1993 EVTM

Bronco/F150-F350 E-Super Duty

E Vacuum Troubleshooting Manual

1993 Bronco/F150-F350/F-Super Duty Electrical & Vacuum Trouble-Shooting Manual (EVTM)

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ELECTRICAL AND VACUUM TROUBLESHOOTING MANUAL
FPS-12128-93

FORD PARTS and SERVICE DIVISION

Quality is Job 1

Ford Parts and Service Division has developed a new format for the 1993 BRONCO/F-SERIES EVTM . Our goal is to provide accurate and timely electrical and vacuum service information.

1993 EVTM FEATURES

- "**CIRCUIT OPERATION**" descriptions (CELL 7) that explain how each circuit works. These descriptions are designed to be used in conjunction with the Electrical Schematic.
- **Schematic pages** now contain **COMPONENT LOCATION** references to full-view illustrations.
- "**COMPONENT TESTING**" procedures (CELL 149) that tell the user how to perform diagnostic tests on various circuits.
- **Connector End Views** are now located at the end of individual cells and are shown for connectors with five or more cavities; for connectors with ten or more cavities, a circuit function chart is provided.
- **NOTES, CAUTIONS and WARNINGS** that contain important safety information.
- Full view "**COMPONENT LOCATION VIEWS**" (CELL 151) to help locate on-vehicle components.
- Circuit voltages have been added to schematic pages to help simplify troubleshooting. Starting with this edition of the EVTM nonessential troubleshooting hints have been deleted.
- **Cellular Pagination:** A specific section (or cell) in all EVTMs is numbered by cell and starts with page 1. Example: "**HOW TO USE THIS MANUAL**" is CELL 2 and begins with page 2-1.

...r all electrical connectors. "C" numbers are listed in numerical order in ...).

ORDERING INFORMATION

Information about how to order additional copies of this publication or other Ford publications may be obtained by writing to Helm Incorporated at the address shown below or by calling 1-800-782-4356. Other publications available include:

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Table Of Contents

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TABLE OF CONTENTS/INDEX 1–2

IMPORTANT SAFETY NOTICE

Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all motor vehicles, as well as the personal safety of the individual doing the work. This Manual provides general directions for accomplishing service and repair work with tested, effective techniques. Following them will help assure reliability.

There are numerous variations in procedures, techniques, tools, and parts for servicing vehicles, as well as in the skill of the individual doing the work. This Manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Accordingly, anyone who departs from the instructions provided in this Manual must first establish that he compromises neither his personal safety nor the vehicle integrity by his choice of methods, tools or parts.

2–1 HOW TO USE THIS MANUAL

The purpose of this manual is to show electrical and vacuum circuits in a clear and simple fashion to make troubleshooting easier. **NOTES, CAUTIONS** and **WARNINGS** containing important information appear in boxes on text pages.

- **NOTES** describe how switches and other components operate to help complete a particular procedure.
- **CAUTIONS** provide information that could prevent making an error that may damage the vehicle.
- **WARNINGS** provide information to prevent personal injury.

The **WARNINGS** list on page 2-2 contains general warnings to follow when servicing a vehicle.

Components that work together are shown together. All electrical components used in a specific system are shown on one diagram. The circuit breaker or fuse is shown at the top of the page. All wires, connectors, components and splices are shown in the flow of current to ground at the bottom of the page. If a component is used in several different systems, it is shown in several places. For example, the Main Light Switch is electrically a part of many systems and is repeated on many pages.

In some cases, a component may seem (by its name) to belong to a system where it has no electrical connection. For example, Radio Illumination is electrically part of Instrument Illumination, but because it has no electrical connection to the Radio system, it is not shown on the Radio diagram.

Schematic pages now contain references to illustrations. These references are re- ch compo- r to the ap- uit voltages

to help simplify troubleshooting hints. 12V is used to imply battery voltage on a component connector terminal, and 0V is used to show that there should be continuity to ground on that particular terminal. Conditional voltages such as "12V with the ignition switch in RUN" will also be provided. Troubleshooting hints that can't be simplified with circuit voltages will be shown at the end of each cell.

Connector face information specific to a certain cell is now found at the end of that cell. A Connector Face Reference List is provided to locate connector faces that are shown in different cells. Component connectors with five or more terminals are illustrated. Component connectors with ten or more terminals are accompanied by a pinout chart that lists the function of all circuitry associated with that component.

"CIRCUIT OPERATION" (Cell 7) contains descriptions of HOW THE CIRCUIT WORKS for each system as well as reference to the appropriate diagnostic section of the Service Manual. The beginning of each section has a reverse–text block identifying the page on which the corresponding schematic appears.

"GROUNDS"(Cell 10) contains ground circuitry shown in complete detail. This information is useful for checking interconnections of the ground circuits of different systems.

"POWER DISTRIBUTION" (Cell 13) contains power distribution circuitry shown in complete detail. This section displays how the various fuses are powered and in turn, how each system is powered.

"COMPONENT TESTING" (Cell 149) contains testing procedures for various switches. This information includes schematics, component terminal locations and step–by–step procedures.

"COMPONENT LOCATION VIEWS" (Cell 151) contains full–view illustrations which show the location of all components and connectors in the vehicle.

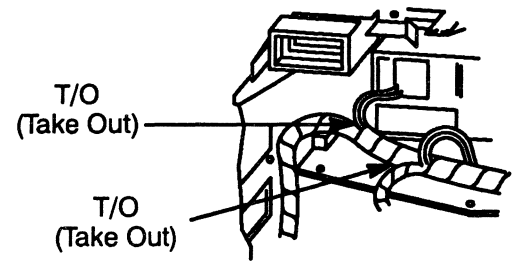
The **"LOCATION INDEX"** (Cell 152) provides the base part numbers, locations, connector face references and illustration references for all components, connectors, splices and grounds.

HELPFUL REMINDERS

Before using the EVTM for troubleshooting, refer to the HELPFUL REMINDERS;

1. The abbreviation T/O, for take out, used in the Location Index (Cell 152), refers to the point at which a group of wires branch off the harness trunk. Refer to the wiring harness illustration.

Wiring harness at back of Instrument Panel, showing typical T/O (Take Out) locations



2. If a connector serves the same purpose in two separate versions (e.g., EFI/Carb), but is physically different, *two* connector numbers are used. However, if a connector serves the same purpose in two separate versions (e.g., EFI/Carb) and is physically the same, but the wire colors are different, only *one* connector number is used. If the same physical connector is used more than once, then more than *one* connector number is used.

HELPFUL REMINDERS (CONTINUED)

3. Wiring schematics provide a picture of how and under what conditions the circuit is powered, of the current path to circuit components, and of how a circuit is grounded. Each circuit component is named (underlined titles). Wire and connector colors are listed (standard Ford color abbreviations are used):

COLOR ABBREVIATIONS

BL	**Blue**	**N**	**Natural**
BK	**Black**	**O**	**Orange**
BR	**Brown**	**PK**	**Pink**
DB	**Dark Blue**	**P**	**Purple**
DG	**Dark Green**	**R**	**Red**
GN	**Green**	**T**	**Tan**
GY	**Gray**	**W**	**White**
LB	**Light Blue**	**Y**	**Yellow**
LG	**Light Green**		

NOTE: *Whenever a wire is labeled with two colors, the first color listed is the basic color of the wire, and the second color listed is the stripe marking of the wire.*

4. When reporting Vehicle Repair Location Codes to Ford Parts and Service Division, refer 160 (beginning on page 160-1). Note: l (begin- hicle Re-

5. **WARNINGS**

- *Always wear safety glasses for eye protection.*
- *Use safety stands whenever a procedure requires being under a vehicle.*
- *Be sure that the* **Ignition Switch** *is always in the OFF position, unless otherwise required by the procedure.*
- *Set the parking brake when working on any vehicle. An automatic transmission should be in PARK. A manual transmission should be in NEUTRAL.*
- *Operate the engine only in a well-ventilated area to avoid danger of carbon monoxide.*
- *Keep away from moving parts, especially the fan and belts, when the engine is running.*
- *To prevent serious burns, avoid contact with hot metal parts such as the radiator, exhaust manifold, tail pipe, catalytic converter, and muffler.*
- *Do not allow flame or sparks near the battery. Gases are always present in and around the battery cell. An explosion could occur.*
- *Do not smoke.*
- *To avoid injury, always remove rings, watches, loose hanging jewelry, and loose clothing.*

HOW TO FIND ELECTRICAL CONCERNS

TROUBLESHOOTING STEPS

These six steps present an orderly method of troubleshooting.

Step 1. Verify the concern.

- Operate the complete system to check the accuracy and completeness of the customer's complaint.

Step 2. Narrow the concern.

- Using the EVTM, narrow down the possible causes and locations of the concern to pinpoint the exact cause.
- Read the description of *Circuit Operation* and study the wiring schematic. You should then know enough about the circuit operation to determine where to check for the trouble. Further information can be found by referring to the Service Manual pages listed after *Circuit Operation.*

Step 3. Test the cause.

- Use electrical test procedures to find the specific cause of the symptoms.
- The *Component Location reference bars* and the pictures will help you find components. The Location Index (at the end of the manual) gives component location information for connectors, diodes, resistors, splices and grounds.

Step 4. Verify the cause.

- Confirm that you have found the correct cause by connecting jumper wires and/or temporarily installing a known good component and operating the circuit.

HOW TO FIND ELECTRICAL CONCERNS

Step 5. Make the repair.

- Repair or replace the inoperative component.

Step 6. Verify the repair.

- Operate the system as in Step 1 and check that your repair has removed all symptoms without creating any new symptoms.

Some engine circuits may need special test equipment and special procedures. See the *Service Manual* and other service books for details. You will find the circuits in this manual to be helpful with those special tests procedures.

TROUBLESHOOTING TOOLS

JUMPER WIRE

This is a test lead used to connect two points of a circuit. A Jumper Wire can bypass an open to complete a circuit.

WARNING

Never use a jumper wire across loads (motors, etc.) connected between hot and ground. This direct battery short may cause injury or fire.

ETER

oltage. Con-
d, and posi-
ng point.

OHMMETER

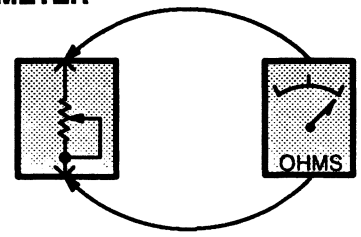


Figure 1–Resistance Check

An Ohmmeter shows the resistance between two connected points (Figure 1).

TEST LAMP

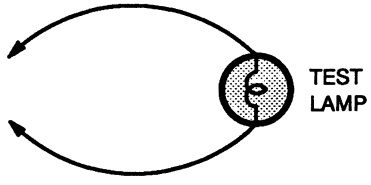


Figure 2–Test Lamp

A Test Light is a 12-volt bulb with two test leads (Figure 2).

Uses: Voltage Check, Short Check

SELF-POWERED TEST LAMP

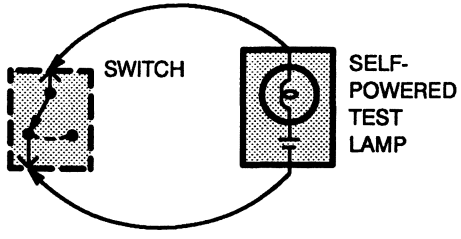


Figure 3–Continuity Check

The Self-Powered Test Lamp is a bulb, battery and set of test leads wired in series (Figure 3). When connected to two points of a continuous circuit, the bulb glows.

Uses: Continuity Check, Ground Check

CAUTION

When using a self-powered test lamp or ohmmeter, be sure power is off in circuit during testing. Hot circuits can cause equipment damage and false readings.

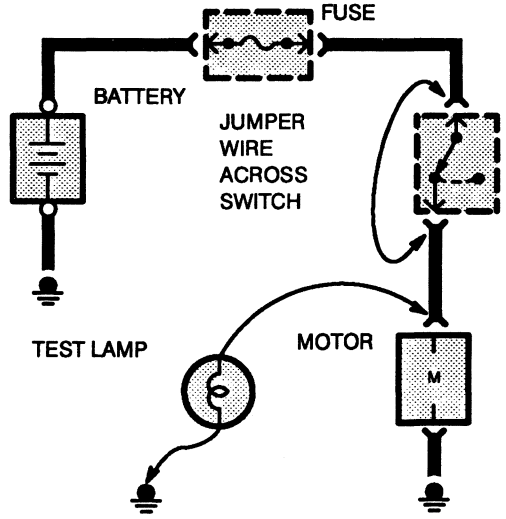


Figure 4—Switch Circuit Check and Voltage Check

In an inoperative circuit with a switch in series with the load, jumper the terminals of the switch to power the load. If jumpering the terminals powers the circuit, the switch is inoperative (Figure 4).

HOW TO FIND ELECTRICAL CONCERNS (CONTINUED)

CONTINUITY CHECK (Locating open circuits)

Connect one lead of Self-Powered Test Lamp or Ohmmeter to each end of circuit (Figure 3). Lamp will glow if circuit is closed. Switches and fuses can be checked in the same way.

VOLTAGE CHECK

Connect one lead of test lamp to a known good ground or the negative (-) battery terminal. Test for voltage by touching the other lead to the test point. Bulb goes on when the test point has voltage (Figure 4).

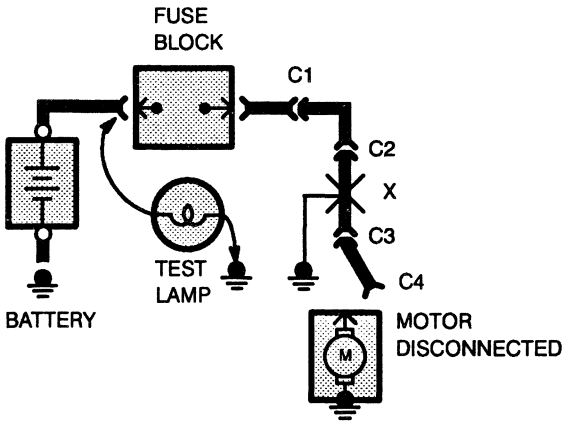


Figure 5—Short Check

A fuse that repeatedly blows is usually caused by a short to ground. It's important to be able to lo- a short quickly (Figure 5).

the fuse.

ough the

(Connector C4 in Figure 5)

- Lights: remove bulbs.

3. Turn Ignition Switch to RUN (if necessary) to power fuse.
4. Connect one Test Lamp lead to hot end of blown fuse. Connect other lead to ground. Bulb should glow, showing power to fuse. *(This step is just a check to be sure you have power to the circuit.)*
5. Disconnect the test lamp lead that is connected to ground, and reconnect it to the load side of the fuse at the connector of the disconnected component. (In Figure 5, connect the test lamp lead to connector C4.)

- If the Test Lamp is off, the short is in the disconnected component.
- If the Test Lamp goes on, the short is in the wiring. You must find the short by disconnecting the circuit connectors, one at a time, until the Test Lamp goes out. For example, in figure 5 with a ground at X, the bulb goes out when C1 or C2 is disconnected, but not after disconnecting C3. This means the short is between C2 and C3.

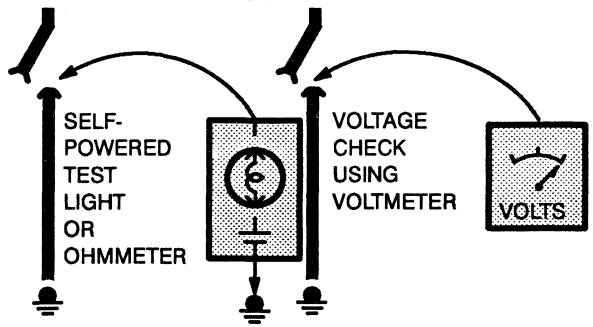


Figure 6—Ground Check

Turn on power to the circuit. Perform a Voltage Check between the suspected inoperative ground and the frame. Any indicated voltage means that the ground is inoperative (Figure 6).

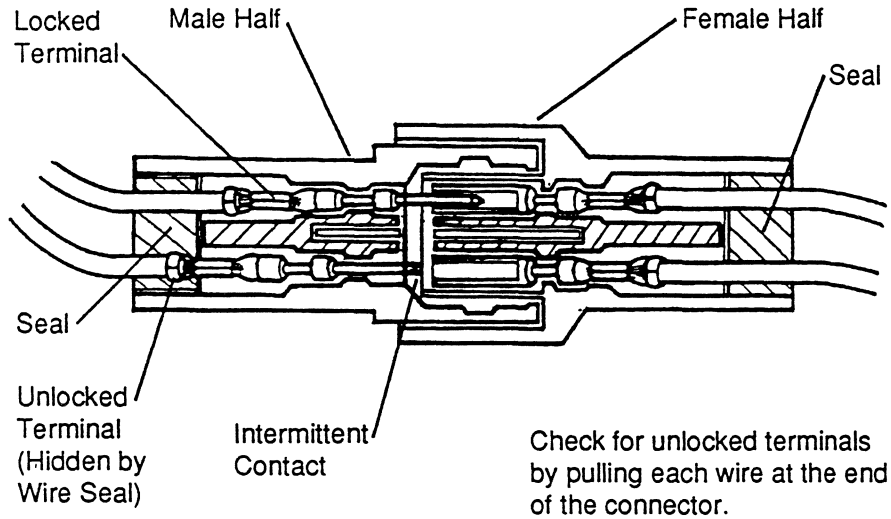
Turn off power to the circuit. Connect one lead of a Self-Powered Test Lamp or Ohmmeter to the wire in question and the other lead to a known ground. If the bulb glows, the circuit ground is OK (Figure 6).

The circuit schematics in this manual make it easy to identify common points in circuits. This knowledge can help narrow the concern to a specific area. For example, if several circuits fail at the same time, check for a common power or ground connection (See *Power Distribution* or *Grounds*). If part of a circuit fails, check the connections between the part that works and the part that doesn't work.

For example, if lo beam headlamps work, but the high beams and the indicator lamp don't work, then power and ground paths must be good. Since the dimmer switch is the component that switches this power to the high beam lights and indicator, it is most likely the cause of failure.

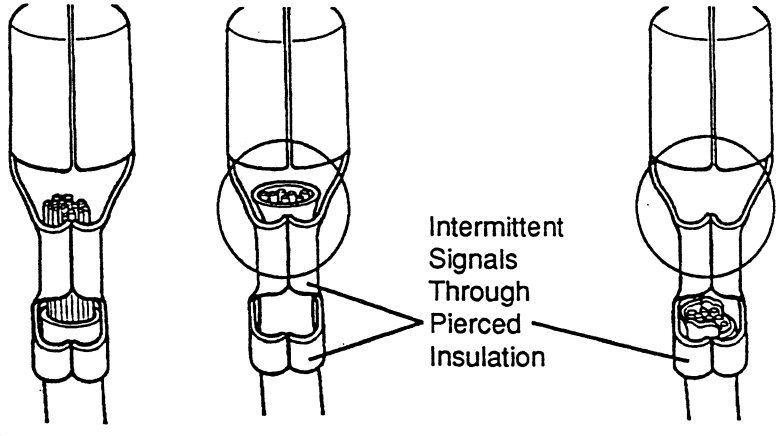
TROUBLESHOOTING WIRING HARNESS AND CONNECTOR HIDDEN CONCERNS

The following illustrations are known examples of wiring harness, splices and connectors that will create intermittent electrical concerns. The concerns are hidden and can only be discovered by a physical evaluation as shown in each illustration.

