## UNDERSTANDING AND TROUBLESHOOTING ELECTRICAL SYSTEMS

### BASIC ELECTRICAL THEORY

For any 12 volt, negative ground, electrical system to operate, the electricity must travel in a complete circuit. This simply means that current (power) from the positive (+) terminal of the battery must eventually return to the negative (—) terminal of the battery. Along the way, this current will travel through wires, fuses, switches and components. If, for any reason, the flow of current through the circuit is interrupted, the component fed by that circuit will cease to function properly.

Perhaps the easiest way to visualize a circuit is to think of connecting a light bulb (with two wires attached to it) to the battery - one wire attached to the negative (—) terminal of the battery and the other wire to the positive (+) terminal. With the two wires touching the battery terminals, the circuit would be complete and the light bulb would illuminate. Electricity would follow a path from the battery to the bulb and back to the battery. It's easy to see that with longer wires on our light bulb, it could be mounted anywhere. Further, one wire could be fitted with a switch so that the light could be turned on and off.

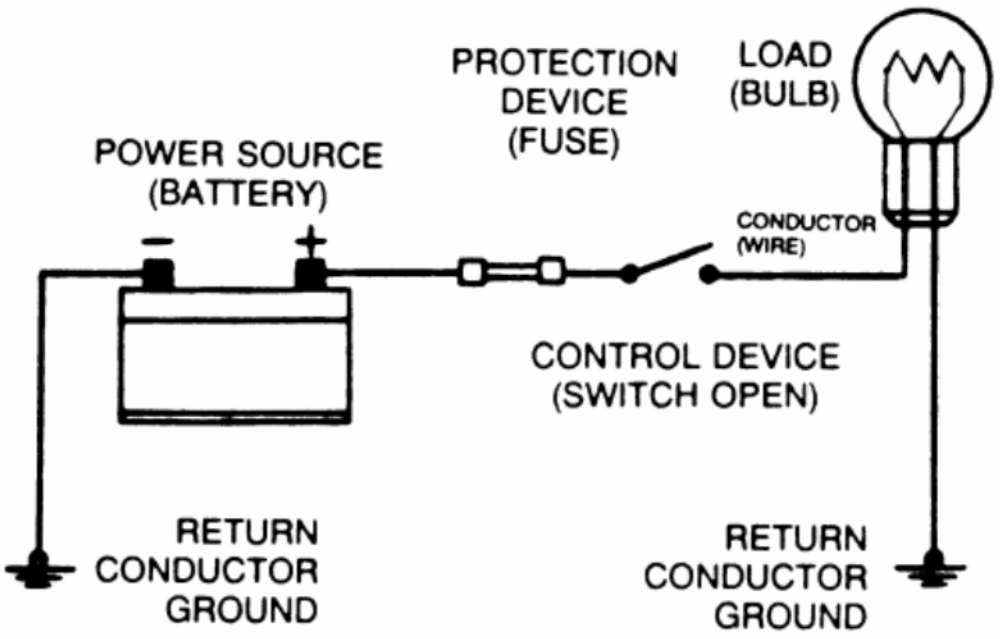



Fig. 1: This example illustrates a simple circuit. When the switch is closed, power from the positive (+) battery terminal flows through the fuse and the switch, and then to the light bulb. The light illuminates and the circuit is completed through the ground wire back to the negative (—) battery terminal. In reality, the two ground points shown in the illustration are attached to the metal frame of the vehicle, which completes the circuit back to the battery

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The normal automotive circuit differs from this simple example in two ways. First, instead of having a return wire from the bulb to the battery, the current travels through the frame of the vehicle. Since the negative (—) battery cable is attached to the frame (made of electrically conductive metal), the frame of the vehicle can serve as a ground wire to complete the circuit. Secondly, most automotive circuits contain multiple components which receive power from a single circuit. This lessens the amount of wire needed to power components on the vehicle.

## HOW DOES ELECTRICITY WORK: THE WATER ANALOGY

Electricity is the flow of electrons - the subatomic particles that constitute the outer shell of an atom. Electrons spin in an orbit around the center core of an atom. The center core is comprised of protons (positive charge) and neutrons (neutral charge). Electrons have a negative charge and balance out the positive charge of the protons. When an outside force causes the number of electrons to unbalance the charge of the protons, the electrons will split off the atom and look for another atom to balance out. If this imbalance is kept up, electrons will continue to move and an electrical flow will exist.

Many people have been taught electrical theory using an analogy with water. In a comparison with water flowing through a pipe, the electrons would be the water and the wire is the pipe.

The flow of electricity can be measured much like the flow of water through a pipe. The unit of measurement used is amperes, frequently abbreviated as amps (a). You can compare amperage to the volume of water flowing through a pipe. When connected to a circuit, an ammeter will measure the actual amount of current flowing through the circuit. When relatively few electrons flow through a circuit, the amperage is low. When many electrons flow, the amperage is high.

Water pressure is measured in units such as pounds per square inch (psi); The electrical pressure is measured in units called volts (v). When a voltmeter is connected to a circuit, it is measuring the electrical pressure.

The actual flow of electricity depends not only on voltage and amperage, but also on the resistance of the circuit. The higher the resistance, the higher the force necessary to push the current through the circuit. The standard unit for measuring resistance is an ohm. Resistance in a circuit varies depending on the amount and type of components used in the circuit. The main factors which determine resistance are:

- Material - some materials have more resistance than others. Those with high resistance are said to be insulators. Rubber materials (or rubber-like plastics) are some of the most common insulators used in vehicles as they have a very high resistance to electricity. Very low resistance materials are said to be conductors. Copper wire is among the best conductors. Silver is actually a superior conductor to copper and is used in some relay contacts, but its high cost prohibits its use as common wiring. Most automotive wiring is made of copper.

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- Size - the larger the wire size being used, the less resistance the wire will have. This is why components which use large amounts of electricity usually have large wires supplying current to them.
- Length - for a given thickness of wire, the longer the wire, the greater the resistance. The shorter the wire, the less the resistance. When determining the proper wire for a circuit, both size and length must be considered to design a circuit that can handle the current needs of the component.
- Temperature - with many materials, the higher the temperature, the greater the resistance (positive temperature coefficient). Some materials exhibit the opposite trait of lower resistance with higher temperatures (negative temperature coefficient). These principles are used in many of the sensors on the engine.

**OHM'S LAW**

There is a direct relationship between current, voltage and resistance. The relationship between current, voltage and resistance can be summed up by a statement known as Ohm's law.

Voltage (E) is equal to amperage (I) times resistance (R): E=I x ROther forms of the formula are R=E/I and I=E/R

In each of these formulas, E is the voltage in volts, I is the current in amps and R is the resistance in ohms. The basic point to remember is that as the resistance of a circuit goes up, the amount of current that flows in the circuit will go down, if voltage remains the same.

The amount of work that the electricity can perform is expressed as power. The unit of power is the watt (w). The relationship between power, voltage and current is expressed as:

Power (w) is equal to amperage (I) times voltage (E): W=I x EThis is only true for direct current (DC) circuits; The alternating current formula is a tad different, but since the electrical circuits in most vehicles are DC type, we need not get into AC circuit theory.

**ELECTRICAL COMPONENTS**

**POWER SOURCE**

Power is supplied to the vehicle by two devices: The battery and the alternator. The battery supplies electrical power during starting or during periods when the current demand of the vehicle's electrical system exceeds the output capacity of the alternator. The alternator supplies electrical current when the engine is running. Just not does the alternator supply the current needs of the vehicle, but it recharges the battery.

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## THE BATTERY

In most modern vehicles, the battery is a lead/acid electrochemical device consisting of six 2 volt subsections (cells) connected in series, so that the unit is capable of producing approximately 12 volts of electrical pressure. Each subsection consists of a series of positive and negative plates held a short distance apart in a solution of sulfuric acid and water.

The two types of plates are of dissimilar metals. This sets up a chemical reaction, and it is this reaction which produces current flow from the battery when its positive and negative terminals are connected to an electrical load . The power removed from the battery is replaced by the alternator, restoring the battery to its original chemical state.

## THE ALTERNATOR

On some vehicles there isn't an alternator, but a generator. The difference is that an alternator supplies alternating current which is then changed to direct current for use on the vehicle, while a generator produces direct current. Alternators tend to be more efficient and that is why they are used.

Alternators and generators are devices that consist of coils of wires wound together making big electromagnets. One group of coils spins within another set and the interaction of the magnetic fields causes a current to flow. This current is then drawn off the coils and fed into the vehicles electrical system.

## GROUND

Two types of grounds are used in automotive electric circuits. Direct ground components are grounded to the frame through their mounting points. All other components use some sort of ground wire which is attached to the frame or chassis of the vehicle. The electrical current runs through the chassis of the vehicle and returns to the battery through the ground (—) cable; if you look, you'll see that the battery ground cable connects between the battery and the frame or chassis of the vehicle.

*It should be noted that a good percentage of electrical problems can be traced to bad grounds.*

## PROTECTIVE DEVICES

It is possible for large surges of current to pass through the electrical system of your vehicle. If this surge of current were to reach the load in the circuit, the surge could burn it out or severely damage it. It can also overload the wiring, causing the harness to get hot and melt the insulation. To prevent this, fuses, circuit breakers and/or fusible links are connected into the supply wires of the electrical system. These items are nothing more than a built-in weak spot in the system. When an abnormal amount of current flows through the system, these protective devices work as follows to protect the circuit:

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- Fuse - when an excessive electrical current passes through a fuse, the fuse "blows" (the conductor melts) and opens the circuit, preventing the passage of current.



Fig. 1: Most vehicles use one or more fuse panels. This one is located on the driver's side kick panel

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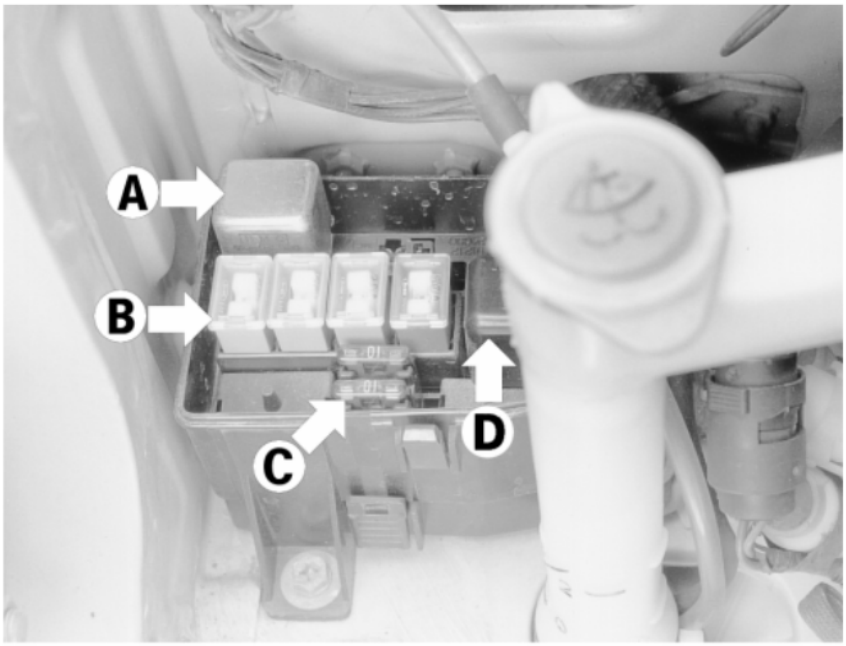
- Circuit Breaker - a circuit breaker is basically a self-repairing fuse. It will open the circuit in the same fashion as a fuse, but when the surge subsides, the circuit breaker can be reset and does not need replacement.

- Fusible Link - a fusible link (fuse link or main link) is a short length of special, high temperature insulated wire that acts as a fuse. When an excessive electrical current passes through a fusible link, the thin gauge wire inside the link melts, creating an intentional open to protect the circuit. To repair the circuit, the link must be replaced. Some newer type fusible links are housed in plug-in modules, which are simply replaced like a fuse, while older type fusible links must be cut and spliced if they melt. Since this link is very early in the electrical path, it's the first place to look if nothing on the vehicle works, yet the battery seems to be charged and is properly connected.

**CAUTION** - Always replace fuses, circuit breakers and fusible links with identically rated components. Under no circumstances should a component of higher or lower amperage rating be substituted.

**SWITCHES & RELAYS**

Switches are used in electrical circuits to control the passage of current. The most common use is to open and close circuits between the battery and the various electric devices in the system. Switches are rated according to the amount of amperage they can handle. If a sufficient amperage rated switch is not used in a circuit, the switch could overload and cause damage.




A. Relay
B. Fusible link
C. Fuse
D. Flasher

Fig. 2: The underhood fuse and relay panel usually contains fuses, relays, flashers and fusible links

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Some electrical components which require a large amount of current to operate use a special switch called a relay. Since these circuits carry a large amount of current, the thickness of the wire in the circuit is also greater. If this large wire were connected from the load to the control switch, the switch would have to carry the high amperage load and the fairing or dash would be twice as large to accommodate the increased size of the wiring harness. To prevent these problems, a relay is used.

Relays are composed of a coil and a set of contacts. When the coil has a current passed though it, a magnetic field is formed and this field causes the contacts to move together, completing the circuit. Most relays are normally open, preventing current from passing through the circuit, but they can take any electrical form depending on the job they are intended to do. Relays can be considered "remote control switches." They allow a smaller current to operate devices that require higher amperages. When a small current operates the coil, a larger current is allowed to pass by the contacts. Some common circuits which may use relays are the horn, headlights, starter, electric fuel pump and other high draw circuits.

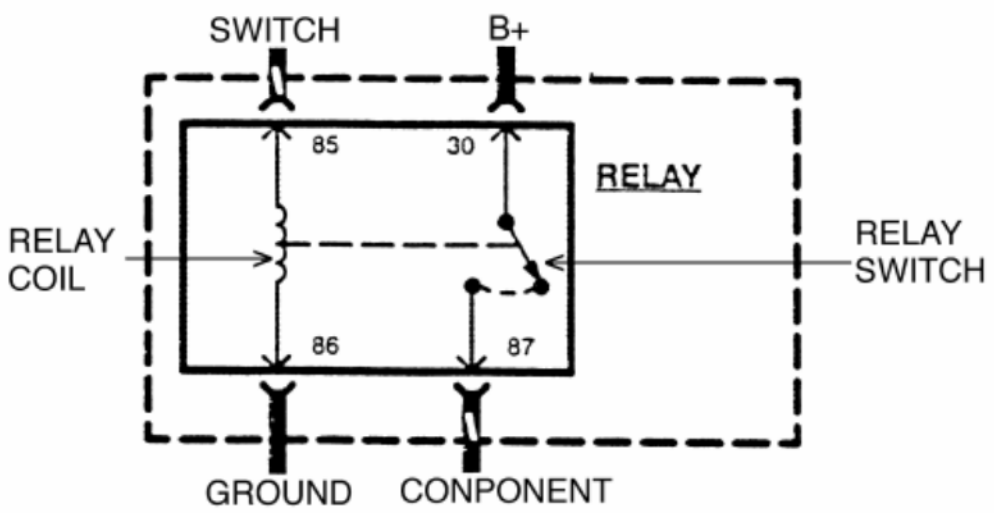



Fig. 3: Relays are composed of a coil and a switch. These two components are linked together so that when one operates, the other operates at the same time. The large wires in the circuit are connected from the battery to one side of the relay switch (B+) and from the opposite side of the relay switch to the load (component). Smaller wires are connected from the relay coil to the control switch for the circuit and from the opposite side of the relay coil to ground

**LOAD**

Every electrical circuit must include a "load" (something to use the electricity coming from the source). Without this load, the battery would attempt to deliver its entire power supply from one pole to another. This is called a "short circuit." All this electricity would take a short cut to ground and cause a great amount of damage to other components in the circuit by developing a tremendous amount of heat. This condition could develop sufficient heat to melt the insulation on all the surrounding wires and reduce a multiple wire cable to a lump of plastic and copper.

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## WIRING & HARNESSES

The average vehicle contains meters and meters of wiring, with hundreds of individual connections. To protect the many wires from damage and to keep them from becoming a confusing tangle, they are organized into bundles, enclosed in plastic or taped together and called wiring harnesses. Different harnesses serve different parts of the vehicle. Individual wires are color coded to help trace them through a harness where sections are hidden from view.

