp high/low beam relay to the headlamp bulbs through circut 12 (LG/BK).

Possible Causes

- An open in circuit 12 (LG/BK), 1708 (LG/BK) or 1732 (BK/YE)
- Multifunction switch
- Headlamp high/low beam relay

Table 60 PINPOINT TEST C: THE HIGH BEAMS ARE INOPERATIVE

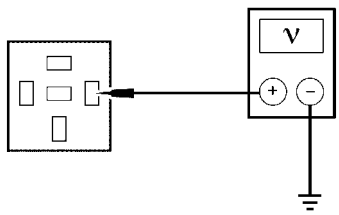
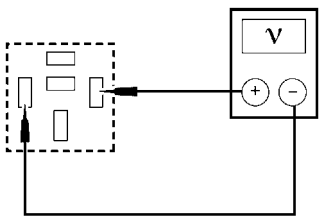
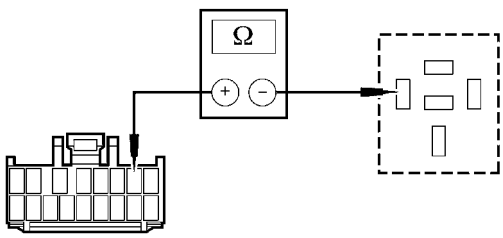
Test Step	Result / Action to Take
C1 CHECK CIRCUIT 1732 (BK/YE) FOR AN OPEN • **Disconnect:** Headlamp High/Low Beam Relay • Place the multifunction switch in the HEADLAMPS position. • Measure the voltage between ground and headlamp high/low beam relay pin 86, circuit 1732 (BK/YE).  N0018921 **Is the voltage greater than 10 volts?**	**Yes** GO to C2. **No** REPAIR circuit 1732 (BK/YE) for an open. TEST the system for normal operation.

Table 60 PINPOINT TEST C: THE HIGH BEAMS ARE INOPERATIVE (cont.)

Test Step	Result / Action to Take
C2 CHECK CIRCUIT 12 (LG/BK) FOR AN OPEN • Activate the high beams. • Measure the voltage between headlamp high/low beam relay pin 86, circuit 1732 (BK/YE) and headlamp high/low beam relay pin 85, circuit 1708 (LG/BK).  N0024007 **Is the voltage greater than 10 volts?**	**Yes** CARRY OUT the headlamp high/low beam relay component test. Refer to the Wiring Diagrams for component testing. If OK, REPAIR circuit 12 (LG/BK) for an open. TEST the system for normal operation. **No** GO to C3.
C3 CHECK CIRCUIT 1708 (LG/BK) FOR AN OPEN • **Disconnect:** Multifunction Switch C202a • Measure the resistance between headlamp high/low beam relay pin 85, circuit 1708 (LG/BK) and multifunction switch C202a-7, circuit 1708 (LG/BK).  N0025228 **Is the resistance less than 5 ohms?**	**Yes** INSTALL a new multifunction switch. TEST the system for normal operation. **No** REPAIR circuit 1708 (LG/BK) for an open. TEST the system for normal operation.

Pinpoint Test D: One Low Beam Headlamp Is Inoperative

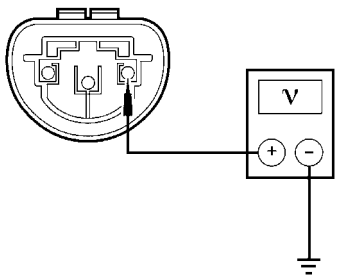
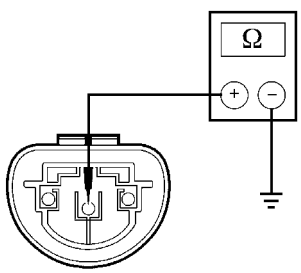
Normal Operation

Under normal operation, voltage is sent from the headlamp high/low beam relay to the headlamp bulbs through circut 13 (RD/BK). The headlamp bulbs are grounded through circuit 57 (BK).

Possible Causes

- An open in circuit 13 (RD/BK) or 57 (BK)
- Headlamp bulb

Table 61 PINPOINT TEST D: ONE LOW BEAM HEADLAMP IS INOPERATIVE

Test Step	Result / Action to Take
D1 CHECK THE VOLTAGE TO THE INOPERATIVE HEADLAMP BULB • **Disconnect:** Headlamp Bulb (LH) C1021 or (RH) C1041 • Place the multifunction switch in the HEADLAMPS position. • Place the multifunction switch in the LOW BEAM position. • Measure the voltage between ground and inoperative headlamp: — (LH) C1021-A, circuit 13 (RD/BK). — (RH) C1041-A, circuit 13 (RD/BK).  N0025229 **Is the voltage greater than 10 volts?**	**Yes** GO to D2. **No** REPAIR circuit 13 (RD/BK) for an open. TEST the system for normal operation.
D2 CHECK THE GROUND TO THE INOPERATIVE HEADLAMP BULB • Measure the resistance between ground and inoperative headlamp: — (LH) C1021-B, circuit 57 (BK). — (RH) C1041-B, circuit 57 (BK).  N0025230 **Is the resistance less than 5 ohms?**	**Yes** INSTALL a new bulb. TEST the system for normal operation. **No** REPAIR circuit 57 (BK) for an open. TEST the system for normal operation.

Under normal operation, when the multifunction switch is in the HEADLAMPS position, ground is fed from the multifunction switch to the headlamp relay coil through circuit 1708 (LG/BK). Battery voltage is supplied to the headlamp relay coil through circuit 1709 (BN). When the relay is energized, voltage is sent to the headlamp high/low beam relay through circuit 1732 (BK/YE). Voltage is sent to the low beams through circuit 13 (RD/BK) or to the high beams through circuit 12 (LG/BK).

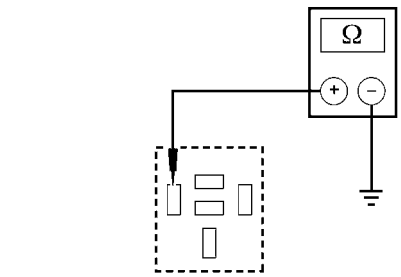
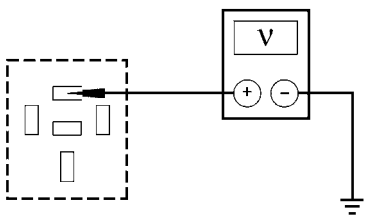
Possible Causes

- A short to voltage in circuit 12 (LG/BK), 13 (RD/BK) or 1732 (BK/YE)
- A short to ground in circuit 1708 (LG/BK)
- Multifunction switch
- Headlamp relay
- Headlamp high/ low beam relay

Table 62 PINPOINT TEST E: THE HEADLAMPS ARE ON CONTINUOUSLY

Test Step	Result / Action to Take
E1 CHECK THE HEADLAMP RELAY	**Yes**
• **Disconnect:** Headlamp Relay.	GO to E2.
• Observe the headlamps.	
Do the headlamps continue to illuminate?	**No**
	CARRY OUT the headlamp relay component test. Refer to the Wiring Diagrams for component testing. If OK, GO to E3.
E2 CHECK THE HEADLAMP HIGH/LOW BEAM RELAY	**Yes**
• **Disconnect:** Headlamp High/Low Beam Relay.	GO to E4.
• Observe the headlamps.	
Do the headlamps continue to illuminate?	**No**
	CARRY OUT the headlamp high/ low beam relay component test. Refer to the Wiring Diagrams for component testing. If OK, REPAIR circuit 1732 (BK/YE) for a short to voltage. TEST the system for normal operation.

Table 62 PINPOINT TEST E: THE HEADLAMPS ARE ON CONTINUOUSLY (cont.)

Test Step	Result / Action to Take
E3 CHECK CIRCUIT 1708 (LG/BK) FOR A SHORT TO GROUND • **Disconnect:** Multifunction Switch C202a • Measure the resistance between ground and headlamp high/low beam relay pin 85, circuit 1708 (LG/BK).  N0024013 **Is the resistance greater than 10,000 ohms?**	**Yes** INSTALL a new multifunction switch. TEST the system for normal operation. **No** REPAIR circuit 1708 (LG/BK) for a short to ground. TEST the system for normal operation.
E4 CHECK CIRCUIT 12 (LG/BK) FOR A SHORT TO VOLTAGE • Measure the voltage between ground and headlamp high/low beam relay pin 87, circuit 12 (LG/BK).  A0013861 **Is voltage present?**	**Yes** REPAIR circuit 12 (LG/BK) for a short to voltage. TEST the system for normal operation. **No** REPAIR circuit 13 (RD/BK) for a short to voltage. TEST the system for normal operation.

Pinpoint Test F: The Flash-To-Pass Feature Inoperative

Normal Operation

Under normal operation, when the multifunction switch is in the flash-to-pass position, ground is fed from the multifunction switch to the headlamp high/low beam relay coil through circuit 1708 (LG/BK)/196 (DB/OG).

Possible Causes

- An open in circuit 1708 (LG/BK)/196 (DB/OG)
- Multifunction switch

Table 63 PINPOINT TEST F: THE FLASH-TO-PASS FEATURE IS INOPERATIVE

Test Step	Result / Action to Take
F1 CHECK HIGH BEAM OPERATION • Place the multifunction switch in the HEADLAMPS position. • Place the multifunction switch in the HIGH BEAM position. • Observe the headlamps. **Do the high beams operate?**	**Yes** GO to F2. **No** REPAIR the high beams. GO to Pinpoint Test C.
F2 CHECK THE MULTIFUNCTION SWITCH • **Disconnect:** Multifunction Switch C202a. • CARRY OUT the multifunction switch component test. Refer to the Wiring Diagrams for component testing. **Does the switch test good?**	**Yes** REPAIR circuit 1708 (LG/BK)/196 (DB/OG) for an open. TEST the system for normal operation. **No** INSTALL a new multifunction switch. REFER to Steering Column Switches in S05017. TEST the system for normal operation.

Inspection and Verification — Stoplamps

1. Verify the customer concern by operating the stoplamps.
2. Visually inspect the following for obvious signs of mechanical and electrical damage.

Table 64 Visual Inspection Chart

Mechanical	Electrical
• Stoplamp switch • Multifunction switch	• Power distribution center (PDC) fuse: — 22 (30A) — 21 (30A) — 10 (20A) • Circuitry open/shorted • Stoplamp bulb

3. If the concern is not visually evident, verify the symptom. GO to Symptom Chart.

Table 65 Symptom Chart

Condition	Possible Sources	Action
The stoplamps are inoperative	• Fuse. • Circuitry open. • Lamp/bulb.	GO to Pinpoint Test G.
One or more stoplamps are inoperative	• Circuitry open. • Lamp/bulb.	Go to Pinpoint Test H.
The stoplamps are on continuously	• Circuitry shorted. • Stoplamp switch.	Go to Pinpoint Test I.

Pinpoint Tests — Stoplamps

Pinpoint Test G: The Stoplamps Are Inoperative

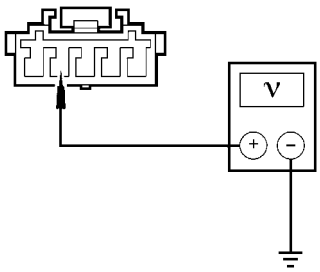
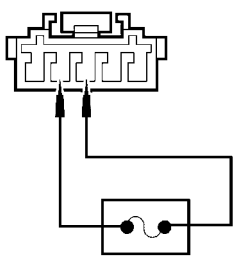
Normal Operation

Under normal operation, voltage is supplied to the stoplamp switch through circuit 10 (LG/RD). When the brake pedal is pressed and the stoplamp switch is closed, voltage is sent to the stoplamps through circuit 511 (LG).

Possible Causes

- An open in circuit 10 (LG/RD) or 511 (LG)
- Fuse
- Stoplamp relay

Table 66 PINPOINT TEST G: THE STOPLAMPS ARE INOPERATIVE

Test Step	Result / Action to Take
G1 CHECK THE EXTERIOR LAMP OPERATION • Place the main lamp switch in the PARKLAMPS position. • Activate the hazard lamps. **Do the hazard and park lamps operate?**	**Yes** GO to G2. **No** REPAIR lamp/box ground circuit. TEST the system for normal operation.
G2 CHECK THE VOLTAGE TO THE STOPLAMP SWITCH • **Disconnect:** Stoplamp Switch C278 • Measure the voltage between ground and stoplamp switch C278-4, circuit 10 (LG/RD).  N0025232 **Is the voltage greater than 10 volts?**	**Yes** GO to G3. **No** VERIFY the power distribution center (PDC) fuse 10 (20A) is OK. If OK, REPAIR circuit 10 (LG/RD) for an open. TEST the system for normal operation.
G3 CHECK THE STOPLAMP SWITCH • Connect a fused jumper wire between stoplamp switch C278-4, circuit 10 (LG/RD) and stoplamp switch C278-3, circuit 511 (LG).  N0025233 **Do the stoplamps operate?**	**Yes** INSTALL a new stoplamp switch. TEST the system for normal operation. **No** REPAIR circuit 511 (LG) for an open. TEST the system for normal operation.

Pinpoint Test H: One Or More Stoplamps Are Inoperative **Normal Operation**

Under normal operation, when the brake pedal is pressed and the stoplamp switch is closed, voltage is sent to the stoplamps through circuit 511 (LG). The stoplamps are grounded through circuit 57 (BK).

Possible Causes

- An open in circuit 57 (BK) or 511 (LG)
- Bulb/lamp

Table 67 PINPOINT TEST H: ONE OR MORE STOPLAMPS ARE INOPERATIVE

Test Step	Result / Action to Take
H1 CHECK THE GROUND TO THE STOPLAMP • **Disconnect:** Inoperative Stoplamp. • Measure the resistance between ground and the inoperative stoplamp connector ground circuit 57 (BK). **Is the resistance less than 5 ohms?**	**Yes** GO to H2. **No** REPAIR circuit 57 (BK) for an open. TEST the system for normal operation.
H2 CHECK THE VOLTAGE TO THE STOPLAMP • While pressing and holding the brake pedal, measure the voltage between ground and inoperative stoplamp connector circuit 511 (LG). **Is the voltage greater than 10 volts?**	**Yes** INSPECT the bulb for an open. If OK, INSTALL a new lamp. TEST the system for normal operation. **No** REPAIR circuit 511 (LG) for an open. TEST the system for normal operation.

Pinpoint Test I: The Stoplamps Are On Continuously

Normal Operation

Under normal operation, when the brake pedal is pressed and the stoplamp switch is closed, voltage is sent to the stoplamps through circuit 511 (LG).

Possible Causes

- A short to voltage in circuit 511 (LG)
- Stoplamp switch

Table 68 PINPOINT TEST I: THE STOPLAMPS ARE ON CONTINUOUSLY

Test Step	Result / Action to Take
I1 CHECK THE STOPLAMP SWITCH • **Disconnect:** Stoplamp Switch C278 • Observe the stoplamps. **Are the stoplamps illuminated?**	**Yes** REPAIR circuit 511 (LG) for a short to voltage. TEST the system for normal operation. **No** INSTALL a new stoplamp switch. TEST the system for normal operation.

Inspection and Verification — Turn Signal and Hazard Lamps

1. Verify the customer concern by operating the turn signal/hazard lamps.
2. Visually inspect the following for obvious signs of mechanical and electrical damage.

Table 69 Visual Inspection Chart

Mechanical	Electrical
• Multifunction switch • Hazard switch	• Power distribution center (PDC) fuse: — 25 (20A) — 22 (30A) • Circuitry open/shorted • Electronic flasher • Signal/hazard bulb/ lamp

3. If the concern is not visually evident, verify the symptom. GO to Symptom Chart.

Table 70 Symptom Chart

Condition	Possible Sources	Action
The turn signal lamps are inoperative	• Circuitry open/ shorted. • Bulb/lamp. • Electronic flasher. • Multifunction switch.	GO to Pinpoint Test J.
The turn signal lamps are always on	• Circuitry shorted. • Electronic flasher. • Multifunction switch.	Go to Pinpoint Test K.
The hazard lamps are inoperative	• Fuse(s). • Circuitry open. • Hazard switch.	Go to Pinpoint Test L.
The hazard lamps are always on.	• Circuitry shorted. • Electronic flasher. • Multifunction switch.	Go to Pinpoint Test M.