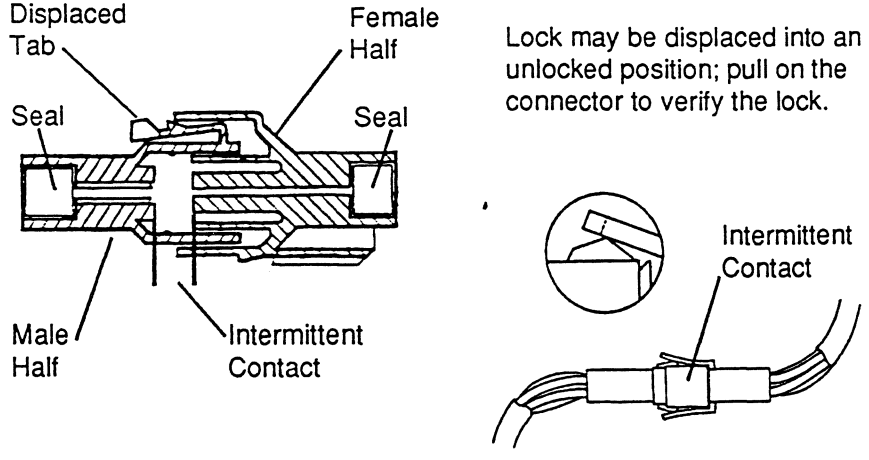


Check for unlocked terminals by pulling each wire at the end of the connector.

TERMINAL NOT PROPERLY SEATED

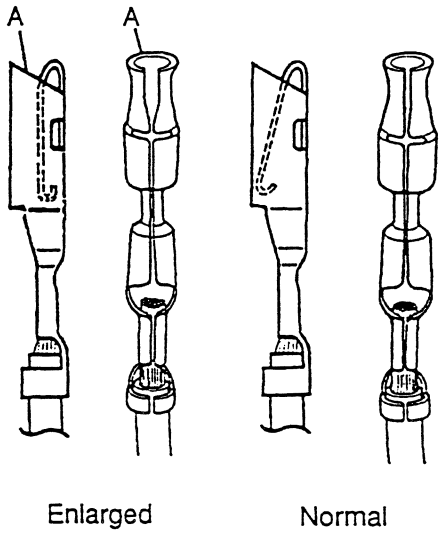


ATION STRIPPING



Lock may be displaced into an unlocked position; pull on the connector to verify the lock.

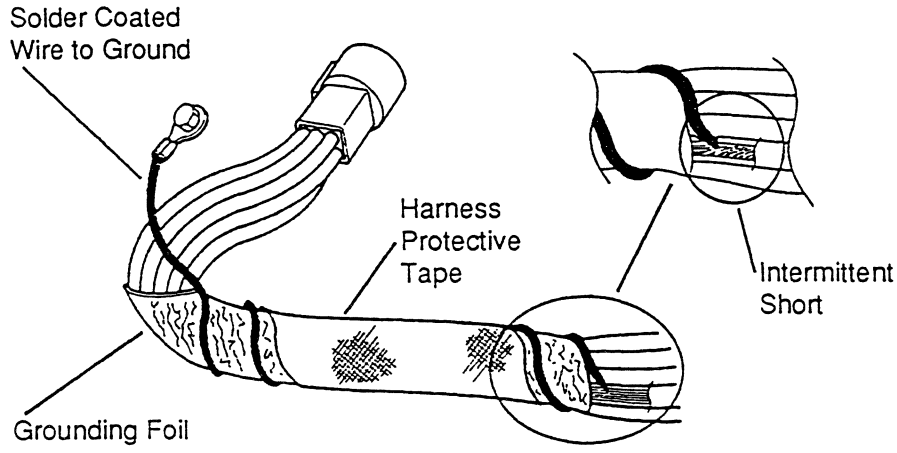
PARTIALLY MATED CONNECTORS



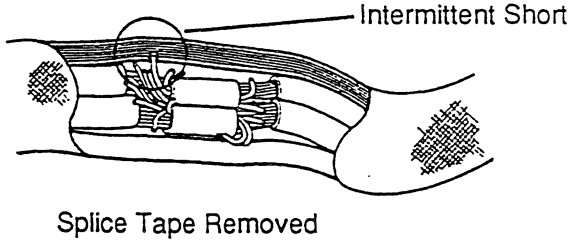
Any probe entering the terminal may enlarge the contact spring opening creating an intermittent signal. Insert the correct mating terminal (Location A) from the service kit and feel for a loose fit.

DEFORMED (ENLARGED) FEMALE TERMINALS

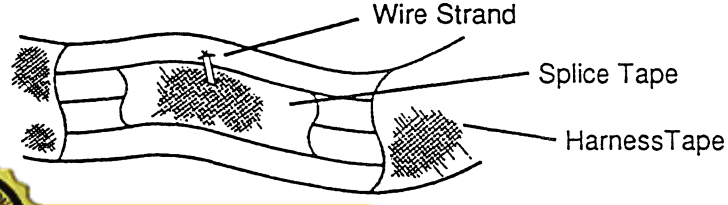
Solder coated wire pierced through the insulation of another circuit.



ELECTRICAL SHORT INSIDE THE HARNESS

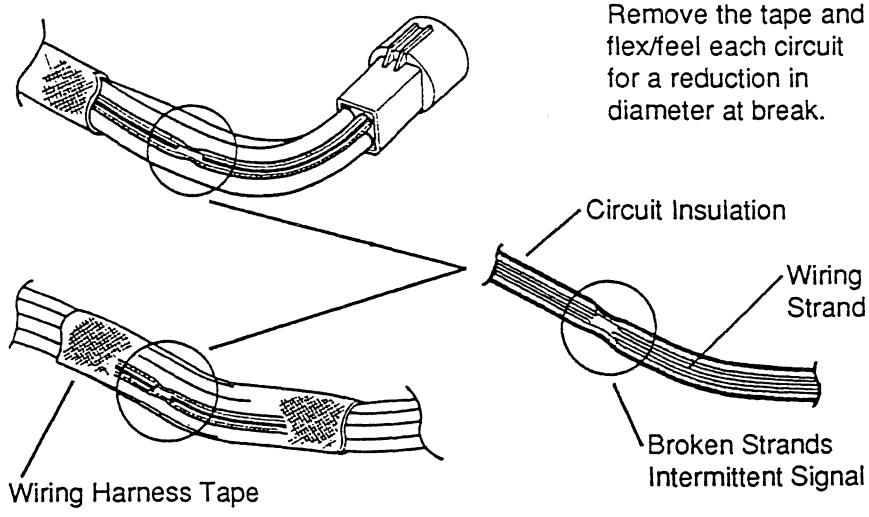


Operate the system and flex the harness at splice location noted in Section 152.



RT WITHIN THE HARNESS

Remove the tape and flex/feel each circuit for a reduction in diameter at break.



BROKEN WIRE STRANDS IN HARNESS

HOW TO FIND THE VACUUM CONCERNS

These six steps present an orderly method of troubleshooting.

Step 1. Verify the concern.

- Operate the system and observe all symptoms to check the accuracy and completeness of the customer's complaint.

Step 2. Narrow the concern.

- Narrow down the possible causes and location of the concern to pinpoint the exact cause.

Step 3. Test the cause.

- Use test procedures to find the specific cause of the symptoms.

Step 4. Verify the cause.

- Confirm that you have found the right cause by operating the parts of the circuit you think are good.

Step 5. Make the repair.

- Repair or replace the inoperative component.

Step 6. Verify the repair.

- Operate the system as in Step 1. Check that your repair has removed all symptoms without creating any new symptoms.

NOTE: Vacuum system problems fall into roups:

tor dia-

mo-

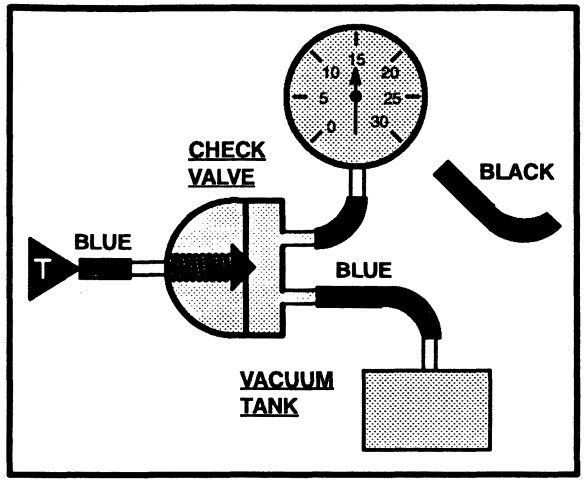


Figure1 - System Supply Test

Vacuum Supply Test

1. Connect Vacuum Tester to system side of Check Valve (Figure 1).
2. Start engine. Gauge should show approximately 15 inches of vacuum.
3. Turn off engine, and observe gauge:
   - If vacuum holds, supply OK.
   - If vacuum fails, replace Check Valve or Tank.

Leak Test

1. Connect Vacuum Gauge and Vacuum Pump (Figure 2) to system hose in place of tank.
2. Open valve and start pump. Operate control in all modes.
3. Listen for hiss and observe gauge.

NOTE: Hissing is normal at Function Control when changing modes.

If system hisses or loses vacuum, find system leak as follows:

1. Turn on Vacuum Pump and check vacuum build-up.
2. Stop pump; vacuum should drop.
3. Clamp supply hoses with needlenose pliers, one at a time, until vacuum stops dropping (Figure 2).
4. Check vacuum schematic to find components in that line.
5. Clamp hoses through circuit to find leak.

Component Test

1. Connect Vacuum Tester to component.
2. Pump Vacuum Tester. Check that all components operate correctly and vacuum holds.
3. Replace components if vacuum does not hold.

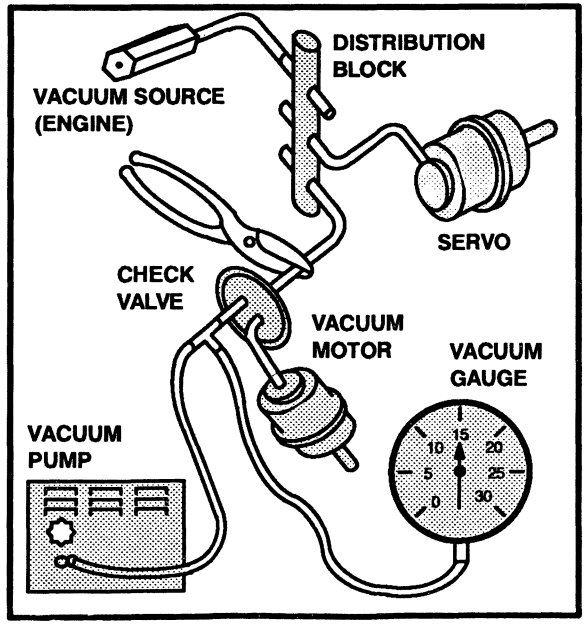


Figure 2 - Testing For Leaks In Typical Vacuum System

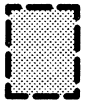
SAE J1930 NOMENCLATURE STANDARDS

Certain Ford component names have been changed in this EVTM to conform to Society of Automotive Engineers (SAE) directive J1930.

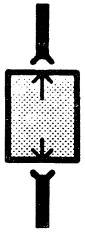
SAE J1930 standardizes automotive component names for all vehicle manufacturers. The table below lists new 1993 SAE J1930 component names and the obsolete 1992 component names.

1993 BRONCO/F–SERIES COMPONENT NAMES	1992 BRONCO/F–SERIES COMPONENT NAMES
Barometric Pressure (BARO) Sensor	Barometric Pressure (BP) Sensor
Clutch Pedal Position Switch	Clutch Interlock Switch
Clutch Pedal Position Switch Jumper	Clutch Interlock Switch Jumper
Distributor Ignition (DI)	TFI Thick Film Ignition
DSS Data Link Connector	DSS Test Connector
Engine Controls	Electronic Engine Control
Engine Speed Sensor	Engine RPM Sensor (RPMS)
Heated Oxygen Sensor (HO2S)	Heated Exhaust Gas Oxygen (HEGO) Sensor
Idle Air Control (IAC) Valve	Idle Air Bypass Valve
Ignition Control Module (ICM)	TFI Ignition Module
Inertia Fuel Shutoff (IFS)	Inertia Switch (IS)
Intake Air Temperature (IAT) Sensor	Air Charge Temperature (ACT) Sensor
Malfunction Indicator Lamp	Check Engine Light
Multiport Fuel Injector (MFI)	Electronic Fuel Injector (EFI)
Park/Neutral Position Switch	Backup/Neutral Safety Switch
PCM Power Diode	EEC Power Diode
Power Relay	EEC Power Relay
	EEC Module
3)	Thermactor Air Bypass (TAB)
D)	Thermactor Air Diverter (TAD)
	VIP Test Connector

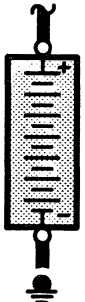
ELECTRICAL SYMBOLS



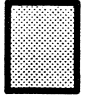
DASHED COMPONENT BOX
ONLY PART OF THE COMPONENT IS SHOWN ON THE PAGE: THE COMPONENT IS SHOWN COMPLETE IN ANOTHER LOCATION



COMPONENT WITH CONNECTORS

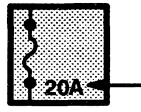


BATTERY



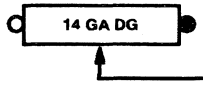
SCREW TERMINAL ON COMPONENT

SEALED ELECTRONIC COMPONENT
ANY CIRCUITRY SHOWN INSIDE THE BOX IS A FUNCTIONAL



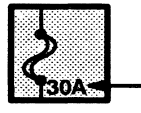
FUSE

CURRENT RATING



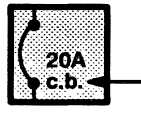
FUSIBLE LINK

WIRE SIZE AND COLOR



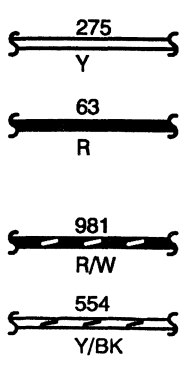
MAXI–FUSE
or
FUSIBLE LINK CARTRIDGE

CURRENT RATING



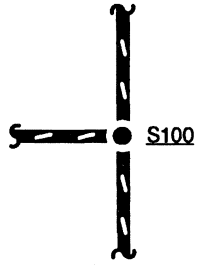
CIRCUIT BREAKER

CURRENT RATING

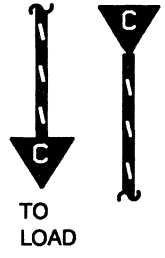


SOLID WIRE

STRIPED WIRE

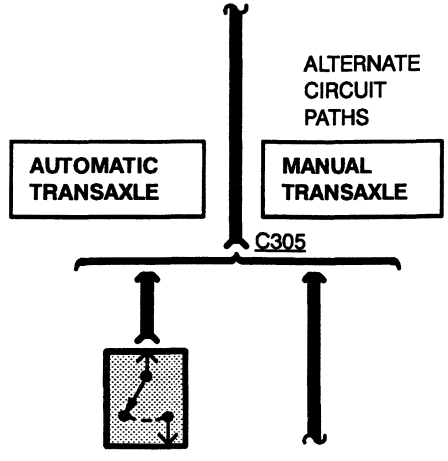


SPLICE OR CRIMP TERMINAL

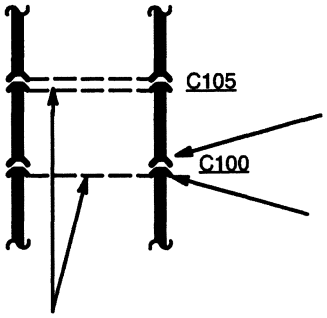


"CUT" WIRES REFERENCED BETWEEN PAGES
ARROWS SHOW CURRENT FLOW FROM POWER TO GROUND

"REFERENCE" WIRES
COMPLETE WIRING SHOWN ON ANOTHER PAGE



ELECTRICAL SYMBOLS

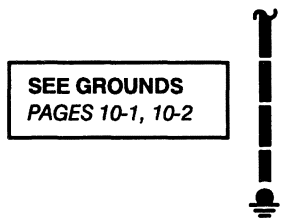


SOCKET

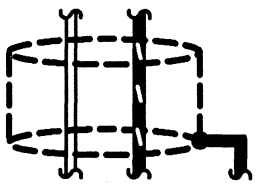
IN-LINE CONNECTOR

PIN OR BLADE

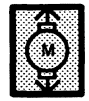
SINGLE OR DOUBLE DASHED LINE INDICATES THAT WIRE ON LEFT ALSO PASSES THROUGH THE SAME CONNECTOR



DASHED WIRE
CIRCUITRY IS NOT SHOWN IN COMPLETE DETAIL, BUT IS COMPLETE ON ANOTHER PAGE



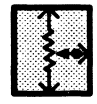
SHIELD
WIRES ARE COVERED BY A SHIELD



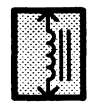
MOTOR

HEATING ELEMENT

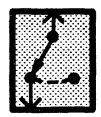
THERMISTOR



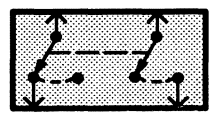
RHEOSTAT OR POTENTIOMETER



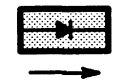
SOLENOID



SWITCH



GANGED SWITCHES
CONTACTS MOVE AT THE SAME TIME



DIODES
CURRENT FLOWS IN DIRECTION OF ARROW ONLY

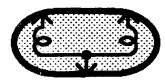
CAPACITOR

TRANSISTOR

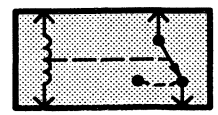
GAUGE

LIGHT BULB

LIGHT EMITTING DIODE (LED)

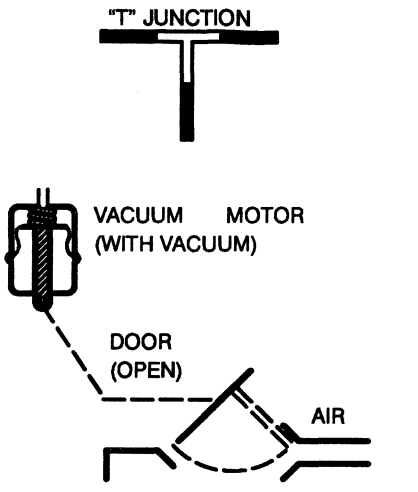


DUAL FILAMENT LIGHT BULB



RELAY
CONTACTS CHANGE POSITION WITH CURRENT THROUGH COIL

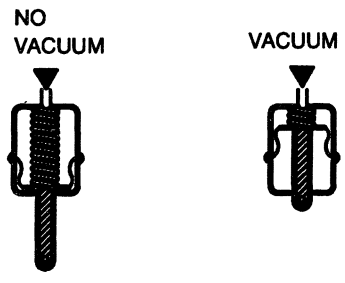
VACUUM SYMBOLS



VACUUM ON VACUUM MOTOR PULLS DOOR OPEN TO LET AIR PASS THROUGH

VACUUM MOTOR OPERATIONS

SINGLE DIAPHRAGM MOTOR



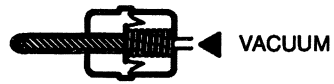
Vacuum motors operate like electrical sole- mechanically pushing or pulling a shaft be- fixed positions. When vacuum is applied, the shift is pushed all the way out by a spring.

TO SYSTEM

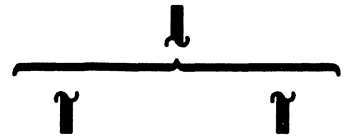
"CUT" HOSES REFERENCED BETWEEN PAGES ARROW SHOWS FROM MANIFOLD FITTING TO COMPONENT

FROM VACUUM DISTRIBUTION

SERVO MOTOR



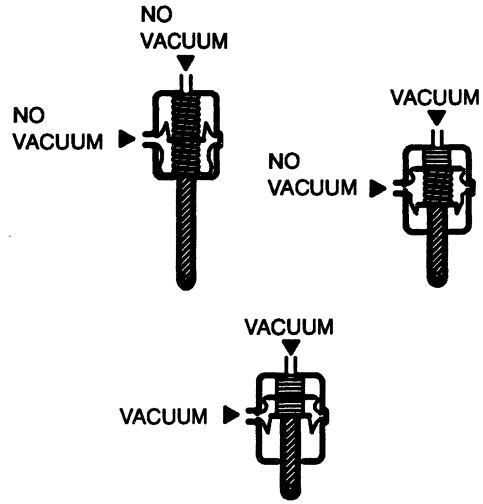
Some vacuum motors, such as the Servo Motor in the Speed Control, can position the actuating arm at any position between fully extended and fully retracted. The Servo is operated by a control valve that applies varying amounts of vacuum to the motor. The higher the vacuum level, the greater the retraction of the motor arm. Servo Motors work nearly the same way as two-position motors, except for the way the vacuum is applied. Servo Motors are generally larger and provide a calibrated control.