Automotive wiring or circuit conductors can be either single strand wire, multi-strand wire or printed circuitry. Single strand wire has a solid metal core and is usually used inside such components as alternators, motors, relays and other devices. Multi-strand wire has a core made of many small strands of wire twisted together into a single conductor. Most of the wiring in an automotive electrical system is made up of multi-strand wire, either as a single conductor or grouped together in a harness. All wiring is color coded on the insulator, either as a solid color or as a colored wire with an identification stripe. A printed circuit is a thin film of copper or other conductor that is printed on an insulator backing. Occasionally, a printed circuit is sandwiched between two sheets of plastic for more protection and flexibility. A complete printed circuit, consisting of conductors, insulating material and connectors for lamps or other components is called a printed circuit board. Printed circuitry is used in place of individual wires or harnesses in places where space is limited, such as behind instrument panels.

Since automotive electrical systems are very sensitive to changes in resistance, the selection of properly sized wires is critical when systems are repaired. A loose or corroded connection or a replacement wire that is too small for the circuit will add extra resistance and an additional voltage drop to the circuit.

The wire gauge number is an expression of the cross-section area of the conductor. Vehicles from countries that use the metric system will typically describe the wire size as its cross-sectional area in square millimeters. In this method, the larger the wire, the greater the number. Another common system for expressing wire size is the American Wire Gauge (AWG) system. As gauge number increases, area decreases and the wire becomes smaller. An 18 gauge wire is smaller than a 4 gauge wire. A wire with a higher gauge number will carry less current than a wire with a lower gauge number. Gauge wire size refers to the size of the strands of the conductor, not the size of the complete wire with insulator. It is possible, therefore, to have two wires of the same gauge with different diameters because one may have thicker insulation than the other.

It is essential to understand how a circuit works before trying to figure out why it doesn't. An electrical schematic shows the electrical current paths when a circuit is operating properly. Schematics break the entire electrical system down into individual circuits. In a schematic, usually no attempt is made to represent wiring and components as they physically appear on the vehicle; switches and other components are shown as simply as possible. Face views of harness connectors show the cavity or terminal locations in all multi-pin connectors to help locate test points.

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## CONNECTORS

Three types of connectors are commonly used in automotive applications - weatherproof, molded and hard shell.

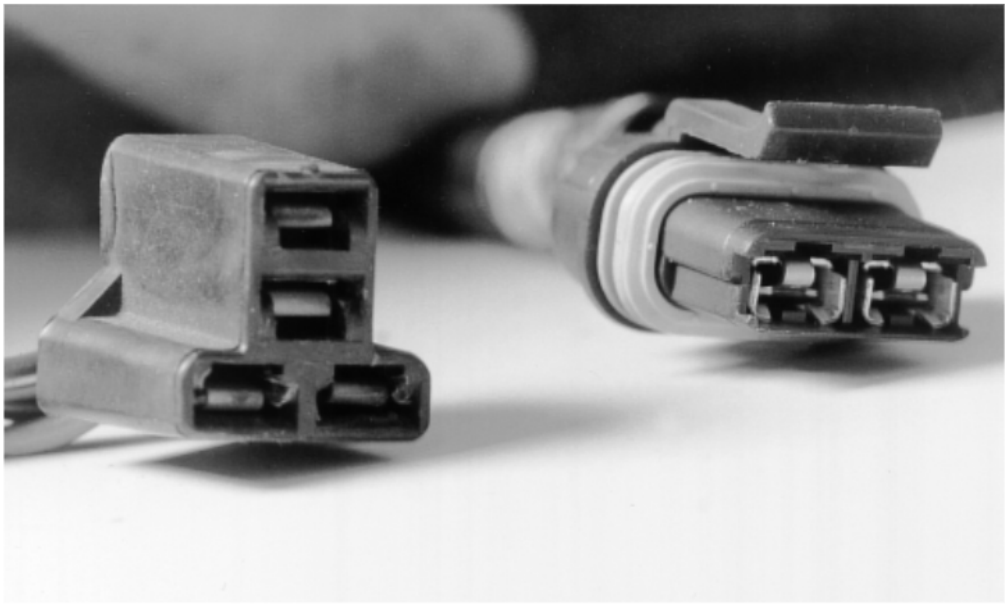


Fig. 4: Hard shell (left) and weatherproof (right) connectors have replaceable terminals

- Weatherproof - these connectors are most commonly used where the connector is exposed to the elements. Terminals are protected against moisture and dirt by sealing rings which provide a weathertight seal. All repairs require the use of a special terminal and the tool required to service it. Unlike standard blade type terminals, these weatherproof terminals cannot be straightened once they are bent. Make certain that the connectors are properly seated and all of the sealing rings are in place when connecting leads.
- Molded - these connectors require complete replacement of the connector if found to be defective. This means splicing a new connector assembly into the harness. All splices should be soldered to insure proper contact. Use care when probing the connections or replacing terminals in them, as it is possible to create a short circuit between opposite terminals. If this happens to the wrong terminal pair, it is possible to damage certain components. Always use jumper wires between connectors for circuit checking and NEVER probe through weatherproof seals.
- Hard Shell - unlike molded connectors, the terminal contacts in hard-shell connectors can be replaced. Replacement usually involves the use of a special terminal removal tool that depresses the locking tangs (barbs) on the connector terminal and allows the connector to be removed from the rear of the shell. The connector shell should be replaced if it shows any evidence of burning, melting, cracks, or breaks. Replace individual terminals that are burnt, corroded, distorted or loose.

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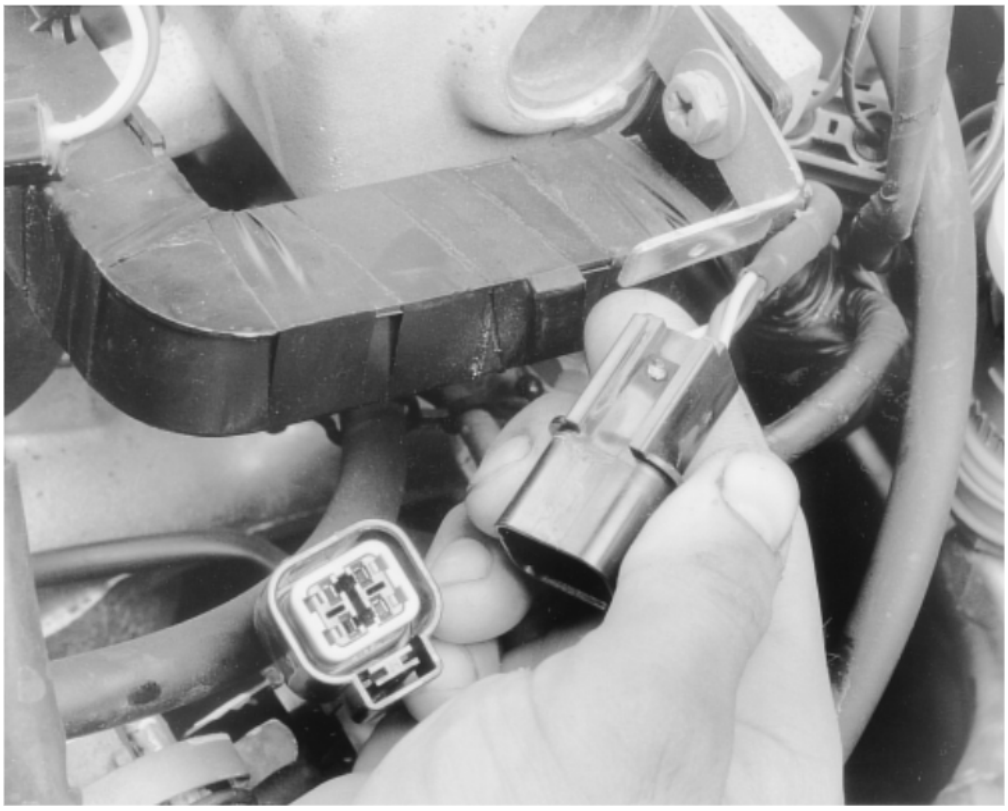


Fig. 5: Weatherproof connectors are most commonly used in the engine compartment or where the connector is exposed to the elements

## TEST EQUIPMENT

Pinpointing the exact cause of trouble in an electrical circuit is most times accomplished by the use of special test equipment. The following describes different types of commonly used test equipment and briefly explains how to use them in diagnosis. In addition to the information covered below, the tool manufacturer's instructions booklet (provided with the tester) should be read and clearly understood before attempting any test procedures.

## JUMPER WIRES

**CAUTION** - Never use jumper wires made from a thinner gauge wire than the circuit being tested. If the jumper wire is of too small a gauge, it may overheat and possibly melt. Never use jumpers to bypass high resistance loads in a circuit. Bypassing resistances, in effect, creates a short circuit. This may, in turn, cause damage and fire. Jumper wires should only be used to bypass lengths of wire or to simulate switches.

Jumper wires are simple, yet extremely valuable, pieces of test equipment. They are basically test wires which are used to bypass sections of a circuit. Although jumper wires can be purchased, they are usually fabricated from lengths of standard automotive wire and whatever type of connector (alligator clip, spade connector or pin connector) that is required for the particular application being tested. In cramped, hard-to-reach areas, it is advisable to have insulated boots over the jumper wire terminals in order to prevent

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accidental grounding. It is also advisable to include a standard automotive fuse in any jumper wire. This is commonly referred to as a "fused jumper". By inserting an in-line fuse holder between a set of test leads, a fused jumper wire can be used for bypassing open circuits. Use a 5 amp fuse to provide protection against voltage spikes.

Jumper wires are used primarily to locate open electrical circuits, on either the ground (—) side of the circuit or on the power (+) side. If an electrical component fails to operate, connect the jumper wire between the component and a good ground. If the component operates only with the jumper installed, the ground circuit is open. If the ground circuit is good, but the component does not operate, the circuit between the power feed and component may be open. By moving the jumper wire successively back from the component toward the power source, you can isolate the area of the circuit where the open is located. When the component stops functioning, or the power is cut off, the open is in the segment of wire between the jumper and the point previously tested.

You can sometimes connect the jumper wire directly from the battery to the "hot" terminal of the component, but first make sure the component uses 12 volts in operation. Some electrical components, such as fuel injectors or sensors, are designed to operate on about 4 to 5 volts, and running 12 volts directly to these components will cause damage.

**TEST LIGHTS**



Fig. 1: A 12 volt test light is used to detect the presence of voltage in a circuit

The test light is used to check circuits and components while electrical current is flowing through them. It is used for voltage and ground tests. To use a 12 volt test light, connect the ground clip to a good ground and probe wherever necessary with the pick. The test light will illuminate when voltage is detected. This does not necessarily mean that 12 volts (or any particular amount of

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voltage) is present; it only means that some voltage is present. It is advisable before using the test light to touch its ground clip and probe across the battery posts or terminals to make sure the light is operating properly.

**WARNING** - Do not use a test light to probe electronic ignition, spark plug or coil wires. Never use a pick-type test light to probe wiring on computer controlled systems unless specifically instructed to do so. Any wire insulation that is pierced by the test light probe should be taped and sealed with silicone after testing

Like the jumper wire, the 12 volt test light is used to isolate opens in circuits. But, whereas the jumper wire is used to bypass the open to operate the load, the 12 volt test light is used to locate the presence of voltage in a circuit. If the test light illuminates, there is power up to that point in the circuit; if the test light does not illuminate, there is an open circuit (no power). Move the test light in successive steps back toward the power source until the light in the handle illuminates. The open is between the probe and a point which was previously probed.

The self-powered test light is similar in design to the 12 volt test light, but contains a 1.5 volt penlight battery in the handle. It is most often used in place of a multimeter to check for open or short circuits when power is isolated from the circuit (continuity test).

The battery in a self-powered test light does not provide much current. A weak battery may not provide enough power to illuminate the test light even when a complete circuit is made (especially if there is high resistance in the circuit). Always make sure that the test battery is strong. To check the battery, briefly touch the ground clip to the probe; if the light glows brightly, the battery is strong enough for testing.

*A self-powered test light should not be used on any computer controlled system or component. The small amount of electricity transmitted by the test light is enough to damage many electronic automotive components.*

**MULTIMETERS**

Multimeters are an extremely useful tool for troubleshooting electrical problems. They can be purchased in either analog or digital form and have a price range to suit any budget. A multimeter is a voltmeter, ammeter and ohmmeter (along with other features) combined into one instrument. It is often used when testing solid state circuits because of its high input impedance (usually 10 megaohms or more). A brief description of the multimeter main test functions follows:

- Voltmeter - the voltmeter is used to measure voltage at any point in a circuit, or to measure the voltage drop across any part of a circuit. Voltmeters usually have various scales and a selector switch to allow the reading of different voltage ranges. The voltmeter has a positive and a negative lead. To avoid damage to the meter, always connect the negative lead to the negative (—) side of the circuit (to ground or nearest

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the ground side of the circuit) and connect the positive lead to the positive (+) side of the circuit (to the power source or the nearest power source). Note that the negative voltmeter lead will always be black and that the positive voltmeter will always be some color other than black (usually red).

- Ohmmeter - the ohmmeter is designed to read resistance (measured in ohms) in a circuit or component. Most ohmmeters will have a selector switch which permits the measurement of different ranges of resistance (usually the selector switch allows the multiplication of the meter reading by 10, 100, 1,000 and 10,000). Some ohmmeters are "auto-ranging" which means the meter itself will determine which scale to use. Since the meters are powered by an internal battery, the ohmmeter can be used like a self-powered test light. When the ohmmeter is connected, current from the ohmmeter flows through the circuit or component being tested. Since the ohmmeter's internal resistance and voltage are known values, the amount of current flow through the meter depends on the resistance of the circuit or component being tested. The ohmmeter can also be used to perform a continuity test for suspected open circuits. In using the meter for making continuity checks, do not be concerned with the actual resistance readings. Zero resistance, or any ohm reading, indicates continuity in the circuit. Infinite resistance indicates an opening in the circuit. A high resistance reading where there should be none indicates a problem in the circuit. Checks for short circuits are made in the same manner as checks for open circuits, except that the circuit must be isolated from both power and normal ground. Infinite resistance indicates no continuity, while zero resistance indicates a dead short.

**WARNING** - Never use an ohmmeter to check the resistance of a component or wire while there is voltage applied to the circuit

- Ammeter - an ammeter measures the amount of current flowing through a circuit in units called amperes or amps. At normal operating voltage, most circuits have a characteristic amount of amperes, called "current draw" which can be measured using an ammeter. By referring to a specified current draw rating, then measuring the amperes and comparing the two values, one can determine what is happening within the circuit to aid in diagnosis. An open circuit, for example, will not allow any current to flow, so the ammeter reading will be zero. A damaged component or circuit will have an increased current draw, so the reading will be high. The ammeter is always connected in series with the circuit being tested. All of the current that normally flows through the circuit must also flow through the ammeter; if there is any other path for the current to follow, the ammeter reading will not be accurate. The ammeter itself has very little resistance to current flow and, therefore, will not affect the circuit, but it will measure current draw only when the circuit is closed and electricity is flowing. Excessive current draw can blow fuses and drain the battery, while a reduced current draw can cause motors to run slowly, lights to dim and other components to not operate properly.

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## TROUBLESHOOTING ELECTRICAL SYSTEMS

When diagnosing a specific problem, organized troubleshooting is a must. The complexity of a modern automotive vehicle demands that you approach any problem in a logical, organized manner. There are certain troubleshooting techniques, however, which are standard:

- Establish when the problem occurs. Does the problem appear only under certain conditions? Were there any noises, odors or other unusual symptoms? Isolate the problem area. To do this, make some simple tests and observations, then eliminate the systems that are working properly. Check for obvious problems, such as broken wires and loose or dirty connections. Always check the obvious before assuming something complicated is the cause.
- Test for problems systematically to determine the cause once the problem area is isolated. Are all the components functioning properly? Is there power going to electrical switches and motors. Performing careful, systematic checks will often turn up most causes on the first inspection, without wasting time checking components that have little or no relationship to the problem.
- Test all repairs after the work is done to make sure that the problem is fixed. Some causes can be traced to more than one component, so a careful verification of repair work is important in order to pick up additional malfunctions that may cause a problem to reappear or a different problem to arise. A blown fuse, for example, is a simple problem that may require more than another fuse to repair. If you don't look for a problem that caused a fuse to blow, a shorted wire (for example) may go undetected.

