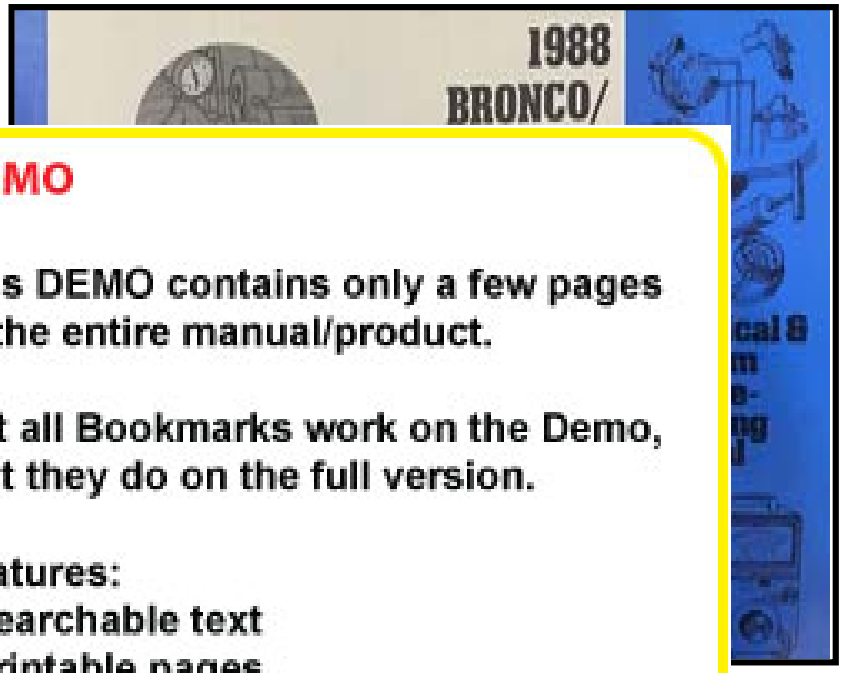
1987-1991 Bronco/F150-350 Electrical & Vacuum Trouble-Shooting Manual

1987

1988



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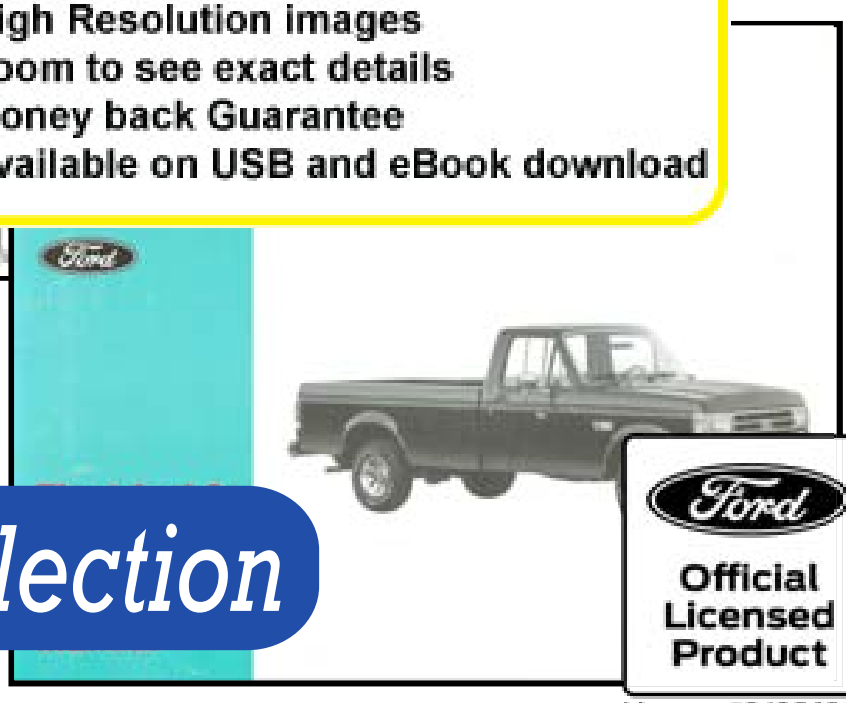

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1987-1991 Bronco/F150-F350 Electrical & Vacuum Trouble-Shooting Manual - 5 Manual Collection

EAN: 978-1-60371-424-2
ISBN: 1-60371-424-3

Forel Publishing Company, LLC
Woodbridge, VA 22192
Email: sales@ForelPublishing.com
https://www.ForelPublishing.com

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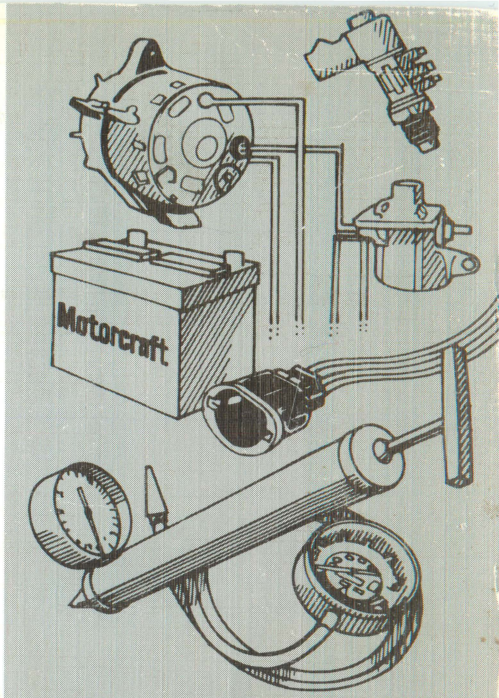
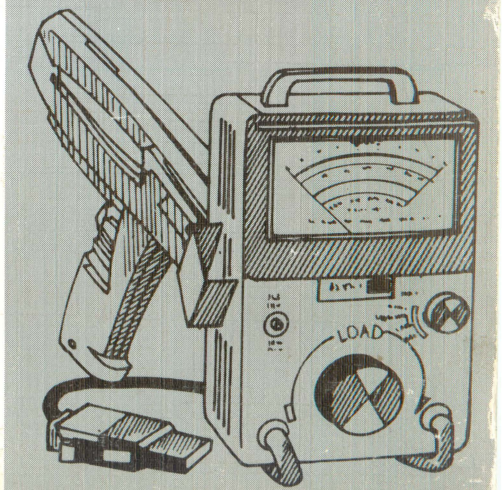
1987 BRONCO/F150-350

1987 BRONCO/ F150-350

Ford



Electrical & Vacuum Trouble-Shooting Manual



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1987 Bronco/F150-F350 Electrical & Vacuum Trouble-Shooting Manual (EVTM)

EAN: 978-1-60371-410-5
ISBN: 1-60371-410-3

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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.

The purpose of this manual is to show electrical and vacuum circuits of these vehicles in a clear and simple fashion to make troubleshooting easier. With each circuit is a description of *How the Circuit Works* and some *Troubleshooting Hints*. A *Component Location* chart lists components, connectors, and grounds in that circuit. The chart includes a description of where each item is located, and references to pictures in the manual.

Wiring Diagrams give a schematic picture of when and how the circuit is powered, what the current path is to circuit components, and how the 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
GR	Green	T	Tan
GY	Gray	W	White
LB	Light Blue	Y	Yellow
LG	Light Green		

Where two colors are shown for a wire, the first color is the basic color of the wire. The second color is the stripe marking. It should be noted that the use of dots and hashes for circuit identification has been eliminated. Dots may ... encountered as an additional identifica- ... the ... facturer has ... same iden- ... connector

Connector end views of switches and other components are shown to help with bench testing. The views show the harness wire colors that connect to the mating terminals. Connector colors and locations are shown in the *Component Location* chart. Two-color listings indicate separate colors for each connector half.

Components which work together are shown together. For example, all electrical components used in any circuit are shown on one diagram. The circuit breaker or fuse is shown at the top of the page. All wires, connectors, splices, switches, and motors are shown in the flow of current to ground at the bottom of the page. Notes are included which describe how switches and other components work. If a component is used in several different circuits, it is shown in several places. For example, the **Main Light Switch** is an electrical part of many circuits, and is repeated on many pages. In some cases, however, a component may seem, by its name, to belong on a page where it has no electrical connection. For example, **Radio Illumination** is electrically part of **Instrument Illumination.** Since it has no electrical connection at all with the actual **Radio** circuit, it is not shown on the **Radio** page.

Troubleshooting Hints point the technician in a general direction, but are not intended as a step-by-step procedure. Ignition troubleshooting is an exception to this. It includes a step-by-step procedure of basic quick checks to locate some of the more common **Ignition System** problems. Read the Shop Manual for more detailed repair procedures.

The **Grounds** pages show detailed views of multiple component ground points. This is useful for checking interconnections among the ground circuits of different diagrams.

Notes, Cautions, and **Warnings** appear in boxes on text pages and contain important **vehicle and mechanic safety information.**

Notes give added information to help complete a particular procedure. Cautions are included to prevent making an error that could damage the vehicle. Warnings highlight areas where carelessness can cause personal injury. The following list contains some general **Warnings** that should be followed when working on a vehicle.

- 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 the danger of carbon monoxide.
- Keep away from moving parts when the engine is running, especially the fan and belts.
- 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.

TROUBLESHOOTING STEPS

These six steps present an orderly method of troubleshooting:

Step 1. Verify the problem.

- Operate the complete system and see all symptoms for yourself in order to:
  - —check the accuracy and completeness of the customer's complaint.
  - —learn more that might give a clue to the nature and location of the problem.

Step 2. Narrow the problem.

- Using this manual, narrow down the possible causes and locations of the problem in order to more quickly find the exact cause.
- Read the description of *How the Circuit Works* and study the wiring diagram. You should then know enough about the circuit operation to figure out where to check for this trouble.

Step 3. Test the cause.

- Use electrical test procedures to find the specific cause of the symptoms.
- *Troubleshooting Hints* will give some helpful ideas.
- The *Component Location* charts and the pictures will help you find components, grounds, and connectors.

Step 4. Verify the cause.

- Confirm the fact that you have found the correct cause through operating the parts of the circuit you think are good.

Step 5. Make the repair.

- Repair or replace the faulty component.

Step 6. Verify the repair.

1 and check symptoms, any new special test . See the

Shop Manual and other service books for details. You will find the circuits in this manual to be helpful with these special tests.

TROUBLESHOOTING TOOLS

JUMPER WIRE

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

Uses: Bypassing Switches or Open Circuits

WARNING

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

VOLTMETER

A DC **Voltmeter** measures circuit voltage. Connect negative (- or black) lead to ground, and positive (+ or red) lead to voltage measuring point.

OHMMETER

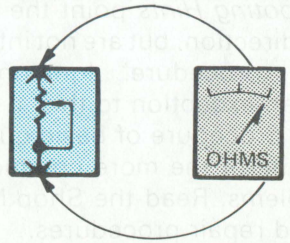


Figure 1— Resistance Check

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

TEST LIGHT

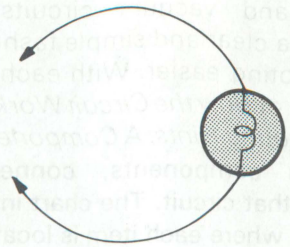


Figure 2 —Test Light

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

Uses: Voltage Check. Short Check

SELF-POWERED TEST LIGHT

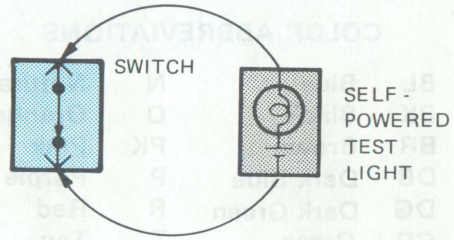


Figure 3—Continuity Check

The **Self-Powered Test Light** 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 light or ohmmeter, be sure power is off in circuit during testing. Hot circuits can cause equipment damage and false readings.

TROUBLESHOOTING CHECKS

SWITCH CIRCUIT CHECK

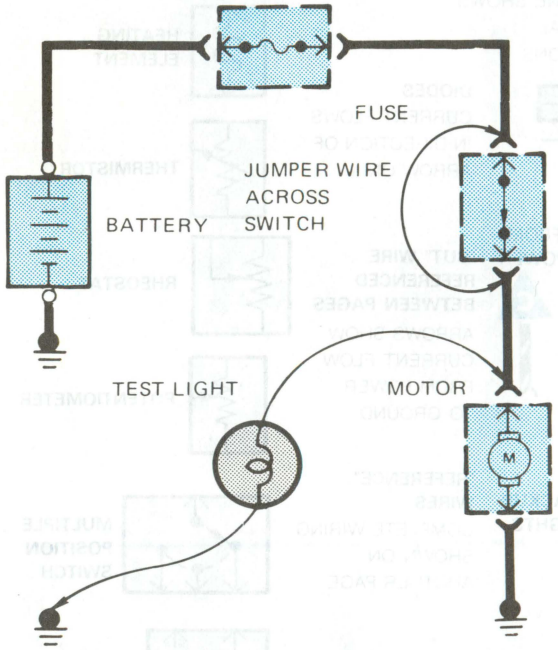


Figure 4—Switch Circuit Check and Voltage Check

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

CONTINUITY CHECK (Locating open circuits)

With power off, connect one lead of **Self-Powered Test Light** or **Ohmmeter** to each end of circuit (Figure 3). Light will glow if circuit is closed. Switches and fuses can be checked in ...me way.

...o a known -) battery ...g the other ...when the

SHORT CHECK (short to ground)

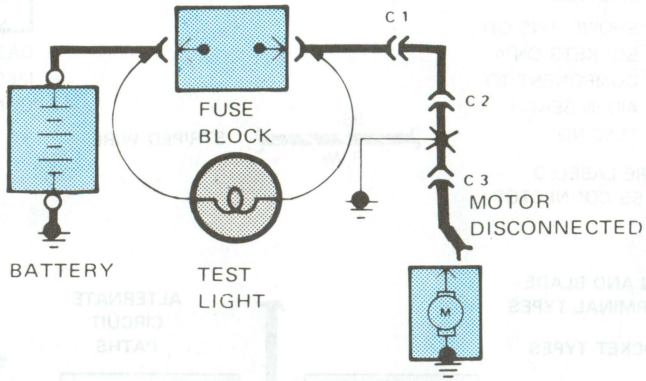


Figure 5— Short Check

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

1) Turn off everything powered through the fuse.
2) Disconnect other loads powered through the fuse:
   - Motors: disconnect motor connector.
   - Lights: remove bulbs.
3) Turn **Ignition Switch** to RUN (if necessary) to power fuse.
4) Connect one **Test Light** 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 Light** lead from ground and reconnect it to the load side of the fuse.
   - If the **Test Light** is off, the short is in the disconnected equipment.
   - If the **Test Light** 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 Light** goes out. For example: with a ground at X, the bulb goes out when C1 or C2 is disconnected, but stays on after disconnecting C3. This means the ground is between C2 and C3.

"GOOD GROUND" CHECK

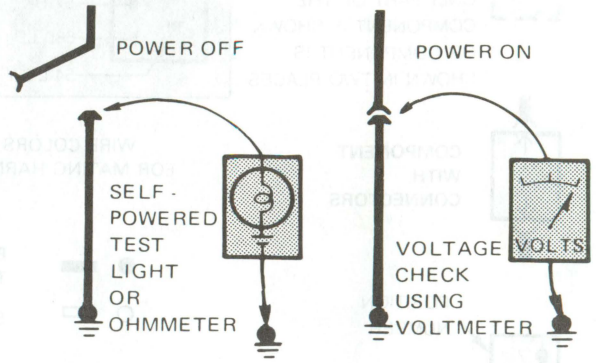


Figure 6 — Grounds Checks

Turn on power to circuit. Perform Voltage Check between suspected bad ground and frame. Any voltage means ground is bad.

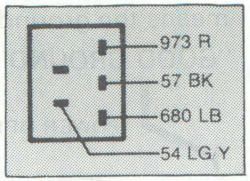
Turn off power to circuit. Connect one lead of **Self-Powered Test Light** or **Ohmmeter** to wire in question, and the other to known ground. If bulb glows, circuit ground is OK (Figure 6).

TROUBLESHOOTING HINTS

The circuit schematics in this manual are designed to make it easy to identify common points in circuits. This knowledge can help narrow the problem 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.

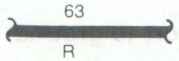
For example, if low beam headlights work but high beams and the indicator light don't work, then power and ground paths must be good. Since the dimmer switch is the component which switches this power to the high beam lights and indicator, it is most likely the cause of failure.

DASHED COMPONENT BOX
ONLY PART OF THE COMPONENT IS SHOWN, OR COMPONENT IS SHOWN IN TWO PLACES

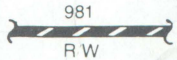


COMPONENT CONNECTOR END VIEW
SHOWS PINS OR SOCKETS ON A COMPONENT TO AID IN BENCH TESTING

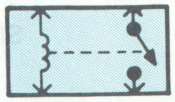
WIRE COLORS ARE LABELED FOR MATING HARNESS CONNECTOR



SOLID WIRE



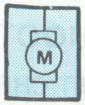
STRIPED WIRE



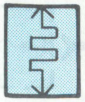
RELAY
CONTACTS CLOSE WITH CURRENT THROUGH COIL

DASHED LINE SHOWS MECHANICAL CONNECTIONS

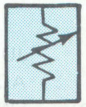
DIODES
CURRENT FLOWS IN DIRECTION OF ARROW ONLY



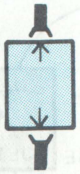
MOTOR



HEATING ELEMENT



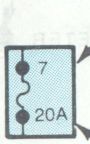
THERMISTOR



COMPONENT WITH CONNECTORS

PIN AND BLADE TERMINAL TYPES

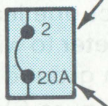
SOCKET TYPES



POSITION NUMBER

FUSE

CURRENT RATING

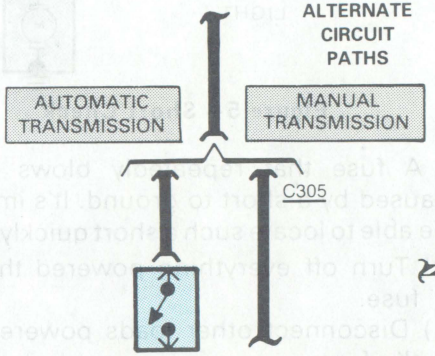


POSITION NUMBER

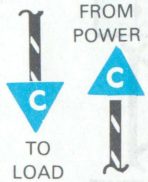
CIRCUIT BREAKER

CURRENT RATING

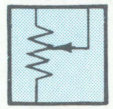
IN-LINE CONNECTOR



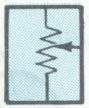
ALTERNATE CIRCUIT PATHS



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



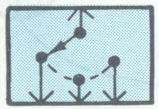
RHEOSTAT



POTENTIOMETER

BACKUP LIGHTS

"REFERENCE" WIRES
COMPLETE WIRING SHOWN ON ANOTHER PAGE

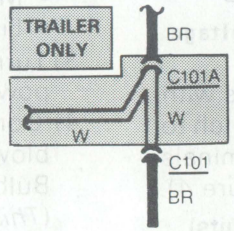


MULTIPLE POSITION SWITCH

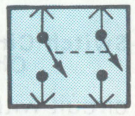
SCREW TERMINAL ON COMPONENT

SPLICE OR CRIMP CONNECTION
MOST ARE BUILT INTO HARNESS AND ARE NOT ACCESSIBLE

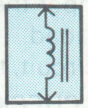
CANDELABRA CONNECTOR
ACCEPTS SINGLE-PIN CONNECTORS



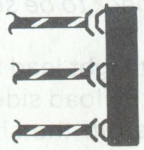
OPTIONAL WIRING
BR WIRES (INCLUDING C101) ARE ON ALL VEHICLES, BUT W WIRES (INCLUDING C101A) ARE USED ONLY WITH TRAILER



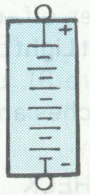
GANGED SWITCHES



SOLENOID



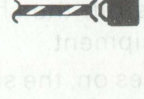
JUNCTION BLOCK



12V BATTERY

SEALED ELECTRONIC COMPONENT
ANY CIRCUITRY SHOWN INSIDE THE

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



GROUND CONNECTION

SEE GROUNDS *PAGE 5-15*

20 GA BLUE ● **FUSE LINK**

RESISTOR

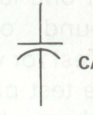
SINGLE FILAMENT LIGHT BULB

DUAL FILAMENT LIGHT BULB

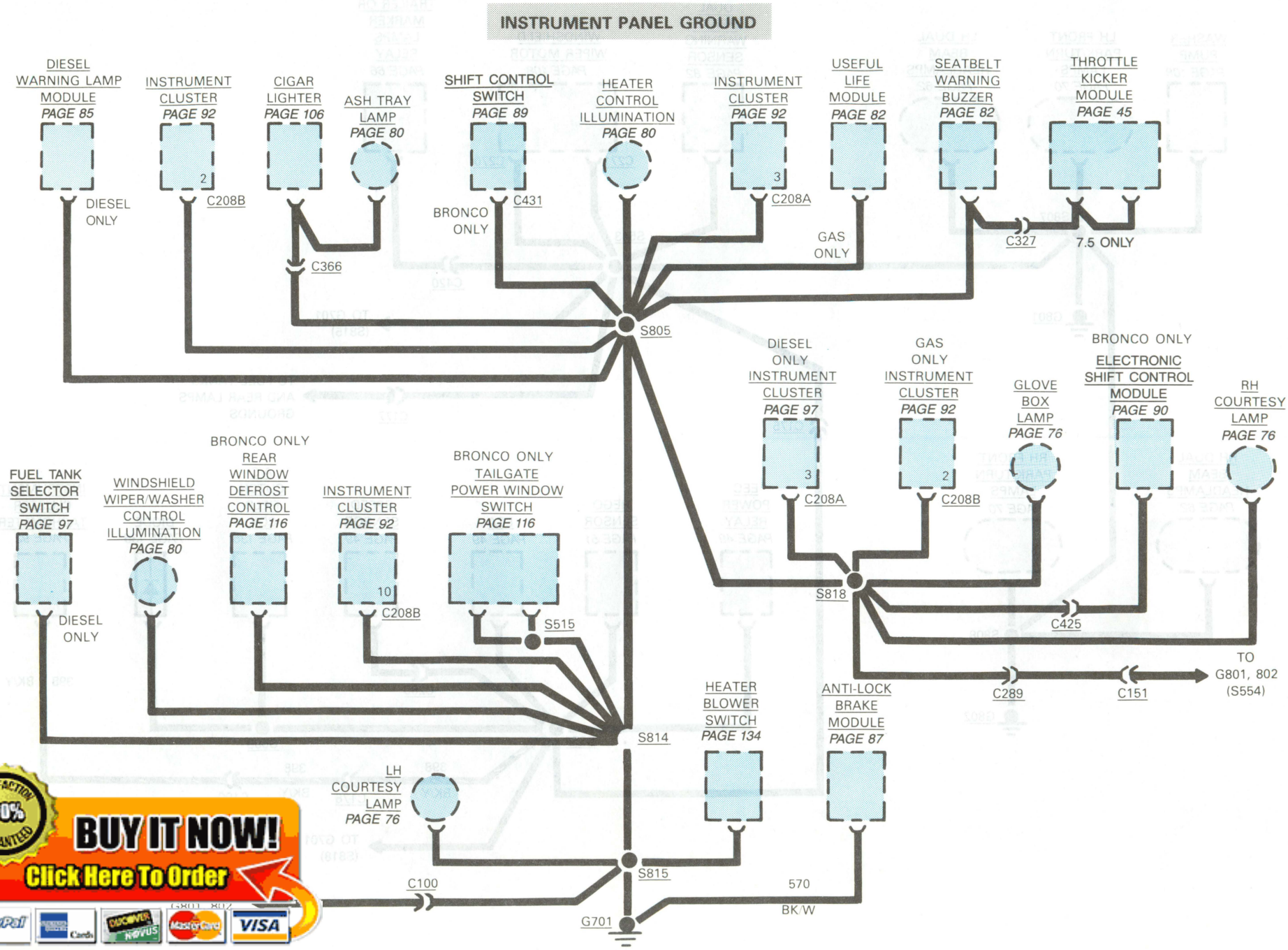
TRANSISTOR

LIGHT EMITTING DIODE

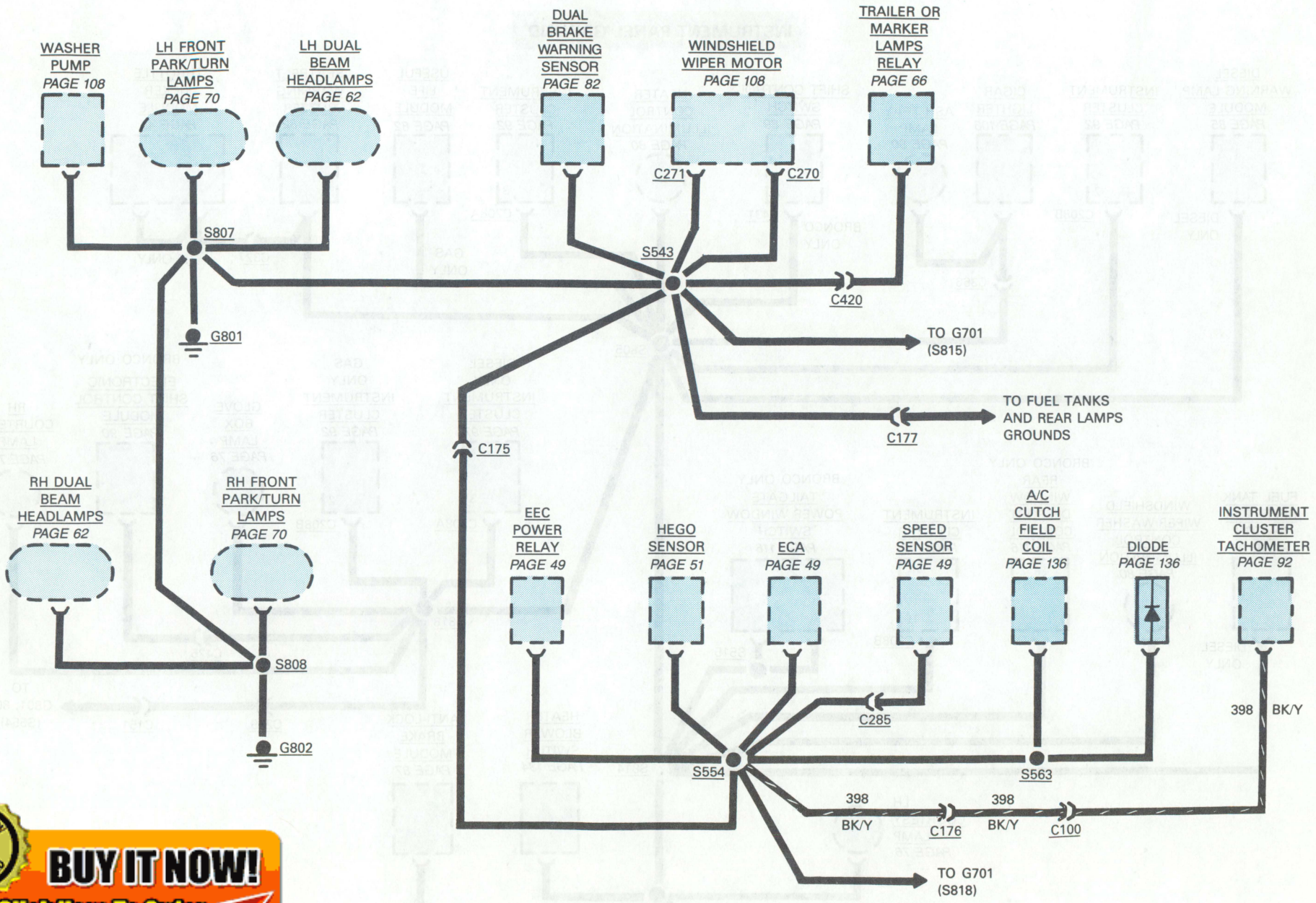
ZENER DIODE

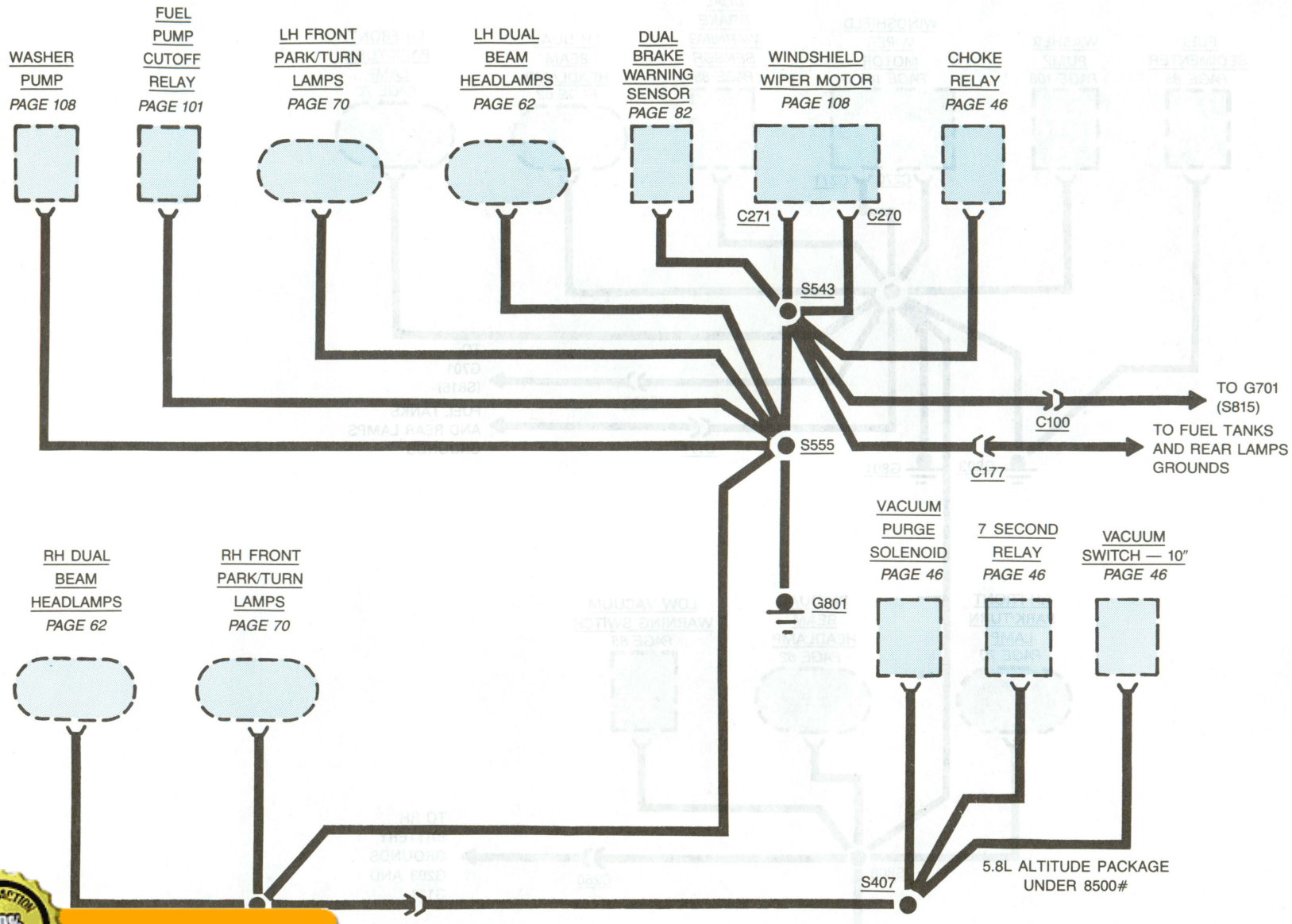


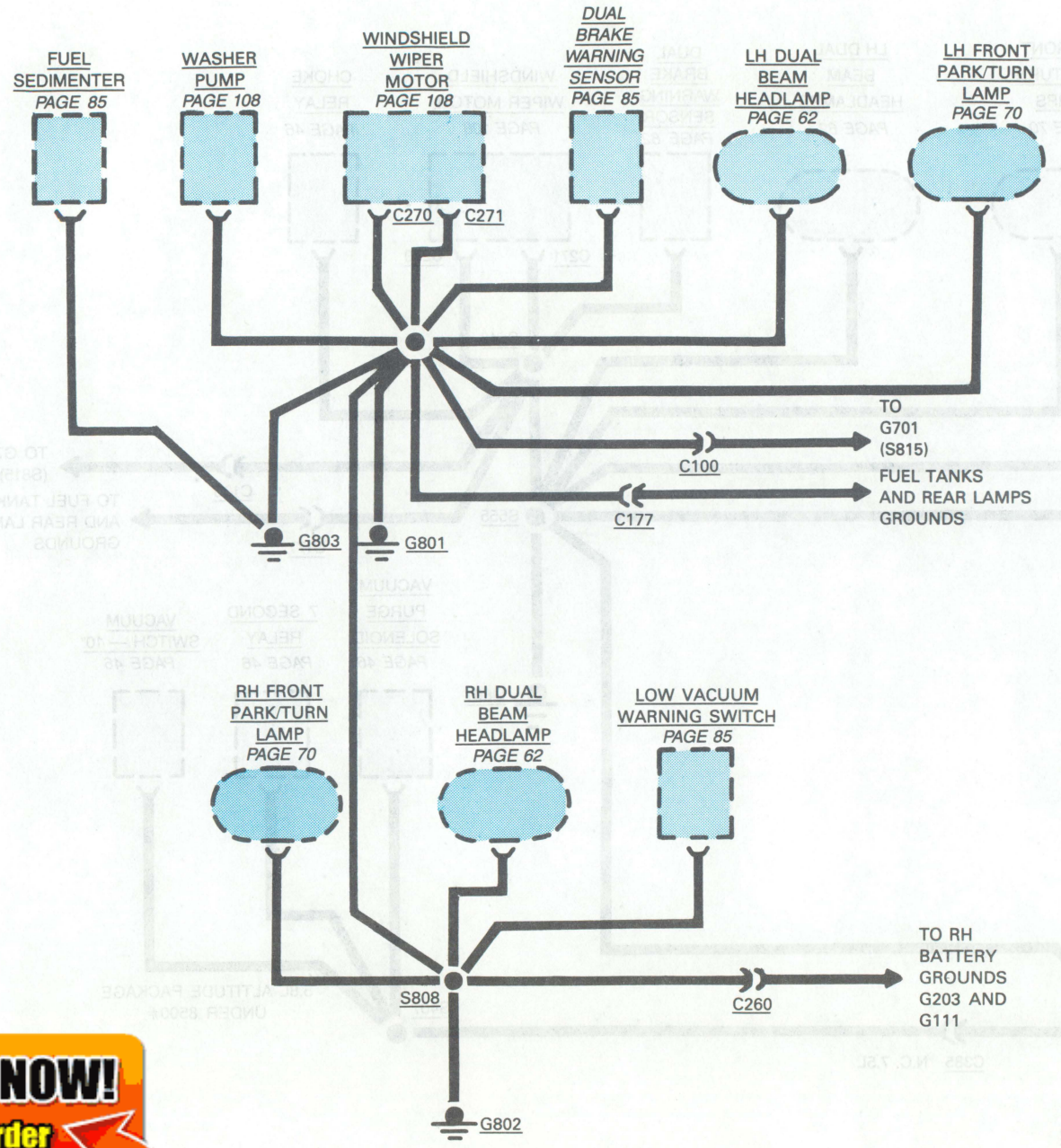
CAPACITOR

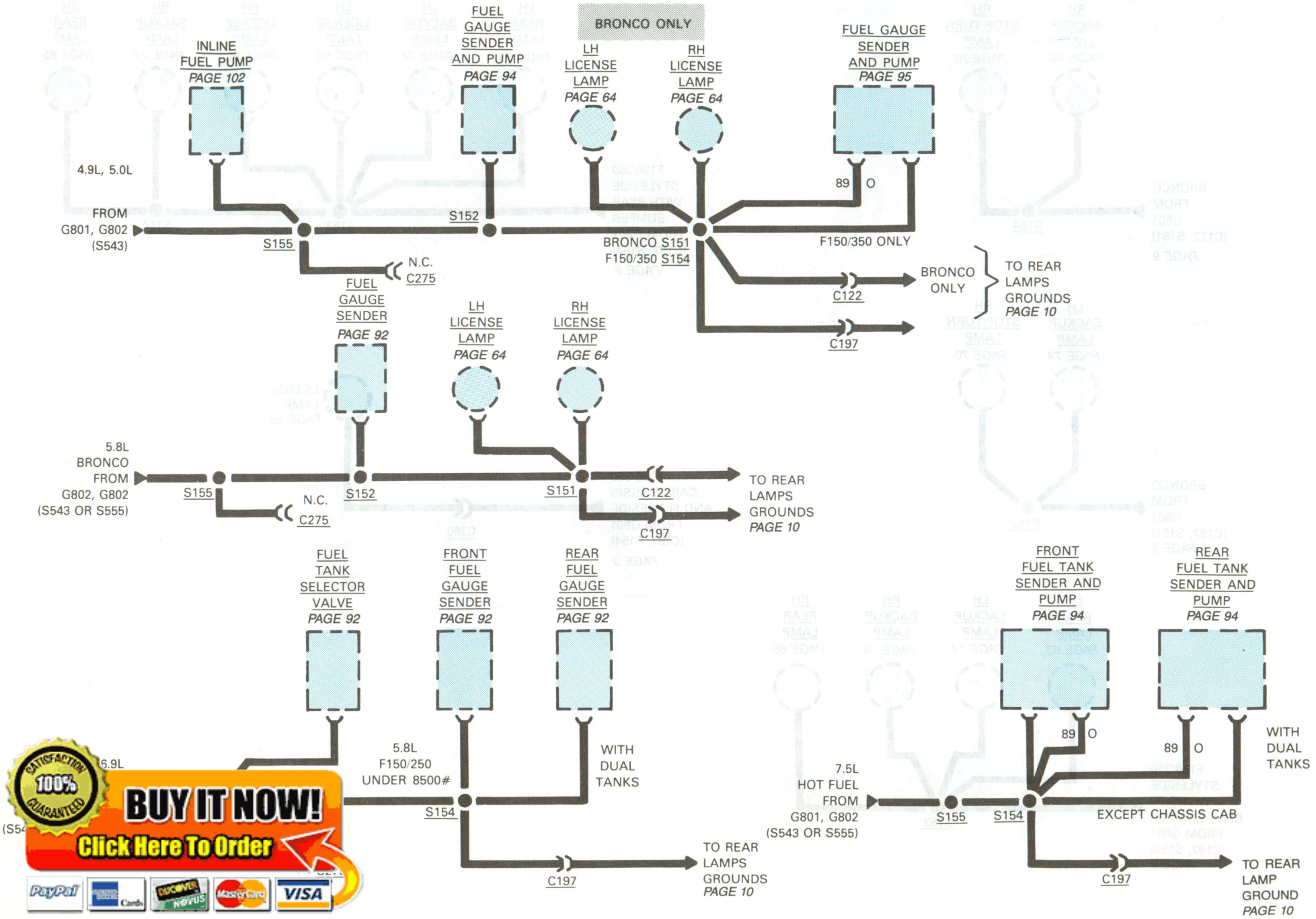


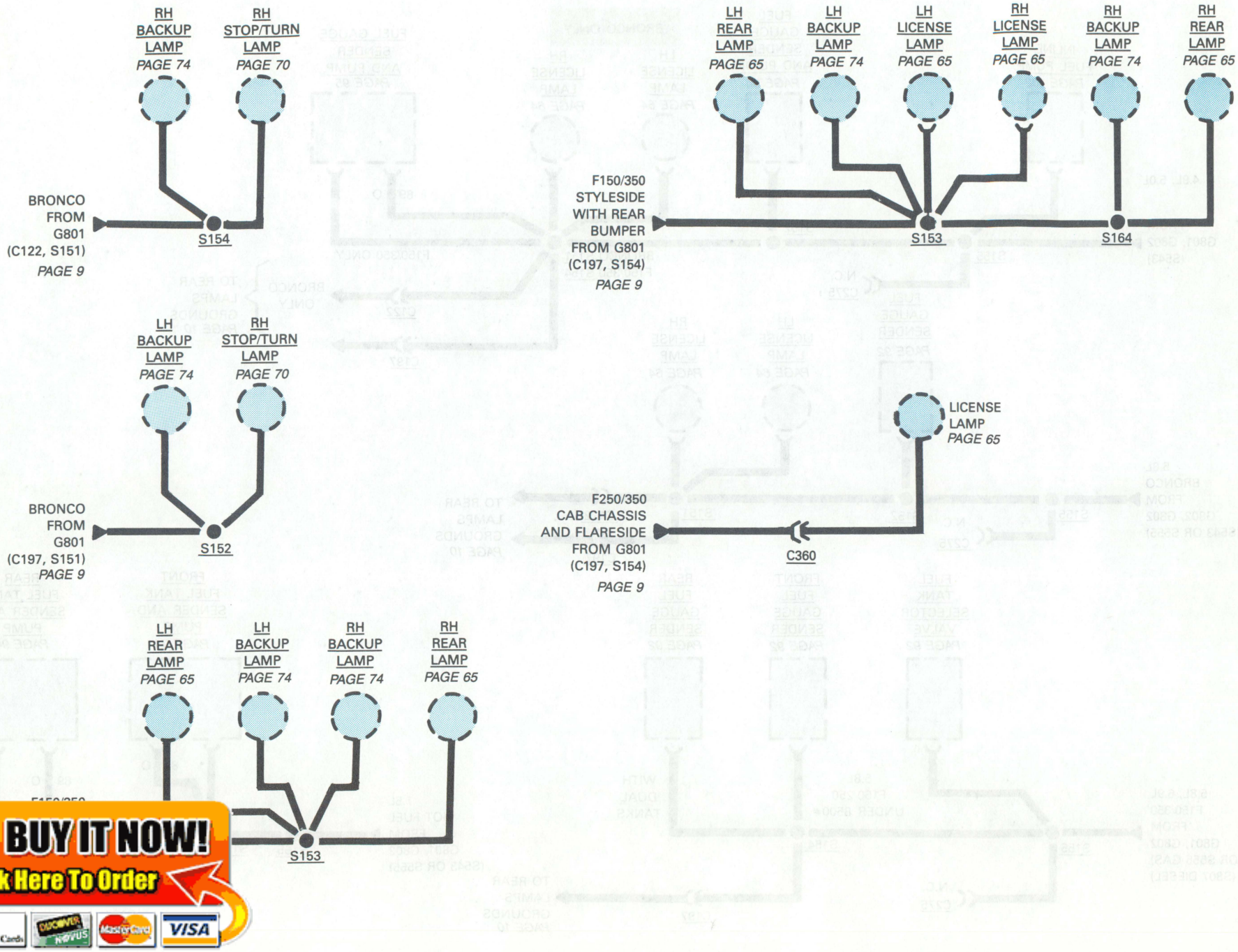
6 GROUNDS (G801, 802) (4.9L AND 5.0L GASOLINE)

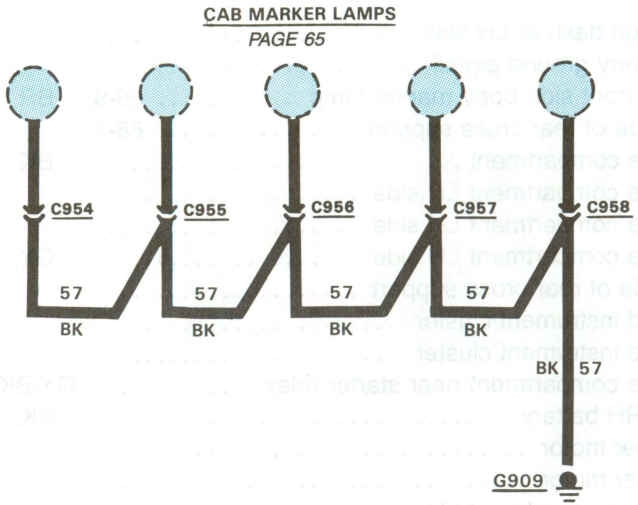


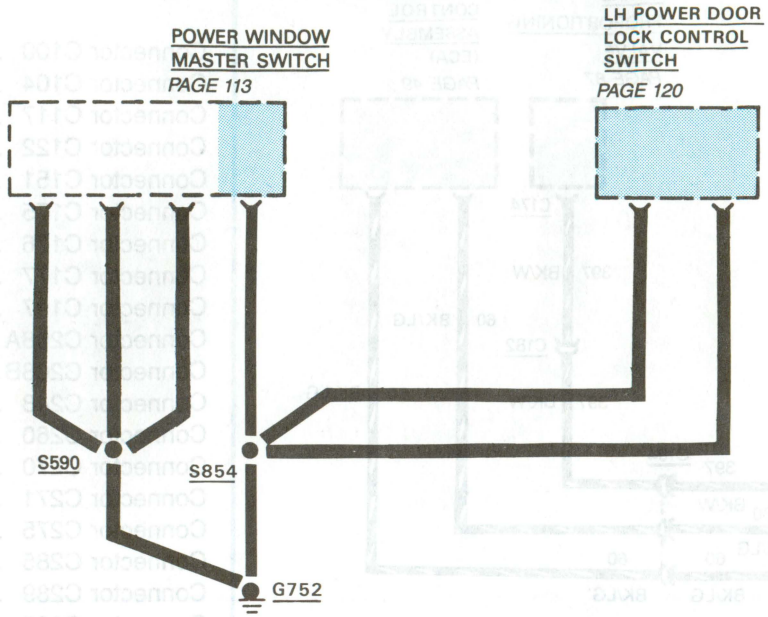


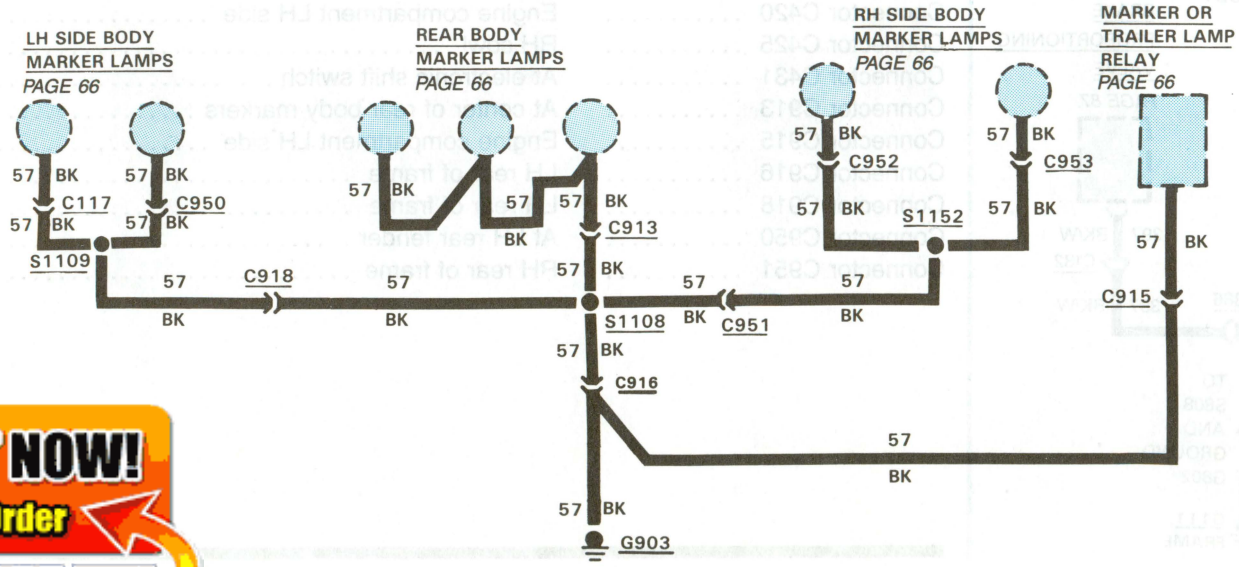


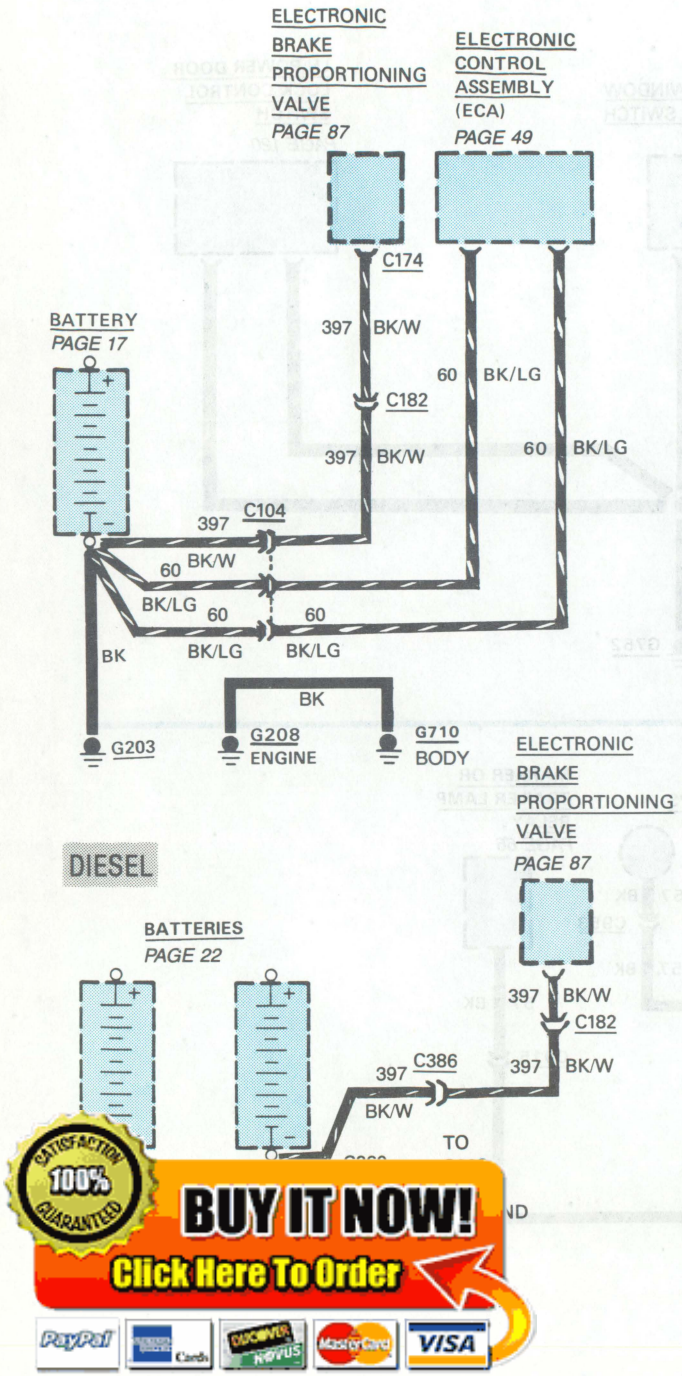












COMPONENT LOCATION

		Page-Figure	Color	Terminals
Connector C100	Through dash at LH side			53
Connector C104	At battery ground pigtail			4
Connector C117	At LH front side body marker lamp	69-8	BR	2
Connector C122	RH side of rear cross support	68-3		4
Connector C151	Engine compartment		BK	2
Connector C175	Engine compartment LH side			10
Connector C176	Engine compartment LH side			8
Connector C177	Engine compartment LH side		GY	12
Connector C197	LH side of rear cross support			8
Connector C208A	Behind instrument cluster			14
Connector C208B	Behind instrument cluster			14
Connector C248	Engine compartment near starter relay		GY/BK	4
Connector C260	Near RH battery		BK	1
Connector C270	At wiper motor			3
Connector C271	At wiper motor			3
Connector C275	Engine compartment LH rear			8
Connector C285	At speed sensor		BR	2
Connector C289	RH cowl		BK	4
Connector C327	Behind LH side of I/P	48-1		3
Connector C366	Behind center of I/P		GY	3
Connector C386	Near RH battery			1
Connector C420	Engine compartment LH side		BK	4
Connector C425	RH cowl		BK	6
Connector C431	At electronic shift switch			6
Connector C913	At center of rear body markers	69-5	GY	2
Connector C915	Engine compartment LH side		BK	2
Connector C916	LH rear of frame	68-1	BK	2
Connector C918	LH rear of frame	68-1	GY	2
Connector C950	At LH rear fender	69-8	BR	2
Connector C951	RH rear of frame	69-6	BR	2

(Continued on next page)

HOW THE CIRCUIT WORKS

The ground circuits shown here are complete and connect several components together to screw terminal ground points. On other pages only parts of these circuits may be shown. Partial ground circuits are shown dashed on those pages.

All simple or component ground circuits are shown on the individual circuit pages and are complete on those pages.

All ground wires are **57 BK** unless otherwise noted.

COMPONENT LOCATION

(Continued from previous page)

		Page-Figure	Color	Terminals
Connector C952	At front of RH rear fender		BR	2
Connector C953	At rear of RH rear fender	69-8	BR	2
Connector C954	At front of cab roof	67-1	BR	2
Connector C955	At front of cab roof	67-1	BK	2
Connector C956	At front of cab roof	67-1	BK	2
Connector C957	At front of cab roof	67-1	BK	2
Connector C958	At front of cab roof	67-1	BK	2
Ground G111	RH frame near battery	26-2		
Ground G203	RH side of engine	21-1		
Ground G208	Near throttle position solenoid	35-2, 37-4		
Ground G210	At electronic voltage regulator			
Ground G211	Near starter motor relay			
Ground G701	Behind I/P near center			
Ground G710	LH side of dash panel			
Ground G752	In LH door	114-1		
Ground G801	LH inner fender behind headlamps			
Ground G802	RH inner fender behind headlamps			
Ground G803	At fuel sedimenter bolt			
Ground G903	At LH side of rear crossmember	68-1		
Ground G909	At lower LH cowl access hole	69-7		
Ground G1201	At front LH side of engine	26-1		
Splice S151	Near license lamp T/O			
Splice S152	Near LH backup lamp T/O			
Splice S153	Near license lamp T/O			
Splice S154	Near front fuel gage sender T/O			
Splice S155	Near electronic rear brake pressure valve T/O			
Splice S164	Near license lamp T/O			
Splice S515	Behind I/P near liftgate power window switch T/O			
Splice S543	Engine compartment near brake sensor T/O			
Splice S554	Engine compartment near speed sensor T/O			
Splice S555	Engine compartment near ignition module T/O			
Splice S563	Engine compartment near A/C compressor clutch T/O			
Splice S590	In LH door near power window switch T/O			
Splice S805	Near cigar lighter T/O			
Splice S807	Near LH headlamp T/O			
Splice S808	Near RH front park lamp T/O			

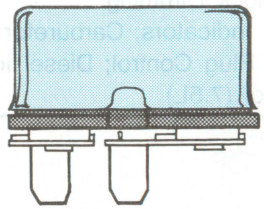
Splice S814	Near W/S wiper illumination lamp T/O
Splice S815	Near G701 T/O
Splice S818	Near RH courtesy lamp T/O
Splice S854	Near LH master window switch T/O
Splice S1108	Near rear marker lamp T/O
Splice S1109	Near LH front side marker lamp T/O
Splice S1152	Near RH front side marker lamp T/O

REPLACEMENT OF FUSES/ CIRCUIT BREAKERS

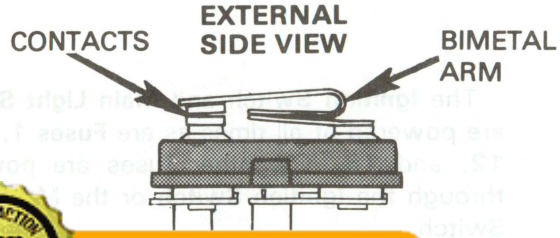
GOOD FUSE BLOWN FUSE

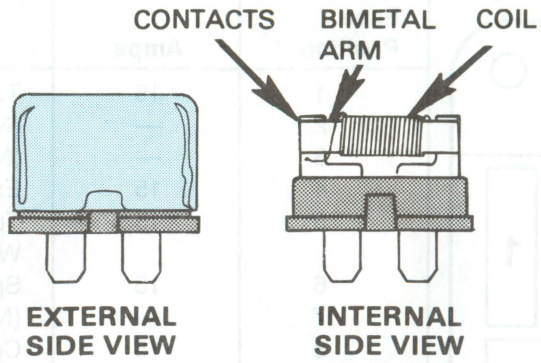
Fuses are mounted either in the **Fuse Panel** or in-line. They are identified by the numbered value in amperes, and by a color code. Some positions may have either a fuse with adapter or a circuit breaker. Be sure to replace a fuse or circuit breaker with the same kind of unit and with the same ampere rating. Remove fuses in order to check them.