ALTERNATE VACUUM PATHS

NOTE
Other vacuum symbols used on vacuum system diagrams are fully explained on these pages.

DOUBLE DIAPHRAGM MOTOR



A double diaphragm motor has three positions (it is actually two motors in one housing). When the top port gets vacuum, the shaft pulls half-way in. When both ports get vacuum, the shaft pulls all the way in.

SECTION 10

GROUNDS

HOW THE CIRCUIT WORKS

The ground circuits show how many different systems may share a common ground point.

While all of the ground circuits are shown complete, additional ground circuits may exist in the vehicle. Any ground circuit not shown in cell 10 is shown complete in the appropriate system schematic.

All wires are 57 (BK) unless otherwise noted.

SECTION 12

CHARGING SYSTEM

HOW THE CIRCUIT WORKS

With Integral Regulator

The Alternator is belt-driven by the engine and generates power to keep the Battery fully charged and to operate electrical systems in the vehicle.

Alternator output is variable and depends on the speed at which the alternator rotor spins, as well as the amount of current passing through the rotor winding. Current flow through the rotor winding is controlled by a Regulator that is built into the Alternator.

The Alternator generates alternating current, which is passed through a series of rectifier diodes and converted to direct current.

Charge Indicator

With the Ignition Switch in START or RUN, battery voltage is present at the Charge Indicator.

If the Alternator is not generating power, the Regulator inside the Alternator grounds the Charge Indicator through circuit 904 (LG/R). The Charge Indicator illuminates.

When the Alternator is generating power, the Regulator inside the Alternator applies battery voltage to the Charge Indicator through circuit 904 (LG/R). With battery voltage present at both ends of the Charge Indicator, there is no current flow and the Charge Indicator does not illuminate.

For diagnostic information refer to section 14-00 of the Service Manual.

SECTION 13

POWER DISTRIBUTION

HOW THE CIRCUIT WORKS

The Power Distribution circuits show how several systems receive power through the same fuse, circuit breaker or fuse link cartridge.

The circuits shown also indicate whether a particular fuse, circuit breaker or fuse link cartridge receives power directly from the Battery or through the Ignition Switch contacts.

For diagnostic information refer to section 18-01 of the Service Manual.

SECTION 20

RTING SYSTEM

Switch and Starter Relay contacts at all times.

With the Ignition Switch in START (and the Clutch Pedal Position Switch, Park/Neutral Position Switch or Manual Lever Position Sensor closed), current flows through the Ignition Switch, the appropriate transmission switch (mentioned above) and the Starter Relay coil to ground. The Starter Relay coil is energized and its contacts close.

SECTION 20 (cont'd)

Current now flows from the Battery directly through the Starter Relay contacts and Starter Motor to ground; the Motor runs to crank the engine.

The Ignition Control Module (ICM) also receives a start signal with the Ignition Switch in START (and the appropriate transmission switch closed).

Diesel

With the Ignition Switch in START, voltage is applied to the Wait To Start Indicator, which is grounded by the Glow Plug Controller. See Section 26 for Glow Plug Control's circuit operation.

For diagnostic information refer to section 03–06 of the Service Manual.

SECTION 21

IGNITION SYSTEM

HOW THE CIRCUIT WORKS

The Distributor contains no centrifugal or vacuum advance mechanisms. All spark advance/retard is accomplished electronically by the Powertrain Control Module (PCM).

During engine cranking (and after the engine starts), a Hall Effect Switch inside the Distributor assembly sends a variable, Profile Ignition Pickup (PIP), voltage signal to the Ignition Control Module (ICM), which is mounted on the left fender wall, and to the PCM, which uses it to determine crankshaft position and engine speed. Using the signal and information provided by other engine control sensors, the PCM determines the appropriate ignition timing. The PCM then sends a Spark Output (SPOUT) timing signal back to the ICM.

The ICM turns the Ignition Coil primary circuit on and off, according to the SPOUT signal from the PCM. Each interruption of the Ignition Coil primary circuit causes the Ignition Coil secondary circuit to produce an open circuit high voltage pulse of up to 40,000 volts. These high voltage pulses are routed to the Distributor, which sends them to the spark plugs.

The PCM monitors the ICM'S control of the Ignition Coil through the Ignition Diagnostic Monitor (IDM) circuit.

If the ICM does not receive a SPOUT signal from the PCM, the ICM will set timing at a fixed value.

For diagnostic information, refer to Section 8A of the Powertrain Control/Emissions Diagnosis Manual.

SECTION 23

ENGINE CONTROLS (4.9L)

HOW THE CIRCUIT WORKS

The Engine Controls System includes a Powertrain Control Module (PCM) that receives inputs from various sensors, and uses the input informa-
ti ntrol (1) Fuel Flow, (2) Exhaust Gas Recir-
GR), (3) Ignition and (4) Evaporative
CM work
my and
s.
P
to the
P nents.

When the Ignition Switch is turned to START or RUN, voltage is applied to the PCM Power Relay coil, and the Relay's contacts close.

Voltage is also applied through the PCM Power Relay contacts to the Fuel Pump Relay, the Fuel Injectors, the PCM, the EGR Solenoid, Secondary Air Injection Solenoids, Idle Air Control, and Canister Purge Solenoid.

Fuel Flow

The 4.9L Multiport Fuel Injection (MFI) engine uses Fuel Injectors, mounted in the intake manifold at the intake port, to meter fuel into the engine.

The Fuel Injectors are divided into two groups of three. With each crankshaft revolution, one group of Fuel Injectors is energized. The next crankshaft revolution energizes the second group of Fuel Injectors.

The PCM controls the injectors' "on time" or pulse width. The PCM determines the appropriate injector pulse width and outputs a command to the injector to meter the exact quantity of fuel.

The electric Fuel Pump supplies fuel under pressure to the fuel rail and the Fuel Injectors. When the Ignition Switch is in START or RUN, voltage is applied from the PCM Power Relay to the Fuel Pump Relay coil. The coil is grounded by the PCM, the relay contacts close and voltage is applied to the electric Fuel Pump.

SECTION 23 (cont'd)

The Inertia Fuel Shutoff is a safety device that cuts voltage to the Electric Fuel Pump in the event of a collision. Once the Inertia Fuel Shutoff opens it must be reset manually.

Exhaust Gas Recirculation (EGR)

The PCM controls exhaust gas recirculation by varying the duty cycle of the voltage applied to the EGR Control Solenoid. This solenoid, in turn, regulates the amount of vacuum applied to the EGR valve. The EGR Valve Position Sensor indicates valve position to the PCM by providing a voltage signal proportional to the EGR position, depending on engine operating conditions.

Secondary Air Injection System

The efficiency of the catalytic converter depends upon the temperature and chemical composition of the exhaust gases.

A Secondary Air Injection System, including a Secondary Air Injection Bypass (AIRB) and Secondary Air Injection Diverter (AIRD), controls the flow of secondary air to the exhaust manifold, catalytic converter, or to the atmosphere, depending on engine operating conditions.

When the AIRB Solenoid is OFF (deenergized), secondary air is dumped into the atmosphere. When the AIRB Solenoid is (ON) energized, and the AIRD Solenoid is OFF (deenergized), secondary air is routed to the catalytic converter. When the AIRB Solenoid and the AIRD Solenoid are both ON (energized), secondary air is routed to the exhaust manifold.

Canister Purge Solenoid

The Powertrain Control Module (PCM) controls the Canister Purge Solenoid. When the PCM grounds the Canister Purge Solenoid, fuel vapors collected by the carbon canister are released and burned by the engine.

Idle Air Control (IAC)

The Idle Air Control (IAC) regulates engine idle speed by controlling the duty cycle of the Idle Air Control Valve.

Knock Sensor

The Knock Sensor signals the PCM to retard timing if the engine knocks during operation.

Engine Coolant Temperature (ECT) Sensor

The Engine Coolant Temperature (ECT) Sensor is a thermistor in which resistance decreases as engine coolant temperature increases. The PCM detects the voltage drop across the ECT Sensor and uses this information to help calculate fuel delivery, spark timing and EGR control.

Throttle Position Sensor (TPS)

The Throttle Position Sensor (TPS) is a potentiometer with a DC voltage output that varies with throttle plate angle. By monitoring the TPS output, the PCM calculates fuel delivery requirements based on driver demand.

Intake Air Temperature (IAT) Sensor

The Intake Air Temperature (IAT) Sensor is a thermistor in which resistance decreases as intake air temperature increases. The PCM detects the voltage drop across the IAT Sensor and uses this information to help calculate fuel delivery, spark timing, and EGR control.

Manifold Absolute Pressure (MAP) Sensor

The Manifold Absolute Pressure (MAP) Sensor measures the pressure in the intake manifold and provides this information as a variable frequency signal to the PCM. With the Ignition Switch in the KEY ON/ENGINE OFF position, the MAP Sensor measures the barometric pressure in the intake manifold.

EGR Valve Position Sensor

The PCM uses the EGR Position Sensor to check the position of the EGR Vacuum Regulator Solenoid. The PCM also uses the EGR Position Sensor to calculate the proper amount of EGR flow necessary to reduce NO_2 emissions. The PCM then determines the proper operating cycle for the EGR Vacuum Regulator Solenoid.

Heated Oxygen Sensor (HO2S)

The Heated Oxygen Sensor (HO2S) provides to the PCM a voltage that regulates the air/fuel ratio by sensing the oxygen content of the exhaust gases. Too much oxygen indicates a lean mixture, while too little oxygen indicates a rich mixture.

For diagnostic information, refer to the Powertrain Control/Emissions Diagnosis Manual.

NG)

The Engine Controls System includes a Powertrain Control Module (PCM) that receives inputs from various sensors. The PCM uses the input information to control (1) Fuel Flow, (2) Exhaust Gas Recirculation (EGR), (3) Ignition and (4) Evaporative Emissions. These four systems and the PCM work together to provide improved fuel economy and performance, and lower exhaust emissions.

SECTION 24 (cont'd)

PCM Power Relay

The PCM Power Relay supplies power to the Powertrain Control Module (PCM) and PCM System-related components. When the Ignition Fuel Switch is turned to START or RUN, voltage is applied to the PCM Power Relay coil, and the Relay's contacts close.

Voltage is also applied through the PCM Power Relay contacts to the Fuel Pump Relay, the Fuel Injectors, the PCM, the EGR Solenoid and the Secondary Air Injection Solenoids.

Fuel Flow

The 5.0L and 5.8L Multiport Fuel Injection (MFI) Engine uses Fuel Injectors, mounted in the Intake Manifold at the Intake Port, to meter fuel into the engine.

The Fuel Injectors are divided into two groups of four. With each crankshaft revolution, one group of Fuel Injectors is energized. The next crankshaft revolution energized the second group of Fuel Injectors.

The PCM controls the injectors' "on time" or pulse width. The PCM determines the appropriate injector pulse width and outputs a command to the injector to meter the exact quantity of fuel.

The Electric Fuel Pump supplies fuel under pressure to the fuel rail and the Fuel Injectors. When the Ignition Switch is in START or RUN, voltage is applied from the PCM Power Relay to the Fuel Pump Relay coil. The coil is grounded by the PCM, the Relay's contacts close and voltage is applied to the Electric Fuel Pump.

The Inertia Fuel Shutoff is a safety device that cuts voltage to the Electric Fuel Pump in the event o[illegible]ion. Once the Inertia Fuel Shutoff opens [illegible] reset manually.

[illegible]lation by va[illegible]ed to the E[illegible], regulates the amount of vacuum applied to the EGR Valve. The EGR Valve Position Sensor indicates valve position to the PCM by providing a voltage signal proportional to the EGR position, depending on engine operating conditions.

Secondary Air Injection System

The efficiency of the Catalytic Converter depends upon the temperature and chemical composition of exhaust gases.

A Secondary Air Injection System, including a Secondary Air Injection Bypass (AIRB) and Secondary Air Injection Diverter (AIRD), controls the flow of secondary air to the Exhaust Manifold, Catalytic Converter, or the atmosphere, depending on engine operating conditions.

When the Secondary Air Injection Bypass (AIRB) Solenoid is OFF (deenergized), secondary air is dumped into the atmosphere. When the Secondary Air Injection Bypass (AIRB) Solenoid is (ON) energized and the Secondary Air Injection Diverter (AIRD) Solenoid is off (deenergized), secondary air is routed to the Catalytic Converter. When the Secondary Air Injection Bypass (AIRB) Solenoid and the Secondary Air Injection Diverter (AIRD) Solenoid are both ON (energized), secondary air is routed to the Exhaust Manifold.

Canister Purge Solenoid

The Powertrain Control Module (PCM) controls the Canister Purge Solenoid. When the PCM grounds the Canister Purge Solenoid, fuel vapors collected by the carbon canister are released and burned by the engine.

Idle Air Control Valve

The Idle Air Control Valve regulates engine idle speed by controlling the duty cycle of the Idle Air Control Valve.

Knock Sensor (5.0L Only)

The Knock Sensor signals the PCM to retard timing if the engine knocks during operation.

Power Steering Pressure Switch (5.0L Without E4OD Only)

The Power Steering Pressure Switch signals the PCM when power steering pressure exceeds 350 psi ±50. The engine then increases idle speed to compensate for the additional load.

Throttle Position Sensor (TPS)

The Throttle Position Sensor (TPS) is a potentiometer with a DC voltage output that varies with throttle plate angle. By monitoring the Throttle Position Sensor (TPS) output, the PCM calculates fuel delivery requirements based on driver demand.

EGR Valve Position Sensor

The PCM uses the EGR Position Sensor to check the position of the EGR Vacuum Regulator Solenoid. The PCM also uses the EGR Position Sensor to calculate the proper amount of EGR flow necessary to reduce NO_2 emissions. The PCM then determines the proper operating cycle for the EGR Vacuum Regulator Solenoid.

Manifold Absolute Pressure (MAP) Sensor

The Manifold Absolute Pressure (MAP) Sensor measures the pressure in the intake manifold and provides this information as a variable frequency signal to the PCM. With the Ignition Switch in the KEY ON/ENGINE OFF position, the MAP Sensor measures the barometric pressure in the intake manifold.

Engine Coolant Temperature (ECT) Sensor

The Engine Coolant Temperature (ECT) Sensor is a thermistor in which resistance decreases as engine coolant temperature increases. The PCM detects the voltage drop across the Engine Coolant Temperature (ECT) Sensor and uses this information to help calculate fuel delivery, spark timing and EGR control.

SECTION 24 (cont'd)

Intake Air Temperature (IAT) Sensor

The Intake Air Temperature (IAT) Sensor is a thermistor in which resistance decreases as intake air temperature increases. The PCM detects the voltage drop across the Intake Air Temperature (IAT) Sensor and uses this information to help calculate fuel delivery, spark timing and EGR control.

Heated Oxygen Sensor (HO2S)

The Heated Oxygen Sensor (HO2S) provides to the PCM a voltage that regulates the air fuel ratio by sensing the oxygen content of the exhaust gases. Too much oxygen indicates a lean mixture, while too little oxygen indicates a rich mixture.

For diagnostic information, refer to the Powertrain Control/Emissions Diagnosis Manual.

SECTION 25

ENGINE CONTROLS (7.5L)

HOW THE CIRCUIT WORKS

The Engine Controls System includes a Powertrain Control Module (PCM) that receives inputs from various sensors. The PCM uses the input information to control (1) Fuel Flow, (2) Exhaust Gas Recirculation (EGR), (3) Ignition and (4) Evaporative Emissions. These four systems and the PCM work together to provide improved fuel economy and performance, and lower exhaust emissions.

PCM Power Relay

The PCM Power Relay supplies power to the PCM and PCM System-related components. When the Ignition Switch is turned to START or RUN, voltage is applied to the PCM Power Relay coil, and the Relay's contacts close.

Voltage is applied through the PCM Power Relay contacts to the Fuel Pump Relay, the Fuel Injectors, the PCM, the EGR Solenoid and the Secondary Air Injection Solenoids.

Flow

7.5L Multiport Fuel Injection (MFI) engine intake manifold at the intake port, to meter fuel into the engine.

The Fuel Injectors are divided into two groups of four. With each crankshaft revolution, one group of Fuel Injectors is energized. The next crankshaft revolution energizes the second group of Fuel injectors.

The PCM controls the injectors' "on time" or pulse width. The PCM determines the appropriate injector pulse width and outputs a command to the injector to meter the exact quantity of fuel.

The Electric Fuel Pump supplies fuel under pressure to the fuel rail and the Fuel Injectors. When the Ignition Switch is in START or RUN, voltage is applied from the PCM Power Relay to the Fuel Pump Relay coil. The coil is grounded by the PCM, the relay's contacts close, and voltage is applied to the Electric Fuel Pump.

The Inertia Fuel Shutoff is a safety device that cuts voltage to the Electric Fuel Pump in the event of a collision. Once the Inertia Fuel Shutoff opens it must be reset manually.

Exhaust Gas Recirculation (EGR)

The PCM controls exhaust gas recirculation by varying the duty cycle of the voltage applied to the EGR Control Solenoid. This solenoid, in turn, regulates the amount of vacuum applied to the EGR Valve. The EGR Valve Position Sensor indicates Valve position to the PCM by providing a voltage signal proportional to the EGR position, depending on engine operating conditions.

Canister Purge Solenoid

The PCM controls the Canister Purge Solenoid. When the PCM grounds the Canister Purge Solenoid, fuel vapors collected by the carbon canister are released and burned by the engine.

Idle Air Control Valve

The Idle Air Control Valve controls engine idle speed by regulating the duty cycle of the Idle Air Control Valve. This permits the PCM to make idle speed corrections to prevent engine stall during cold engine warm-ups. As engine load changes, the diode provides voltage spike suppression.

Secondary Air injection System

A Secondary Air Injection System supplies secondary air to the exhaust manifold(s), to the catalytic converter or to the atmosphere, depending on engine conditions sensed by the PCM through the system inputs.

SECTION 25 (cont'd)

When the Secondary Air Injection Bypass (AIRB) Solenoid is off (deenergized), secondary air is dumped into the atmosphere rather than routed to the catalytic converter or exhaust manifold.

When the Secondary Air Injection Bypass (AIRB) Solenoid is on (energized), the secondary air is routed to the catalytic converter.

Secondary Air Injection System (F450)

The efficiency of the catalytic converter depends upon the temperature and chemical composition of the exhaust gases.

A Secondary Air Injection System, including a Secondary Air Injection Bypass (AIRB) and Secondary Air Injection Diverter (AIRD), controls the flow of secondary air to the exhaust manifold, catalytic converter, or to the atmosphere, depending on engine operating conditions.

When the Secondary Air Injection Bypass (AIRB) Solenoid is OFF (deenergized), secondary air is dumped into the atmosphere. When the Secondary Air Injection Bypass (AIRB) Solenoid is (ON) energized, and the Secondary Air Injection Diverter (AIRD) Solenoid is OFF (deenergized), secondary air is routed to the catalytic converter. When the Secondary Air Injection Bypass (AIRB) Solenoid and the Secondary Air Injection Diverter (AIRD) Solenoid are both ON (energized), secondary air is routed to the exhaust manifold.

Ignition System

The PCM System has a special Distributor and Ignition Module. The PCM Distributor has no vacuum advance mechanism. Instead, all ignition timing is controlled by the PCM.

The PCM receives engine timing information from the Distributor through the Ignition Control Module (ICM). The PCM uses this information to determine spark timing and advance.

Electronic Control Assembly Inputs

The PCM uses information from various sensors to determine engine operating conditions.