Experience has shown that most problems tend to be the result of a fairly simple and obvious cause, such as loose or corroded connectors, bad grounds or damaged wire insulation which causes a short. This makes careful visual inspection of components during testing essential to quick and accurate troubleshooting.

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## TESTING

### OPEN CIRCUITS




Fig. 1: The infinite reading on this multimeter indicates that the circuit is open

This test already assumes the existence of an open in the circuit and it is used to help locate the open portion.

1. Isolate the circuit from power and ground.
2. Connect the self-powered test light or ohmmeter ground clip to the ground side of the circuit and probe sections of the circuit sequentially.
3. If the light is out or there is infinite resistance, the open is between the probe and the circuit ground.
4. If the light is on or the meter shows continuity, the open is between the probe and the end of the circuit toward the power source.

### SHORT CIRCUITS

*Never use a self-powered test light to perform checks for opens or shorts when power is applied to the circuit under test. The test light can be damaged by outside power.*

1. Isolate the circuit from power and ground.
2. Connect the self-powered test light or ohmmeter ground clip to a good ground and probe any easy-to-reach point in the circuit.
3. If the light comes on or there is continuity, there is a short somewhere in the circuit.

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4. To isolate the short, probe a test point at either end of the isolated circuit (the light should be on or the meter should indicate continuity).
5. Leave the test light probe engaged and sequentially open connectors or switches, remove parts, etc. until the light goes out or continuity is broken.
6. When the light goes out, the short is between the last two circuit components which were opened.

**VOLTAGE**

This test determines voltage available from the battery and should be the first step in any electrical troubleshooting procedure after visual inspection. Many electrical problems, especially on computer controlled systems, can be caused by a low state of charge in the battery. Excessive corrosion at the battery cable terminals can cause poor contact that will prevent proper charging and full battery current flow.

1. Set the voltmeter selector switch to the 20V position.
2. Connect the multimeter negative lead to the battery's negative (-) post or terminal and the positive lead to the battery's positive (+) post or terminal.
3. Turn the ignition switch *ON* to provide a load.
4. A well charged battery should register over 12 volts. If the meter reads below 11.5 volts, the battery power may be insufficient to operate the electrical system properly.

**VOLTAGE DROP**

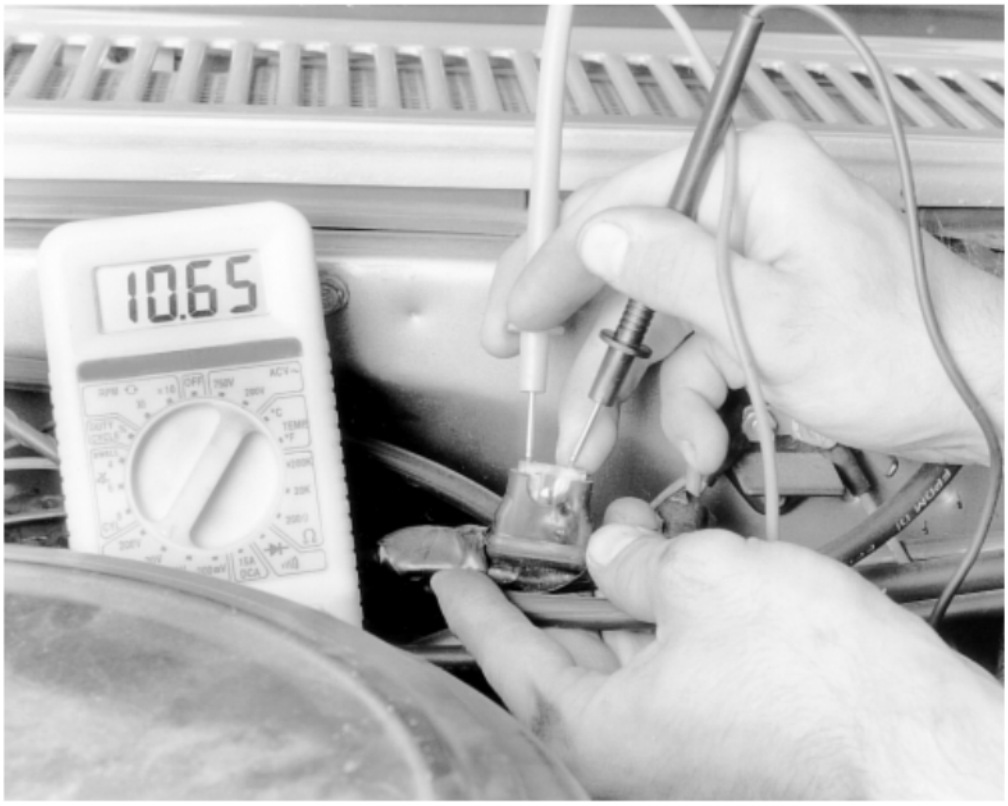


Fig. 2: This voltage drop test revealed high resistance (low voltage) in the circuit

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When current flows through a load, the voltage beyond the load drops. This voltage drop is due to the resistance created by the load and also by small resistances created by corrosion at the connectors and damaged insulation on the wires. The maximum allowable voltage drop under load is critical, especially if there is more than one load in the circuit, since all voltage drops are cumulative.

1. Set the voltmeter selector switch to the 20 volt position.
2. Connect the multimeter negative lead to a good ground.
3. Operate the circuit and check the voltage prior to the first component (load).
4. There should be little or no voltage drop in the circuit prior to the first component. If a voltage drop exists, the wire or connectors in the circuit are suspect.
5. While operating the first component in the circuit, probe the ground side of the component with the positive meter lead and observe the voltage readings. A small voltage drop should be noticed. This voltage drop is caused by the resistance of the component.
6. Repeat the test for each component (load) down the circuit.
7. If a large voltage drop is noticed, the preceding component, wire or connector is suspect.

**RESISTANCE**




Fig. 3: Checking the resistance of a coolant temperature sensor with an ohmmeter. Reading is 1.04 kilohms

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Fig. 4: Spark plug wires can be checked for excessive resistance using an ohmmeter

**WARNING** - Never use an ohmmeter with power applied to the circuit. The ohmmeter is designed to operate on its own power supply. The normal 12 volt electrical system voltage could damage the meter!

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1. Isolate the circuit from the vehicle's power source.
2. Ensure that the ignition key is *OFF* when disconnecting any components or the battery.
3. Where necessary, also isolate at least one side of the circuit to be checked, in order to avoid reading parallel resistances. Parallel circuit resistances will always give a lower reading than the actual resistance of either of the branches.
4. Connect the meter leads to both sides of the circuit (wire or component) and read the actual measured ohms on the meter scale. Make sure the selector switch is set to the proper ohm scale for the circuit being tested, to avoid misreading the ohmmeter test value.

## WIRE AND CONNECTOR REPAIR

Almost anyone can replace damaged wires, as long as the proper tools and parts are available. Wire and terminals are available to fit almost any need. Even the specialized weatherproof, molded and hard shell connectors are now available from aftermarket suppliers.

Be sure the ends of all the wires are fitted with the proper terminal hardware and connectors. Wrapping a wire around a stud is never a permanent solution and will only cause trouble later. Replace wires one at a time to avoid confusion. Always route wires exactly the same as the factory.

*If connector repair is necessary, only attempt it if you have the proper tools. Weatherproof and hard shell connectors require special tools to release the pins inside the connector. Attempting to repair these connectors with conventional hand tools will damage them.*

## BATTERY CABLES

## DISCONNECTING THE CABLES

When working on any electrical component on the vehicle, it is always a good idea to disconnect the negative (-) battery cable. This will prevent potential damage to many sensitive electrical components such as the Engine Control Module (ECM), radio, alternator, etc.

*Any time you disengage the battery cables, it is recommended that you disconnect the negative (&mdash) battery cable first. This will prevent your accidentally grounding the positive (+) terminal to the body of the vehicle when disconnecting it, thereby preventing damage to the above mentioned components.*

Before you disconnect the cable(s), first turn the ignition to the *OFF* position. This will prevent a draw on the battery which could cause arcing (electricity trying to ground itself to the body of a vehicle, just like a spark plug jumping the gap) and, of course, damaging some components such as the alternator diodes.

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When the battery cable(s) are reconnected (negative cable last), be sure to check that your lights, windshield wipers and other electrically operated safety components are all working correctly. If your vehicle contains an Electronically Tuned Radio (ETR), don't forget to also reset your radio stations. Ditto for the clock.

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## SUPPLEMENTAL INFLATABLE RESTRAINT SYSTEM

### GENERAL INFORMATION

All 1990-1992 models are equipped with an airbag system. The Supplemental Inflatable Restraint (SIR) system helps supplement the protection offered by the seat belts by deploying an air bag from the center of the steering wheel. The air bag deploys when the vehicle is involved in a frontal crash of sufficient force up to 30 degrees off the centerline of the vehicle. To further absorb the crash energy, there is a knee bolster located beneath the instrument panel and the steering column is collapsible.

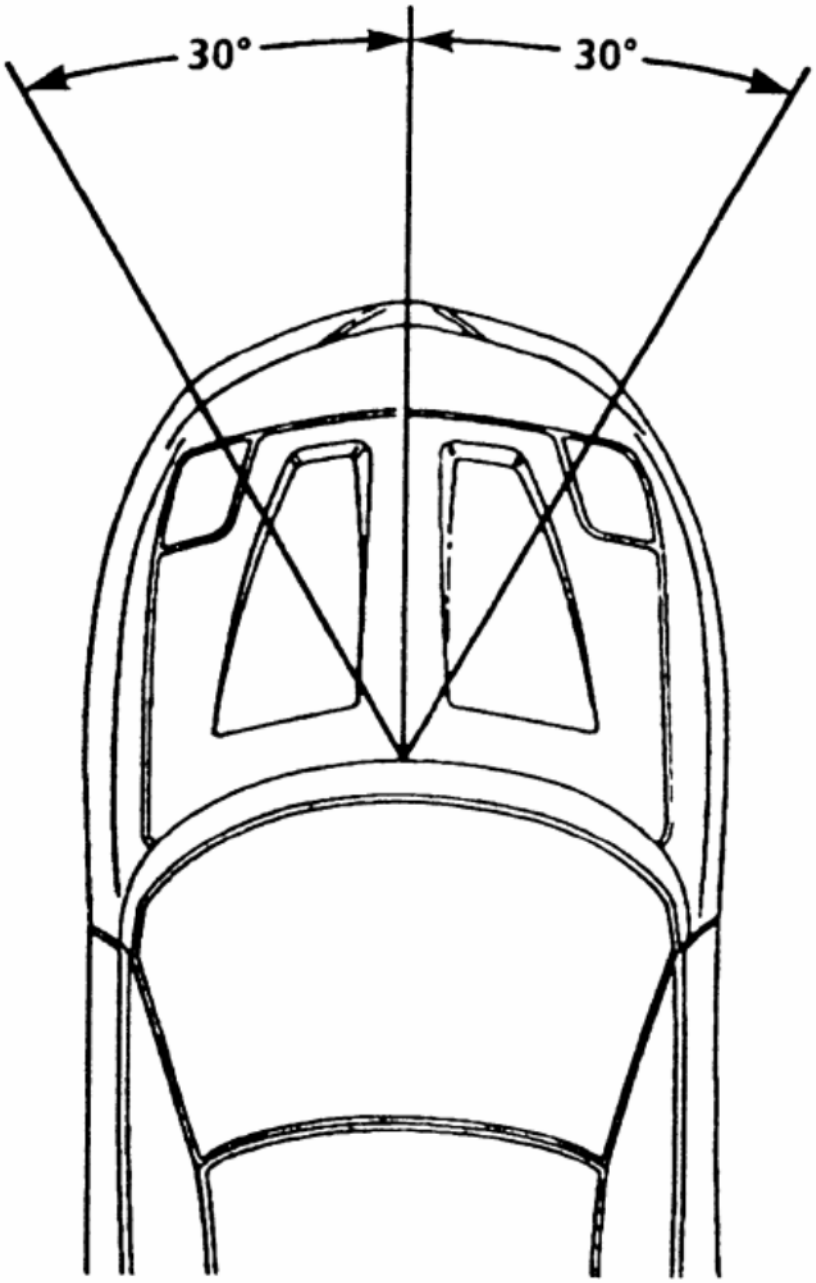



Fig. 1: SIR system deployment window

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## SYSTEM OPERATION

The main portions of the SIR system are the deployment loops and the Diagnostic Energy Reserve Module (DERM). The main function of the deployment loops is to supply current through the inflator module(s), which will cause deployment of the air bag(s) in the event of a frontal crash of sufficient force. The arming sensor, SIR coil assembly (driver side only), passenger inflator module jumper (passenger side only), inflator module(s), passenger compartment discriminating sensor and forward discriminating sensor make up the deployment loops.

The DERM has two functions. One to supply the deployment loops with a 36 volt reserve to ensure sufficient energy is available to deploy the airbag(s) if the battery voltage feed to the arming sensor is lost during a frontal crash. Another function is SIR electrical system diagnostics.

The arming sensor switches power to the inflator module(s) on the high side (power side) of the deployment loops. Either of the discriminating sensors can supply ground to the inflator module(s) on the low side (ground side) of the loop. The inflator module(s) are only supplied sufficient current to deploy when the arming sensor and at least one of the two discriminating sensors are closed simultaneously.

## SYSTEM COMPONENTS

### DIAGNOSTIC ENERGY RESERVE MODULE

The DERM is designed to perform the following functions in the SIR system:

- Energy Reserve - Maintains 36 volt energy reserve(s) to provide deployment energy when the vehicle voltage is low or lost in a frontal impact
- Malfunction Detection - Performs diagnostic monitoring of the SIR system electrical components
- Malfunction Recording - Provides diagnostic trouble code information
- Frontal Crash Recording - Records the SIR system status during a frontal crash

### WARNING LAMP

The "INFL REST" or "AIR BAG" warning lamp is used to do the following:

- Verify lamp and DERM operation by flashing seven to nine times when the ignition key is first turned ON
- Warn the driver of SIR electrical system faults which could potentially affect the operation of the SIR system
- Provide diagnostic information by flashing the fault codes when the diagnostic mode is enabled

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## ARMING SENSOR

The arming sensor is a protective switch located in the power feed side of the deployment loop. It is calibrated to close at low level velocity changes (lower than the discriminating sensors). This assures that the inflator module is connected directly to the 36 volt output of the DERM or battery voltage feed when either of the discriminating sensors close.

## DISCRIMINATING SENSORS

The discriminating sensors are wired in parallel on the ground side of the deployment loop. These sensors are calibrated to close with velocity changes which are severe enough to warrant deployment.

## SIR COIL ASSEMBLY

The SIR coil assembly consists of two current carrying coils. They are attached to the steering column and allow rotation of the steering wheel while maintaining continuous contact of the deployment loop to the inflator module.

## INFLATOR MODULES

Each inflator module consists of an inflatable bag and an inflator (a canister of gas generating material with an initiating device). When the vehicle is in a frontal crash of sufficient force, current flows through the deployment loops. Current flowing through the initiator ignites the material in the inflator module. The gas produced from this reaction rapidly inflates the air bag.