Pinpoint Tests — Turn Signal and Hazard Lamps

Pinpoint Test J: The Turn Signal Lamps Are Inoperative

Normal Operation

Under normal operation, the electronic flasher receives voltage from the ignition switch through circuit 8 (OG/YE). The electronic flasher is grounded through circuit 57 (BK). When the multifuction switch is in the LH or RH turn position, a pulsed voltage is received from the electronic flasher through circuit 44 (LB). The pulsed voltage is sent from the multifunction switch to the front and rear turn signal lamps through circuit (LH) 3 (LG/WH) and (RH) 2 (WH/LB). The turn signal lamps are grounded through circuit 57 (BK).

Possible Causes

- An open in circuit 2 (WH/LB), 3 (LG/WH), 8 (OG/YE), 44 (LB) or 57 (BK)
- Multifunction switch
- Electronic flasher

Table 71 PINPOINT TEST J: THE TURN SIGNAL LAMPS ARE INOPERATIVE

Test Step	Result / Action to Take
J1 CHECK TURN SIGNAL/HAZARD LAMP OPERATION	**Yes**
• Key in ON position.	GO to J2.
• Activate the LH and RH turn signals.	
Is only a single turn signal lamp inoperative?	**No**
	If only the front lamps are inoperative, REPAIR circuit 57 (BK) from the front lamps for an open. TEST the system for normal operation.
	If only the rear lamps are inoperative, REPAIR lamp/box ground circuit for an open. TEST the system for normal operation.
	If all turn signal lamps are inoperative, GO to J4.
J2 CHECK THE GROUND TO THE INOPERATIVE LAMP	**Yes**
• Key in OFF position.	GO to J3.
• **Disconnect:** Inoperative Turn Signal/Hazard Flasher Lamp	
• Measure the resistance between ground and the inoperative lamp connector ground circuit.	**No**
Is the resistance less than 5 ohms?	REPAIR the lamp ground circuit for an open. TEST the system for normal operation.
J3 CHECK THE VOLTAGE TO THE INOPERATIVE LAMP	**Yes**
• Place the hazard flasher lamp switch in the ON position.	INSTALL a new bulb/lamp. TEST the system for normal operation.
• Measure the voltage between ground and the inoperative lamp connector:	
— LH front circuit 3 (LG/WH).	**No**
— RH front circuit 2 (WH/LB).	REPAIR circuit 2 (WH/LB) or 3 (LG/WH) for an open. TEST the system for normal operation.
— LH rear circuit 3 (LG/WH).	
— RH rear circuit 2 (WH/LB).	
Does the voltage alternate between less than 1 volt and greater than 10 volts?	

Table 71 PINPOINT TEST J: THE TURN SIGNAL LAMPS ARE INOPERATIVE (cont.)

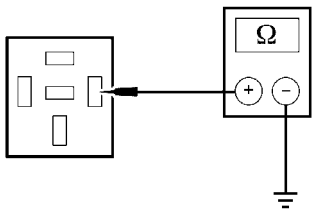
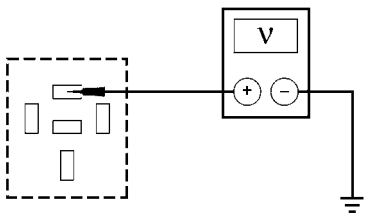
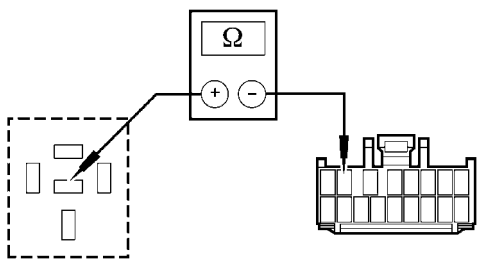
Test Step	Result / Action to Take
J4 CHECK GROUND TO THE ELECTRONIC FLASHER • Key in OFF position. • **Disconnect:** Electronic Flasher • Measure the resistance between ground and electronic flasher connector pin 5, circuit 57 (BK).  N0018951 **Is the resistance less than 5 ohms?**	**Yes** GO to J5. **No** REPAIR circuit 57 (BK) for an open. TEST the system for normal operation.

Table 71 PINPOINT TEST J: THE TURN SIGNAL LAMPS ARE INOPERATIVE (cont.)

Test Step	Result / Action to Take
J5 CHECK THE VOLTAGE TO THE ELECTRONIC FLASHER • Key in ON position. • Measure the voltage between ground and electronic flasher connector pin 1, circuit 8 (OG/YE).  A0013861 **Is the voltage greater than 10 volts?**	**Yes** CARRY OUT the multifunction switch component test. Refer to the Wiring Diagrams for component testing. If OK, GO to J6. **No** REPAIR circuit 8 (OG/YE) for an open. TEST the system for normal operation.
J6 CHECK CIRCUIT 44 (LB) FOR AN OPEN • Key in OFF position. • **Disconnect:** Multifunction Switch C202a • Measure the resistance between electronic flasher connector pin 4, circuit 44 (LB) and multifunction switch C202a-2, circuit 44 (LB).  N0025239 **Is the resistance less than 5 ohms?**	**Yes** INSTALL a new electronic flasher. TEST the system for normal operation. **No** REPAIR circuit 44 (LB) for an open. TEST the system for normal operation.

Pinpoint Test K: The Turn Signal Lamps Are Always On

Normal Operation

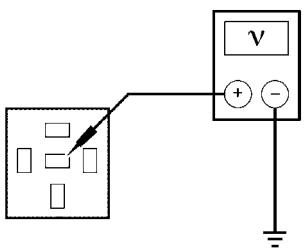
Under normal operation, when the multifunction switch is in the LH or RH turn position, a pulsed voltage is received from the electronic flasher through circuit 44 (LB). The pulsed voltage is sent from the multifunction switch to the front and rear turn signal lamps through circuit (LH) 3 (LG/WH) and (RH) 2 (WH/LB).

Possible Causes

- A short to voltage in circuit 2 (WH/LB), 3 (LG/WH) or 44 (LB)
- Multifunction switch

- Electronic flasher

Table 72 PINPOINT TEST K: THE TURN SIGNAL LAMPS ARE ALWAYS ON

Test Step	Result / Action to Take
K1 CHECK THE TURN SIGNAL LAMP OPERATION • Observe the turn signal lamps. **Are the turn signals flashing?**	**Yes** INSTALL a new multifunction switch. TEST the system for normal operation. **No** GO to K2.
K2 CHECK THE MULTIFUNCTION SWITCH OPERATION • Observe the turn signal lamps. **Is one or more turn signal lamp ON with the switch OFF?**	**Yes** REPAIR circuit 2 (WH/LB) or 3 (LG/WH) for a short to voltage. TEST the system for normal operation. **No** GO to K3.
K3 CHECK CIRCUIT 44 (LB) FOR A SHORT TO VOLTAGE • **Disconnect:** Electronic Flasher • Key in ON position. • Measure the voltage between ground and electronic flasher pin 4, circuit 44 (LB).  N0018919 **Is voltage present?**	**Yes** REPAIR circuit 44 (LB) for a short to voltage. TEST the system for normal operation. **No** INSTALL a new electronic flasher. TEST the system for normal operation.

Pinpoint Test L: The Hazard Lamps Are Inoperative

Normal Operation

Under normal operation, the electronic flasher receives battery voltage through circuit 383 (RD/WH). The electronic flasher is grounded through circuit 57 (BK). When the hazard switch is pressed, a pulsed voltage is received from the electronic flasher through circuit 385 (WH/RD). The pulsed voltage is sent from the hazard switch to the front and rear turn signal lamps through circuit (LH) 3 (LG/WH) and (RH) 2 (WH/LB).

Possible Causes

- An open in circuit 2 (WH/LB), 3 (LG/WH), 57 (BK), 383 (RD/WH) or 385 (WH/RD)
- Fuse

- Hazard switch
- Electronic flasher

Table 73 PINPOINT TEST L: THE HAZARD LAMPS ARE INOPERATIVE

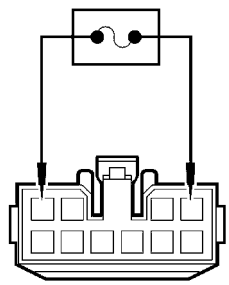
Test Step	Result / Action to Take
L1 CHECK THE TURN SIGNAL LAMP OPERATION • Activate the LH and RH turn signals. **Do the turn signals work correctly?**	**Yes** GO to L2. **No** GO to Pinpoint Test J.
L2 CHECK THE HAZARD LAMP OPERATION • Place the hazard flasher lamp switch in the ON position. **Are all hazard lamps inoperative?**	**Yes** GO to L3. **No** GO to L7.
L3 CHECK THE HAZARD SWITCH • **Disconnect:** Hazard Switch C2039 • Connect a fused jumper wire between hazard switch C2039-4, circuit 385 (WH/RD) and hazard switch C2039-1, circuit 2 (WH/LB).  N0034470 **Do the RH turn signal/hazard lamps operate?**	**Yes** INSTALL a new hazard switch. TEST the system for normal operation. **No** GO to L4.

Table 73 PINPOINT TEST L: THE HAZARD LAMPS ARE INOPERATIVE (cont.)

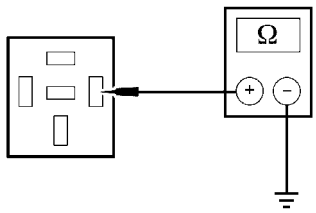
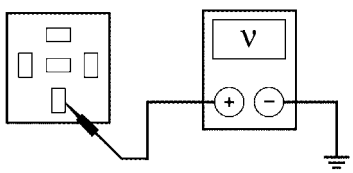
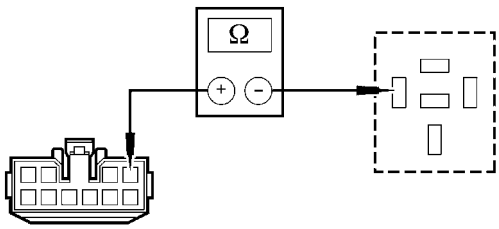
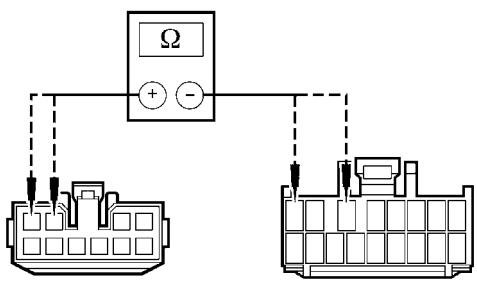
Test Step	Result / Action to Take
L4 CHECK THE GROUND TO THE ELECTRONIC FLASHER • **Disconnect:** Electronic Flasher • Measure the resistance between ground and electronic flasher connector pin 5, circuit 57 (BK).  N0018951 **Is the resistance less than 5 ohms?**	**Yes** GO to L5. **No** REPAIR circuit 57 (BK) for an open. TEST the system for normal operation.
L5 CHECK THE VOLTAGE TO THE ELECTRONIC FLASHER • Measure the voltage between ground and electronic flasher connector pin 2, circuit 383 (RD/WH).  N0020014 **Is the voltage greater than 10 volts?**	**Yes** GO to L6. **No** VERIFY the power distribution center (PDC) fuse 25 (20A) is OK. If OK, REPAIR circuit 383 (RD/WH) for an open. TEST the system for normal operation.

Table 73 PINPOINT TEST L: THE HAZARD LAMPS ARE INOPERATIVE (cont.)

Test Step	Result / Action to Take
L6 CHECK CIRCUIT 385 (WH/RD) FOR AN OPEN • Measure the resistance between electronic flasher connector pin 3, circuit 385 (WH/RD) and hazard switch C2039-4, circuit 385 (WH/RD).  N0025241 **Is the resistance less than 5 ohms?**	**Yes** INSTALL a new electronic flasher. TEST the system for normal operation. **No** REPAIR circuit 385 (WH/RD) for an open. TEST the system for normal operation.
L7 CHECK CIRCUIT 2 (WH/LB) AND 3 (LG/WH) FOR AN OPEN • **Disconnect:** Multifunction Switch C202a • Measure the resistance between: — (LH) multifunction switch C202a-1, circuit 3 (LG/WH) and hazard switch C2039-1, circuit 3 (LG/WH). — (RH) multifunction switch C202a-3, circuit 2 (WH/LB) and hazard switch C2039-2, circuit 2 (WH/LB).  N0025242 **Are the resistances less than 5 ohms?**	**Yes** INSTALL a new hazard switch. TEST the system for normal operation. **No** REPAIR circuit 2 (WH/LB) or 3 (LG/WH) for an open. TEST the system for normal operation.

Pinpoint Test M: The Hazard Lamps Are Always On

Normal Operation

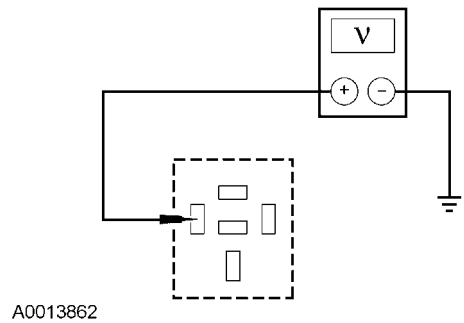
Under normal operation, when the hazard switch is pressed, a pulsed voltage is received from the electronic flasher through circuit 385 (WH/RD). The pulsed voltage is sent from the hazard switch to the front and rear turn signal lamps through circuit (LH) 3 (LG/WH) and (RH) 2 (WH/LB).

Possible Causes

- A short to voltage in circuit 385 (WH/RD)
- Hazard switch

- Electronic flasher

Table 74 PINPOINT TEST M: THE HAZARD LAMPS ARE ALWAYS ON

Test Step	Result / Action to Take
M1 CHECK THE HAZARD LAMP OPERATION • Observe the hazard lamps. **Are the hazard lamps flashing?**	**Yes** INSTALL a new hazard switch. TEST the system for normal operation. **No** GO to M2.
M2 CHECK CIRCUIT 385 (WH/RD) FOR A SHORT TO VOLTAGE • **Disconnect:** Electronic Flasher. • Key in ON position. • Measure the voltage between ground and electronic flasher pin 3, circuit 385 (WH/RD).  A0013862 **Is voltage present?**	**Yes** REPAIR circuit 385 (WH/RD) for a short to voltage. TEST the system for normal operation. **No** INSTALL a new electronic flasher. TEST the system for normal operation.

Inspection and Verification — Parking, Rear and License Plate Lamps

1. Verify the customer concern by operating the parking lamps.
2. Visually inspect the following for obvious signs of mechanical and electrical damage.

Table 75 Visual Inspection Chart

Mechanical	Electrical
• Multifunction switch	• Power distribution center (PDC) fuse 22 (30A) • Circuitry open/shorted • Bulb/ lamp

3. If the concern is not visually evident, verify the symptom. GO to Symptom Chart.

Table 76 Symptom Chart

Condition	Possible Sources	Action
The parking, license or cab marker lamps are inoperative	• Fuse. • Circuitry open. • Park lamp relay.	GO to Pinpoint Test N.
One or more parking, license or cab marker lamps are inoperative	• Circuitry open. • Bulb/lamp.	Go to Pinpoint Test O.
The parking, license or cab marker lamps are on continuously	• Circuitry shorted. • Multifunction switch. • Park lamp relay.	Go to Pinpoint Test P.

Pinpoint Tests — Parking, Rear and License Plate Lamps

Pinpoint Test N: The Parking, License Or Cab Marker Lamps Are Inoperative

Normal Operation

Under normal operation, when the headlamp switch is in the PARKLAMPS position, ground is fed from the multifunction switch to the parklamp relay coil through circuit 1032 (WH/BK). Battery voltage is supplied to the parklamp relay switch and coil through circuit 1057 (OG/BK). When the parklamp relay is energized voltage is sent to the parking, license and cab marker lamps through circuit 14 (BN).