Intake Air Temperature (IAT) Sensor

The Intake Air Temperature (IAT) Sensor is a thermistor in which resistance decreases as intake air temperature increases. The PCM detects the voltage drop across the Intake Air Temperature (IAT) Sensor and uses this information to help calculate fuel delivery, spark timing, and EGR control.

Throttle Position Sensor (TPS)

The Throttle Position Sensor is a potentiometer with a DC voltage output that varies with throttle plate angle. By monitoring the Throttle Position Sensor (TPS) output, the PCM calculates fuel delivery requirements based on driver demand.

Engine Coolant Temperature (ECT) Sensor

The Engine Coolant Temperature (ECT) Sensor is a thermistor in which resistance increases as engine coolant temperature decreases. The PCM detects the voltage drop across the Engine Coolant Temperature (ECT) Sensor and uses this information to help calculate fuel delivery, spark timing and EGR control.

Manifold Absolute Pressure (MAP) Sensor

The Manifold Absolute Pressure (MAP) Sensor measures the pressure in the intake manifold and provides this information as a variable frequency signal to the PCM. With the Ignition Switch in the KEY ON/ENGINE OFF position, the MAP Sensor measures the barometric pressure in the intake manifold.

Heated Oxygen Sensor (HO2S)

The Heated Oxygen Sensor (HO2S) provides to the PCM a voltage that regulates the air/fuel ratio by sensing the oxygen content of the exhaust gases. Too much oxygen indicates a lean mixture, while too little oxygen indicates a rich mixture.

For diagnostic information, refer to the Powertrain Control/Emissions Diagnosis Manual.

SECTION 26

GLOW PLUG CONTROL

power to the glow plugs in the combustion chambers.

Glow Plug Controller

The solid-state Glow Plug Controller, attached to the top of the engine block, controls the Glow Plug pre-glow and after-glow time. It also controls the circuit's operation by sensing engine temperature, Glow Plug voltage and after-glow voltage from the start/run circuit.

When the Ignition Switch is turned to START or RUN, voltage from Maxi-fuse K is applied through the Glow Plug Controller to the Wait-To-Start Indicator Lamp.

SECTION 26 (cont'd)

The Glow Plugs heat up in zero to fifteen seconds, depending on engine coolant temperature. After the Glow Plugs heat up, the controller cycling switch opens and turns the Wait-To-Start Indicator Lamp off. The Glow Plugs are now warm enough for the engine to be started.

At the same time the Ignition Switch is turned to RUN, voltage from Maxi-fuse K is applied to the after-glow timer (located inside the Glow Plug Controller). The after-glow timer cycles the Glow Plugs for up to two minutes, depending on engine temperature. The after-glow timer then opens. The Wait-To-Start Indicator Lamp will not light during the after-glow period.

If the Ignition Switch is turned OFF, it can be turned to ON immediately, and the Glow Plug heating cycle will start again.

Diesel Start/Run

The diesel engine uses two batteries to provide extra power for starting and Glow Plug heating. Power is applied from the batteries, through heavy gauge wires, to the Starter Solenoid (located in the Starter Motor assembly). When the Wait-To-Start Indicator goes out, the Ignition Switch can be turned to START.

With the Ignition Switch in START or RUN, voltage is supplied to the Fuel Heater, Fuel Shutoff Solenoid, and the Engine Temperature Switch through Maxi-fuses K and U.

The Fuel Heater is in the Fuel Filter/Separator. It heats the diesel fuel, melting any wax that might clog the filter. The heater has an internal thermostat to turn it on as needed.

The Fuel Shutoff Solenoid controls the flow of fuel into the injection pump. With the Ignition Switch in START or RUN, the Solenoid is energized, and fuel is allowed to flow into the injection pump. When the Ignition Switch is turned off, the solenoid is deenergized, fuel flow stops, and the engine stops running.

The Engine Temperature Switch provides voltage to the Cold Timing Advance Solenoid and the Cold Idle Solenoid. When the engine temperature is below 112°F (44°C), the Engine Temperature Switch is closed. When the Ignition Switch is turned to START or RUN, the solenoids are energized, advancing injection pump timing and engine idle, allowing the engine to run more smoothly when cold. When the engine temperature reaches 112°F (44°C), the Engine Temperature Switch opens. This deenergizes the solenoids, returning the timing and idle to normal.

For diagnostic information, refer to the Powertrain Control/Emissions Diagnosis Manual.

SECTION 30

E4OD TRANSMISSION CONTROL

HOW THE CIRCUIT WORKS

The E4OD Transmission is an electronically controlled four speed automatic transmission. The Powertrain Control Module (PCM) uses inputs from various sensors to control the operation of the [illegible] Transmission. The Transmission Control [illegible] disables operation in fourth gear allowing [illegible] hree gears. [illegible] capabilities [illegible] ver to the PCM and PCM System-related components. When the Ignition Switch is turned to RUN or START, voltage is applied to the PCM Power Relay coil, closing the relay's contacts.

Voltage is supplied to the Shift Solenoids, Electronic Pressure Control (EPC) Solenoid, Torque Converter Clutch Solenoid and the Coast Clutch Solenoid through the PCM Relay. On Diesel application power to the EPC Solenoid is supplied by the PCM and NOT the relay.

Ignition

The Profile Ignition Pickup (PIP) signal is produced by a Hall Effect device in the distributor. It sends RPM and crankshaft position information to the PCM. This information is used by the PCM to determine shift scheduling and EPC.

Throttle Position (TP) Sensor

The Throttle Position (TP) Sensor is a potentiometer. The sensor output is a DC voltage that varies with throttle angle. By monitoring the TP Sensor output, and other sensors, the PCM calculates the proper transmission line pressure, shift scheduling, and Torque Converter Clutch.

Brake On/Off (BOO) Switch

The Brake On/Off Switch is used to prevent converter clutch operation when the brake has been depressed.

This input is ignored if the Throttle Position Sensor indicated more than one third throttle position.

SECTION 30 (cont'd)

Manifold Absolute Pressure (MAP) Sensor (Gasoline)
Barometric Pressure (BARO) Sensor (Diesel)

The Manifold Absolute Pressure (MAP) Sensor measures atmospheric pressure and provides this information as a variable frequency signal to the PCM.

The Barometric Pressure (BARO) Sensor measures barometric pressure and provides this information as a variable frequency signal to the PCM.

The PCM uses this input from the MAP or BARO sensor to adjust transmission line pressure and shift scheduling for vehicle operation at higher altitudes in mountainous areas.

Programmable Speedometer/Odometer Module (PSOM)

The PSOM receives a speed signal from the Rear Anti-Lock Brake Sensor (RABS) and, using a programmed conversion constant, converts it to the standard 8000 pulses per mile vehicle speed signal. The PCM uses this speed signal and other inputs to determine the proper transmission line pressure, shift scheduling, and converter clutch control.

Engine RPM Sensor (Diesel Only)

The frequency of this signal is used to calculate engine speed which is combined with other sensor inputs to determine proper shift scheduling, capacity and Torque Converter Clutch.

Transmission Control Switch (TCS) and Transmission Control Indicator Light (TCIL)

When the TCS has been depressed, the PCM will disable fourth gear operation and turn on the Coast Clutch Solenoid to provide engine braking in third gear. The PCM will turn on the TCIL to indicate that the overdrive cancel mode has been selected.

As a malfunction warning, the TCIL will flash to indicate a short in the Electronic Pressure Control electrical circuit or some sensor failure.

Air Conditioning Clutch (ACC)

The Powertrain Control Module (PCM) receives a signal when the air conditioning compressor clutch is on. With the clutch on the PCM may adjust transmission EPC pressure to compensate for the change in torque supply to the transmission.

Transmission Oil Temperature (TOT) Sensor

The TOT Sensor is located on the transmission solenoid body. This device is a temperature sensitive thermistor. With varying temperature the resistance value of the TOT will change. The PCM monitors the voltage across the TOT to determine the temperature of the transmission oil.

The PCM uses the TOT signal to determine if a "cold start" shift schedule is necessary.

The shift schedule is compensated when the transmission fluid temperature is cold. The PCM strategy will also prevent converter clutch engagement when the fluid is cold.

TRANSMISSION SHIFT SOLENOIDS

Electronic Pressure Control (EPC) Solenoid

The Electronic Pressure Control (EPC) Solenoid is a variable force type solenoid (VFS) The VFS is a electro-hydraulic actuator combining a solenoid and a regulating valve. It supplies Electronic Pressure Control (EPC) which regulates transmission line pressure.

Shift Solenoids (SS1, SS2)

The Shift Solenoids provide gear selection of first through fourth gears by controlling the pressure to the shift valves.

Torque Converter Clutch (TCC)

The Torque Converter Clutch (TCC) Solenoid provides the torque converter clutch control by shifting the converter clutch control valve to apply or release the torque converter clutch.

Coast Clutch Solenoid (CCS)

The Coast Clutch Solenoid (CCS) provides coast clutch control by shifting the coast clutch shift valve. CCS is activated by pressing the transmission control switch or selecting the manual 1 or 2 with the selector lever. In manual 1 and 2, the coast clutch is controlled by the solenoid and also hydraulically to ensure engine braking. In reverse, the coast clutch is controlled hydraulically and the solenoid is off.

For diagnostic information refer to Powertrain Control/Emissions Diagnosis Manual, section 07 of the Service Manual and Transmission Reference Manual.

SECTION 31

SPEED CONTROL

HOW THE CIRCUIT WORKS

The Speed Control Servo/Amplifier Assembly controls vacuum to move the throttle through the Actuator cable.

To operate the Speed Control System, the engine must be running and vehicle speed must be greater than 30 mph. The System is turned on by pressing the Speed Control Switch ON.

Pressing and releasing SET/ACCEL or COAST sends a command to the Speed Control Amplifier. This command makes the vehicle's current speed the set speed. The Programmable Speedometer/Odometer Module (located in the Instrument Cluster) sends a speed signal to the input of the Speed Control Servo/Amplifier Assembly through the 679 (GY/BK) wire. This signal tells the Amplifier to increase or decrease the vacuum to keep the vehicle at the set speed.

Pressing and holding SET/ACCEL increases the vehicle's speed as long as SET/ACCEL is depressed. Releasing SET/ACCEL gives the System a new set speed to maintain. Vehicle speed may also be increased by depressing the accelerator until the higher speed is reached, then depressing and releasing SET/ACCEL.

Pressing and holding COAST decreases the vehicle's speed as long as COAST is depressed. Releasing COAST gives the system a new set speed to maintain.

Pressing OFF turns off the System (grounds LB/BK wire). The System is also turned off when the Ignition Switch is turned off. Depressing the brake pedal cancels the speed controls. The Deactivator Switch also operates when the brake pedal is depressed. This is a backup device that releases the servo. In vehicles with manual transaxle, the Clutch Switch opens when the clutch pedal is depressed and cancels the System.

When the System has been cancelled by depressing the brake or clutch pedal, the last set speed may be resumed by pressing RESUME. This feature will not work if OFF has been depressed or with car speed below 30 mph.

For diagnostic information refer to section 10-03A of the Service Manual.

SECTION 34

ELECTRONIC SHIFT CONTROL

HOW THE CIRCUIT WORKS

The Electronic Shift Control Module is powered at all times through Circuit Breaker 12 of the Fuse Panel to retain its memory capability. Fuse 18 provides power for the switches and the Electric Shift Motor when the Ignition Switch is in RUN. Fuse 10 provides power for nighttime illumination of the Electronic Shift Control Switch.

When the Electronic Shift Control Switch is placed in the 4x4 or LO position, the Electronic Shift Control Module analyzes information from the Shift Position Sensors to determine their current positions. The Module also analyzes information inputs from the Transfer Case Speed Sensor and the MLP Sensor or Park/Neutral Position Switch. The Electronic Shift Control Module then activates the Transfer Case Motor to produce the desired shift, and the 4x4 Indicator lights up.

For diagnostic information, refer to Section 07-07A of the Service Manual.

SECTION 42

LOCK BRAKES

RABS) continuously monitors rear wheel speed with a sensor mounted on the rear axle. When the teeth on exciter ring (mounted on the ring gear) pass the sensor pole piece, an AC voltage with a frequency proportional to the average rear wheel speed is induced in the sensor circuit. If an impending lockup condition occurs during braking, the RABS modulates hydraulic pressure to the rear brakes to inhibit rear wheel lockup.

SECTION 42 (cont'd)

When the brake pedal is applied, the RABS Module senses the drop in rear wheel speed. If the rate of deceleration is too great (indicating an impending rear wheel lockup) the RABS Module activates the RABS Valve Assembly Isolation Solenoid, causing the isolation valve to close. With the isolation valve closed, the rear wheel cylinders are isolated from the master cylinder and the rear brake pressure cannot increase. If the rate of deceleration is still too great, the RABS Module will energize the dump solenoid with a series of rapid pulses to bleed off rear wheel cylinder fluid into an accumulator built into the RABS valve. This reduces the rear wheel cylinder pressure and allows the rear wheels to spin back up to vehicle speed.

When the driver releases the brake pedal at the end of a stop, the isolation valve deenergizes, and any fluid in the accumulator is returned to the master cylinder. Normal brake operation then resumes.

Note:
A RABS/4WABS malfunction may cause the transmission to malfuntion.

System Self-Test

The Rear Anti-lock Brake System has self-test capabilities similar to those in other electronic control systems. Two warning lamps, located in the instrument panel, alert the driver to a System malfunction. The red Brake Warning Lamp indicates a low fluid level or that the parking brake is on. The yellow Anti-lock Brake Indicator lights up for approximately two seconds when the Ignition Switch is first moved to ON or START for circuit prove out. The Indicator also lights up when the RABS Module detects a malfunction in the System.

The self-test feature contains thirteen codes that indicate the area of the malfunction. When a malfunction is detected, the RABS Control Module shuts down the System and the yellow Anti-lock Warning Lamp comes on. This permits normal braking. A code can be retrieved by momentarily grounding the diagnostic pigtail (Black with orange stripe wire) after it is disconnected from KAM (keep - alive power red wire) and counting the flashes of the yellow ABS Lamp. To ensure the fault code is not lost from memory the ignition key must be left in the ON position before the diagnostic lead is disconnected from KAM power. If more than one fault exists, only the first code stored will be displayed. Additional codes will be output only after the first fault is corrected. Two new codes are available for the 1993 model year, code 12 and 16. Code 12 indicates a fault with the base brake system, code 16 is system OK.

4-Wheel Anti-lock Brakes (Bronco)

The 4-Wheel Anti-lock Brake System (4WABS) prevents wheel lockup by automatically modulating the brake pressure during an emergency stop. By preventing wheel lockup, the driver can maintain steering control and stop the vehicle in the shortest possible distance under most conditions.

The 4WABS controls each front brake separately and rear together. The brake pedal force required to engage the 4WABS function may vary with road surface conditions. A dry surface requires much less force.

During 4WABS operation, the driver will sense a pulsation in the brake pedal, accompanied by a slight up and down movement in the pedal height and a clicking sound. The pedal effort and pedal feel during normal breaking are similar to that of a conventional power brake system.

For diagnostic information refer to section 06–09 of the Service Manual.

SECTION 44

HORN/CIGAR LIGHTER

THE CIRCUIT WORKS

gh Fuse 9 to the Cigar Lighter. When the Cigar Lighter is depressed, the contacts close and current flows through the heating element to ground.

Horn

When the Horn Switch on the steering wheel is depressed, the Horn Relay coil is grounded, allowing the Relay to energize. Current flows from Fuse C, in the Engine Compartment Fuse Box, through the Horn Relay to the Low Pitch and High Pitch Horns.

agnostic information, refer to Sections 13-06, 13-07 and 18-04 of the Service Manual.

SECTION 49

FUEL TANK SELECTOR

HOW THE CIRCUIT WORKS

Diesel Engine

Voltage from Fuse 6 is supplied to the Fuel Tank Selector Switch when the Ignition Switch is in START or RUN. The position of the Fuel Tank Selector Switch determines the direction in which the Fuel Tank Selector Valve Motor will move. This determines which Fuel Tank Sender will control the Fuel Gauge position. Vehicles with diesel engines use mechanical fuel pumps.

Gasoline Engine

Voltage is supplied to the Fuel Tank Selector Switch whenever the Fuel Pump relay is energized (contacts closed).

When the Fuel Tank Selector Switch is placed in the FRONT position, power is supplied from the 786 (R) terminal of the Switch to the Front Tank Fuel Pump Motor. Fuel is pumped from the front tank. The signal from the Front Tank Fuel Gauge Sender is carried through the 673 (DB/Y) wire to the Fuel Tank Selector Switch, and then through the 29 (Y/W) wire to the Fuel Gauge in the Instrument Cluster.

When the Fuel Tank Selector Switch is in the REAR position, power is supplied to the Rear Tank Fuel Pump Motor through the 789 (BR/W) wire from the Fuel Tank Selector Switch. The Rear Tank Fuel Gauge Sender signal is transmitted to the Switch through the 675 (Y/LB) wire, and then to the Instrument Cluster through the 29 (Y/W) wire.

For diagnostic information, refer to Section 10-01 of the Service Manual.

SECTION 53

HEATER

HOW THE CIRCUIT WORKS

With the Ignition Switch in RUN and the Heater Control Assembly in any position except OFF, voltage is applied to the Blower Motor. With the Blower Motor Switch in LO, current flows through the Blower Motor and three resistors. In MED-LO, current flows through two resistors. In MED-HI, current flows through one resistor. In HI, current does not flow through a resistor. With the A/C-Heater Function Selector Switch in OFF, the Blower Motor does not run.

Lever Position and Operation

OFF - Vacuum is applied to the Outside-Recirculate Door Vacuum Motor, closing that door to outside air. The Panel Door closes the instrument panel outlets. The Floor-Defrost Door opens the floor outlets. The Blower does not operate and air does not pass through the system.

VENT - Outside air comes through the Outside-Recirculate Air Door. The Panel Door sends air to the instrument panel outlets (vacuum on motor). The Temperature Blend Door controls the air through the Heater Core.

FLOOR - Outside air controlled by the Temperature Control Lever passes through or around the Heater Core. The Panel Door closes and air is sent to the floor outlets (vacuum at ports A and B of the Floor-Defrost Door Vacuum Motor).

FLR/DEF - The Outside-Recirculate Air Door lets in outside air (no vacuum at motor). Vacuum is applied to port A of the Floor-Defrost Door. The door moves to mid-position and air is split between the floor and defrost outlets. The Panel Door closes.

DEFROST - With no vacuum at any Vacuum Motor, air passes through the outlets.

For diagnostic information, refer to Section 12-02 of the Service Manual.

SECTION 54

ER

ntains a Function Selector Switch and Vacuum Valve, a Temperature Control Lever (on the instrument panel), a blower housing assembly, an evaporator assembly and ductwork (behind the instrument panel), and Compressor and Condenser (in the engine compartment).

SECTION 54 (cont'd)

The Function Selector Switch and Vacuum Valve operate together to control system vacuum and electrical operation. Vacuum motors operate doors to direct air flow. The Function Selector Switch connects power to the Blower Motor and to the A/C Clutch Field Coil circuit.

The A/C Clutch Cycling Pressure Switch cuts off power to the A/C Clutch Field Coil when there is low refrigerant pressure.

A/C MAX - The Outside Recirculate Door closes to outside air. The Panel Door sends air to the instrument panel outlets (vacuum on motor). With the Temperature Control Lever in the Cool position, the Temperature Blend Door prevents air flow through the Heater Core.

The Temperature Control Lever moves a control cable connected to the Temperature Blend Door, which directs air through and around the Heater Core to obtain the desired air temperature.

With the Ignition Switch in RUN and the Function Selector Switch in any position except OFF, voltage is applied to the Blower Motor.

The speed of the Blower Motor is regulated by the Blower Switch and Blower Motor Resistor. With the front Blower Switch in LO, current flows through the Blower Motor and three resistors. In MED-LO, current flows through two resistors. In MED-HI, current flows through one resistor. In HI, current does not flow through any resistors. With the Function Selector Switch in OFF, the Blower Motor does not run.