CIRCUIT BREAKER OPERATION



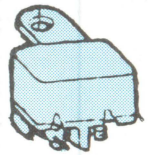
EXTERNAL SIDE VIEW





EXTERNAL SIDE VIEW INTERNAL SIDE VIEW

Non-Cycling Fuse Block Type



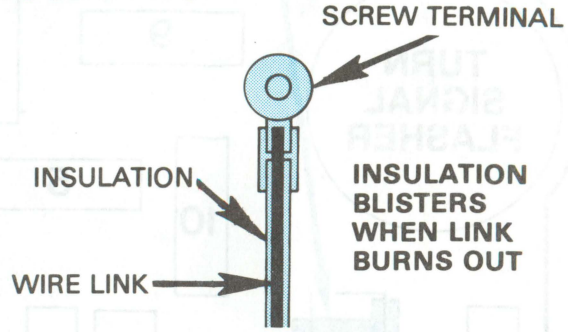
Cycling In-Line Type

Some circuits are protected by circuit breakers. (Abbreviated "c.b." in fuse chart.) They can be **Fuse Panel** mounted or in-line. Like fuses, they are rated in amperes.

Each circuit breaker conducts current through an arm made of two types of metal bonded together (bimetal arm). If the arm starts to carry too much current, it heats up. As one metal expands faster than the other, the arm bends, opening the contacts. Current flow is broken. In the cycling type, the arm cools and straightens out. This closes the circuit again. This cycle repeats as long as the overcurrent exists, with power applied.

In the non-cycling type, there is also a coil wrapped around the bimetal arm. When an overcurrent exists and the contacts open, a small current passes through the coil. This current through the coil is not large enough to operate a load, but it does heat up both the coil and bimetal arm. This keeps the arm in the open position until power is removed.

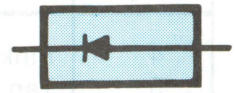
FUSE LINKS



The fuse link is a short length of wire smaller in gage than the wire in the protected circuit. The wire is covered with a thick non-flammable insulation. An overload causes the link to heat and the insulation to blister. If the overload remains, the link will melt, causing an open circuit.

When replacing, make tight crimp joints or hot solder joints for good connections.

DIODES



Diodes are electrical devices that permit current to flow in one direction only. The current flows in the direction indicated by the arrow.

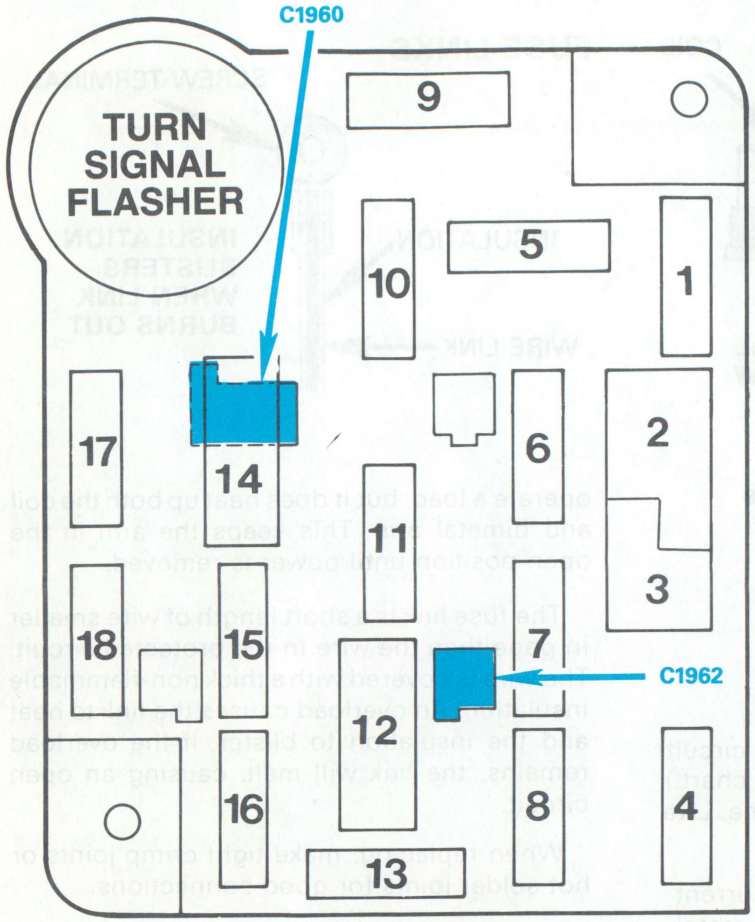


Figure 1 - Fuse Panel

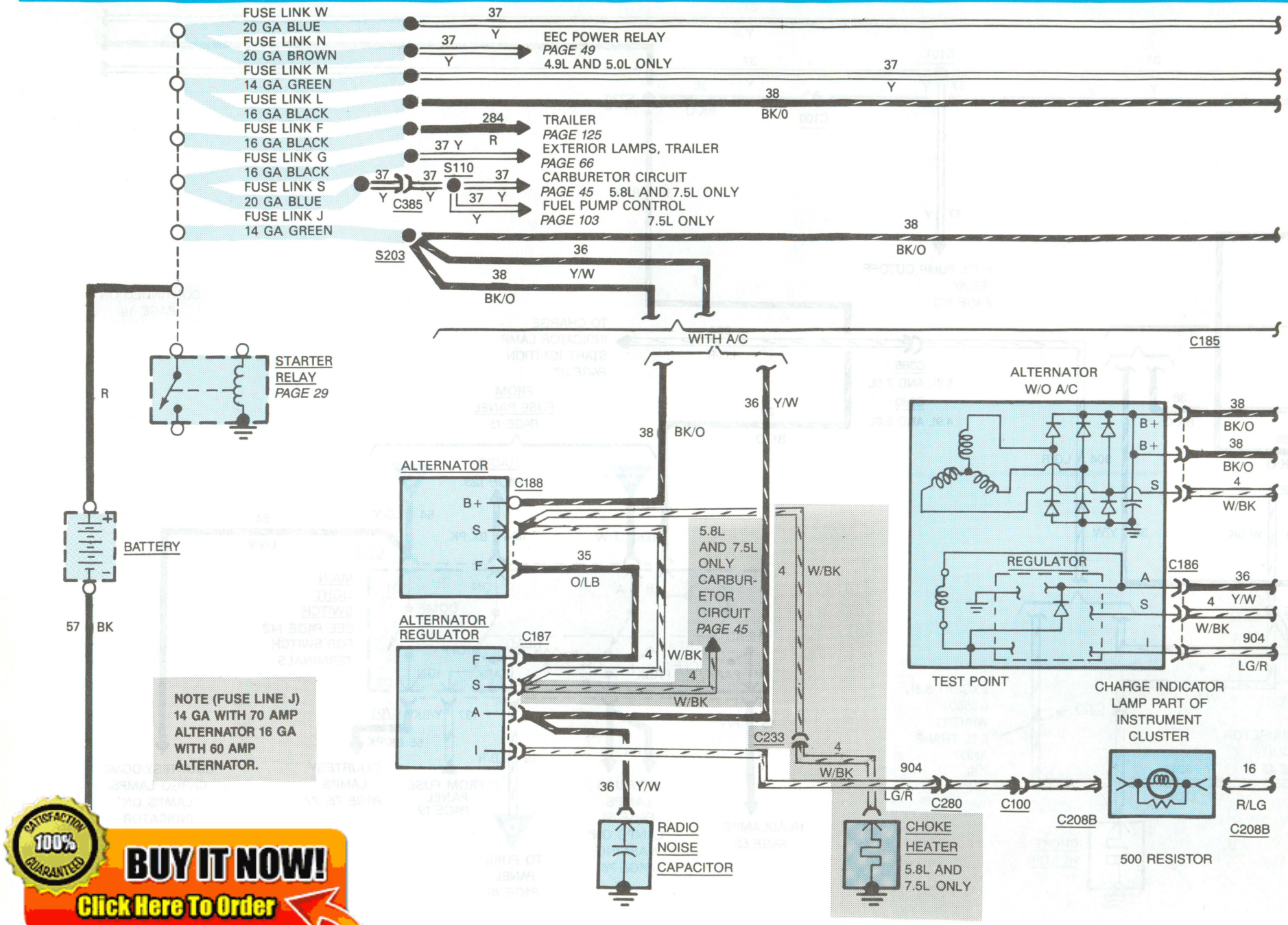
Fuse Position	Amps	Circuits Protection
1	15	Turn/Stop/Hazard Lamps; Speed Control
2	—	(Not used)
3	—	(Not used)
4	15	Exterior Lamps; Instrument Illumination
5	15	Turn Lamps; Backup Lamps; Rear Window Defrost
6	15	Speed Control; Electronic Shift-4 Wheel Drive
7	—	(Not Used)
8	15	Courtesy, Dome, Cargo Lamps; Warning Buzzer
9	30	Heater; A/C-Heater
10	20	Anti-lock Brakes
11	15	Radio; Main Light Switch; Clock Illumination
12	25	Tailgate Power Window; Power Mirrors
	30 c.b.	Power Door Locks; Electronic Shift-4 Wheel Drive
13	—	(Not used)
14	25	Tailgate Power Window
	30 c.b.	Power Windows
15	10	Auxiliary Fuel Tank Selector
16	30	Horn; Cigar Lighter; Speed Control; 4.9L EFI After Run Blower
17	5	Instrument Illumination; Clock Dimming
18	15	Seatbelt Buzzer; Warning Indicators; Carburetor Circuits; Tachometer; Diesel Glow Plug Control; Diesel Indicators; Electric Fuel Pump Control (7.5L)

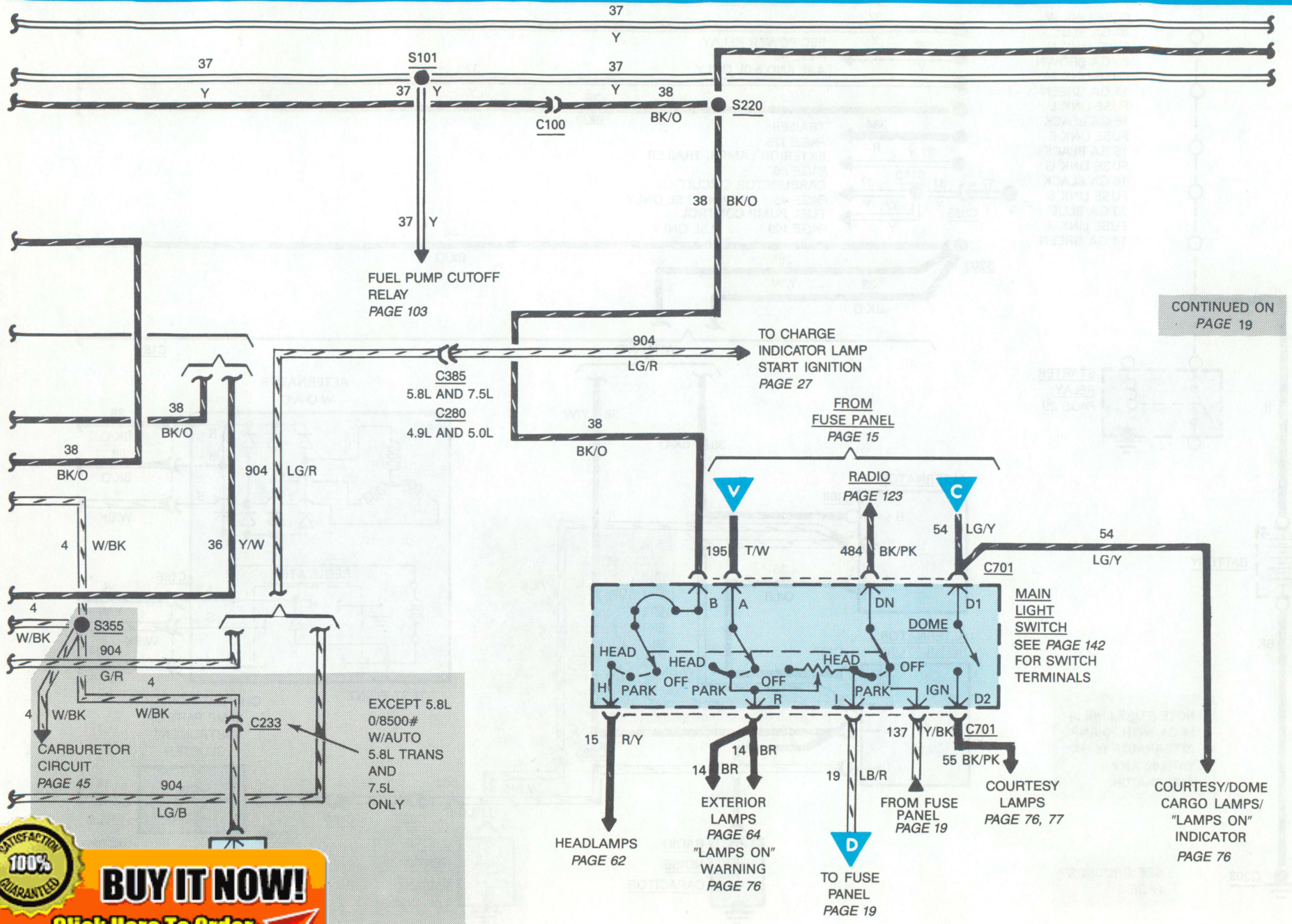
Fuse Value Amps	Color Code
4	Pink
5	Tan
10	Red

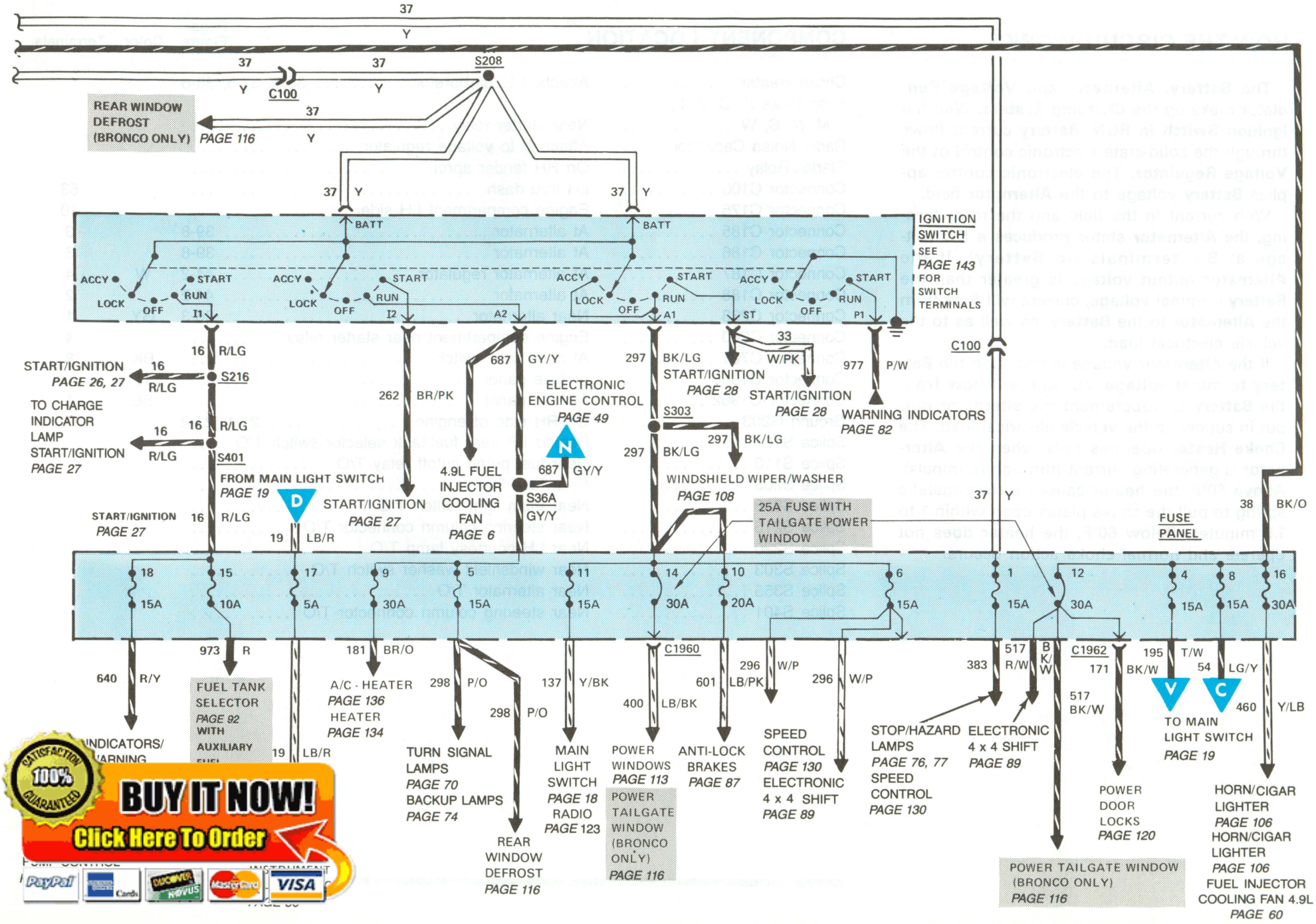
Power Distribution

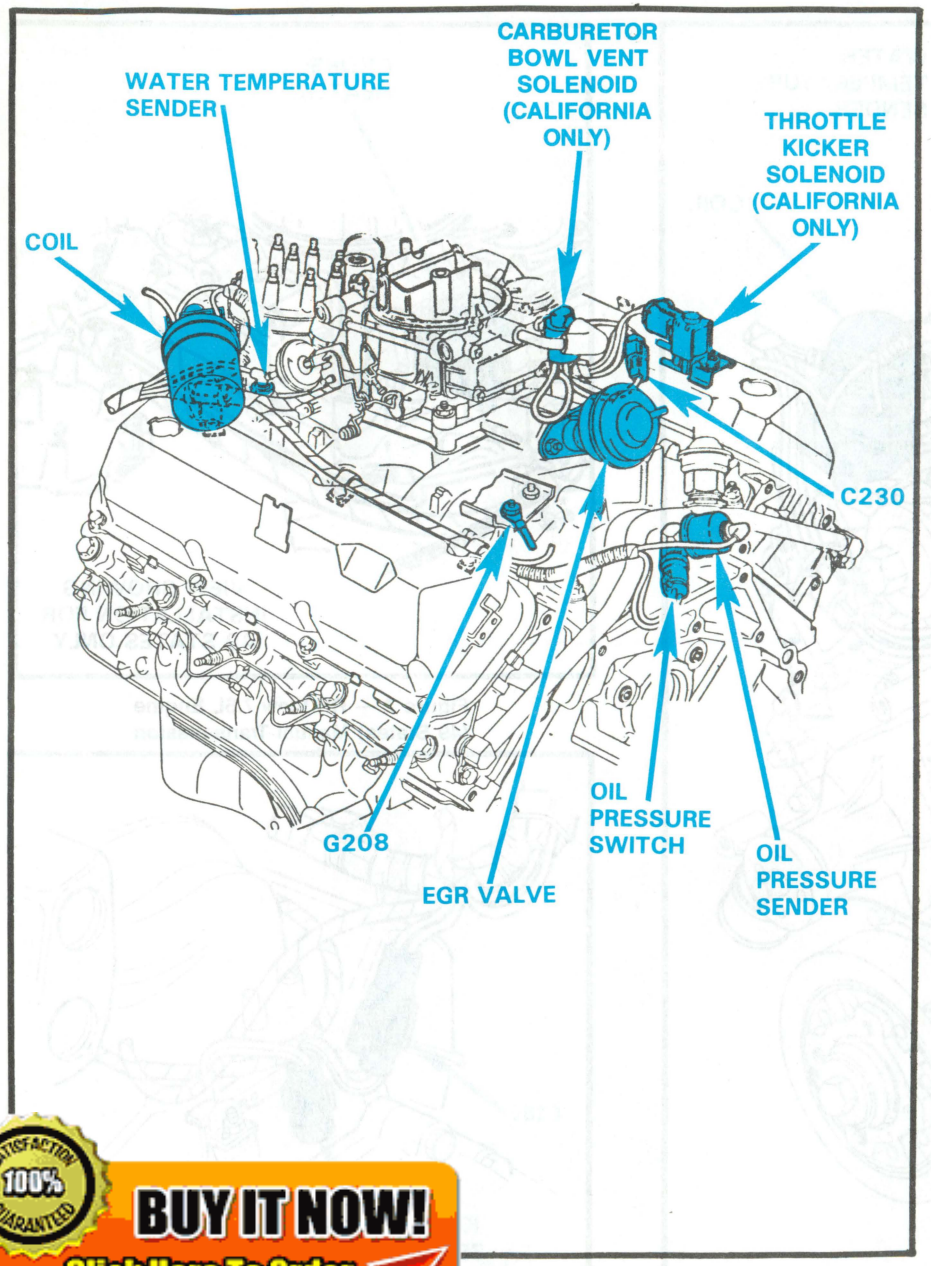
The **Alternator** and **Battery** are connected together at the **Starter Relay** hot terminal. Other circuits originate at the **Starter Relay** hot terminal and are protected by fuse links. Low power circuits are also protected by fuses.

The **Ignition Switch** and **Main Light Switch** are powered at all times as are **Fuses 1, 4, 8, 12,** and **16.** The other fuses are powered through the **Ignition Switch** or the Main Light Switch.









5L Engine (50 States)

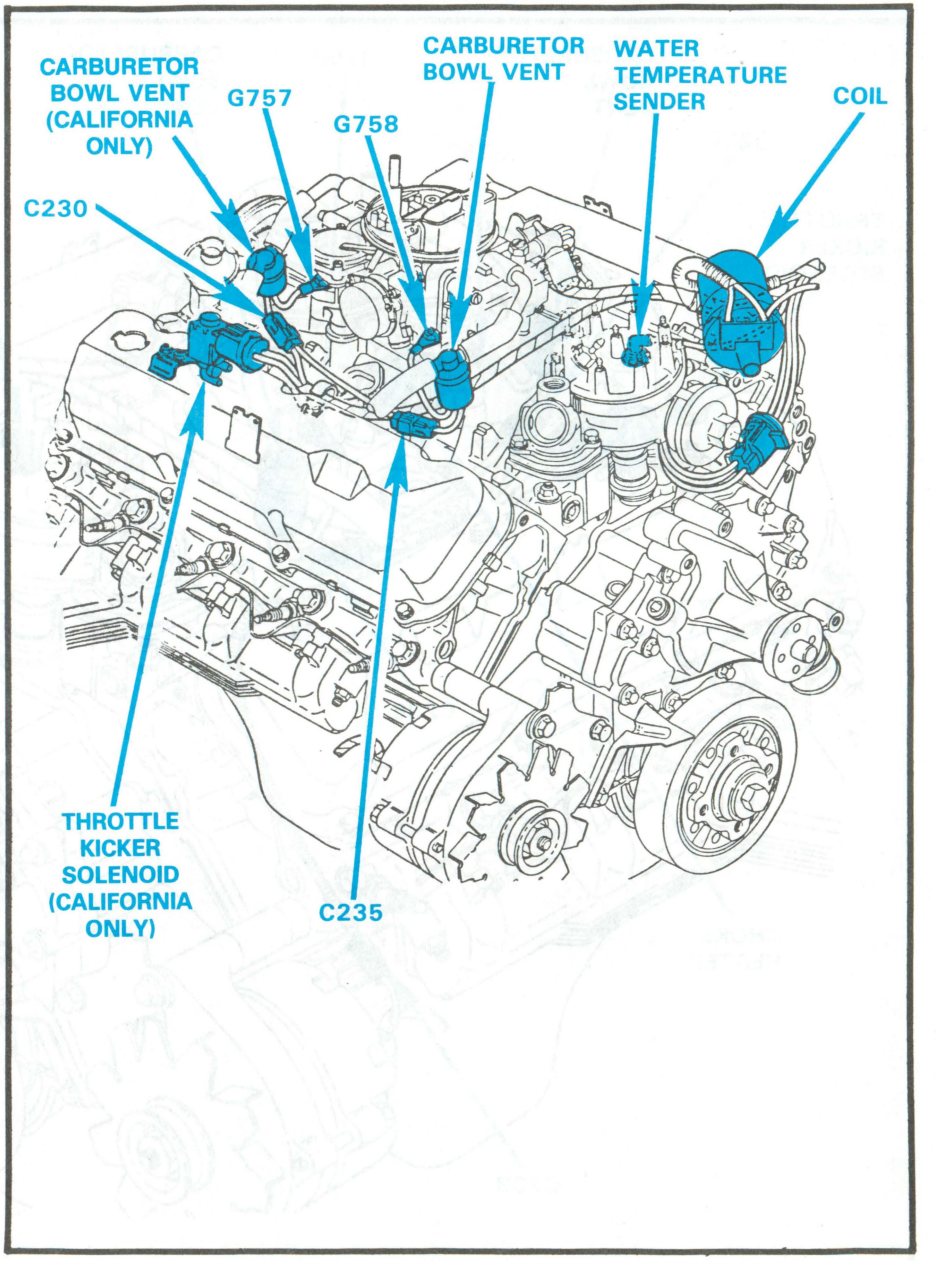
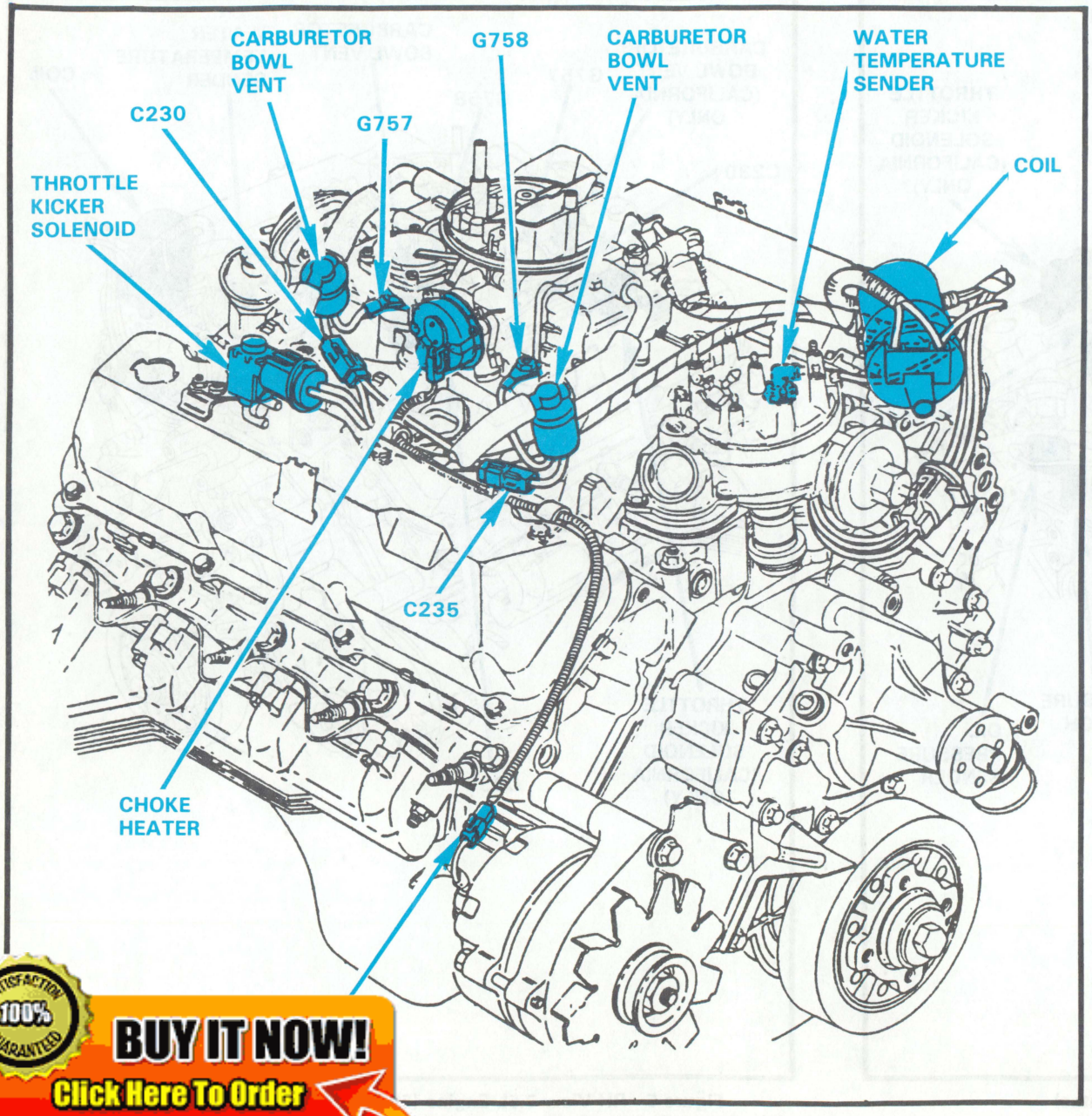


Figure 5 – RH View 7.5L Engine (50 States) Automatic Transmission



7.5L Engine (50 States) Manual Transmission

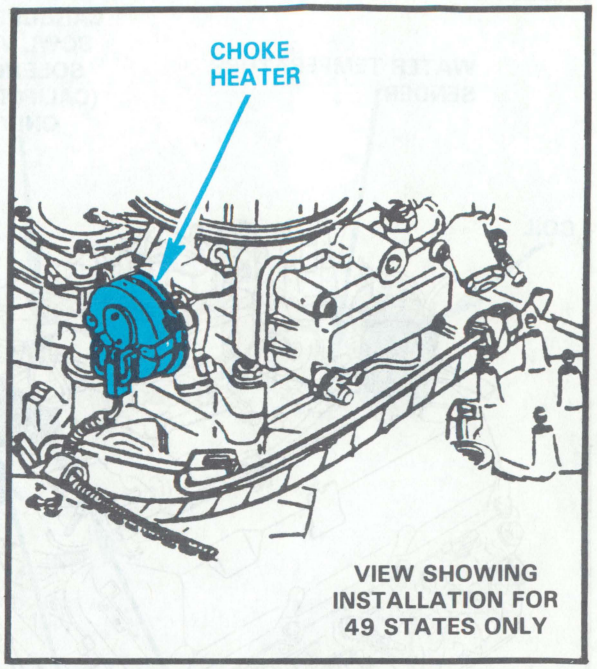


Figure 7 — RH View 7.5L Engine (49 States) Manual Transmission

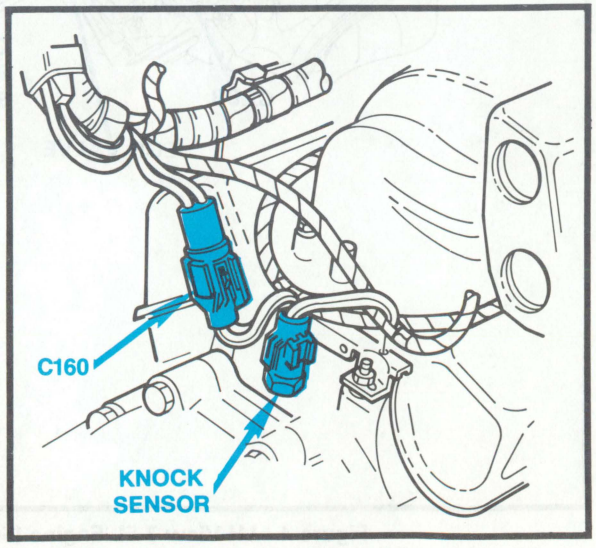
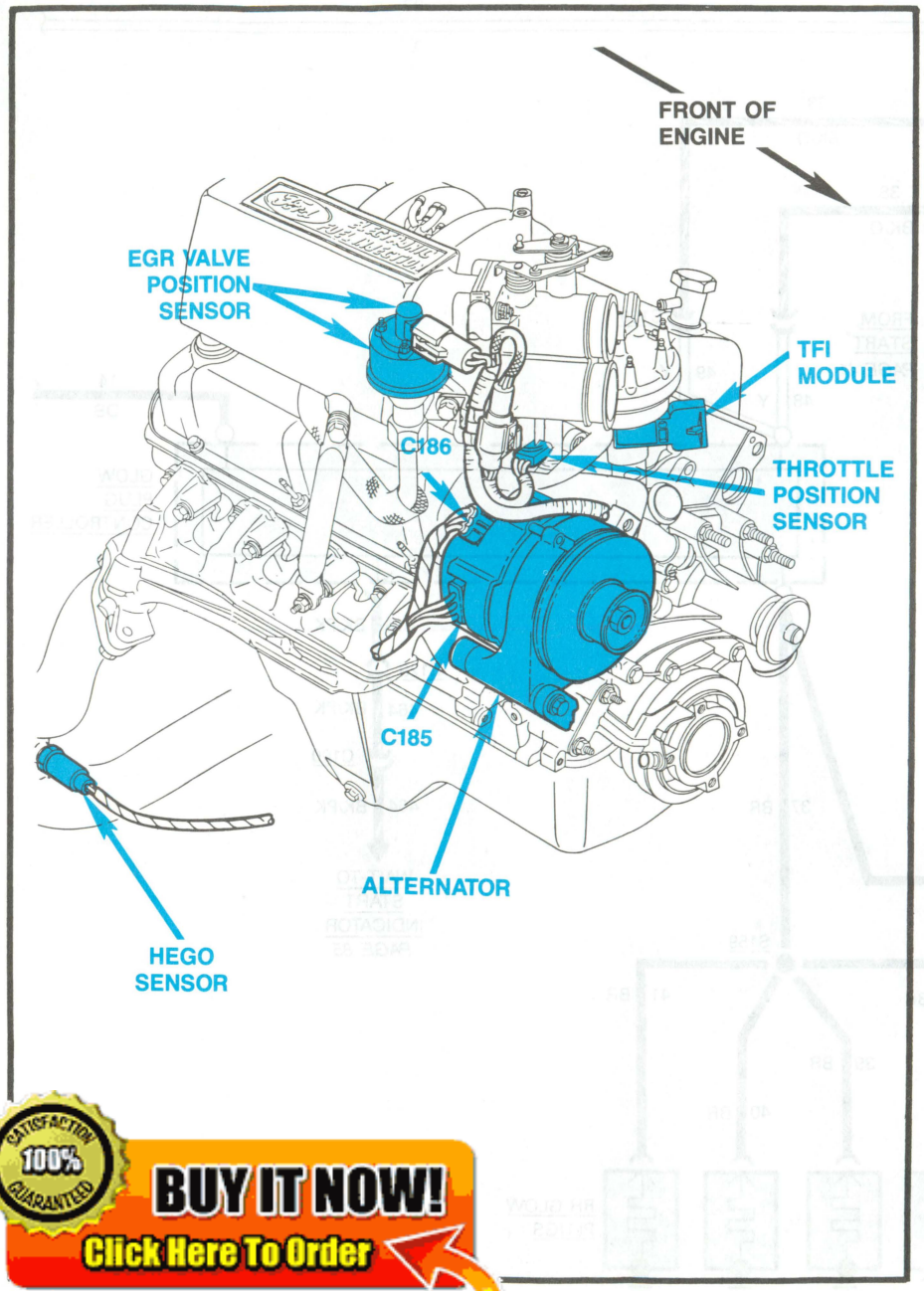
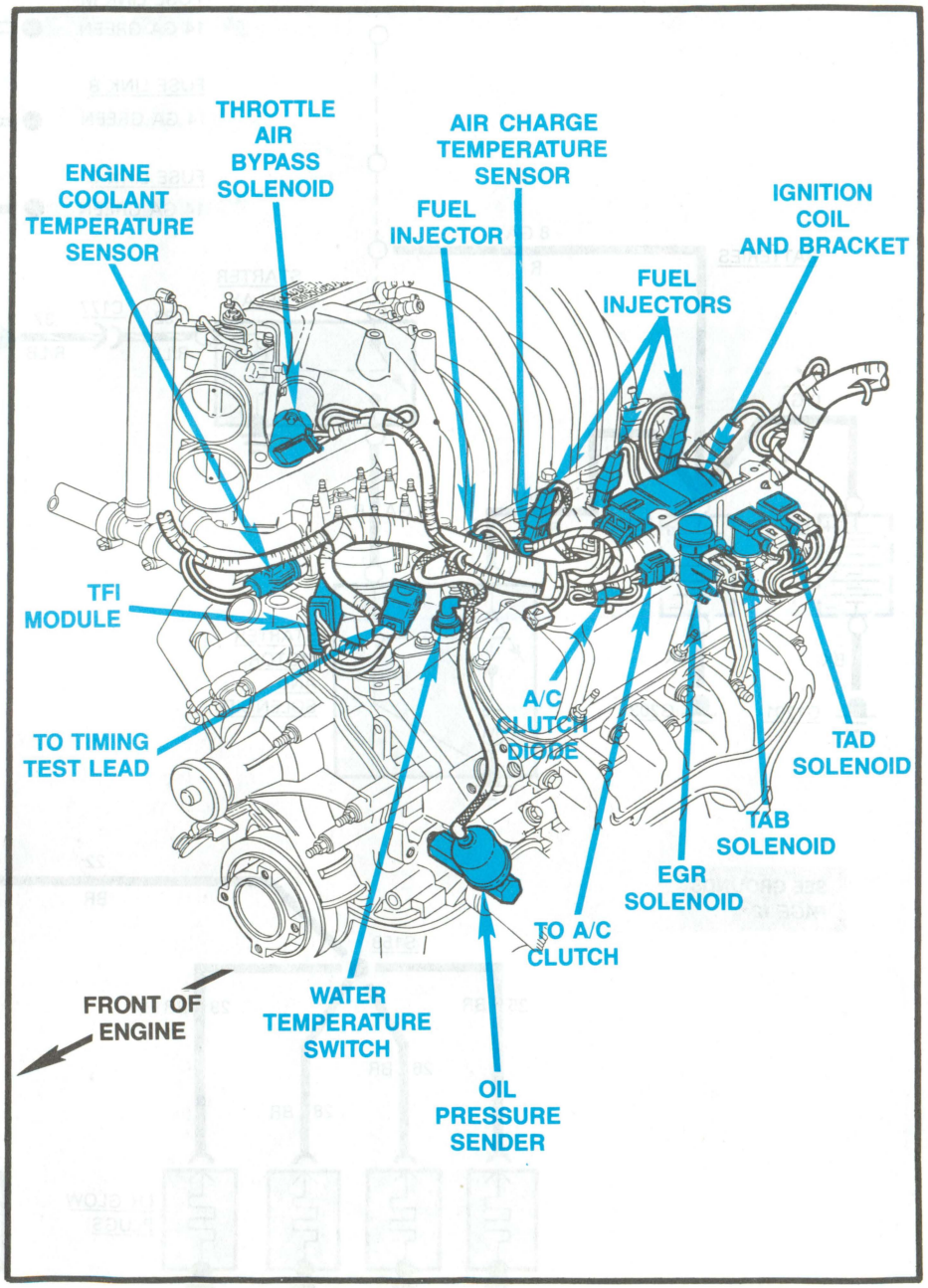


Figure 8 — Knock Sensor Location — 5.0L EFI

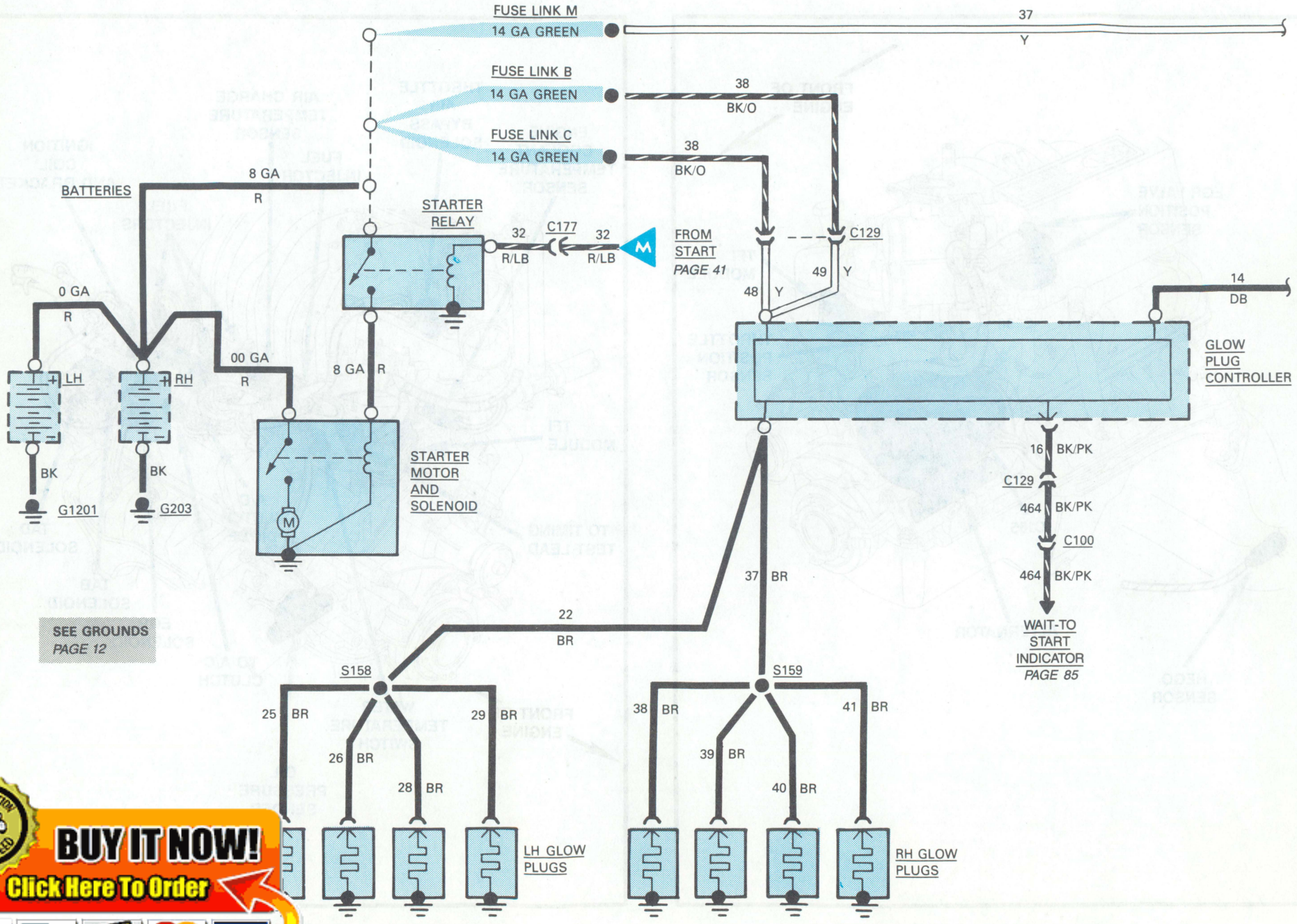


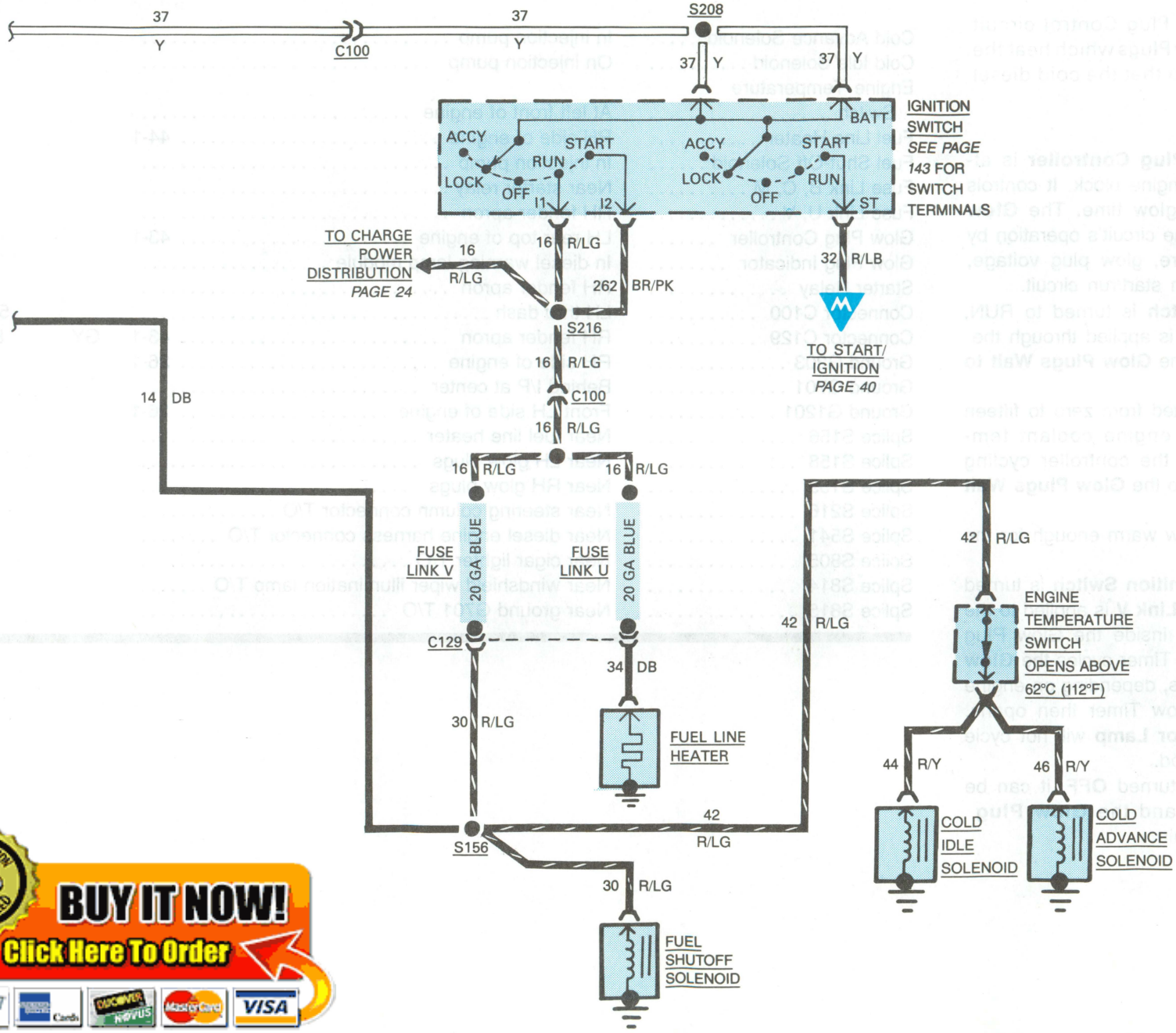


(50 States) (EEC-IV)

Figure 10 — LH View 5.0L Engine (50 States) (EEC-IV)

40 START/GLOW PLUG CONTROL/RUN (DIESEL)





HOW THE CIRCUIT WORKS

The Diesel Start/Glow Plug Control circuit applies power to the **Glow Plugs** which heat the combustion chambers, so that the cold diesel engine can be started.

Glow Plug Control

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

When the **Ignition Switch** is turned to RUN, voltage from **Fuse Link V** is applied through the **Glow Plug Controller** to the **Glow Plugs Wait to Start Indicator Lamp.**

The glow plugs are heated from zero to fifteen seconds, depending on engine coolant temperature. After this time, the controller cycling switch opens and voltage to the **Glow Plugs Wait to Start Indicator Lamp.**

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 **Fuse Link V** 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 cycle during the After-Glow period.

If the ignition switch is turned **OFF,** it can be turned **ON** immediately and the **Glow Plug** ...ting cycle will start again.

COMPONENT LOCATION

		Page-Figure	Color	Terminals
Cold Advance Solenoid	In injection pump			
Cold Idle Solenoid	On injection pump			
Engine Temperature Switch	At left front of engine			
Fuel Line Heater	RH side of engine	44-1		
Fuel Shut-Off Solenoid	In injection pump			
Fuse Link B, C, M	Near starter relay			
Fuse Link U, V	RH fender apron			
Glow Plug Controller	LH rear top of engine	43-1		
Glow Plug Indicator	In diesel warning lamp module			
Starter Relay	RH fender apron			
Connector C100	LH thru dash			53
Connector C129	RH fender apron	43-1	GY	8
Ground G203	RH side of engine	26-1		
Ground G701	Behind I/P at center			
Ground G1201	Front LH side of engine	26-1		
Splice S156	Near fuel line heater			
Splice S158	Near LH glow plugs			
Splice S159	Near RH glow plugs			
Splice S216	Near steering column connector T/O			
Splice S541	Near diesel engine harness connector T/O			
Splice S805	Near cigar lighter T/O			
Splice S814	Near windshield wiper illumination lamp T/O			
Splice S815	Near ground G701 T/O			

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 in the Starter motor assembly. When the **Glow Plug Indicator** goes out, the **Ignition Switch** can be turned to START. With the transmission selector in park or neutral (automatic transmission), or the clutch pedal depressed (manual transmission), power is applied to the **Starter Relay.** The relay applies power to the solenoid coil which closes contacts to apply battery power to the starter motor.

With the **Ignition Switch** in Start or Run, voltage is supplied to the **Fuel Line Heater, Fuel Shut-Off Solenoid, Engine Temperature Switch, Cold Advance Solenoid,** and the **Cold Idle Solenoid,** through **Fuse Links U and V.**

The **Fuel Line Heater** is wrapped around the fuel line. It heats the diesel fuel to melt any wax which might clog the filter. The heater has an interval thermostat to turn it on as needed.

The **Fuel Shut-Off 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 de-energized, fuel flow stops, and the engine stops running.

The **Engine Temperature Switch** provides voltage to the **Cold Advance Solenoid** and the **Cold Idle Solenoid.** When engine temperature is below 62°C (112°F), 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 62°C (112°F), the **Engine Temperature Switch** opens. This de-energizes the Solenoids, returning the Timing and Idle to normal.

TROUBLESHOOTING HINTS

See the Engine/Emission Diagnosis Manual.

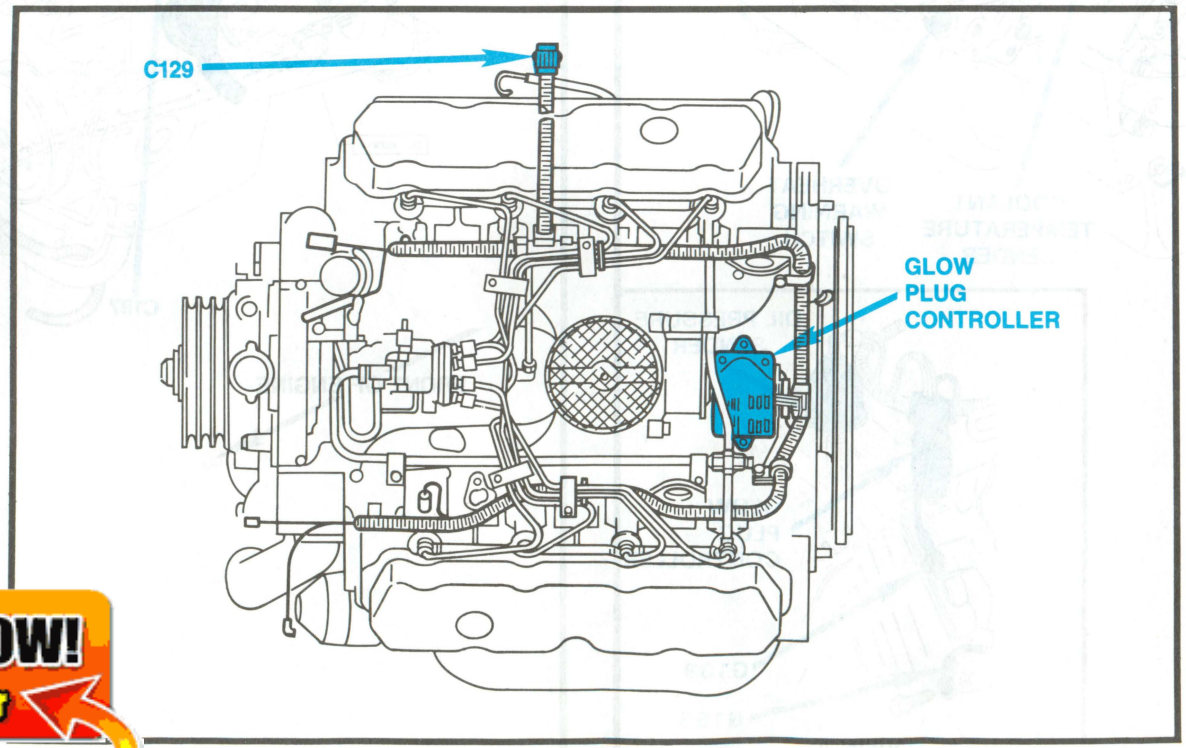


Figure 1 — Glow Plug Controller

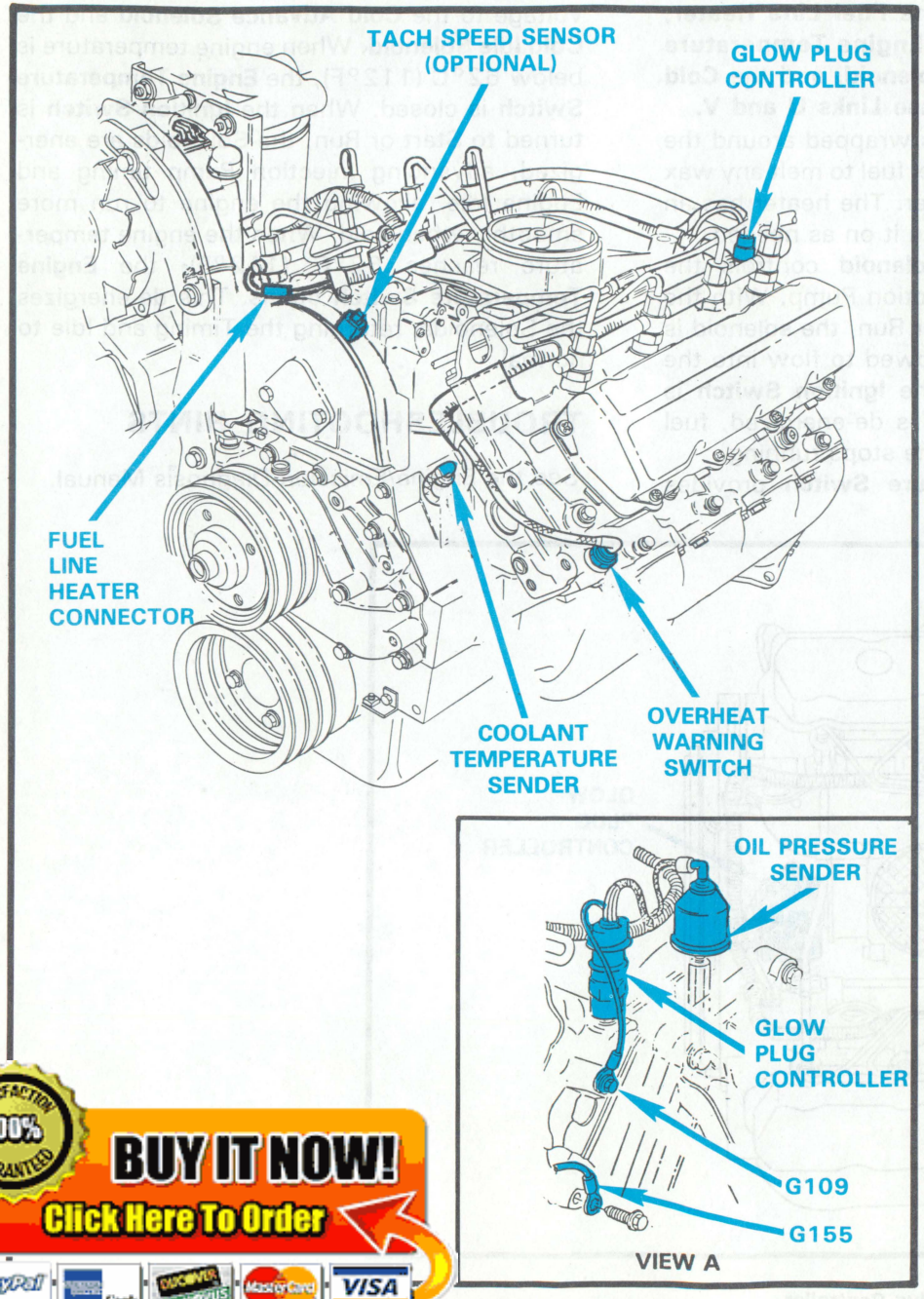


Figure 2 — LH Side of 6.9L Diesel Engine

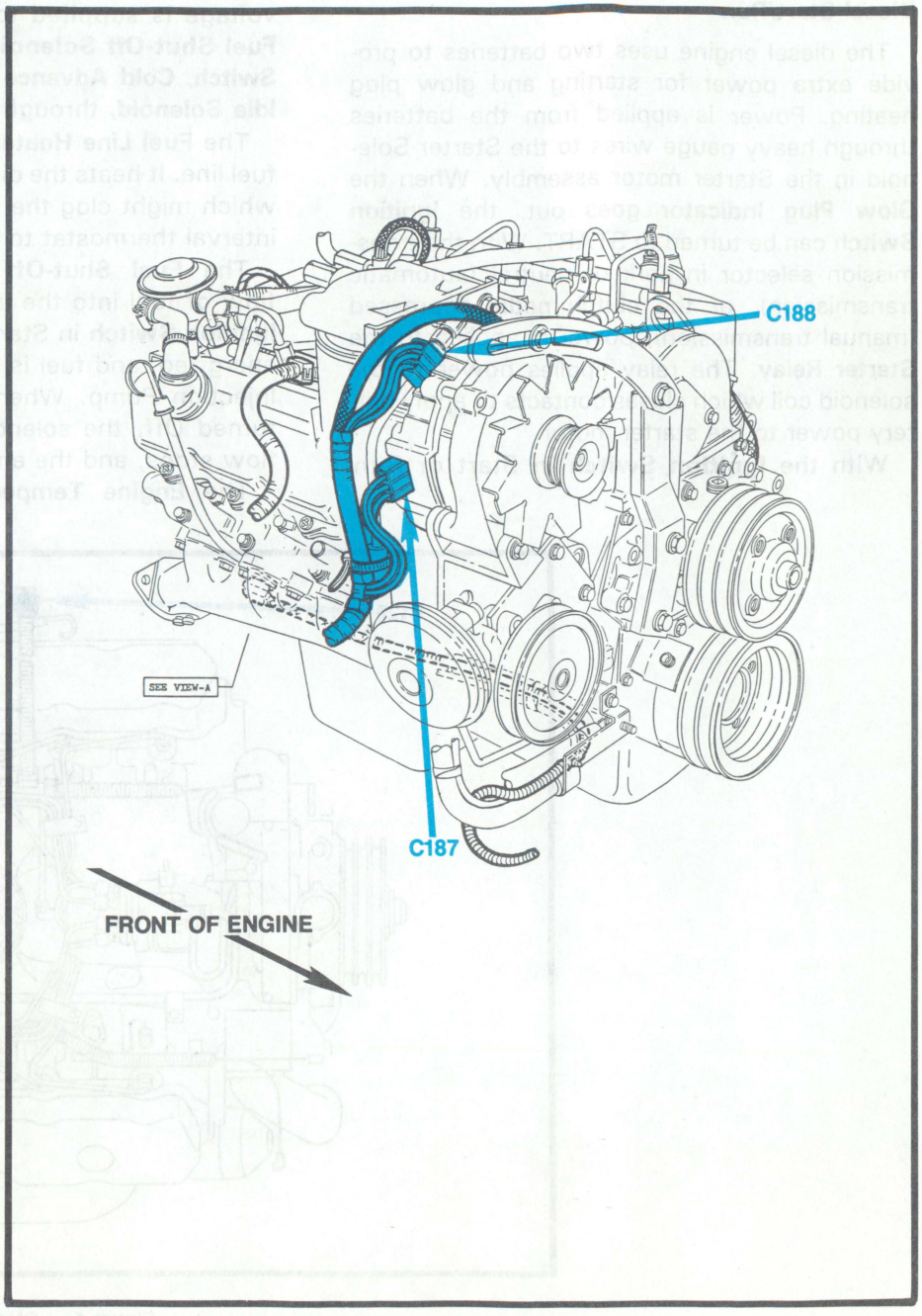


Figure 3 — RH Side of 6.9L Diesel Engine

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Ford Parts and Service Division
Training and Publications Department

FPS-12129-87

1988 BRONCO/ F150-F350/ F-SUPER DUTY

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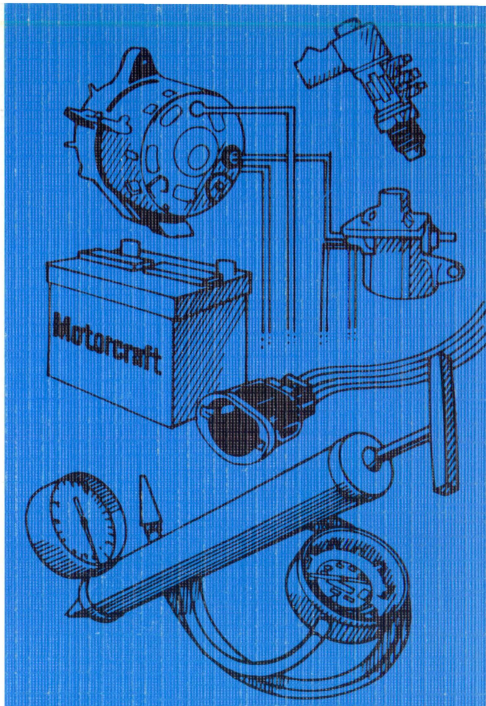
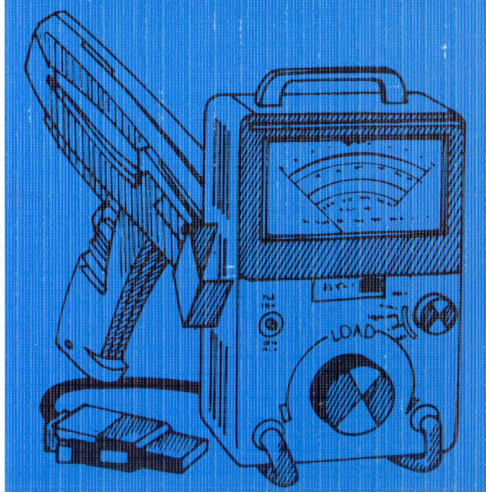


Electrical & Vacuum Trouble-Shooting Manual



1988 Bronco/F150-F350/ F-Super Duty Electrical & Vacuum Trouble-Shooting Manual (EVTM)

EAN: 978-1-60371-411-2
ISBN: 1-60371-411-1

Forel Publishing Company, LLC
Woodbridge, VA 22192
Email: sales@ForelPublishing.com
https://www.ForelPublishing.com

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ELECTRICAL AND VACUUM TROUBLESHOOTING MANUAL

FPS — 12129 - 88

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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.