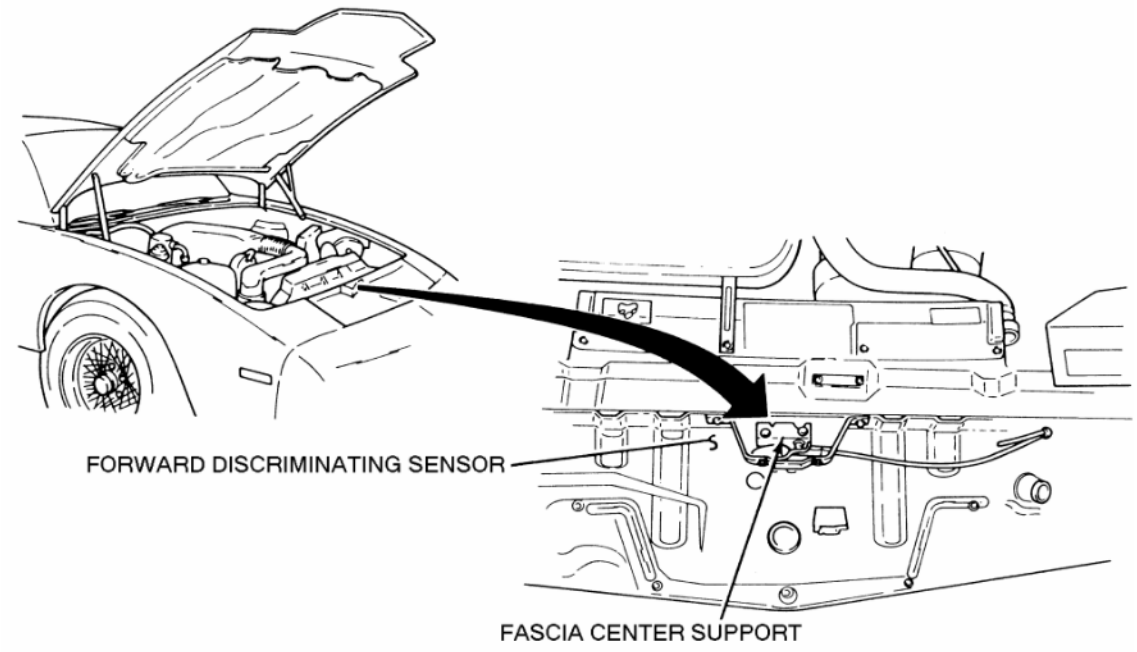



Fig. 2: Forward discriminating sensor location on 1990-1992 models

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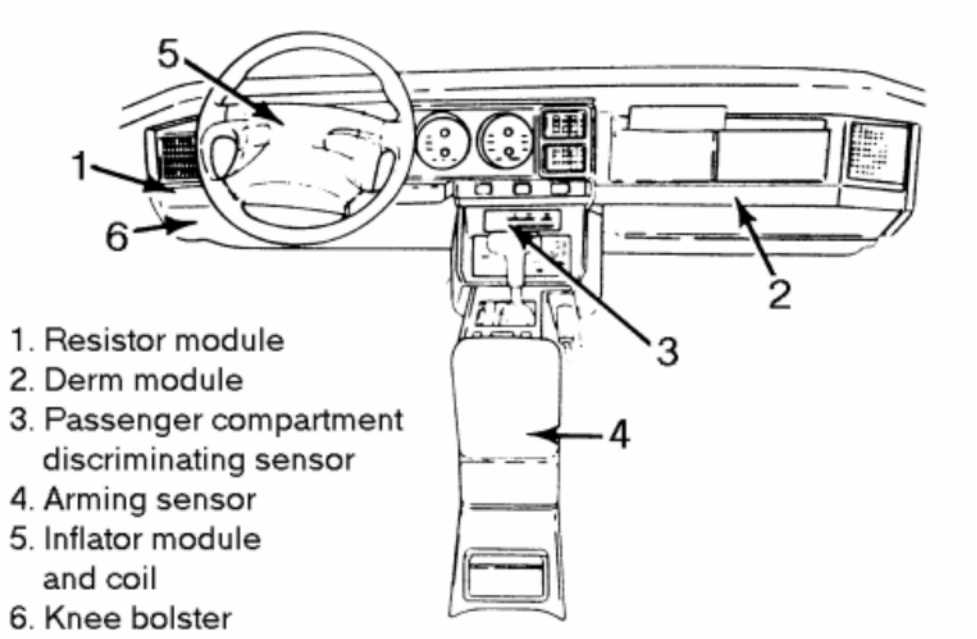



Fig. 3: Passenger compartment SIR component locations on 1990-1992 models

**SERVICE PRECAUTIONS**

The DERM can maintain sufficient voltage to cause a deployment for up to 10 minutes after the ignition switch is turned OFF or the battery is disconnected. *Always disable the system when performing service procedures ON OR NEAR the system and it's components.*

**CAUTION** - The disarming and arming procedures must be followed in the order listed to temporarily disable the SIR system. Failure to do so could result in possible air bag deployment, personal injury or otherwise unneeded SIR system repairs.

**DISARMING THE SYSTEM**

1. Turn the steering wheel so that the vehicle's wheels are pointing straight ahead.
2. Turn the ignition switch to the LOCK position.
3. Remove the SIR or AIR BAG fuse from the fuse panel.
4. Remove the left side trim panel, then remove the Connector Position Assurance (CPA) device and disconnect the yellow two-way SIR harness connector at the base of the steering column.
5. On vehicles with passenger side air bags, remove the glove box door then disconnect the yellow two-way connector located near the yellow 24-way DERM harness connector.

*With the fuse removed and the ignition switch ON, the air bag warning lamp will be on. This is normal and does not indicate a SIR system malfunction.*

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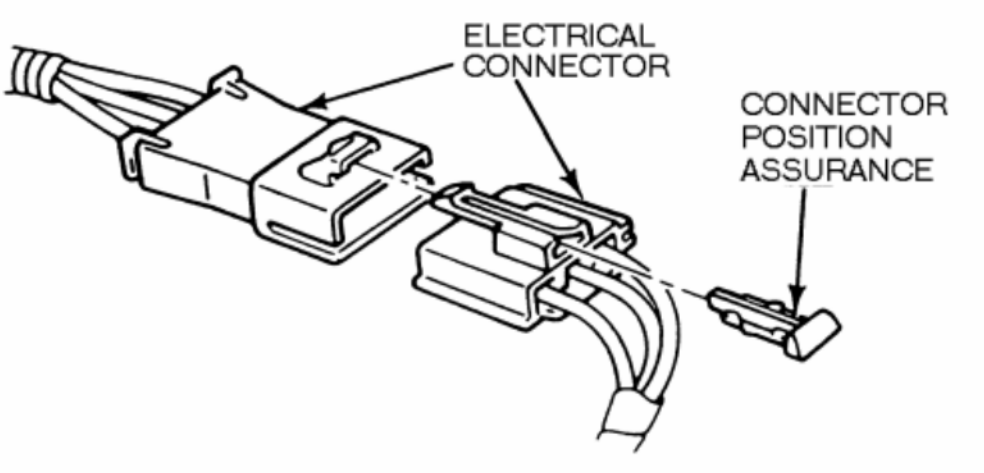
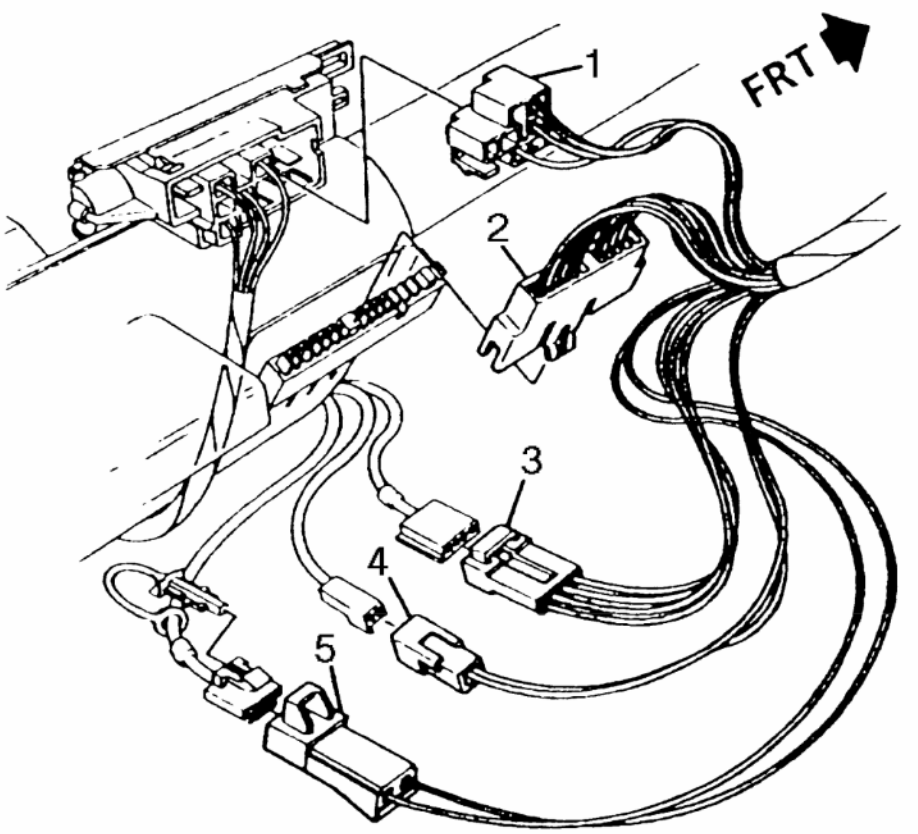



Fig. 4: Connector Position Assurance (CPA) device removal




1. Ignition switch harness connector
2. Turn signal, hazards and horn harness connector
3. Redundant radio control harness connector (Firebird with UK3)
4. Ignition lock cylinder (Pass-key®) harness connector
5. Steering column (Yellow 2-way) harness connector

Fig. 5: Drivers side yellow two way SIR connector location. The connector on the passenger side air bag is located behind the glove compartment

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## ARMING THE SYSTEM

1. Turn the ignition key to the LOCK position and remove the key.
2. On vehicles with a passenger side air bag, reconnect the yellow two-way connector assembly located near the yellow 24-way DERM harness connector. Install the glove box door assembly.
3. Connect the yellow two-way connector assembly at the base of the steering column.

*Always be sure to reinstall the Connector Position Assurance (CPA) device.*

4. Install the left side trim panel and reinstall the fuse in the fuse block.
5. Turn the ignition key to the RUN position and verify that the warning lamp flashes seven to nine times and then turns OFF. If it does not operate as described, have the system repaired by a qualified technician.

## HEATING AND AIR CONDITIONING

### BLOWER MOTOR

### REMOVAL & INSTALLATION

1. Disconnect the negative battery cable. If necessary, remove the diagonal fender brace at the right rear corner of the engine compartment to gain access to the blower motor.
2. Disconnect the electrical wiring from the blower motor. If equipped with air conditioning, remove the blower relay and bracket as an assembly and swing them aside.
3. Remove the blower motor cooling tube.
4. Remove the blower motor retaining screws.
5. Remove the blower motor and fan as an assembly from the case.

To install:

6. Position the blower motor into place and install the retaining screws.
7. Install the blower motor cooling tube.
8. Connect all the electrical connections.
9. Connect the negative battery cable.

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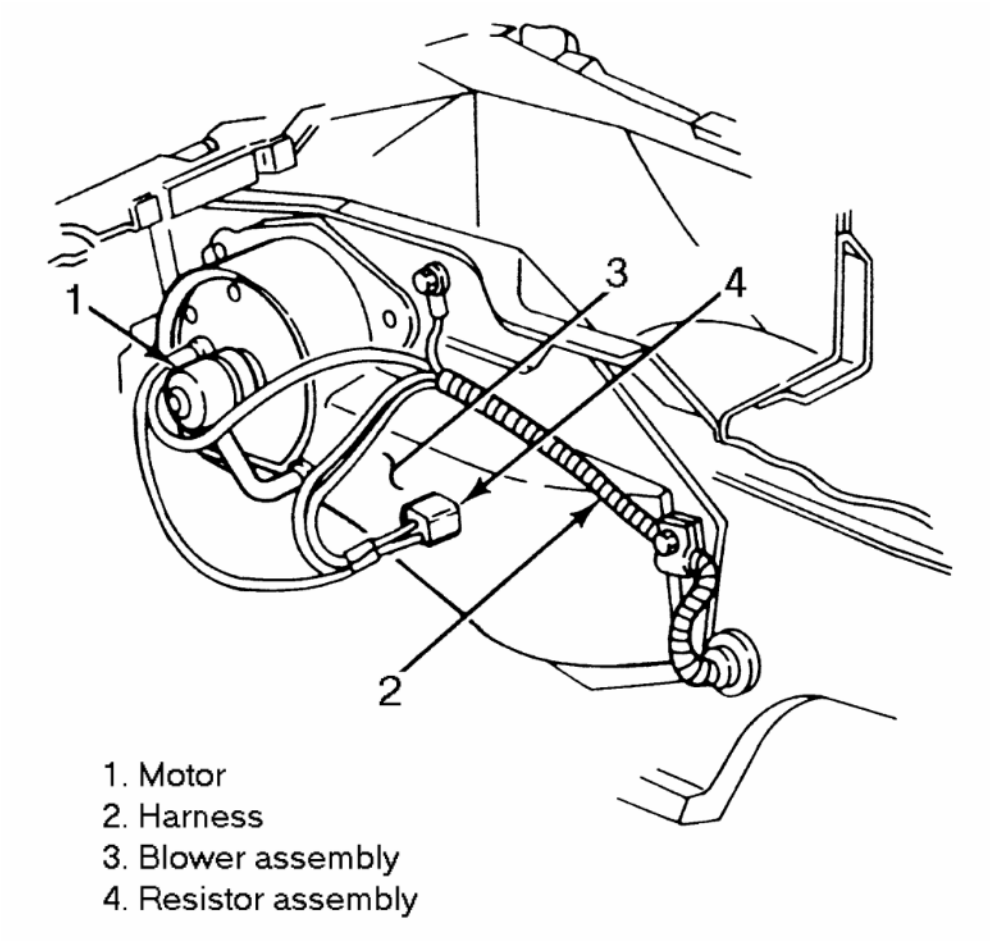



Fig. 1: Blower motor case assembly

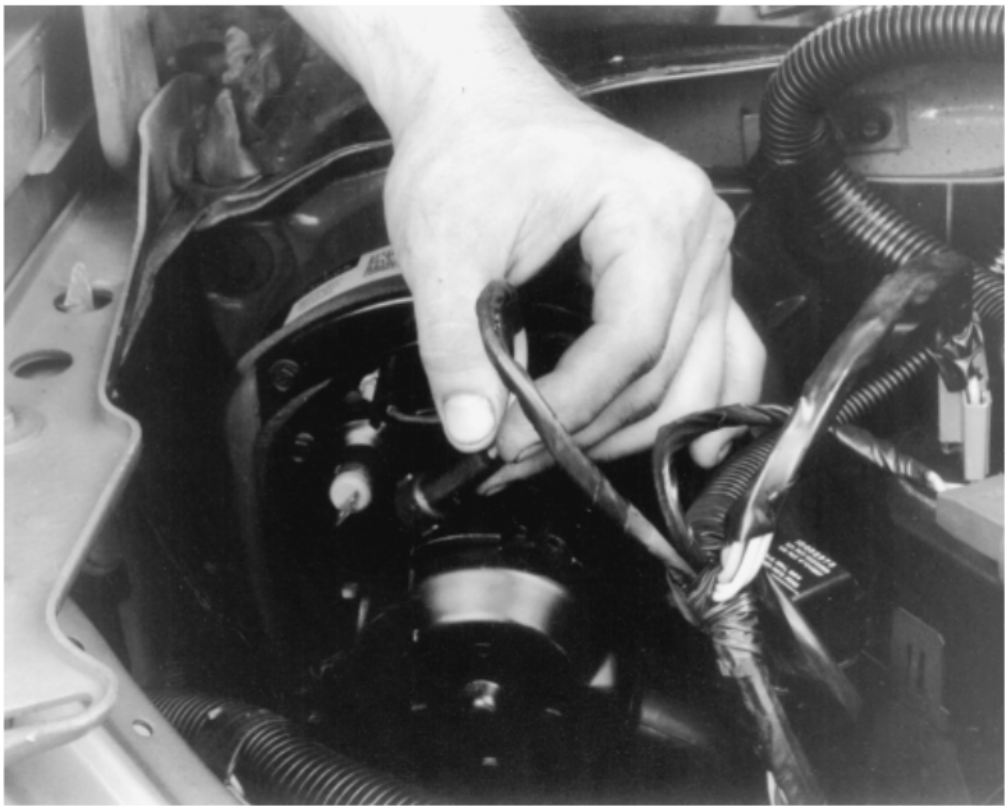


Fig. 2: Disconnect the blower motor electrical connector by pulling it straight out