With the Ignition Switch in RUN and the Function Selector Switch in MAX, NORM (A/C), FLR/DEF or DEFROST, the A/C Clutch Field Coil is activated, and the Compressor starts.

Lever Position and Operation

OFF - Vacuum is applied to the Outside Recirculate Door Vacuum Motor, closing that door to outside air. The Panel Door closes the instrument panel outlets. The Floor-Defrost Door opens the floor outlets. The Blower does not operate and air does not pass through the system.

A/C MAX - Outside Recirculate Door closes to outside air. The panel Door sends air to the instrument panel outlets (vacuum on motor). With the Temperature Control Lever in the Cool position, the Temperature Blend Door prevents air flow through the Heater Core.

A/C NORM - Outside air comes through the Outside Recirculate Door. The Panel Door sends air to the instrument panel outlets (vacuum on motor). The Temperature Blend Door controls the air through the Heater Core.

VENT - Air flow is the same as in A/C NORM. The compressor is OFF.

FLOOR - Outside air, controlled by the Temperature Control Lever, is passed through or around the Heater Core. The Panel Door is closed and air is sent to the floor outlets (vacuum at ports A and B of the Floor-Defrost Door Vacuum Motor). The compressor is OFF.

FLR/DEF- The Outside-Recirculate Door lets in outside air (no vacuum at motor). Vacuum is applied at port A of the Floor-Defrost Door. The door moves to mid-position and air is split between the floor and defrost outlets. The Panel Door closes and the A/C compressor operates to dehumidify the air.

DEFROST - With no vacuum at any Vacuum Motor, air passes through the outlets. The compressor operates to dehumidify the air.

For diagnostic information, refer to Sections 12-00 and 12-03B of the Service Manual.

SECTION 56

REAR WINDOW DEFROST (BRONCO)

HOW THE CIRCUIT WORKS

the Ignition Switch in RUN, the Rear Win- Fuse 7.

Pressing the momentary defrost switch ON closes the contacts of the Rear Window Defrost Relay and starts the ten minute (approximate) timing cycle. Current then flows to the Rear Window Defrost Grid. When the Rear Window Defrost Control is released from ON, the solid state circuitry keeps the defrost relay coil energized.

Pressing the Rear Window Defrost Control OFF turns off the defrost relay. This removes power from the Rear Window Defrost circuit.

If the OFF switch is not pressed, power will remain on until the time delay runs out. Then the coil will turn off and remove power from the Rear Window Defrost Grid.

For diagnostic information, refer to Section 01-11 the Service Manual.

SECTION 60

INSTRUMENT CLUSTER

HOW THE CIRCUIT WORKS

When the Ignition Switch is in START or RUN, the gasoline and diesel engine gauges and several indicators are powered by Fuse 17 through the 640 (R/Y) wires.

The Instrument Cluster gauges include the following: Fuel, Oil, Temperature, and Tachometer (optional). Each gauge consists of 2 coils, a magnet and a pointer, which moves in direct proportion to the output of its sender.

When the gauges are powered, a magnetic field is produced. The field varies in direction and strength according to the resistance of the sender.

Fuel Gauge and Fuel Gauge Sender

The Fuel Gauge Sender's resistance controls the magnetic Fuel Gauge's pointer position. The Sender has a resistance of 145 ohms when the fuel tank is full and 22.5 ohms when the fuel tank is empty.

Coolant Temperature Gauge and Sender

The Coolant Temperature Sender's resistance controls the Coolant Temperature Gauge's pointer position. The Sender provides 74 ohms of resistance when the engine coolant is cold and 9.7 ohms when the engine is hot.

The diesel engine's Coolant Temperature Gauge uses an overheat switch that closes at approximately 247^{0}F.

Oil Pressure Gauge and Oil Pressure Switch

The Oil Pressure Switch controls the magnetic Oil Pressure Gauge's pointer position. The Oil Pressure Switch closes under normal engine operating conditions; the Oil Pressure Switch opens with the engine off and no oil pressure.

Tachometer (Optional)

The Tachometer is an electrically operated gauge that indicates engine speed in rpm. In vehicles with gasoline engines, the Tachometer receives its voltage pulses from the ignition coil when the engine is running. In vehicles with diesel engines, the engine's speed is indicated by the Engine RPM Sensor.

Voltmeter

With the Ignition Switch in START or RUN, the Voltmeter measures voltage to indicate the Battery state of charge.

Programmable Speedometer/ Odometer Module

The Programmable Speedometer/Odometer Module includes the Speedometer, the Odometer, and the Trip Odometer, all of which are electronically controlled by a programmable integrated microprocessor. The microprocessor receives a speed signal input from the Differential Speed Sensor (DSS), and uses a programmed conversion constant to convert the signal to the standard 8000 pulses per mile speed signal output. The Programmable Speedometer/Odometer Module is serviceable only as a unit. It is important to keep the Speedometer face-up since speedometer function will be affected by storage in the face-down position.

For Programmable Speedometer/Odometer Module diagnosis, refer to Section 13-02 of the Shop Manual.

For diagnostic information, refer to Section 13-00 of the Service Manual.

SECTION 64

VEHICLE SPEED SIGNAL

HOW THE CIRCUIT WORKS

Programmable Speedometer/Odometer Module receives a speed signal input from the Differential Speed Sensor, and uses a programmed conversion constant to convert the signal to the standard 8000 pulses per mile speed signal output. The speed signal output is proportional to the road speed of the vehicle. The Programmable Speedometer/Odometer Module supplies this signal to all components that require vehicle speed information including the Speed Control Amplifier and the Powertrain Control Module (PCM).

For diagnostic information, refer to Section 10–03A of the Service Manual.

SECTION 65

WARNING INDICATORS (DIESEL)

HOW THE CIRCUIT WORKS

When the Ignition Switch is in START or RUN, the Warning Indicators are powered through Fuse 17.

The Plugged Fuel Filter Indicator illuminates when fuel pressure in the engine exceeds operational limits.

The Wait-to-Start Indicator illuminates for 1 to 15 seconds after the Ignition Switch is placed in the START or RUN position, indicating that the diesel engine is not ready to be started.

The Water-In-Fuel Indicator illuminates when the Ignition Switch is in START or RUN and the Fuel Water Switch senses water in the fuel/water separator sediment bowl.

When water is detected in the fuel/water separator sediment bowl, the bowl must be drained to prevent damage to the fuel injectors. Refer to the Service Manual for draining instructions.

The Engine Warning Indicator illuminates with the Ignition Switch in START as a bulb test and when there is a high coolant temperature condition.

For diagnostic information refer to section 13–03, 13–04, 13–05, 13–09 and 13–10 of the Service Manual.

SECTION 66

WARNING CHIME

HOW THE CIRCUIT WORKS

Seat Belt Warning

When the Ignition Switch is turned to START or RUN, power is supplied to the Warning Chime Module through circuit 640 (R/Y). Power is then supplied through circuit 450 (DG/LG) to illuminate the Fasten Seat Belt Indicator for six seconds, whether or not the driver's seat belt is fastened. If the driver's seat belt is NOT fastened during this time, ground is supplied from the Seat Belt Switch through circuit 85 (BR/LB) to the Warning Chime Module, causing it to sound for six seconds.

Key-in-Ignition Warning

The warning chime sounds when the driver's door is open and the key is in the Ignition Switch. It continues to sound until the key is removed or the door is closed. When the key is in the ignition, ground is supplied to the Warning Chime Module through circuit 158 (BK/PK). When the driver's door is open, power is supplied to the Warning Chime Module through circuit 159 (R/PK).

Headlamps-On Warning

The warning chime sounds when the Main Light Switch is in PARK or HEAD and the driver's door is open, and continues to sound until the switch is moved to OFF or the door is closed. When the Main Light Switch is in PARK or HEAD, power is supplied through circuit 14 (BR) to the Warning Chime Module. When the driver's door is open, power is supplied to the Module through circuit 159 (R/PK).

For diagnostic information refer to section 13–09 of the Service Manual.

SECTION 71

INSTRUMENT ILLUMINATION

Main Light Switch at all times through Fuse 4. When the Main Light Switch is turned to PARK or HEAD, voltage is applied through the switch to the Instrument Illumination Lamps. The amount of voltage that controls the intensity of the lamps can be adjusted by rotating the Dimmer Switch of the Main Light Switch.

For diagnostic information refer to section 13–01 of the Service Manual.

SECTION 81
INTERVAL WIPER/WASHER

HOW THE CIRCUIT WORKS

The Interval Wiper/Washer System allows the driver to select LO speed, HI speed, or interval (INT) wiping action.

During washer operation, with the Wiper Switch in the LO or HI position, normal wiping action occurs. If the Wiper Switch is in the OFF or INT position during washer operation, the wipers operate in LO speed. The wipers will continue to operate in LO speed for a few cycles after the washer button is released to dry off the windshield. The wipers then return to OFF or INT operation.

During Interval operation, the wipers make single low speed wipes separated by a variable length pause of one to fifteen seconds.

When the wiper switch is moved to OFF, the wipers will continue to sweep until they reach the park position. Parking is completed when the motor is braked to a stop by shunting the L and C terminals of the motor through circuits 57 and 28 of the wiper motor switch. Braking occurs when the wiper motor switch moves to the PARK position. The L terminal of the motor is connected to terminal C through the PARK contact of the motor switch and the contacts of the de-energized wiper control module relays.

For diagnostic information, refer to Section 01-16 of the Service Manual.

SECTION 85
HEADLAMPS

HOW THE CIRCUIT WORKS

Battery voltage is applied to the Main Light Switch at all times through Maxi-fuse R . When the Main Light Switch is pulled to HEAD, voltage is applied through the Main Light Switch and the Dimmer Switch to the Headlamps. The Headlamps will operate in either HI or LO Beam, depending upon the position of the Dimmer Switch. The Headlamps are permanently grounded through grounds G100 and G101.

When the Dimmer Switch is in HI, voltage is also applied to the Hi Beam Indicator. The Hi Beam Indicator bulb is powered by the 932 (GY/W) circuit.

Canadian vehicles are equipped with Daytime Running Lamps. See Section 97 for an explanation of this system.

For diagnostic information, refer to Section 17-01 of the Service Manual.

SECTION 86
FOG LAMPS (LIGHTNING)

HOW THE CIRCUIT WORKS

Voltage is applied to the Fog Lamp Switch with the Main Light Switch in Head and the Multi-function Switch in LO. With Fog Lamp Switch in the ON position, the Fog Lamp Relay coil is energized closing its contacts. Voltage is applied to the Fog Lamps through the closed relay from Maxi-Fuse B. The Fog Lamp Switch Indicator illuminates with the switch in the ON position.

For diagnostic information, refer to Section 17-01 of the Service Manual.

Voltage is applied at all times through Fuse 8 to the Main Light Switch, Door Jamb Switches, Glove Compartment Lamp, Map Lamps, and the Cargo Lamp.

SECTION 89 (cont'd)

When the Main Light Switch is turned fully counterclockwise, or if the left or right doors are opened, the Dome Lamp is energized and lights up.

The Map Lamps are energized independently of the Dome Lamp by two switches, one located at each Map Lamp housing.

Outside Cargo Lamp

The Cargo Lamp can be turned on in two ways. It can be turned on when the Main Light Switch is turned fully counterclockwise, or it can be turned on when either the left or right door is opened.

Inside Cargo Lamp (BRONCO)

The Cargo Lamp can be turned on in several ways. It can be turned on manually. It can be turned on when the Main Light Switch is turned fully counterclockwise, or it can be turned on when either the left or right door is opened.

For diagnostic information, refer to Section 17-02 of the Service Manual.

SECTION 90

TURN/STOP/HAZARD LAMPS

HOW THE CIRCUIT WORKS

Turn Signals

With the Ignition Switch in RUN, current flows through Fuse 7, the Turn Flasher, the Multi-function Switch, and on to the Turn Lamps and Indicators.

The Turn Switch sends power to either the Left or Right Turn Lamps.

Hazard Flasher

Current flows through Fuse 13 to the Turn Lamps and Indicators when the Hazard Switch is pulled out.

The Hazard Switch sends pulsing current to both the Right and Left Turn Lamps at the same time.

Stop Lamps

Current flows through Fuse 13 to the Rear Park/Stop/Turn Lamps and the High Mount Stop Lamp when the Brake On/Off Switch is closed.

For diagnostic information, refer to Section 17-01 of the Service Manual.

SECTION 92

EXTERIOR LAMPS

HOW THE CIRCUIT WORKS

The Exterior lamps are powered through Fuse 4 and the Main Light Switch. The Exterior Lamps light when the Main Light Switch is moved to the PARK or HEAD position. Fuse 4 is hot at all times, which allows the driver to leave the Exterior Lamps on whenever necessary.

The Engine Lamp is powered directly from Fuse 8 in the Fuse Panel.

For diagnostic information, refer to Section 17-01 of the Service Manual.

SECTION 93

plied from Fuse E, in the Engine Compartment Fuse Box, to the Manual Lever Position Sensor (E4OD), Park/Neutral Position Switch (C6 or AOD) or Backup Lamp Switch (MTX). With the switch closed, voltage is applied to the Backup Lamps through the 140 (BK/PK) wires.

SECTION 93 (cont'd)

For diagnostic information, refer to Section 17-01 of the Service Manual.

SECTION 95

TRAILER ADAPTER

HOW THE CIRCUIT WORKS

Fuses for the trailer circuits and all the trailer relays are located in the Engine Compartment Fuse Box or Trailer Relay Box (Bronco). Trailer Marker Lamps and Trailer Backup Lamps are powered through Fuse D. Trailer brakes are powered through Maxi-fuse T. The Turn/Stop/Hazard Lamps are powered through Fuse F and Fuse G. The trailer battery charge circuit is powered through Maxi-fuse Q.

For diagnostic information refer to section 02–04 of the Service Manual.

SECTION 97

DAYTIME RUNNING LAMPS (CANADIAN VEHICLES ONLY)

HOW THE CIRCUIT WORKS

The Daytime Running Lamps (DRL) System operates the vehicle's High Beam Headlamps at reduced power during the daytime to make the vehicle more visible to other drivers.

With the Ignition Switch in RUN, the park brake released, and the Headlamps turned OFF, the DRL Module outputs a pulsing voltage at pin 8 to operate the High Beam Headlamps at reduced intensity. When the DRL System is operating, the Hi Beam Indicator is not illuminated.

Applying the park brake or turning on the Headlamps disables the DRL System. Applying the park brake grounds pin 6 of the DRL Module. Turning on the Headlamps in the low beam position applies battery voltage to pin 7 of the Module (and removes the ground input that the DRL Module senses through the Low Beam Headlamps). Turning on the Headlamps in the high beam position applies 12 volts to pin 8 of the DRL Module.

The DRL System is used only on vehicles sold in Canada.

NOTE:

The headlamps may flicker during engine start-up and shut-down on DRL-equipped vehicles if the A/C-Heater Blower Motor is turned ON. This is a normal condition.

Also, during Lo Beam Headlamp operation on a DRL-equipped vehicle, the Hi Beam Indicator will not illuminate when using the flash-to-pass feature.

For diagnostic information, refer to Section 17-01 of the Service Manual.

When the ignition switch is in ACC or RUN, the Master and Right Window Control Switches are powered.

When the Control Switch is placed in either the UP or DN position, current from Circuit Breaker 14 causes the window motor(s) to operate in a clockwise or counterclockwise direction, raising or lowering the window(s).

In the REST position, both motor wires are grounded through separate switch contacts.

SECTION 100 (cont'd)

When the DN switch is pushed, power flows to the DN motor lead. The UP lead acts as ground.

When the UP switch is pushed, power flows to the UP motor lead. The DN lead acts as ground.

The Power Windows are protected by Circuit Breaker 14. Each motor assembly also has a self-resetting circuit breaker to cut off power if a switch is held too long in the UP or DN position.

Tailgate Power Window (Bronco Only)

The Tailgate Power Window Motor includes an internal circuit breaker to cut off power if a switch is held too long in the UP or DN position. The Tailgate Latch Switch prevents the Tailgate Power Window Motor from operating when the tailgate is open.

The Master Tailgate Window Switch, located on the Instrument Panel, is powered by Circuit Breaker 14 when the Ignition Switch is in ACC or RUN. The Tailgate Power Window can also be controlled by a key-operated Tailgate Window Switch, powered at all times by Circuit Breaker 12.

Either switch assembly can send current through the Tailgate Power Window Motor, causing the Motor to turn in a clockwise or counter-clockwise direction, raising or lowering the window in a manner identical to that of the Right and Left Power Window Motors. In the REST position, both wires are grounded through separate contacts.

For diagnostic information, refer to Sections 01-11A and 01-14A of the Service Manual.

SECTION 110

POWER DOOR LOCKS

HOW THE CIRCUIT WORKS

The Power Door Locks are powered at all times by Circuit Breaker 12. When either the Left or Right Door Lock Control Switch is placed in the LOCK position, current flows from Circuit Breaker 12, through the 171 (BK/W) wire, the closed switch contacts, and the 118 (PK/O) wires to the Door Lock Motors, locking all the Doors.

When either the Left or Right Door Lock Control Switch is placed in the UNLOCK position, current flows from Circuit Breaker 12, through the 171 (BK/W) wire, the closed switch contacts, and the 117 (PK/BK) wires to the Door Lock Motors, causing the Door Lock Motors to reverse direction and unlock all the doors.

In the REST position, both Door Lock Motors are grounded through separate switch contacts.

For diagnostic information refer to section 01–11A and 01–14A of the Service Manual.

SECTION 122

POWER LUMBAR SEATS

HOW THE CIRCUIT WORKS

With Circuit Breaker 12 hot at all times, voltage is applied to the Power Lumbar Switch.

Each Lumbar Seat has a switch that changes cushion shape by operating an air pump. Operating the switch in one direction causes the compressor to inflate the bladder; operating the switch in the other direction causes a bleeder valve to deflate the bladder.

For diagnostic information refer to section 01–10 of the Service Manual.

SECTION 124

P

H

Each Power Mirror is equipped with two motors operated by a single joystick–type Directional Control Switch. The Directional Control Switch directs current to the motors. By reversing current flow, each motor operates horizontally (left and right) and vertically (up and down).

The Left and Right Mirror Switch connects the Directional Control Switch to either the Left or Right Power Mirror.

SECTION 124 (cont'd)

For diagnostic information refer to section 01–09 of the Service Manual.

SECTION 130

RADIO

HOW THE CIRCUIT WORKS

With the Ignition Switch in ACC or RUN, voltage is applied through Fuse 11 to operate the Radio.