Possible Causes

- An open in circuit 14 (BN), 1032 (WH/BK) or 1057 (OG/BK)
- Fuse
- Multifunction switch
- Park lamp relay

Table 77 PINPOINT TEST N: THE PARKING, LICENSE OR CAB MARKER LAMPS ARE INOPERATIVE

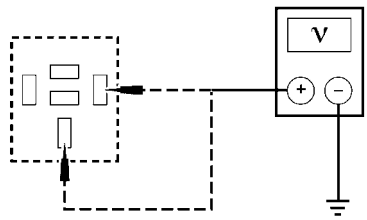
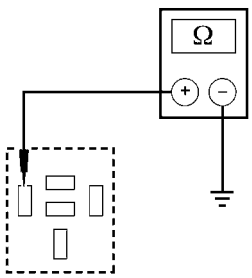
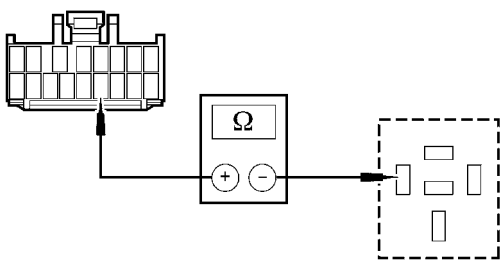
Test Step	Result / Action to Take
N1 CHECK FOR VOLTAGE TO THE PARK LAMP RELAY • **Disconnect:** Park Lamp Relay • Measure the voltage between ground and park lamp relay: — pin 30, circuit 1057 (OG/BK). — pin 86, circuit 1057 (OG/BK).  N0024006 **Are the voltages greater than 10 volts?**	**Yes** GO to N2. **No** VERIFY the power distribution center (PDC) fuse 3 (20A) is OK. If OK, REPAIR circuit 1057 (OG/BK) for an open. TEST the system for normal operation.

Table 77 PINPOINT TEST N: THE PARKING, LICENSE OR CAB MARKER LAMPS ARE INOPERATIVE (cont.)

Test Step	Result / Action to Take
N2 CHECK CIRCUIT 1032 (WH/BK) FOR GROUND • Place the main lamp switch in the PARKLAMPS position. • Measure the resistance between ground and park lamp relay pin 85, circuit 1032 (WH/BK).  N0024013 **Is the resistance less than 5 ohms?**	**Yes** CARRY OUT the park lamp relay component test. Refer to the Wiring Diagrams for component testing. If OK, REPAIR circuit 14 (BN) for an open. TEST the system for normal operation. **No** GO to N3.
N3 CHECK CIRCUIT 1032 (WH/BK) FOR AN OPEN • **Disconnect:** Multifunction Switch C202a. • Measure the resistance between the multifunction switch C202a-14, circuit 1032 (WH/BK) and the park lamp relay pin 85, circuit 1032 (WH/BK).  N0025244 **Is the resistance less than 5 ohms?**	**Yes** INSTALL a new multifunction switch. TEST the system for normal operation. **No** REPAIR circuit 1032 (WH/BK) for an open. TEST the system for normal operation.

Pinpoint Test O: One Or More Parking, License Or Cab Marker Lamps Are Inoperative

Normal Operation

Under normal operation, when the headlamp switch is in the PARKLAMPS position, ground is fed from the multifunction switch to the parklamp relay coil through circuit 1032 (WH/BK). When the parklamp relay is energized voltage is sent to the parking, license and cab marker lamps through circuit 14 (BN). Ground for the parking, license and cab marker lamps is supplied through circuit 57 (BK).

Possible Causes

- An open in circuit 14 (BN) or 57 (BK)
- Bulb/lamp

NOTE: If the turn signal/hazard lamps are also inoperative, diagnose them first. REFER to Turn Signal and Hazard Lamps above for diagnosing the turn signal/hazard lamps.

Table 78 PINPOINT TEST O: ONE OR MORE PARKING, LICENSE OR CAB MARKER LAMPS ARE INOPERATIVE

Test Step	Result / Action to Take
O1 VERIFY LAMP OPERATION • Place the headlamp switch in the ON position. • Verify the inoperative lamp(s). **Is one or more of the front parking or cab marker lamps inoperative?**	**Yes** GO to O2. **No** GO to O4.
O2 CHECK GROUND TO THE INOPERATIVE LAMP(S) • **Disconnect:** Inoperative Lamp. • Measure the resistance between ground and the inoperative lamp connector circuit 57 (BK). **Is the resistance less than 5 ohms?**	**Yes** GO to O3. **No** REPAIR circuit 57 (BK) for an open. TEST the system for normal operation.
O3 CHECK THE VOLTAGE TO THE INOPERATIVE LAMP(S) • Key in ON position. • Measure the voltage between ground and the inoperative lamp connector circuit 14 (BN). **Is the voltage greater than 10 volts?**	**Yes** INSPECT the bulb for an open. If OK, INSTALL a new lamp. TEST the system for normal operation. **No** REPAIR circuit 14 (BN) for an open. TEST the system for normal operation.
O4 VERIFY THE REAR LAMP OPERATION • Verify the inoperative lamp(s). **Is a single lamp inoperative?**	**Yes** GO to O6. **No** INSPECT the bulb for an open. If OK, GO to O5.
O5 CHECK GROUND TO THE REAR LAMPS • **Disconnect:** Any Inoperative Lamp • Measure the resistance between ground and the inoperative lamp connector circuit 57 (BK). **Is the resistance less than 5 ohms?**	**Yes** GO to O6. **No** REPAIR circuit 14 (BN) for an open. TEST the system for normal operation.

Table 78 PINPOINT TEST O: ONE OR MORE PARKING, LICENSE OR CAB MARKER LAMPS ARE INOPERATIVE (cont.)

Test Step	Result / Action to Take
O6 CHECK THE GROUND TO THE INOPERATIVE REAR LAMP • **Disconnect:** Inoperative Lamp. • Measure the resistance between ground and the inoperative lamp connector circuit 57 (BK). **Is the resistance less than 5 ohms?**	**Yes** GO to O7. **No** REPAIR circuit 57 (BK) for an open. TEST the system for normal operation.
O7 CHECK THE VOLTAGE TO THE INOPERATIVE REAR LAMP • Key in ON position. • Measure the voltage between ground and the inoperative lamp connector circuit 14 (BN). **Is the voltage greater than 10 volts?**	**Yes** INSPECT the bulb for an open. If OK, INSTALL a new lamp. TEST the system for normal operation. **No** REPAIR circuit 14 (BN) for an open. TEST the system for normal operation.

Pinpoint Test P: The Parking, License Or Cab Marker Lamps Are On Continuously

Normal Operation

Under normal operation, when the headlamp switch is in the PARKLAMPS position, ground is fed from the multifunction switch to the parklamp relay coil through circuit 1032 (WH/BK). When the parklamp relay is energized voltage is sent to the parking, license and cab marker lamps through circuit 14 (BN).

Possible Causes

- A short to voltage in circuit 14 (BN)
- A short to ground in circuit 1032 (WH/BK)
- Multifunction switch

Table 79 PINPOINT TEST P: THE PARKING, LICENSE OR CAB MARKER LAMPS ARE ON CONTINUOUSLY

Test Step	Result / Action to Take
P1 CHECK THE PARK LAMP RELAY • **Disconnect:** Park Lamp Relay • Observe the parking, license and cab marker lamps. **Do the parking, license or cab marker lamps continue to illuminate?**	**Yes** REPAIR circuit 14 (BN) for a short to voltage. TEST the system for normal operation. **No** CARRY OUT the park lamp relay component test. Refer to the Wiring Diagrams for component testing. If OK, GO to P2..
P2 CHECK CIRCUIT 1032 (WH/BK) FOR SHORT TO GROUND • **Connect:** Park Lamp Relay. • **Disconnect:** Multifunction Switch C202a. • Observe the parking, license and cab marker lamps. **Do the parking, license or cab marker lamps continue to illuminate?**	**Yes** INSTALL a new multifunction switch. TEST the system for normal operation. **No** REPAIR circuit 1032 (WH/BK) for a short to ground. TEST the system for normal operation.

Inspection and Verification — Fog Lamps

1. Verify the customer concern by operating the fog lamps.
2. Visually inspect the following for obvious signs of mechanical and electrical damage.
3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the concern is not visually evident, verify the symptom. GO to Symptom Chart.

Table 80 Visual Inspection Chart

Mechanical	Electrical
• Multifunction switch	• Power distribution center (PDC) fuse 22 (30A) • Circuitry open/shorted • Bulb/ lamp • Fog lamp relay

Table 81 Symptom Chart

Condition	Possible Sources	Action
The fog lamps are inoperative	• Fuse. • Circuitry open. • Multifunction switch. • Fog lamp relay.	GO to Pinpoint Test Q.
The individual fog lamp is inoperative	• Bulb. • Circuitry open.	Go to Pinpoint Test R.
The fog lamps are on continuously	• Circuitry shorted. • Fog lamp relay. • Multifunction switch.	Go to Pinpoint Test S.

Pinpoint Tests — Fog Lamps

Pinpoint Test Q: The Fog Lamps Are Inoperative

Normal Operation

Under normal operation, when the multifunction switch is in the FOGLAMPS position, voltage is fed from the multifunction switch to the fog lamp relay coil through circuit 477 (LB/BK). The fog lamp relay coil is grounded through circuit 57 (BK). Battery voltage is provided from the power distribution center (PDC) fuse 17 (15A) to the fog lamp relay switch through circuit 475 (WH/LG). When the relay is energized, voltage is sent to the fog lamps through circuit 1721 (LB/BK). The fog lamps are grounded through circuit 57 (BK).

Possible Causes

- An open in circuit 57 (BK), 475 (WH/LG), 477 (LB/BK) or 1721 (LB/BK)
- Fuse
- Bulb
- Fog lamp relay
- Multifunction switch

Table 82 PINPOINT TEST Q: THE FOG LAMPS ARE INOPERATIVE

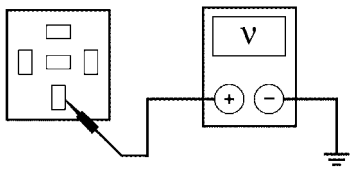
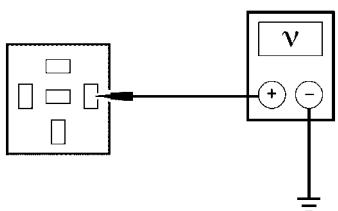
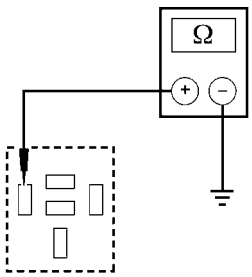
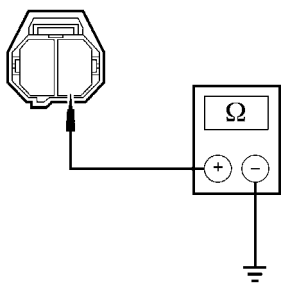
Test Step	Result / Action to Take
Q1 CHECK FOR VOLTAGE TO THE FOG LAMP RELAY • **Disconnect:** Fog Lamp Relay. • Measure the voltage between ground and fog lamp relay pin 30, circuit 475 (WH/LG).  N0020014 **Is the voltage greater than 10 volts?**	**Yes** GO to Q2. **No** VERIFY the power distribution center (PDC) fuse 17 (15A) is OK. If OK, REPAIR circuit 475 (WH/LG) for an open. TEST the system for normal operation.
Q2 CHECK THE FOG LAMP SWITCH OUTPUT **NOTE:** Headlamps must be on and in the LOW BEAM position. • Turn the multifunction switch to the FOGLAMPS position. • Measure the voltage between ground and fog lamp relay pin 86, circuit 477 (LB/BK).  N0018921 **Is the voltage greater than 10 volts?**	**Yes** GO to Q3. **No** CARRY OUT the multifunction switch component test. Refer to the Wiring Diagrams for component testing. If OK, REPAIR circuit 477 (LB/BK) for an open. TEST the system for normal operation.

Table 82 PINPOINT TEST Q: THE FOG LAMPS ARE INOPERATIVE (cont.)

Test Step	Result / Action to Take
Q3 CHECK THE FOG LAMP RELAY GROUND • Measure the resistance between ground and fog lamp relay pin 85, circuit 57 (BK).  N0024013 **Is the resistance less than 5 ohms?**	**Yes** CARRY OUT the fog lamp relay component test. Refer to the Wiring Diagrams for component testing. If OK, GO to Q4. **No** REPAIR circuit 57 (BK) for an open. TEST the system for normal operation.
Q4 CHECK THE FOG LAMP GROUND • **Disconnect:** Inoperative Fog Lamp. • Measure the resistance between ground and fog lamp connector pin 2, circuit 57 (BK).  N0025247 **Is the resistance less than 5 ohms?**	**Yes** REPAIR circuit 1721 (LB/BK) for an open. TEST the system for normal operation. **No** REPAIR circuit 57 (BK) for an open. TEST the system for normal operation.

Pinpoint Test R: The individual Fog Lamp Is Inoperative

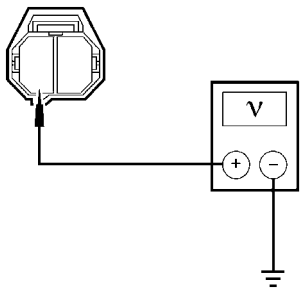
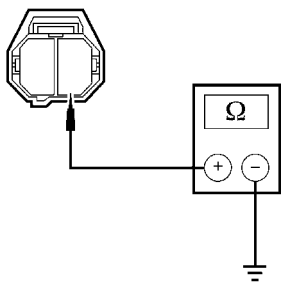
Normal Operation

Under normal operation, voltage is sent to the fog lamps through circuit 1721 (LB/BK). The fog lamps are grounded through circuit 57 (BK).

Possible Causes

- An open in circuit 57 (BK) or 1721 (LB/BK)
- Bulb

Table 83 PINPOINT TEST R: THE INDIVIDUAL FOG LAMP IS INOPERATIVE

Test Step	Result / Action to Take
R1 CHECK VOLTAGE TO THE FOG LAMP • **Disconnect:** Inoperative Fog Lamp. **NOTE:** Headlamps must be on and in the LOW BEAM position. • Turn the multifunction switch to the FOGLAMPS position. • Measure the voltage between ground and fog lamp connector pin 1, circuit 1721 (LB/BK).  N0025248 **Is the voltage greater than 10 volts?**	**Yes** GO to R2. **No** REPAIR circuit 1721 (LB/BK) for an open. TEST the system for normal operation.
R2 CHECK THE FOG LAMP GROUND • Measure the resistance between ground and fog lamp connector pin 2, circuit 57 (BK).  N0025247 **Is the resistance less than 5 ohms?**	**Yes** INSTALL a new bulb. TEST the system for normal operation. **No** REPAIR circuit 57 (BK) for an open. TEST the system for normal operation.

Pinpoint Test S: The Fog Lamps Are ON Continuously

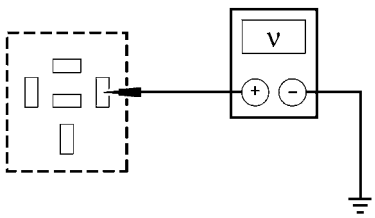
Normal Operation

Under normal operation, when the multifunction switch is in the FOGLAMPS position, voltage is fed from the multifunction switch to the fog lamp relay coil through circuit 477 (LB/BK). When the relay is energized, voltage is sent to the fog lamps through circuit 1721 (LB/BK).

Possible Causes

- A short to voltage in circuit 477 (LB/BK) or 1721 (LB/BK)
- Fog lamp relay
- Multifunction switch

Table 84 PINPOINT TEST S: THE FOG LAMPS ARE ON CONTINUOUSLY

Test Step	Result / Action to Take
S1 CHECK THE FOG LAMP RELAY • **Disconnect:** Fog Lamp Relay • Observe the fog lamps. **Do the fog lamps continue to illuminate?**	**Yes** CARRY OUT the fog lamp relay component test. Refer to the Wiring Diagrams for component testing. If OK, GO to S2. **No** REPAIR circuit 1721 (LB/BK) for an open. TEST the system for normal operation.
S2 CHECK CIRCUIT 477 (LB/BK) FOR SHORT TO VOLTAGE • **Disconnect:** Multifunction Switch C202a. • Measure the voltage between ground and fog lamp relay pin 86, circuit 477 (LB/BK).  A0020210 **Is voltage present?**	**Yes** REPAIR circuit 477 (LB/BK) for a short to voltage. TEST the system for normal operation. **No** INSTALL a new multifunction switch. TEST the system for normal operation.

Inspection and Verification — Reversing Lamps

1. Verify the customer concern by operating the reversing lamps.
2. Visually inspect the following for obvious signs of mechanical and electrical damage.
3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the concern is not visually evident, verify the symptom. GO to Symptom Chart.