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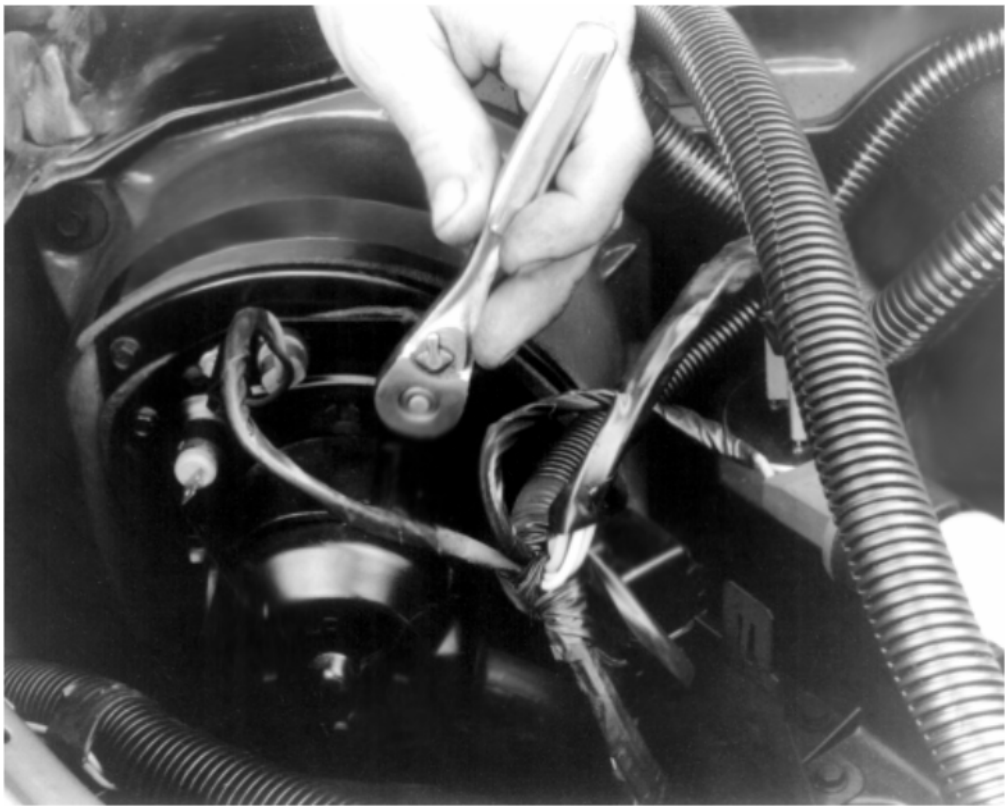


Fig. 3: Removing the blower motor attaching bolts

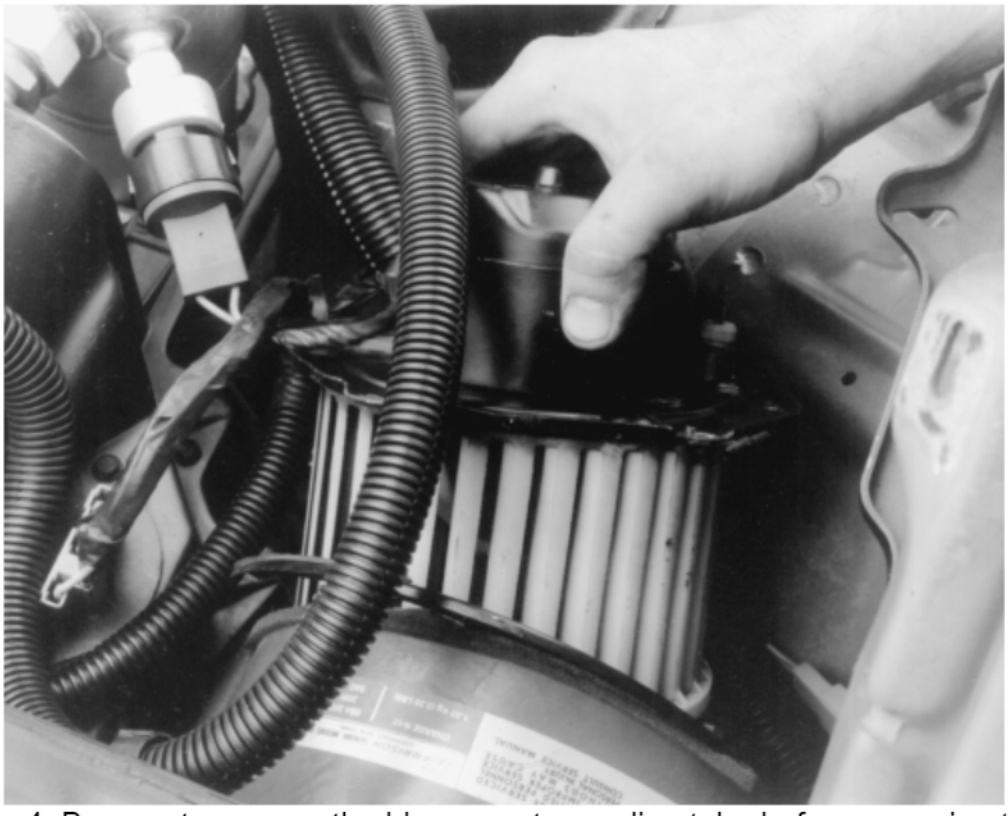


Fig. 4: Be sure to remove the blower motor cooling tube before removing the motor from the case

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## HEATER CORE

## REMOVAL & INSTALLATION

**CAUTION** - When draining the coolant, keep in mind that cats and dogs are attracted by the ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

1. Drain the cooling system.
2. Remove both heater hoses.
3. Remove the lower right hush panel.
4. Remove the lower right instrument panel and the ESC module if necessary.
5. Remove the lower right instrument panel-to-cowl screw.
6. Remove the heater case screws.

*The upper left screw may be reached with a long socket extension. Carefully lift the lower right corner of the instrument panel to align the extension.*

7. Remove the case cover.
8. Remove the support plate and baffle screws.
9. Remove the heater core and baffle plate from the housing.

To install:

10. Position the heater core and baffle plate into the housing.
11. Install the support plate and baffle screws.
12. Install the case cover.
13. Install the heater case screws.
14. Install the lower right instrument panel-to-cowl screw.
15. Install the lower right instrument panel and the ESC module if necessary.
16. Install the lower right hush panel.
17. Install both heater hoses.
18. Fill the cooling system and check for leaks.

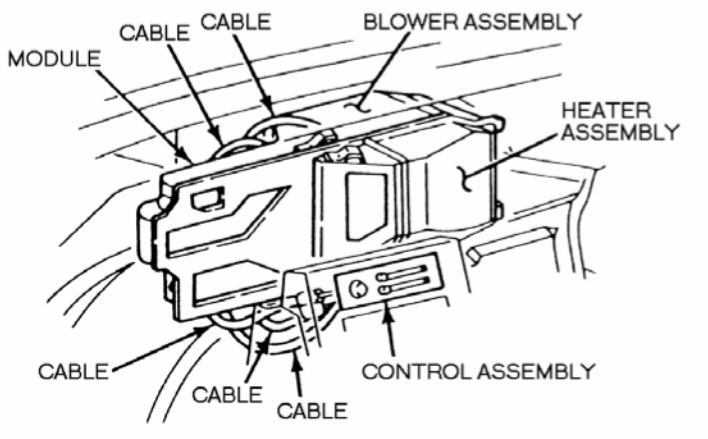



Fig. 1: Heater module assembly

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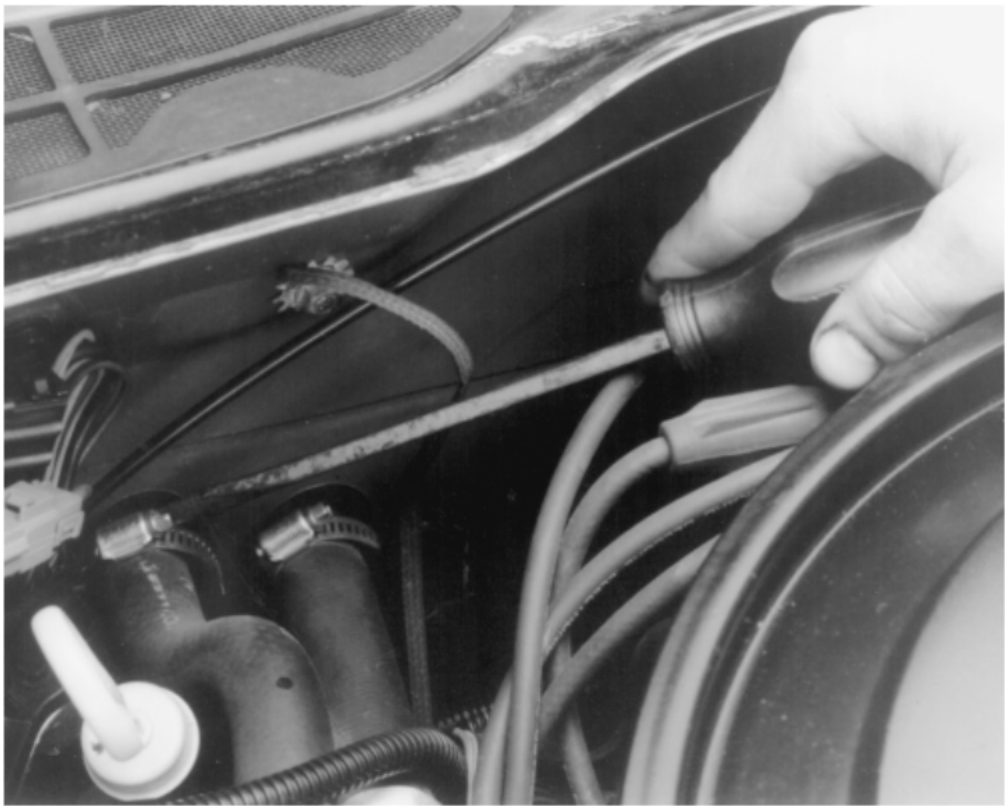


Fig. 2: Removing the heater core inlet hoses



Fig. 3: Removing the sound insulator attaching screws

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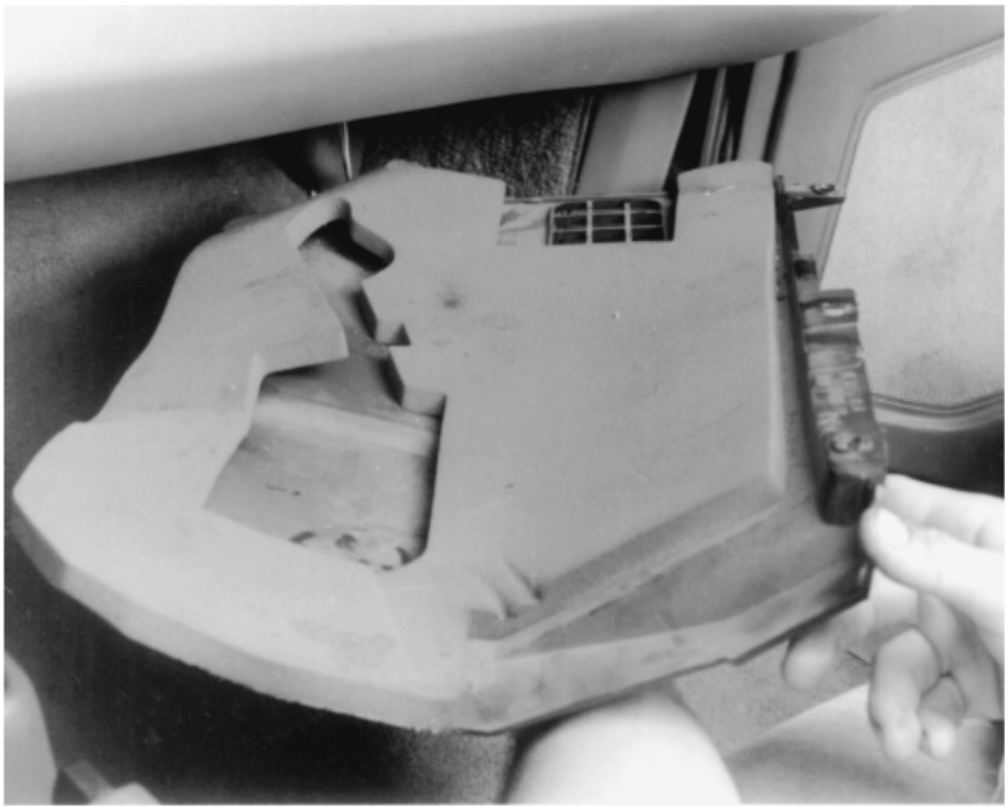


Fig. 4: Once the sound insulator has been removed, the heater module can be accessed

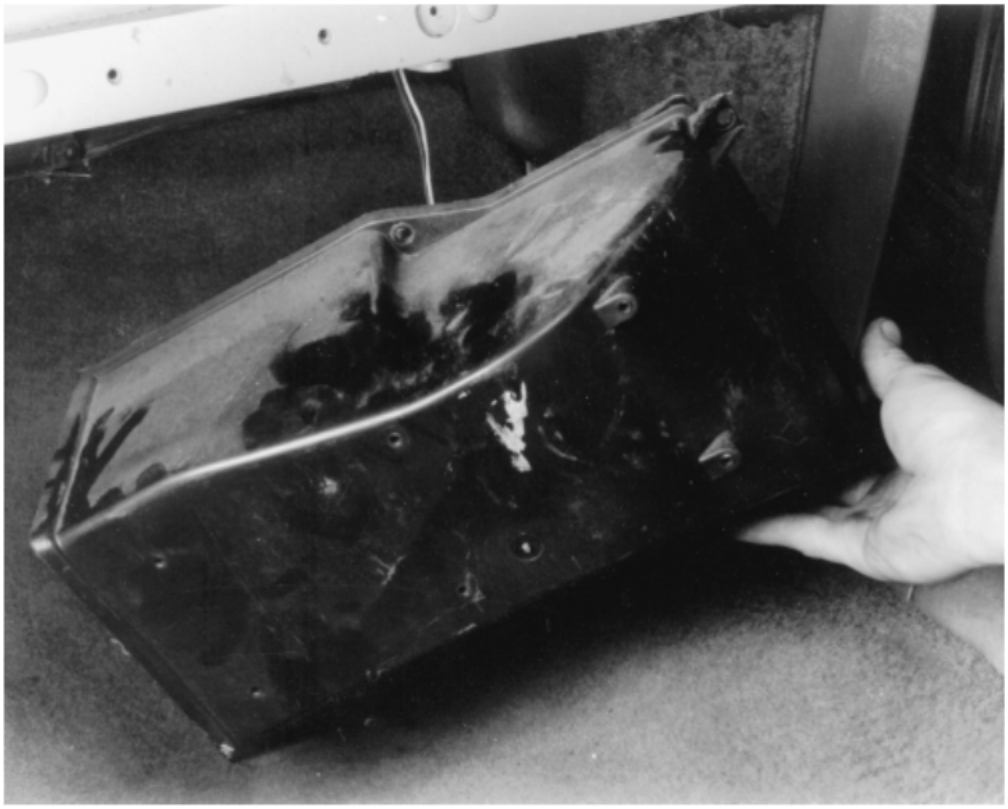


Fig. 5: Removing the heater module cover

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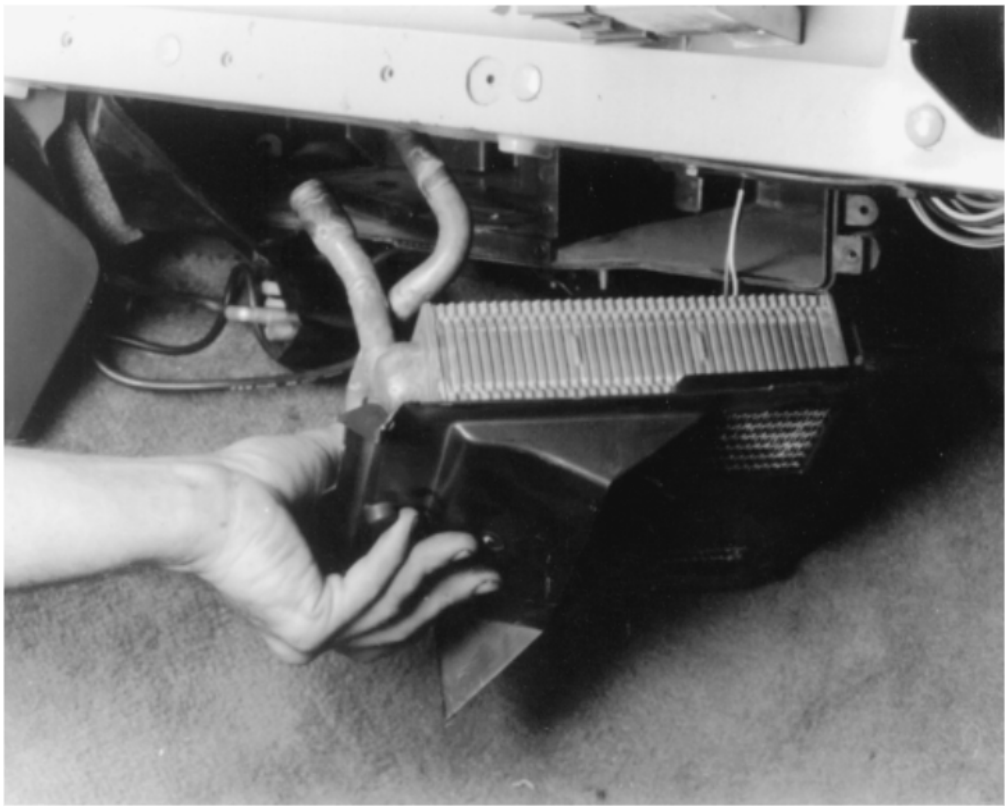


Fig. 6: Be careful not to allow any coolant to drain on the carpet when removing the heater core

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## HOT WATER VALVE

## REMOVAL & INSTALLATION

*Not all model years and engine applications use hot water valves.*

1. Drain the coolant.
2. Disconnect the vacuum hose at the hot water valve by sliding the tab of the connector past the L-shaped bend in the actuator vacuum tube. Then, slide the hose connector off the tube while continuing to hold the tab back against the connector end.
3. Disconnect the heater hoses from the valve.