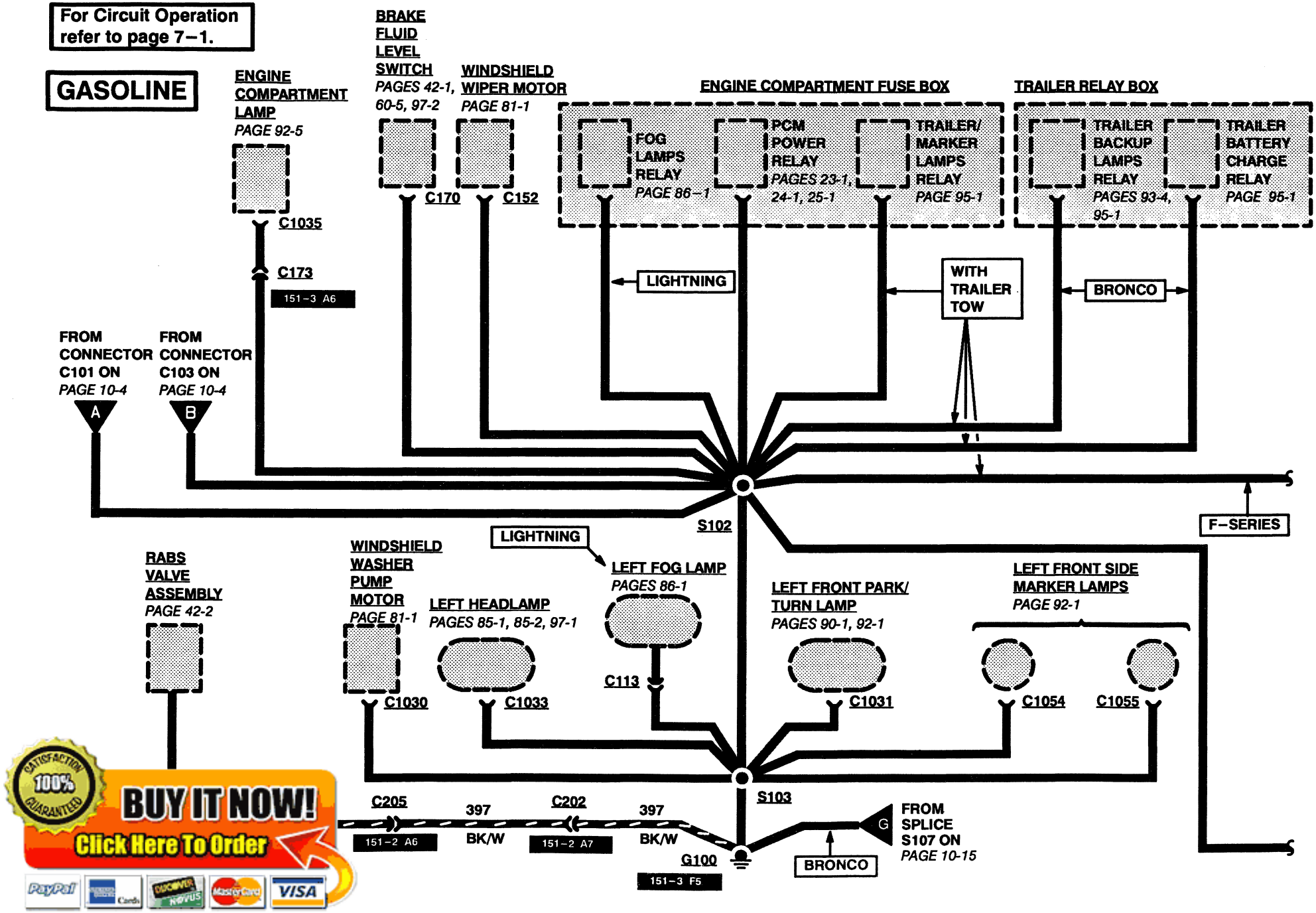
Fuse 8 applies voltage to the Radio at all times to power the memory-related functions, which retain the memory portions with the Radio turned off.

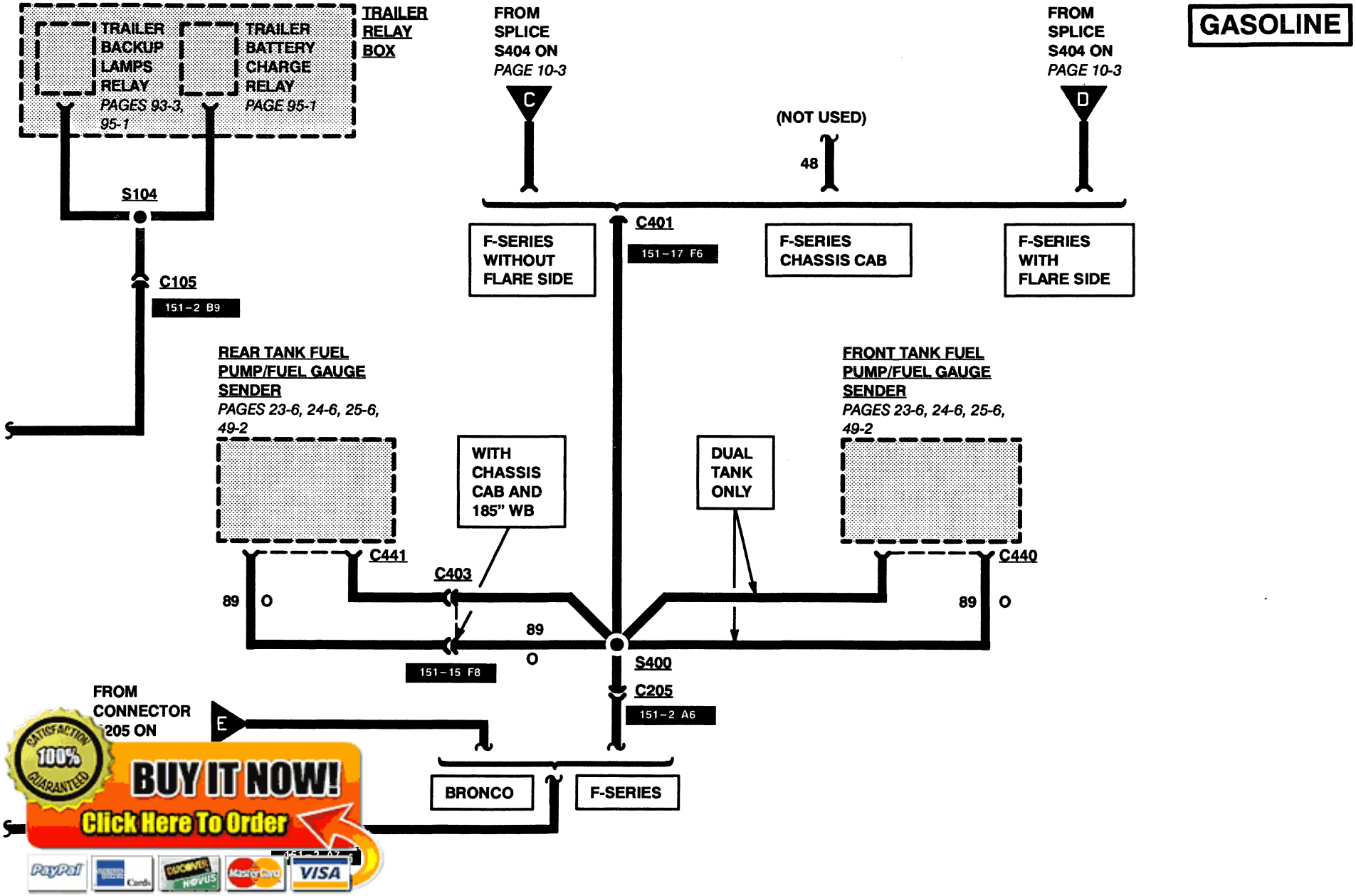
Panel dimming is controlled by the instrument panel dimming switch. A variable voltage is applied through the 19 (LB/R) wire to control the brightness of the panel lamps.

The display's brightness is controlled by the Main Light Switch. When the park lamps are turned on, battery voltage is applied to the Radio through the 484 (O/BK) wire. The display will dim. When the park lamps are turned off, voltage is no longer reduced by the dimmer resistor and the display will brighten.

For further diagnostic information refer to the Audio System Diagnosis manual or section 15 of the Service Manual.

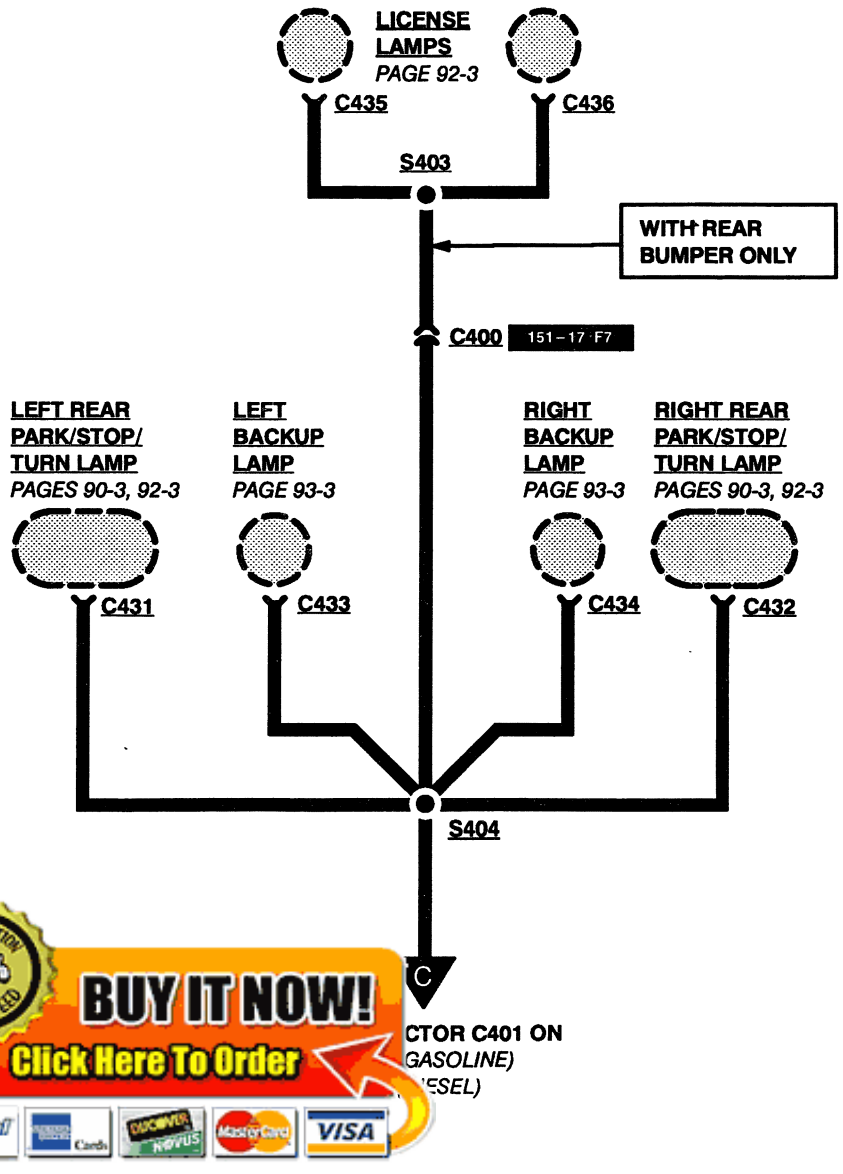
For Circuit Operation refer to page 7–1.