Table 85 Visual Inspection Chart

Mechanical	Electrical
• Reversing lamp	• Power distribution center (PDC) fuse 16 (15A) • Circuitry open/shorted • Bulb/ lamp • Reversing lamp relay

Table 86 Symptom Chart

Condition	Possible Sources	Action
The reversing lamps are inoperative	• Fuse. • Circuitry open. • Reversing lamp relay. • Transmission control module (TCM).	GO to Pinpoint Test T.
An individual reversing lamp is inoperative	• Circuitry open. • Bulb/lamp.	Go to Pinpoint Test U.
The reversing lamps are on continuously	• Circuitry shorted. • Reversing lamp relay. • Transmission control module (TCM).	Go to Pinpoint Test V.

Pinpoint Tests — Reversing Lamps

Pinpoint Test T: The Reversing Lamps Are Inoperative

Normal Operation

Under normal operation, when the vehicle is in REVERSE, the transmission control module (TCM) provides a ground to the reversing lamp relay coil through circuit 1789 (VT/WH). Voltage is supplied to the reversing lamp relay coil through circuit 296 (WH/VT). Battery voltage is supplied from the power distribution center (PDC) fuse 16 (15A) to the reversing lamp relay switch through circuit 175 (BK/YE). When the relay is energized, voltage is sent to the reversing lamps through circuit 140 (BK/PK). The reversing lamps are grounded through circuit 57 (BK).

Possible Causes

- An open in circuit 57 (BK), 140 (BK/PK), 175 (BK/YE), 296 (WH/VT) or 1789 (VT/WH)
- Fuse
- Transmission control module (TCM)
- Reversing lamp relay

Table 87 PINPOINT TEST T: THE REVERSING LAMPS ARE INOPERATIVE

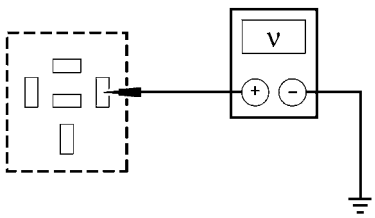
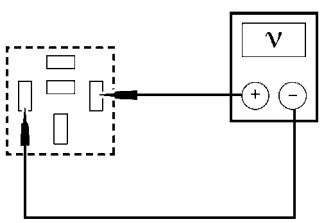
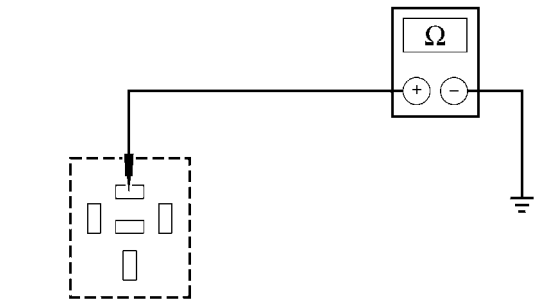
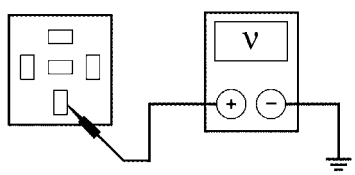
Test Step	Result / Action to Take
T1 CHECK THE VOLTAGE TO THE REVERSING LAMP RELAY COIL • Key in OFF position. • **Disconnect:** Reversing Lamp Relay. • Key in ON position. • Measure the voltage between ground and reversing lamp relay pin 86, circuit 296 (WH/VT).  A0020210 **Is the voltage greater than 10 volts?**	**Yes** GO to T2. **No** REPAIR circuit 296 (WH/VT) for an open. TEST the system for normal operation.
T2 CHECK THE TCM REVERSING LAMP RELAY OUTPUT • Apply the parking brake. • Place the vehicle in REVERSE. • Measure the voltage between reversing lamp relay pin 86, circuit 296 (WH/VT) and pin 87, circuit 1789 (VT/WH).  N0024007 **Is the voltage greater than 10 volts?**	**Yes** GO to T4. **No** GO to T3.

Table 87 PINPOINT TEST T: THE REVERSING LAMPS ARE INOPERATIVE (cont.)

Test Step	Result / Action to Take
T3 CHECK CIRCUIT 1789 (VT/WH) FOR AN OPEN • Key in OFF position. • **Disconnect:** TCM C168. • Measure the resistance between ground and reversing lamp relay pin 87, circuit 1789 (VT/WH).  A0020416 **Is the resistance less than 5 ohms?**	**Yes** INSTALL a new TCM. TEST the system for normal operation. **No** REPAIR circuit 1789 (VT/WH) for an open. TEST the system for normal operation.
T4 CHECK THE VOLTAGE TO THE REVERSING LAMP RELAY SWITCH • Measure the voltage between ground and reversing lamp relay pin 30, circuit 175 (BK/YE).  N0020014 **Is the voltage greater than 10 volts?**	**Yes** CARRY OUT the reversing lamp relay component test. Refer to the Wiring Diagrams for component testing. If OK, GO to T5. **No** VERIFY the power distribution center (PDC) fuse 16 (15A) is OK. If OK, REPAIR circuit 175 (BK/YE) for an open. TEST the system for normal operation.
T5 CHECK CIRCUIT 140 (BK/PK) FOR AN OPEN • **Disconnect:** Inoperative Reversing Lamp. • Measure the resistance between the inoperative reversing lamp, circuit 140 (BK/PK) and reversing lamp relay pin 87, circuit 140 (BK/PK). **Is the resistance less than 5 ohms?**	**Yes** REPAIR circuit 57 (BK) for an open. TEST the system for normal operation. **No** REPAIR circuit 140 (BK/PK) for an open. TEST the system for normal operation.

Pinpoint Test U: An Individual Reversing Lamp Is Inoperative

Normal Operation

Under normal operation, when the relay is energized, voltage is sent to the reversing lamps through circuit 140 (BK/PK). The reversing lamps are grounded through circuit 57 (BK).

Possible Causes

- An open in circuit 57 (BK) or 140 (BK/PK)
- Bulb/lamp

Table 88 PINPOINT TEST U: AN INDIVIDUAL REVERSING LAMP IS INOPERATIVE

Test Step	Result / Action to Take
U1 CHECK THE VOLTAGE TO THE INOPERATIVE REVERSING LAMP • Key in OFF position. • **Disconnect:** Inoperative Reversing Lamp. • Key in ON position. • Apply the parking brake. • Place the vehicle in REVERSE. • Measure the voltage between ground and the inoperative reversing lamp, circuit 140 (BK/PK). **Is the voltage greater than 10 volts?**	**Yes** GO to U2. **No** REPAIR circuit 140 (BK/PK). TEST the system for normal operation.
U2 CHECK GROUND TO THE INOPERATIVE REVERSING LAMP • Key in OFF position. • Measure the resistance between ground and the inoperative reversing lamp ground circuit. **Is the resistance less than 5 ohms?**	**Yes** INSPECT the bulb for an open. If OK, INSTALL a new lamp. TEST the system for normal operation. **No** REPAIR circuit 57 (BK) for an open. TEST the system for normal operation.

Pinpoint Test V: The Reversing Lamps Are ON Continuously

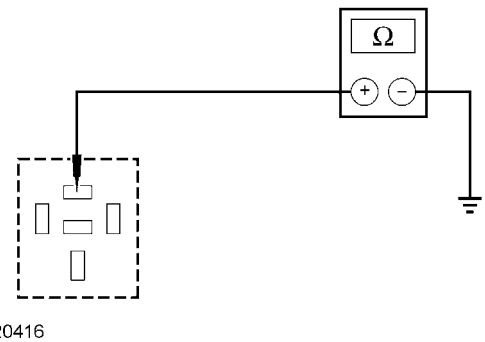
Normal Operation

Under normal operation, when the vehicle is in REVERSE, the transmission control module (TCM) provides a ground to the reversing lamp relay coil through circuit 1789 (VT/WH). When the relay is energized, voltage is sent to the reversing lamps through circuit 140 (BK/PK).

Possible Causes

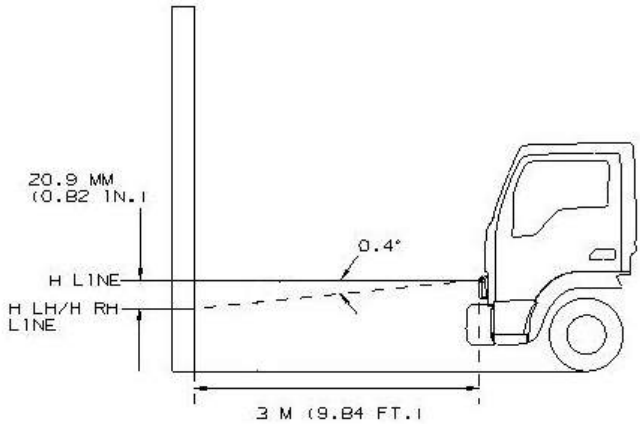
- A short to ground in circuit 1789 (VT/WH)
- A short to voltage in circuit 140 (BK/PK)
- Transmission control module (TCM)
- Reversing lamp relay

Table 89 PINPOINT TEST V: THE REVERSING LAMPS ARE ON CONTINUOUSLY

Test Step	Result / Action to Take
V1 CHECK THE FOG LAMP RELAY • **Disconnect:** Reversing Lamp Relay. • Observe the reversing lamps. **Do the reversing lamps continue to illuminate?**	**Yes** REPAIR circuit 140 (BK/PK) for a short to voltage. TEST the system for normal operation. **No** CARRY OUT the reversing lamp relay component test. Refer to the Wiring Diagrams for component testing. If OK, GO to V2.
V2 CHECK CIRCUIT 1789 (VT/WH) FOR A SHORT TO GROUND • **Disconnect:** TCM C168. • Measure the resistance between ground and the reversing lamp relay pin 87, circuit 1789 (VT/WH).  A0020416 **Is the resistance greater than 10,000 ohms?**	**Yes** INSTALL a new TCM. TEST the system for normal operation. **No** REPAIR circuit 1789 (VT/WH) for a short to ground. TEST the system for normal operation.

General Procedures — Headlamp Aim Adjustment

1. Place the vehicle with the following conditions:
   a. The area around the headlamps is not deformed.
   b. The unloaded vehicle is parked on a flat level surface.
   c. Tire inflation pressure is at the specified value.
   d. The vehicle is in a state ready for driving (with a full tank of fuel, oil level and coolant).
   e. The vehicle has been bounced several times.
2. To check the headlamp aiming:
   a. Prepare a thick white paper.
   b. Stand the paper perpendicular to the ground at a position 3 m (9.84 ft) away from the headlamps.
   c. Ensure that the centerline of the vehicle is perpendicular to the paper face.



d. Draw a horizontal line (H line) on the paper, showing where the headlamps should strike (at the same height from ground as the headlamp bulb center, which is marked on the headlamp lens by a 2 mm by 2 mm square).

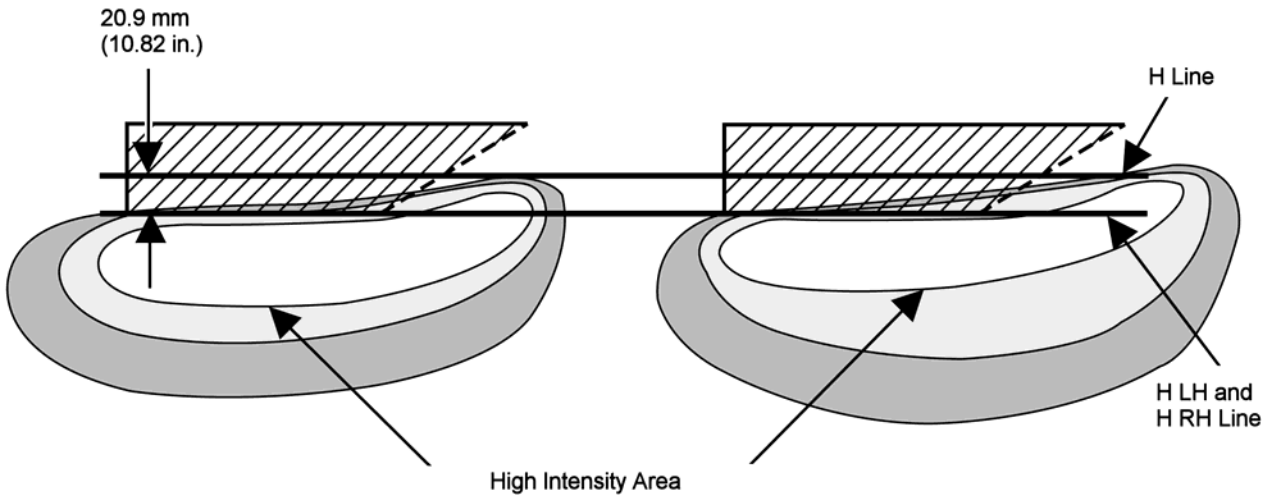
e. Draw a horizontal line (H LH and H RH lines) parallel to the H line but 20.9 mm (0.82 in) below it.

f. Take appropriate measures to prevent any influence of other lights.

g. Start the engine.

h. Turn the LOW beam headlamps ON.

i. On the paper, observe the portion of the light pattern that has a distinctly higher area of intensity. Check that the top edge of this high intensity area is at the H RH/H LH reference line and below the cross-hatched area as shown in the illustration below.



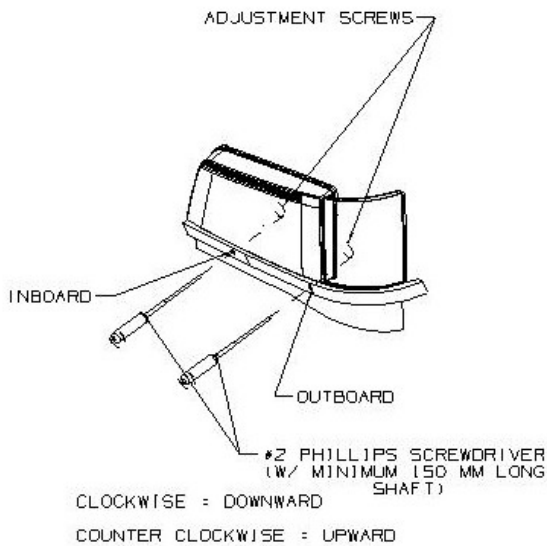
Low Beam Pattern on Paper

j. If not, adjust the lights in the vertical direction.

3. To adjust the headlamp aim:

CAUTION: Both the inboard and outboard vertical aim screws must be turned the same amount in the same direction. Do NOT turn the screws different amounts or in different directions.

NOTE: Do not finish the aiming procedure by turning the screws in the counterclockwise screwdriver direction. If you are adjusting in the counterclockwise screwdriver direction, overshoot the adjustment by one full turn and then turn the screwdriver clockwise one full turn, so you finish the adjustment in the clockwise direction and still line up with the vertical aiming line. This applies to both screws.



a. Use a #2 Phillips screwdriver with at least a 150 mm (6 in) long shaft.