This manual contains the following diagnostic information:

- Electrical and Vacuum Schematics
- Component Location Indexes and Views
- Troubleshooting Hints
- Descriptions of Circuit Operation
- Component Testing

The vehicle's entire electrical system is broken down into individual systems. There are also sections for the vehicle's ground and power distribution circuitry. Each system section begins with a wiring schematic. The **Schematics** should always be your starting point in using this manual. These schematics show the paths of electrical current during proper circuit operation. The source of voltage (circuit breaker or fuse) is shown at the top of the page. All wire, connectors, splices, switches, and motors are shown in the flow of current to ground at the bottom of the page. Connector end views of switches and other components are shown to help with bench testing. Each circuit component is named (underlined titles). Wire and connector colors are listed (standard Ford color abbreviations are used). These abbreviations are:

COLOR ABBREVIATIONS

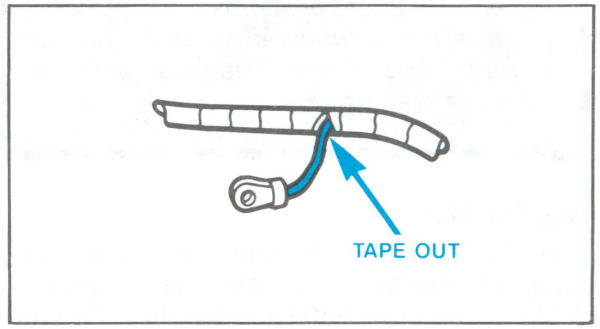
BL	**Blue**	**N**	**Natural**
BK	**Black**	**O**	**Orange**
BR	**Brown**	**PK**	**Pink**
DB	**Dark Blue**	**R**	**Red**
DG	**Dark Green**	**P**	**Purple**
GR	**Green**	**T**	**Tan**
GY	**Gray**	**W**	**White**
LB	**Light Blue**	**Y**	**Yellow**
LG	**Light Green**		

wire, the
e. The sec-

The **Component Location** section of each system helps you locate the circuit's components in the vehicle. A brief statement of the location is given as well as a reference to an illustrative figure in the manual. There is also a full listing of connector, ground, and splice locations in the **Location Index** in the back of the manual.

OTHER ABBREVIATIONS

T/O (Tape Out) **The point at which a harness branches to feed a component.**



The **Troubleshooting Hints** offer shortcuts or tests that help you determine the cause of an electrical problem. They are not intended to be a rigid procedure for solving an electrical situation. Rather, Troubleshooting Hints represent a common-sense approach that is based on an understanding of the circuit.

A description of **How the Circuit Works** is written to help you understand the operation of the circuit as a whole. Emphasis is placed on how the components and circuitry interact in a properly working system.

A **Component Testing** section provides procedures to determine whether a component is good or bad.

Notes, Cautions, and **Warnings** appear in boxes on text pages and contain important vehicle and mechanic **safety** information.

Notes give added information to help complete a particular procedure. Cautions are included to prevent making an error that could damage the vehicle. Warnings highlight areas where carelessness can cause personal injury. The following list contains some general **Warnings** that should be followed when working on a vehicle.

- 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 the danger of carbon monoxide.
- Keep away from moving parts when the engine is running, especially the fan and belts.
- 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.

TROUBLESHOOTING STEPS

These six steps present an orderly method of troubleshooting:

Step 1. Verify the problem.

- Operate the complete system and see all symptoms for yourself in order to:
  - —check the accuracy and completeness of the customer's complaint.
  - —learn more that might give a clue to the nature and location of the problem.

Step 2. Narrow the problem.

- Using this manual, narrow down the possible causes and locations of the problem in order to more quickly find the exact cause.
- Read the description of *How the Circuit Works* and study the wiring diagram. You should then know enough about the circuit operation to figure out where to check for this trouble.

Step 3. Test the cause.

- Use electrical test procedures to find the specific cause of the symptoms.
- *Troubleshooting Hints* will give some helpful ideas.
- The *Component Location* charts and the pictures will help you find components, grounds, and connectors.

Step 4. Verify the cause.

- Confirm the fact that you have found the correct cause through operating the parts of the circuit you think are good.

Step 5. Make the repair.

- Repair or replace the faulty component.

Step 6. Verify the repair.

...1 and check ...ll symptoms, ... any new ... special test ...s. See the

Shop Manual and other service books for details. You will find the circuits in this manual to be helpful with these special tests.

TROUBLESHOOTING TOOLS

JUMPER WIRE

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

Uses: Bypassing Switches or Open Circuits

WARNING

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

VOLTMETER

A DC **Voltmeter** measures circuit voltage. Connect negative (- or black) lead to ground, and positive (+ or red) lead to voltage measuring point.

OHMMETER

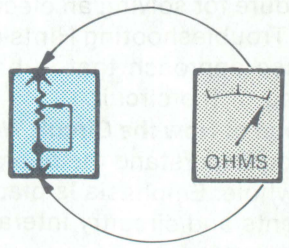


Figure 1— Resistance Check

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

TEST LIGHT

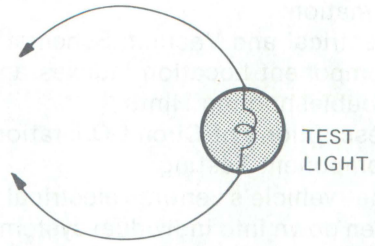


Figure 2 —Test Light

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

Uses: Voltage Check. Short Check

SELF-POWERED TEST LIGHT

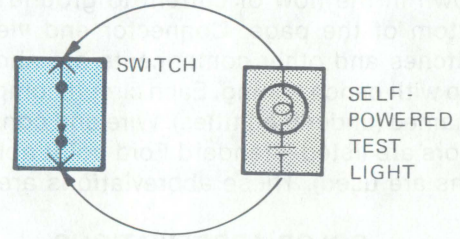


Figure 3—Continuity Check

The **Self-Powered Test Light** 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 light or ohmmeter, be sure power is off in circuit during testing. Hot circuits can cause equipment damage and false readings.

TROUBLESHOOTING CHECKS

SWITCH CIRCUIT CHECK

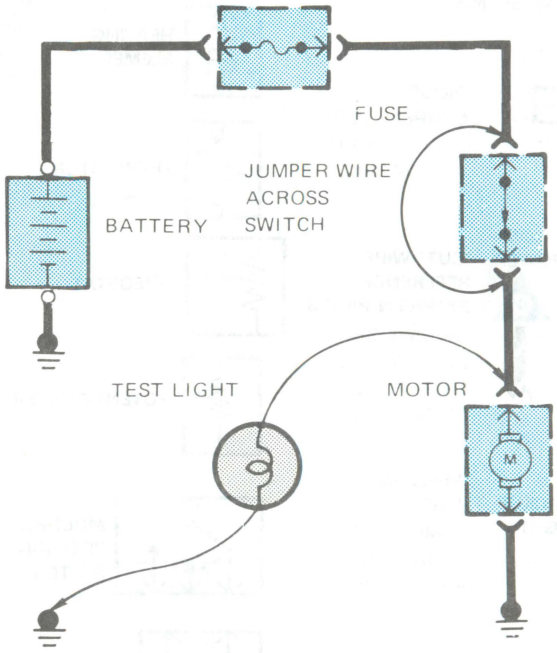


Figure 4—Switch Circuit Check and Voltage Check

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

CONTINUITY CHECK (Locating open circuits)

With power off, connect one lead of **Self-Powered Test Light** or **Ohmmeter** to each end of circuit (Figure 3). Light will glow if circuit is closed. Switches and fuses can be checked in the same way.

VOLTAGE CHECK

) a known
-) battery
g the other
when the

SHORT CHECK (short to ground)

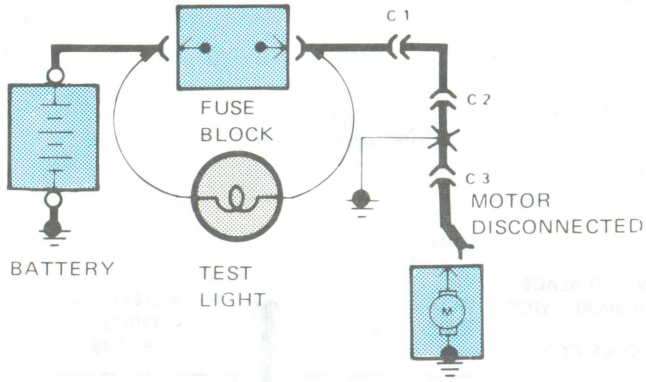


Figure 5— Short Check

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

1) Turn off everything powered through the fuse.
2) Disconnect other loads powered through the fuse:
   - Motors: disconnect motor connector.
   - Lights: remove bulbs.
3) Turn **Ignition Switch** to RUN (if necessary) to power fuse.
4) Connect one **Test Light** 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 Light** lead from ground and reconnect it to the load side of the fuse.
   - If the **Test Light** is off, the short is in the disconnected equipment.
   - If the **Test Light** 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 Light** goes out. For example: with a ground at X, the bulb goes out when C1 or C2 is disconnected, but stays on after disconnecting C3. This means the ground is between C2 and C3.

"GOOD GROUND" CHECK

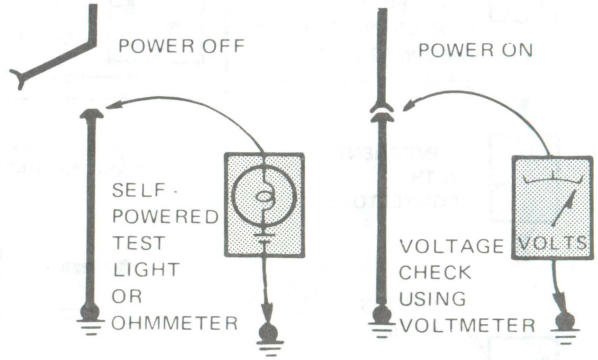


Figure 6 — Grounds Checks

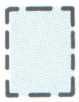
Turn on power to circuit. Perform Voltage Check between suspected bad ground and frame. Any voltage means ground is bad.

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

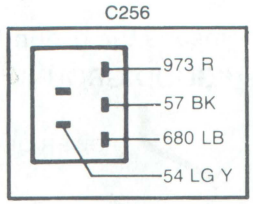
TROUBLESHOOTING HINTS

The circuit schematics in this manual are designed to make it easy to identify common points in circuits. This knowledge can help narrow the problem 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 low beam headlights work but high beams and the indicator light don't work, then power and ground paths must be good. Since the dimmer switch is the component which switches this power to the high beam lights and indicator, it is most likely the cause of failure.



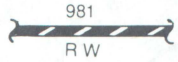
DASHED COMPONENT BOX
ONLY PART OF THE COMPONENT IS SHOWN, OR COMPONENT IS SHOWN IN TWO PLACES



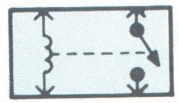
COMPONENT CONNECTOR END VIEW
SHOWS PINS OR SOCKETS ON A COMPONENT TO AID IN BENCH TESTING

WIRE COLORS ARE LABELED FOR MATING HARNESS CONNECTOR

SOLID WIRE



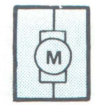
STRIPED WIRE



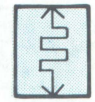
RELAY
CONTACTS CLOSE WITH CURRENT THROUGH COIL

DASHED LINE SHOWS MECHANICAL CONNECTIONS

DIODES
CURRENT FLOWS IN DIRECTION OF ARROW ONLY

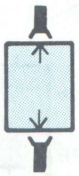


MOTOR



HEATING ELEMENT

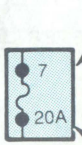
THERMISTOR



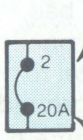
COMPONENT WITH CONNECTORS

PIN AND BLADE TERMINAL TYPES

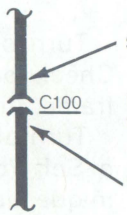
SOCKET TYPES



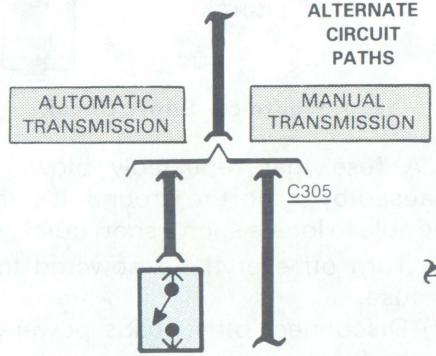
FUSE



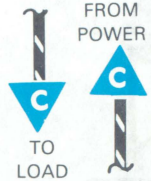
CIRCUIT BREAKER



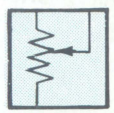
IN-LINE CONNECTOR



ALTERNATE CIRCUIT PATHS



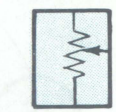
"CUT" WIRE REFERENCED BETWEEN PAGES
ARROWS SHOW CURRENT FLOW FROM POWER TO GROUND



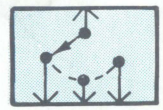
RHEOSTAT

BACKUP LIGHTS

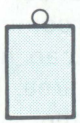
"REFERENCE" WIRES
COMPLETE WIRING SHOWN ON ANOTHER PAGE



POTENTIOMETER

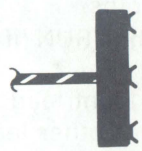


MULTIPLE POSITION SWITCH

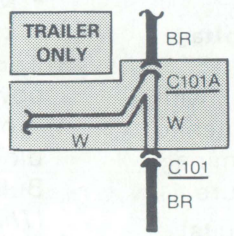


SCREW TERMINAL ON COMPONENT

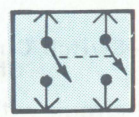
SPLICE OR CRIMP CONNECTION
MOST ARE BUILT INTO HARNESS AND ARE NOT ACCESSIBLE



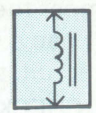
CANDELABRA CONNECTOR
ACCEPTS SINGLE-PIN CONNECTORS



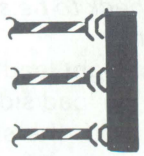
OPTIONAL WIRING
BR WIRES (INCLUDING C101) ARE ON ALL VEHICLES, BUT W WIRES (INCLUDING C101A) ARE USED ONLY WITH TRAILER



GANGED SWITCHES



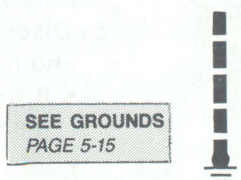
SOLENOID



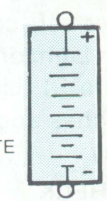
JUNCTION BLOCK

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

GROUND CONNECTION



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



12V BATTERY

20 GA BLUE

FUSE LINK

RESISTOR

SINGLE FILAMENT LIGHT BULB

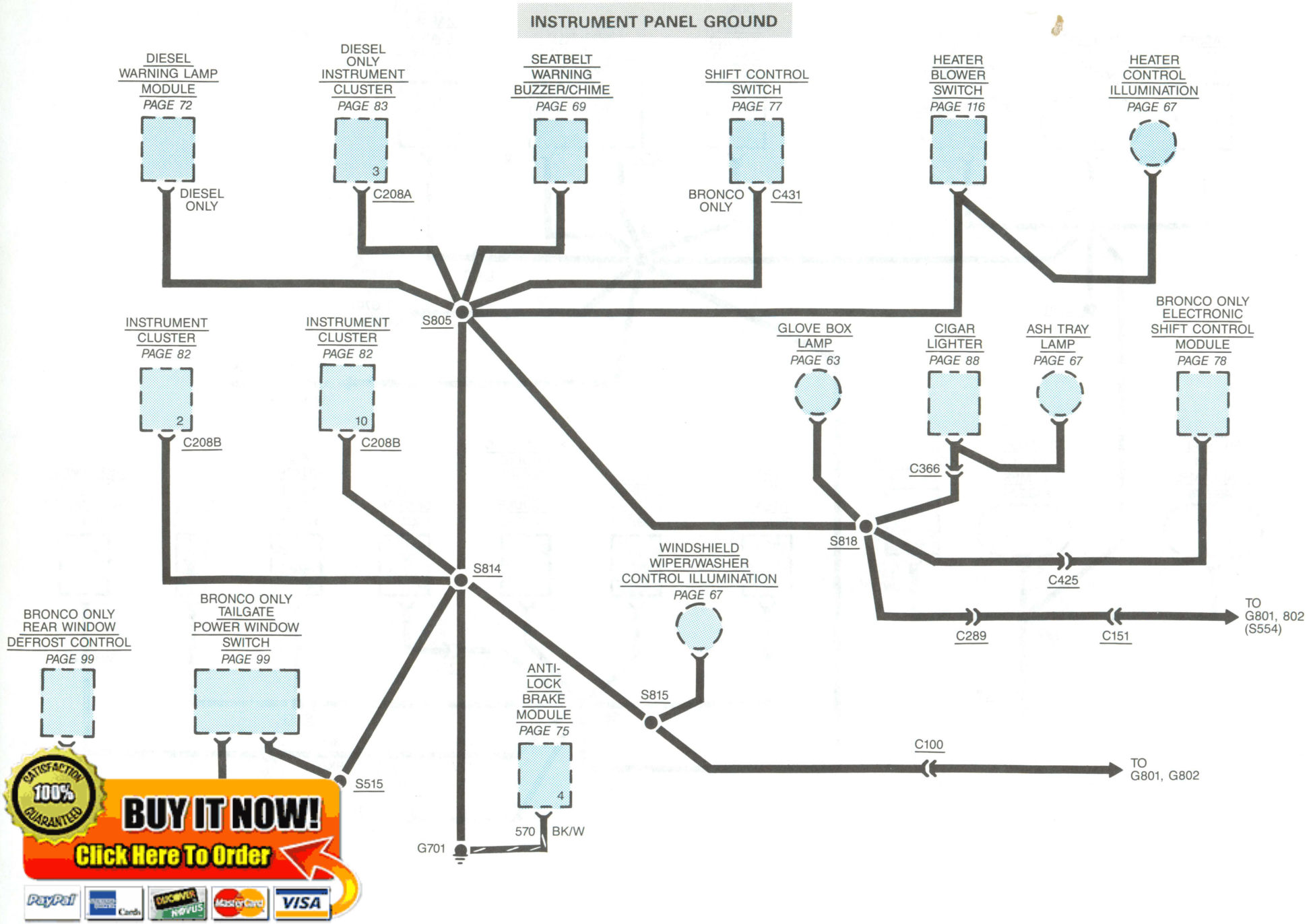
DUAL FILAMENT LIGHT BULB

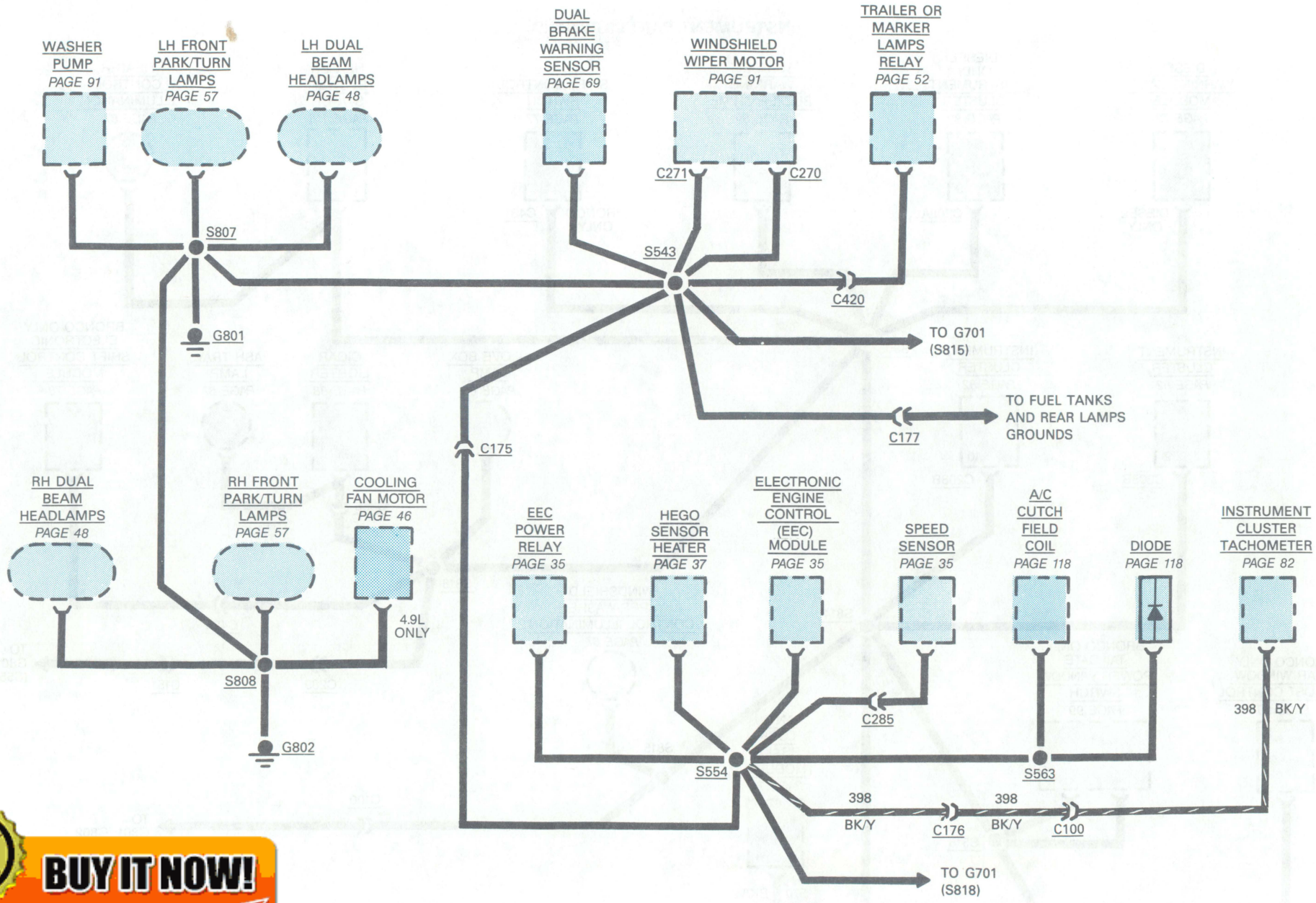
TRANSISTOR

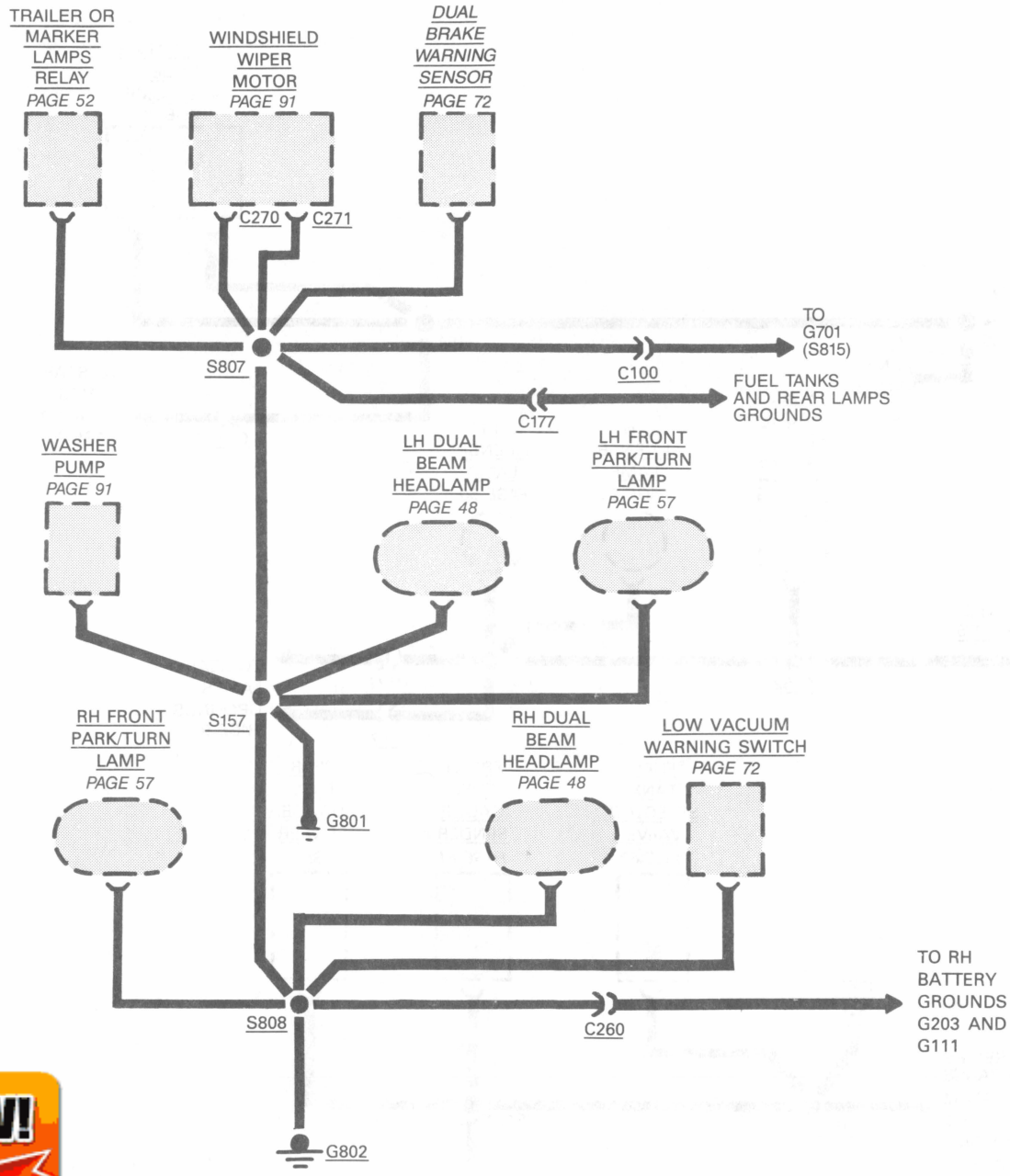
LIGHT EMITTING DIODE

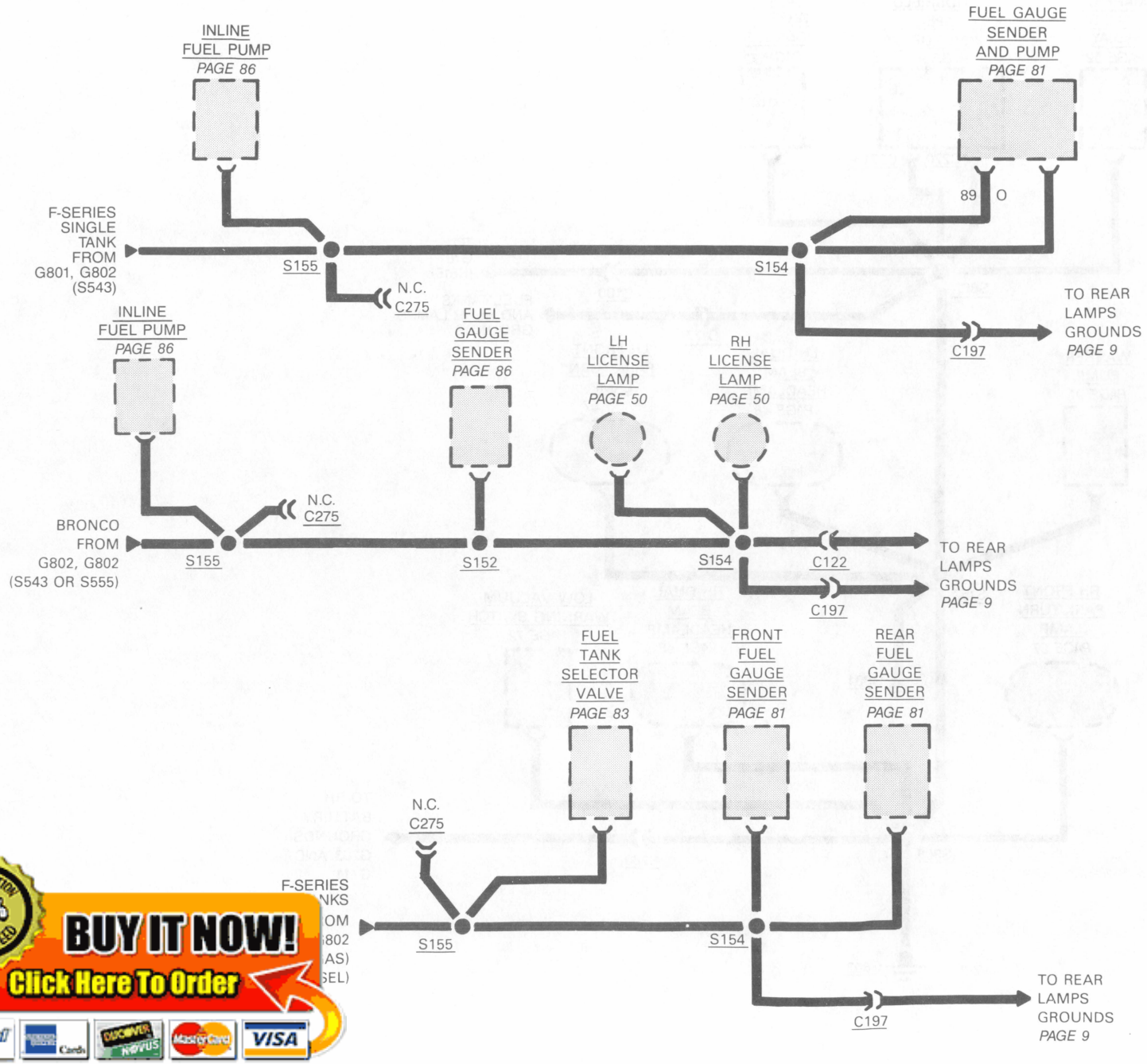
ZENER DIODE

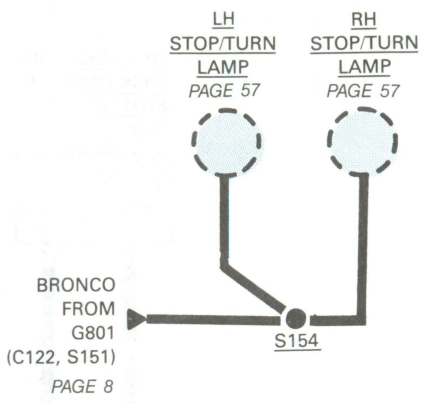
CAPACITOR

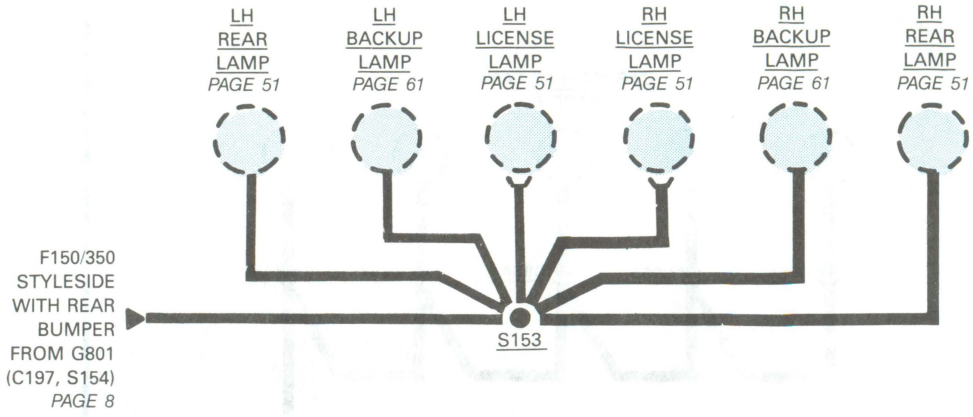


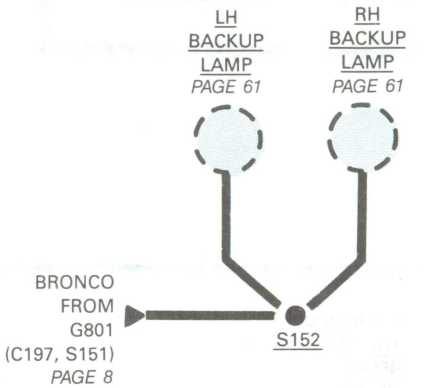


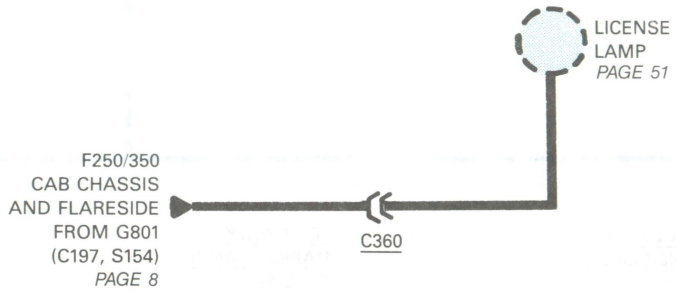


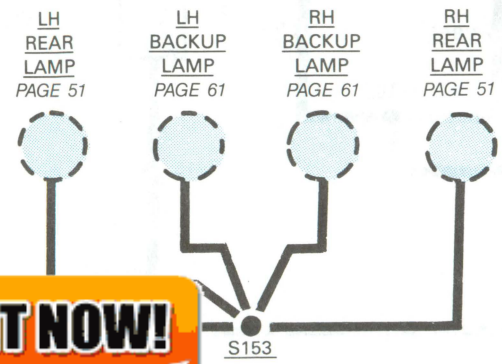


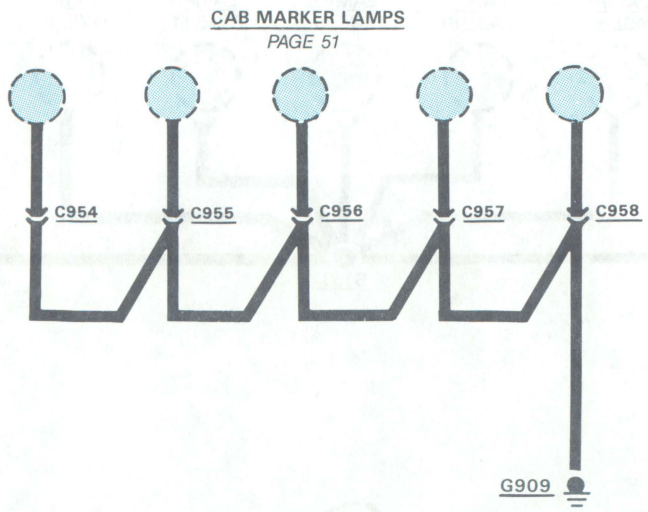


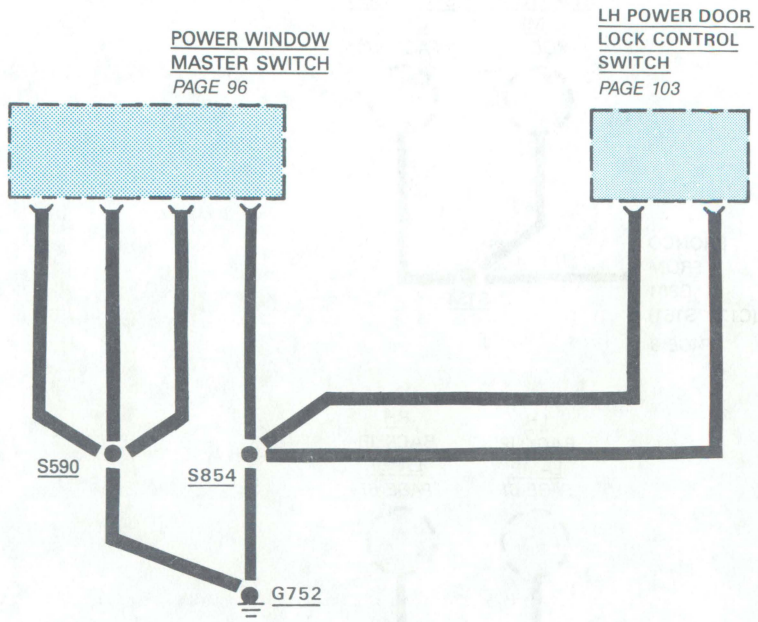


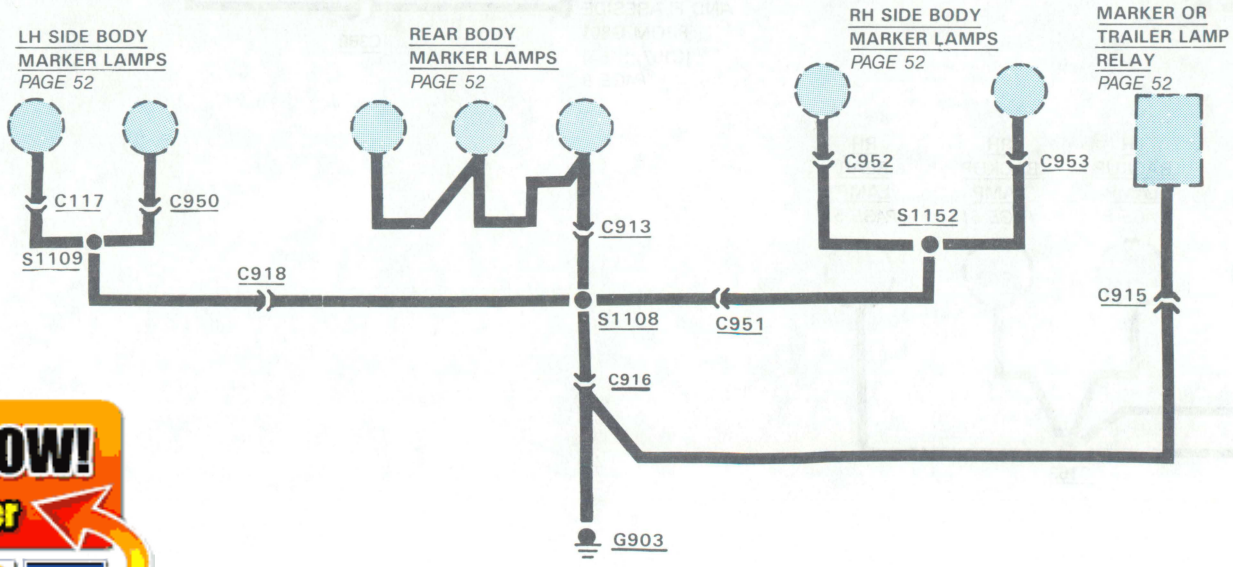


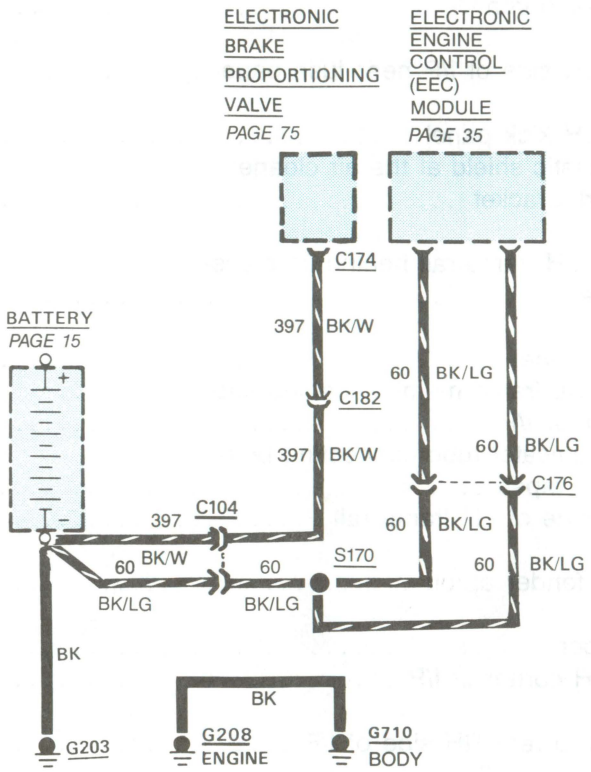


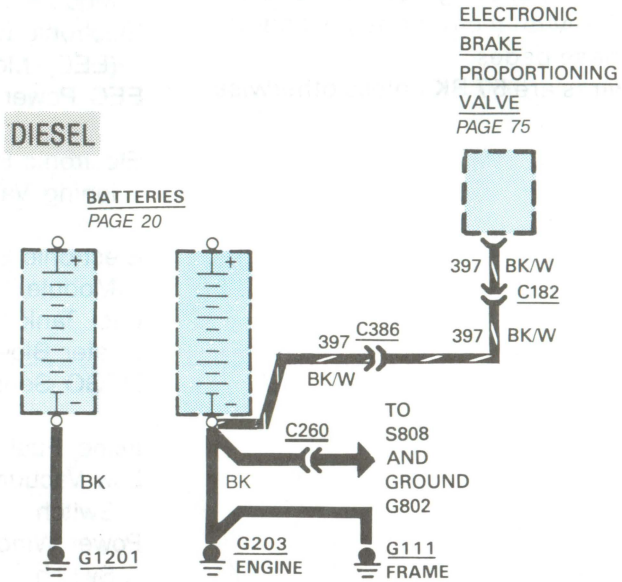












HOW THE CIRCUIT WORKS

The ground circuits shown here are complete and connect several components together to screw terminal ground points. On other pages only parts of these circuits may be shown. Partial ground circuits are shown dashed on those pages.

All simple or component ground circuits are shown on the individual circuit pages and are complete on those pages.

All ground wires are **57 BK** unless otherwise noted.

COMPONENT LOCATION

		Page-Figure
A/C Clutch Field Coil	Part of compressor	
Anti-Lock Brake Module	Behind I/P left of center	
Brake Sensor	Part of master cylinder	
Cooling Fan Motor	RH fender apron	
Diesel/Warning Lamp Module	Behind LH side of I/P near fuse panel	
Electronic Engine Control (EEC) Module	Behind LH kick panel	
EEC Power Relay	Under plastic shield at the air cleaner support bracket	
Electronic Brake Proportioning Valve	Inside of LH frame rail behind #1 cross-member	
Electronic Shift Control Module	RH cowl panel	
Fuel Tank Selector Valve	On LH side frame member behind cab	85-1
Heater Blower Switch	At center of I/P	
HEGO Sensor	In communicator tube connecting both exhaust pipes	29-3,122-2
Inline Fuel Pump	Inboard side of LH frame rail	
Low Vacuum Warning Switch	7.3L RH fender apron	
Power Window Master Switch	In LH door	
Rear Defrost Control	Under LH corner of I/P	
Seatbelt Warning Buzzer/Chime	Attached to rear RH side of I/P	101-2
Shift Control Switch	On LH side of I/P	
Speed Sensor	At transmission	
Tailgate Power Window Motor	In center of tailgate	102-3
Washer Pump	In washer reservoir	
Windshield Wiper Motor	Attached to center of dash panel	

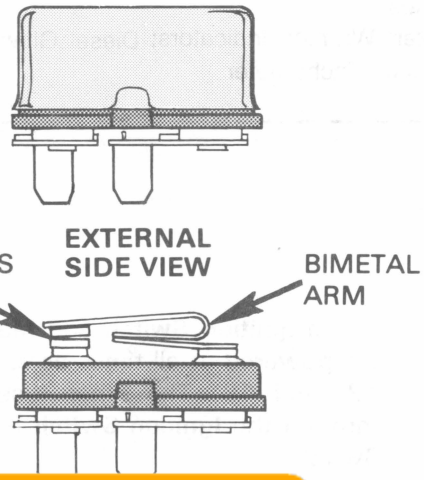
Refer to the **Location Index** in the back of the manual for connector, ground, and splice descriptions and locations.

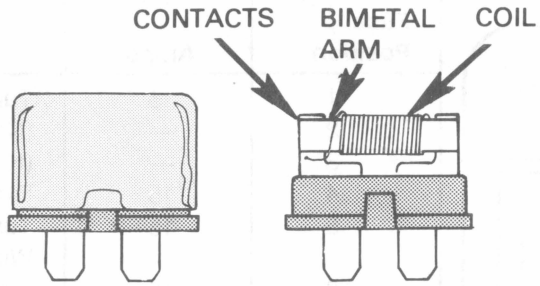
REPLACEMENT OF FUSES/ CIRCUIT BREAKERS

GOOD FUSE BLOWN FUSE

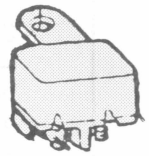
Fuses are mounted either in the **Fuse Panel** or in-line. They are identified by the numbered value in amperes, and by a color code. Some positions may have either a fuse with adapter or a circuit breaker. Be sure to replace a fuse or circuit breaker with the same kind of unit and with the same ampere rating. Remove fuses in order to check them.

CIRCUIT BREAKER OPERATION





Non-Cycling Fuse Block Type



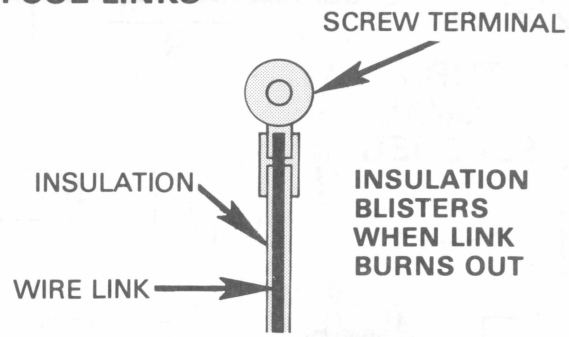
Cycling In-Line Type

Some circuits are protected by circuit breakers. (Abbreviated "c.b." in fuse chart.) They can be **Fuse Panel** mounted or in-line. Like fuses, they are rated in amperes.

Each circuit breaker conducts current through an arm made of two types of metal bonded together (bimetal arm). If the arm starts to carry too much current, it heats up. As one metal expands faster than the other, the arm bends, opening the contacts. Current flow is broken. In the cycling type, the arm cools and straightens out. This closes the circuit again. This cycle repeats as long as the overcurrent exists, with power applied.

In the non-cycling type, there is also a coil wrapped around the bimetal arm. When an overcurrent exists and the contacts open, a small current passes through the coil. This current through the coil is not large enough to operate a load, but it does heat up both the coil and bimetal arm. This keeps the arm in the open position until power is removed.

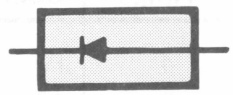
FUSE LINKS



The fuse link is a short length of wire smaller in gage than the wire in the protected circuit. The wire is covered with a thick non-flammable insulation. An overload causes the link to heat and the insulation to blister. If the overload remains, the link will melt, causing an open circuit.

When replacing, make tight crimp joints or hot solder joints for good connections.

DIODES



Diodes are electrical devices that permit current to flow in one direction only. The current flows in the direction indicated by the arrow.