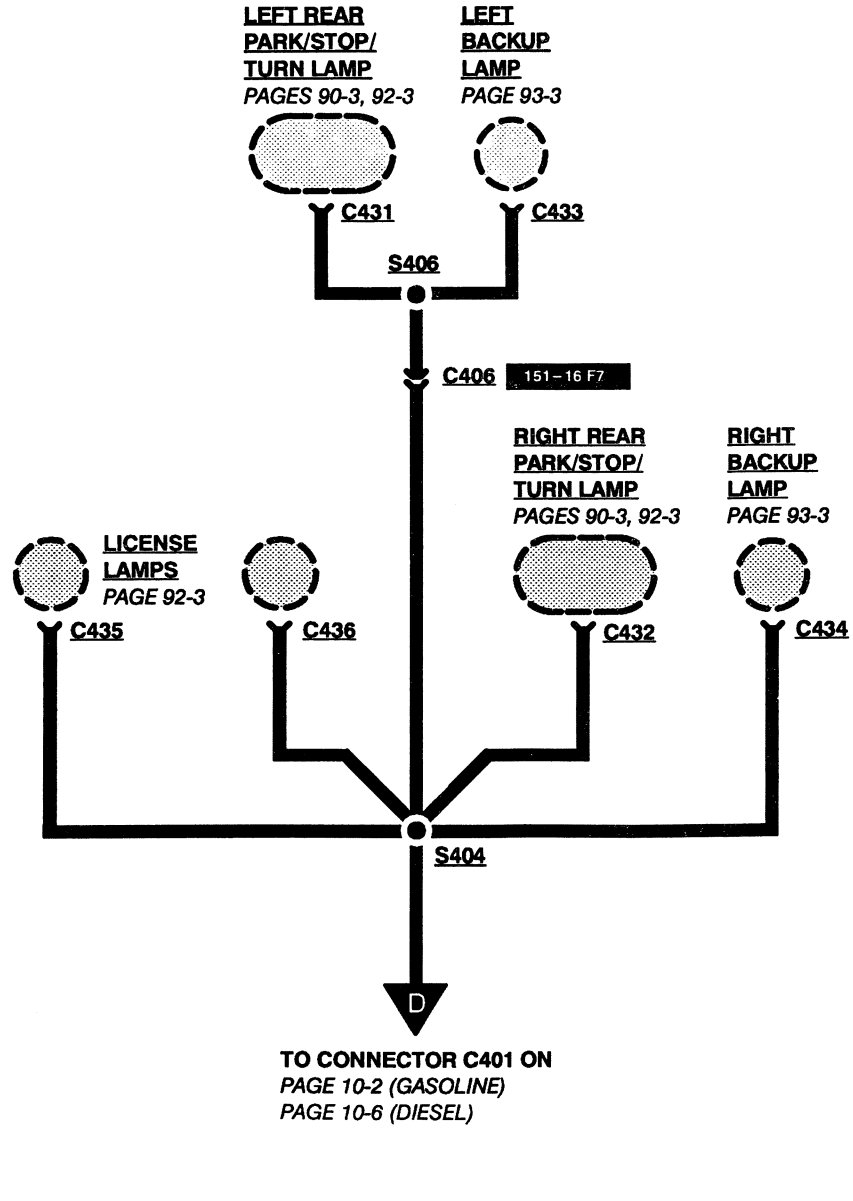


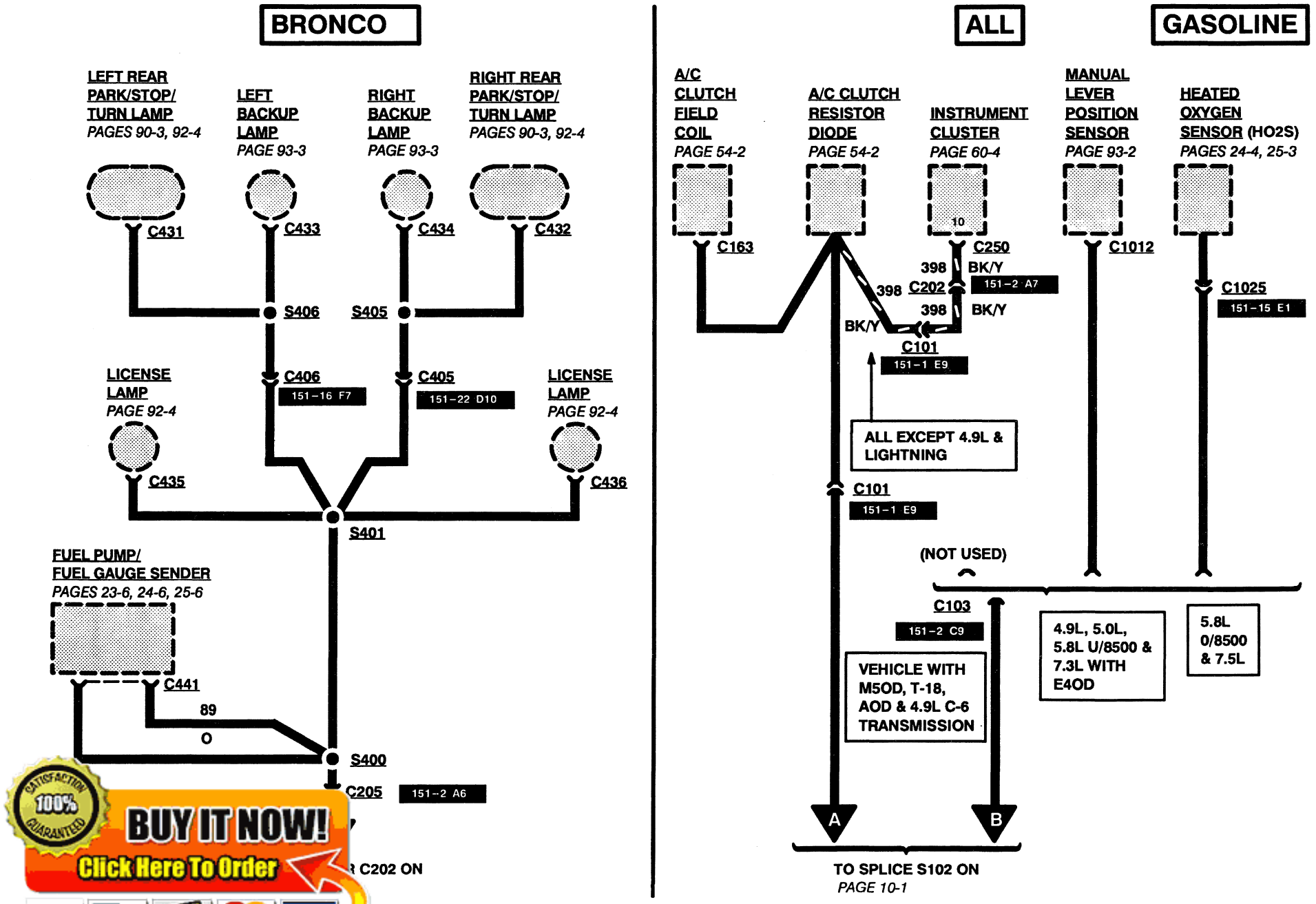
ALL

F-SERIES WITHOUT FLARE SIDE

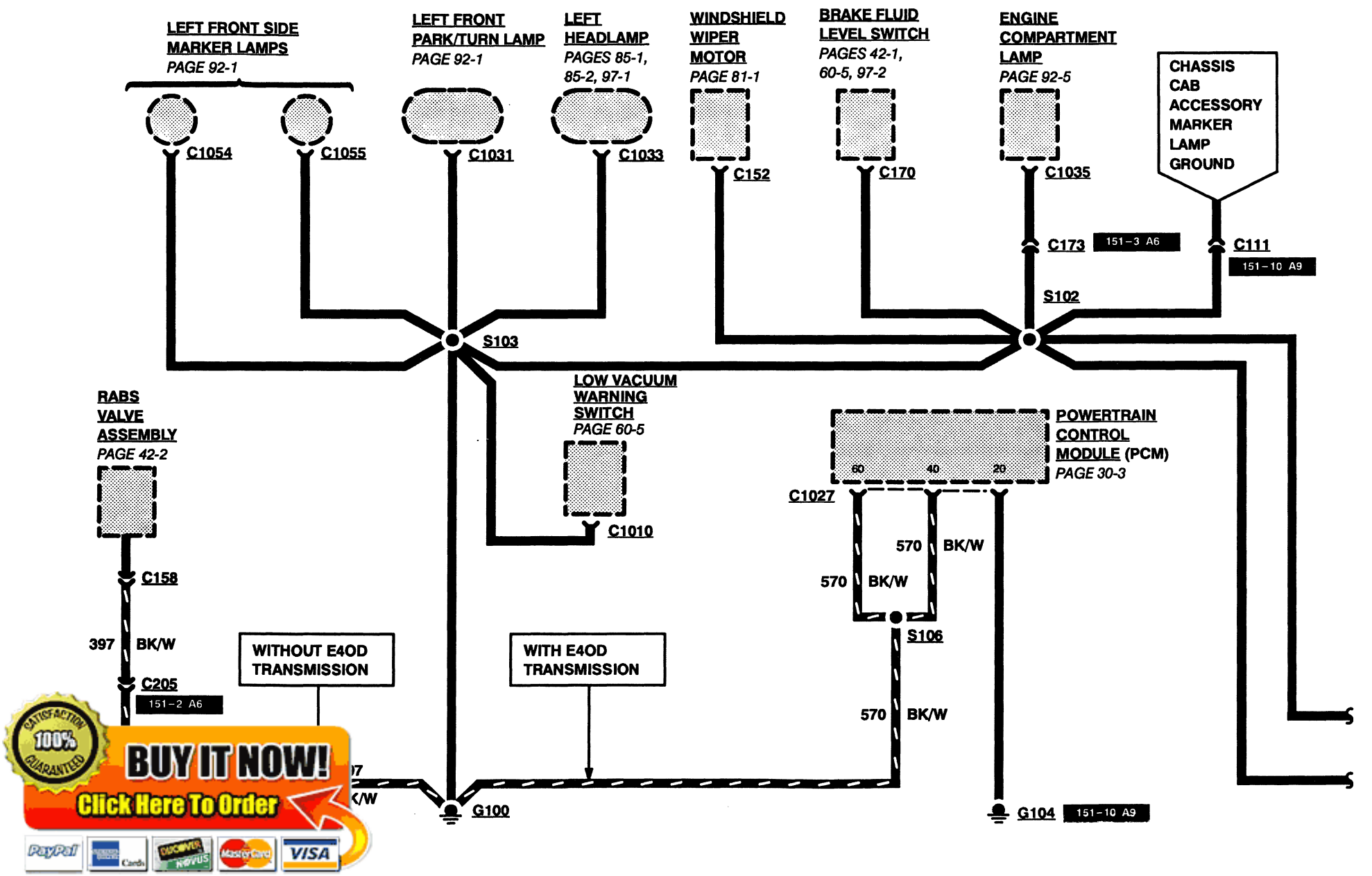


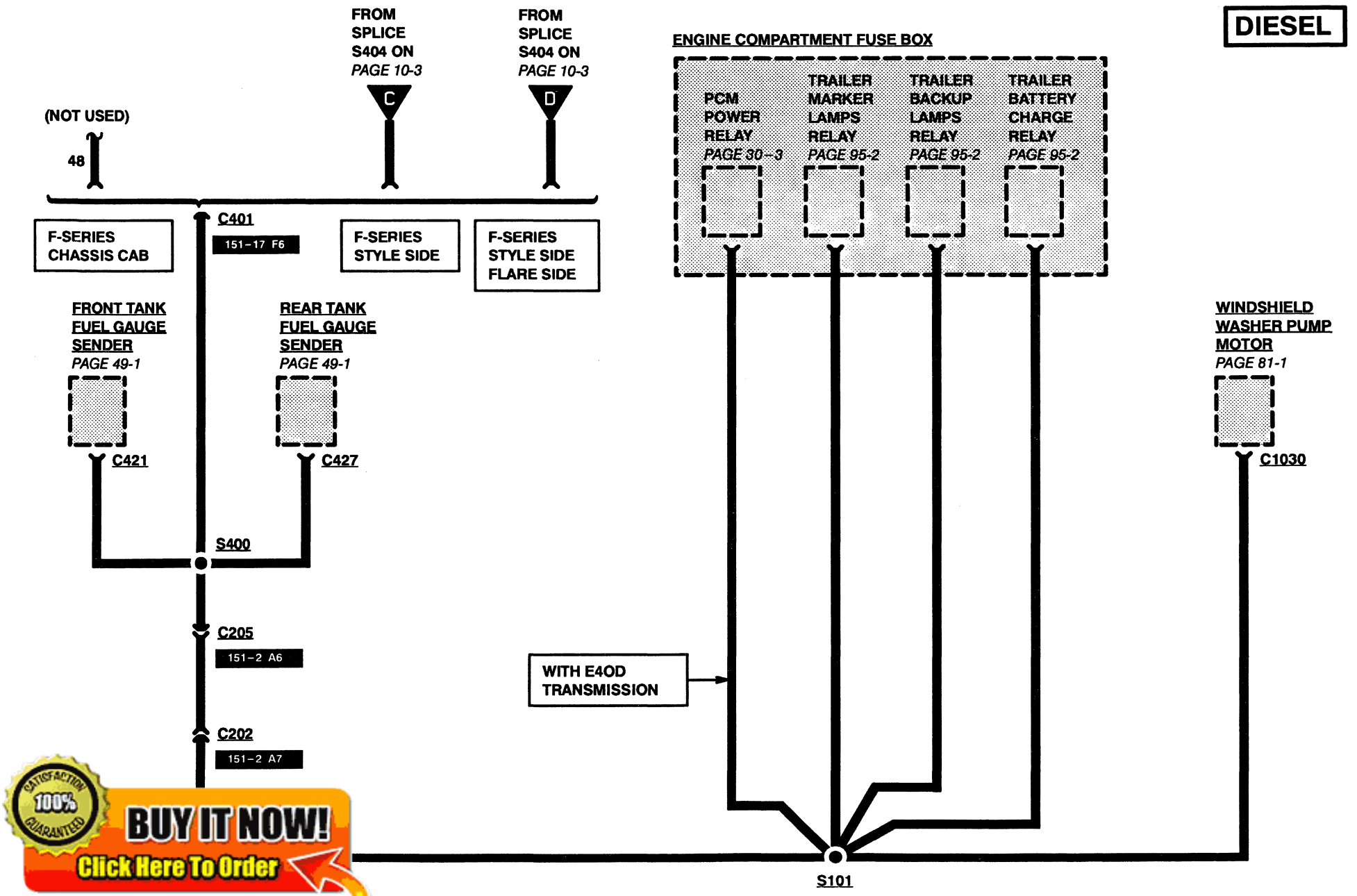
F-SERIES WITH FLARE SIDE



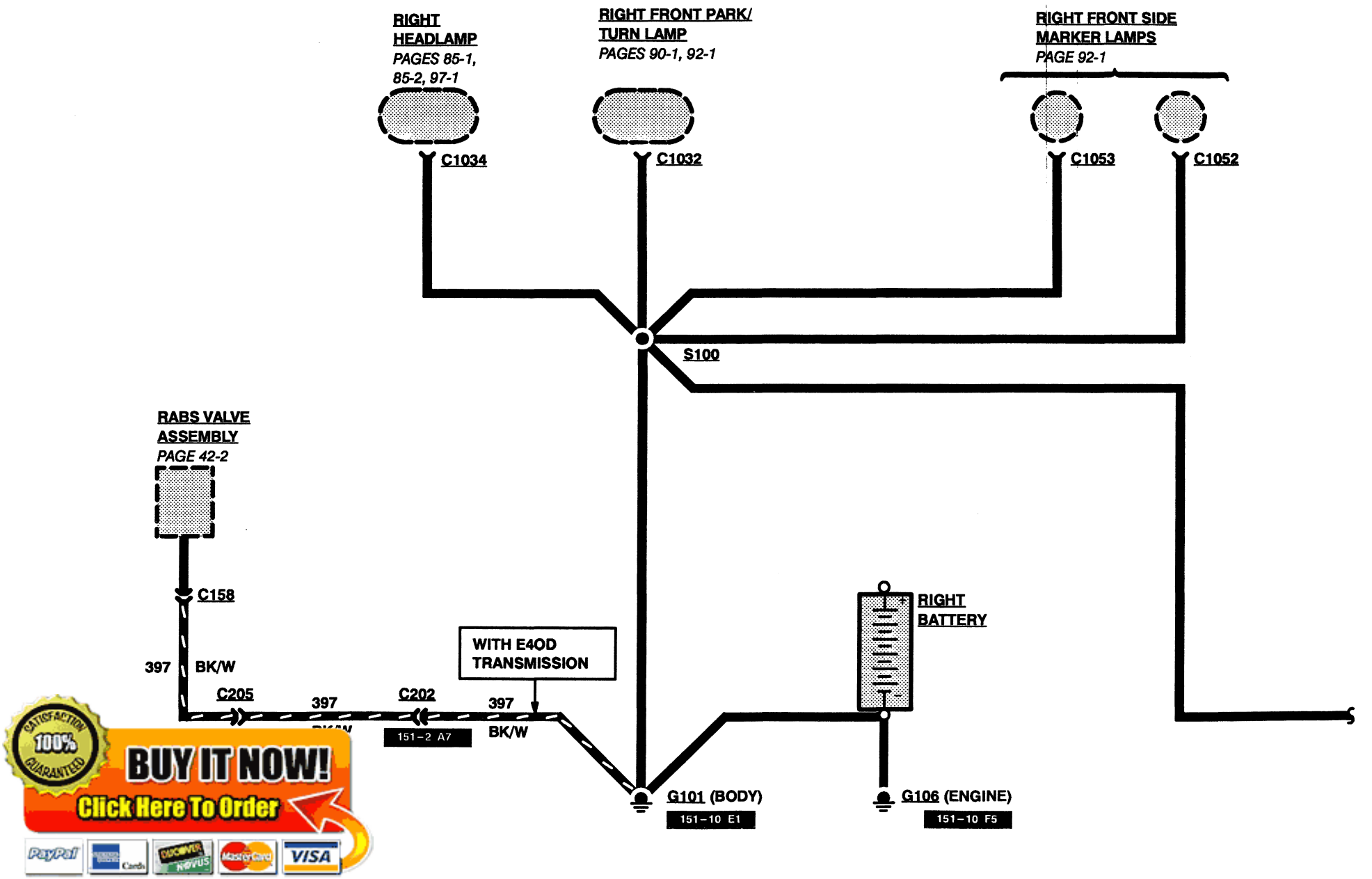


DIESEL

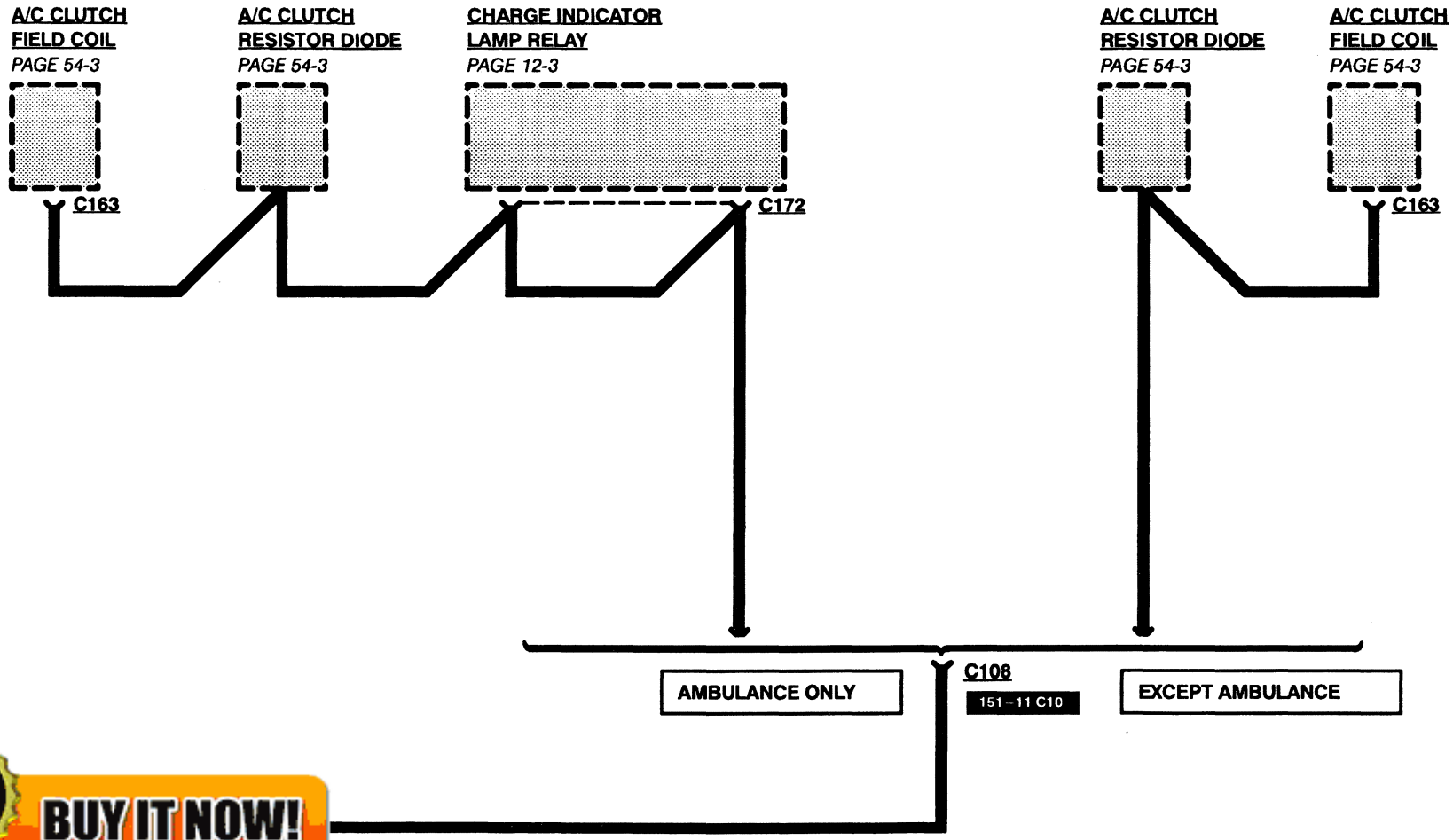




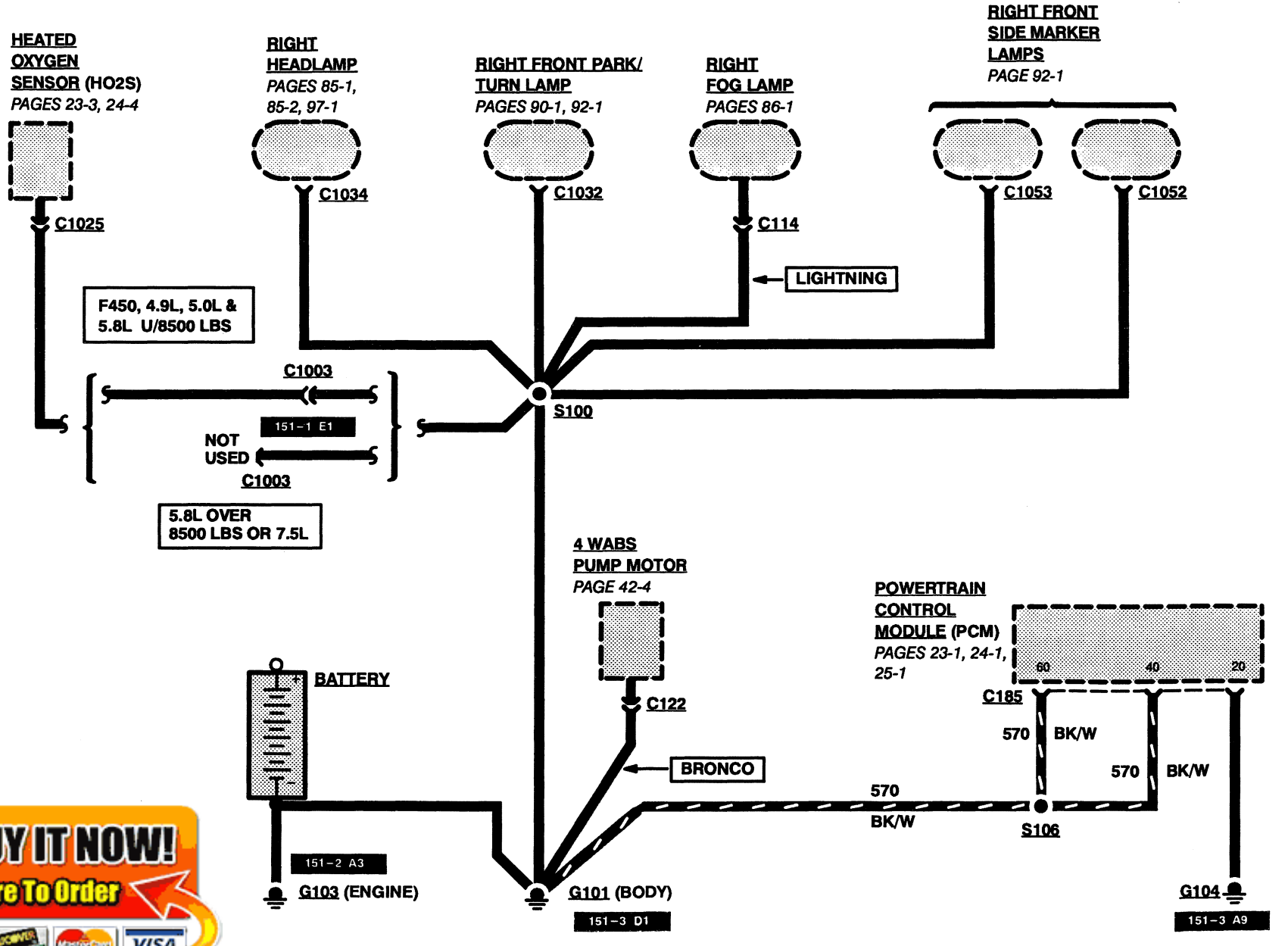
DIESEL



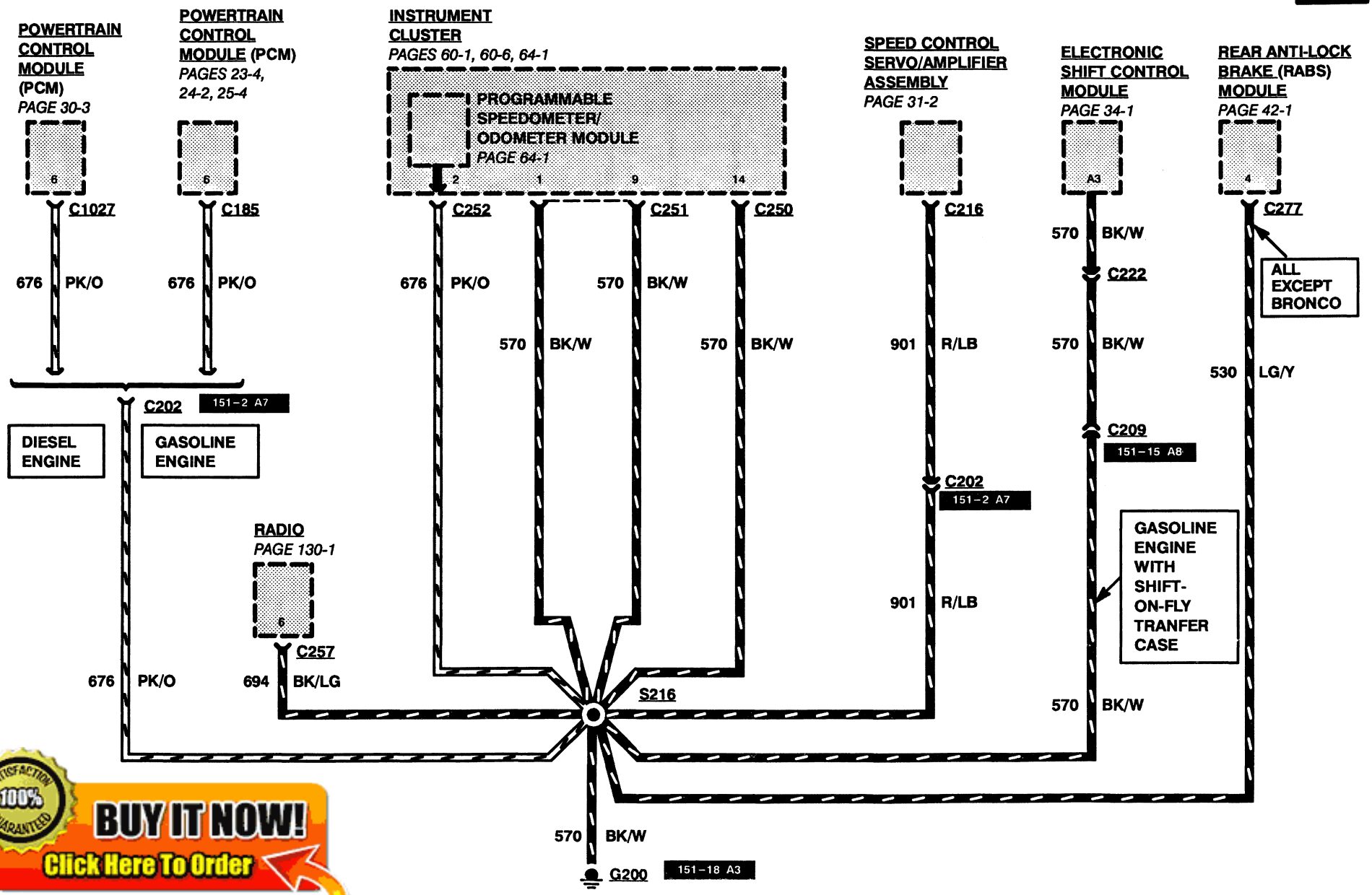
DIESEL

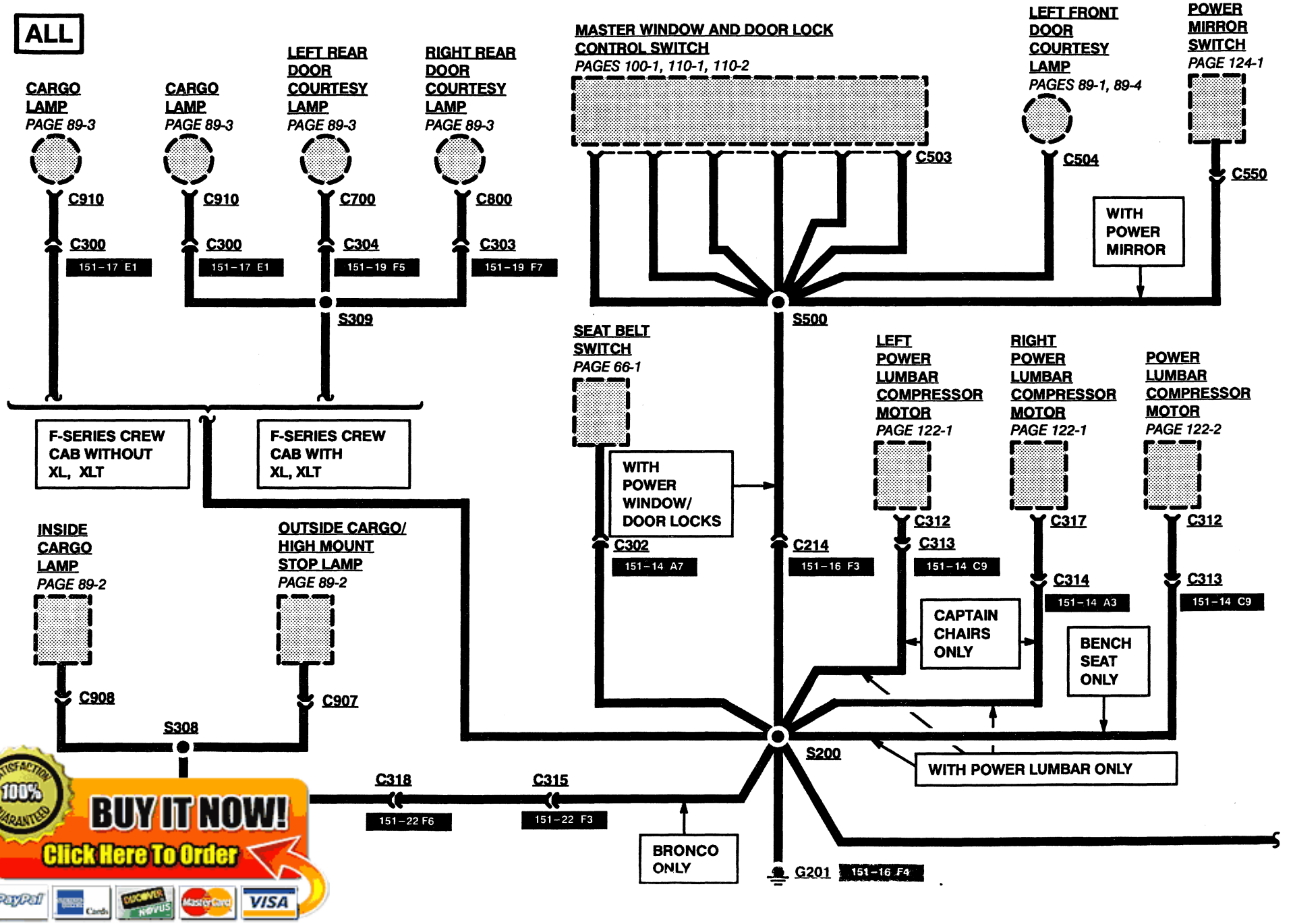


GASOLINE



ALL



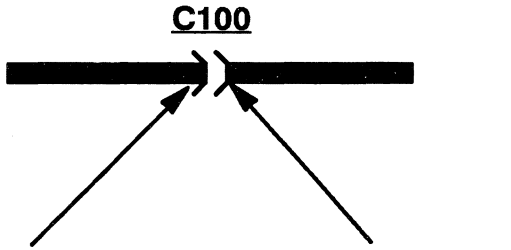


Connector	Location	Page Zone	Connector Page	Color	Terminal
C1025 (5.8L Over 8500 GVW) (7.5L) (S5-42 ZF Transmission)	Lower RH side of engine, to heated oxygen sensor (HO2S)	151- 18- F3		N	4
C1026 (4.9L)	Top LH rear of engine, on throttle position sensor (TPS)	151- 1- F8		BK	3
C1026 (7.5L)	Top LH side of engine, on throttle position sensor (TPS)	151- 7- A5		BK	3
C1027	LH side of safety wall, on powertrain control module (PCM)	151- 8- A8	30-7	GY	60
C1029	Top RH front of engine, on alternator	151- 10- F6		BK	4
C1030 (4.9L)	Lower LH front of engine compartment, on windshield washer pump motor	151- 3- D9		BK	2
C1030 (5.0L)(5.8L)	Lower LH front of engine compartment, on windshield washer pump motor	151- 5- D9		BK	2
C1030 (7.3L)	LH side of engine compartment, on windshield washer pump motor	151- 10- C9		BK	2
C1030 (7.5L)	Lower LH front of engine compartment, on windshield washer pump motor	151- 8- E9		BK	2
C1031	LH front of vehicle, on left front park/turn lamp	151- 3- F6		BK	3
C1032	RH front of vehicle, on right front park/turn lamp	151- 3- F3		BK	3
C1033	LH front of vehicle, on left headlamp	151- 3- F7		BK	3
C1034	RH front of vehicle, on right headlamp	151- 3- F2		BK	3
C1035	LH underside of engine compartment hood, on engine compartment lamp	151- 3- A7		GY	2
C1040	Top of engine, on glow plug #1	★			1
C1041	Top of engine, on glow plug #2	★			1
C1042	Top of engine, on glow plug #3	★			1
C1043	Top of engine, on glow plug #4	★			1
C1044	Top of engine, on glow plug #5	★			1
C1045	Top of engine, on glow plug #6	★			1
C1046	Top of engine, on glow plug #7	★			1
C1047	Top of engine, on glow plug #8	★			1
	Below center of vehicle, RH side of transmission, on E4OD trans.	151- 15- A3	30-6	GY	12
	RH front of vehicle, on right front side marker lamp	151- 3- E1		BK	2
	RH front of vehicle, on right front side marker lamp	151- 3- E1		BK	2
	LH front of vehicle, on left front side marker lamp	151- 3- E10		BK	2
	LH front of vehicle, on left front side marker lamp	151- 3- E9		BK	2
	Mounted under fuel filter	★			4

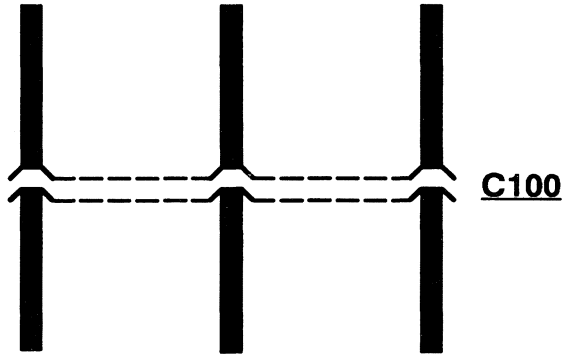
HOW TO IDENTIFY A BASIC HARNESS NUMBER BY USING A "C" NUMBER

Understand these symbols before using the following listing:

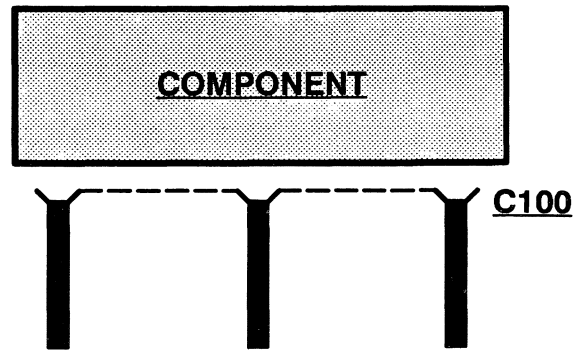
HARNESS TO HARNESS CONNECTION



DASHED LINES INDICATE TERMINALS OF SAME CONNECTOR



COMPONENT CONNECTION



Identify the basic harness part number by:

nector, find the connector "C" number in the EVTM schematics. Then locate the "C" number in the following listing and umber.

onnector (such as a short or a broken wire), then choose a connector located on the same harness that has the problem. ollowing listing and read the base part number of the harness that has the problem.

Connector Number	Wire Assembly
C101 (F)	9D930
C101 (M)	12A581
C101 (F) 4.9L	14289
C102	15525
C103 (F)	15525
C103 (M)	12A581
C105 (F)	14A346
C105 (M)	12A581
C106 (F)	12A581
C106 (M)	18A586
C108 (F)	12A581
C108 (M)	14305
C110 (F)	15525
C110 (M)	12A581
C111	12A581
C112	14305
C113	12A581
C114	12A581
C115 (F)	12A581
C115 (M)	14305
C116	*
C117 (F)	14K067
C117 (M)	15525
C118	14305
C119	12A581
C120	12A581
C121	12A581
	12A581
C135	9D930

Connector Number	Wire Assembly
C138	12A581
C139 (F)	14305
C139 (M)	12A581
C143	12A581
C148 (F)	14405
C148 (M)	12A581
C149 (F)	14A346
C149 (M)	14405
C150	9D930
C151	12A581
C152	12A581
C153	14305
C154	14305
C155	14A346
C158	14405
C159 (F)	14401
C159 (M)	14401
C161	14K067
C162	18A586
C163	9D930
C163 4.9L	14289
C163 DIESEL	14305
C164	9D930
C165	14305
C166	15525
C167	15525
C168	18A586
C169	18A586
C170	12A581
C171	9D930
C172	14305
C173 (F)	15A702
C173 (M)	12A581
C174	PIA
C175	PIA

Connector Number	Wire Assembly
C177	12A581
C178 4.9L	14289
C178	9D930
C180 4.9L	14289
C180	9D930
C181	9D930
C182	9D930
C182 4.9L	14289
C183	9D930
C184	14305
C185	12A581
C186	PIA
C187	14305
C188	PIA
C190	9D930
C191	9D930
C192	9D930
C193	9D930
C194	9D930
C195	9D930
C196	9D930
C197	9D930
C198	12A581
C199	12A581
C200 (F)	14A504
C200 (M)	14401
C201 (F)	15460
C201 (M)	14401
C202 (F)	14401