To install:

4. Install the valve with the vacuum actuator facing up. The heater hoses will hold the valve in position.
5. Install the vacuum hose to the actuator.
6. Refill the cooling system. Run the engine long enough to purge any trapped air, then add more coolant if necessary.
7. Check for leaks.

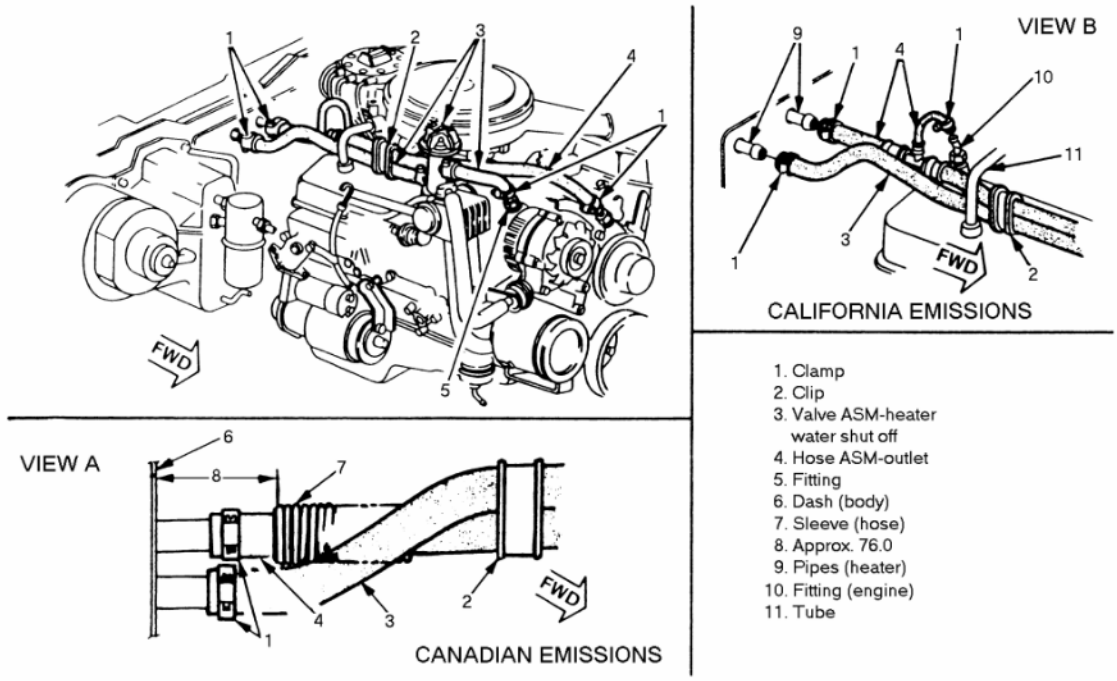



Fig. 1: Hot water valve location on carbureted V8 engines

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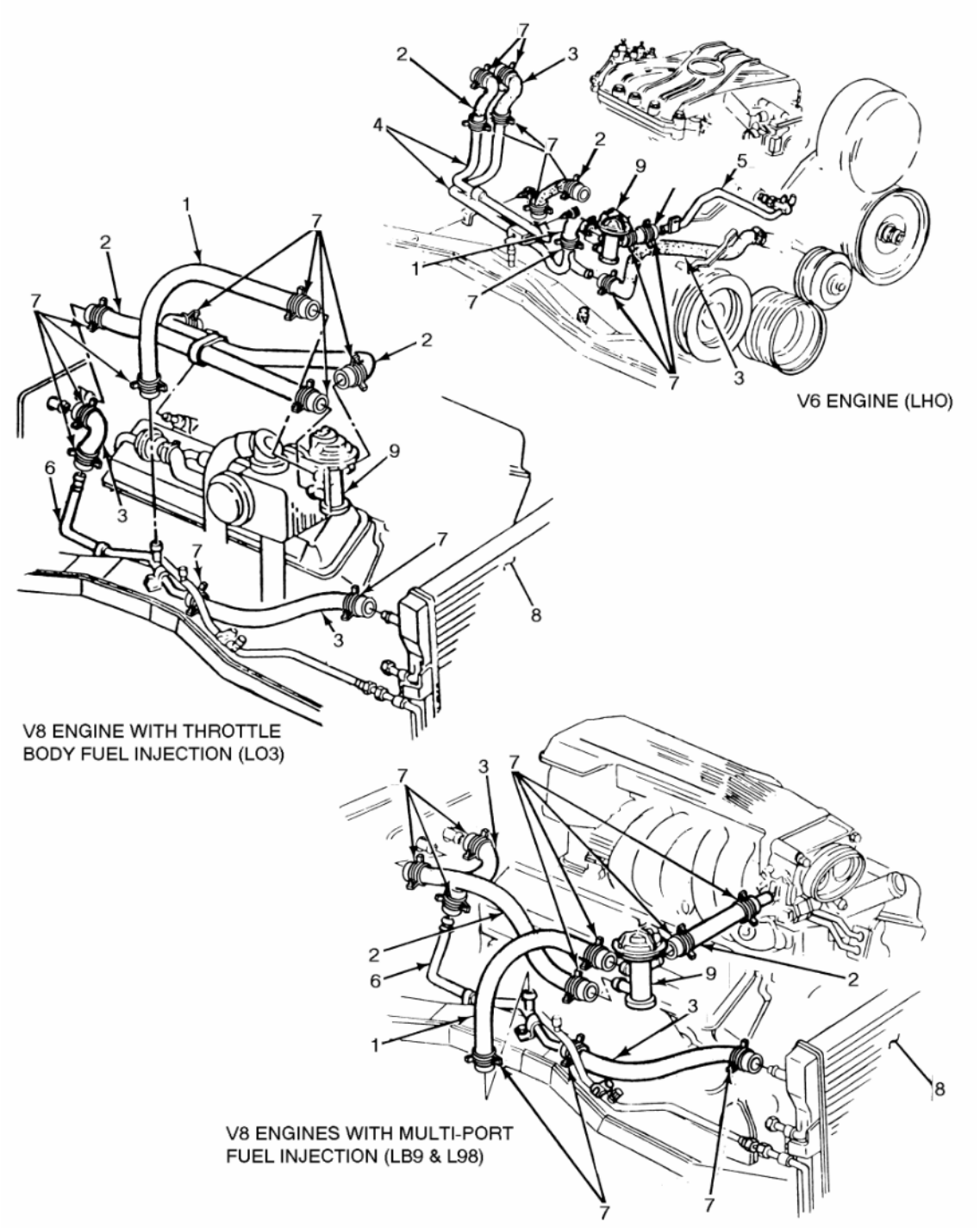



Fig. 2: Hot water valve location on fuel injected engines

## AIR CONDITIONING COMPONENTS

## REMOVAL & INSTALLATION

Repair or service of air conditioning components is not covered by this information, because of the risk of personal injury or death, and because of the legal ramifications of servicing these components without the proper EPA certification and experience. Cost, personal injury or death, environmental

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damage, and legal considerations (such as the fact that it is a federal crime to vent refrigerant into the atmosphere), dictate that the A/C components on your vehicle should be serviced only by a Motor Vehicle Air Conditioning (MVAC) trained, and EPA certified automotive technician.

*If your vehicle's A/C system uses R-12 refrigerant and is in need of recharging, the A/C system can be converted over to R-134a refrigerant (less environmentally harmful and expensive). Refer to* General Information & Maintenance *for additional information on R-12 to R-134a conversions, and for additional considerations dealing with your vehicle's A/C system.*

## CONTROL CABLES

## REMOVAL & INSTALLATION

*Some of the following cables will not be used on all models and model years.*

Left and Right Air Vent Cables

1. Remove the left and right sound insulators.
2. Remove the screws attaching the cables to the steering column cover.
3. Disengage the cable clamps at the vent ducts.
4. Disengage the Z-shaped cable ends from the vent valve levers.
5. Remove the air vent cables noting their positions for installation.

To install:

6. Place the cables in position under the instrument panel.
7. Engage the Z-shaped cable ends to the vent valve levers.
8. Snap the cable clamps into the slot of the bracket formed on the vent ducts.
9. Attach the air vent cables at the steering column cover.
10. Install the sound insulators and test cable operation.

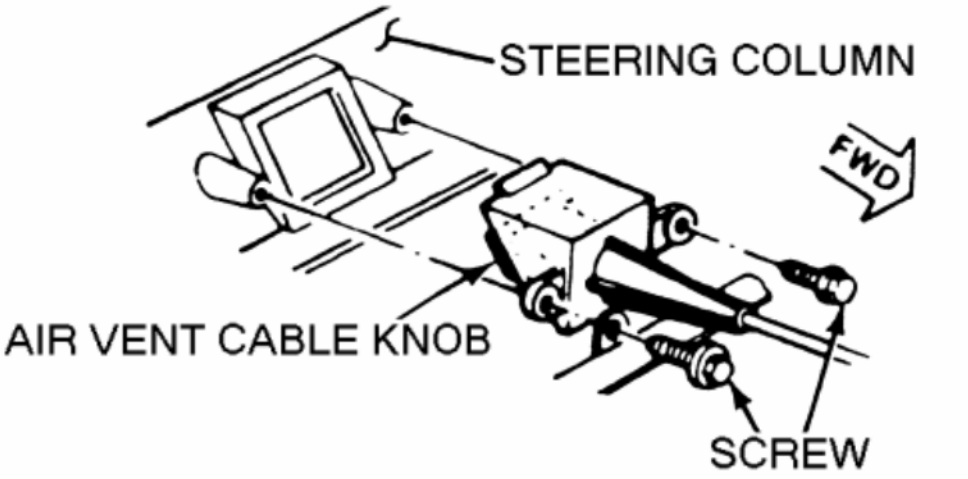



Fig. 1: Cable attachment at the steering column cover

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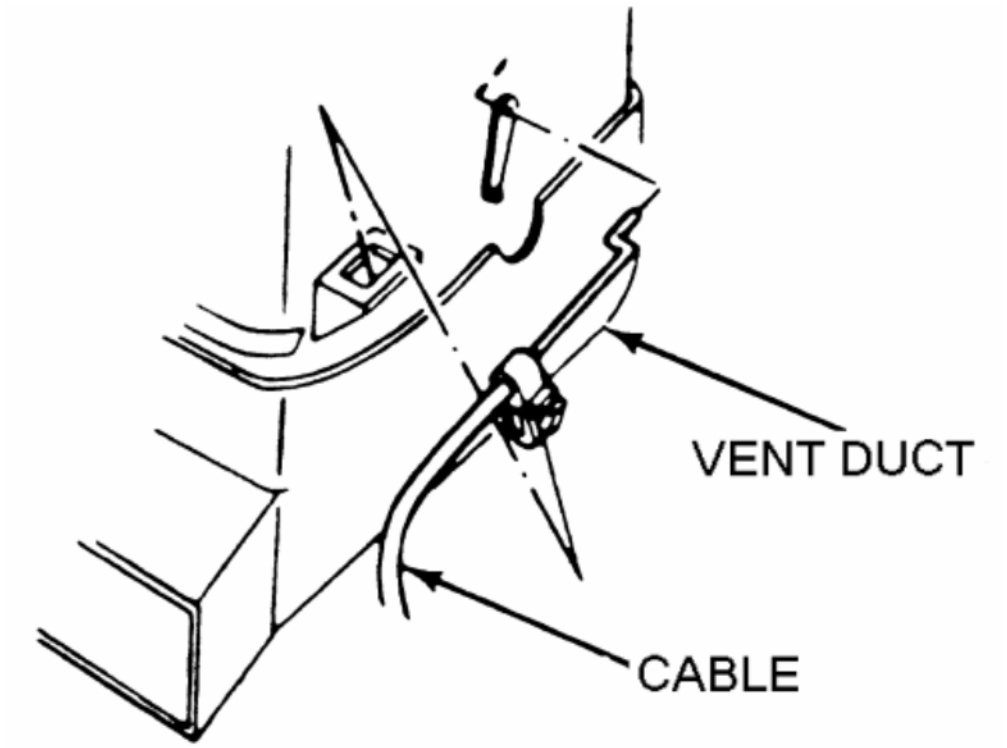



Fig. 2: Cable attachment at the left vent duct

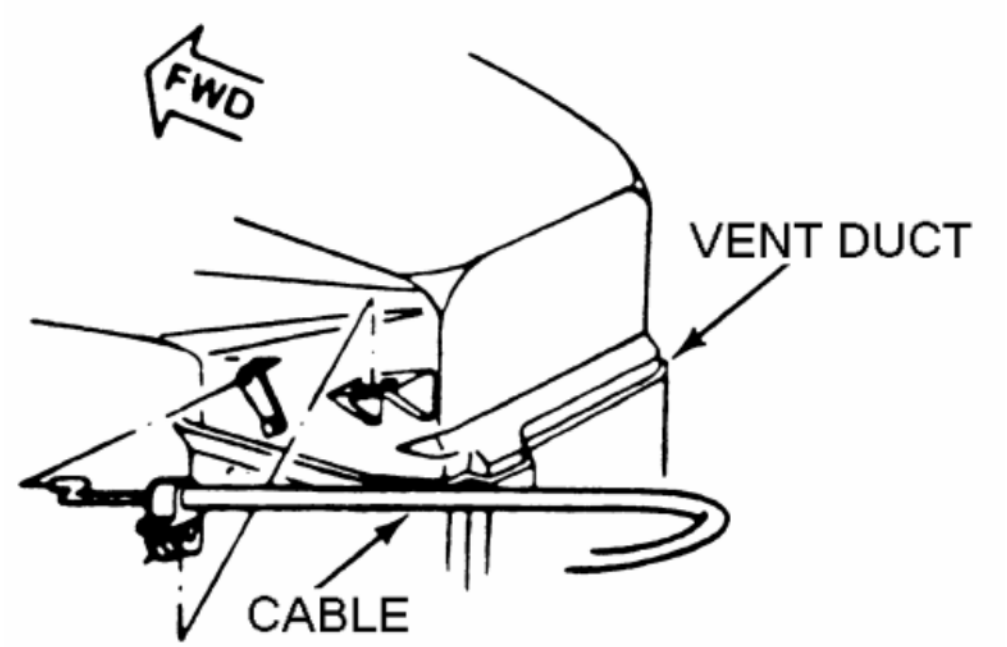



Fig. 3: Cable attachment at the right vent duct

**VENT CONTROL CABLE**

1. Remove the right side sound insulator.
2. Remove the push nut retainer holding the cable self-adjusting clip to the vent valve lever pin.
3. Disengage the cable clamp from the slot in the bracket on the heater module.