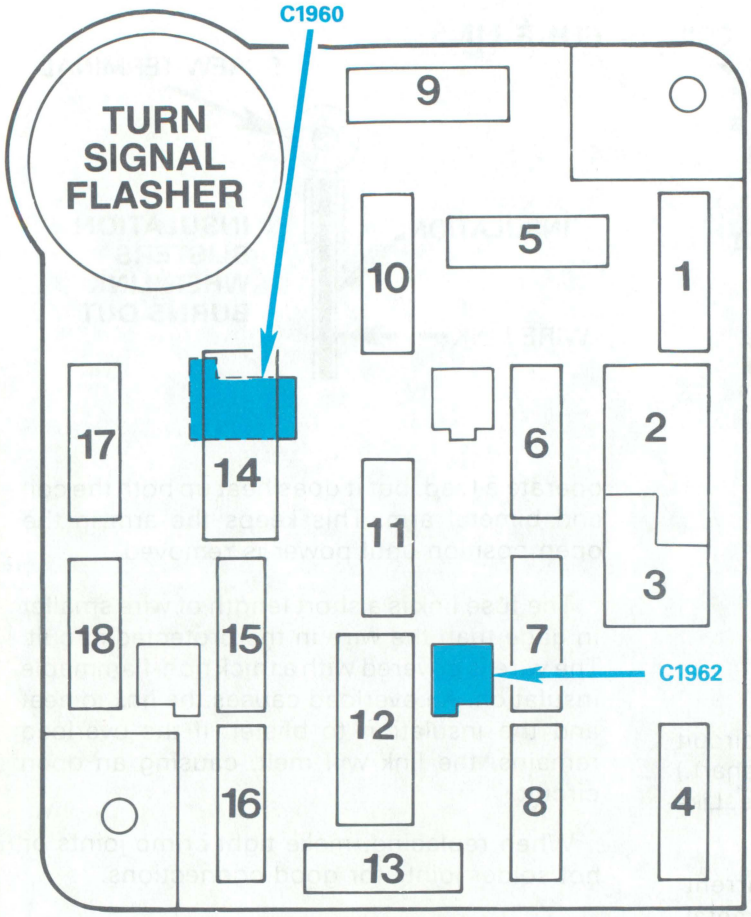


Figure 1 - Fuse Panel

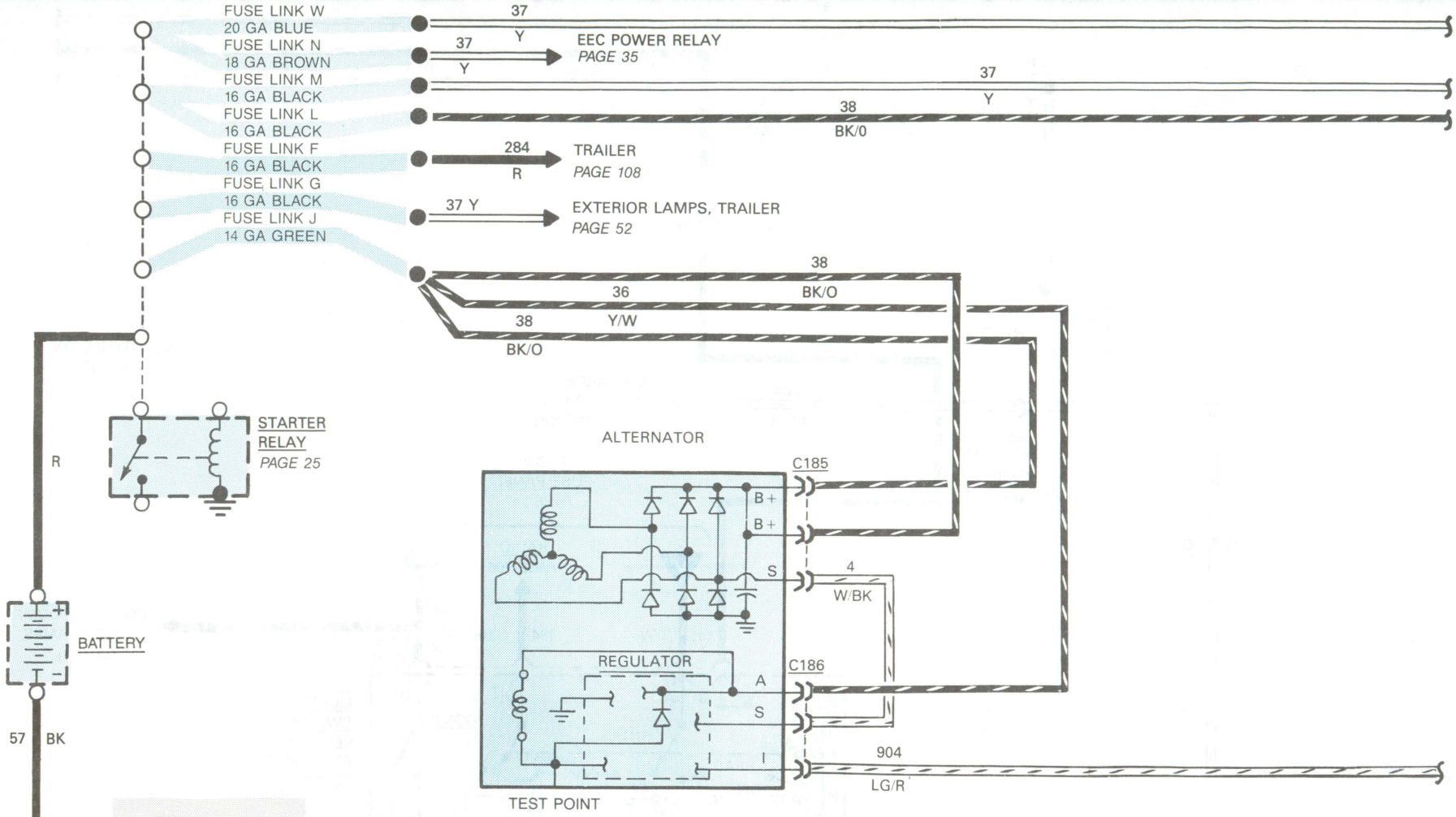
Fuse Position	Amps	Circuits Protection
1	15	Turn/Stop/Hazard Lamps; Speed Control
2	—	(Not used)
3	—	(Not used)
4	15	Exterior Lamps; Instrument Illumination
5	15	Turn Lamps; Backup Lamps; Rear Window Defrost
6	15	Speed Control; Electronic Shift-4 Wheel Drive
7	—	(Not Used)
8	15	Courtesy, Dome, Cargo Lamps; Warning Buzzer
9	30	Heater; A/C-Heater
10	5	Instrument Illumination; Clock Dimming
11	15	Radio; Main Light Switch; Clock Illumination
12	25	Tailgate Power Window; Power Mirrors
	30 c.b.	Power Door Locks; Electronic Shift-4 Wheel Drive
13	—	(Not used)
14	25	Tailgate Power Window
	30 c.b.	Power Windows
15	10	Auxiliary Fuel Tank Selector
16	30	Horn; Cigar Lighter; Speed Control; 4.9L EFI After Run Blower
17	20	Anti-lock Brakes
18	15	Seatbelt Buzzer; Warning Indicators; Diesel Glow Plug Control; Diesel Indicators; Tachometer

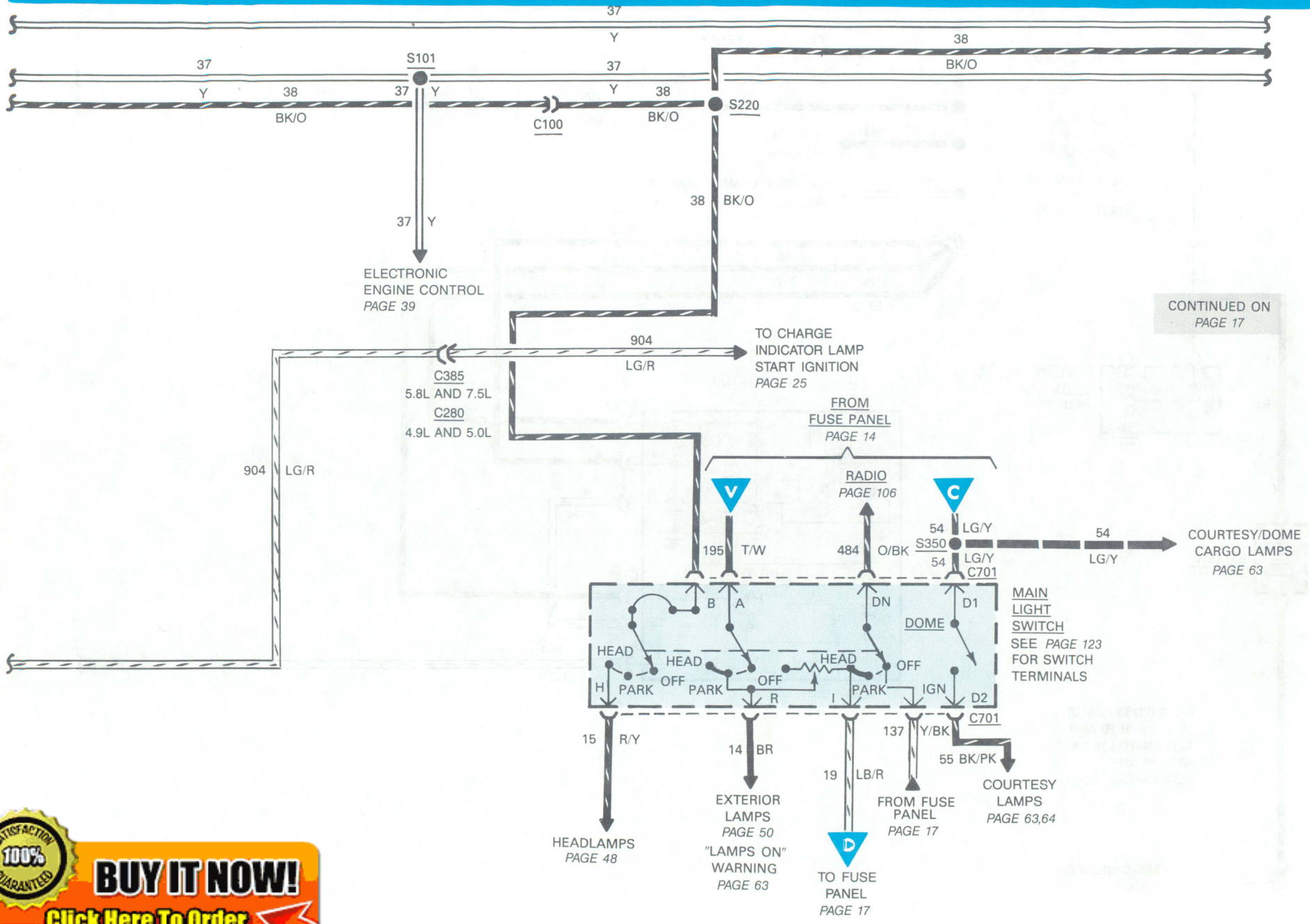
Fuse Value Amps	Color Code
4	Pink
5	Tan
10	Red
	lue
	reen

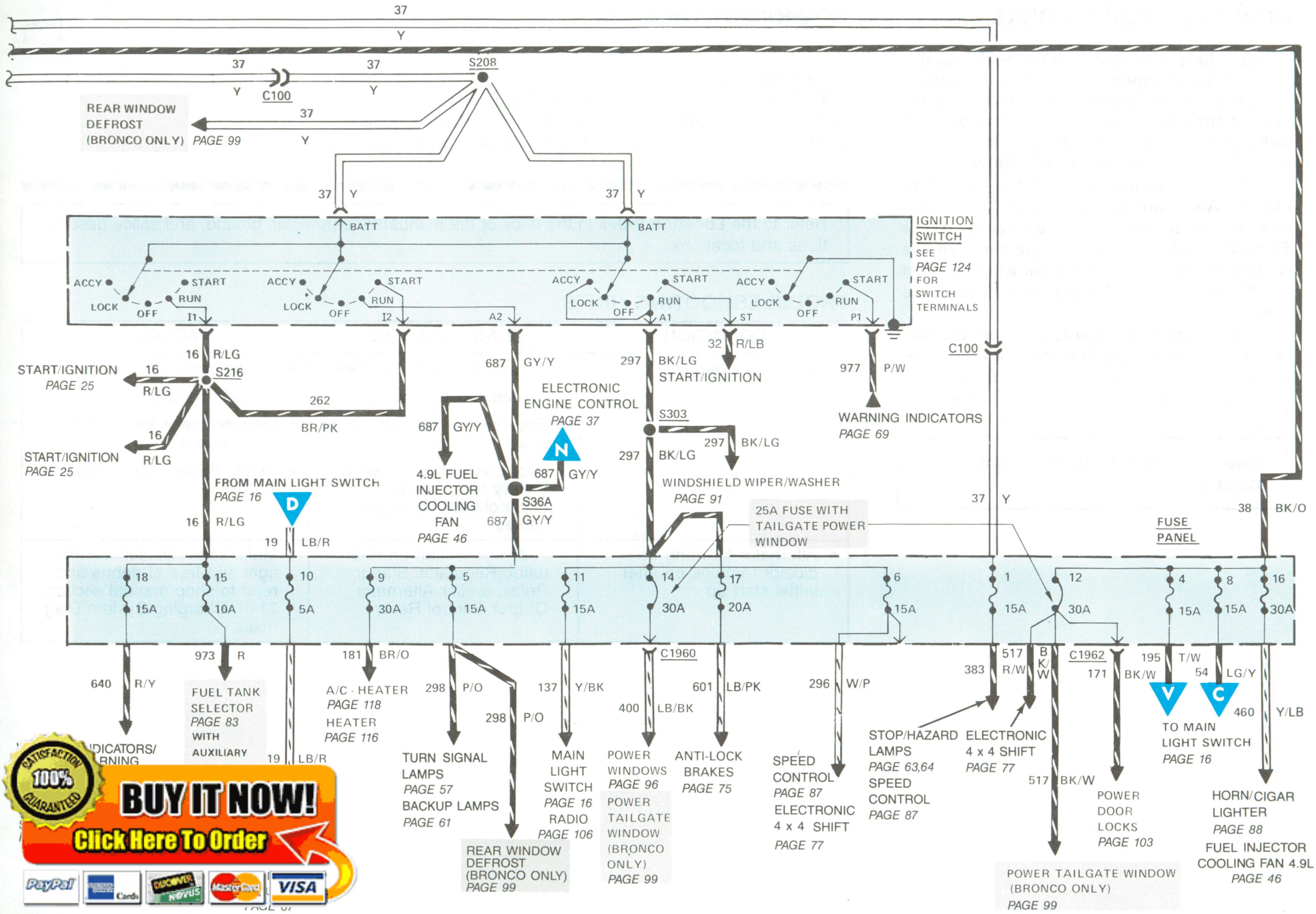
Power Distribution

The **Alternator** and **Battery** are connected together at the **Starter Relay** hot terminal. Other circuits originate at the **Starter Relay** hot terminal and are protected by fuse links. Low power circuits are also protected by fuses.

The **Ignition Switch** and **Main Light Switch** are powered at all times as are **Fuses 1, 4, 8, 12,** and **16.** The other fuses are powered through the **Ignition Switch** or the Main Light Switch.







HOW THE CIRCUIT WORKS

The **Battery, Alternator** and **Voltage Regulator** make up the **Charging System.** With the **Ignition Switch** in RUN, **Battery** voltage is applied through the solid-state electronic control of the **Voltage Regulator.** The electronic control applies **Battery** voltage to the **Alternator** field.

With current in the field and the rotor turning, the **Alternator** stator produces a DC voltage at B+ terminals (to **Battery**). If the **Alternator** output voltage is greater than the **Battery** terminal voltage, current will flow from the **Alternator** to the **Battery**, as well as to the vehicle electrical load.

If the **Alternator** voltage is less than the **Battery** terminal voltage, current will flow from the **Battery** to supplement the alternator output in supplying the vehicle electrical load.

Refer to section 31-01 of the shop manual.

COMPONENT LOCATION

Refer to the **Location Index** in the back of the manual for connector, ground, and splice descriptions and locations.

TROUBLESHOOTING HINTS

CONDITION	POSSIBLE CAUSE	ACTION
• Improper Charging	• Loose/worn alternator belt	• Tighten/replace
	• Defective/dead battery	• Replace battery
	• Fuse Link J open at starter relay	• Visually check for open in link, replace
	• Poor connection between battery terminals and cable clamps/damaged cables	• Clean, tighten and/or replace
• Alternator Warning Indicator remains on after initial start up	• Poor connection on Alternator, Regulator, Starter Relay, and/or Alternator Output Control Relay	• Make sure connections are tight and free of debris and refer to shop manual section 31-01, Charging System Diagnosis

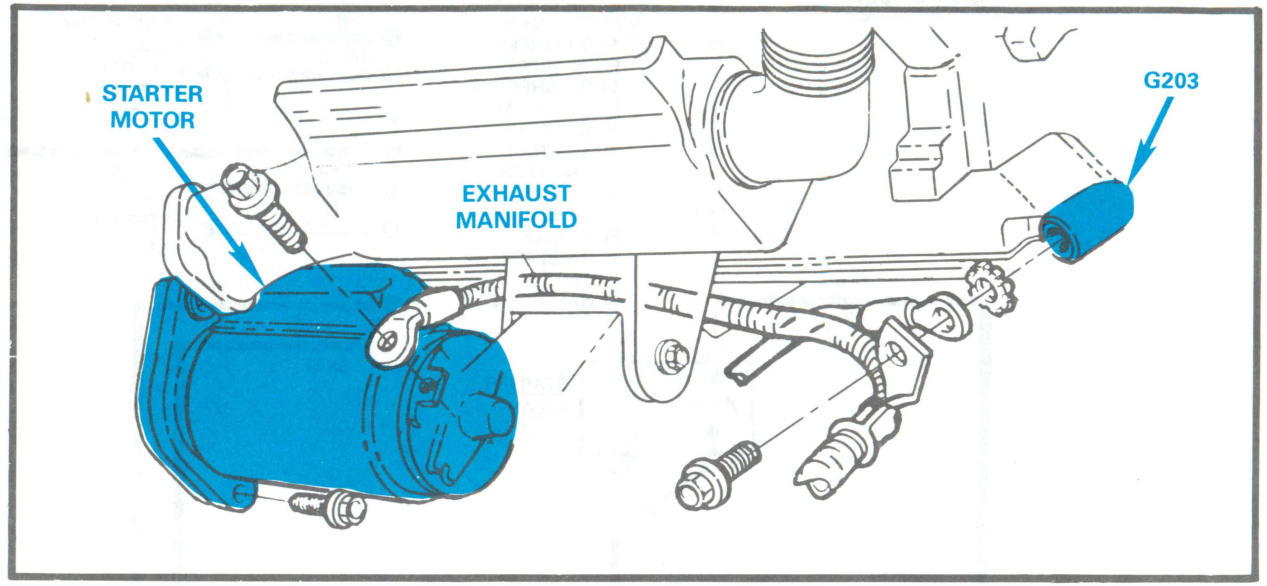


Figure 1 — Lower RH Side of Engine (5.0L, 5.8L, 7.5L, 8 Cyl.)

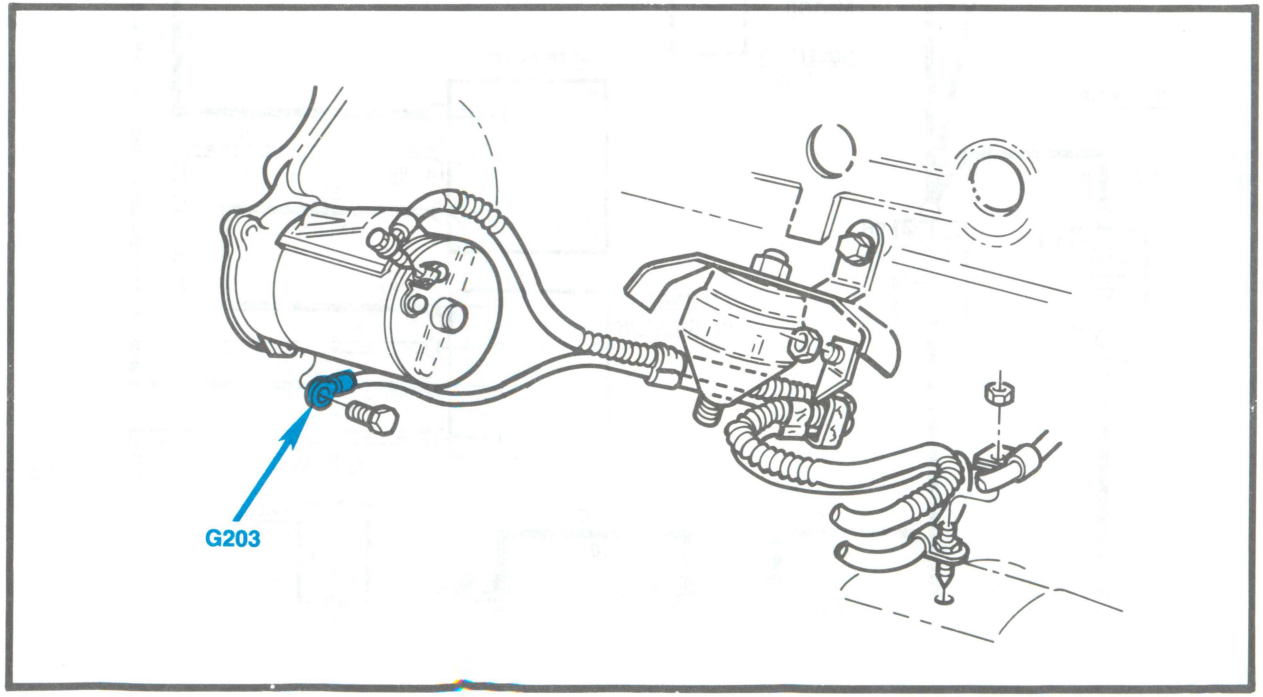
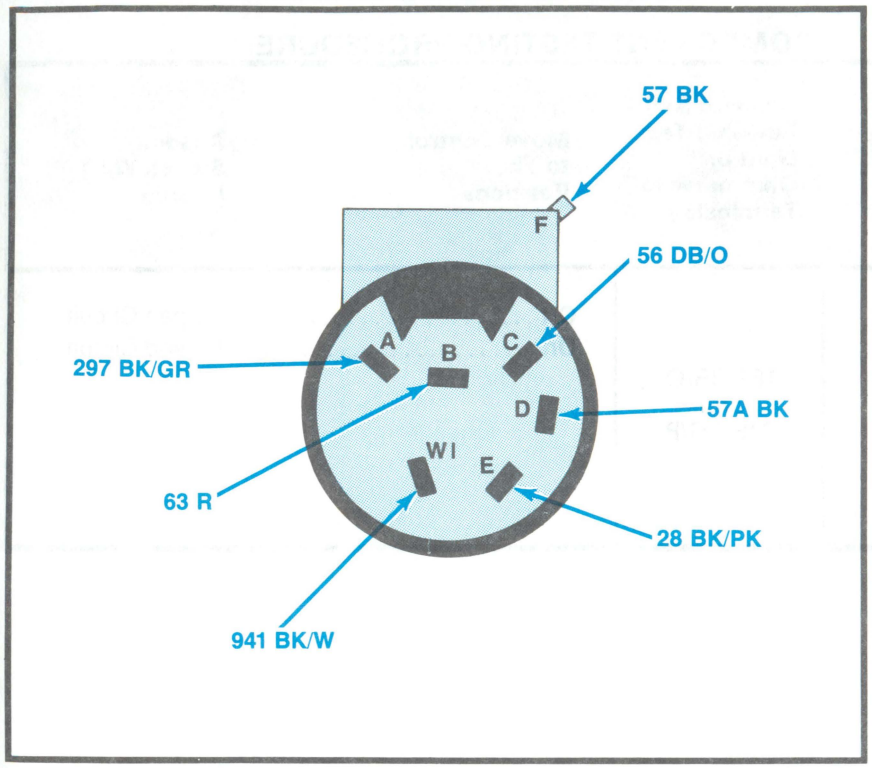


Figure 2 — Lower RH Side of Engine (4.9L 6 Cyl. ONLY)

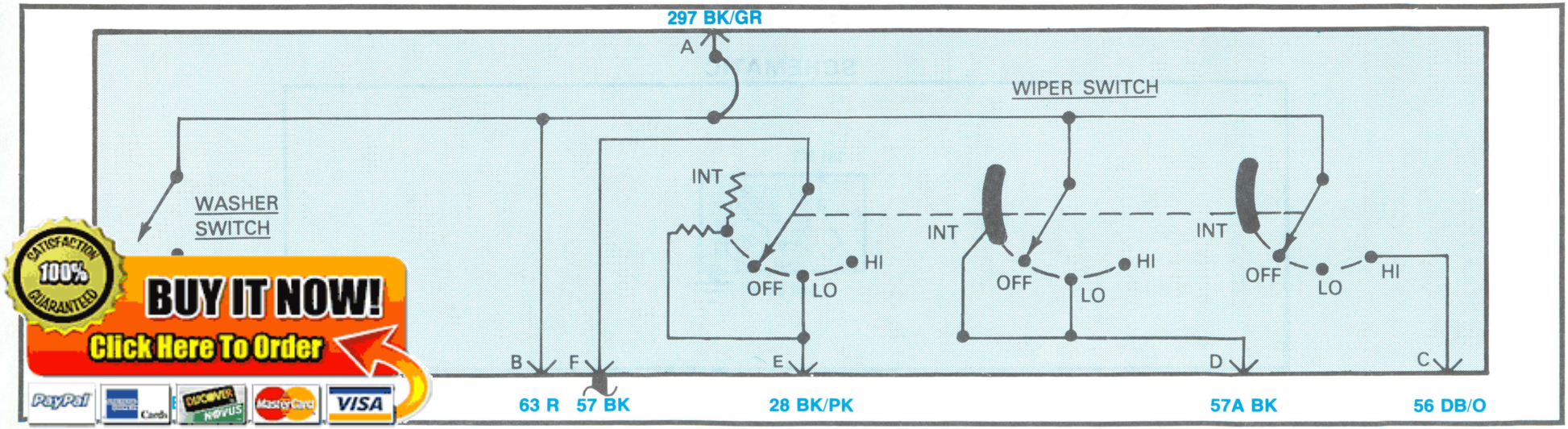
TERMINAL LOCATIONS ON SWITCH



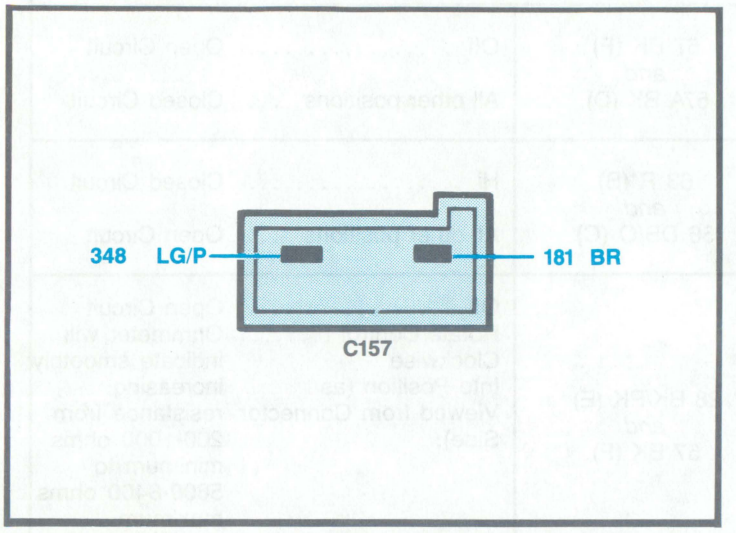
COMPONENT TESTING PROCEDURE

TO TEST	Connect Self-Powered Test Light or Ohmmeter to Terminals	Move Switch to These Positions	A Good Switch Will Indicate
Wiper Switch Circuit	57 BK (F) *and* 57A BK (D)	Off	Open Circuit
		All other positions	Closed Circuit
	63 R (B) *and* 56 DB/O (C)	Hi	Closed Circuit
		All other positions	Open Circuit
	28 BK/PK (E) *and* 57 BK (F)	Off	Open Circuit
		Rotate Control ..... Clockwise Into Position (as Viewed from Connector Side).	Ohmmeter will indicate smoothly increasing resistance from 200-1000 ohms minimum to 5600-8400 ohms maximum
		All other positions	Closed Circuit

SCHEMATIC



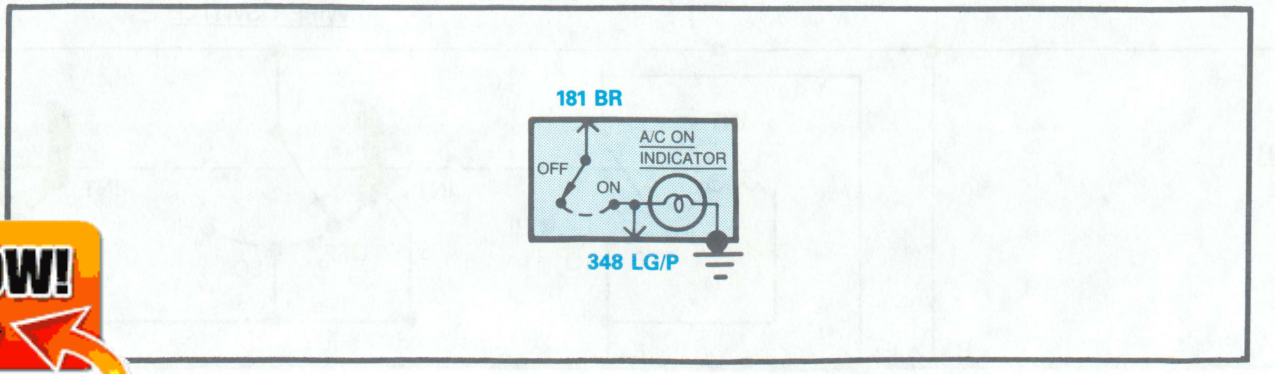
TERMINAL LOCATIONS ON SWITCH



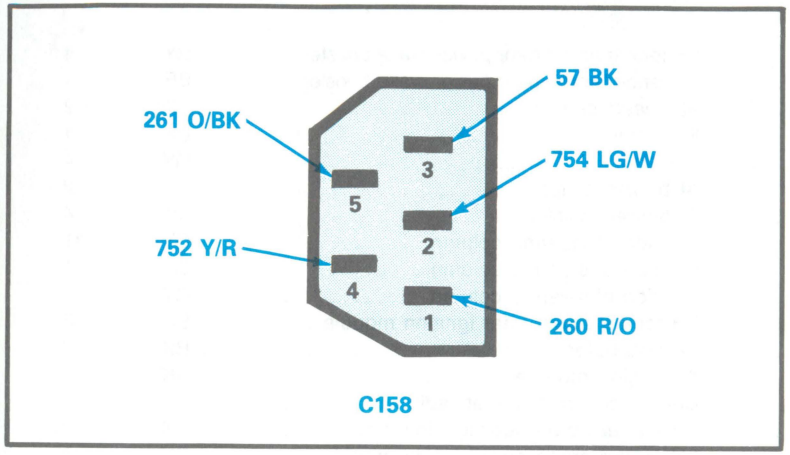
COMPONENT TESTING PROCEDURE

TO TEST	Connect Self Powered Test Light or Ohmmeter to Terminals	Move Control to These Positions	A Good Switch Will Indicate
A/C Clutch Circuit	181 BR/O *and* 348 LG/P		Off ..... Open Circuit On ..... Closed Circuit

SCHEMATIC



TERMINAL LOCATIONS ON SWITCH



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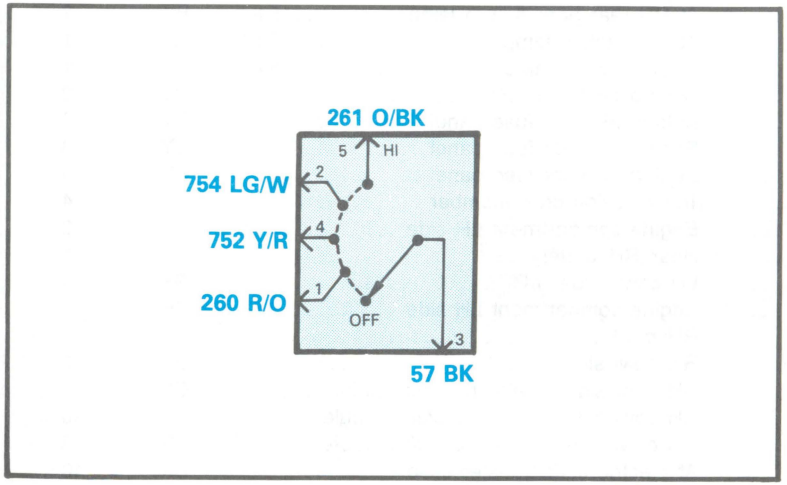


COMPONENT TESTING PROCEDURE

TO TEST	Connect Self-Powered Test Light or Ohmmeter to Terminals	Move Switch to These Positions	A Good Switch Will Indicate
Medium-Lo Speed	57 BK (3) *and* 752 Y/R (4)	Lo Medium-1 Medium-2 Hi	Open Circuit Closed Circuit Open Circuit Open Circuit
Low Speed	57 BK (3) *and* 260 R/O (1)	Lo Medium-1 Medium-2 Hi	Closed Circuit Open Circuit Open Circuit Open Circuit
Medium-High Speed (M2)	57 BK (3) *and* 754 LG/W (2)	Lo Medium-1 Medium-2 Hi	Open Circuit Open Circuit Closed Circuit Open Circuit
Hi Speed	57 BK (3) *and* 261 O/BK (5)	Lo Medium-1 Medium-2 Hi	Open Circuit Open Circuit Open Circuit Closed Circuit
Off	57 BK (3) *and* all others	Lo Medium-1 Medium-2 Hi	Open Circuit Open Circuit Open Circuit Open Circuit

CONNECTOR LOCATION

		Page-Figure	Color	Terminals
C100	Through dash at LH side			53
C103	Near HEGO sensor			4
C104	At battery ground pigtail			4
C107	At license lamps	54-2	BR	1
C111	Behind I/P LH end (test)		BK	1
C117	At LH front side body marker lamp	55-8	BR	2
C122	RH side of rear cross support	54-3	BK	4
C123	LH side of frame at rear crossmember	102-5	BK	4
C126	LH side of rear crossmember	54-2		2
C129	At RH fender apron (diesel only)	33-1	GY	8
C151	Engine compartment		BK	2
C157	At A/C clutch switch		W	2
C158	At blower switch		GY	5
C168	Engine compartment test		GY	6
C170	Near ignition module	121-1	BK	2
C171	Engine compartment test			1
C174	At proportioning valve, LH frame rail		BK	4
C175	LH fender apron		BK	10
C176	LH fender apron		BK	8
C177	Engine compartment LH side		GY	12
C178	On rear of engine		BK	8
C182	Engine compartment LH		GY	6
C183	Engine compartment LH		BR	2
C185	At alternator	29-3		3
C186	At alternator	29-3		3
C187	At alternator regulator	34-3	W	4
C188	At alternator	34-3		2
C190	At clutch lockout switch	34-1	GY	2
C197	LH side of rear cross support		GY	5
C202	Lower hole of LH quarter panel	66-2,3,4	GY	3
C202A	Lower hole of LH quarter panel	66-2,3,4	GY	3
C203	Lower hole of LH quarter panel	66-2,3,4	GY	3
C208A	At instrument cluster			14
C208B	At instrument cluster			14
C233	Near alternator		GY	1
C240	At ignition key, seat belt warning buzzer			7
C244	Behind center of I/P		BK	8
C247	Engine compartment RH side			4
[illegible]	Engine compartment near starter relay		GY/BK	4
[illegible]	Near RH battery		BK	1
[illegible]	[illegible]			3
[illegible]	[illegible]			3
[illegible]	[illegible]nber			8
[illegible]	[illegible]on			5
[illegible]	[illegible]ear starter relay			4
[illegible]	[illegible]		BK	2

CONNECTOR LOCATION

		Page-Figure	Color	Terminals
C285	LH fender apron near power brake booster		GY	4
C285A	LH fender apron near power brake booster		BR	4
C285B	At speed sensor		BK	2
C289	RH cowl		BK	4
C290	RH cowl		GY	4
C292	At blower motor			2
C293	At blower resistor		W	4
C305	LH side of steering column		GY	11
C305A	LH side of steering column		GY	11
C305B	LH side of steering column		GY	11
C321	LH fender apron near ignition module		BK	3
C322	At distributor		BK	3
C323	At ignition module		BK	4
C333	Behind center of I/P at radio			8
C343	LH fender apron near ignition module		BK	8
C344	LH fender apron near ignition module		BK	8
C353	Rear LH side of frame at rear crossmember	54-4	Y	1
C354	At LH rear park & turn lamp	54-4	BK	2
C355	At RH rear park & turn lamp	54-4	BK	2
C356	At RH backup lamp	54-4	Y	1
C357	At LH backup lamp	54-4	Y	1
C358	Behind center of I/P		GY	2
C366	Behind I/P near fuse panel		GY	3
C366A	Behind I/P near fuse panel		GY	3
C366B	Behind I/P near fuse panel		GY	3
C370	Transmission crossmember		GY	4
C380	Engine compartment LH side			2
C386	Near RH battery			1
C406	LH cowl under I/P		GY	4
C420	Engine compartment LH side		BK	4
C425	RH cowl		BK	6
C426	RH cowl side		GY	2
C427	RH cowl side — electric shift module		GY	8
C428	RH cowl side — electric shift module		W	10
C429	RH cowl side — electric shift module		BR	5
C430	At electric shift transfer case		BK	10
C431	At electronic shift switch			6
C450	LH side rear support cross		BK	2
C522	Behind center of I/P at radio			8
C523	Lower LH cowl access hole		BR	2
C524	Lower RH cowl access hole	107-1	BR	2
C550	At windshield wiper/washer switch	95-1	BK	10
C650	At RH door lock motor		BK	2
C701	At main light switch		BK	8
C714	At speed control amplifier		GR	8

CONNECTOR LOCATION

		Page-Figure	Color	Terminals
C717	At speed control amplifier		GY	6
C752	LH side of hood at engine compartment lamp		GY	1
C753	At speed control servo		BR	6
C755	At clutch switch		GR	2
C789	LH side of driver's seat on floor pan	72-1	GY	2
C850	Lower LH cowl access hole		GY	4
C906	At LH cowl access hole	54-7	BR	1
C913	At center of rear body markers	54-5	GY	2
C915	Engine compartment LH side		BK	2
C916	At LH side of rear crossmember	54-2	BK	2
C918	Near LH side of rear crossmember	54-2	GY	2
C950	At rear of LH rear fender	55-8	BR	2
C951	Near RH side of rear crossmember	54-6	BR	2
C952	At front of RH rear fender		BR	2
C953	At rear of RH rear fender	55-8	BR	2
C954	In forward part of cab roof	53-1	BK	2
C955	In forward part of cab roof	53-1	BK	2
C956	In forward part of cab roof	53-1	BK	2
C957	At front of cab roof	53-1	BK	2
C958	At front of cab roof	53-1	BK	2
C1002	At rear crossmember	60-1		3
C1101	Behind I/P LH end		BK	3
C1102	Behind I/P LH end		BR	6
C1105	LH side of frame at rear crossmember	55-9	BK	2
C1110	LH rear engine compartment	55-9	BR	6
C1111	LH rear of frame		BR	3
C1114	LH rear of frame			3
C1206	At rear crossmember	60-1		3
C1907	Behind LH rear lamp	102-4	BR	3
C1951	Behind LH rear crossmember	102-5 & 60-1	BR	1
C1952	Behind LH rear lamp	102-4	BR	1
C1953	LH cowl center access hole		GY	8
C1954	RH cowl center access hole		GR	8
C1955	LH cowl area			2
C1960	On fuse panel		N	1
C1962	At fuse panel		BL	1
C1963	LH frame rail		BK	2
C1	Engine compartment LH side		BK	4

S elector switch T/O
S switch T/O
S switch T/O

SPLICE LOCATION

S110	Near fuel pump relay T/O
S140	Between S142 and S143
S142	Near T/O to no. 4 fuel injector
S143	Near T/O to no. 8 fuel injector
S150	In ignition coil lead
S151	Near license lamp T/O
S152	Near LH backup lamp T/O
S153	Near license lamp T/O
S154	Near front fuel gage sender T/O
S155	Near ERBP Valve T/O
S156	Near fuel line heater T/O
S157	Near LH headlamp T/O
S158	Near LH glow plugs T/O
S159	Near RH glow plugs T/O
S160	Near ignition coil T/O
S161	Near clutch interlock switch T/O
S162	Near heater control switch T/O
S163	Near heater control switch T/O
S165	In T/O to throttle air by pass solenoid
S167	In T/O to map sensor
S168	Near T/O to EEC diode
S170	Near battery
S172	Near T/O to EEC diode
S173	Near throttle position sensor T/O
S174	Near T/O to EEC power relay
S175	Near cooling fan relay T/O
S176	Near fuel tank selector valve T/O
S177	Near fuel tank selector valve T/O
S185	Near radio T/O
S190	Near backup lamp T/O
S200	Near clutch switch T/O
S208	Near main light switch T/O
S216	Near steering column connector T/O
S220	Near LH courtesy lamp T/O
S221	Near ignition switch T/O
S270	Between T/O's to EEC power relay
S271	Near T/O to C178 (LH side)
S272	Near main light switch T/O
S276	Near T/O to C178 (LH side)
S277	Near T/O to C178 (RH side)
S303	Near main light switch T/O
S305	In ignition coil lead
S350	Near main light switch T/O
S352	Near vehicle speed sensor T/O
S353	Near vehicle speed sensor T/O
S360	Near LH horn T/O

SPLICE LOCATION

SPLICE LOCATION

GROUND LOCATION

GROUND LOCATION

WE SUPPORT VOLUNTARY
TECHNICIAN CERTIFICATION

Ford Parts and Service Division
Training and Publications Department

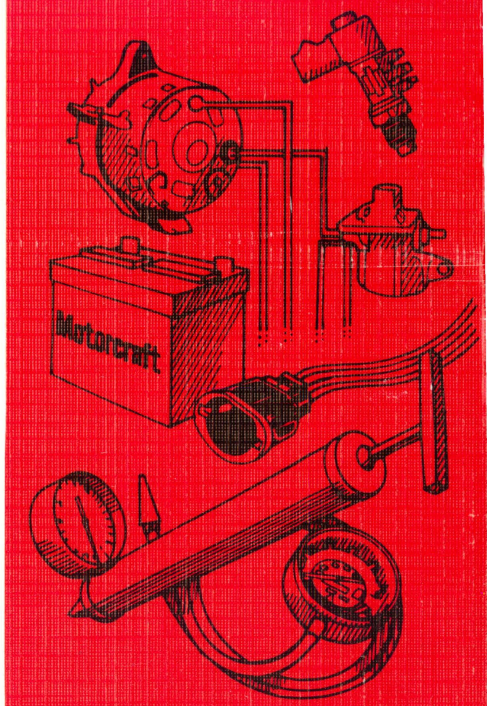
TOGETHER WE CAN SAVE LIVES

AUG. 1987

FPS-12129-88

1989 BRONCO/ F150-F350/ F-SUPER DUTY

Ford



Electrical & Vacuum Trouble-Shooting Manual

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1989 Bronco/F150-F350/ F-Super Duty Electrical & Vacuum Trouble-Shooting Manual (EVTM)

EAN: 978-1-60371-412-9
ISBN: 1-60371-412-X

Forel Publishing Company, LLC
Woodbridge, VA 22192
Email: sales@ForelPublishing.com
https://www.ForelPublishing.com

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ELECTRICAL AND VACUUM TROUBLESHOOTING MANUAL

FPS — 12129 - 89

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TABLE OF CONTENTS

SYSTEM INDEX

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.

contents are hyperlinked to pages

This manual contains the following diagnostic information:

- Electrical and Vacuum Schematics
- Component Location Indexes and Views
- Troubleshooting Hints
- Descriptions of Circuit Operation
- Component Testing

The vehicle's entire electrical system is broken down into individual systems. There are also sections for the vehicle's ground and power distribution circuitry. Each system section begins with a wiring schematic. The **Schematics** should always be your starting point in using this manual. These schematics show the paths of electrical current during proper circuit operation. The source of voltage (circuit breaker or fuse) is shown at the top of the page. All wire, connectors, splices, switches, and motors are shown in the flow of current to ground at the bottom of the page. Connector end views of switches and other components are shown to help with bench testing. Each circuit component is named (underlined titles). Wire and connector colors are listed (standard Ford color abbreviations are used). These abbreviations are:

COLOR ABBREVIATIONS

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

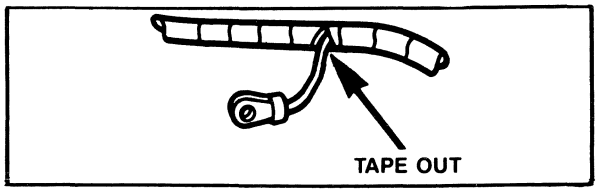
re two colors are shown for a wire, the ...re. The sec-

... of each ...uit's com- ...ent of the ... to an il-

lustrative figure in the manual. There is also a full listing of connector, ground, diode, and splice locations in the **Location Index** in the back of the manual.

Resistors and diodes are currently covered with pvc molds and are taped to the harness outside of the tubing. Many of the 1989 model year assemblies will be covered with heat shrinkable tubing making the assembly small enough to be placed within the harness bundle. The wiring diagrams show the number of times the resistor and diodes are used as well as the distance from connector/length of wire in exact centimeters. Resistors and diodes are identified on the wiring diagrams by the following base part numbers:

Resistor/diode assembly	14A601
Diode only	14A604



OTHER ABBREVIATIONS

T/O (Tape Out) **The point at which a harness branches to feed a component.**

The **Troubleshooting Hints** offer shortcuts or tests in a three-column format that help you determine the cause of an electrical problem. They are not intended to be a rigid procedure for solving an electrical situation. Rather, Troubleshooting Hints represent a common-sense approach that is based on an understanding of the circuit.

A description of **How the Circuit Works** is written to help you understand the operation of the circuit as a whole. Emphasis is placed on how the components and circuitry interact in a properly working system.

A **Component Testing** section provides procedures to determine whether a component is good or bad.

Notes, Cautions, and **Warnings** appear in boxes on text pages and contain important **vehicle and mechanic safety information.**

Notes give added information to help complete a particular procedure. Cautions are included to prevent making an error that could damage the vehicle. Warnings highlight areas where carelessness can cause personal injury. The following list contains some general **Warnings** that should be followed when working on a vehicle.

- 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 the danger of carbon monoxide.
- Keep away from moving parts when the engine is running, especially the fan and belts.
- 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.

TROUBLESHOOTING STEPS

These six steps present an orderly method of troubleshooting:

Step 1. Verify the problem.

- Operate the complete system and see all symptoms for yourself in order to:
  - —check the accuracy and completeness of the customer's complaint.
  - —learn more that might give a clue to the nature and location of the problem.

Step 2. Narrow the problem.

- Using this manual, narrow down the possible causes and locations of the problem in order to more quickly find the exact cause.
- Read the description of *How the Circuit Works* and study the wiring diagram. You should then know enough about the circuit operation to figure out where to check for this trouble.

Step 3. Test the cause.

- Use electrical test procedures to find the specific cause of the symptoms.
- *Troubleshooting Hints* will give some helpful ideas.
- The *Component Location* charts and the pictures will help you find components, grounds, and connectors.

Step 4. Verify the cause.

- Confirm the fact that you have found the correct cause through operating the parts of the circuit you think are good.

Step 5. Make the repair.

- Repair or replace the faulty component.

6. Verify the repair.

rate the system as in Step 1 and check ymptoms, any new

pecial test See the

Shop Manual and other service books for details. You will find the circuits in this manual to be helpful with these special tests.

TROUBLESHOOTING TOOLS

JUMPER WIRE

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

Uses: Bypassing Switches or Open Circuits

WARNING

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

VOLTMETER

A DC **Voltmeter** measures circuit voltage. Connect negative (- or black) lead to ground, and positive (+ or red) lead to voltage measuring point.

OHMMETER

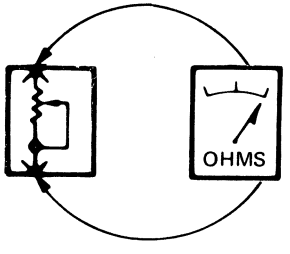


Figure 1— Resistance Check

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

TEST LIGHT

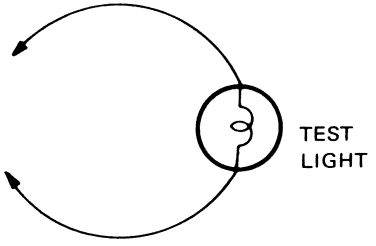


Figure 2 —Test Light

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

Uses: Voltage Check. Short Check

SELF-POWERED TEST LIGHT

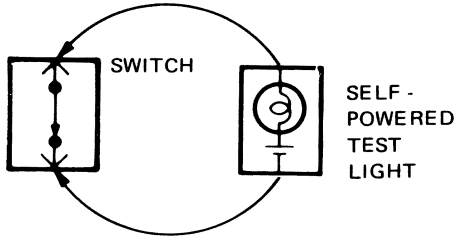


Figure 3—Continuity Check

The **Self-Powered Test Light** 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 light or ohmmeter, be sure power is off in circuit during testing. Hot circuits can cause equipment damage and false readings.

TROUBLESHOOTING CHECKS

SWITCH CIRCUIT CHECK

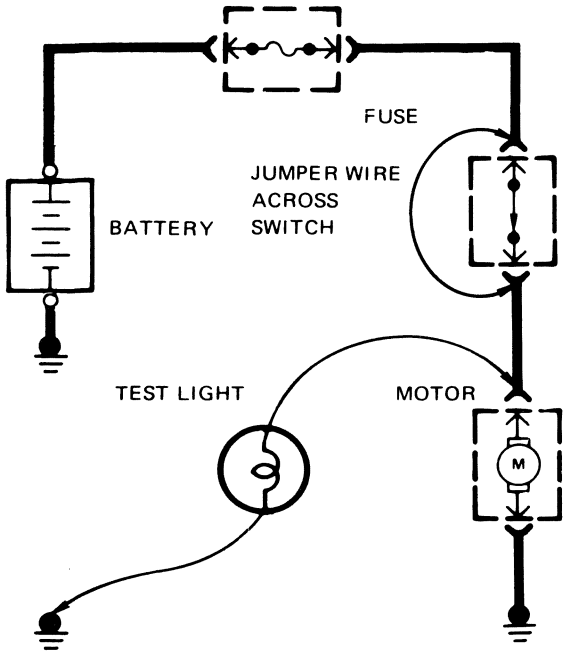


Figure 4—Switch Circuit Check and Voltage Check

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

CONTINUITY CHECK (Locating open circuits)

With power off, connect one lead of **Self-Powered Test Light** or **Ohmmeter** to each end of circuit (Figure 3). Light will glow if circuit is closed. Switches and fuses can be checked in t[illegible]me way.

[illegible] a known
[illegible] battery
the other
[illegible]hen the

SHORT CHECK (short to ground)

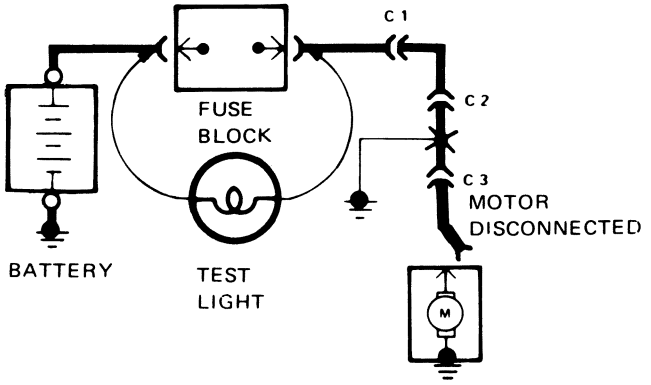


Figure 5— Short Check

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

1) Turn off everything powered through the fuse.
2) Disconnect other loads powered through the fuse:
   - Motors: disconnect motor connector.
   - Lights: remove bulbs.
3) Turn **Ignition Switch** to RUN (if necessary) to power fuse.
4) Connect one **Test Light** 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 Light** lead from ground and reconnect it to the load side of the fuse.
   - If the **Test Light** is off, the short is in the disconnected equipment.
   - If the **Test Light** 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 Light** goes out. For example: with a ground at X, the bulb goes out when C1 or C2 is disconnected, but stays on after disconnecting C3. This means the ground is between C2 and C3.

"GOOD GROUND" CHECK

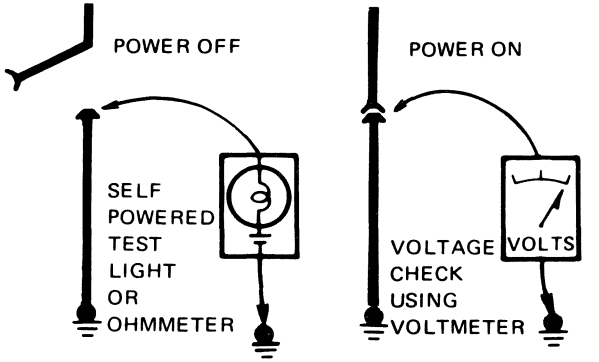


Figure 6 — Grounds Checks

Turn on power to circuit. Perform Voltage Check between suspected bad ground and frame. Any voltage means ground is bad.

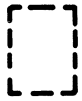
Turn off power to circuit. Connect one lead of **Self-Powered Test Light** or **Ohmmeter** to wire in question, and the other to known ground. If bulb glows, circuit ground is OK (Figure 6).

TROUBLESHOOTING HINTS

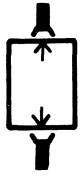
The circuit schematics in this manual are designed to make it easy to identify common points in circuits. This knowledge can help narrow the problem to a specific area. For example, if several circuits fail at the same time, check for a common power or ground connection. (See *Power Distribution* or *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 low beam headlights work but high beams and the indicator light don't work, then power and ground paths must be good. Since the dimmer switch is the component which switches this power to the high beam lights and indicator, it is most likely the cause of failure.