C202 (M)	12A581
C203 (F)	18A586
C203 (M)	14401
C204 (F)	14401
C204 (M)	13A726
C205 (F)	14401

Connector Number	Wire Assembly
C205 (M)	14405
C206	14401
C207	14401
C208 (F)	7A786
C209 (M)	14401
C210 (F)	14A348
C210 (M)	14401
C213 (F)	14630
C213 (M)	14631
C214 (F) CREW CAB	14631
C214 (M)	14A504
C214 (F) **	19A123
C216	12A581
C219 (F)	14401
C219 (M)	9C899
C220	7A786
C221	7A786
C222	7A786
C223	7A786
C224	14401
C228 (F)	14630
C228 (M)	14401
C229 (F)	14A504
C229 (M)	14401
C230	14401
C231	14401
C232	14401
C233 (F)	14631
C233 (M)	14A504
C234	13A726
C235	13A726
C250	14401
C251	14401

* No Figure Available
** Custom & XL Trim

HARNESS CAUSAL PART NUMBER

F-SERIES

Connector Number	Wire Assembly
	14401
	14401
	14401
	14401
	14401
	14401
263	14A504
C264	14401
C267	14401
C268	14401
C269	14401
C271	14401
C273	14401
C274	14401
C275	14401
C276	14401
C277	14401
C278	14401
C279	14401
C280	14401
C282 STEERING COLUMN ASS.	
C283 STEERING COLUMN ASS.	
C292	14401
C293	13A726
C294	13A726
C295	13A726
C296	14401
C298	14401
C300 (F)	14334
C300 (M)	14A504
C302	14A504
C303 (F)	14632
C303 (M)	14A504
C304 (F)	13632
C304 (M)	14A504
C305	14B084
C306	14B084
C310	14086
C311	14086
C312	14B084
C313 (F)	14A504
C313 (M)	14B084
C314 (F)	14A504
C314 (M)	14B084
C315 (F)	14335
C315 (M)	14A504
C317	14B084
C318 (F)	13A625
C318 (M)	14335
C320 (F)	13A724
C320 (M)	14334
C321	13A724
C322	13A724
C326	14A504
C327	14A504
C400 (F)	13412
C400 (M)	13A409
C401 (F)	13A409
C401 (M)	14405
C402 BRONCO	14405
C403 (F)	14406
C403 (M)	14405
C404 BRONCO	14405
C405 (F) BRONCO	14405
C405 (M) BRONCO	13A409
C406 (F) *	14405
C406 (M) *	13A409
C406 (F) BRONCO	14405
C406 (M) BRONCO	13A409
C407 (F)	13A576
C407 (M)	14405
C408 (F)	13A409
C408 (M)	15A411
C409 (F)	13A409
C409 (M)	15A411
C410 (F)	13A409
C410 (M)	15425
C411	15A411
C412	15A411
C413	15A411
C417	13A576
C418 (F)	14405
C418 (M)	14086
C420	15A411
C421	14405
C423	14405
C424 (F)	13A576
C424 (M)	14405
C427	14405
C428	14086
C429	14086
C431 **	13A409
C431 ***	13A409
C432	13A409
C433	13A409
C434	13A409
C435 ****	13412
C435 BRONCO	14405
C435 *	13A409
C436 BRONCO	14405
C436 ****	13412
C436 *	13A409
C440	14405
C441 *****	14406
C441	14405
C444	14405
C446 ******	13412
C447 *******	13A409
C448 *******	13A409
C500	14631
C502	14631
C503	14631
C504	14631
C507	14631
C507 ********	19A123
C508	14631
C509 (F)	14630
C509 (M)	14631
C550	14631
C600	14630
C602	14630
C603	14630
C606	14630
C607	14630
C608	14630

* F–Series W/Flareside

** F–Series W/Flareside & Bronco

*** F–Series W/O Flareside & Chassis Cab

**** F–Series W/O Flareside W Rear Bumper

***** Chassis Cab & 185 Wheelbase

****** F–Series W/O Flareside W/O Rear Bumper

******* Chassis Cab

******** Custom & XL Trim

Connector Number	Wire Assembly
C700	13632
C701	14632
C800	13632
C801	14632
C900	15460
C901	15460
C902	15460
C903	15460
C904	15460
C905	14334
C906	14334
C907	13A625
C908	13A625
C910	14334
C1000	PIA
C1001	PIA
C1002	PIA
C1003 (F)	12A690
C1003 (M)	12A581
C1005	12A581
C1006	12A581
C1007	9D930
C1007 4.9L	14289
C1008	9D930
C1008 4.9L	14289
C1009	9D930
C1009 4.9L	14289
C1010	12A581
C1011	12A581
C1012	15525
C1014	PIA
C1015	PIA
C1016	9D930
C1017	9D930
C1017 4.9L	14289
C1019	12A581
C1021	12A581
C1022	9D930
C1022 4.9L	14289
C1023	9D930
C1023 4.9L	14289
C1024	9D930
C1025	12A690
C1025 *	15525
C1026	9D930
C1026 4.9L	14289
C1027	12A581
C1029	14305
C1030	12A581
C1031	12A581
C1032	12A581
C1033	12A581
C1034	12A581
C1035	15A702
C1040	PIA
C1041	PIA
C1042	PIA
C1043	PIA
C1044	PIA
C1045	PIA
C1046	PIA
C1047	PIA
C1048	15525
C1052	12A581
C1053	12A581
C1054	12A581
C1055	12A581
C1056	PIA

* All 7.5L Except F450 & 5.8L over 8500 LBS

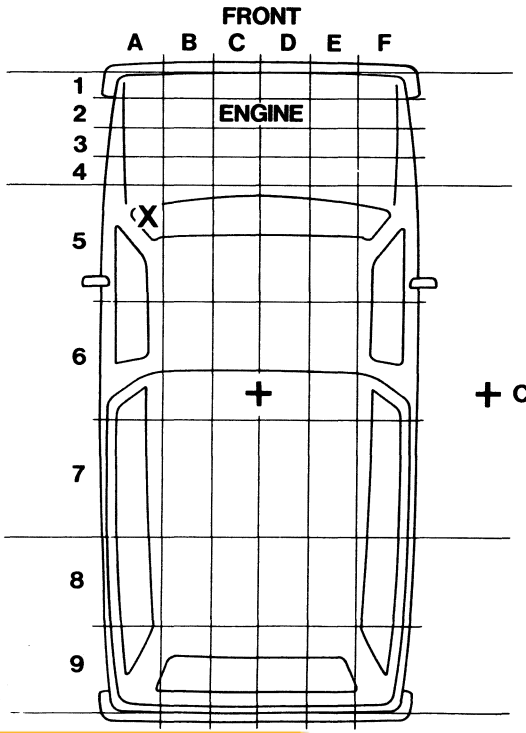
VEHICLE REPAIR LOCATION CODES

TO PINPOINT THE ACTUAL VEHICLE LOCATION OF A REPAIR. THE VEHICLE REPAIR LOCATION CODE IS REQUIRED.

FOR EXAMPLE, AN "X" HAS BEEN PLACED IN THE QUADRANT OF THE VEHICLE DIAGRAMS INDICATING THE LOCATION OF THE REPAIR. SEE DIAGRAMS.

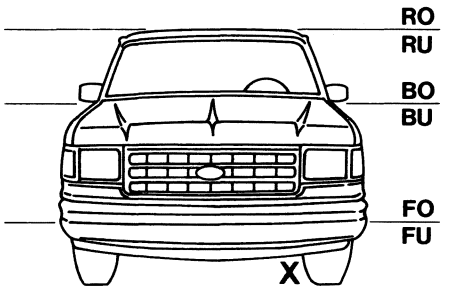
LOCATION CODE, FOR THE EXAMPLE IS: A5/FU — (UNDER THE FLOOR OF DRIVER'S LEFT FOOT.)

FRONT/REAR DIRECTION



+ CENTER OF VEHICLE

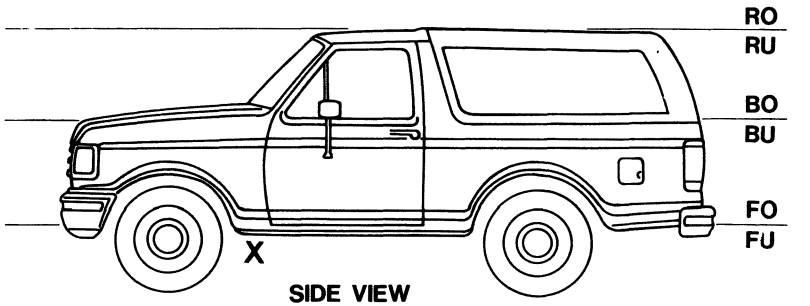
OVER/UNDER DIRECTION



R = ROOF LINE
RO = ROOF OVER
RU = ROOF UNDER

B = BELT LINE
BO = BELT OVER
BU = BELT UNDER

F = FLOOR PAN
FO = FLOOR OVER
FU = FLOOR UNDER



SIDE VIEW

BRONCO F150 F250 F350 SUPER DUTY

FPS-12129-93

WE SUPPORT VOLUNTARY TECHNICIAN CERTIFICATION

Ford

TECHNICAL
PUBLICATION DEPARTMENT
Ford Parts and Service Division

LITHO IN U.S.A.
AUGUST 1992

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