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4. Remove the radio and heater control panel trim plate.
5. Remove the heater control head attaching screws and remove the control head.
6. Pull the vent control cable clip from the control assembly, then tilt the assembly to slip the vent control cable end loop off the pin of the mode lever.
7. Remove the vent control cable.

To install:

8. Install the vent control cable to the control assembly and install the control head.
9. Install the radio and heater control trim plate.
10. Fit the cable self-adjusting clip onto the vent valve lever pin.
11. Snap the cable clamp into the slot in the bracket on the heater module.
12. Install the push nut retainer to the vent valve lever pin.
13. Install the right side sound insulator.
14. Check operation and adjust the cable if necessary.

**DEFROST CONTROL CABLE**

1. Remove the left side sound insulator.
2. Remove the push nut retainer holding the cable self-adjusting clip to the defroster valve lever pin at the heater module.
3. Disengage the cable clamp from the slot in the bracket on the heater module.
4. Remove the radio and heater control trim plate.
5. Remove the control head assembly.
6. Disconnect the defroster control cable by pulling the cable clip from the control assembly. Then tilt the control assembly to slip the control cable end loop off the pin of the mode lever.
7. Remove the cable.

To install:

8. Install the defroster control cable to the control assembly and install the control head.
9. Install the radio and heater control trim plate.
10. Fit the cable self-adjusting clip onto the defroster valve lever pin.
11. Snap the cable clamp into the slot in the bracket on the heater module.
12. Install the push nut retainer to the defroster valve lever pin.
13. Install the left side sound insulator.
14. Check operation and adjust the cable if necessary.

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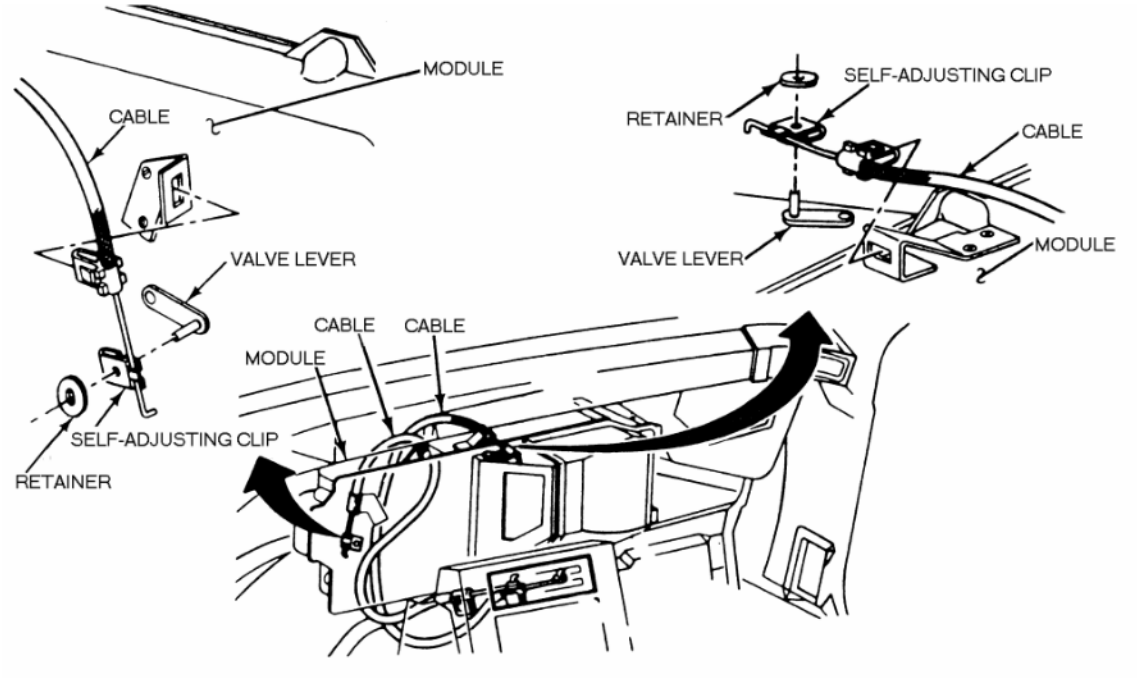



Fig. 4: Vent and defroster control cable attachments at the module

## TEMPERATURE CONTROL CABLE

1. Remove the right side sound insulator.
2. Remove the cable cover attaching screws and remove the cover.
3. Remove the push nut retainer holding the cable self-adjusting clip to the temperature valve lever pin.
4. Disengage the cable clamp from the slot in the bracket on the heater module.
5. Remove the radio and heater control panel trim plate.
6. Remove the heater control head attaching screws and remove the control head.
7. Remove the temperature control cable push nut retainer.
8. Pull the temperature control cable clip from the control assembly, then tilt the assembly to slip the vent control cable end loop off the pin of the mode lever.
9. Remove the temperature control cable.

To install:

10. Install the temperature control cable to the control assembly. Install the cable push nut retainer and install the control head.
11. Install the radio and heater control trim plate.
12. Fit the cable self-adjusting clip onto the temperature valve lever pin.
13. Snap the cable clamp into the slot in the bracket on the heater module.
14. Install the push nut retainer to the temperature valve lever pin.
15. Install the cable cover.
16. Install the right side sound insulator.
17. Check operation and adjust the cable if necessary.

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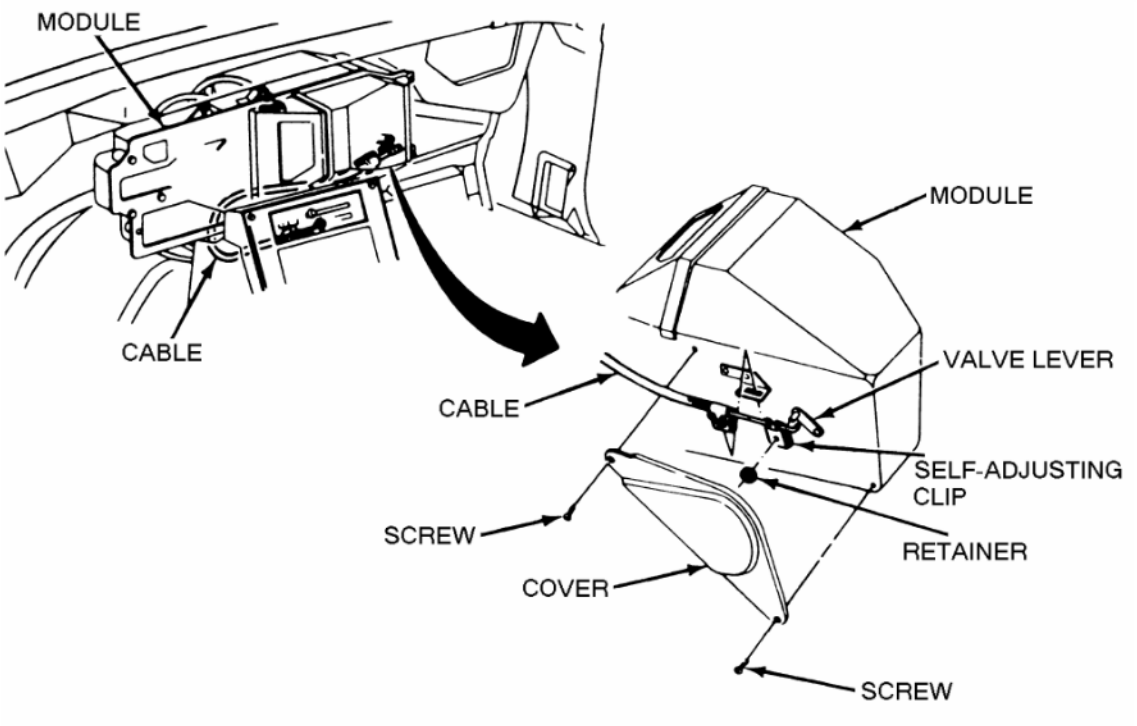



Fig. 5: Temperature control cable attachment at the module

## ADJUSTMENTS

The control cables are connected at the heater module to the air valve that each cable operates. The cable ends are attached to the air valve crank arm by a self-adjusting clip that grips the cable core firmly. Adjustment can be accomplished by moving the mode lever (to adjust the vent or defrost control cables) or the temperature lever (to adjust the temperature control cable) briskly back and forth to both extremes of lever travel in the control assembly. When the cable is properly adjusted, the air valve may be heard hitting it's stop at both extremes of travel.

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## CONTROL HEAD

## REMOVAL & INSTALLATION

1. Disconnect the negative battery cable.
2. Remove the air conditioning/radio console trim plate.
3. Remove the control head retaining screws.
4. Pull the assembly forward, disconnect the electrical and vacuum connections. Remove the temperature control cable.
5. Remove the control assembly from the vehicle.

To install:

6. Position the control head into the vehicle.
7. Install the temperature control cable.
8. Connect the electrical and vacuum connections and push the assembly rearward.
9. Install the control head retaining screws.
10. Install the air conditioning/radio console trim plate.
11. Connect the negative battery cable.

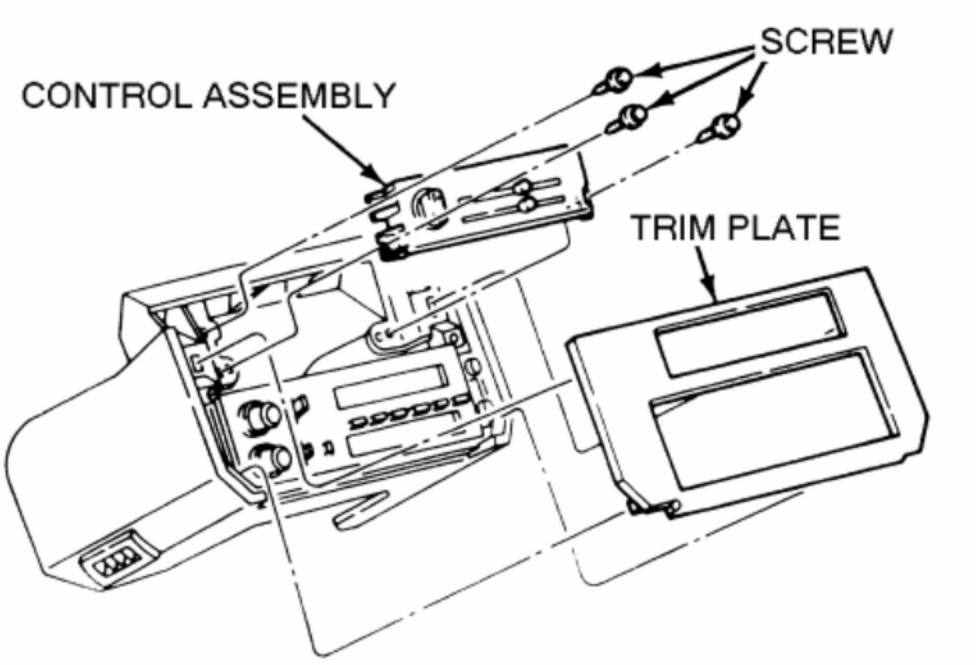
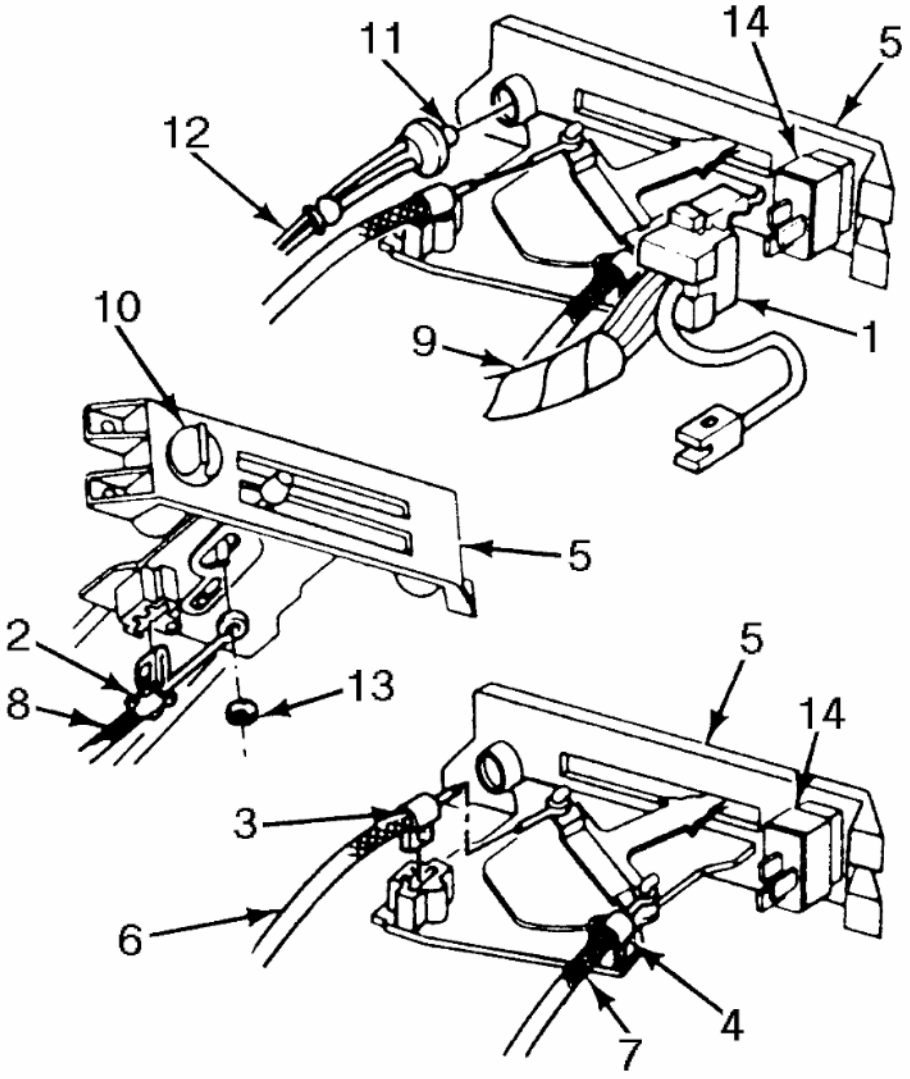



Fig. 1: Control head assembly

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1. Blower switch connector
2. Temperature control cable clip
3. Vent control cable clip
4. Defroster control cable clip
5. Control assembly
6. Cable
7. Cable
8. Cable
9. Harness
10. Blower switch knob
11. Bulb
12. Harness
13. Retainer
14. Switch

Fig. 2: Control head assembly attachments

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## BLOWER SWITCH

With the control head removed from the vehicle, the blower switch may be removed by pulling the blower switch knob off and removing the retaining clip or retaining screws.

## VACUUM MOTORS

### OPERATION

Used on certain heating and air conditioning systems, the vacuum actuators operate the air doors determining the different modes. The actuator consists of a spring loaded diaphragm connected to a lever. When vacuum is applied to the diaphragm, the lever moves the control door to its appropriate position. When the lever on the control panel is moved to another position, vacuum is cut off and the spring returns the actuator lever to its normal position.

### TESTING

1. Disconnect the vacuum line from the actuator.
2. Attach a hand held vacuum pump to the actuator.
3. Apply vacuum to the actuator.
4. The actuator lever should move to its engaged position and remain there while vacuum is applied.
5. When vacuum is released it should move back to its normal position.
6. The lever should operate smoothly and not bind.

### REMOVAL & INSTALLATION

1. Remove the vacuum lines from the actuator.
2. Disconnect the linkage from the actuator.
3. Remove the hardware attaching the actuator.
4. Remove the actuator.

To install:

5. Install the actuator and attaching hardware.
6. Connect the linkage to the actuator.
7. Connect the vacuum lines to the actuator.
8. Test system to confirm proper functioning of the actuator.