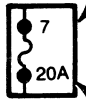
4 ELECTRICAL SYMBOLS



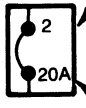
DASHED COMPONENT BOX
ONLY PART OF THE COMPONENT IS SHOWN, OR COMPONENT IS SHOWN IN TWO PLACES



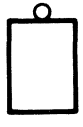
COMPONENT WITH CONNECTORS



POSITION NUMBER
FUSE
CURRENT RATING

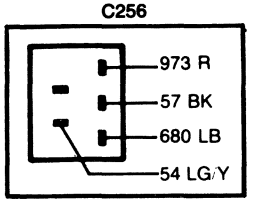


POSITION NUMBER
CIRCUIT BREAKER
CURRENT RATING



SCREW TERMINAL ON COMPONENT

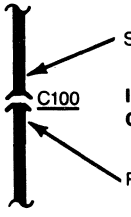
SEALED ELECTRONIC COMPONENT
ANY CIRCUITRY SHOWN INSIDE THE BOX IS A FUNCTIONAL



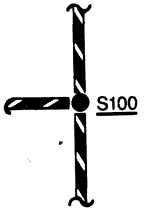
COMPONENT CONNECTOR END VIEW
SHOWS PINS OR SOCKETS ON A COMPONENT TO AID IN BENCH TESTING

WIRE COLORS ARE LABELED FOR MATING HARNESS CONNECTOR

PIN AND BLADE TERMINAL TYPES
SOCKET TYPES

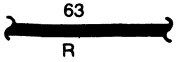


IN-LINE CONNECTOR

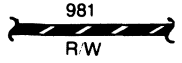


SPLICE OR CRIMP CONNECTION
MOST ARE BUILT INTO HARNESS AND ARE NOT ACCESSIBLE

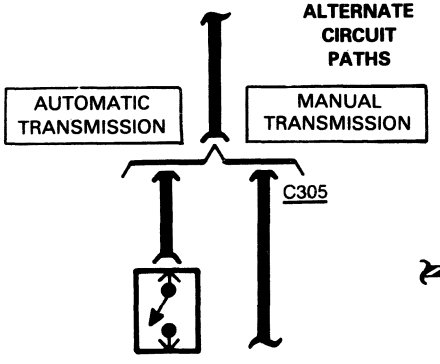
GROUND CONNECTION



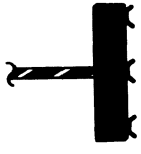
SOLID WIRE



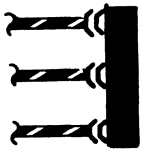
STRIPED WIRE



ALTERNATE CIRCUIT PATHS



CANDELABRA CONNECTOR
ACCEPTS SINGLE-PIN CONNECTORS



JUNCTION BLOCK

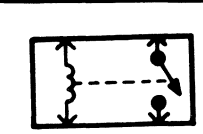
20 GA BLUE ● **FUSE LINK**

SINGLE FILAMENT LIGHT BULB

DUAL FILAMENT LIGHT BULB

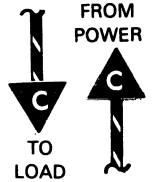
RESISTOR

TRANSISTOR



RELAY
CONTACTS CLOSE WITH CURRENT THROUGH COIL
DASHED LINE SHOWS MECHANICAL CONNECTIONS

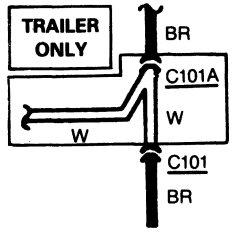
DIODES
CURRENT FLOWS IN DIRECTION OF ARROW ONLY



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

BACKUP LIGHTS

"REFERENCE" WIRES
COMPLETE WIRING SHOWN ON ANOTHER PAGE



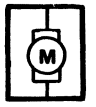
OPTIONAL WIRING
BR WIRES (INCLUDING C101) ARE ON ALL VEHICLES, BUT W WIRES (INCLUDING C101A) ARE USED ONLY WITH TRAILER

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

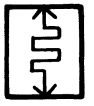
LIGHT EMITTING DIODE

ZENER DIODE

CAPACITOR

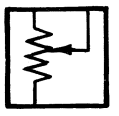


MOTOR



HEATING ELEMENT

THERMISTOR



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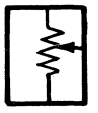
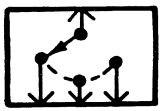
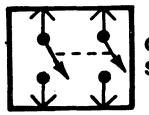


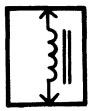
POTENTIOMETER



MULTIPLE POSITION SWITCH



GANGED SWITCHES



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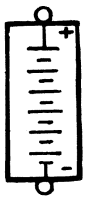
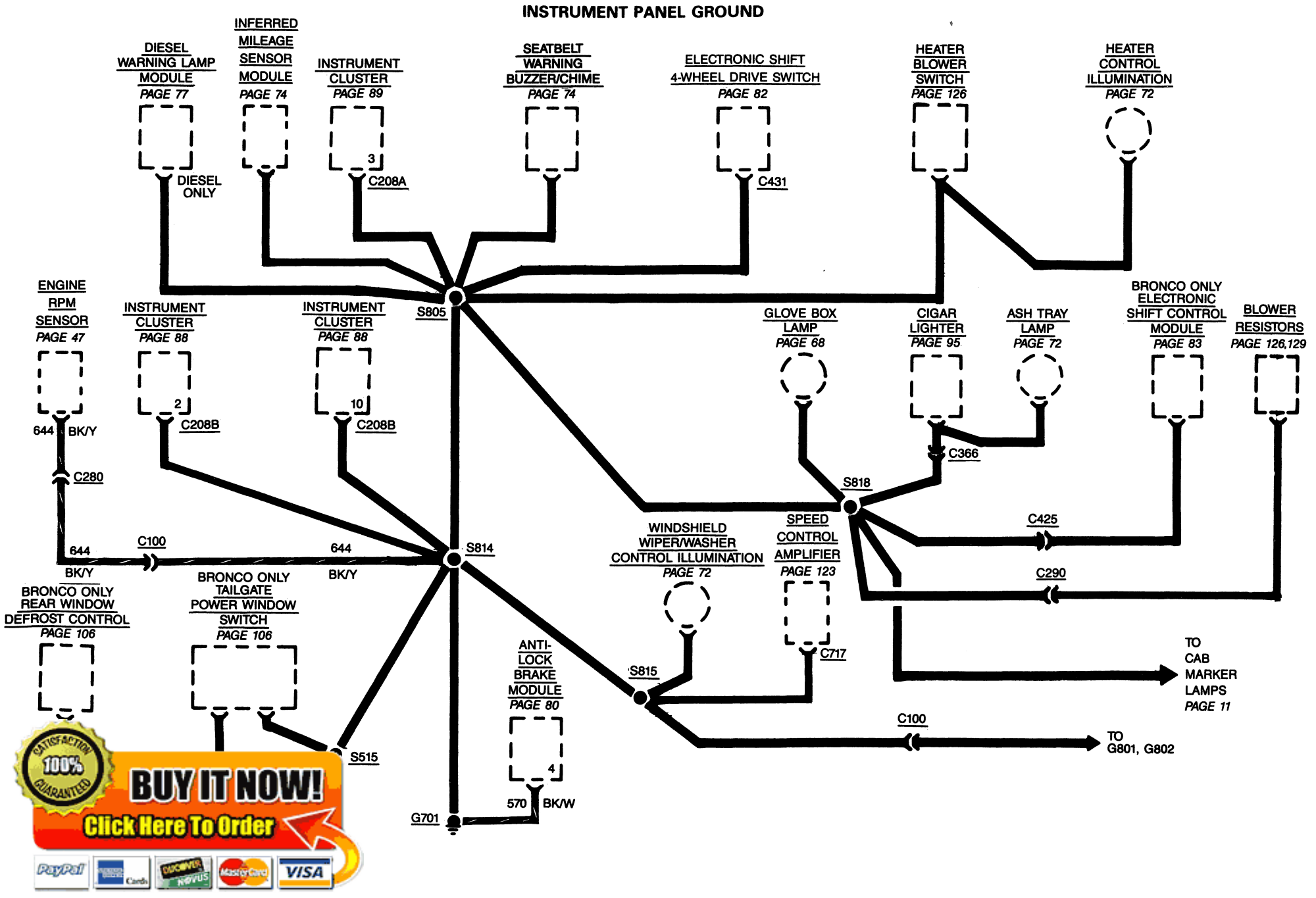
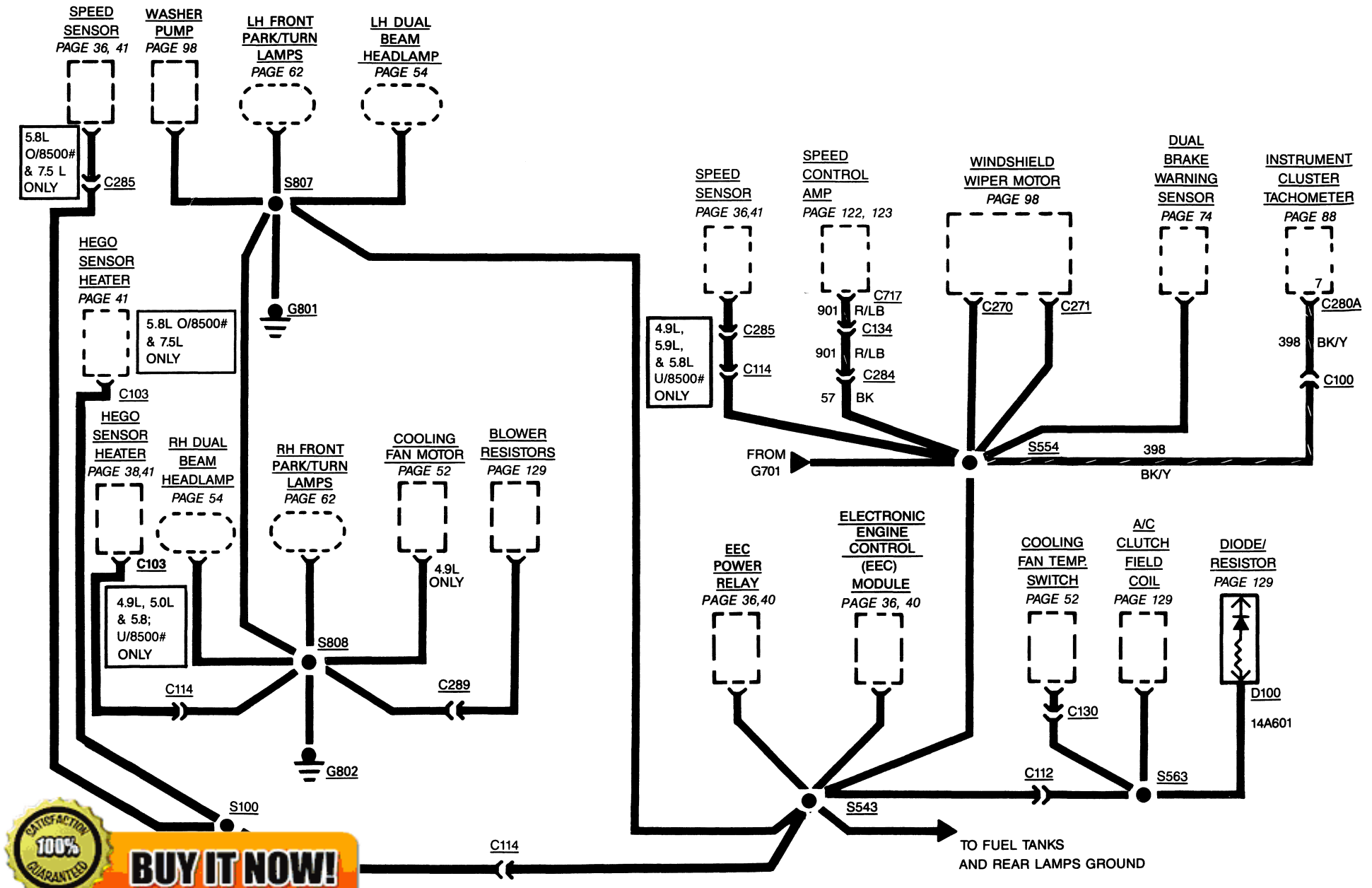
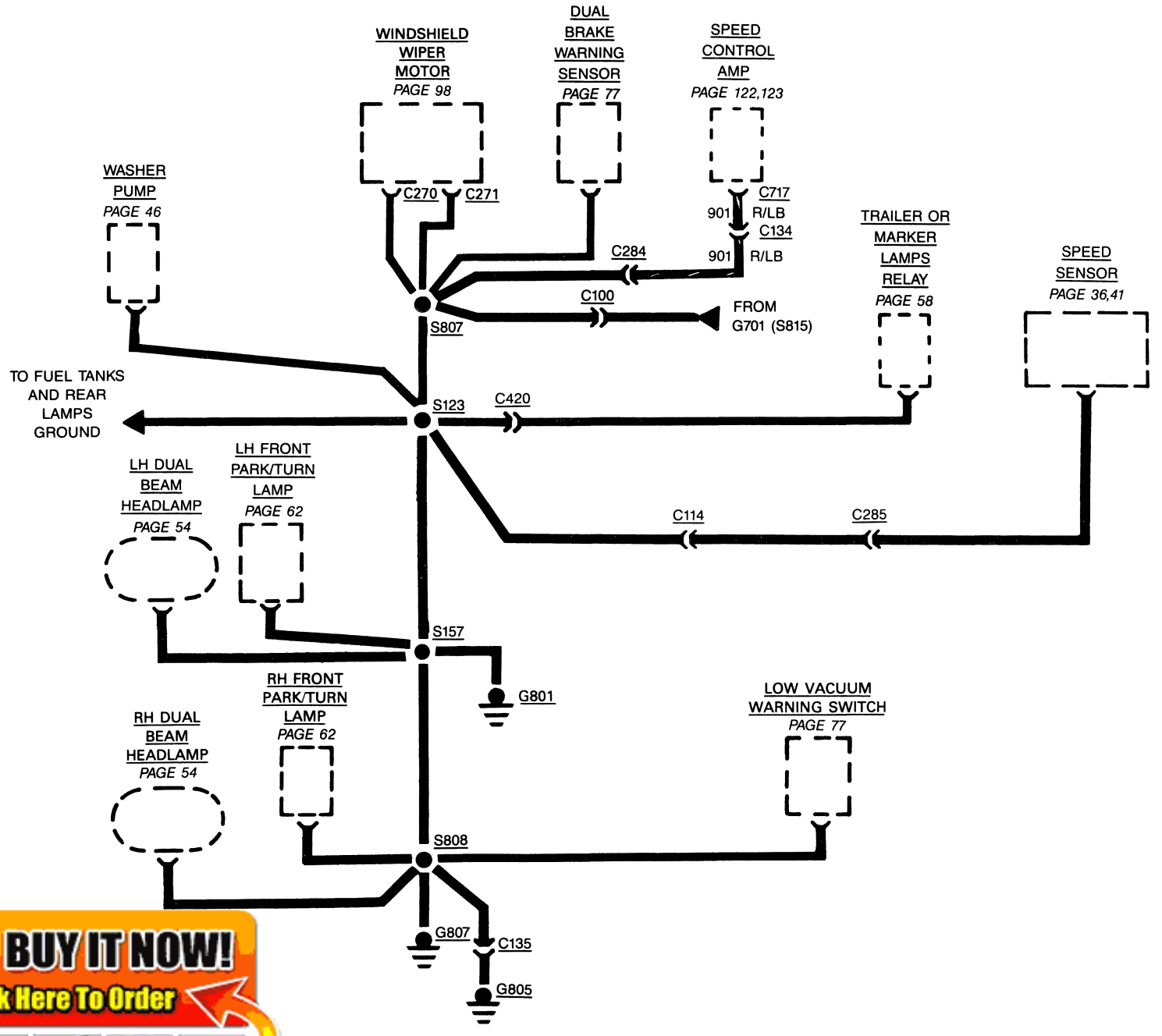


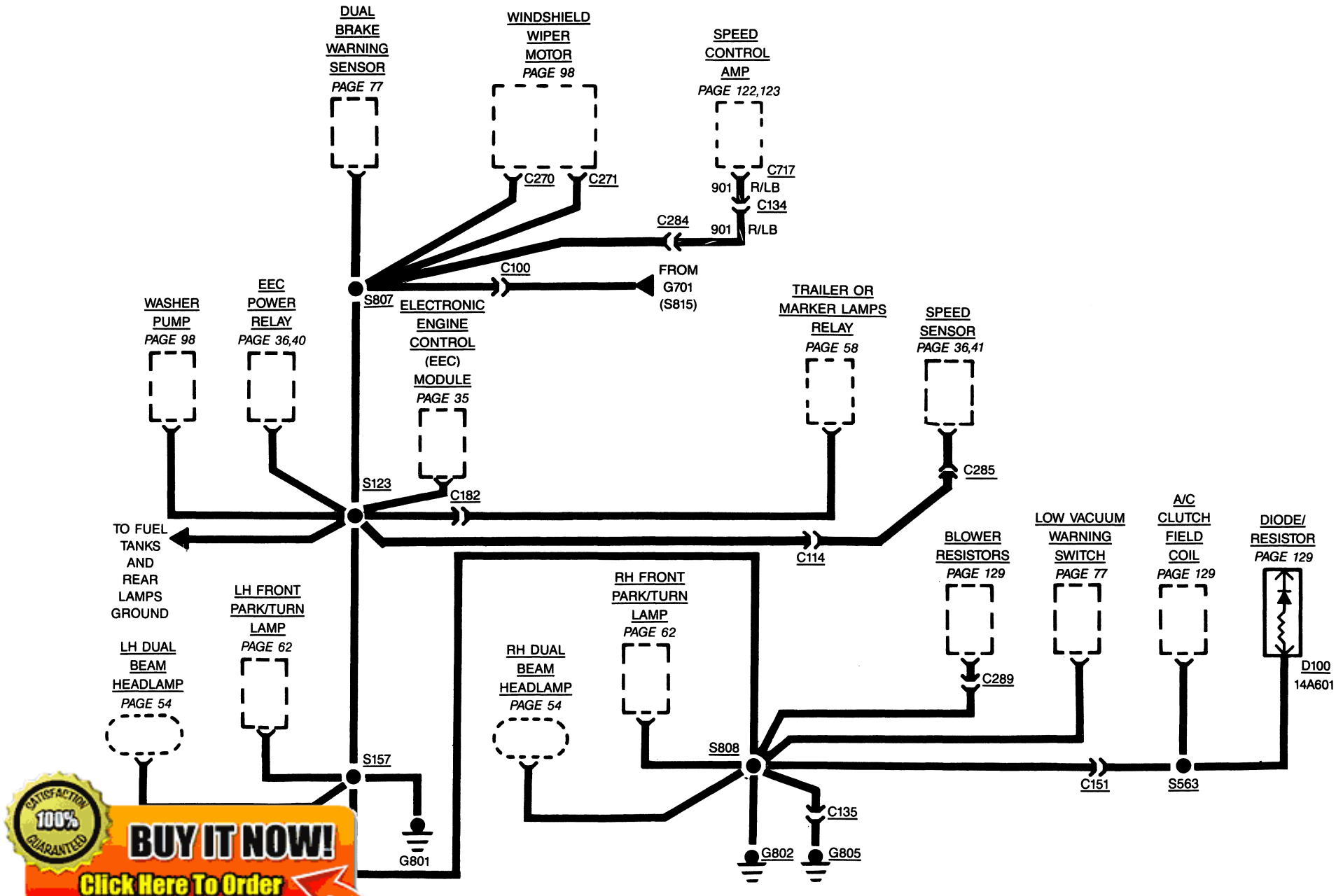
12V BATTERY

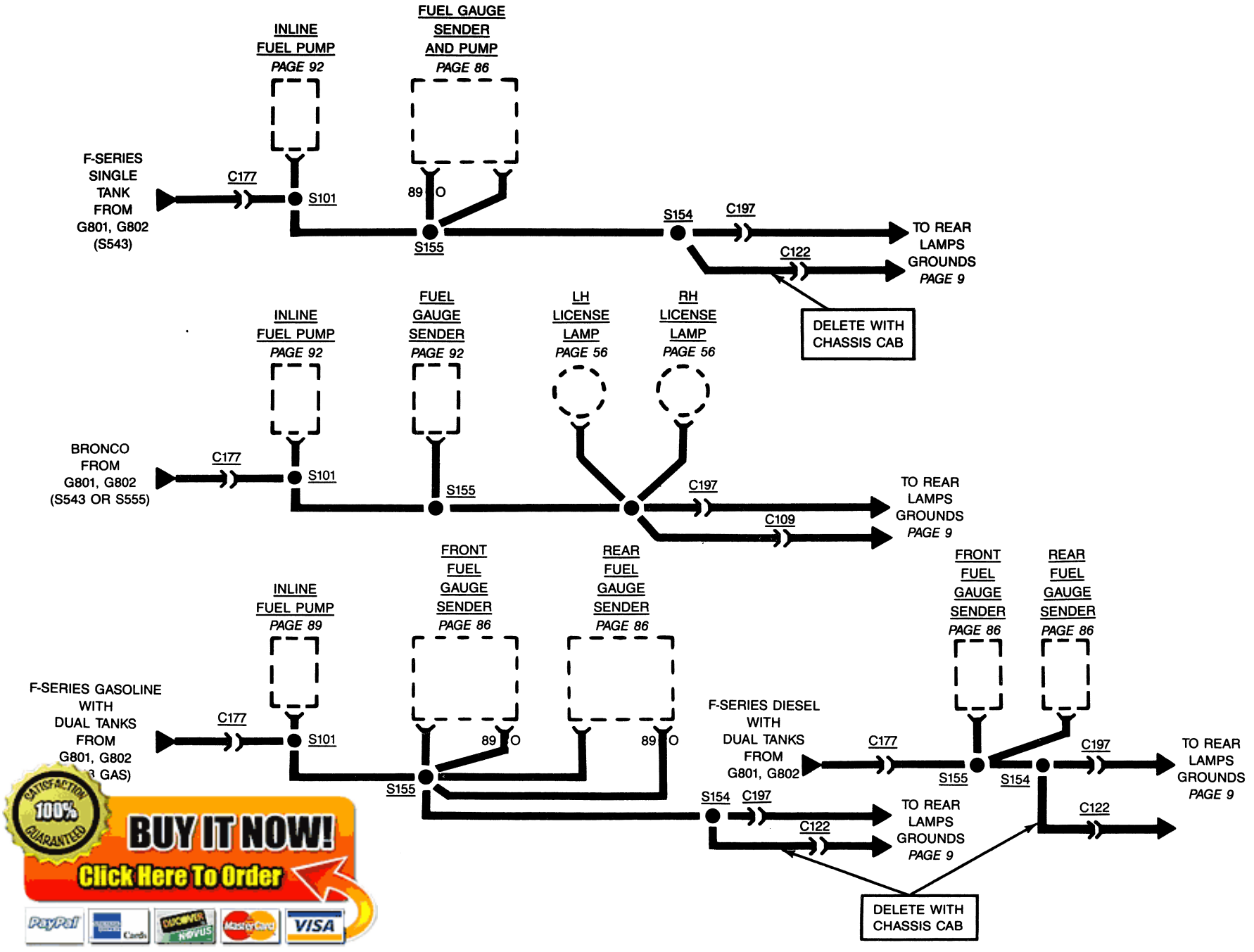


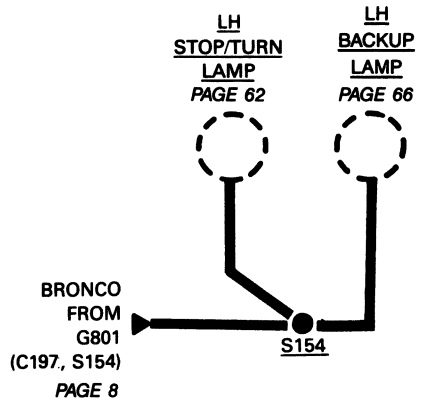


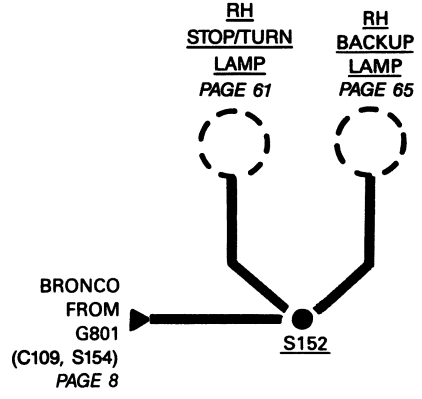


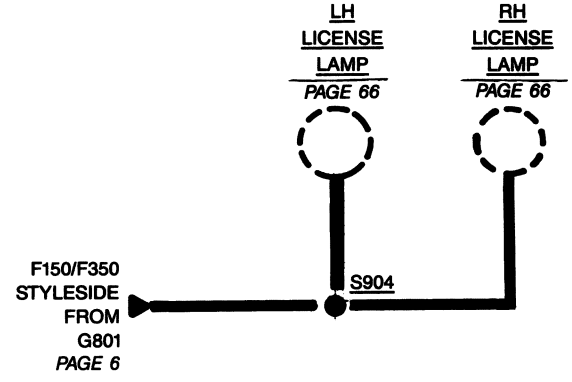
8 GROUNDS (G801, G802, G805) (7.3L DIESEL WITH E40D TRANS.)

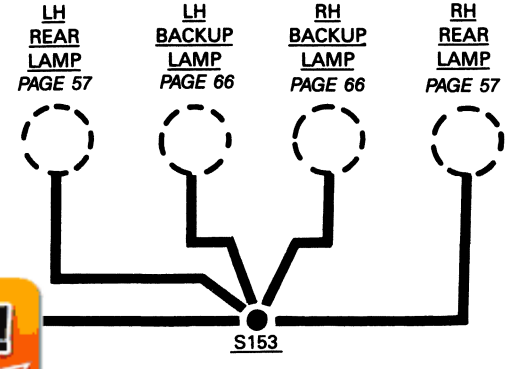


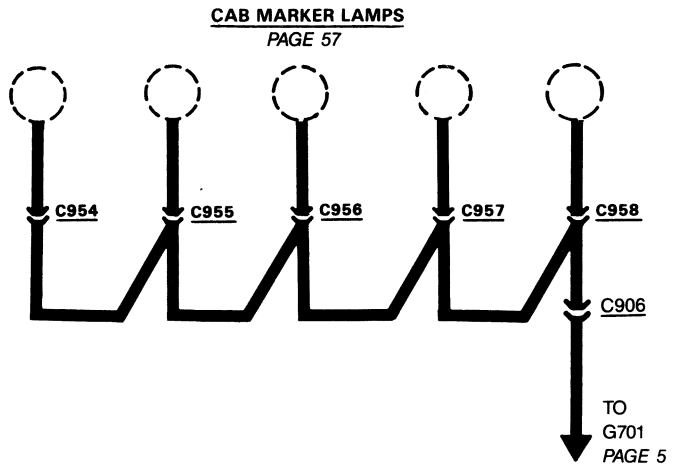


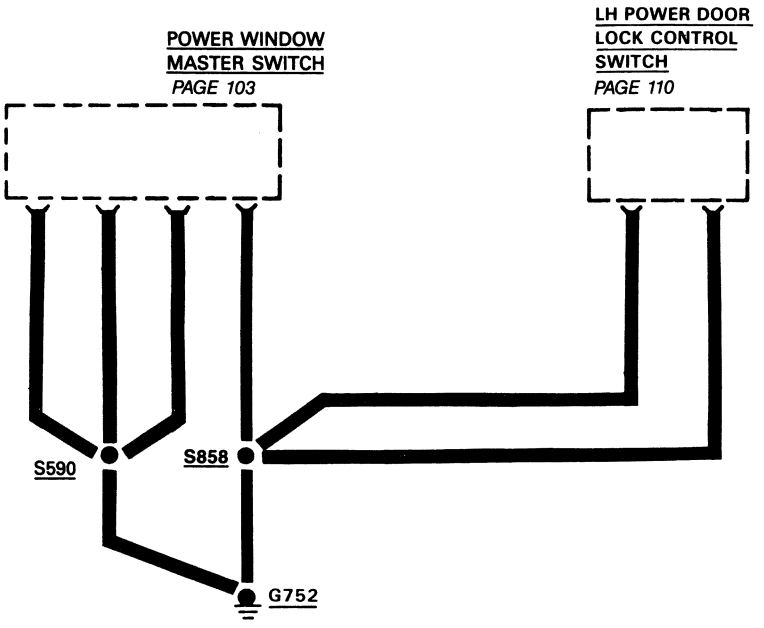


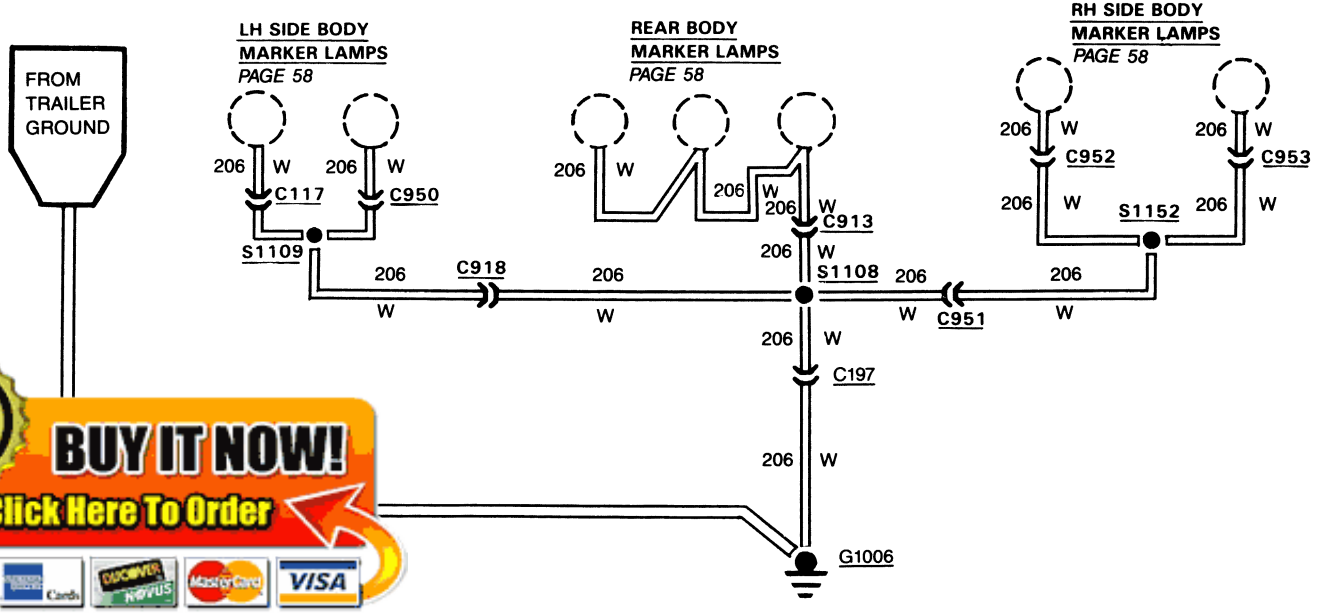


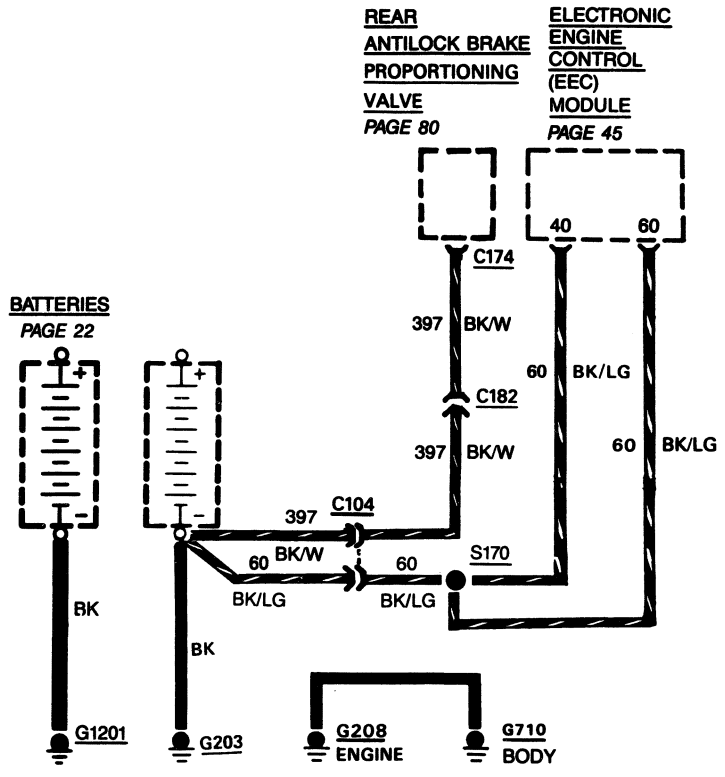




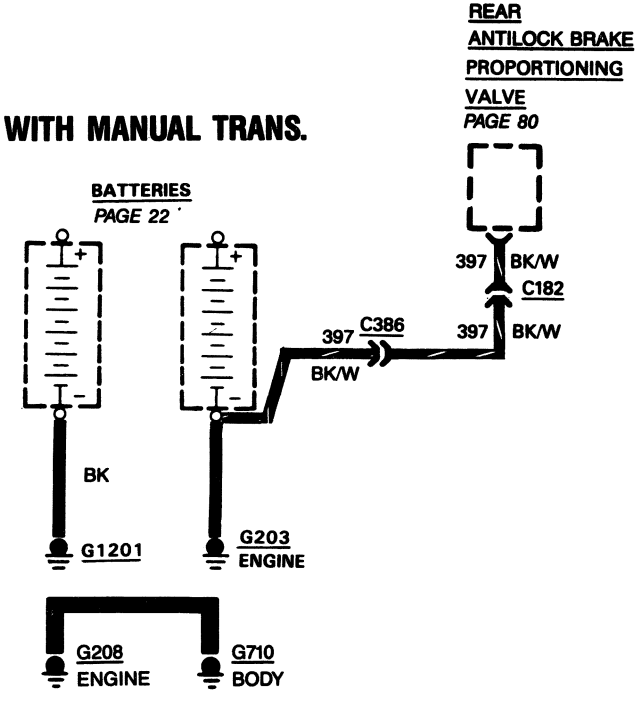








DIESEL WITH MANUAL TRANS.



HOW THE CIRCUIT WORKS

The ground circuits shown here are complete and connect several components together to screw terminal ground points. On other pages only parts of these circuits may be shown. Partial ground circuits are shown dashed on those pages.

All simple or component ground circuits are shown on the individual circuit pages and are complete on those pages.

All ground wires are **57 BK** unless otherwise noted.

COMPONENT LOCATION

		Page-Figure
A/C Clutch Field Coil	Part of compressor	
Anti-Lock Brake Module	Behind I/P left of center	
Blower Resistors	Mounted to plenum next to blower	131-1
Brake Sensor	Part of master cylinder	
Cooling Fan Motor	RH fender apron	
Diesel/Warning Lamp Module	Behind LH side of I/P near fuse panel	
Electronic Engine Control (EEC) Module	Behind LH kick panel	
EEC Power Relay	Under plastic shield at the air cleaner support bracket	
Rear Anti-lock Brake Proportioning Valve	Inside of LH frame rail behind #1 cross-member	
Electronic Shift 4 Wheel Drive Control Module	RH cowl panel	
Fuel Tank Selector Valve	On LH side frame member behind cab	91-1
Heater Blower Switch	At center of I/P	
Refer to Component Testing Page 000 for additional testing details.		
HEGO Sensor	In communicator tube connecting both exhaust pipes	134-2,135-3
Inferred Mileage Sensor	Attached to instrument panel to left of steering column	
Inline Fuel Pump	Inboard side of LH frame rail	
Low Vacuum Warning Switch	7.3L RH fender apron	
Power Window Master Switch	In LH door	
Rear Defrost Control	Under LH corner of I/P	
Seatbelt Warning Buzzer/Chime	Attached to rear RH side of I/P	
Electronic Shift 4-Wheel Drive Switch	On LH side of I/P	
Speed Sensor	At transmission	
Tailgate Power Window Motor	In center of tailgate	109-3
Washer Pump	In washer reservoir	
Windshield Wiper Motor	Attached to center of dash panel	

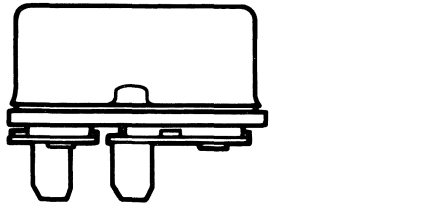
Refer to the **Location Index** in the back of the manual for connector, ground, diode and splice descriptions and locations.

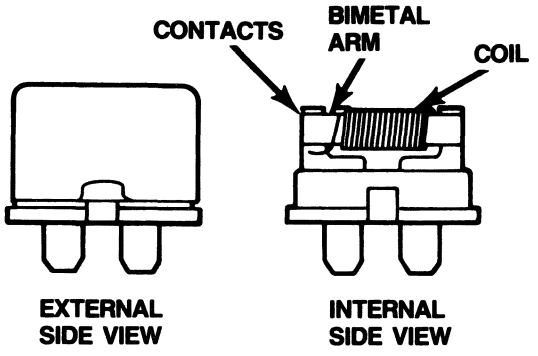
REPLACEMENT OF FUSES/ CIRCUIT BREAKERS

GOOD FUSE BLOWN FUSE

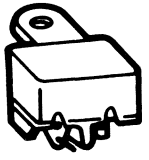
Fuses are mounted either in the **Fuse Panel** or in-line. They are identified by the numbered value in amperes, and by a color code. Some positions may have either a fuse with adapter or a circuit breaker. Be sure to replace a fuse or circuit breaker with the same kind of unit and with the same ampere rating. Remove fuses in order to check them.

CIRCUIT BREAKER OPERATION





Non-Cycling Fuse Panel Type



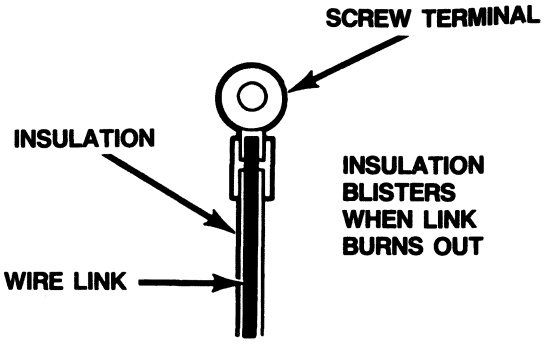
Cycling In-Line Type

Some circuits are protected by circuit breakers. (Abbreviated "c.b." in fuse chart.) They can be **Fuse Panel** mounted or in-line. Like fuses, they are rated in amperes.

Each circuit breaker conducts current through an arm made of two types of metal fastened together (bimetal arm). If the arm starts to carry too much current, it heats up. As one metal expands faster than the other the arm bends, opening the contacts. Current flow is broken. In the cycling type, the arm cools and straightens out. This closes the circuit again. This cycle repeats as long as the overcurrent exists, with power applied.

In the non-cycling type, there is also a coil wrapped around the bimetal arm. When an overcurrent exists and the contacts open, a small current passes through the coil. This current through the coil is not large enough to operate a load, but it does heat up both the coil and bimetal arm. This keeps the arm in the open position until power is removed.

FUSE LINKS

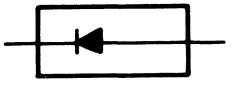


The fuse link is a short length of wire smaller in gauge than the wire in the protected circuit. The wire is covered with a thick non-flammable insulation. An overload causes the link to heat and the insulation to blister. If the overload remains, the link will melt, causing an open circuit. The links are color coded for wire size as follows:

COLOR CODE	
BLUE	20 GA
BROWN	18 GA
BLACK	16 GA
GREEN	14 GA

When replacing, make tight crimp joints or hot solder joints for good connections.

DIODES



Diodes are electrical devices that permit current to flow in one direction only. The current flows in the direction indicated by the arrow.

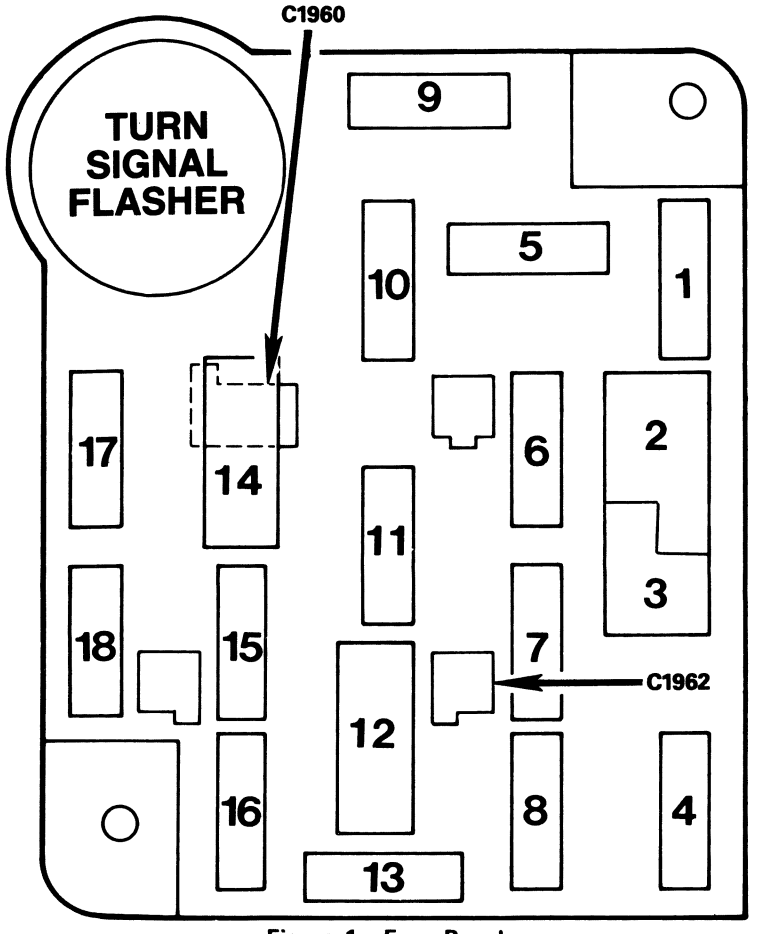


Figure 1 - Fuse Panel

Fuse Position	Amps	Circuits Protection
1	15	Stop/Hazard Lamps; Speed Control
2	—	(Not used)
3	—	(Not used)
4	15	Exterior Lamps; Instrument Illumination; Glove Compartment Lamp;
5	15	Map Lamp; Turn Lamps; Backup Lamps; Rear Window Defrost; E40D Transmission
6	15	Speed Control; Electronic Shift-4 Wheel Drive; Cargo Lamp (Bronco)
7	—	(Not Used)
8	15	Courtesy, Dome, Cargo Lamp (F-Series); Warning Buzzer
9	30	Heater; A/C-Heater
10	5	Instrument Illumination; Clock Dimming
11	15	Radio; Main Light Switch; Clock Illumination
12	25	Tailgate Power Window; Power Mirrors
	30 c.b.	Power Door Locks; Electronic Shift-4 Wheel Drive
13	—	(Not used)
14	25	Tailgate Power Window
	30 c.b.	Power Windows
15	10	Auxiliary Fuel Tank Selector
16	30	Horn; Cigar Lighter; Speed Control; 4.9L EFI After Run Blower
17	20	Anti-lock Brakes
18	15	Seatbelt Buzzer; Warning Indicators; Diesel Glow Plug Control; Diesel Indicators; Tachometer

Fuse Value Amps	Color Code
4	Pink
5	Tan
10	Red

Power Distribution

The **Alternator** and **Battery** are connected together at the **Starter Relay** hot terminal. Other circuits originate at the **Starter Relay** hot terminal and are protected by fuse links. Low power circuits are also protected by fuses.

The **Ignition Switch** and **Main Light Switch** are powered at all times as are **Fuses 1, 4, 8, 12,** and **16.** The other fuses are powered through the **Ignition Switch** or the **Main Light Switch.**

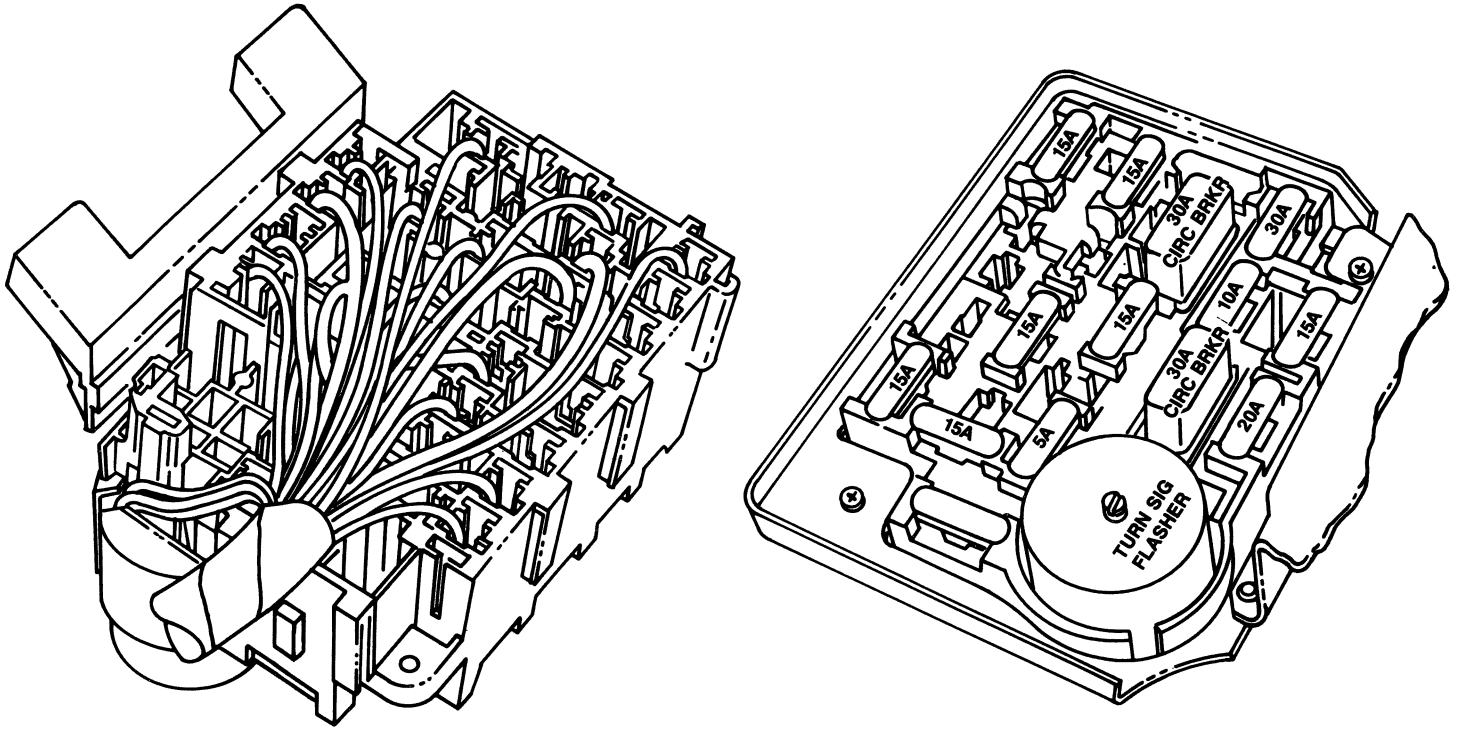


Figure 1 - Fuse Panel

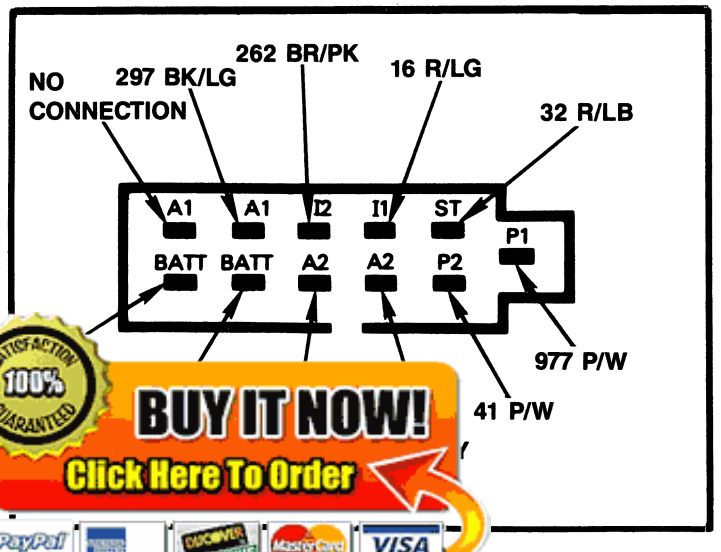
COMPONENT TESTING PROCEDURE

TO TEST	Connect Self Powered Test Light or Ohmmeter to Terminals	Move Switch to These Positions	A Good Switch Will Indicate
Internal Switch Connections (perform these tests first)	37 Y (BATT) *and* 37 Y (BATT)	Accy, Lock, Off, Run, Start	Closed Circuit in all five positions
Starter Relay Circuit	37 Y (BATT) (either terminal) *and* 32 R/L B (ST)	Accy, Lock, Off, Run, Start	Closed Circuit in **Start** position only
A/C, Heater Circuit, Turn/ Stoplamps, Backup Lamps	37 Y (BATT) (either terminal) *and* 687 GY/Y (A2) (either terminal)	Accy, Lock, Off, Run, Start	Closed Circuit in **Run** position only

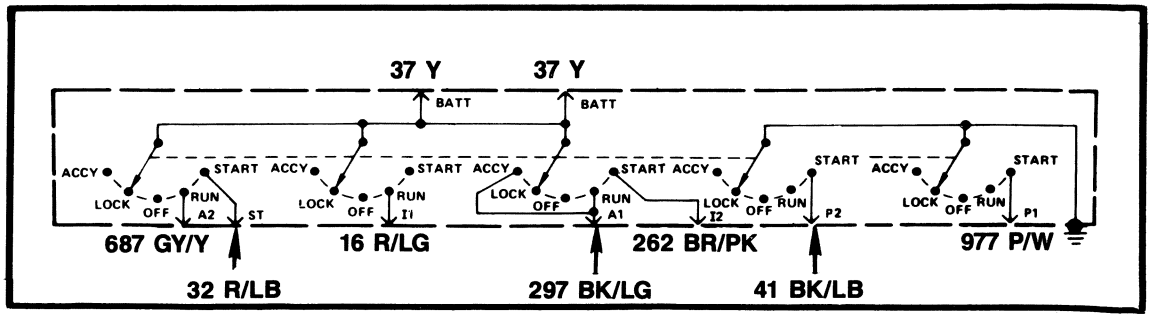
COMPONENT TESTING PROCEDURE

TO TEST	Connect Self Powered Test Light or Ohmmeter to Terminals	Move Switch to These Positions	A Good Switch Will Indicate
Ignition Circuit	37 Y (BATT) (either terminal) *and* 16 R/LG	Accy, Lock, Off, Run, Start	Closed Circuit in **Run**.
	37 Y (BATT) (either terminal) *and* 262 BR/PK (I2)	Accy, Lock, Off, Run, Start	Closed Circuit in **Start** position only
"Accy" Circuit	37 Y (BATT) (either terminal) *and* 297 BK/LG (A1)	Accy, Lock, Off, Run, Start	Closed Circuit in **Run** and **Accy** position only
Bulb-Test Circuit	41 BK/LB (P2) *and* Ignition Switch Case	Accy, Lock, Off, Run, Start	Closed Circuit in **Start** position only
	977 P/W (P1) *and* Ignition Switch Case	Accy, Lock, Off, Run, Start	Closed Circuit in **Start** position only

TERMINAL LOCATIONS



SCHEMATIC



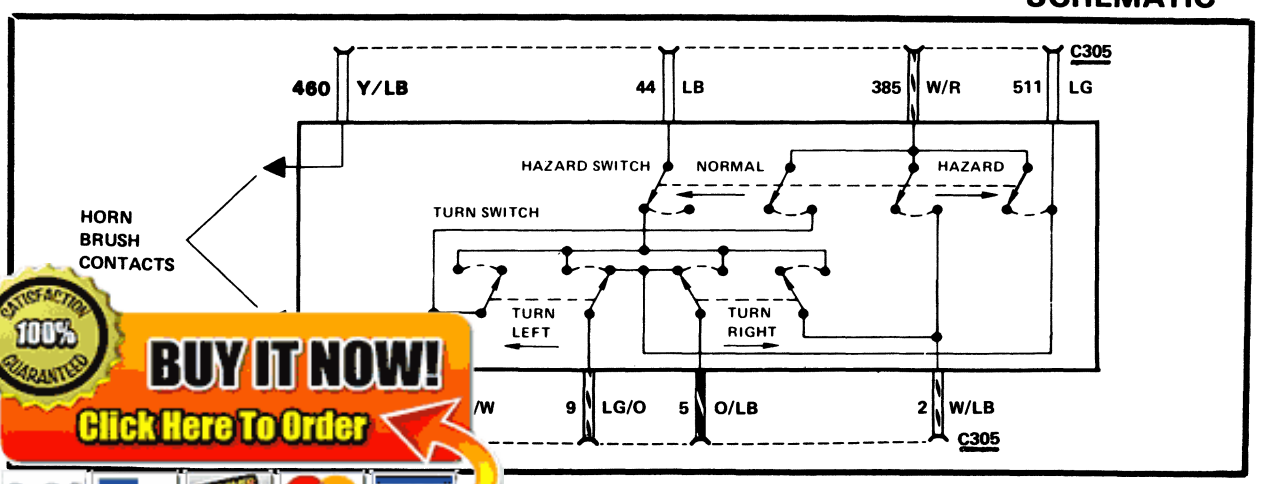
COMPONENT TESTING PROCEDURE

TO TEST	Connect Self Powered Test Light or Ohmmeter to Terminals	Move Switch to These Positions	A Good Switch Will Indicate
Horn Switch Circuit	460 Y/LB *and* 1 DB	Depress Horn Switch (If removed from truck, jumper brush contacts)	Closed Circuit
LH Rear Turn Circuit	44 LB *and* 9 LG/O	**Turn Switch** to **Turn Left** and **Hazard Switch** to **Normal**	Closed Circuit
LH Front Turn Circuit	44 LB *and* 3 LG/W	**Turn Left**	Closed Circuit
RH Rear Turn Circuit	44 LB *and* 5 O/LB	**Turn Right**	Closed Circuit
RH Front Turn Circuit	44 LB *and* 2 W/LB	**Turn Right**	Closed Circuit

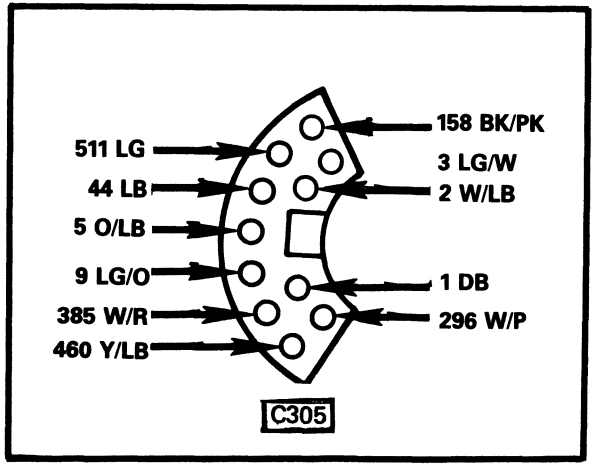
COMPONENT TESTING PROCEDURE

TO TEST	Connect Self Powered Test Light or Ohmmeter to Terminals	Move Switch to These Positions	A Good Switch Will Indicate
Hazard Switch Circuit	385 W/R *and* 511 LG	**Hazard**	Closed Circuit
	385 W/R *and* 2 W/LB	**Hazard**	Closed Circuit
	385 W/R *and* 3 LG/W	**Hazard**	Closed Circuit
Stoplamp Feed-Through Circuit	511 LG *and* 9 LG/O	**Turn Switch** to center (**No Turn**) position or **Turn Right**	Closed Circuit
	511 LG *and* 5 O/LB	**Turn Switch** to center (**No Turn**) position or **Turn Left**	Closed Circuit

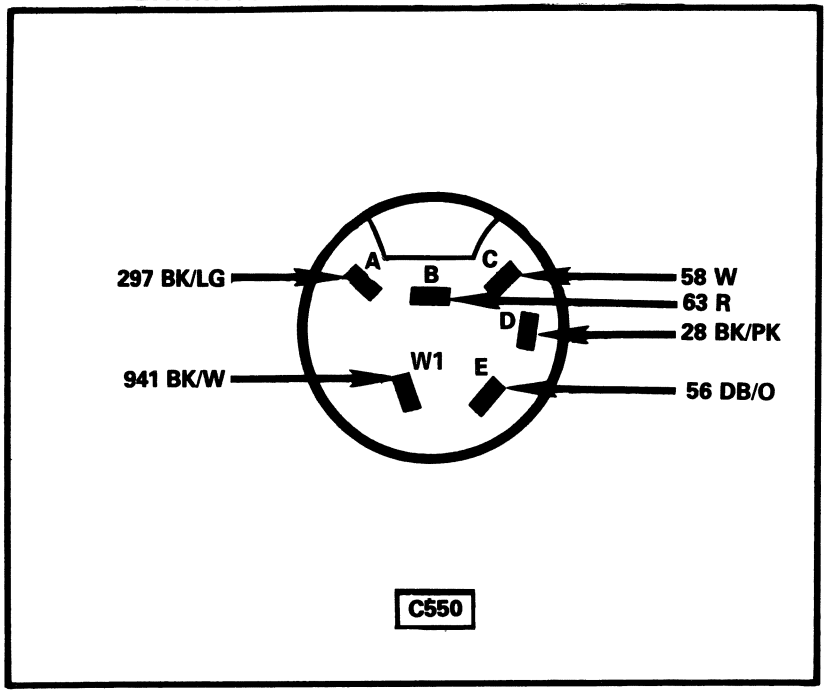
SCHEMATIC



TERMINAL LOCATIONS



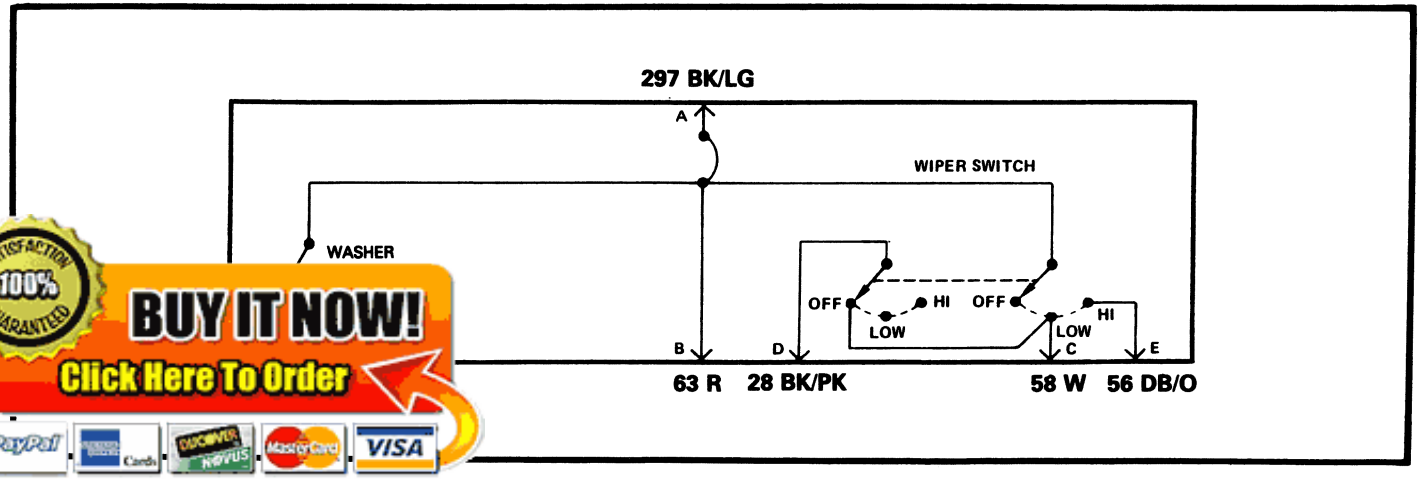
TERMINAL LOCATIONS ON SWITCH



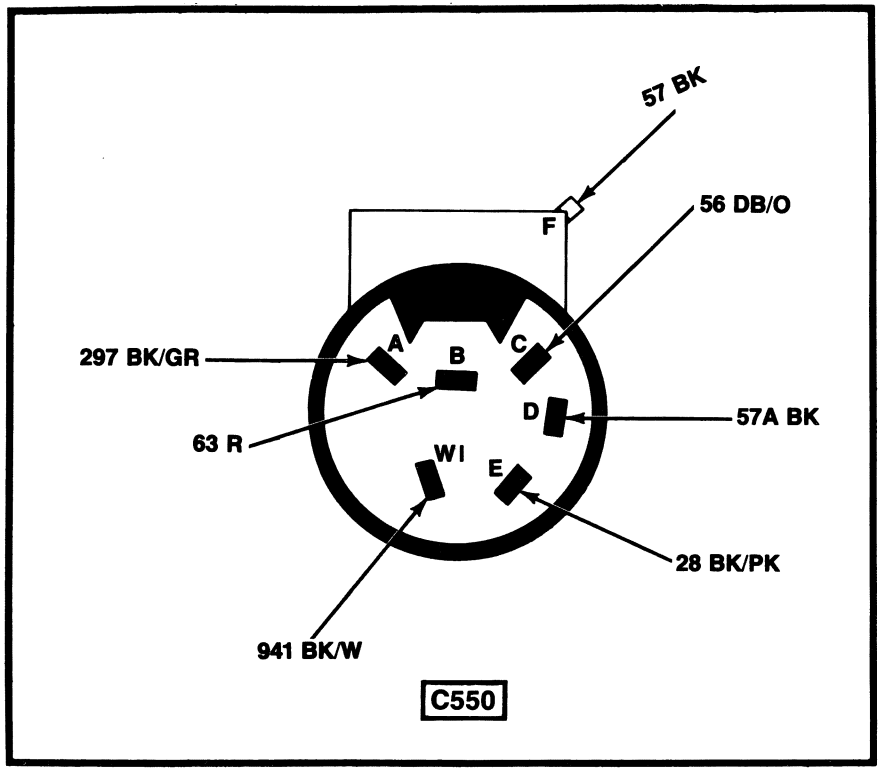
COMPONENT TESTING PROCEDURE

TO TEST	Connect Self Powered Test Light or Ohmmeter to Terminals	Move Switch to These Positions	A Good Switch Will Indicate
Washer Switch Circuit	941 BK/W (W1) *and* 63 R (B)	Push knob Release knob	Closed Circuit Open Circuit
Wiper Switch Circuit	63 R (B) *and* 58 W (C)	**Off** **Lo** **Hi**	Open Circuit Closed Circuit Open Circuit
	63 R (B) *and* 56 DB/O (E)	**Off** **Lo** **Hi**	Open Circuit Open Circuit Closed Circuit
	58 W (C) *and* 28 BK/PK (D)	**Off** **Lo** **Hi**	Closed Circuit Open Circuit Open Circuit
Circuit Breaker	297 BK/LG (A) *and* 63 R (B)	All positions	Closed Circuit

SCHEMATIC



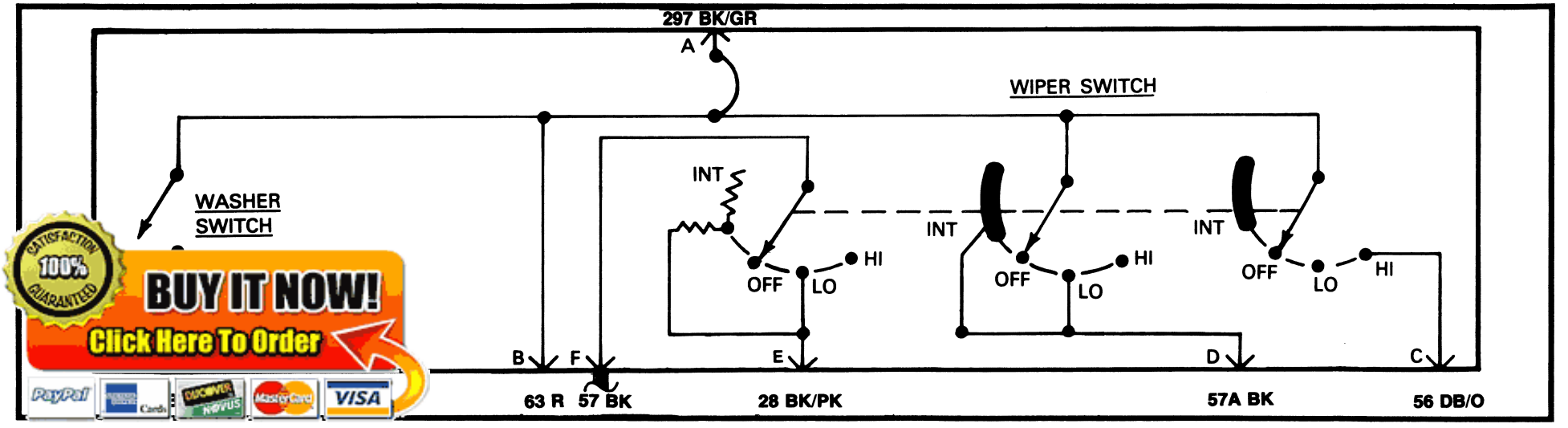
TERMINAL LOCATIONS ON SWITCH



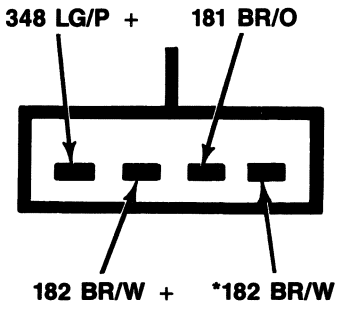
COMPONENT TESTING PROCEDURE

TO TEST	Connect Self Powered Test Light or Ohmmeter to Terminals	Move Switch to These Positions	A Good Switch Will Indicate
Wiper Switch Circuit	57 BK (F) *and* 57A BK (D)	Off	Open Circuit
		All other positions	Closed Circuit
	63 R (B) *and* 56 DB/O (C)	Hi	Closed Circuit
		All other positions	Open Circuit
	28 BK/PK (E) *and* 57 BK (F)	Off	Open Circuit
		Rotate Control ..... Clockwise Into Position (as Viewed from Connector Side).	Ohmmeter will indicate smoothly increasing resistance from 200-1000 ohms minimum to 5600-8400 ohms maximum
		All other positions	Closed Circuit

SCHEMATIC



TERMINAL LOCATIONS



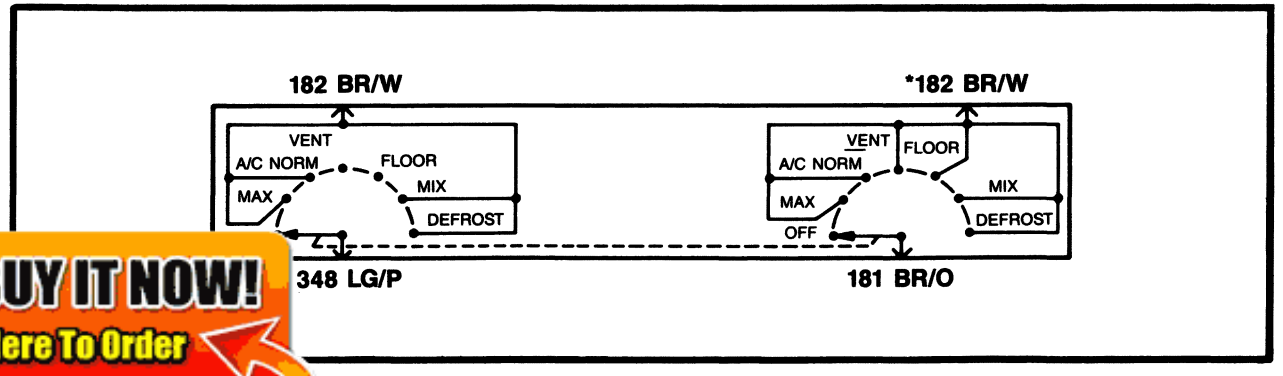
+ NOT USED WITH HEATER ONLY

COMPONENT TESTING PROCEDURE

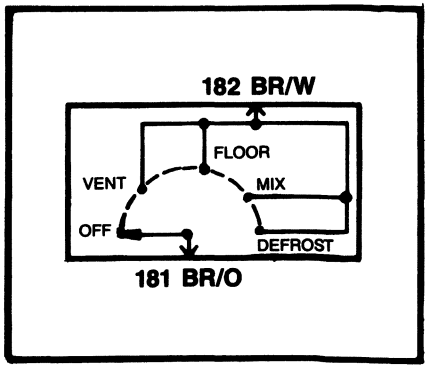
TO TEST	Connect Self Powered Test Light or Ohmmeter to Terminals	Move Switch to These Positions	A Good Switch Will Indicate
A/C Clutch Circuit	182 BR/W *and* 348 LG/P	Off	Open Circuit
		A/C Max	Closed Circuit
		A/C Norm	Closed Circuit
		Vent	Open Circuit
		Floor	Open Circuit
		Mix	Closed Circuit
		Defrost	Closed Circuit
Blower Motor Circuit	*182 BR/W *and* 181 BR/O	Off	Open Circuit
		All other positons	Closed Circuit

NOTE: HEATER ONLY USES BLOWER MOTOR CIRCUIT ONLY.