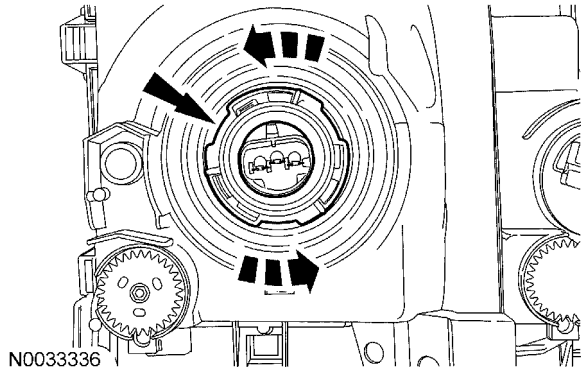
b. Insert the screwdriver in the inboard aiming hole until it engages the gear at the back of the headlamp. ALWAYS start with the inboard aiming screw as it is the primary vertical aiming screw.

c. Turn the screwdriver in the counterclockwise direction to move the headlamp aim upward or in the clockwise direction to move

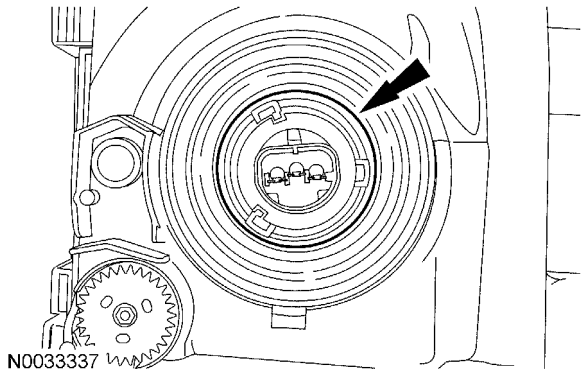
the headlamp aim downward, WHILE COUNTING THE NUMBER OF TURNS MADE. Continue turning this screw until the vertical aim is properly adjusted, but make sure you finish in the clockwise screwdriver direction. If you are adjusting in the counterclockwise screwdriver direction, overshoot the adjustment by one full turn and then turn it clockwise one full turn, so you finish the adjustment in the clockwise direction and still line up with the vertical aiming line.

d. Then insert the screwdriver in the outboard aiming hole until it engages the gear at the back of the headlamp.

e. Turn the screwdriver the same number of turns in the same direction as was done in the inboard aiming hole, but make sure you finish in the clockwise screwdriver direction. If you are adjusting in the counterclockwise screwdriver direction, overshoot the adjustment by one full turn and then turn it clockwise one full turn, so you finish the adjustment in the clockwise direction and still line up with the vertical aiming line. **Do NOT turn this outboard screw in a different direction or a different amount than was done with the inboard aiming screw.**



4. Remove the headlamp bulb.



5. To install, reverse the removal procedure.

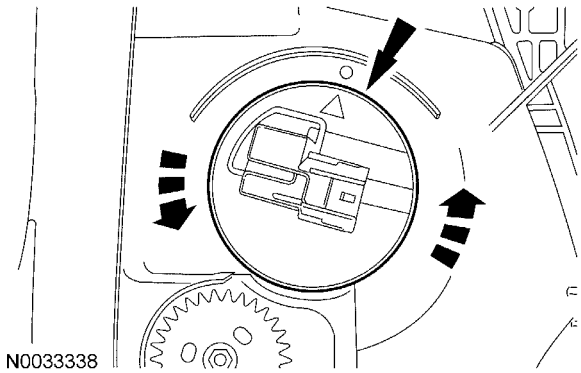
Removal and Installation

Headlamp Bulb

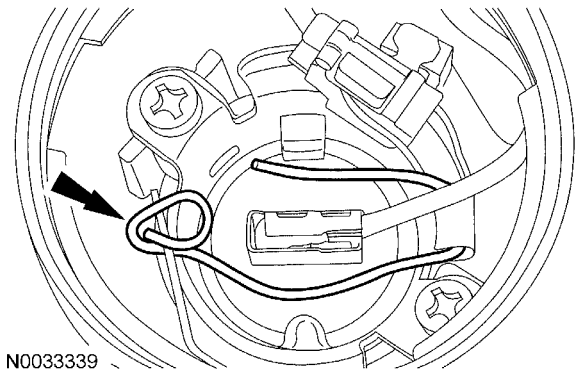
1. Tilt the cab forward.
2. Disconnect the electrical connector.
3. Rotate the headlamp bulb lock ring counterclockwise and remove the lock ring.

Fog Lamp Bulb

1. Tilt the cab forward.
2. Disconnect the electrical connector.
3. Rotate the fog lamp bulb cover counterclockwise and remove the cover.


N0033338

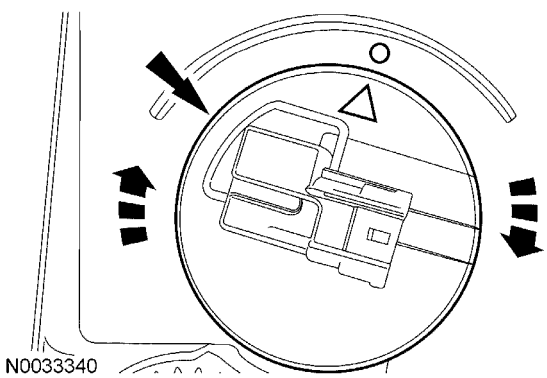
4. Release the fog lamp bulb retainer.


N0033339

5. Remove the fog lamp bulb.

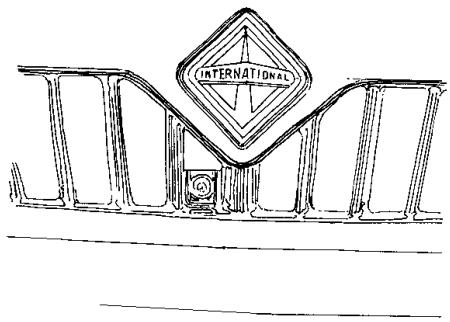
NOTE: To lock the bulb cover, turn clockwise until the triangle and circle marks are aligned.

6. To install, reverse the removal procedure.

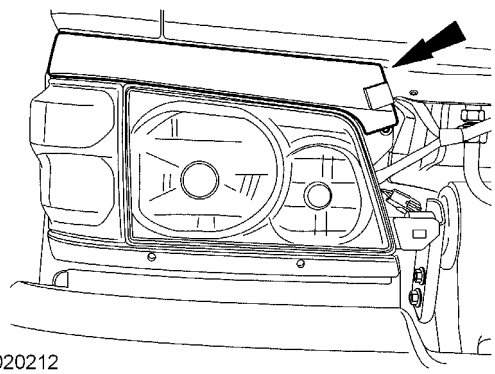

N0033340

Headlamp Assembly

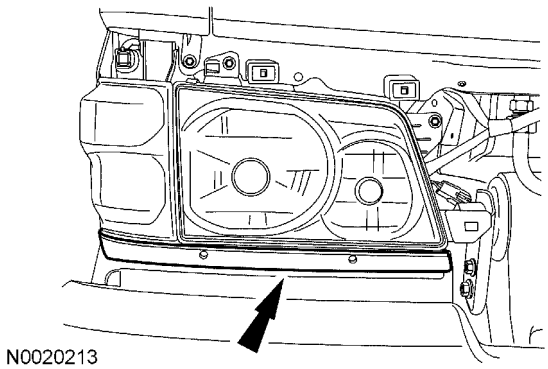
1. Remove the side marker lamp assembly. For additional information, refer to Side Marker Lamp in this section.
2. Remove the radiator grille retaining screw.



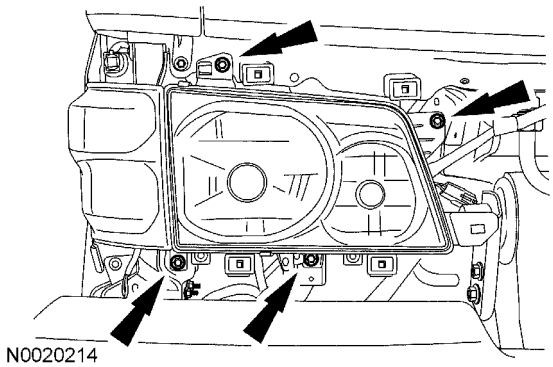
3. Remove the radiator grille.
4. Remove the upper headlamp moulding.


N0020212

5. Remove the lower headlamp moulding.


N0020213

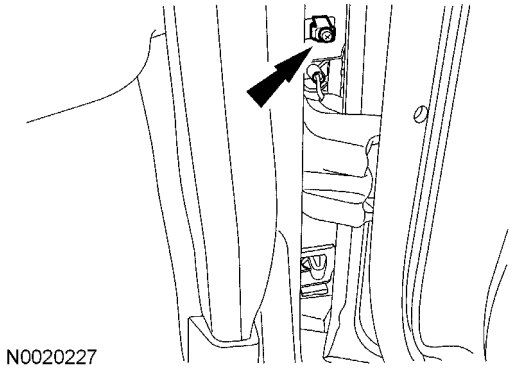
6. Remove the 4 headlamp retaining screws.


N0020214

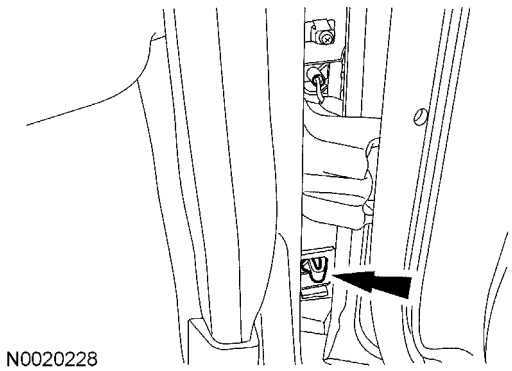
7. Remove the headlamp assembly.
8. Disconnect the electrical connectors.
9. To install, reverse the removal procedure.

Side Marker Lamp Assembly

1. Open the LH and RH doors.
2. Release the upper side lamp assembly retainer.


N0020227

3. Release the lower side lamp assembly retainer.


N0020228

4. Gently remove the side marker lamp by pulling straight out the font of the vehicle.
5. Remove the bulbs.
6. To install, reverse the removal procedure.

Cab Marker Lamp

1. Remove the roof trim panel. For additional information, refer to Interior Trim and Ornamentation in S16032.
2. Remove the cab marker lamps.

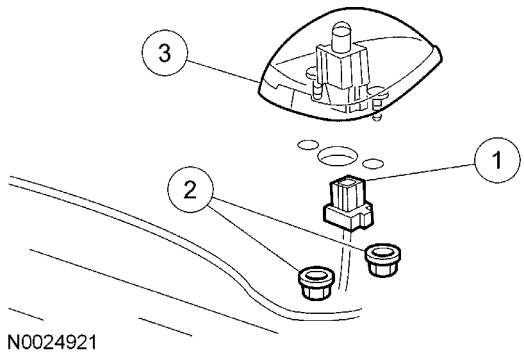


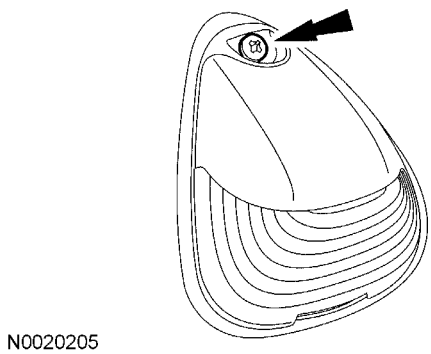
Figure 40

1. Disconnect the electrical connector.
2. Remove the cab marker lamp nuts. • To install, tighten to 10 Nm (89 lb-in).
3. Remove the cab marker lamps.

3. To install, reverse the removal procedure.

Cab Marker Lamp Bulb

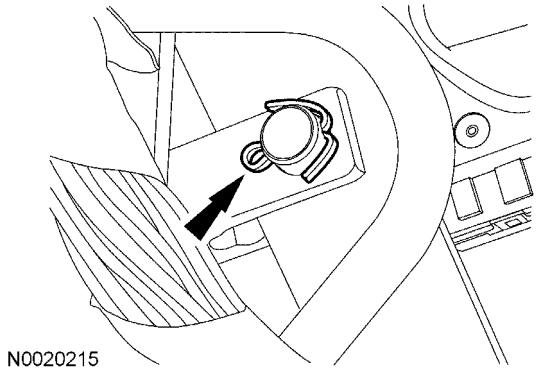
1. Remove the cab marker lamp lens screw.



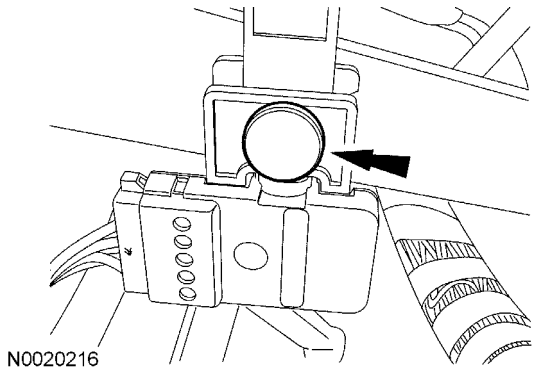
2. Remove the cab marker lamp lens.
3. Remove the cab marker lamp bulb.
4. To install, reverse the removal procedure.

Stoplamp Switch

1. Remove the retaining pin clip.



2. Remove the retaining pin.



3. Remove the stoplamp switch from the pedal.
4. Disconnect the stoplamp switch electrical connector.
5. To install, reverse the removal procedure.

Interior Lighting

Description and Operation

Interior Lighting Components

The interior lighting components include the following:

- Front interior/map lamps
- Door ajar switches

The interior lamp operates as follows:

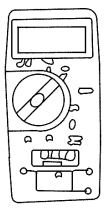
- When the dome lamp switch is in the OFF (left) position, the lamp will always be OFF.

- When the dome lamp switch is in the DOOR (center) position, the lamp will illuminate when either door is opened.
- When the dome lamp switch is in the ON (right) position, the lamp will stay ON continuously.

Diagnosis and Testing

Refer to Wiring Diagrams for schematic and connector information.

Table 90 Special Tools

 ST1137-A	Automotive Meter ZTSE4357

Inspection and Verification — Interior Lighting

1. Verify the customer concern by operating the system.
2. Visually inspect the following for obvious signs of electrical damage.

Table 91 Visual Inspection Chart

Electrical
• Bulbs
• Power distribution center (PDC) fuse 28 (10A)
• Circuitry open/shorted

3. If the concern is not visually evident, verify the symptom. GO to Symptom Chart.

Table 92

Condition	Possible Sources	Action
The interior lamps are inoperative	• Fuse. • Circuitry open. • Bulb.	GO to Pinpoint Test A.
The interior lamps stay on continuously	• Circuitry shorted. • Door ajar switch.	Go to Pinpoint Test B.
The interior lamps do not turn on with one door open	• Circuitry open. • Door ajar switch.	Go to Pinpoint Test C.

Pinpoint Tests — Interior Lighting

Pinpoint Test A: The Interior Lamps Are Inoperative

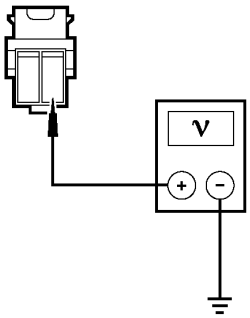
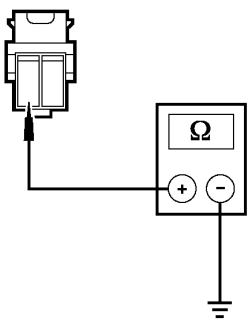
Normal Operation

Under normal operation, voltage is fed from the power distribution center (PDC) fuse 28 (10A) to the interior lamp through circuit 54 (LG/YE). When a door is opened, ground is provided by the door ajar switch to the interior lamp through circuit 159 (RD/PK).

Possible Causes

- An open in circuit 54 (LG/YE) or 159 (RD/PK)
- An open fuse
- Interior lamp
- Bulb

Table 93 PINPOINT TEST A: THE INTERIOR LAMPS ARE INOPERATIVE

Test Step	Result / Action to Take
A1 CHECK CIRCUIT 54 (LG/YE) FOR VOLTAGE • Open the LH and RH doors. • **Disconnect:** Interior Lamp C981. • Measure the voltage between interior lamp C981, circuit 54 (LG/YE) and ground.  N0024056 **Is the voltage greater than 10 volts?**	**Yes** GO to A2. **No** VERIFY the power distribution center (PDC) fuse 28 (10A) is OK. If OK, REPAIR circuit 54 (LG/YE) for an open. TEST the system for normal operation.
A2 CHECK CIRCUIT 159 (RD/PK) FOR AN OPEN • Measure the resistance between interior lamp C981, circuit 159 (RD/PK) and ground  N0024057 **Is the resistance less than 5 ohms?**	**Yes** INSPECT the interior lamp bulb for an open. If OK, INSTALL a new lamp. TEST the system for normal operation. **No** REPAIR circuit 159 (RD/PK) for an open. TEST the system for normal operation.

Pinpoint Test B: The Interior Lamps Stay On Continuously

Normal Operation

Under normal operation, when a door is opened, ground is provided by the door ajar switch to the interior lamp through circuit 159 (RD/PK).

Possible Causes

- A short to ground in circuit 159 (RD/PK)
- Door ajar switch

Table 94 PINPOINT TEST B: THE INTERIOR LAMPS STAY ON CONTINUOUSLY

Test Step	Result / Action to Take
B1 CHECK THE LH DOOR AJAR SWITCH • **Disconnect:** LH Door Ajar Switch C526. • Observe the interior lamps. **Are the interior lamps OFF?**	**Yes** INSTALL a new LH door ajar switch. TEST the system for normal operation. **No** GO to B2.
B2 CHECK THE RH DOOR AJAR SWITCH • **Disconnect:** RH Door Ajar Switch C602. • Observe the interior lamps. **Are the interior lamps OFF?**	**Yes** INSTALL a new RH door ajar switch. TEST the system for normal operation. **No** REPAIR circuit 159 (RD/PK) for a short to ground. TEST the system for normal operation.