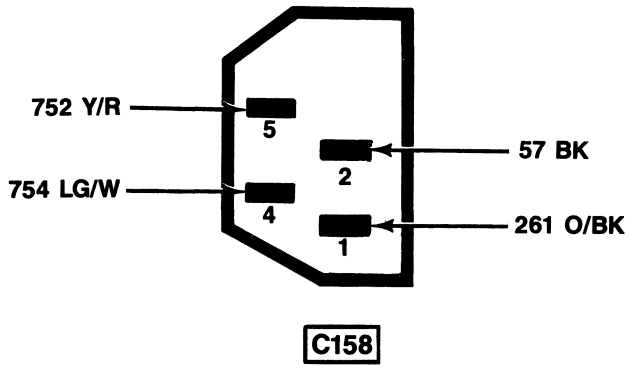
SCHEMATIC A/C HEATER



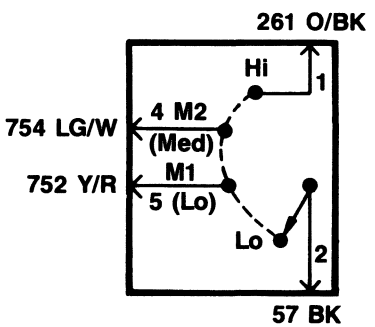
SCHEMATIC - HEATER ONLY



TERMINAL LOCATIONS



SCHEMATIC



COMPONENT TESTING PROCEDURE

TO TEST	Connect Self Powered Test Light or Ohmmeter to Terminals	Move Switch to These Positions	A Good Switch Will Indicate
LO	57 BK (2)	Lo	Open Circuit
Medium-Low Speed (M1)	57 BK (2) *and* 752 Y/R (5)	Lo Medium-1 Medium-2 Hi	Open Circuit Closed Circuit Open Circuit Open Circuit
Medium-High Speed (M2)	57 BK (2) *and* 754 LG/W (4)	Lo Medium-1 Medium-2 Hi	Open Circuit Open Circuit Closed Circuit Open Circuit
Hi Speed	57 BK (2) *and* 261 O/BK (1)	Lo Medium-1 Medium-2 Hi	Open Circuit Open Circuit Open Circuit Closed Circuit

CONNECTOR LOCATION

		Page-Figure	Color	Terminals
C100	Through dash at LH side	—		53
C103	Near HEGO sensor	—	BK	4
C104	At battery ground pigtail	—		4
C107	At license lamps	60-2	BR	1
C108	Engine compartment LH side	—	BK	4
C109	RH side #6 crossmember	60-3	GY	4
C110	LH fender apron	—	GY	8
C111	Behind I/P LH end (test)	—	BK	1
C112	LH fender apron	—	BR	8
C113	LH fender apron	—	N	8
C114	LH fender apron	—	BK	8
C115	On rear of engine	—	BK	8
C116	LH fender apron	—	BK	8
C117	At LH front side body marker lamp	61-8	BK	4
C118	LH fender apron	—	BK	8
C119	On dash panel	—	GY	4
C122	RH side of rear cross support	60-3	GY	4
C123	LH side of frame at rear crossmember	109-5	BK	4
C126	LH side of rear crossmember	60-2		2
C129	At RH fender apron (diesel only)	35-1	GY	8
C132	LH fender apron	—	BK	8
C133	LH fender apron/#5 crossmember on dual tank	—	BK	4
C134	LH fender apron	—	BK	8
C135	RH inner fender behind headlamp		BK	1
C136	At rear left quarter panel	71-2		
C151	Engine compartment	—	BK	4
C157	At A/C clutch switch	—	W	2
C158	At blower switch	—	GY	5
C168	Engine compartment test		GY	6
C170	Near ignition module	133-1	BK	2
C171	Engine compartment test	—		1
C174	At proportioning valve, LH frame rail		BK	4
C177	Engine compartment LH side	—	GY	4
C182	Engine compartment LH	—	GY	4
C183	Engine compartment LH	—	BR	2
C185	At alternator	135-3		3
C186	At alternator	—		3
	At alternator regulator	139-7	W	4
		—		2
	h	—	GY	2
	upport	—	GY	8
	ter panel	71-2	GY	4
	ter panel	70-1	GY	4
	r panel	—	GY	4
		—		14

CONNECTOR LOCATION

		Page-Figure	Color	Terminals
C208B	At instrument cluster	—		14
C233	Near alternator	—	GY	1
C240	At ignition key, seat belt warning buzzer	—		7
C244	Behind center of I/P	—	BK	8
C248	Engine compartment near starter relay	—	GY/BK	4
C260	Near RH battery		BK	1
C270	At wiper motor	—		3
C271	At wiper motor	—		3
C276	At automatic transmission	—		5
C280	Engine compartment near starter relay	—		6
C284	At 4×4 switch	—	BK	2
C285	LH fender apron near power brake booster	—	GY	4
C285A	LH fender apron near power brake booster	—	BR	4
C285B	At speed sensor	—	BK	2
C289	RH cowl	—	BK	4
C290	RH cowl	—	GY	4
C292	At blower motor	—		2
C293	At blower resistor	—	W	4
C300	Inline fuel pump	—	BK	2
C305	LH side of steering column	—	GY	11
C305A	LH side of steering column	—	GY	11
C305B	LH side of steering column	—	GY	11
C321	LH fender apron near ignition module	—	BK	3
C322	At distributor	—	BK	3
C323	At ignition module	—	BK	4
C333	Behind center of I/P at radio	—		8
C343	LH fender apron near ignition module		BK	8
C344	LH fender apron near ignition module		BK	8
C353	Rear LH side of frame at rear crossmember	60-4	Y	1
C354	At LH rear park & turn lamp	60-4	BK	2
C355	At RH rear park & turn lamp	60-4	BK	2
C356	At RH backup lamp	60-4	Y	1
C357	At LH backup lamp	60-4	Y	1
C358	Behind center of I/P	—	GY	2
C366	Behind I/P near fuse panel	—	GY	3
C366A	Behind I/P near fuse panel	—	GY	3
C366B	Behind I/P near fuse panel	—	GY	3
C370	Transmission extension housing	—	GY	4
C380	Engine compartment LH side	—		2
C385	Near alternator/regulator	—	BK	1

CONNECTOR LOCATION

		Page-Figure	Color	Terminals
C386	Near RH battery	—		1
C406	LH cowl under I/P	—	GY	4
C420	Engine compartment LH side	—	BK	4
C425	RH cowl	—	BK	6
C426	RH cowl side	—	GY	2
C427	RH cowl side — electric shift module	—	GY	8
C428	RH cowl side — electric shift module	—	W	10
C429	RH cowl side — electric shift module	—	BR	5
C430	At electric shift transfer case	—	BK	10
C431	At electronic shift switch	—		6
C450	LH side rear support cross	—	BK	2
C522	Behind center of I/P at radio	—		8
C523	Lower LH cowl access hole	—	BR	2
C524	Lower RH cowl access hole	114-1	BR	2
C550	At windshield wiper/washer switch	102-1	BK	10
C650	At RH door lock motor	—	BK	2
C701	At main light switch	—	BK	8
C714	At speed control amplifier	—	GR	8
C717	At speed control amplifier	—	GY	6
C752	LH side of hood at engine compartment lamp	—		1
C753	At speed control servo	—	BR	6
C755	At clutch switch	—	GR	2
C789	LH side of driver's seat on floor pan	79-1	GY	2
C850	Lower LH cowl access hole	—	GY	4
C906	At LH cowl access hole	—		2
C913	At center of rear body markers	60-5		4
C915	Engine compartment LH side	—	BK	2
C918	Near LH side of rear crossmember	60-2	BK	4
C950	At LH rear	61-8		4
C951	Near RH side of rear crossmember	60-6	BR	2
C952	At front of RH side body marker	—	BK	4
C953	At RH rear	61-8	BK	4
C954	In forward part of cab roof	59-1	BK	2
C955	In forward part of cab roof	59-1	BK	2
C	In forward part of cab roof	59-1	BK	2
		59-1	BK	2
		59-1	BK	2
		—	BK	3
C		—	GY	4
C				
		61-9	BK	4
C	ent	61-9	BR	6
C		—	BR	3
C1114	LH rear of frame			4
C1206	At rear crossmember	65-1	GY	3
C1907	Behind LH rear lamp	109-4	BR	3
C1951	Behind LH rear crossmember	109-5	BR	1
C1952	Behind LH rear lamp	109-4	BR	1
C1953	LH cowl center access hole	—	GY	8
C1954	RH cowl center access hole	—	GR	8
C1955	LH cowl area	—		2
C1960	On fuse panel	—	N	1
C1962	At fuse panel	—	BL	2
C1963	LH frame rail	—	BK	2
C1964	Engine compartment LH side	—	BK	4

SPLICE LOCATION

S101	Near inline fuel pump T/O	—
S108	Near tailgate power window switch T/O	—
S109	Near tailgate power window switch T/O	—
S110	Near fuel pump relay T/O	—
S111	Near starter relay T/O	—
S112	Near EEC module T/O	—
S113	Near C115 T/O	—
S114	Near C114 T/O	—
S115	Near manifold pressure sensor T/O	—
S116	Near manifold pressure sensor T/O	—
S117	Near C100 T/O	—
S118	Near EEC module T/O	—
S119	Near E40D T/O	—
S120	Near speed control amplifier T/O	—
S121	Near C112 T/O	—
S123	Near EEC module T/O	—
S124	Near backup lamp switch T/O	—
S125	Near backup lamp switch T/O	—
S126	Near C100 T/O	—
S129	Near E40D Transmission	—
S140	Between S142 and S143	—
S142	Near T/O to no. 4 fuel injector	—
S143	Near T/O to no. 8 fuel injector	—
S150	In ignition coil lead	—
S152	Near LH backup lamp T/O	—
S153	Near license lamp T/O	—
S154	Near front fuel gauge sender T/O	—
S155	Near ERBP valve T/O	—
S156	Near fuel line heater T/O	—
S157	Near LH headlamp T/O	—

SPLICE LOCATION

SPLICE LOCATION

SPLICE LOCATION

DIODE LOCATION

GROUND LOCATION

GROUND LOCATION

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Ford Parts and Service Division
Training and Publications Department

FPS-12129-89

PRINTED IN U.S.A.
AUG. 1988

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Electrical & Vacuum Trouble-Shooting Manual

Ford
Official Licensed Product
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1990 Bronco/F150-F350/F-Super Duty Electrical & Vacuum Trouble-Shooting Manual (EVTM)

EAN: 978-1-60371-413-6
ISBN: 1-60371-413-8

Forel Publishing Company, LLC
Woodbridge, VA 22192
Email: sales@ForelPublishing.com
https://www.ForelPublishing.com

License #84356800

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ELECTRICAL AND VACUUM TROUBLESHOOTING MANUAL
FPS-12129-90

FORD PARTS and SERVICE DIVISION

Quality is Job 1

For customer satisfaction, Ford Parts and Service Division has developed an EVTM for the 1990 model year. The EVTM is directed to you--the technician. Our goal is to provide accurate and timely service information for product maintenance.

1990 EVTM FEATURES

- A **"How to Use This Manual"** section that orients the user to the manual and its use.
- **Electrical Schematics** categorized by system and circuit.
- **"How the Circuit Works"** descriptions that explain how each circuit works. These descriptions are designed to be used in conjunction with the Electrical Schematic.
- **Component Location** information that tells where each component is located on the car as well as a reference to a **Component Location View.**
- **Troubleshooting Hints** presented in a "condition-cause-action" format.
- **Component Testing Procedures** that tell the user how to perform diagnostic tests on various circuits.
- **Connector End Views** designed to help with troubleshooting.
- **Notes, Cautions, and Warnings** that contain important safety information.
- Full view **Component Location Illustrations** to help locate on-vehicle components.
- **Component Base Part Numbers** and **Harness Base Part Numbers** to aid in ordering

in locating systems for easier referencing.

help with the EVTM System Location.

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:

- Shop Manuals
- Service Specification Books
- Car/Truck Wiring Diagrams
- Engine/Emissions Diagnosis Manuals

Helm Incorporated
P.O. Box 87150
Detroit, Michigan 48207

1-1 CONTENTS/INDEX

Table Of Contents

Index

Publisher Note - table of contents are hyperlinked to pages

2-1 HOW TO USE THIS MANUAL

The purpose of this manual is to show electrical and vacuum circuits of these vehicles in a clear and simple fashion to make troubleshooting easier. With each circuit is a description of *How the Circuit Works* and some *Troubleshooting Hints*. A Component Location chart lists components and references to pictures in the manual.

Notes, Cautions and Warnings containing important information appear in boxes on text pages. Notes provide additional information to help complete a particular procedure. Cautions provide information that could prevent making an error that could damage the vehicle. Warnings provide information to prevent personal injury. The warnings list on the previous page contains general warnings to follow when working on a vehicle.

Components which work together are shown together. For example, all electrical components used in any circuit are shown on one diagram. The circuit breaker or fuse is shown at the top of the page. All wires, connectors, splices, switches, and motors are shown in the flow of current to ground at the bottom of the page. Notes are included which describe how switches and other components work. If a component is used in several different circuits, it is shown in several places.

For example, the Main Light Switch is an electrical part of many circuits and is repeated on many pages. In some cases, how- a component may seem (by its name) g on a page where it has no electrical mination ination., ection at shown

Troubleshooting Hints point the technician in a general direction, but are not intended as a step-by-step procedure. Ignition troubleshooting is an exception to this. It includes a step-by-step procedure of basic quick checks to locate some of the more common Ignition System problems. Reading the Shop Manual provides more detailed repair procedures.

Connector end views of switches and other components are shown in Cell 149 (beginning on page 149-1) to help with bench testing. The views show the harness wire colors that connect to the mating terminals. Connector colors and locations are shown in the *Location Index* chart. Two-color listings indicate separate colors for each connector half.

A Location Index in Cell 152 (beginning on page 152-1) identifies individual components, connectors, and splices. This index describes the component, connector, or splice location and directs you to the component illustrations. In addition, the component base part number has been included for your convenience in ordering parts. A list of harness base numbers, harness names and major systems associated with the respective harness base part number is also included within the Location Index.

The Grounds pages show detailed views of multiple component ground points. This is useful for checking interconnections among the ground circuits of different diagrams.

Component Connectors with more than 5 cavities are shown in Cell 150 (Beginning on page 150-1) to help with system troubleshooting. Any component connector with 5-9 cavities will be shown with a connector end view of the connector. A component with 10 or more connector cavities will have a pinout chart in addition to the connector face. The pinout chart contains information such as cavity number, wire number and color, and circuit function.

Resistors and Diodes are currently covered with PVC molds and are taped to the harness outside the tubing. Many of the resistor and diode assemblies will be covered with heat shrinkable tubing making the assembly small enough to be placed within the harness bundle.

The wiring diagrams show the number of times the resistors and diodes are used. The wiring diagrams also show the distance from connector/length of wire in exact centimeters. Resistors and diodes are identified on the wiring diagrams by the following base part numbers:

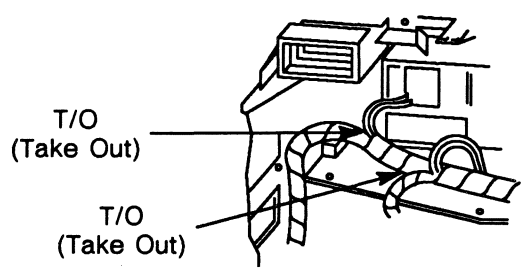
Resistor/diode assembly	14A601
Diode only	14A604

We welcome any comments you may have regarding this EVTM. Use the Feedback Sheet at the back of this manual to submit comments. The information submitted on this sheet will improve future editions.

Before using the EVTM for troubleshooting, refer to the HELPFUL REMINDERS described on this page.

1. The abbreviation T/O, for take out, used in the Component Location Chart, refers to the point at which a harness branches to feed a component. 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

3. Wiring diagrams provide a schematic 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**
GR	**Green**	**T**	**Tan**
GY	**Gray**	**W**	**White**
LB	**Light Blue**	**Y**	**Yellow**
LG	**Light Green**		

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 to Cell 160 (Beginning on page 160-1).

   Note: Do *not* use the illustrations in Cell 151 (Beginning on page 151-1) for reporting Vehicle Repair Location Codes.

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 when the engine is running, especially the fan and belts.*
- *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.*

4-1 HOW TO FIND THE ELECTRICAL PROBLEM

TROUBLESHOOTING STEPS

These six steps present an orderly method of troubleshooting.

Step 1. Verify the problem.
- Operate the complete system to check the accuracy and completeness of the customer's complaint.

Step 2. Narrow the problem.
- Using the EVTM, narrow down the possible causes and locations of the problem to pinpoint the exact cause.
- Read the description of *How the Circuit Works* and study the wiring diagram. You should then know enough about the circuit operation to determine where to check for the trouble. Further information can be found in the Shop Manual pages listed after *How the Circuit Works.*

Step 3. Test the cause.
- Use electrical test procedures to find the specific cause of the symptoms.
- *Troubleshooting Hints* will give you helpful ideas.
- The *Component Location Charts* and the pictures will help you find components. Following each chart, there is a reference to the Location Index at the end of the manual. This index gives component location information for connectors, diodes, resistors, splices and grounds.

Step 4. Verify the cause.

Confirm that you have found the correct ...se by connecting jumper wires and/or ...od com-

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 *Shop Manual* and other service books for details. You will find these circuits in this manual to be helpful with these special tests.

TROUBLESHOOTING TOOLS

JUMPER WIRE

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

WARNING

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

VOLTMETER

A DC Voltmeter measures circuit voltage. Connect negative (- or black) lead to ground, and positive (+ or red) lead to voltage measuring point.

OHMMETER

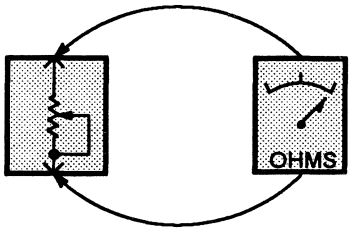


Figure 1–Resistance Check

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

TEST LAMP

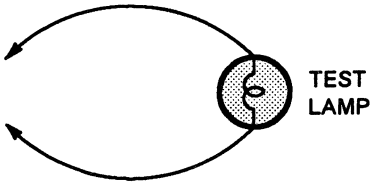


Figure 2–Test Lamp

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

Uses: Voltage Check, Short Check

SELF-POWERED TEST LAMP

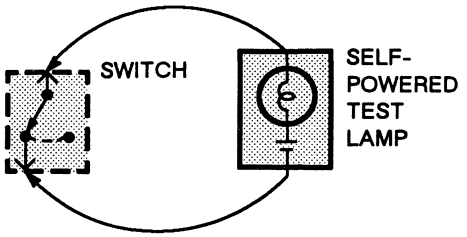


Figure 3–Continuity Check

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.*

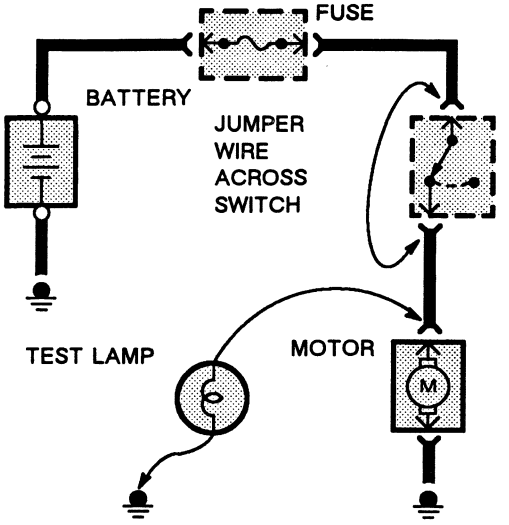


Figure 4—Switch Circuit Check and Voltage Check

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).

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).

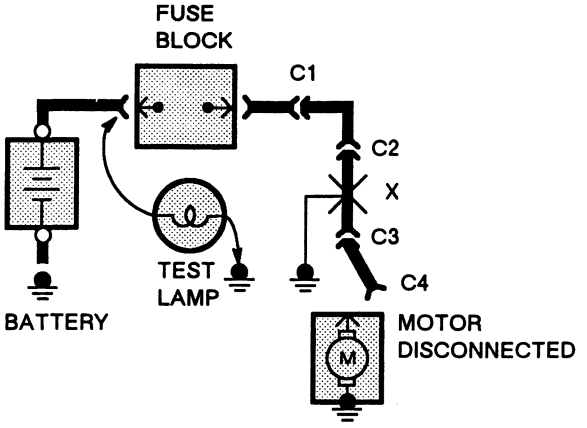


Figure 5—Short Check

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

1. Turn off everything powered through the fuse.
2. Disconnect other loads powered through the fuse:
   - Motors: disconnect motor connector (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 stays on after disconnecting C3. This means the short is between C2 and C3.

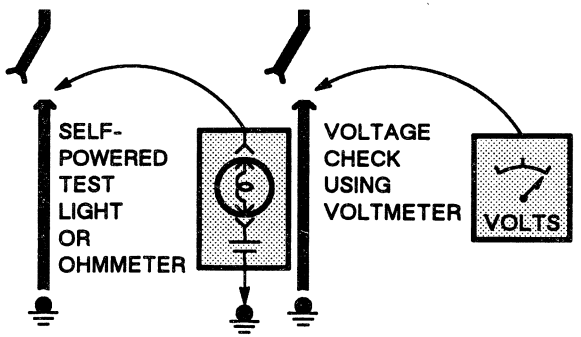


Figure 6—Ground Checks

Turn on power to the circuit. Perform a Voltage Check between the suspected inoperative ground and the frame. Any indicated [illegible] means that the ground is inoperative.

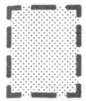
ect one
)hmme-
ıer lead
the cir-

TROUBLESHOOTING HINTS

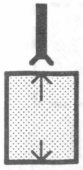
The circuit schematics in this manual make it easy to identify common points in circuits. This knowledge can help narrow the problem to a specific area. For example, if several circuits fail at the same time, check for a common power or ground connection. (See *Power Distribution* or *Grounds*.) If part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

For example, if low beam headlamps work, but 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.

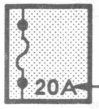
Troubleshooting Hints unique to a particular circuit are given in a new, three column format. Included in the charts are conditions that may develop, possible causes, and one or more tests that can be done quickly to determine the cause of the condition.



DASHED COMPONENT BOX
ONLY PART OF THE COMPONENT IS SHOWN, OR COMPONENT IS SHOWN IN TWO PLACES

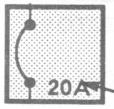


COMPONENT WITH CONNECTORS

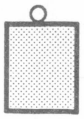


FUSE
CURRENT RATING

FUSIBLE LINK CARTRIDGE
CARTRIDGE CURRENT RATING



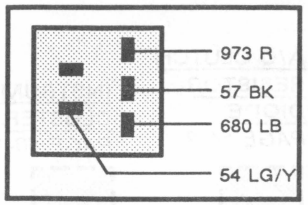
CIRCUIT BREAKER
CURRENT RATING



SCREW TERMINAL ON COMPONENT

SOLID STATE

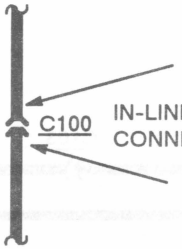
SEALED ELECTRONIC COMPONENT
ANY CIRCUITRY SHOWN INSIDE THE BOX IS A FUNCTIONAL



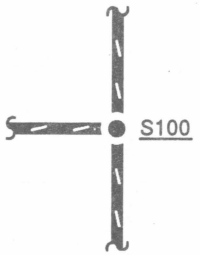
COMPONENT CONNECTOR END VIEW
SHOWS PINS OR SOCKETS ON A COMPONENT TO AID IN BENCH TESTING

WIRE COLORS ARE LABELED FOR MATING HARNESS CONNECTOR

PIN TERMINAL TYPES
SOCKET TYPES



IN-LINE CONNECTOR

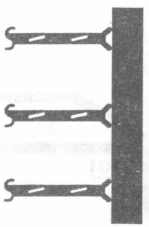


SPLICE OR CRIMP TERMINAL

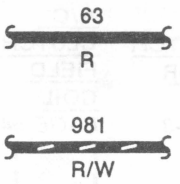
GROUND CONNECTION

A DG

FUSE LINK

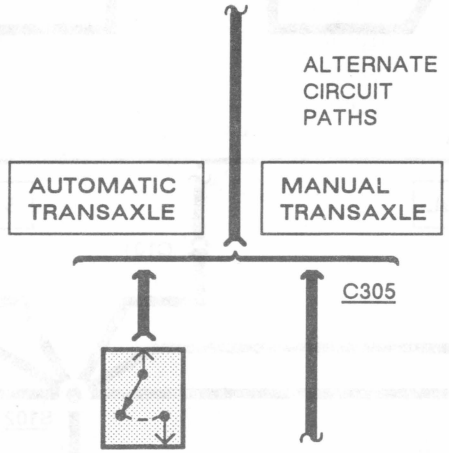


JUNCTION BLOCK

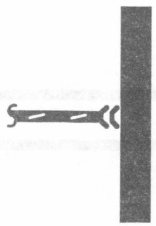


SOLID WIRE

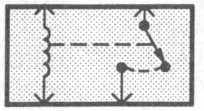
STRIPED WIRE



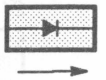
ALTERNATE CIRCUIT PATHS



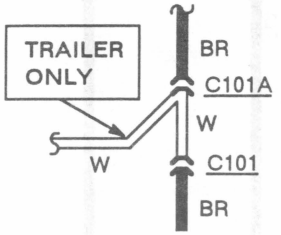
CANDELABRA CONNECTOR
ACCEPTS SINGLE PIN CONNECTORS



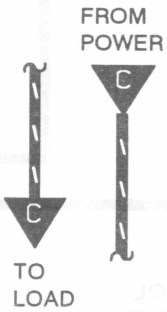
RELAY
CONTACTS CLOSE WITH CURRENT THROUGH COIL



DIODES
CURRENT FLOWS IN DIRECTION OF ARROW ONLY



OPTIONAL WIRING
BR WIRES (INCLUDING C101) ARE ON ALL VEHICLES, BUT W WIRES (INCLUDING C101A) ARE USED ONLY WITH TRAILER



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

BACKUP LIGHTS

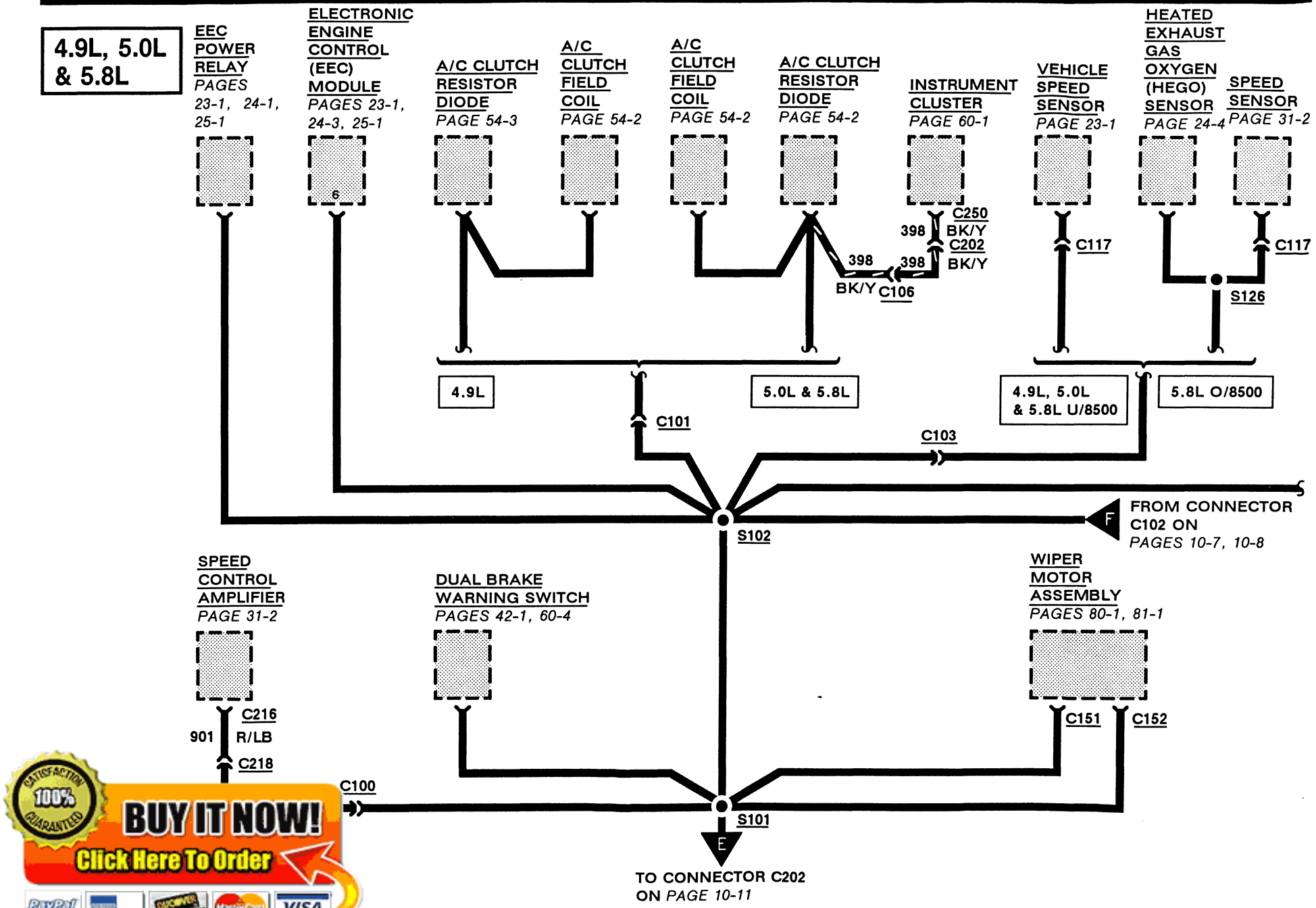
"REFERENCE" WIRES
COMPLETE WIRING SHOWN ON ANOTHER PAGE

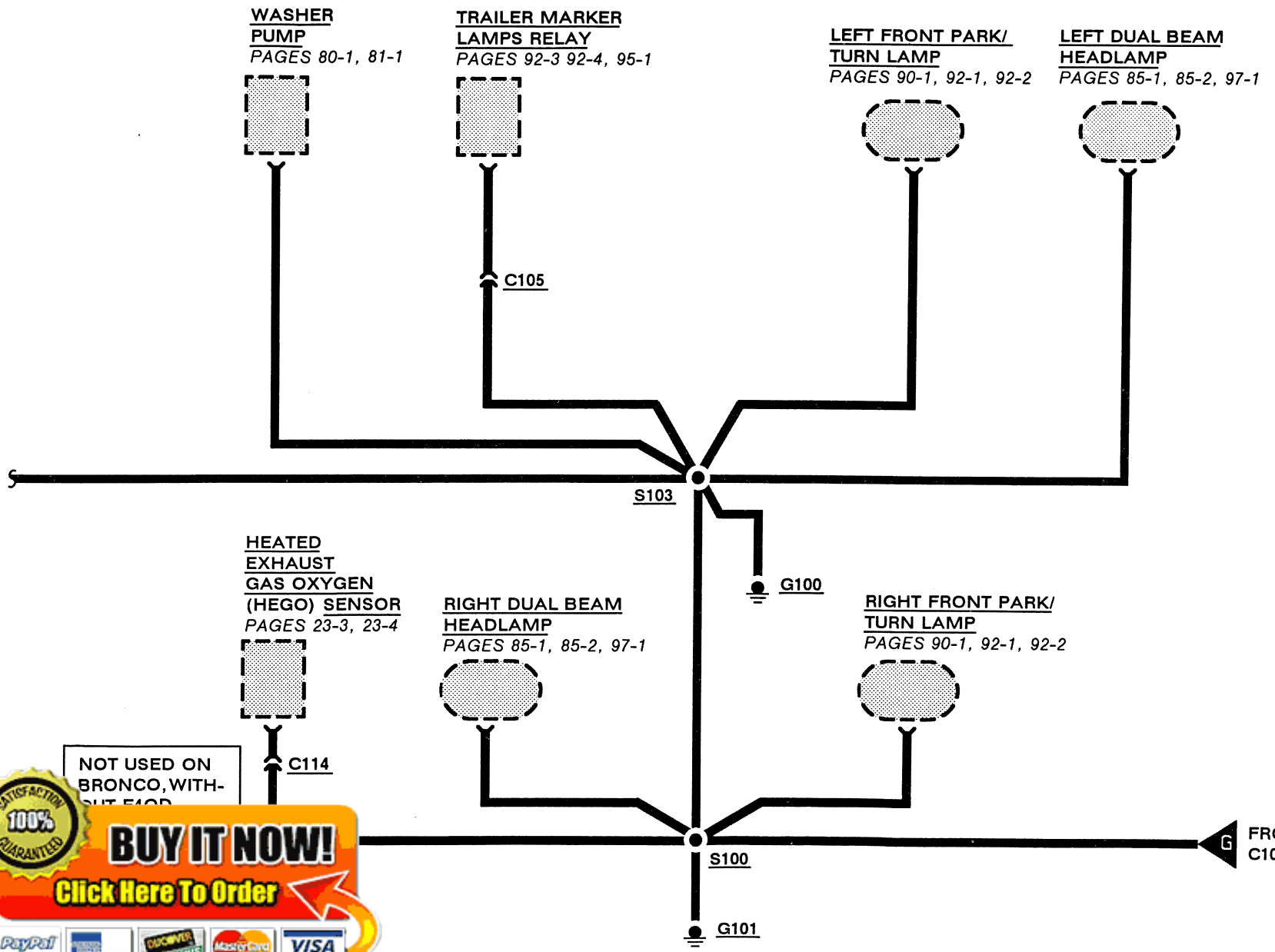
DASHED WIRE
CIRCUITRY IS NOT SHOWN IN COMPLETE DETAIL, BUT IS COMPLETE ON ANOTHER PAGE

SEE GROUNDS
PAGES 10-0, 10-1

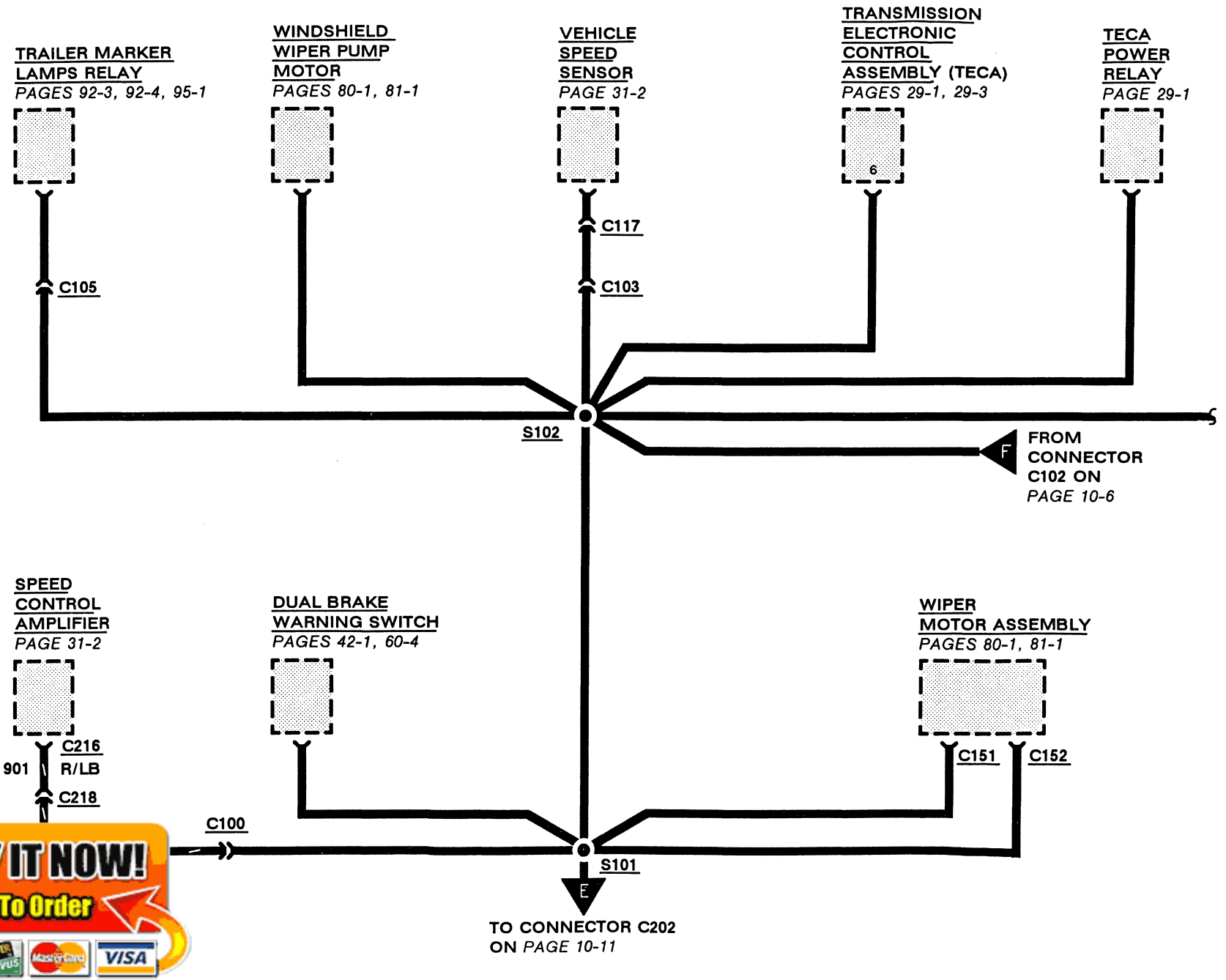
10-1 GROUNDS

4.9L, 5.0L & 5.8L

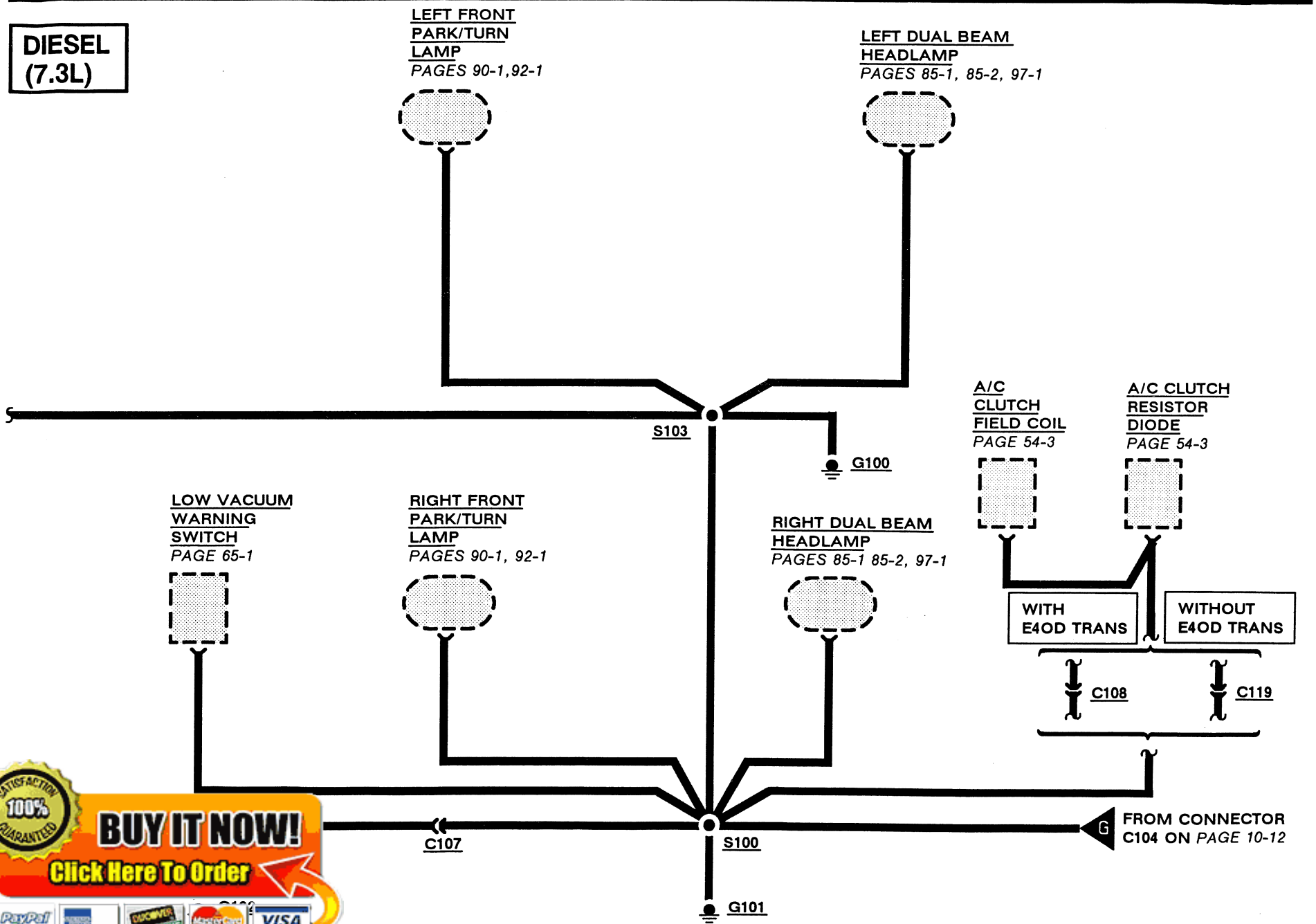




DIESEL (7.3L)

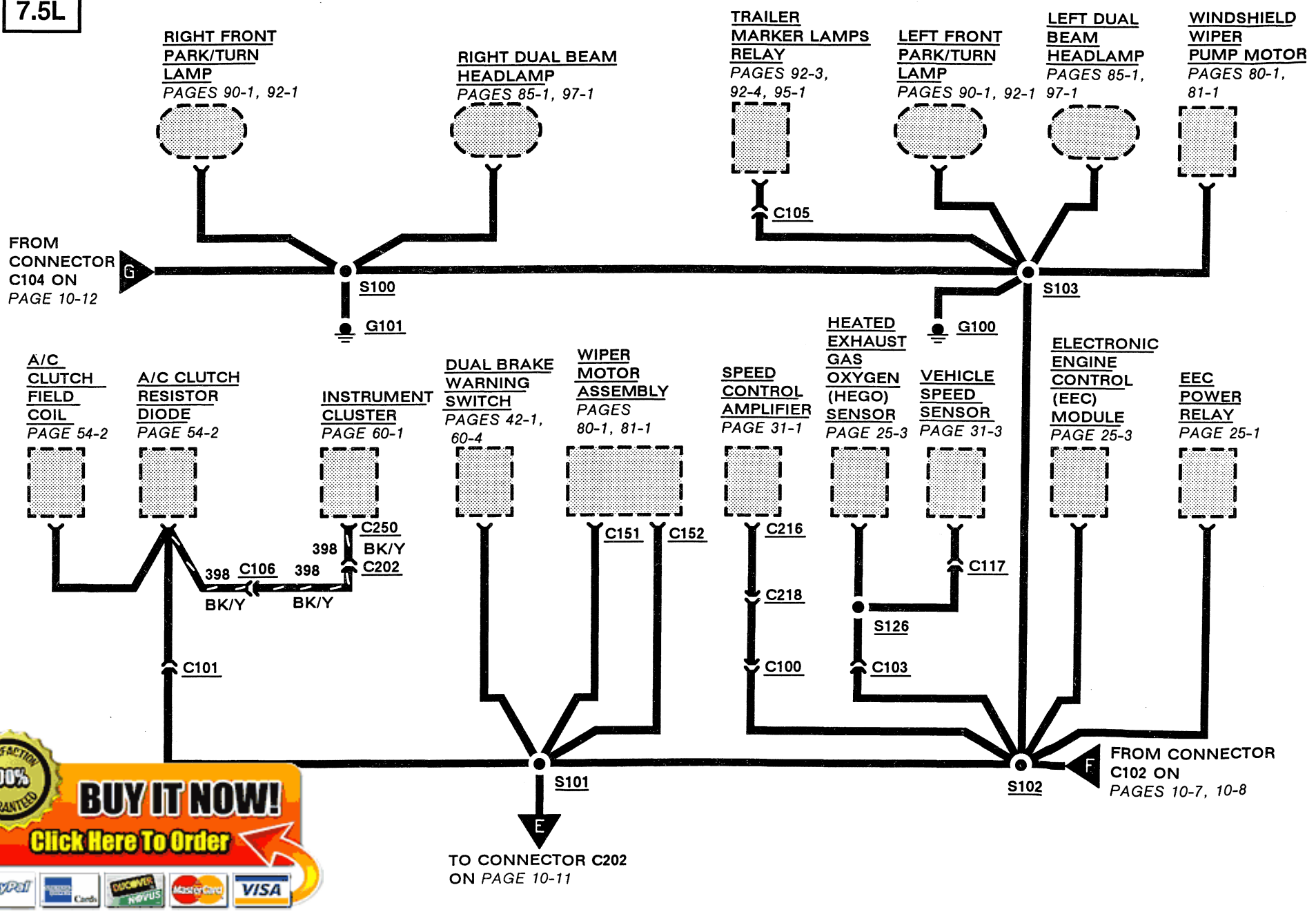


DIESEL (7.3L)



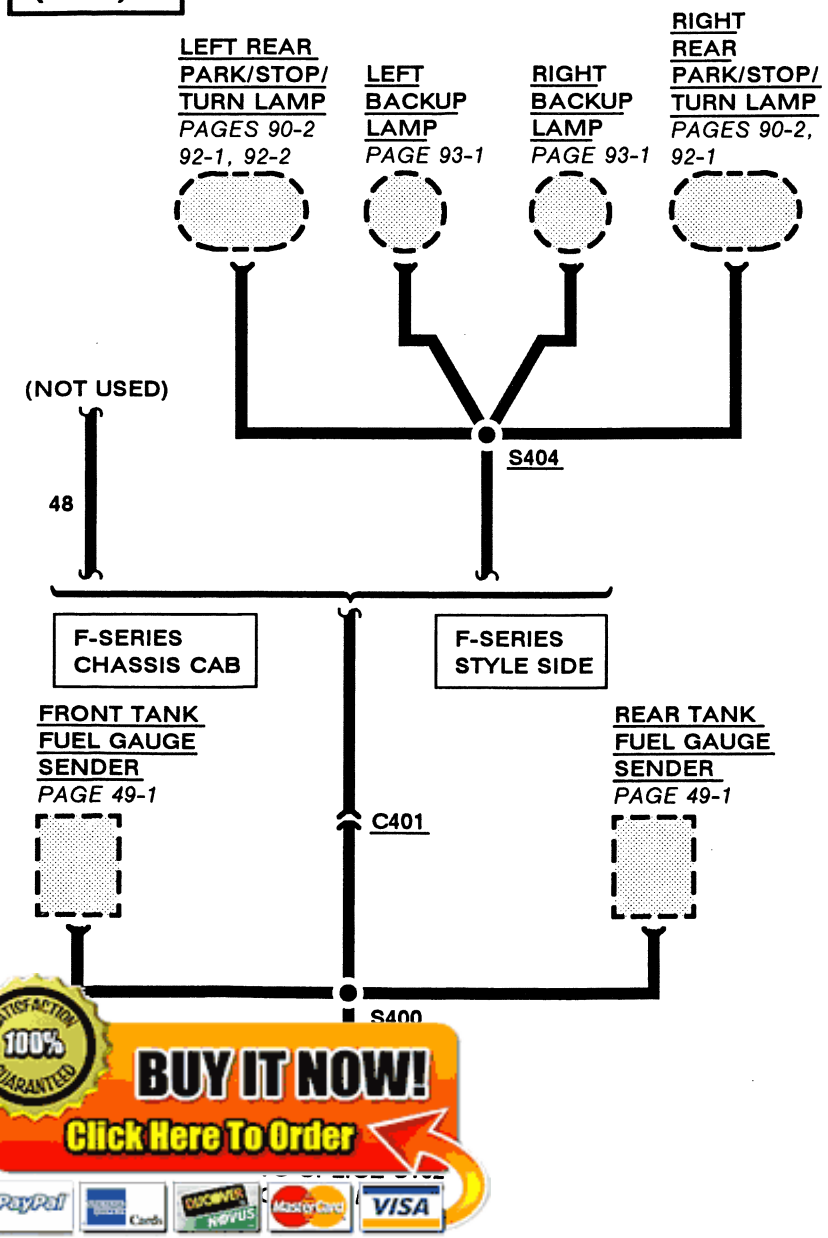
10-5 GROUNDS (G100, G101)

7.5L

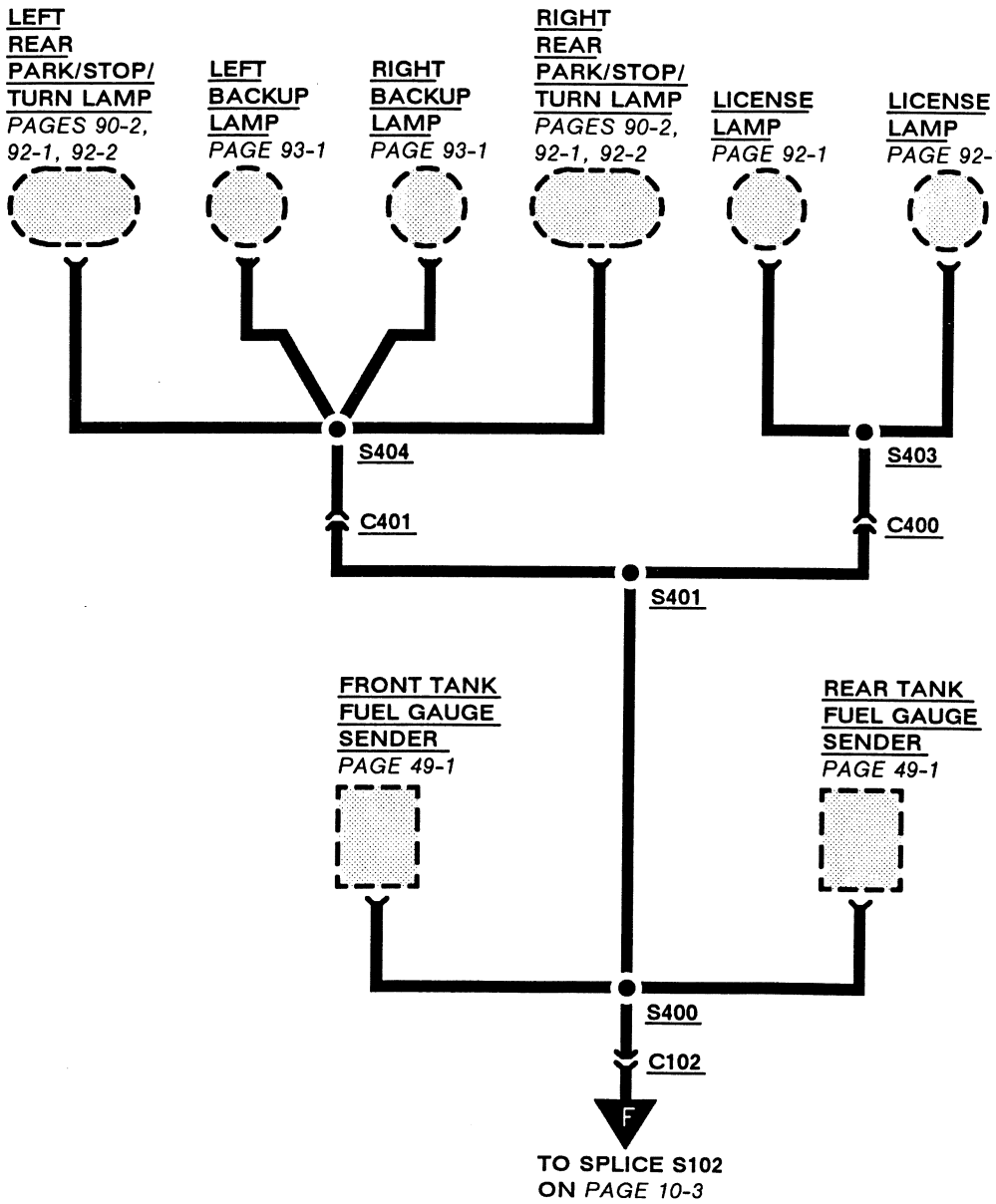


DIESEL (7.3L)

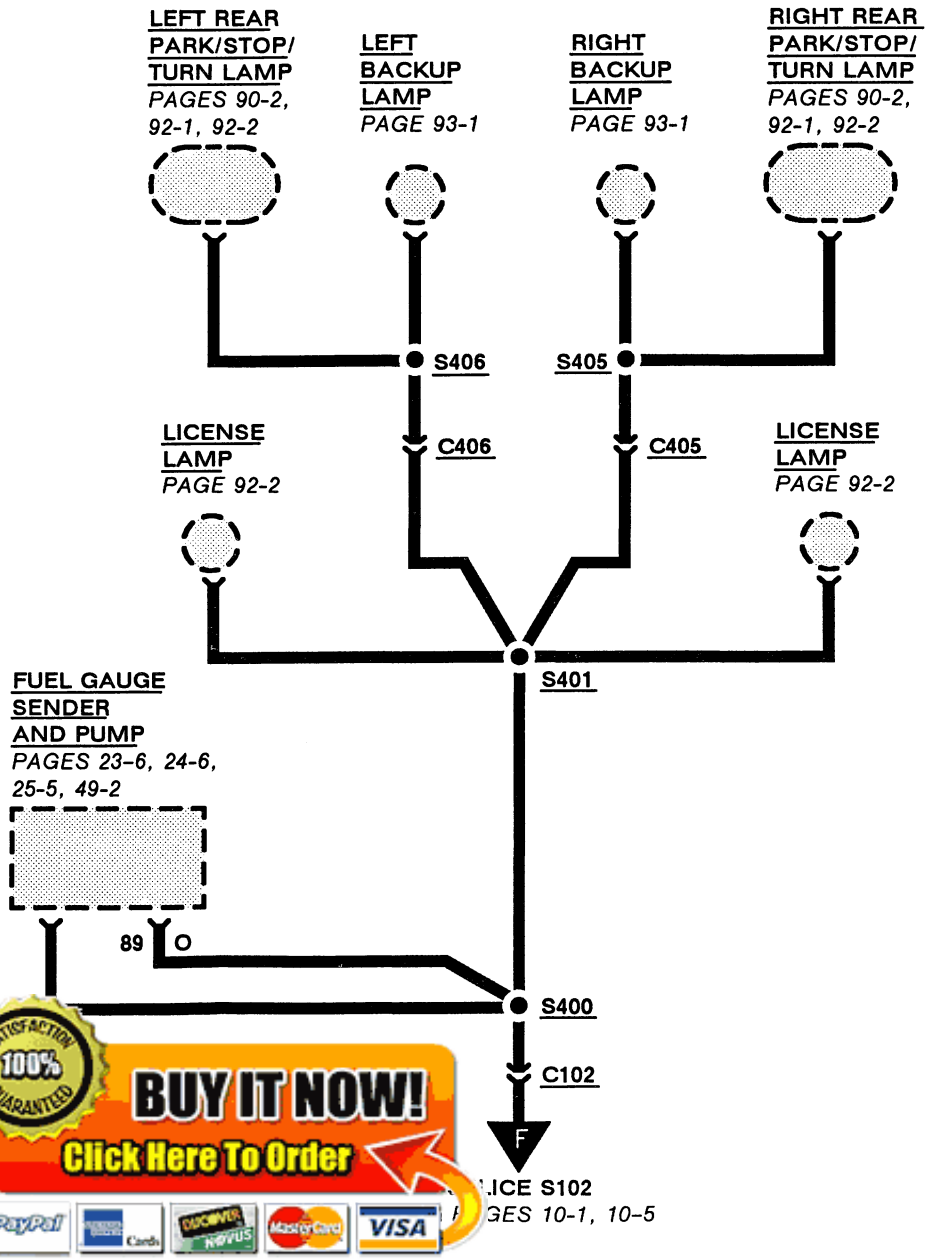
137" + 161" W.B.



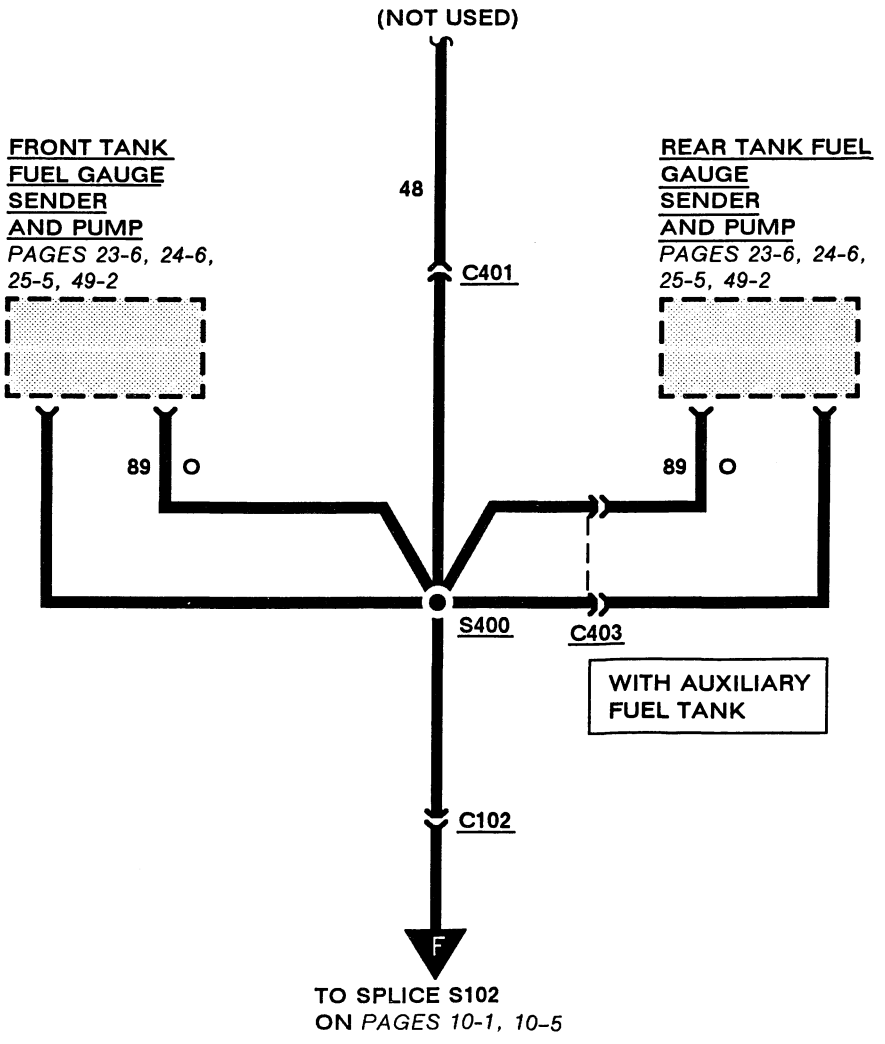
133" + 155" W.B.



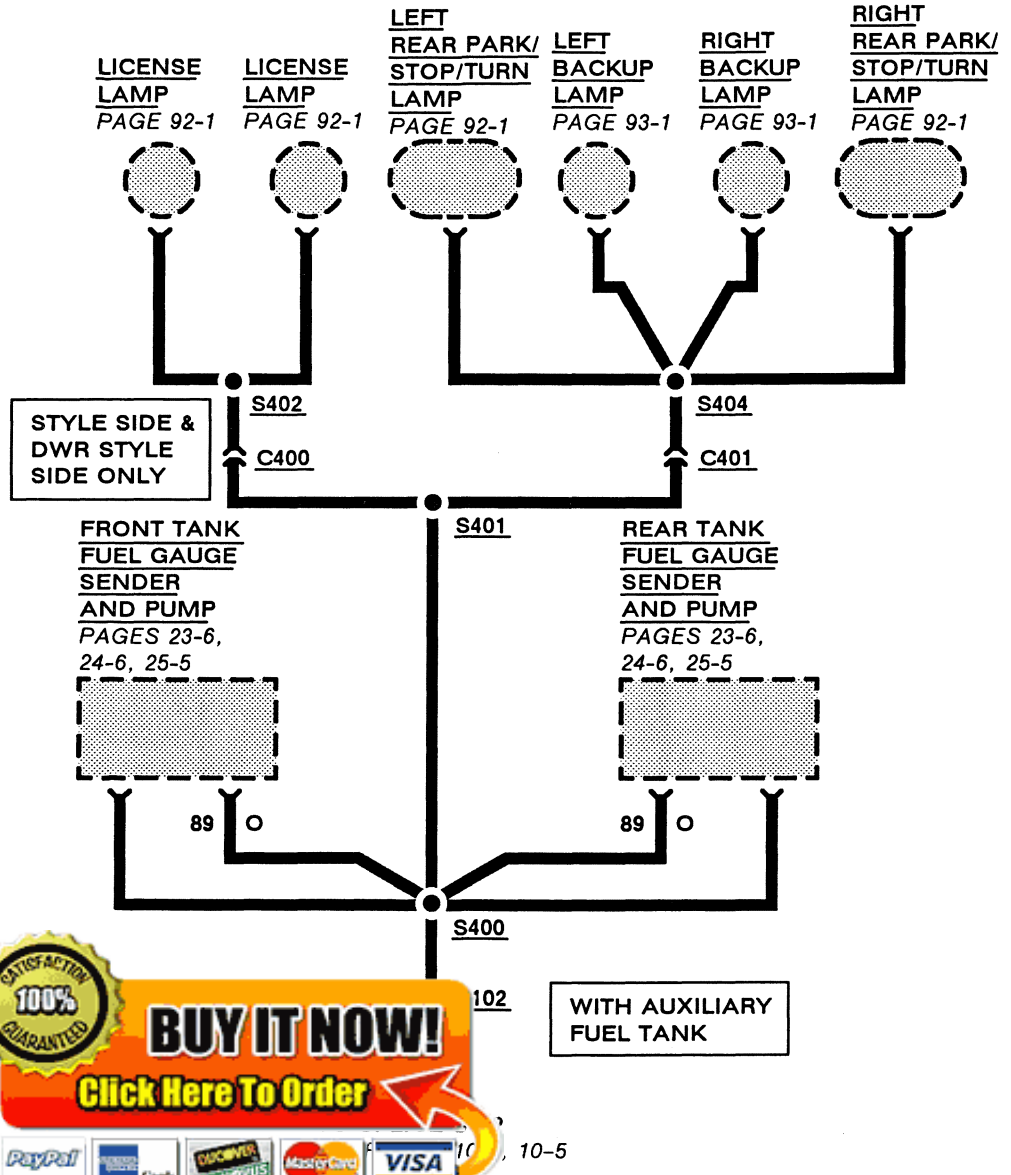
BRONCO



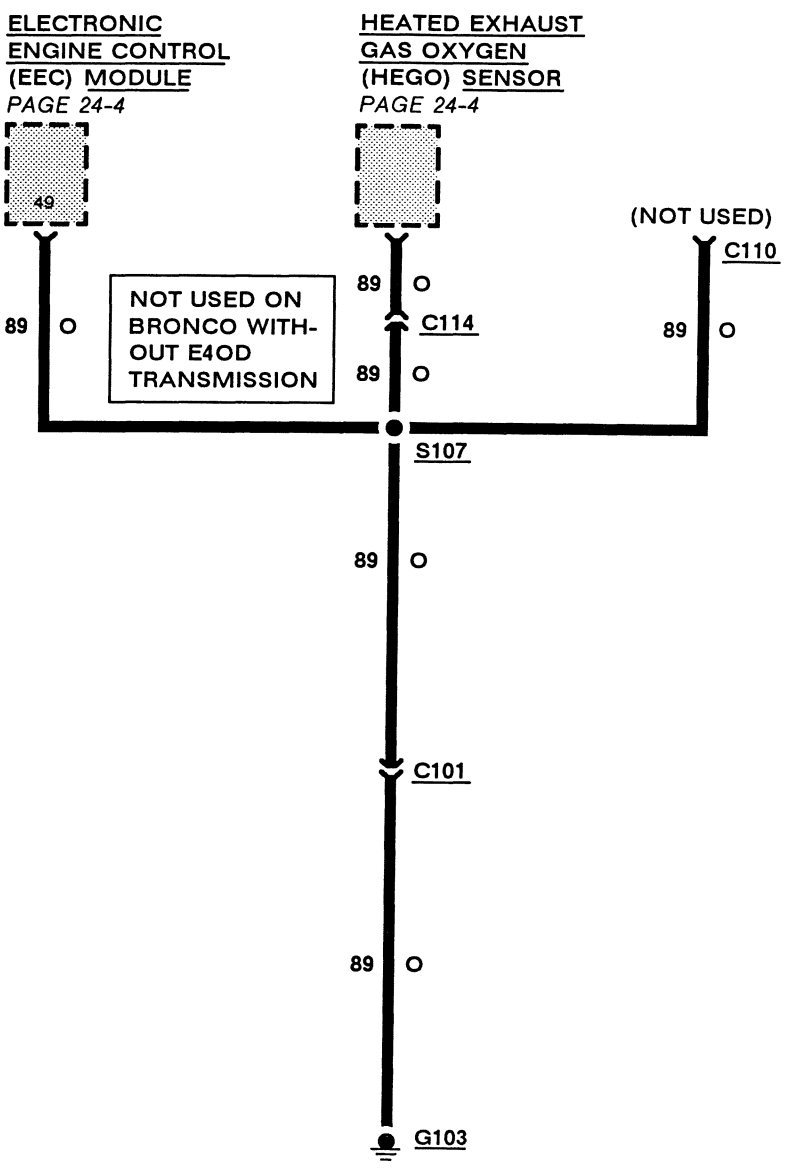
F-SERIES CHASSIS CAB



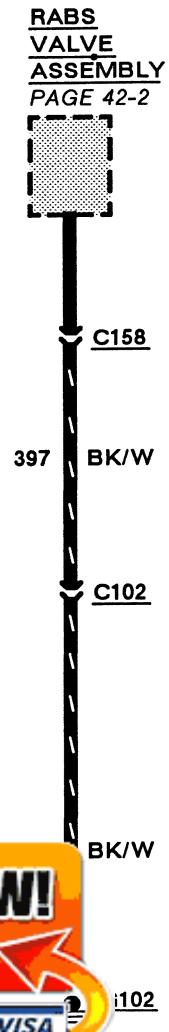
F-SERIES, STYLE SIDE & DWR STYLE SIDE



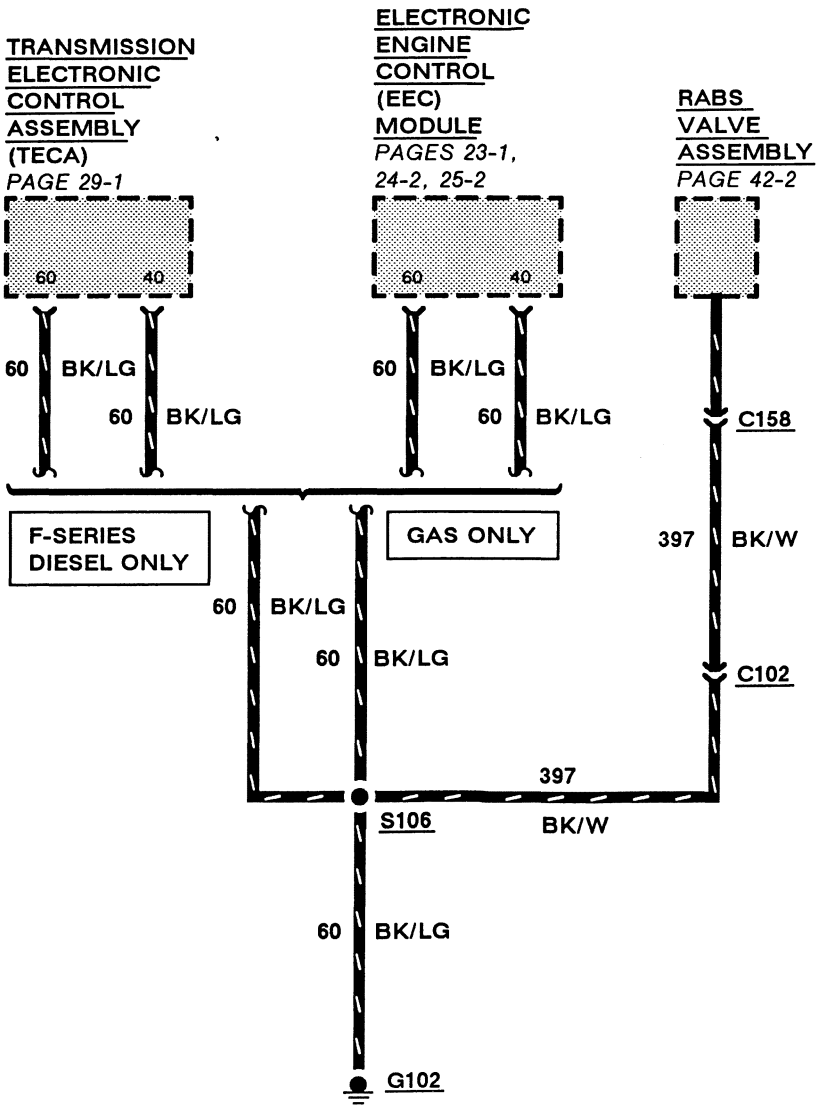
5.0L



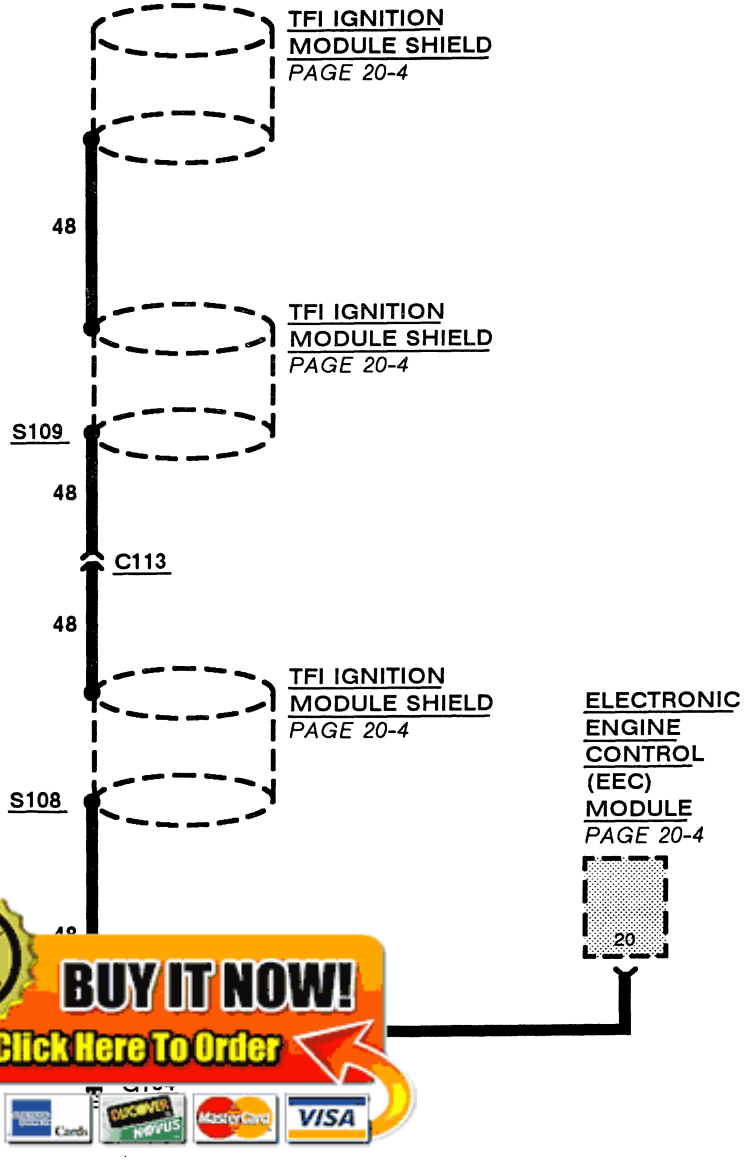
F-SERIES DIESEL WITHOUT E4OD TRANSMISSION



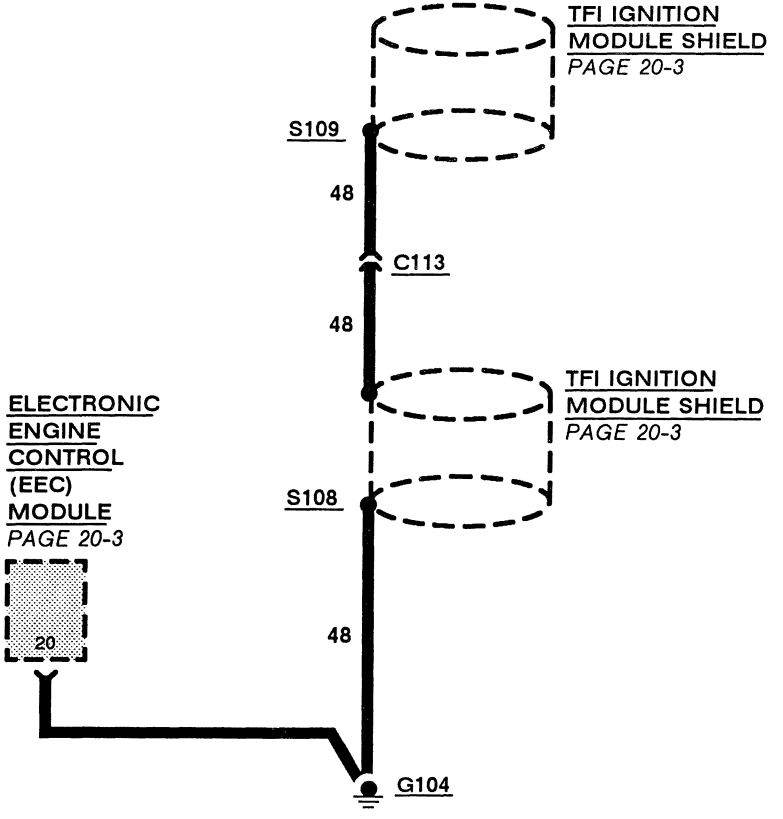
ALL OTHER MODELS

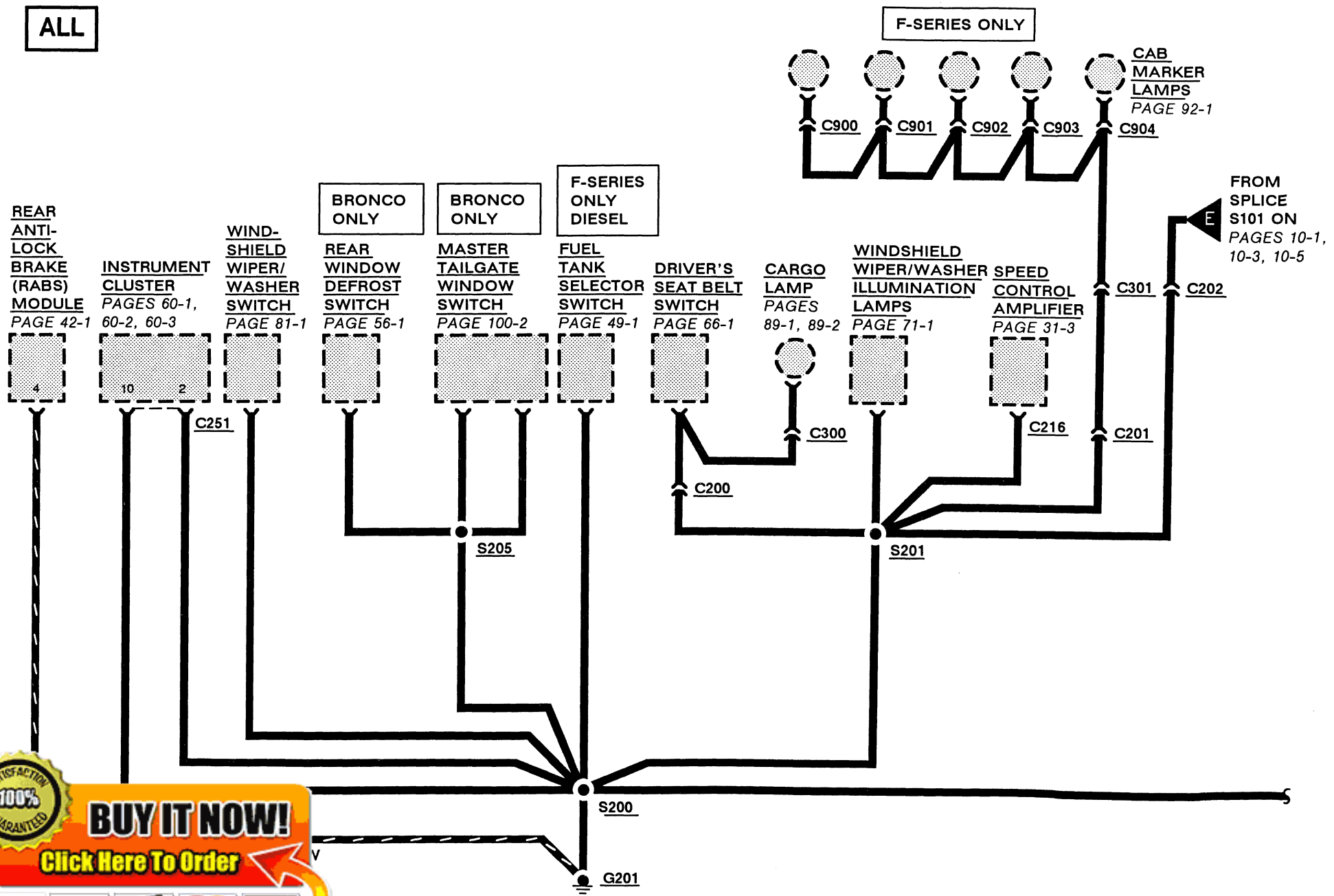


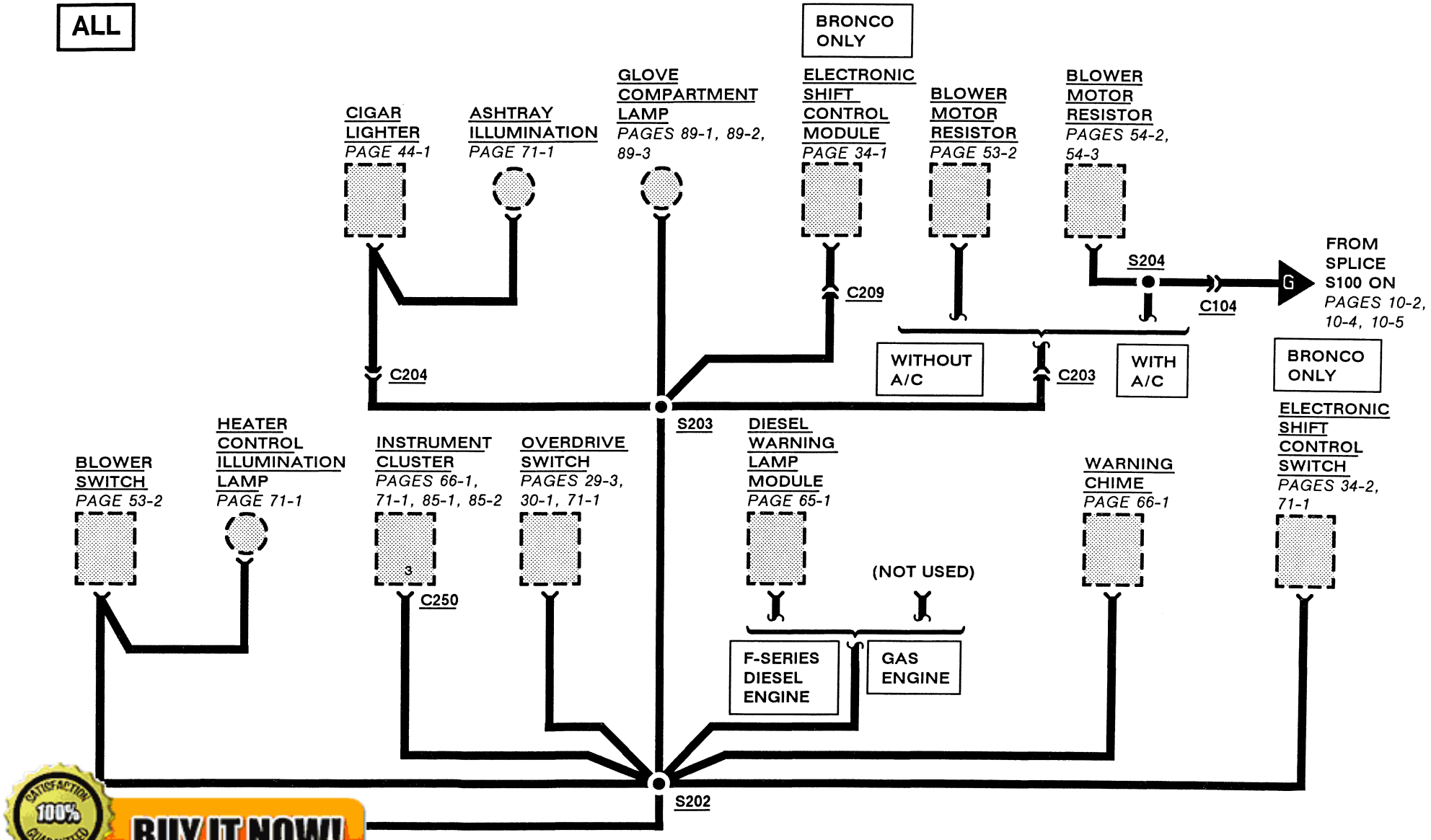
5.0L & 5.8L



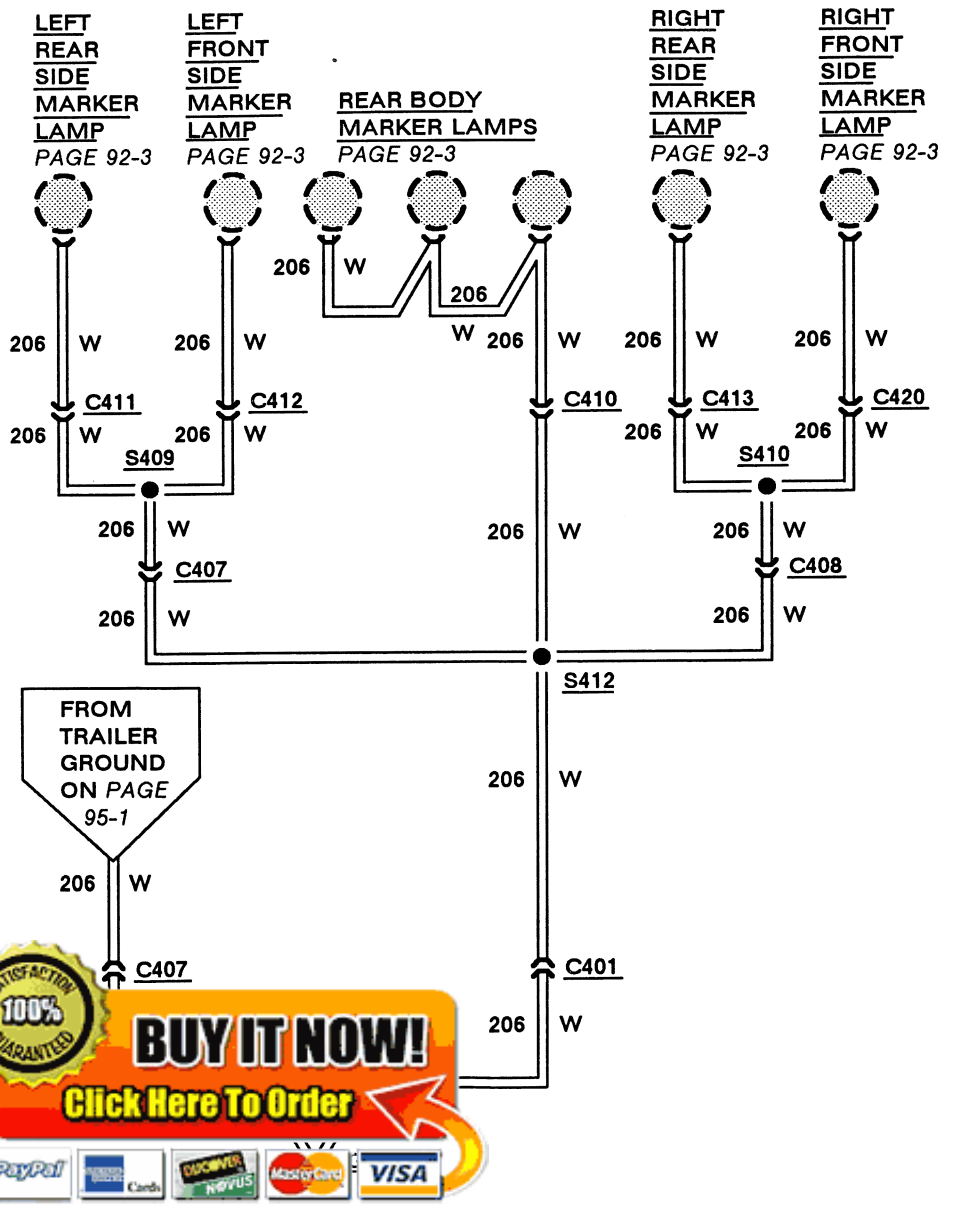
4.9L



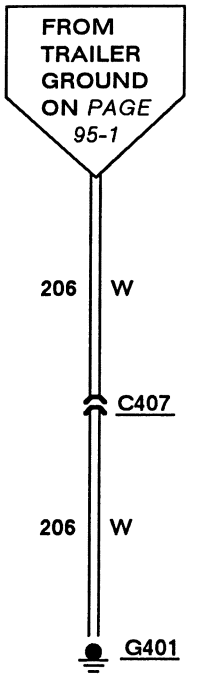




DRW STYLE SIDE



TRAILER TOW LESS DRW STYLE SIDE



HOW THE CIRCUIT WORKS

The ground circuits shown here are complete and connect several components together to screw terminal ground points. Parts of these circuits may be shown on other pages throughout the book. Partial ground circuits are shown dashed on those pages.

All simple or component ground circuits are shown on the individual circuit pages and are complete on those pages.

All wires are 57 BK unless otherwise noted.

Refer to Location Index page 152-1 for Connector, Diode, Resistor, Splice, Ground and Base Part Number descriptions and locations.

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1991 Bronco/F150-F350/F-Super Duty Electrical & Vacuum Trouble-Shooting Manual (EVTM)

EAN: 978-1-60371-414-3
ISBN: 1-60371-414-6

Forel Publishing Company, LLC
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ELECTRICAL AND VACUUM TROUBLESHOOTING MANUAL
ART-12129-91

FORD PARTS and SERVICE DIVISION

Quality is Job 1

Ford Parts and Service Division has developed a new format for the EVTM for the 1991 Thunderbird/Cougar. Our goal is to provide accurate and timely electrical and vacuum service information.

1991 EVTM FEATURES

- **"HOW THE CIRCUIT WORKS"** descriptions that explain how each circuit works. These descriptions are designed to be used in conjunction with the Electrical Schematic.
- **Component Location** information, within each system, that tells where each component is located on the vehicle as well as a reference to a **"COMPONENT LOCATION VIEW."**
- **"COMPONENT TESTING"** procedures (CELL 149) that tell the user how to perform diagnostic tests on various circuits.
- **Connector End Views** (**"COMPONENT CONNECTOR FACES"** CELL 150) are shown for connectors with five or more cavities; and 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.
- **Component Base Part Numbers** and **Harness Base Part Numbers** to aid in ordering parts.
- **Cellular Pagination:** A specific section (or cell) in all EVTMs is numbered by cell and starts with page 1. For example: **"HOW TO FIND ELECTRICAL CONCERNS"** is CELL 5 and begins with page 5-1.

igned for all electrical connectors. **"C"** numbers are listed are listed in numerical order in the **"LOCATION INDEX"**

" – A feedback sheet is provided on the last page.

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:

- Shop Manuals
- Service Specification Books
- Car/Truck Wiring Diagrams
- Engine/Emissions Diagnosis Manuals

Helm Incorporated
P.O. Box 87150
Detroit, Michigan 48207

1-1 TABLE OF CONTENTS/INDEX

Table Of Contents

Index

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 make troubleshooting easier by showing the electrical and vacuum circuits of these vehicles in a clear and simple fashion. With each circuit is a description of *How the Circuit Works* and some *Troubleshooting Hints*. A Component Location chart lists components and references to pictures in the manual.

Notes, Cautions and Warnings containing important information appear in boxes on text pages. Notes provide additional information to help complete a particular procedure. Cautions provide information that could prevent making an error that could damage the vehicle. Warnings provide information to prevent personal injury. The warnings list on the following page contains general warnings to follow when working on a vehicle.

Components which work together are shown together. For example, all electrical components used in any circuit are shown on one diagram. The circuit breaker or fuse is shown at the top of the page. All wires, connectors, splices, switches, and motors are shown in the flow of current to ground at the bottom of the page. Notes are included which describe how switches and other components work. If a component is used in several different circuits, it is shown in several places.

For example, the Main Light Switch is an electrical part of many circuits and is repeated on many pages. In some cases, however, a component may seem (by its name) to belong ge where it has no electrical connec- electri- ut, be- all with on the

Troubleshooting Hints point the technician in a general direction, but are not intended as a step-by-step procedure. Ignition troubleshooting is an exception to this. It includes a step-by-step procedure of basic quick checks to locate some of the more common Ignition System problems. Reading the shop manual provides more detailed repair procedures.

Connector end views of switches and other components are shown in Cell 149 (beginning on page 149-1) to help with bench testing. The views show the harness wire colors that connect to the mating terminals. Connector colors and locations are shown in the *Location Index* chart. Two-color listings indicate separate colors for each connector half.

A Location Index, in Cell 152 (beginning on page 152-1), identifies individual components, connectors and splices. This index describes the component, connector or splice location and directs you to the component illustrations. In addition, the component base part number has been included for your convenience in ordering parts. A list of harness base numbers, harness names and major systems associated with the respective harness base part number is also included within the Location Index.

The Grounds pages show detailed views of multiple component ground points. This is useful for checking interconnections among the ground circuits of different diagrams.

Component Connectors with 5 or more cavities are shown in Cell 150 (beginning on page 150-1) to help with system troubleshooting. Any component connector with 5-9 cavities will be shown with a connector end view of the connector. A component with 10 or more connector cavities will have a pinout chart in addition to the connector face. The pinout chart contains information such as cavity number, wire number and color, and circuit function.

On some car lines, resistors and diodes are covered with PVC molds; terminals are also part of the molded assembly. The assembly plugs into a harness connector and is taped to the harness, outside the conduit.

In other cases, the resistor and diode assemblies will be covered with heat-shrinkable tubing, making the assembly small enough to be placed within the harness conduit.

The wiring diagrams show the number of times the resistors and diodes are used. The wiring diagrams also show the distance from connector/length of wire in exact centimeters. Resistors and diodes are identified on the wiring diagrams by the following base part numbers:

Resistor/diode assembly	14A601
Diode only	14A604

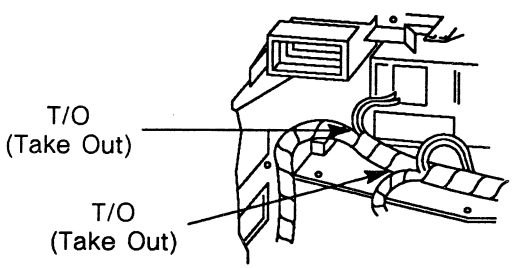
We welcome any comments you may have regarding this EVTM. Use the Feedback Sheet at the back of this manual to submit comments. The information submitted on this sheet will improve future editions.

3-1 HELPFUL REMINDERS

Before using the EVTM for troubleshooting, refer to the HELPFUL REMINDERS described on this page.

1. The abbreviation T/O, for take out, used in the Component Location Chart, refers to the point at which a harness branches to feed a component. 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.

3. Wiring diagrams provide a schematic 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**
GR	**Green**	**T**	**Tan**
GY	**Gray**	**W**	**White**
LB	**Light Blue**	**Y**	**Yellow**
LG	**Light Green**		

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.

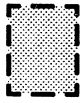
4. When reporting Vehicle Repair Location Codes to Ford Parts and Service Division, refer to Cell 160 (beginning on page 160-1).

   Note: Do *not* use the illustrations in Cell 151 (beginning on page 151-1) for reporting Vehicle Repair Location Codes.

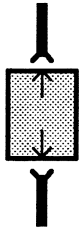
5. **WARNINGS**

- *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 park 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 when the engine is running, especially the fan and belts.*
- *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.*

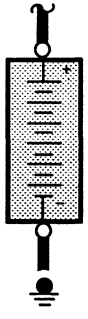
4-1 ELECTRICAL SYMBOLS



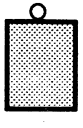
DASHED COMPONENT BOX
ONLY PART OF THE COMPONENT IS SHOWN ON THE PAGE; THE COMPONENT IS SHOWN COMPLETE IN ANOTHER LOCATION



COMPONENT WITH CONNECTORS



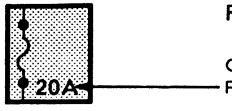
BATTERY



SCREW TERMINAL ON COMPONENT

SOLID STATE

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

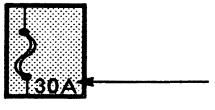


FUSE

CURRENT RATING

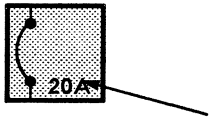
FUSIBLE LINK

WIRE SIZE AND COLOR



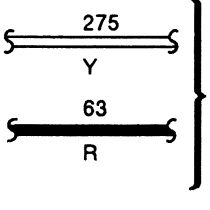
FUSIBLE LINK CARTRIDGE

CARTRIDGE CURRENT RATING

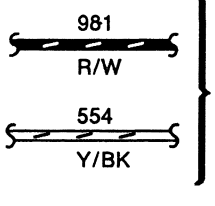


CIRCUIT BREAKER

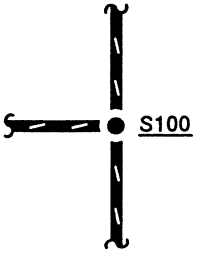
CURRENT RATING



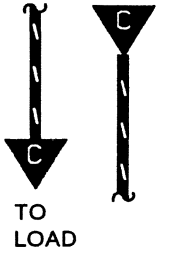
SOLID WIRES



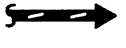
STRIPED WIRES



SPLICE OR CRIMP TERMINAL

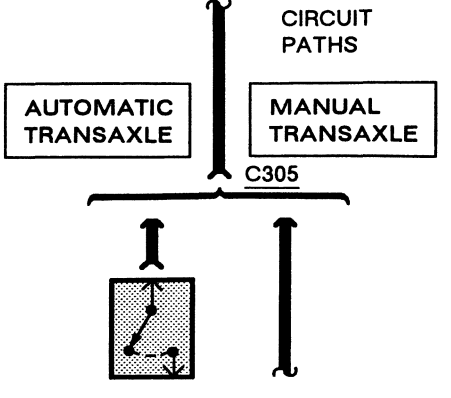


"CUT" WIRES REFERENCED BETWEEN PAGES
ARROWS SHOW CURRENT FLOW FROM POWER TO GROUND

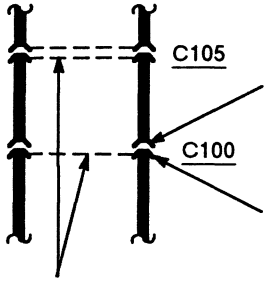


BACKUP LIGHTS

"REFERENCE" WIRES
COMPLETE WIRING SHOWN ON ANOTHER PAGE



ALTERNATE CIRCUIT PATHS



SOCKET

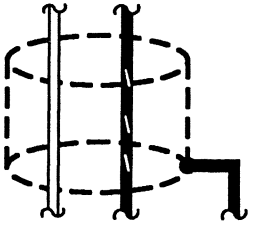
IN-LINE CONNECTOR

PIN OR BLADE

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

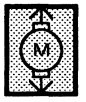
DASHED WIRE
CIRCUITRY IS NOT SHOWN IN COMPLETE DETAIL, BUT IS COMPLETE ON ANOTHER PAGE

SEE GROUNDS
PAGES 10-1, 10-2

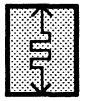


SHIELD
WIRES ARE COVERED BY A SHIELD

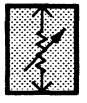
FIELD COIL



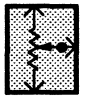
MOTOR



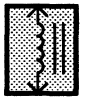
HEATING ELEMENT



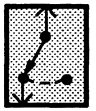
THERMISTOR



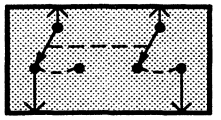
RHEOSTAT OR POTENTIOMETER



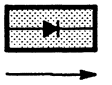
SOLENOID



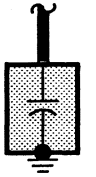
SWITCH



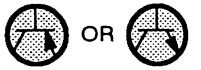
GANGED SWITCHES
CONTACTS MOVE AT THE SAME TIME



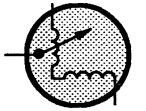
DIODES
CURRENT FLOWS IN DIRECTION OF ARROW ONLY



CAPACITOR

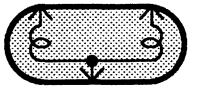


TRANSISTOR

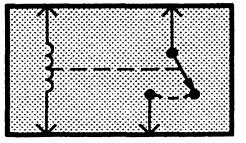


GAUGE

LIGHT BULB



DUAL FILAMENT LIGHT BULB



RELAY
CONTACTS CHANGE POSITION WITH CURRENT THROUGH COIL

5-1 HOW TO FIND THE ELECTRICAL CONCERN

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 *How the Circuit Works* and study the wiring diagram. You should then know enough about the circuit operation to determine where to check for the trouble. Further information can be found in the shop manual pages listed after *How the Circuit Works.*

Step 3. Test the cause.

- Use electrical test procedures to find the specific cause of the symptoms.
- *Troubleshooting Hints* will give you helpful ideas.
- The *Component Location Charts* and the pictures will help you find components. Following each chart, there is a reference to the Location Index at the end of the manual. This index gives component location information for connectors, diodes, resistors, splices and grounds.

Step 4. Verify the cause.

- Confirm that you have found the correct [illegible]use by connecting jumper wires and/or [illegible]od com-

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 *shop manual* and other service books for details. You will find these circuits in this manual to be helpful with these special tests.

TROUBLESHOOTING TOOLS

JUMPER WIRE

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

WARNING

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

VOLTMETER

A DC Voltmeter measures circuit voltage. Connect negative (- or black) lead to ground, and positive (+ or red) lead to voltage measuring point.

OHMMETER

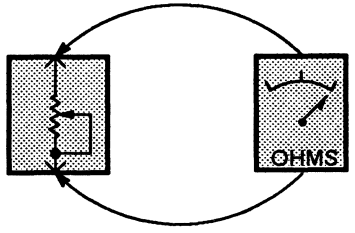


Figure 1–Resistance Check

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

TEST LAMP

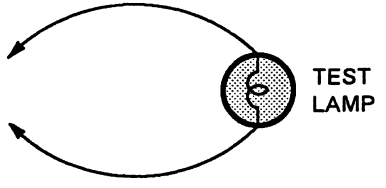


Figure 2–Test Lamp

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

Uses: Voltage Check, Short Check.

SELF-POWERED TEST LAMP

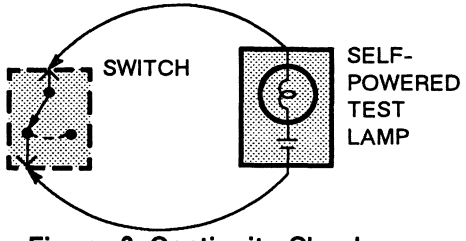


Figure 3–Continuity Check

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.

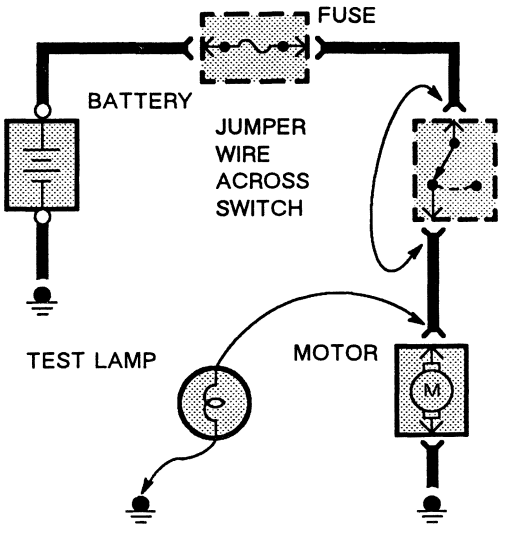


Figure 4—Switch Circuit Check and Voltage Check

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).

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).

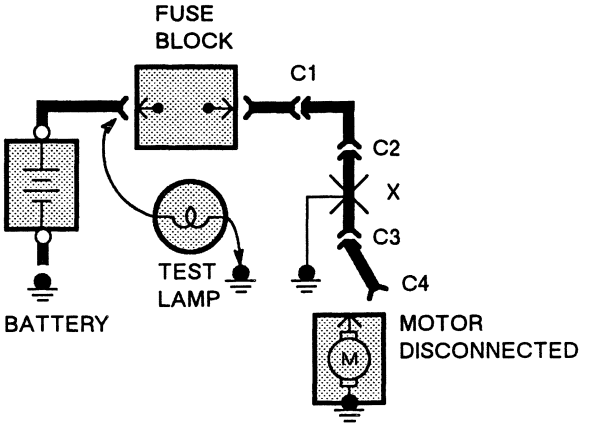


Figure 5—Short Check

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

1. Turn off everything powered through the fuse.
2. Disconnect other loads powered through the fuse:
   - Motors: disconnect motor connector (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 stays on when C1 or C2 is disconnected, but goes out after disconnecting C3. This means the short is between C2 and C3.

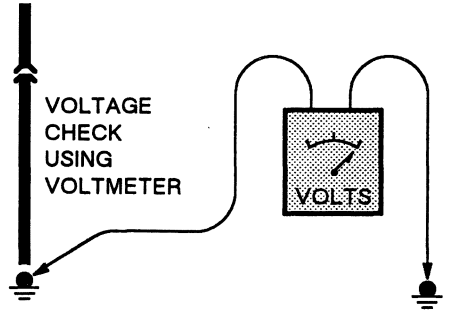


Figure 6—Ground Check

Turn on power to the circuit. Perform a Voltage Check between the suspected inoperative ground and the frame. Any indicated [illegible] means that the ground is inoperative

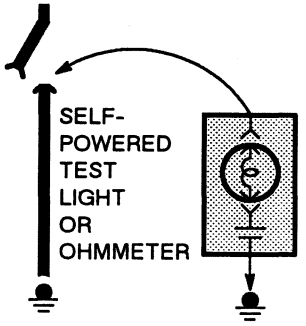


Figure 7—Ground Check

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 7).