Pinpoint Test C: The Interior Lamps Do Not Turn ON With One Door Open

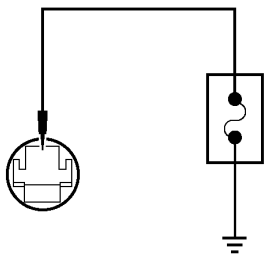
Normal Operation

Under normal operation, when a door is opened, ground is provided by the door ajar switch to the interior lamp through circuit 159 (RD/PK).

Possible Causes

- An open in circuit 159 (RD/PK)
- Door ajar switch

Table 95 PINPOINT TEST C: THE INTERIOR LAMPS DO NOT TURN ON WITH ONE DOOR OPEN

Test Step	Result / Action to Take
C1 CHECK THE INOPERATIVE DOOR AJAR SWITCH • **Disconnect:** Inoperative Door Ajar Switch (RH) C602 or (LH) C526. • Connect a fused jumper wire between the inoperative door ajar switch (RH) C602 or (LH) C526, circuit 159 (RD/PK) and ground.  N0024058 **Are the interior lamps ON?**	**Yes** INSTALL a new RH or LH door ajar switch. TEST the system for normal operation. **No** REPAIR circuit 159 (RD/PK) for an open. TEST the system for normal operation.

Removal and Installation

Interior Lamp

1. Remove the interior rear view mirror. For additional information, refer to Rear View Mirrors in S16032.
2. To install, reverse the removal procedure.

Daytime Running Lamps

Description and Operation

Daytime Running Lamps

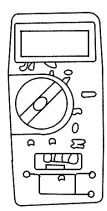
The daytime running lamps (DRL) system operates the low-beam headlamps at a reduced intensity. The DRL module supplies pulse width modulated (PWM) voltage, 80% of battery voltage, to the low-beam headlamps when the following conditions are met:

- The multifunction switch is in the NEUTRAL position
- The parking brake control is released
- The headlamp switch is not in the headlamps ON position
- The ignition switch is in the ON position

Diagnosis and Testing

Refer to Wiring Diagrams for schematic and connector information.

Table 96 Special Tools

 ST1137-A	Automotive Meter ZTSE4357

Inspection and Verification — Interior Lighting

1. Verify the customer concern.
2. Visually inspect the following for obvious signs of mechanical or electrical damage.

Table 97 Visual Inspection Chart

Mechanical	Electrical
• Parking brake switch	• Circuitry open/shorted
• Multifunction switch	• Daytime running lamps (DRL) module

3. Make sure the autolamps and manual control of the headlamps operate correctly before proceeding to the next step.
4. Make sure the parking brake warning indicator operates correctly (the parking brake warning indicator should be illuminated only when the parking brake is engaged). If the parking brake warning indicator does not operate correctly, refer to Instrument Cluster.
5. If the concern is not visually evident, verify the symptom. GO to Symptom Chart.

Table 98 Symptom Chart

Condition	Possible Sources	Action
The daytime running lamps (DRL) are inoperative	• Circuitry open/ shorted. • Parking brake switch • Multifunction switch. • Daytime running lamps (DRL) module.	GO to Pinpoint Test A.
The daytime running lamps are ON with the parking brake set	• Circuitry open. • Parking brake switch. • Daytime running lamps (DRL) module.	Go to Pinpoint Test B.
The daytime running lamps are on with the ignition switch OFF	• Circuitry shorted. • Ignition relay. • Daytime running lamps (DRL) module.	Go to Pinpoint Test C.

Pinpoint Tests — Daytime Running Lamps

Pinpoint Test A: The Daytime Running Lamps (DRL) Are Inoperative

Normal Operation

Under normal operation, the daytime running lamps (DRL) module is grounded through circuit 57 (BK). Battery voltage is provided to the DRL module through circuit 2002 (OG/BK). When the ignition switch is in the ON position, voltage is sent to the DRL module through circuit 489 (PK/BK). The DRL will turn off when either of the following occurs:

- When the fog lamps are ON, ground is provided to the DRL module through 1669 (OG/LG).

- When the parking brake is applied, ground is provided to the DRL module through 162 (LG/RD).

Possible Causes

- An open in circuit 57 (BK), 489 (PK/BK) or 2002 (OG/BK)
- A short to ground in circuit 162 (LG/RD) or 1669 (OG/LG)
- Parking brake switch
- DRL module

Table 99 PINPOINT TEST A: THE DAYTIME RUNNING LAMPS (DRL) ARE INOPERATIVE

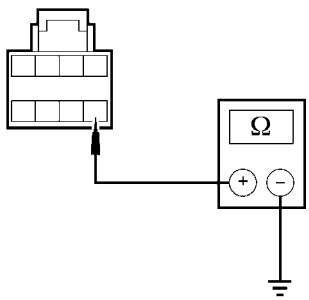
Test Step	Result / Action to Take
A1 CHECK THE DRL MODULE GROUND • **Disconnect:** DRL Module C1030 • Measure the resistance between ground and DRL module C1030-D, circuit 57 (BK).  N0025256 **Is the resistance less than 5 ohms?**	**Yes** GO to A2. **No** REPAIR circuit 57 (BK) for an open. TEST the system for normal operation.

Table 99 PINPOINT TEST A: THE DAYTIME RUNNING LAMPS (DRL) ARE INOPERATIVE (cont.)

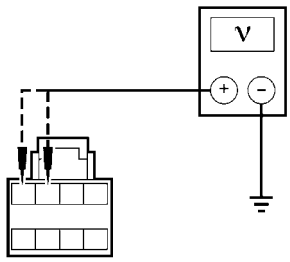
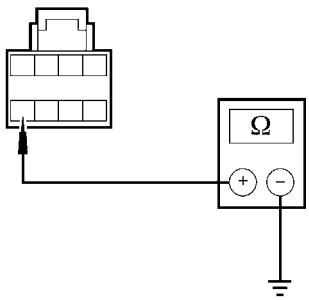
Test Step	Result / Action to Take
A2 CHECK VOLTAGE TO THE DRL MODULE • Key in ON position. • Measure the voltage between ground and DRL module: — C1030-G, circuit 489 (PK/BK). — C1030-H, circuit 2002 (OG/BK).  N0025257 **Are the voltages greater than 10 volts?**	**Yes** GO to A3. **No** REPAIR circuit 489 (PK/BK) or 2002 (OG/BK) for an open. TEST the system for normal operation.

Table 99 PINPOINT TEST A: THE DAYTIME RUNNING LAMPS (DRL) ARE INOPERATIVE (cont.)

Test Step	Result / Action to Take
A3 CHECK CIRCUIT 1669 (OG/LG) FOR GROUND **NOTE:** Verify the fog lamp switch is OFF. • Key in OFF position. • Measure the resistance between ground and DRL module C1030-A, circuit 1669 (OG/LG).  N0025258 **Is the resistance greater than 10,000 ohms?**	**Yes** CARRY OUT the multifunction switch component test. Refer to the Wiring Diagrams for component testing. If OK, REPAIR circuit 1669 (OG/LG) for a short to ground. TEST the system for normal operation. **No** If the parking brake indicator is illuminated, GO to A4. If the parking brake indicator is not illuminated, INSTALL a new DRL module. TEST the system for normal operation.
A4 CHECK THE PARKING BRAKE SWITCH SIGNAL CIRCUIT TO THE DRL MODULE FOR SHORT TO GROUND • **Disconnect:** Parking Brake Switch C306 • Key in ON position. • Observe the parking brake warning indicator. **Is the parking brake warning indicator OFF?**	**Yes** INSTALL a new parking brake switch. TEST the system for normal operation. **No** REPAIR circuit 162 (LG/RD) for a short to ground. TEST the system for normal operation.

Pinpoint Test B: The Daytime Running Lamps Are On With The Parking Brake Set

Normal Operation

Under normal operation, the DRL will turn off when the parking brake is applied and ground is provided to the DRL module through 162 (LG/RD).

Possible Causes

- An open in circuit 57 (BK) or 162 (LG/RD)
- Parking brake switch
- DRL module

Table 100 PINPOINT TEST B: THE DAYTIME RUNNING LAMPS ARE ON WITH THE PARKING BRAKE SET

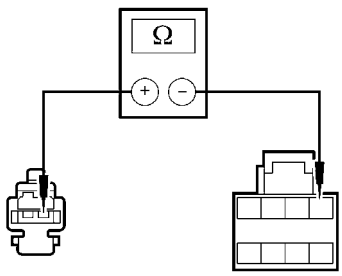
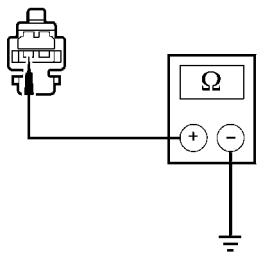
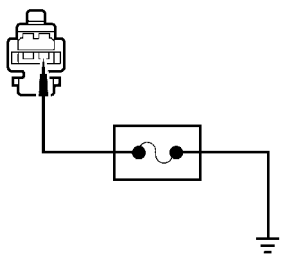
Test Step	Result / Action to Take
B1 CHECK PARKING BRAKE WARNING INDICATOR • Key in ON position. • Observe the parking brake warning indicator. **Is the parking brake warning indicator ON?**	**Yes** GO to B2. **No** GO to B3.
B2 CHECK CIRCUIT 162 (LG/RD) • Key in OFF position. • **Disconnect:** Parking Brake Switch C306 • **Disconnect:** DRL Module C1030 • Measure the resistance between parking brake switch C306-B, circuit 162 (LG/RD) and DRL module C1030-E, circuit 162 (LG/RD).  N0025259 **Is the resistance less than 5 ohms?**	**Yes** INSTALL a new DRL module. TEST the system for normal operation. **No** REPAIR circuit 162 (LG/RD) for an open. TEST the system for normal operation.

Table 100 PINPOINT TEST B: THE DAYTIME RUNNING LAMPS ARE ON WITH THE PARKING BRAKE SET (cont.)

Test Step	Result / Action to Take
B3 CHECK THE PARKING BRAKE SWITCH GROUND • Key in OFF position. • **Disconnect:** Parking Brake Switch C306 • Measure the resistance between ground and parking brake switch C306-A, circuit 57 (BK).  N0025260 **Is the resistance less than 5 ohms?**	**Yes** GO to B4. **No** REPAIR circuit 57 (BK) for an open. TEST the system for normal operation.
B4 CHECK THE PARKING BRAKE SWITCH • Connect a fused jumper wire between ground and parking brake switch C306-B, circuit 162 (LG/RD).  N0025261 • Key in ON position. **Does the brake warning indicator illuminate?**	**Yes** INSTALL a new parking brake switch. TEST the system for normal operation. **No** REPAIR circuit 162 (LG/RD) for an open. TEST the system for normal operation.

Pinpoint Test C: The Daytime Running Lamps Are On With The Ignition Switch Off

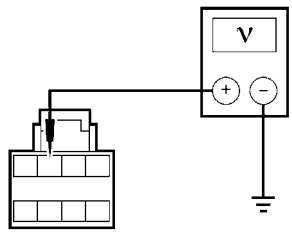
Normal Operation

Under normal operation, when the ignition switch is in the ON position, voltage is sent to the DRL module through circuit 489 (PK/BK).

Possible Causes

- A short to voltage in circuit 489 (PK/BK)
- DRL module

Table 101 PINPOINT TEST C: THE DAYTIME RUNNING LAMPS ARE ON WITH THE IGNITION SWITCH OFF

Test Step	Result / Action to Take
C1 CHECK THE IGNITION SWITCH INPUT TO THE DRL MODULE FOR VOLTAGE • Key in OFF position. • **Disconnect:** DRL Module C1030. • Measure the voltage between ground and DRL module C1030-G, circuit 489 (PK/BK).  N0025262 **Is any voltage indicated?**	**Yes** CARRY OUT the ignition relay component test. Refer to the Wiring Diagrams for component testing. If OK, REPAIR circuit 489 (PK/BK) for a short to voltage. TEST the system for normal operation. **No** INSTALL a new DRL module. TEST the system for normal operation.

Module Communications Network

Description and Operation

Communications Network

The vehicle has 3 module communication networks:

- American Trucking Association (ATA) medium duty truck communication network (J1587/J1708).
- controller area network (CAN) J1939.
- controller area network (CAN) J2284.

The diagnostic tool connects to the CAN J2284 network through the data link connector (DLC), and to the ATA and CAN J1939 networks through the 9-pin Deutsch connector. The DLC and Deutsch connector are located on the driver side cowl panel.

The modules that use the ATA link are:

- engine control module (ECM).
- injector drive module (IDM).

The modules that use the (CAN) J1939 link are:

- engine control module (ECM).
- instrument cluster.
- transmission control module (TCM).

The modules that use the (CAN) J2284 link are:

- anti-lock brake system (ABS) module.
- instrument cluster.

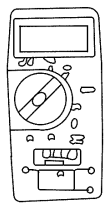
The primary protocol used to communicate with the vehicle is (CAN) J1939. The ATA link is used to program (reflash software calibrations) for the ECM and IDM.

The instrument cluster acts as an interpreter for the brake system by converting (CAN) J1939 messages used by the ECM and TCM into the (CAN) J2284 protocol used by the ABS module.

Diagnosis and Testing

Refer to Wiring Diagrams for schematic and connector information.

Table 102 Special Tools

 ST1137-A	Automotive Meter ZTSE4357

Principles of Operation — Module Communications Network

The vehicle has 3 module communications networks:

- controller area network (CAN) J1939.
- controller area network (CAN) J2284.
- American Trucking Association (ATA) J1587/J1708.

The diagnostic tool connects to the communications networks through either the data link connector (DLC) or the 9-pin Deutsch connector.

The (CAN) J1939 has an unshielded twisted pair cable, data plus circuit 1851 (WH/LG) and data minus circuit 1852 (PK/LG). This communications network is used for the instrument cluster, engine control module (ECM) and the transmission control module (TCM).

The (CAN) J2284 has an unshielded twisted pair cable, data plus circuit 1814 (WH/LB) and data minus circuit 1815 (PK/LB). This communications network is used for the anti-lock brake system (ABS) module and the instrument cluster.

The CAN networks remain operational, even with the severing of one of the CAN circuits, but operate at a degraded level. Communications also continue at a degraded level if one of the CAN circuits are shorted to ground or voltage, or if some but not all termination resistors are lost.

The (ATA) J1587/J1708 has an unshielded twisted pair cable, data plus circuit 914 (TN/OG) and data minus circuit 915 (PK/LB). The ATA communications network is used for the engine control module (ECM) and the injector drive module (IDM).

Inspection and Verification — Module Communications Network

1. Verify the customer concern.
2. Visually inspect the following for obvious signs of mechanical or electrical damage.

Table 103 Visual Inspection Chart

Mechanical	Electrical
• Correct tester program card installed • Tester connections to the vehicle • Ignition switch position	• Power distribution center fuse(s): 4 (40A), 18 (15A), 20 (60A), 31 (10A), 35 (15A) or 41 (10A) • Damaged wiring harness • Loose or corroded connector(s) • Circuitry open/shorted

3. If no obvious cause of the concern is found during the inspection, connect the diagnostic tool to the DLC or the Deutsch diagnostic connector. Attempt to communicate with the module in question. If the diagnostic tool still does not communicate with the module, GO to Symptom Chart.
4. If no response from the diagnostic tool, GO to Pinpoint Test C for DLC or GO to Pinpoint Test D for Deutsch diagnostic connector.

Table 104 Diagnostic Trouble Code Chart

DTC	Description	Source	Action
231	ATA Data Communication Link Error	ECM	GO to Pinpoint Test B.
368	EGR Drive Module/ECM Communication Fault	ECM	GO to Pinpoint Test E.
543	ECM/IDM Communications Fault	ECM	GO to Pinpoint Test E.
DTCs that start with a "U" are faults which occur during module-to-module communication.			
Modules should never be replaced based only on a "U" code. These codes do not always indicate a problem and can be caused by normal diagnostic functions carried out on the vehicle.			
U1900	CAN Communication Bus Fault — Receive Error	ABS	CLEAR the DTCs and REPEAT the self-test. If DTC re-appears, GO to Pinpoint Test A.
U0073	CAN Bus Off — Transmit Error	ABS	CLEAR the DTCs and REPEAT the self-test. If DTC re-appears, GO to Pinpoint Test A.
U0100	Lost Communication with ECM	TCM	CLEAR the DTCs and REPEAT the self-test. If DTC re-appears, GO to Pinpoint Test B.