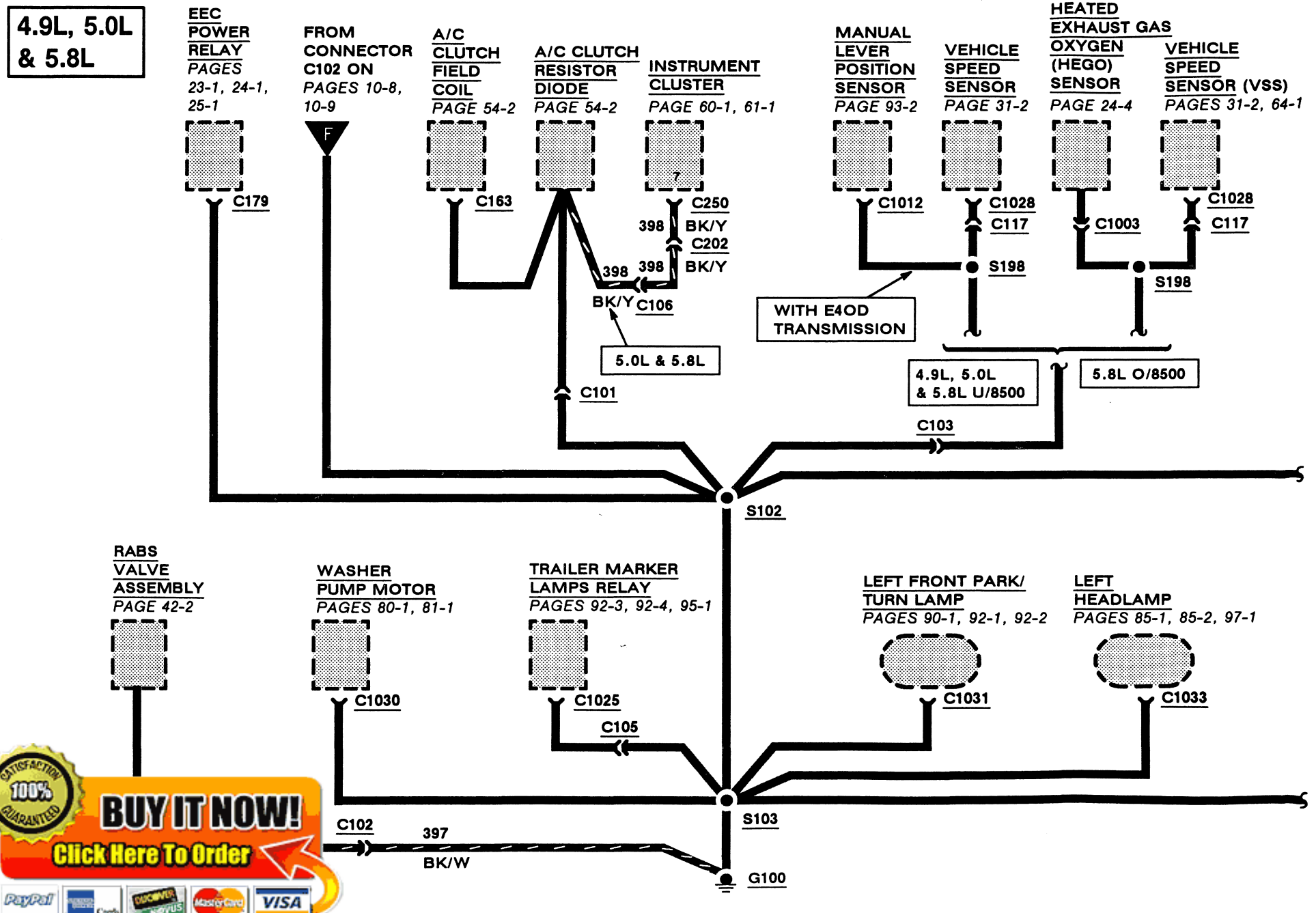
TROUBLESHOOTING HINTS

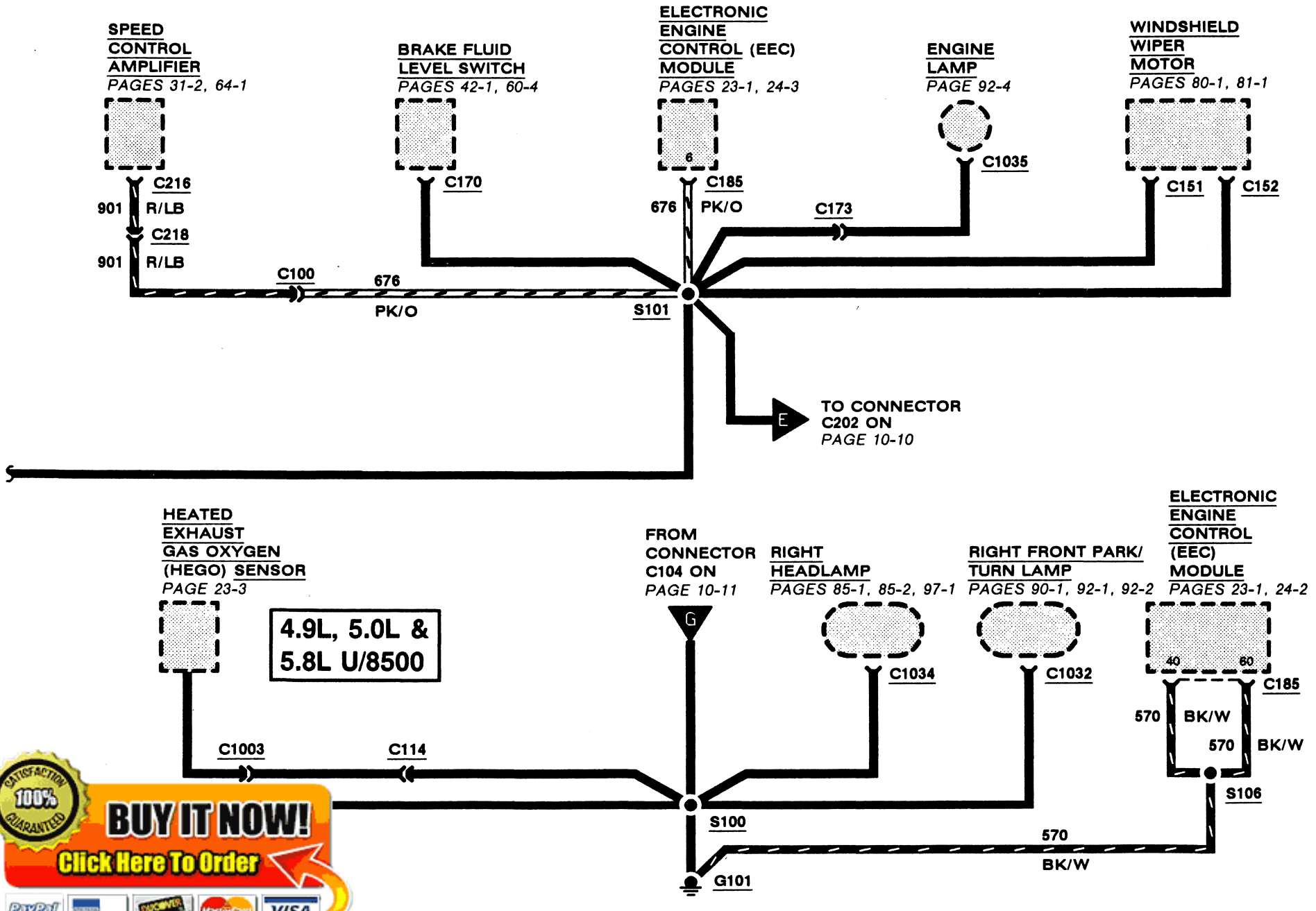
The circuit schematics in this manual make it easy to identify common points in circuits. This knowledge can help narrow the concern to a specific area. For example, if several circuits fail at the same time, check for a common power or ground connection (See *Power Distribution* or *Grounds*). If part 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 hi 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.

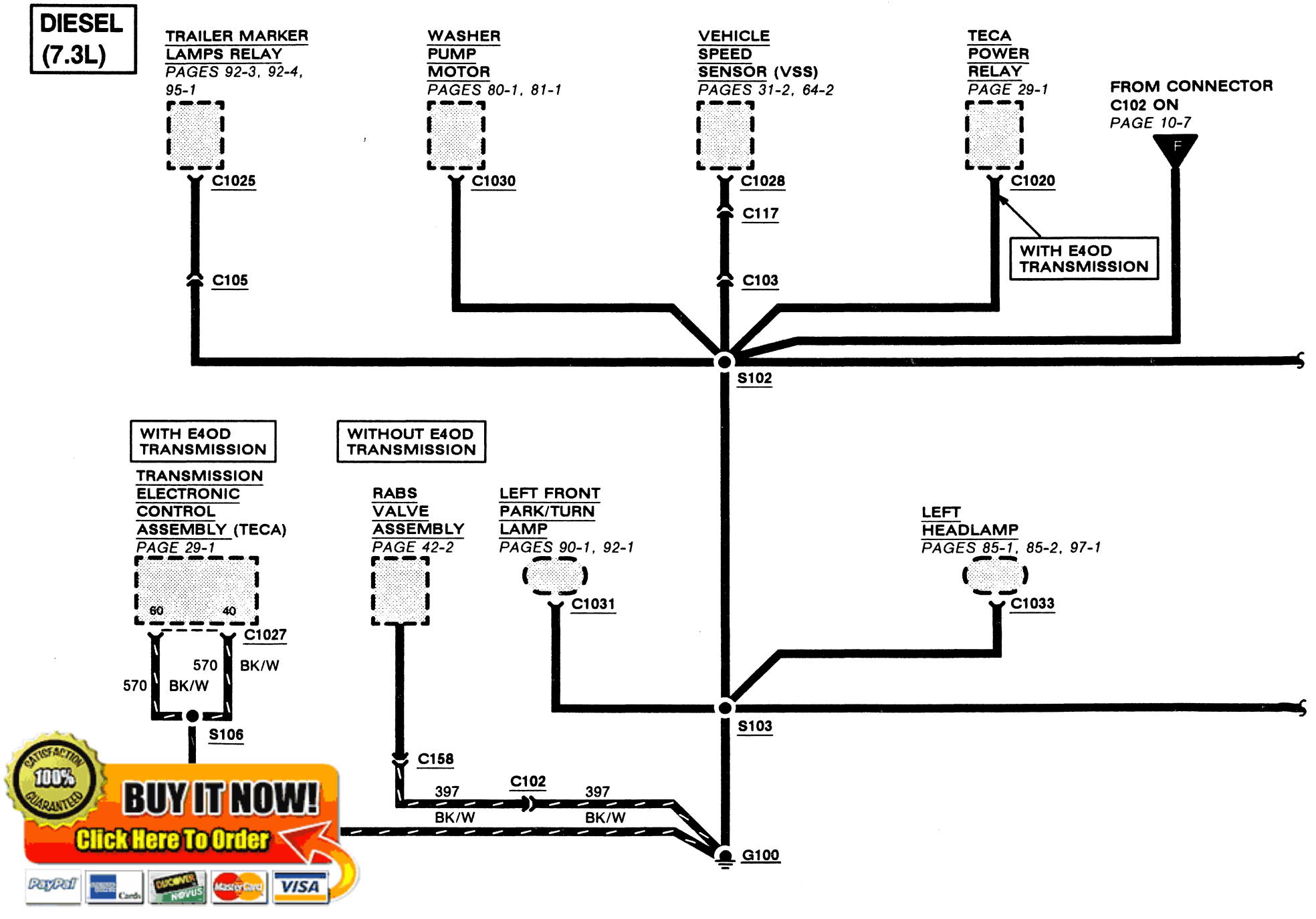
Troubleshooting Hints unique to a particular circuit are given in a new, three column format. Included in the charts are conditions that may develop, possible causes, and one or more tests that can be done quickly to determine the cause of the condition.

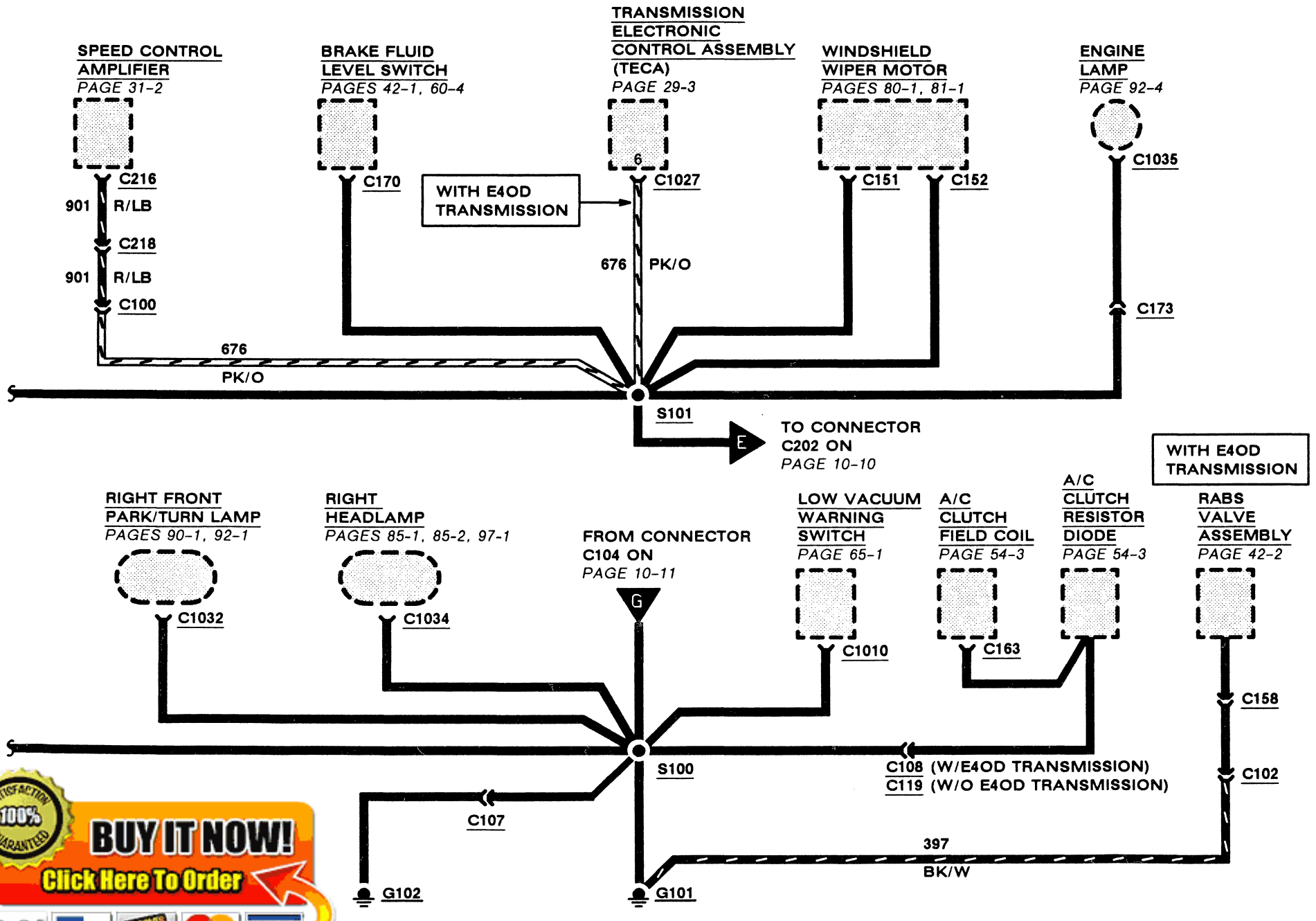
10-1 GROUNDS (G100, G101)





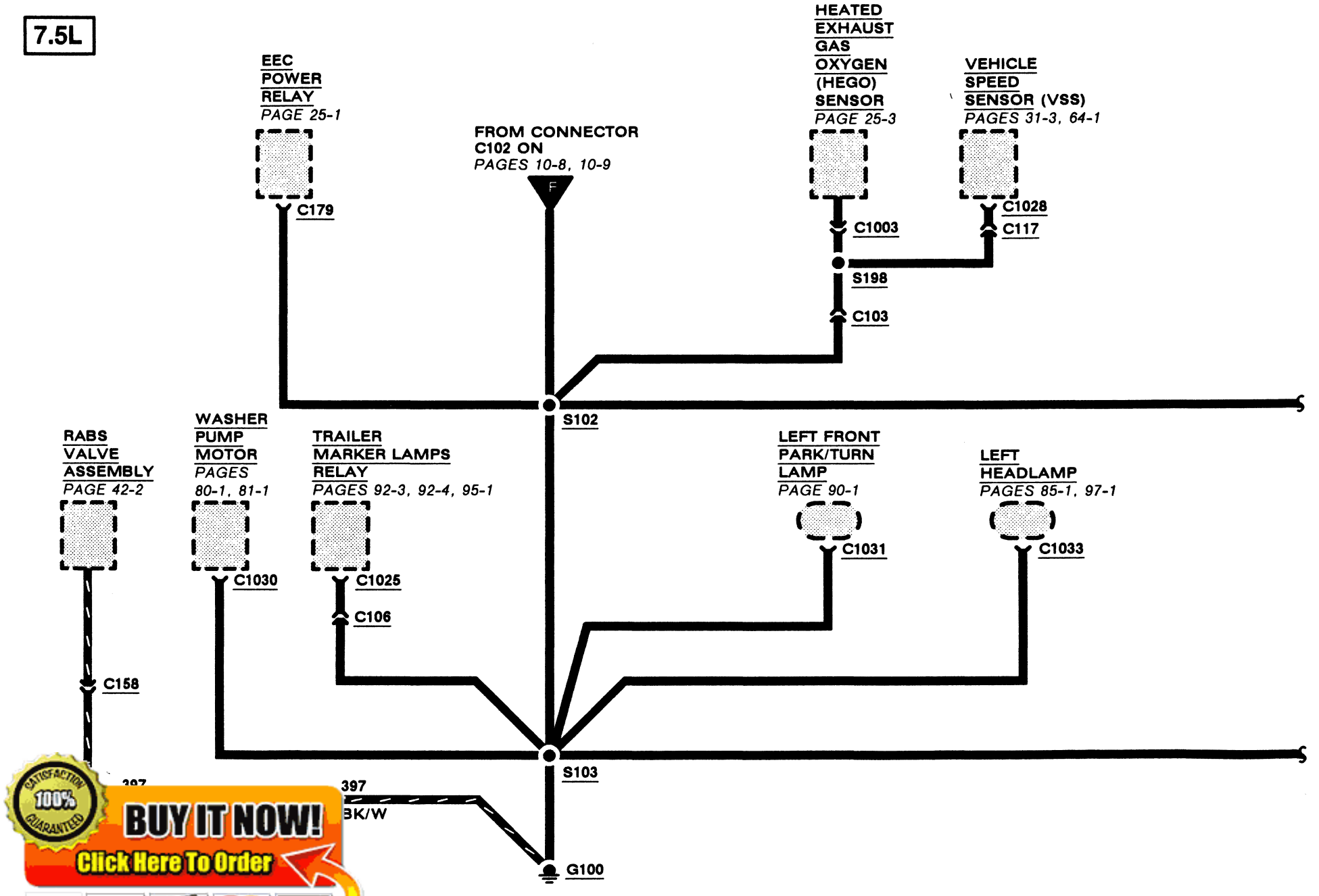
10-3 GROUNDS (G100, G101, G102)



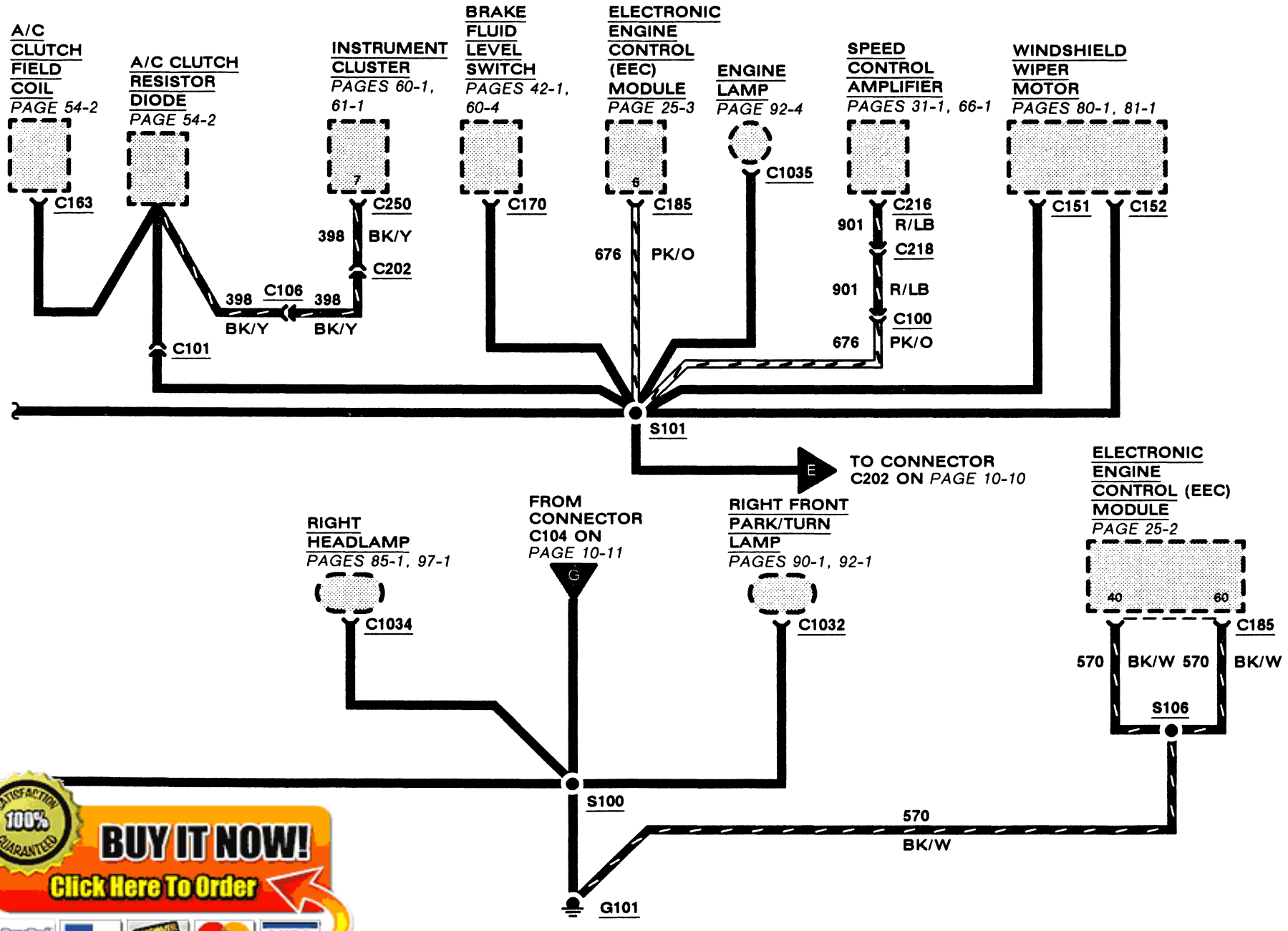


10-5 GROUNDS (G100, G101)

7.5L

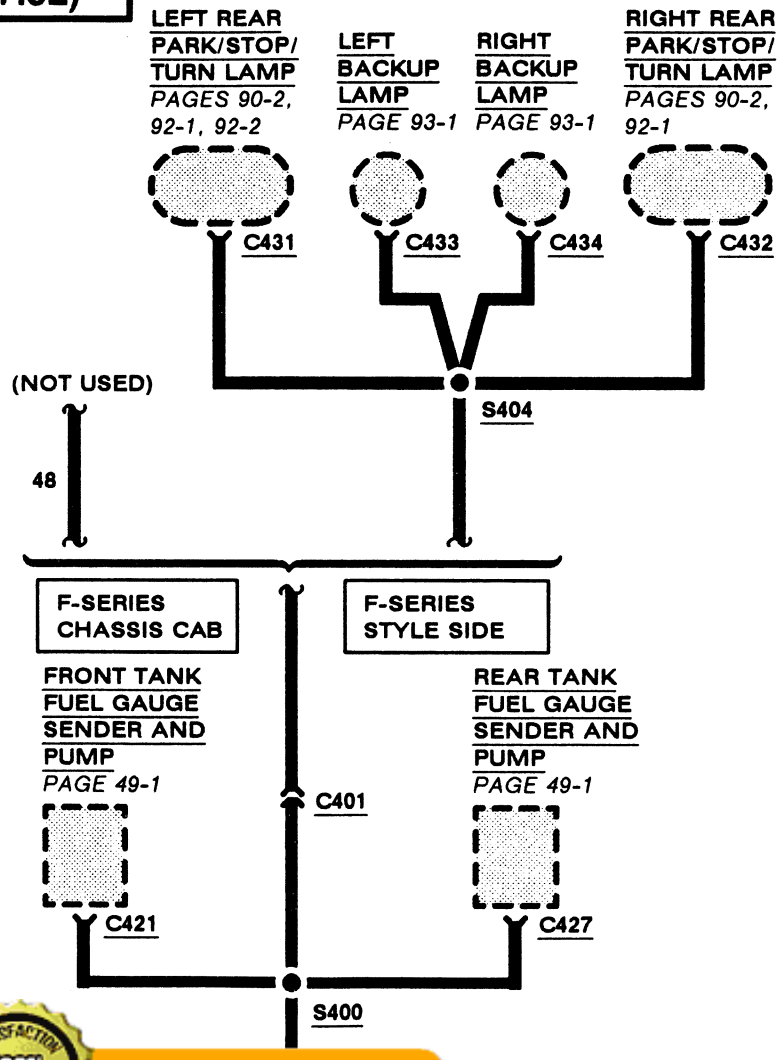


7.5L



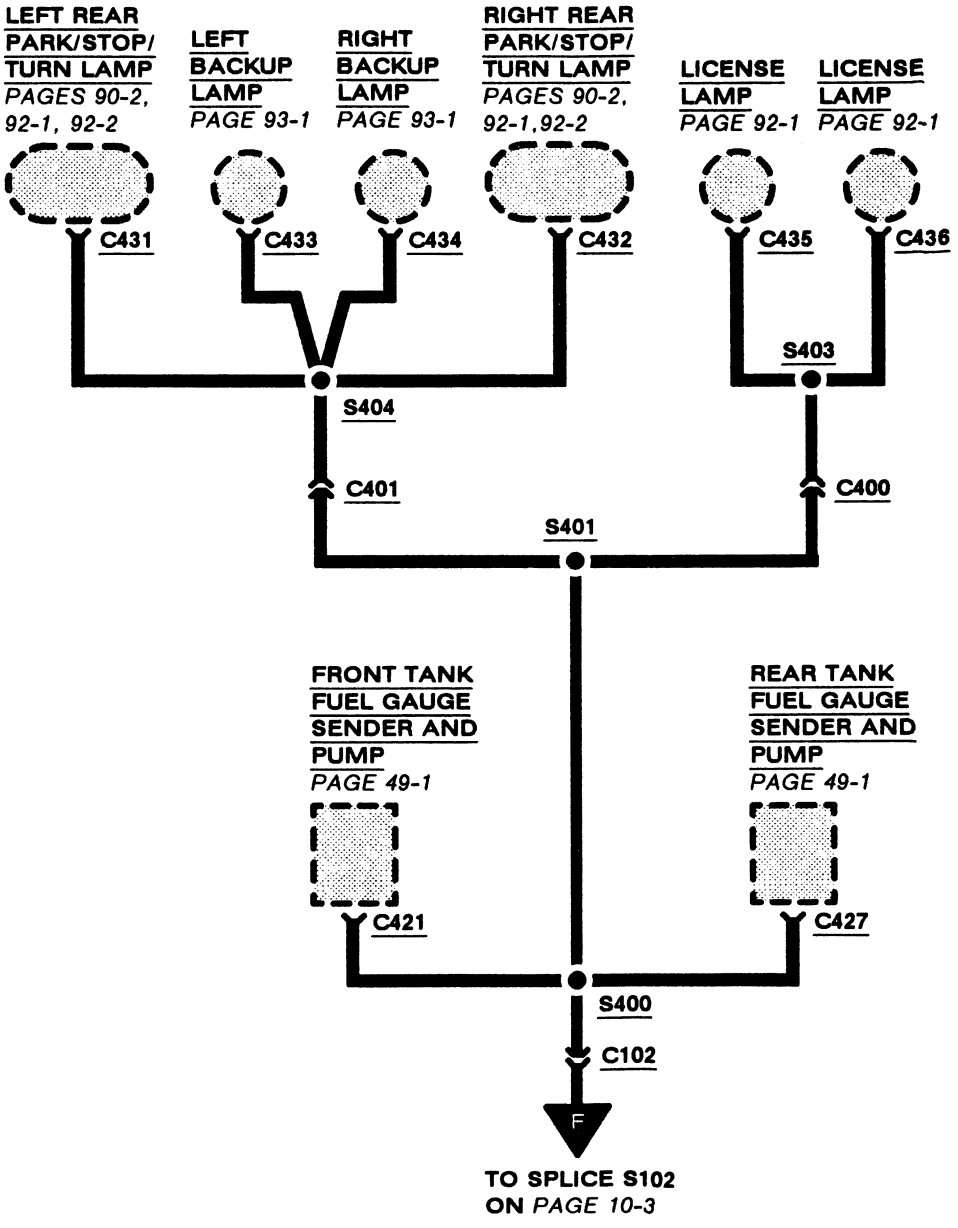
DIESEL (7.3L)

137" + 161" W.B.

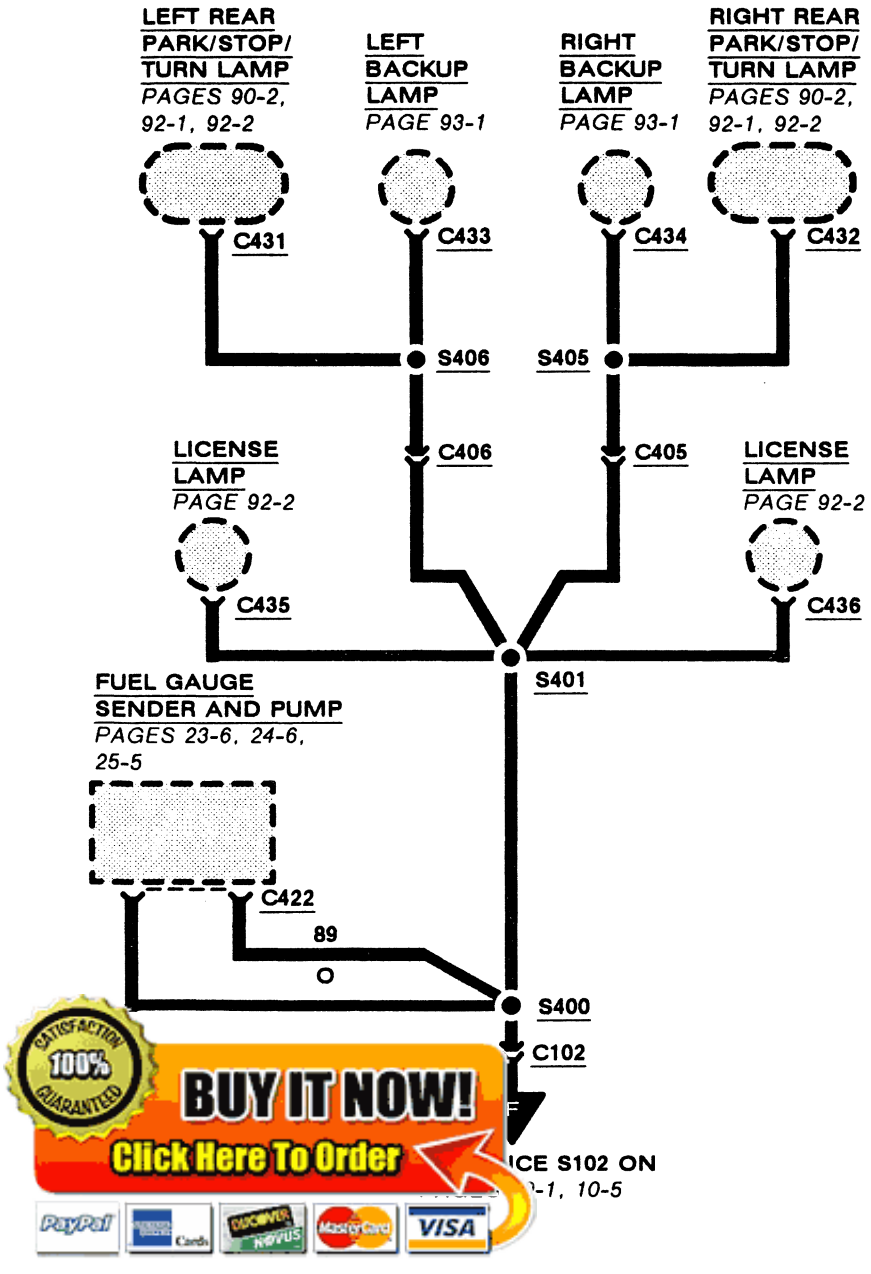


ON PAGE 10-3

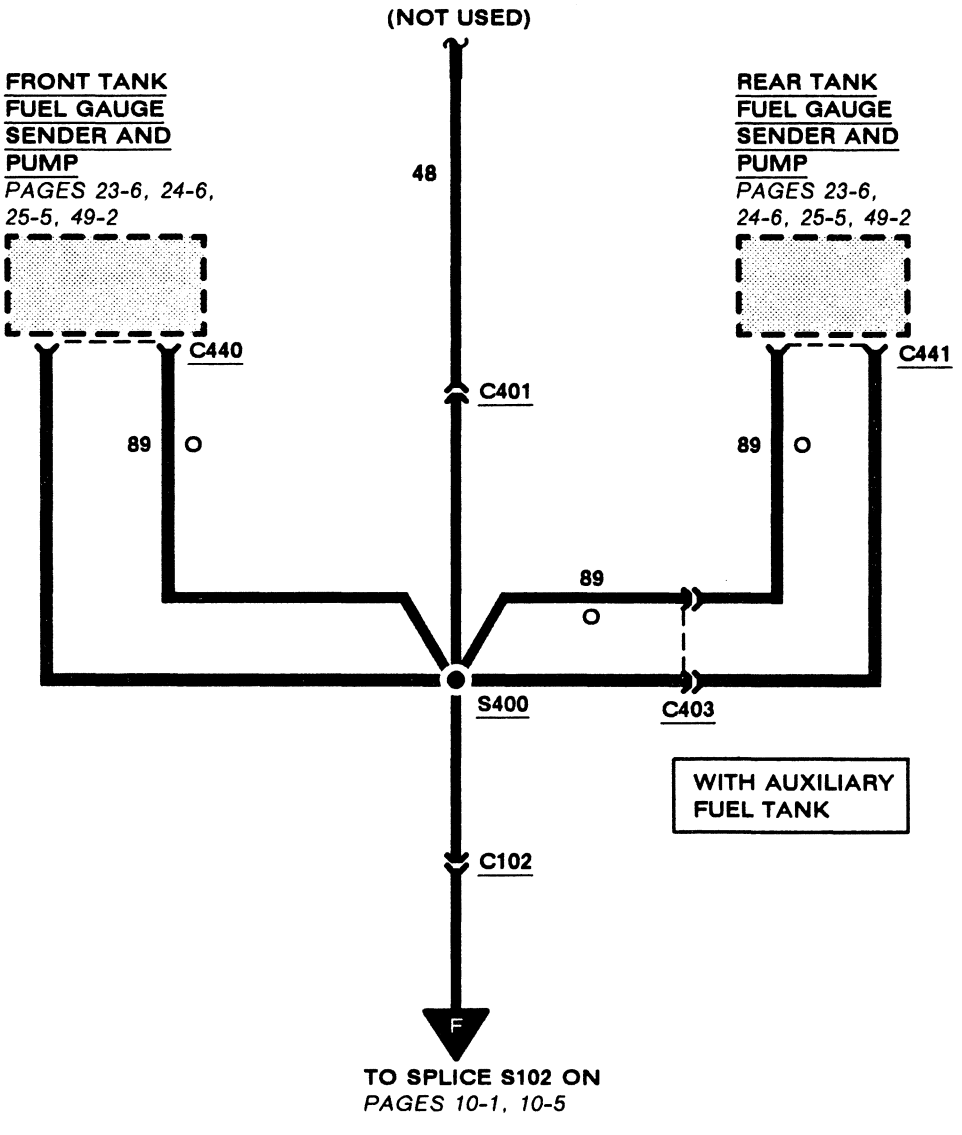
133" + 155" W.B.

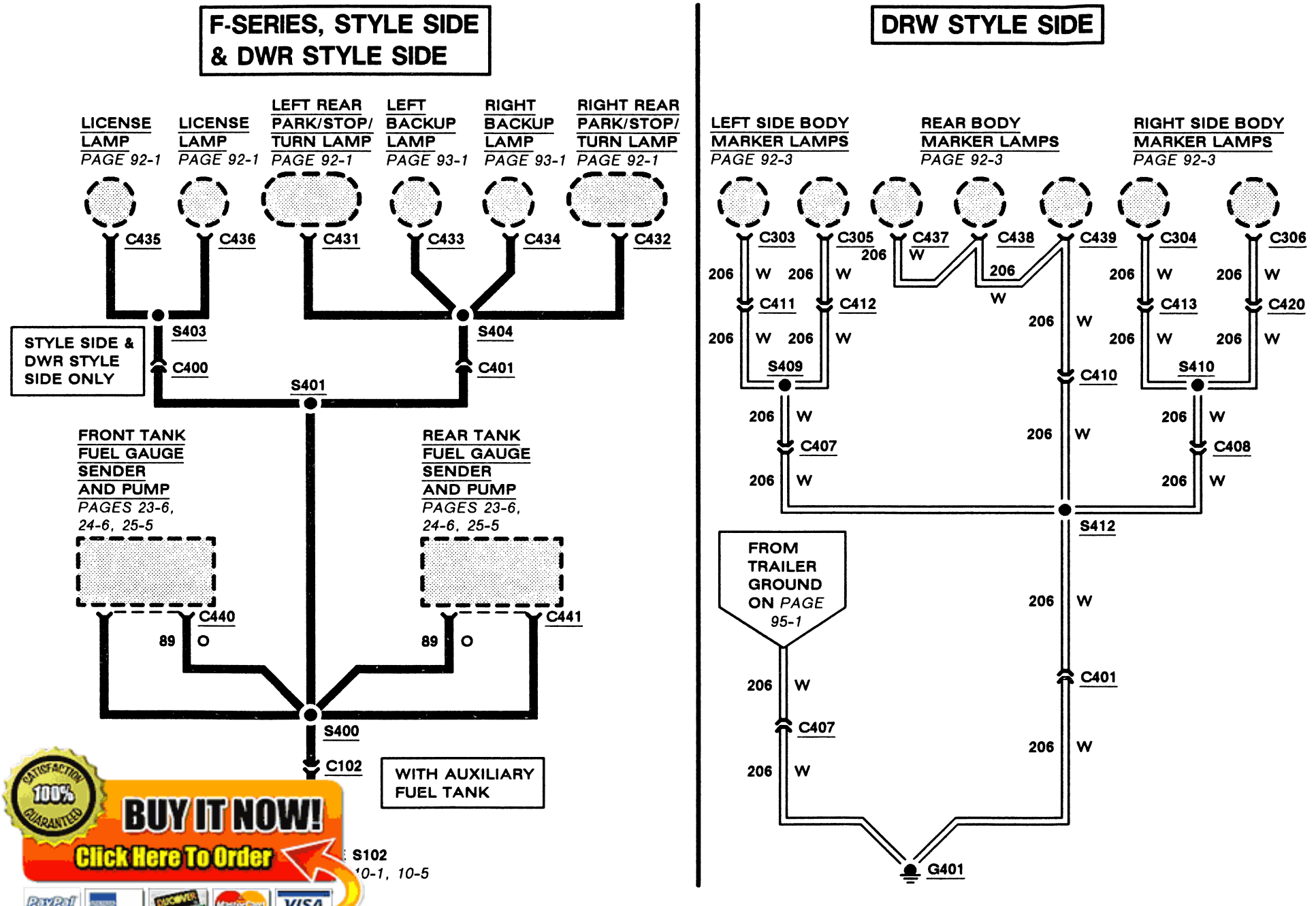


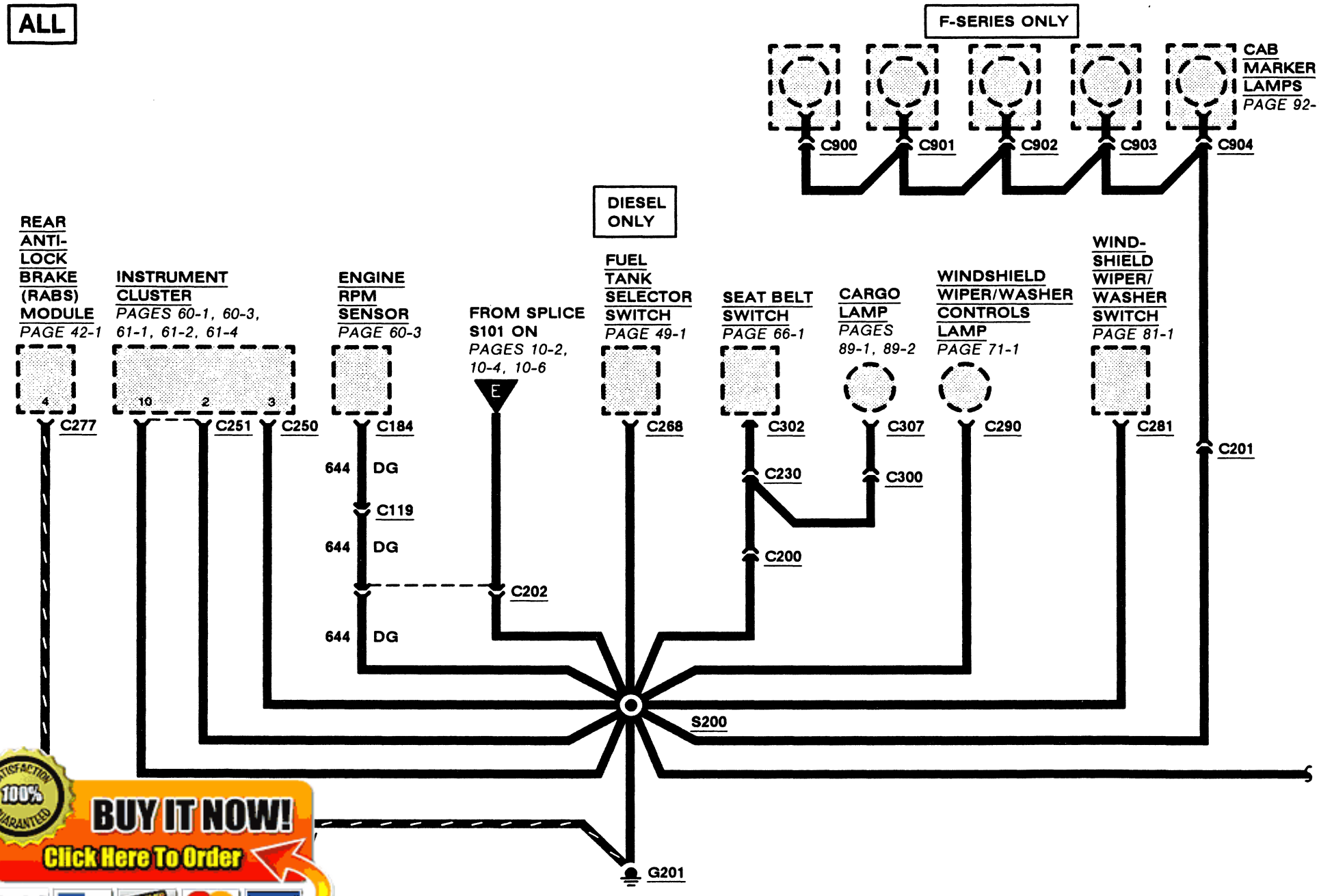
BRONCO



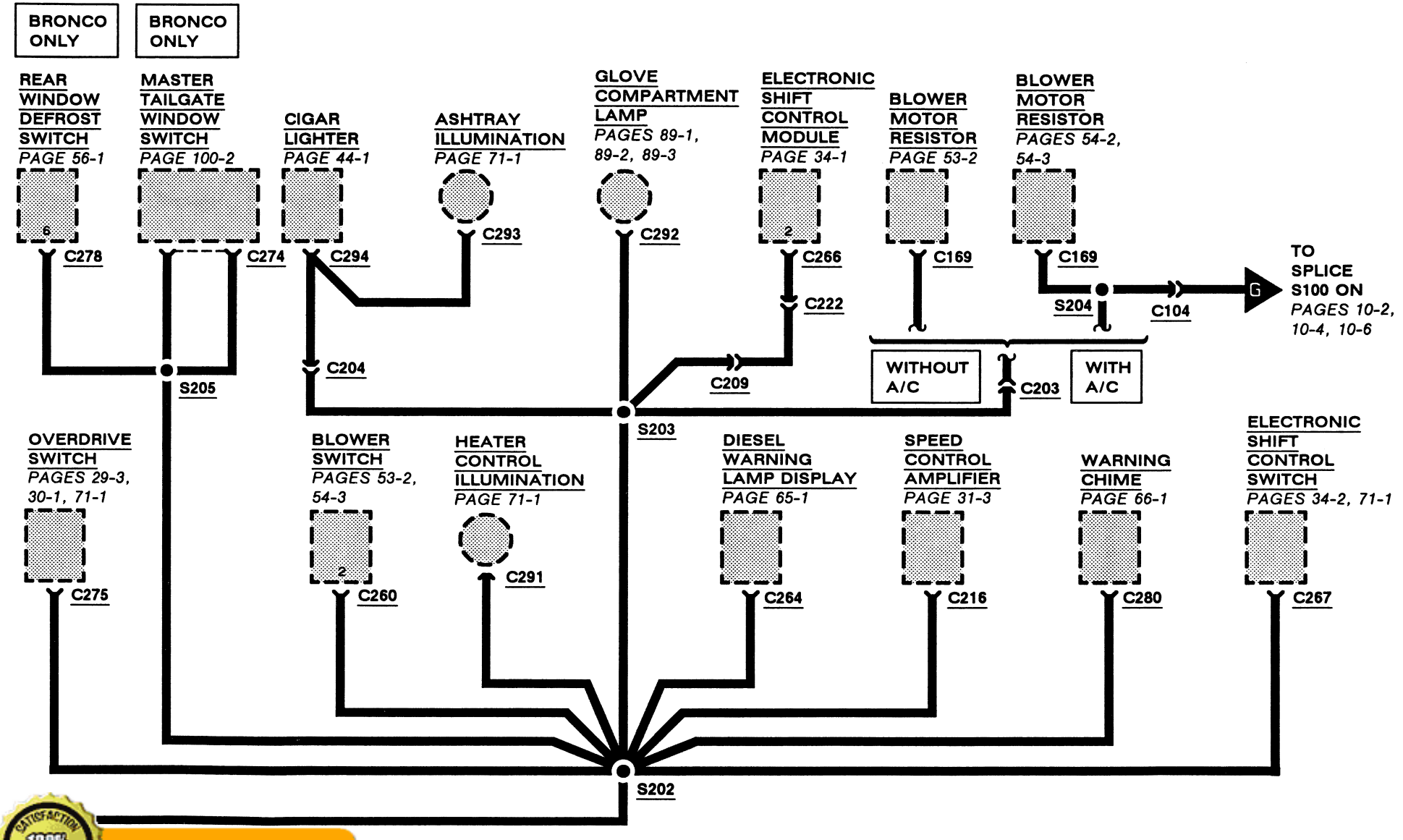
F-SERIES CHASSIS CAB







10-11 GROUNDS (G201)



HOW THE CIRCUIT WORKS

The ground circuits shown here are complete and connect several components together to screw terminal ground points. Parts of these circuits may be shown on other pages throughout the book. Partial ground circuits are shown dashed on those pages.

All simple or component ground circuits are shown on the individual circuit pages and are complete on those pages.

All wires are 57 BK unless otherwise noted.

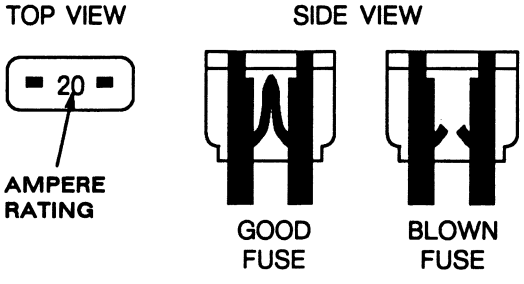
Refer to Location Index, Cell 152, for Base Part Number information and Connector, Splice, Ground, Resistor and Diode locations.

11-1 CIRCUIT PROTECTION/FUSE PANEL

CIRCUIT PROTECTION DEVICES

Electrical circuits on this vehicle may be protected by fuses, fusible links, fusible link cartridges, circuit breakers, or a combination of these devices.

BLADE TYPE FUSE

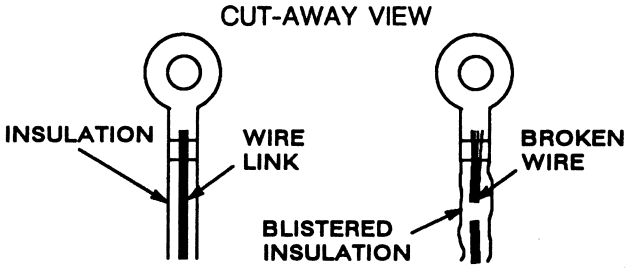


Blade type fuses have a transparent plastic housing. To check a fuse, pull it from the fuse panel and look at the fuse element through the housing. Always replace a blown fuse with a new fuse that has the same ampere rating.

The ampere rating of a blade type fuse can also be determined by following the color code shown here:

BLADE FUSE COLOR CODING	
AMPERE RATING	HOUSING COLOR
4	Pink
5	Tan
10	Red
	ue
	an

FUSIBLE LINK



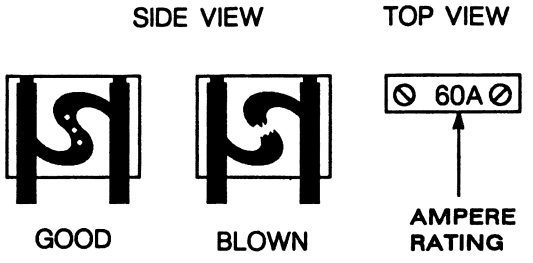
Fusible links are short lengths of wire that are smaller in diameter than the wires they are protecting. Fusible link wire is covered with a special thick, non-flammable insulation. An overload condition causes the insulation to blister. If the overload condition continues, the wire link will melt. To check a fusible link, look for blistered insulation. If the insulation is okay, pull lightly on the wire; If the fusible link stretches, the wire has melted.

When replacing fusible links, first cut the protected wire where it is connected to the fusible link. Then, tightly crimp or solder the new link to the protected wire.

Fusible links are often identified by color coding of the insulation, as shown here:

FUSIBLE LINK COLOR CODING	
WIRE LINK SIZE	INSULATION COLOR
20 GA	Blue
18 GA	Brown or Red
16 GA	Black or Orange
14 GA	Green
12 GA	Gray

FUSIBLE LINK CARTRIDGE



Fusible link cartridges have a transparent colored plastic housing. To check a fusible link cartridge, look at the fuse element through the side of th housing.

To replace a fusible link cartridge, pull it from the fuse box or panel. Always replace a blown fusible link cartridge with a new one having the same ampere rating.

The ampere rating of a fusible link cartridge can also be determined by following the color code shown here:

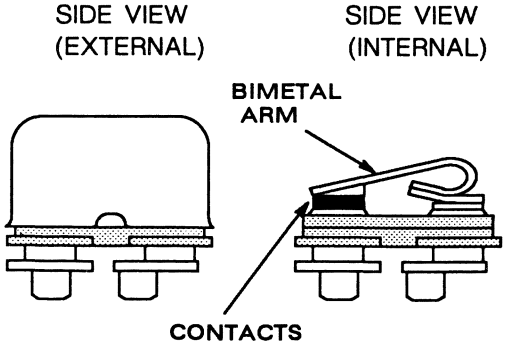
FUSIBLE LINK CARTRIDGE COLOR CODING	
AMPERE RATING	HOUSING COLOR
30	Light Green
40	Amber
50	Red
60	Blue

CIRCUIT BREAKER

Some circuits are protected by circuit breakers (abbreviated "c. b." in fuse chart). They can be Fuse Panel mounted or in-line. Like fuses, they are rated in amperes.

Each circuit breaker conducts current through an arm made of two types of metal bonded together (bimetal arm). If the arm starts to carry too much current, it heats up. As one metal expands faster than the other the arm bends, opening the contacts. Current flow is broken. A circuit breaker can be the cycling or non-cycling type.

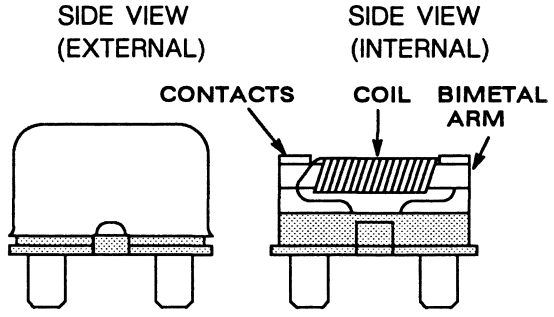
FUSE PANEL MOUNTED CYCLING TYPE



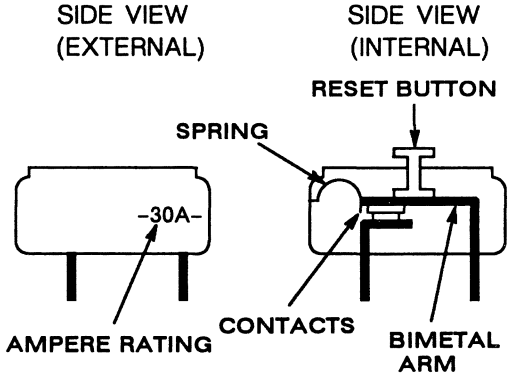
IN-LINE MOUNTED CYCLING TYPE

In the cycling type, the bimetal arm cools and straightens out. This cycle repeats as long as the overcurrent exists and power is applied.

FUSE PANEL MOUNTED NON-CYCLING TYPE



FUSE PANEL MOUNTED MANUAL RESET TYPE



Two types of non-cycling circuit breakers are used; one is reset by removing power from the circuit, and the other is reset by depressing a reset button.

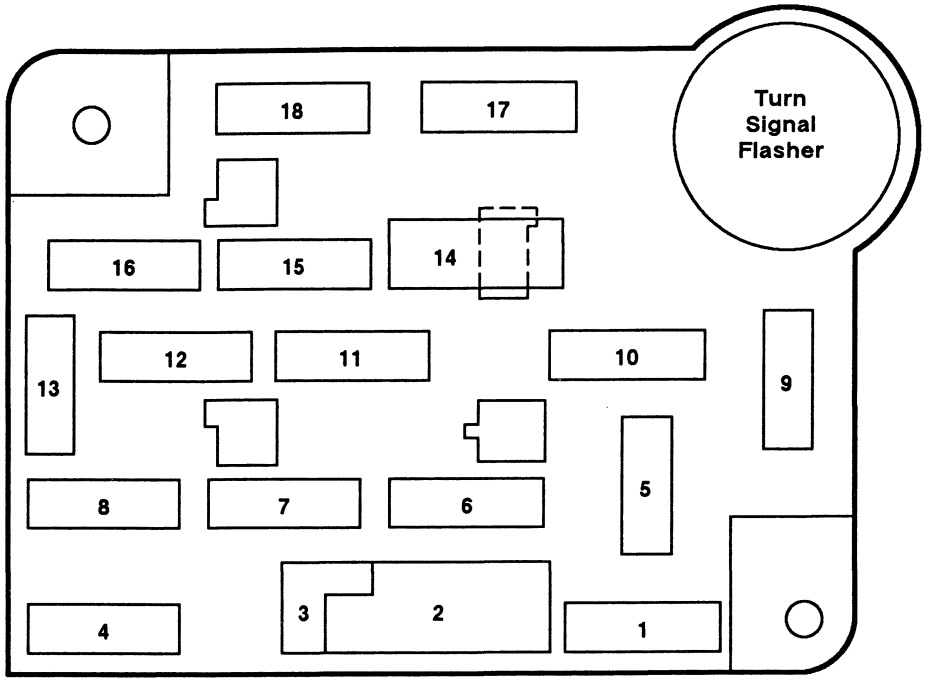
In the first type, there is a coil wrapped around the bimetal arm. When an overcurrent exists and the contacts open, a small current passes through the coil. This current through the coil is not enough to operate a load, but it does heat up both the coil and the bi-metal arm. This keeps the arm in the open position until power is removed.

In the second type, a spring pushes the bi-metal arm down and holds the contacts together. When an overcurrent condition exists and the bimetal arm heats up, the bimetal arm bends enough to overcome the spring and the contacts snap open. The contacts stay open until the reset button is pushed and the contacts snap together again.

DIODE

Diodes are electrical devices that permit current to flow in one direction only. The current flows in the direction indicated by the arrow.

11-3 CIRCUIT PROTECTION/FUSE PANEL



Fuse Position	Amps	Circuits Protected
1	15	Stop and Hazard Lamps, Anti-lock Brakes, Speed Control
2	—	(Not Used)
3	—	(Not Used)
4	15	Exterior Illumination, Instrument Illumination, Radio Clock Illumination
5	15	Turn Lamps, Daytime Running Lamps, Overdrive Switch, Backup Lamps, Hego Sensor and Rear Window Defrost (Bronco Only)
6	15	Speed Control and All Wheel Drive (Bronco Only)
7	—	(Not Used)
8	15	Dome Lamp, Map Lamp, Radio Memory, Cargo Lamps
9	30	A/C-Heater Blower Motor Relay Coil, A/C Clutch
10	5	Instrument Illumination
11	15	Radio and Clock
12	30 c.b.	Power Door Lock, All Wheel Drive, Power Tailgate Window (Bronco Only)
13	—	(Not Used)
14	30 c.b.	Power Windows
15	10	Fuel Tank Selector (Diesel Only)
16	30	Horn, Cigar Lighter and Speed Control
17	20	Anti-lock Brakes
18	15	Instrument Cluster Gauges and Indicators, Warning Chime, Diesel Warning Indicators and IMS/EVL Module

Fuse Value Amps	Color Code
4	Pink
5	Tan
10	Red
15	Light Blue
20	Yellow
25	Natural
30	Light Green

Power Distribution

The Alternator and Battery are connected together at the Starter Relay hot terminal. Other circuits originate at the Starter Relay hot terminal and are protected by fuse links. Low power circuits are also protected by fuses.

The Ignition Switch and Main Light Switch are powered at all times, as are fuses 1, 4, 8, 12 and 16. The other fuses are powered through the Ignition Switch or the Main Light Switch.

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