Table 105 Symptom Chart

Condition	Possible Sources	Action
No module/network communication — ABS	• Fuse(s). • Circuit 1814 (WH/LB) or 1815 (PK/LB). • ABS internal concern. • Worn or damaged DLC. • Diagnostic tool internal concern.	GO to Pinpoint Test A.
No module/network communication — ECM, TCM, IDM or instrument cluster	• Fuse(s). • Circuitry. • Worn or damaged Deutsch diagnostic connector. • ECM internal concern. • TCM internal concern. • IDM internal concern. • Instrument cluster internal concern. • Diagnostic tool internal concern.	Go to Pinpoint Test B.
No module/network communication — no power to the diagnostic tool at the DLC or Deutsch connector	• Fuse(s). • Circuit 57 (BK) open. • Worn or damaged DLC or Deutsch diagnostic connector. • Diagnostic tool internal concern.	For DLC, Go to Pinpoint Test C. For Deutsch diagnostic connector, Go to Pinpoint Test D.

Pinpoint Tests — Module Communications Network

Pinpoint Test A: No Module/Network Communication — ABS

Normal Operation

The ABS module is powered through power distribution center fuse 20 (60A), circuit 601 (LB/PK) and communicates through the CAN J2284 network circuits 1814 (WH/LB) and 1815 (PK/LB). If one of the bus wires becomes shorted to ground or voltage, or if some but not all termination resistors are lost, communications can continue at a degraded level. The instrument cluster serves as a communications network gateway between the ABS (CAN J2284) and ECM (CAN J1939).

Possible Causes

- Fuse(s).
- Circuits 1814 (WH/LB) or 1815 (PK/LB), shorted to ground or open
- DLC C251
- ABS C135
- ABS internal concern

Table 106 PINPOINT TEST A: NO MODULE/NETWORK COMMUNICATION — ABS

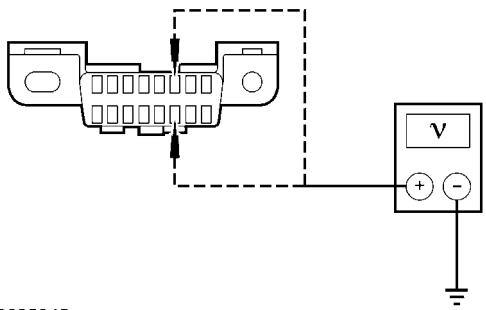
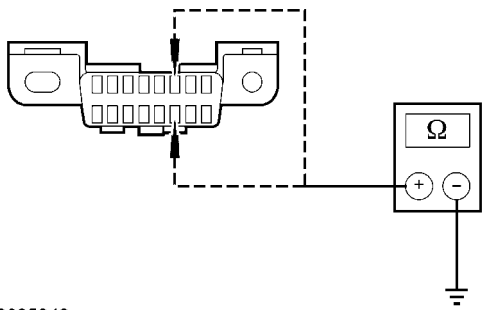
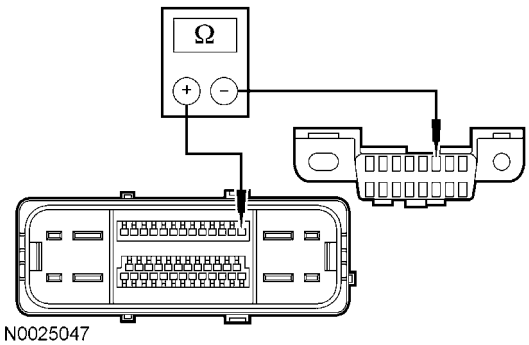
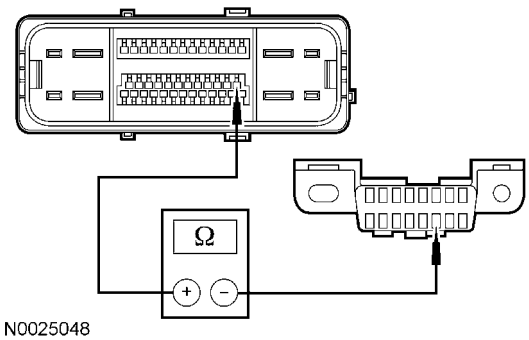
Test Step	Result / Action to Take
A1 CHECK FOR SHORT TO BATTERY ON DIAGNOSTIC LINK • Key in ON position. • Measure the voltage at DLC connector C251-6, circuit 1814 (WH/LB) and C251-14, circuit 1815 (PK/LB).  N0025045 **Is the voltage at battery voltage present?**	**Yes** REPAIR the circuit. TEST the system for normal operation. **No** GO to A2.
A2 CHECK FOR SHORT TO GROUND ON DIAGNOSTIC LINK • Measure the resistance to ground at DLC connector C251-6, circuit 1814 (WH/LB) and C251-14, circuit 1815 (PK/LB).  N0025046 **Is the resistance greater than 10,000 ohms?**	**Yes** GO to A3. **No** REPAIR the circuit. TEST the system for normal operation.

Table 106 PINPOINT TEST A: NO MODULE/NETWORK COMMUNICATION — ABS (cont.)

Test Step	Result / Action to Take
A3 TEST CONTINUITY OF THE ABS DIAGNOSTIC LINK • Key in OFF position. • **Disconnect:** ABS C135. • Measure the resistance between ABS C135-3, circuit 1814 (WH/LB) and DLC C251-6, circuit 1814 (WH/LB).  N0025047 • Measure the resistance between ABS C135-18, circuit 1815 (PK/LB) and DLC C251-14, circuit 1815 (PK/LB).  N0025048 **Is the resistance more than 5 ohms for either measurement?**	**Yes** REPAIR circuit. TEST the system for normal operation. **No** GO to A4.
A4 CHECK FOR CORRECT MODULE OPERATION • Disconnect all the module connectors. • Check for: — corrosion. — pushed-out pins. • Connect all the module connectors and make sure they seat correctly. • Operate the system and verify the concern is still present. **Is the concern still present?**	**Yes** INSTALL a new ABS module. Refer to Anti-Lock Control in S04049. TEST the system for normal operation. **No** The system is operating correctly at this time. The concern may have been caused by a loose or corroded connector. CLEAR the diagnostic trouble codes (DTCs). REPEAT the self-test.

Pinpoint Test B: No Module/Network Communication — ECM, TCM, IDM Or Instrument Cluster

Normal Operation

The ECM and IDM modules communicate through the ATA J1708 network through circuits 914 (TN/OG)/832 (LB/PK) and 915 (PK/LB)/830 (TN). If one of the ATA bus wires becomes open, shorted to ground or voltage, ATA network communication is no longer possible. The ECM, TCM and instrument cluster modules communicate through the CAN J1939 network through circuits 1851 (WH/LG) and 1852 (PK/LG). If one of the bus wires becomes shorted to ground or voltage, communications can continue at a degraded level.

Possible Causes

- Circuits 1814 (WH/LB) or 1815 (PK/LB), shorted to ground or open
- Circuits 914 (TN/OG)/832 (LB/PK) or 915 (PK/LB)/830 (TN), shorted to ground or open
- Deutsch diagnostic connector C2173
- ECM C175a or C175b
- TCM C168
- IDM C1174c
- Instrument cluster C220b
- Instrument cluster internal concern
- ECM internal concern
- TCM internal concern
- IDM internal concern

Table 107 PINPOINT TEST B: NO MODULE/NETWORK COMMUNICATION — ECM, TCM, IDM OR INSTRUMENT CLUSTER

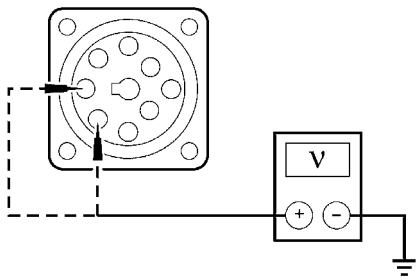
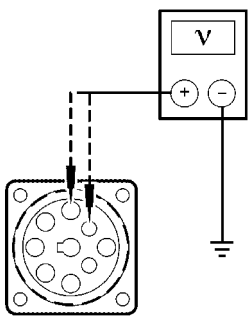
Test Step	Result / Action to Take
B1 CHECK FOR A SHORT TO BATTERY ON THE DIAGNOSTIC LINK • Key in ON position. • Measure the voltage at engine diagnostic connector C2173-F, circuit 914 (TN/OG) and C2173-G, circuit 915 (PK/LB).  A0066565 • Measure the voltage at engine diagnostic connector C2173-C, circuit 1851 (WH/LG) and C2173-D, circuit 1852 (PK/LG).  N0025049 **Is the voltage greater than 10 volts on either measurement?**	**Yes** REPAIR the short to battery. TEST the system for normal operation. **No** GO to B2.

Table 107 PINPOINT TEST B: NO MODULE/NETWORK COMMUNICATION — ECM, TCM, IDM OR INSTRUMENT CLUSTER (cont.)

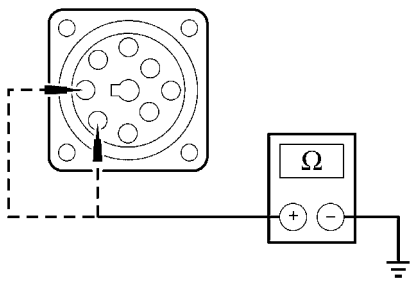
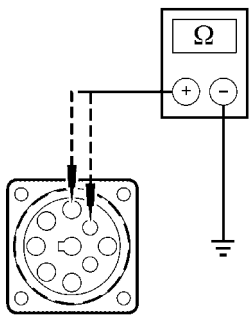
Test Step	Result / Action to Take
B2 CHECK FOR A SHORT TO GROUND ON THE DIAGNOSTIC LINK • Key in OFF position. • Measure the resistance to ground at engine diagnostic connector C2173-F, circuit 914 (TN/OG) and C2173-G, circuit 915 (PK/LB).  A0066566 • Measure the resistance to ground at engine diagnostic connector C2173-C, circuit 1851 (WH/LG) and C2173-D, circuit 1852 (PK/LG).  N0025066 **Is the resistance less than 5 ohms?**	**Yes** REPAIR the short to ground on the diagnostic link. TEST the system for normal operation. **No** For ECM, GO to B3. For TCM, GO to B4. For IDM, GO to B5. For instrument cluster, GO to B6.

Table 107 PINPOINT TEST B: NO MODULE/NETWORK COMMUNICATION — ECM, TCM, IDM OR INSTRUMENT CLUSTER (cont.)

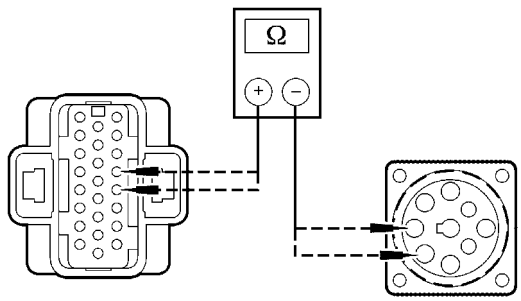
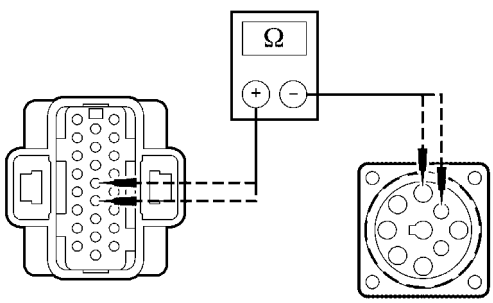
Test Step	Result / Action to Take
B3 CHECK THE CONTINUITY OF THE ECM DIAGNOSTIC LINK • Key in OFF position. • **Disconnect:** ECM C175a. • **Disconnect:** ECM C175b. • Measure the resistance between ECM C175a-20, circuit 914 (TN/OG) and engine diagnostic connector C2173-F, circuit 914 (TN/OG); and measure the resistance between ECM C175a-21, circuit 915 (PK/LB) and engine diagnostic C2173-G, circuit 915 (PK/LB).  N0025050 • Measure the resistance between ECM C175b-12, circuit 1851 (WH/LG) and engine diagnostic C2173-C, circuit 1851 (WH/LG); and measure the resistance between ECM C175b-13, circuit 1852 (PK/LG) and engine diagnostic C2173-D, circuit 1852 (PK/LG).  N0025051 **Is the resistance more than 5 ohms for any measurement?**	**Yes** REPAIR the high resistance concern on the affected circuit. **No** GO to B7.

Table 107 PINPOINT TEST B: NO MODULE/NETWORK COMMUNICATION — ECM, TCM, IDM OR INSTRUMENT CLUSTER (cont.)

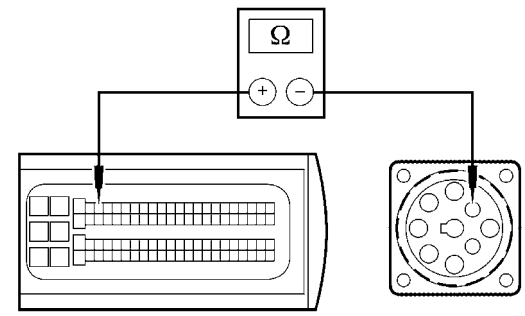
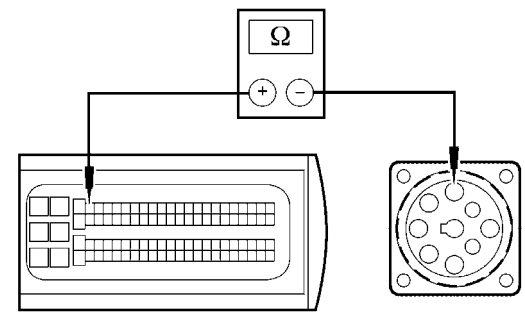
Test Step	Result / Action to Take
B4 CHECK THE CONTINUITY OF THE TCM DIAGNOSTIC LINK • **Disconnect:** TCM C168. • Measure the resistance between TCM C168-9, circuit 1851 (WH/LG) and engine diagnostic connector C2173-C, circuit 1851 (WH/LG)  N0025052 • Measure the resistance between TCM C168-8, circuit 1852 (PK/LG) and engine diagnostic connector C2173-D, circuit 1852 (PK/LG).  N0025053 **Is the resistance greater than 5 ohms for either circuit?**	**Yes** REPAIR the high resistance concern on the affected circuit. TEST the system for normal operation. **No** GO to B7.
B5 TEST THE CONTINUITY OF THE IDM DIAGNOSTIC LINK • Key in OFF position. • **Disconnect:** IDM C1174c. • Measure the resistance between IDM C1174c-28, circuit 832 (LB/PK) and engine diagnostic connector C2173-F, circuit 914 (TN/OG). • Measure the resistance between IDM C1174c-29, circuit 830 (TN) and engine diagnostic connector C2173-G, circuit 915 (PK/LB). **Is the resistance less than 5 ohms for both measurements?**	**Yes** GO to B7. **No** REPAIR the high resistance in the diagnostic link. TEST the system for normal operation.

Table 107 PINPOINT TEST B: NO MODULE/NETWORK COMMUNICATION — ECM, TCM, IDM OR INSTRUMENT CLUSTER (cont.)

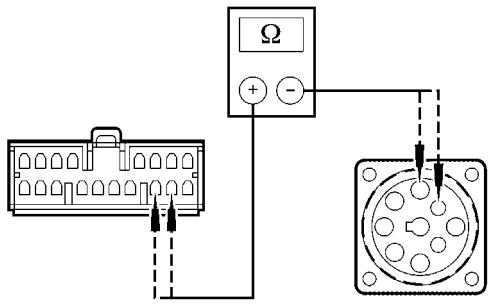
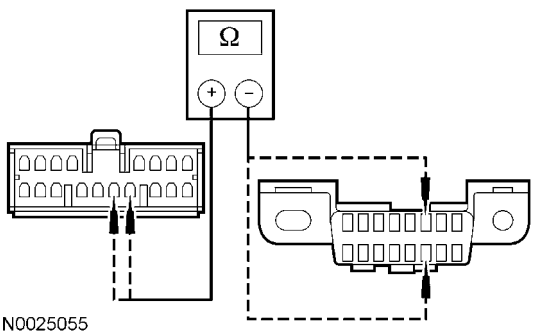
Test Step	Result / Action to Take
B6 TEST THE CONTINUITY OF THE INSTRUMENT CLUSTER DIAGNOSTIC LINK • Key in OFF position. • **Disconnect:** Instrument Cluster C220b. • Measure the resistance between instrument cluster C220b-17, circuit 1851 (WH/LG) and engine diagnostic connector C2173-C, circuit 1851 (WH/LG); and measure the resistance between instrument cluster C220b-16, circuit 1852 (PK/LG) and engine diagnostic C2173-D, circuit 1852 (PK/LG).  N0025054 • Measure the resistance between instrument cluster C220b-15, circuit 1814 (WH/LB) and DLC C251-6, circuit 1814 (WH/LB); and measure the resistance between instrument cluster C220b-14, circuit 1815 (PK/LB) and DLC C251-14, circuit 1815 (PK/LB).  N0025055 **Is the resistance less than 5 ohms for all measurements?**	**Yes** GO to B7. **No** REPAIR the high resistance in the diagnostic link. TEST the system for normal operation.

Table 107 PINPOINT TEST B: NO MODULE/NETWORK COMMUNICATION — ECM, TCM, IDM OR INSTRUMENT CLUSTER (cont.)

Test Step	Result / Action to Take
B7 CHECK FOR CORRECT MODULE OPERATION • Disconnect all the module connectors. • Check for: — corrosion. — pushed-out pins. • Connect all the module connectors and make sure they seat correctly. • Operate the system and verify the concern is still present. **Is the concern still present?**	**Yes** INSTALL a new module. Follow the manufacturer's instructions. TEST the system for normal operation. **No** The system is operating correctly at this time. The concern may have been caused by a loose or corroded connector. CLEAR the diagnostic trouble codes (DTCs). REPEAT the self-test.

Pinpoint Test C: No Module/Network Communication — No Power To The Diagnostic Tool At The DLC

Normal Operation

Under normal operation, the diagnostic tool is connected to the DLC C251 to communicate with the CAN J2284 network. If communication cannot be established, the diagnostic tool and DLC C251 must be checked for damage. If the diagnostic tool and DLC C251 are OK, power distribution center fuse 31 (10A) and circuit 391 (RD/YE) must be checked for voltage and 57 (BK) must be checked for an open condition.

Possible Causes

- Fuse(s).
- Circuit 57 (BK) open
- Worn or damaged DLC diagnostic connector C251
- Diagnostic tool internal concern

Table 108 PINPOINT TEST C: NO MODULE/NETWORK COMMUNICATION — NO POWER TO THE DIAGNOSTIC TOOL AT THE DLC

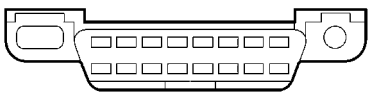
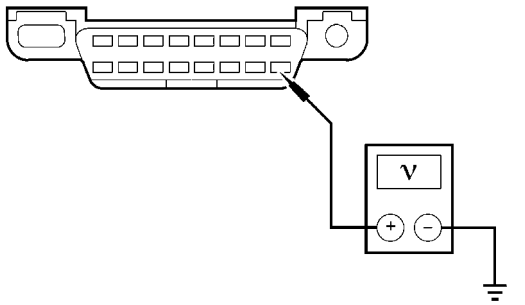
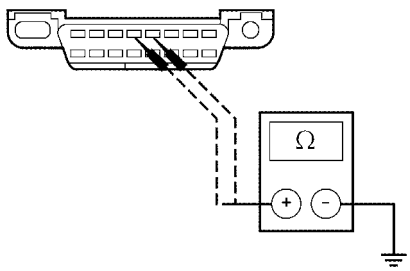
Test Step	Result / Action to Take
C1 CHECK DLC C251 FOR DAMAGE • Key in OFF position. • Inspect the DLC C251 pins for damage.  GK2633-A **Are the pins OK?**	**Yes** GO to C2. **No** REPAIR DLC C251. TEST the system for normal operation.

Table 108 PINPOINT TEST C: NO MODULE/NETWORK COMMUNICATION — NO POWER TO THE DIAGNOSTIC TOOL AT THE DLC (cont.)

Test Step	Result / Action to Take
C2 CHECK THE VOLTAGE TO THE DLC C251 PIN 16, CIRCUIT 391 (RD/YE) • Measure the voltage to the DLC C251-16, circuit 391 (RD/YE).  GK2634-A **Is the voltage greater than 10 volts?**	**Yes** GO to C3. **No** VERIFY the power distribution center (PDC) fuse 31 (10A) is OK. If OK, REPAIR circuit 391 (RD/YE). TEST the system for normal operation.
C3 CHECK THE DLC GROUNDS — CIRCUIT 57 (BK) • Measure the resistance to ground at DLC C251-4, circuit 57 (BK), and DLC C251-5, circuit 57 (BK).  GK4963-A **Are the resistances less than 5 ohms?**	**Yes** CHECK the diagnostic tool. TEST the system for normal operation. **No** REPAIR circuit 57 (BK). TEST the system for normal operation.

Pinpoint Test D: No Module/Network Communication — No Power To The Diagnostic Tool At The Deutsch Diagnostic Connector

Normal Operation

Under normal operation, the diagnostic tool is connected to the Deutsch connector to communicate with the CAN J1939 and ATA J1708 networks. If communication cannot be established, the diagnostic tool and Deutsch connector C2173 must be checked for damage. If the diagnostic tool and C2173 are OK, power distribution center fuse 31 (10A) and circuit 391 (RD/YE) must be checked for voltage and 57 (BK) must be checked for an open condition.

Possible Causes

- Fuse(s).
- Circuit 57 (BK) open
- Worn or damaged Deutsch diagnostic connector C2173
- Diagnostic tool internal concern

Table 109 PINPOINT TEST D: NO MODULE/NETWORK COMMUNICATION — NO POWER TO THE DIAGNOSTIC TOOL AT THE DEUTSCH DIAGNOSTIC CONNECTOR

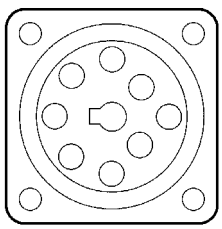
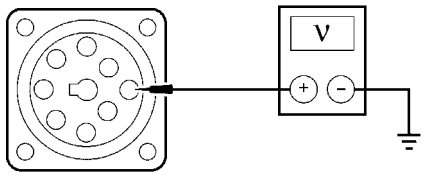
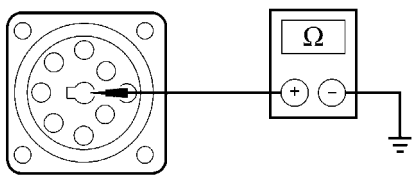
Test Step	Result / Action to Take
D1 CHECK THE DEUTSCH DIAGNOSTIC CONNECTOR C2173 FOR DAMAGE • Key in OFF position. • Inspect the engine diagnostic connector C2173 pins for damage.  A0067239 **Are the pins OK?**	**Yes** GO to D2. **No** REPAIR engine diagnostic connector C2173. TEST the system for normal operation.

Table 109 PINPOINT TEST D: NO MODULE/NETWORK COMMUNICATION — NO POWER TO THE DIAGNOSTIC TOOL AT THE DEUTSCH DIAGNOSTIC CONNECTOR (cont.)

Test Step	Result / Action to Take
D2 CHECK CIRCUIT 391 (RD/YE) FOR VOLTAGE • Measure the voltage at engine diagnostic connector C2173-B, circuit 391 (RD/YE).  A0067238 **Is the voltage greater than 10 volts?**	**Yes** GO to D3. **No** VERIFY the power distribution center (PDC) is OK. If OK, REPAIR circuit 391 (RD/YE). TEST the system for normal operation.
D3 CHECK CIRCUIT 57 (BK) FOR GROUND • Measure the resistance to ground at engine diagnostic connector C2173-A, circuit 57 (BK).  A0067237 **Is the resistance less than 5 ohms?**	**Yes** CHECK the diagnostic tool. TEST the system for normal operation. **No** REPAIR circuit 57 (BK). TEST the system for normal operation.

Pinpoint Test E: No Module/Network Communication — IDM, ECM, EGR Drive Module CAN2 Network Error

Normal Operation

The CAN2 link is a private communication link used only between the ECM, IDM and EGR drive module. There is no relation to the CAN J1939 link that is used for communication with various processors on a vehicle. The CAN2 network consists of circuit 69 and circuit 70. If one of these bus wires becomes open, shorted to ground or voltage, CAN2 network communication is no longer possible and may result in a no-start condition for the vehicle.

Possible Causes

- Circuit 69 or 70 open, shorted to ground or shorted to power
- IDM power feed circuit 1832 (DB/LG) open
- ECM internal concern
- IDM internal concern
- EGR drive module internal concern

Table 110 PINPOINT TEST E: NO MODULE/NETWORK COMMUNICATION — IDM, ECM, EGR DRIVE MODULE CAN2 NETWORK ERROR

Test Step	Result / Action to Take
E1 CHECK FOR A NO-START CONDITION • Key in START position. • Attempt to start the engine. **Does the vehicle engine start?**	**Yes** GO to E2. **No** GO to E4.
E2 CHECK FOR AN OPEN IN CIRCUIT 69 OR 70 • Key in OFF position. • **Disconnect:** EGR Drive Module C1450 • **Disconnect:** ECM C175d • Measure the resistance between EGR drive module C1450-3, circuit 69 and ECM C175d-6, circuit 69. • Measure the resistance between EGR drive module C1450-4, circuit 70 and ECM C175d-13, circuit 70. **Are both resistances less than 5 ohms?**	**Yes** GO to E3. **No** REPAIR the circuit. TEST the system for normal operation.
E3 CHECK FOR CORRECT MODULE OPERATION • Inspect the EGR drive module C1450. • Check for: — corrosion. — pushed-out pins. • Connect EGR drive module C1450 and make sure it is seated correctly. • Operate the system and verify the concern is still present. **Is the concern still present?**	**Yes** INSTALL a new EGR drive module. Follow the manufacturer's instructions. TEST the system for normal operation. **No** The system is operating correctly at this time. The concern may have been caused by a loose or corroded connector. CLEAR the diagnostic trouble codes (DTCs). REPEAT the self-test.
E4 CHECK CIRCUIT 69 AND 70 FOR A SHORT TO BATTERY • Key in OFF position. • **Disconnect:** ECM175d. • Key in ON position. • Measure the voltage at ECM C175d-6, circuit 69 and ECM C175d-13, circuit 70. **Is battery voltage present on either circuit?**	**Yes** GO to E5. **No** GO to E7.

Table 110 PINPOINT TEST E: NO MODULE/NETWORK COMMUNICATION — IDM, ECM, EGR DRIVE MODULE CAN2 NETWORK ERROR (cont.)

Test Step	Result / Action to Take
E5 VERIFY THE EGR DRIVE MODULE OPERATION • Key in OFF position. • **Disconnect:** EGR Drive Module C1450. • Key in ON position. • Measure the voltage at ECM C175d-6, circuit 69 and ECM C175d-13, circuit 70. **Is battery voltage present on either circuit?**	**Yes** GO to E6. **No** INSTALL a new EGR drive module. Follow the manufacturer's instructions. TEST the system for normal operation.
E6 VERIFY IDM OPERATION • Key in OFF position. • **Disconnect:** IDM C1174c. • Key in ON position. • Measure the voltage at ECM C175d-6, circuit 69 and ECM C175d-13, circuit 70. **Is battery voltage present on either circuit?**	**Yes** REPAIR the circuit. TEST the system for normal operation. **No** INSTALL a new IDM drive module. Follow the manufacturer's instructions. TEST the system for normal operation.
E7 CHECK CIRCUIT 69 AND 70 FOR A SHORT TO GROUND • Key in OFF position. • Measure the resistance between ECM C175d-6, circuit 69 and ECM C175d-13, circuit 70. **Is less than 10,000 ohms resistance to ground present on either circuit?**	**Yes** GO to E8. **No** GO to E10.
E8 VERIFY THE EGR DRIVE MODULE OPERATION • **Disconnect:** EGR Drive Module C1450. • Measure the resistance to ground at ECM C175d-6, circuit 69 and ECM C175d-13, circuit 70. **Is less than 10,000 ohms resistance to ground present on either circuit?**	**Yes** GO to E9. **No** INSTALL a new EGR drive module. Follow the manufacturer's instructions. TEST the system for normal operation.

Table 110 PINPOINT TEST E: NO MODULE/NETWORK COMMUNICATION — IDM, ECM, EGR DRIVE MODULE CAN2 NETWORK ERROR (cont.)

Test Step	Result / Action to Take
E9 VERIFY IDM OPERATION • **Disconnect:** IDM C1174c. • Measure the resistance to ground at ECM C175d-6, circuit 69 and ECM C175d-13, circuit 70. **Is less than 10,000 ohms resistance to ground present on either circuit?**	**Yes** REPAIR the circuit. TEST the system for normal operation. **No** INSTALL a new IDM drive module. Follow the manufacturer's instructions. TEST the system for normal operation.
E10 CHECK CIRCUIT 69 AND 70 FOR AN OPEN CIRCUIT • Key in OFF position. • **Disconnect:** IDM C1174c. • Measure the resistance between ECM C175d-6, circuit 69 and IDM C1174c-30, circuit 69. • Measure the resistance between ECM C175d-13, circuit 70and IDM C1174c-31, circuit 70. **Is resistance less than 5 ohms on both measurements?**	**Yes** GO to E11. **No** REPAIR the circuit. TEST the system for normal operation.
E11 CHECK CIRCUIT 1832 (DB/LG) FOR AN OPEN CIRCUIT • Key in ON position. • Measure the voltage between IDM C1450-1, circuit 1832 (DB/LG) and ground. **Is the voltage greater than 10 volts?**	**Yes** GO to E12. **No** VERIFY the power distribution center (PDC) fuse 41 (10A) is OK. If OK, REPAIR the circuit. TEST the system for normal operation.
E12 CHECK FOR CORRECT MODULE OPERATION • Key in OFF position. • Inspect the IDM C1174c and ECM C175d. • Check for: — corrosion. — pushed-out pins. • Connect IDM C1174c and ECM C175d and make sure they are seated correctly. • Operate the system and verify the concern is still present. **Is the concern still present?**	**Yes** INSTALL a new IDM module. Follow the manufacturer's instructions. TEST the system for normal operation. **No** The system is operating correctly at this time. The concern may have been caused by a loose or corroded connector. CLEAR the diagnostic trouble codes (DTCs). REPEAT the self-test.

Multifunction Electronic Modules

Specifications

Table 111 Torque Specifications

Description	Nm	lb-in.
Remote keyless entry (RKE) module	5	44

Description and Operation

Module Controlled Functions

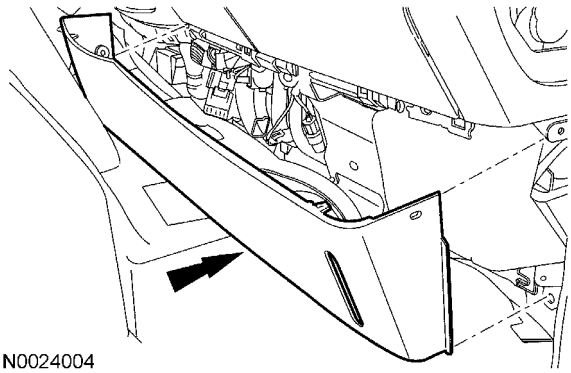
The remote keyless entry module (RKE) commands the door timer module to actuate the door locks when the remote transmitter LOCK/UNLOCK button is pressed. The remote keyless entry module (RKE) does not communicate on the network and provides no diagnostic information.

Removal and Installation

Remote Keyless Entry (RKE) Module

CAUTION: Electronic modules are sensitive to static electrical charges. If exposed to these charges, damage may result.

1. Disconnect the battery. For additional information, refer to Battery, Mounting and Cables(Battery, Mounting and Cables, page 73).
2. Remove the lower RH finish panel from the instrument panel.



3. Remove the remote keyless entry module.
   - To install, tighten to 5 Nm (44 lb-in).

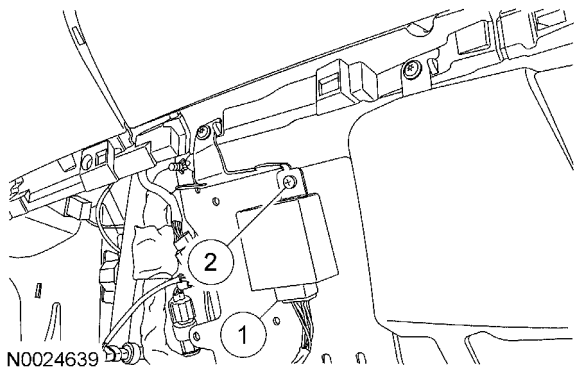


Figure 45

1. Disconnect the remote keyless entry module electrical connector.
2. Remove the remote keyless entry module mounting screw.

4. To install, reverse the removal procedure.