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## CRUISE CONTROL

## CONTROL SWITCHES

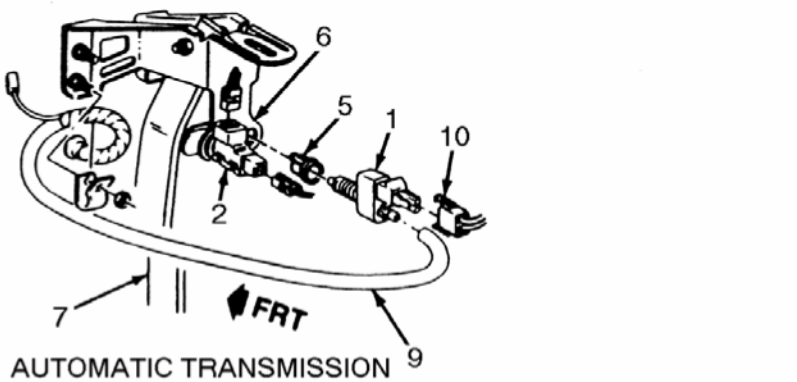
## REMOVAL & INSTALLATION

## RELEASE SWITCH

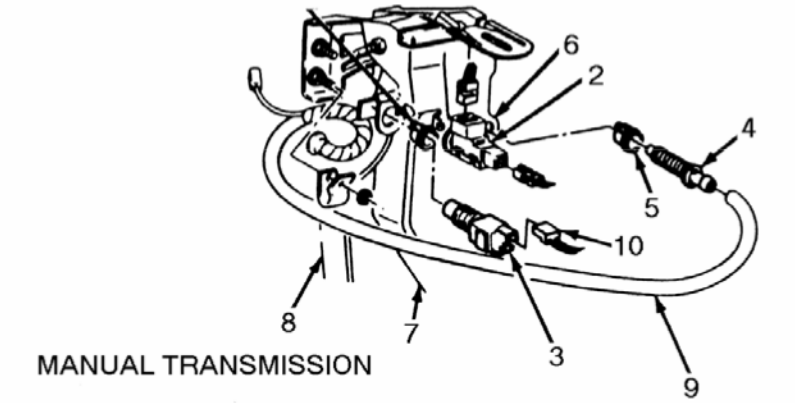
1. At the brake switch, remove either the 2 electrical connectors or the electrical connector and the vacuum hose.
2. Remove the switch from the retainer.
3. Remove the tubular retainer from the brake pedal mounting bracket.

To install:

4. Install the tubular retainer to the brake pedal mounting bracket.
5. Press the brake pedal and install the release switch into the retainer until fully seated in the clips.
6. Connect the wiring and/or vacuum lines. Adjust the switch.




AUTOMATIC TRANSMISSION




MANUAL TRANSMISSION

1. Cruise control vacuum release assembly and TCC switch
2. Stop light and cruise control switch
3. Clutch cruise control switch
4. Vacuum release valve
5. Retainer
6. Brake pedal bracket
7. Brake pedal
8. Clutch pedal
9. Vacuum line
10. I/P wiring harness

Fig. 1: Cruise control release switches

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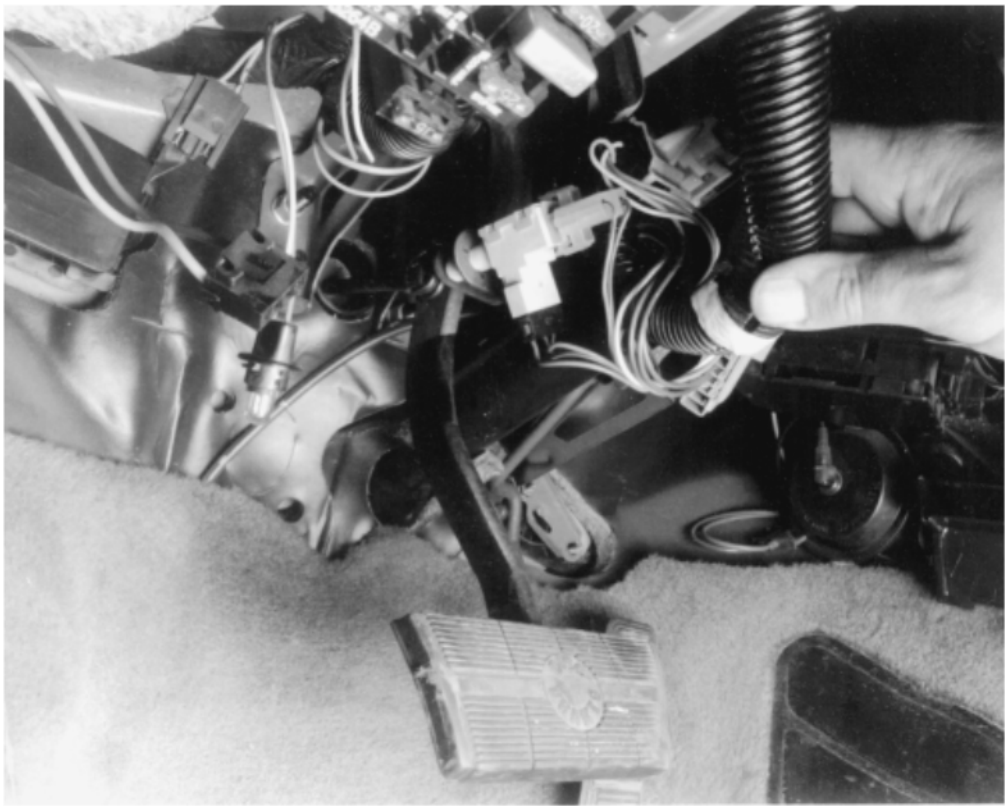


Fig. 2: Cruise control release switch location; all models similar

## ENGAGEMENT SWITCH

The engagement switch cannot be serviced. The complete multi-function lever (turn signal lever) must be replaced as an assembly.

## ADJUSTMENT

1. Depress the brake pedal and check that the release switch is fully seated in the clips.
2. Slowly pull the brake pedal back to the at-rest position; the switch and valve assembly will move within the clips to the adjusted position.
3. Measure pedal travel and check switch engagement. The electric brake release switch contacts must open at less than 1 inch (25.4 mm) of pedal travel. The vacuum release should engage between $^{5}/_{8}$ and 1 inch (16-25mm) of pedal travel.

## SERVO

## REMOVAL & INSTALLATION

1. Disconnect the electrical connector and vacuum hoses at the servo.
2. Disconnect the actuating chain, cable or rod from the servo.
3. Remove the screws holding the vacuum servo and solenoid unit to the bracket, then remove the unit.

To install:

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4. Connect the large diameter brake release vacuum line to the servo unit. Connect the vacuum hose from the vacuum control valve to the servo unit.
5. Connect the actuating chain, rod or cable to the servo.
6. Install the servo unit to the bracket; tighten the screws to 12 inch lbs. (1.4 Nm).
7. Install the electrical connector to the servo.
8. Adjust the cable, rod or chain.

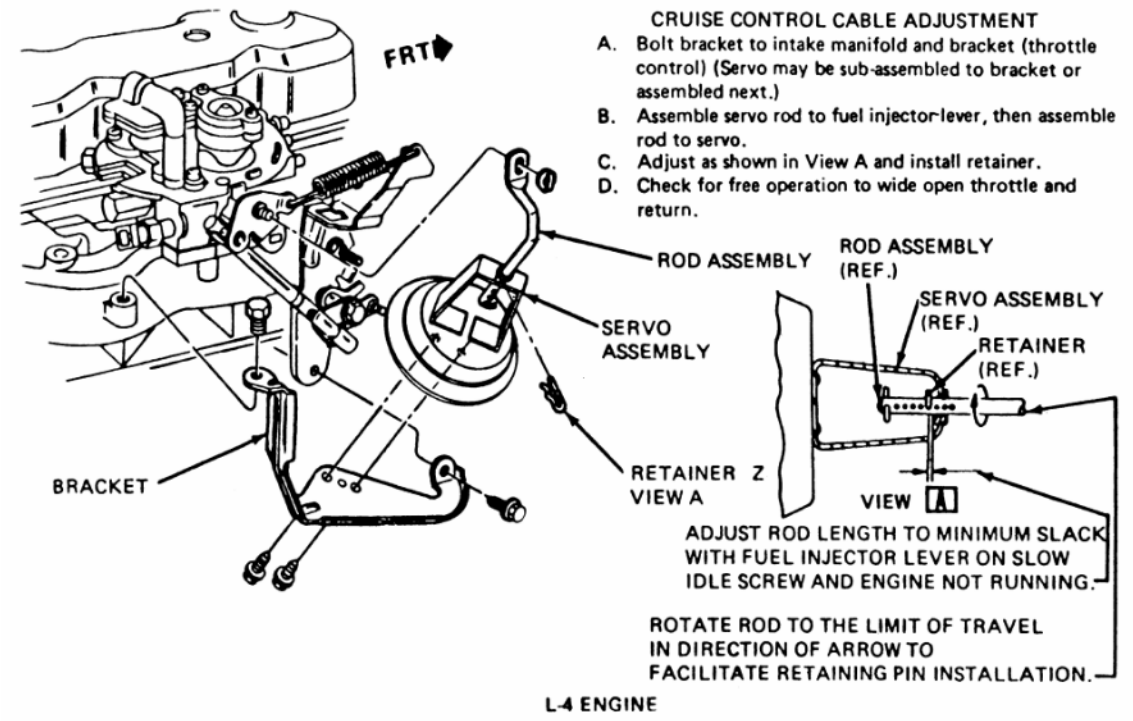



Fig. 1: Servo mounting on 1982-1984 2.5L engines

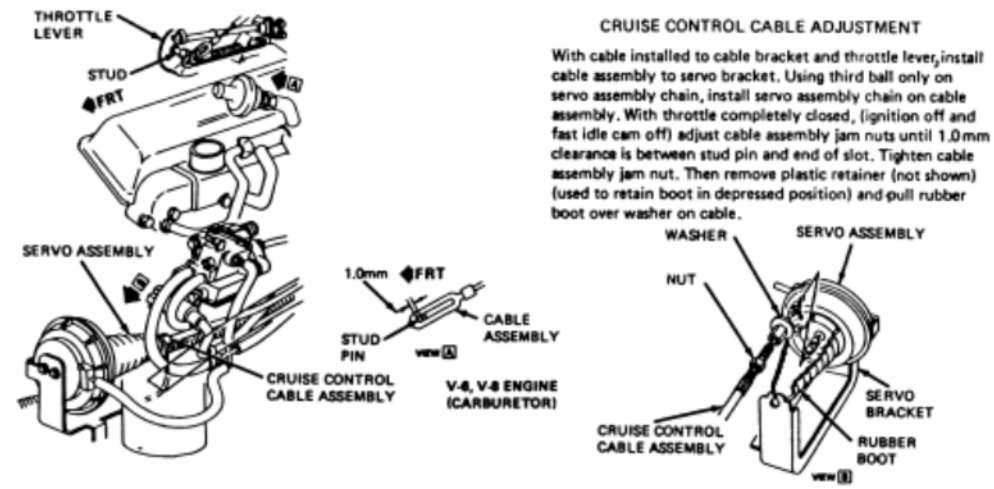



Fig. 2: Servo mounting on 1982-1984 carbureted V6 and V8 engines

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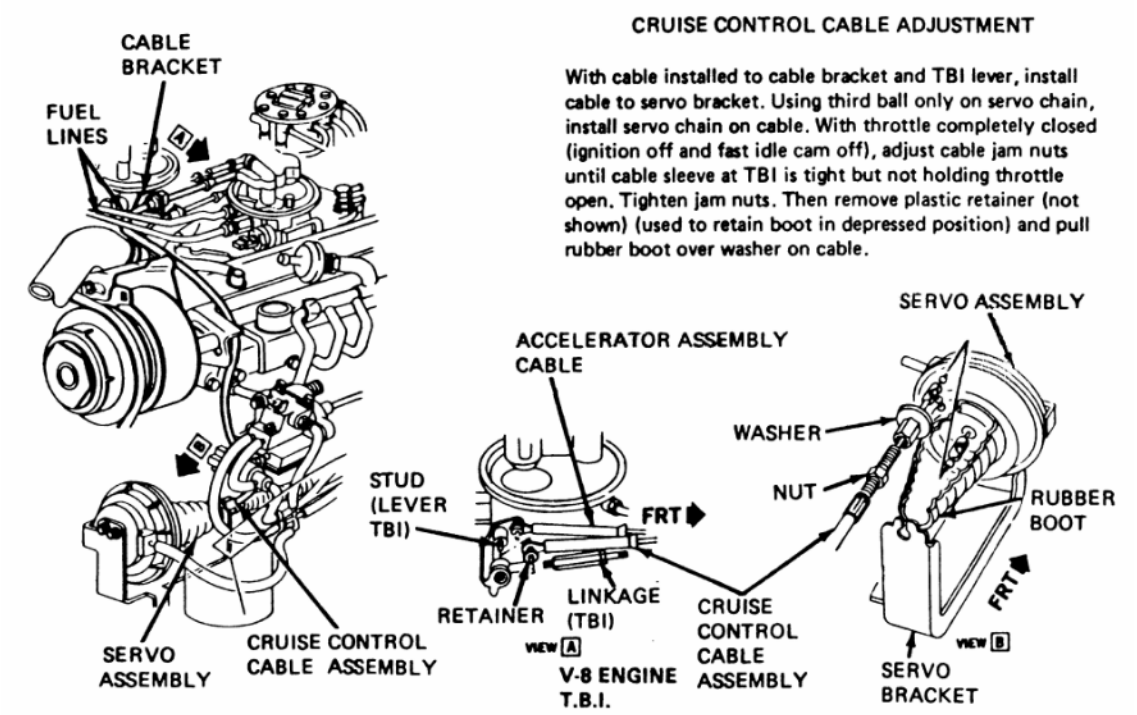



Fig. 3: Servo mounting on Crossfire Injection engines

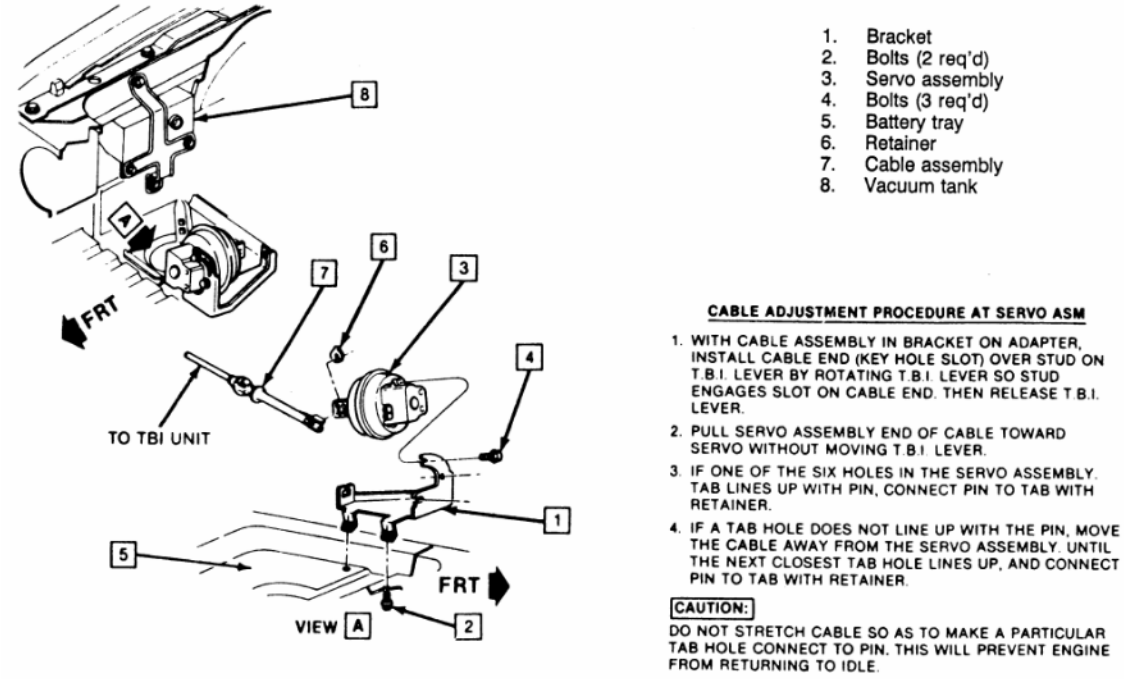



Fig. 4: Servo mounting on 1985-1986 2.5L engines

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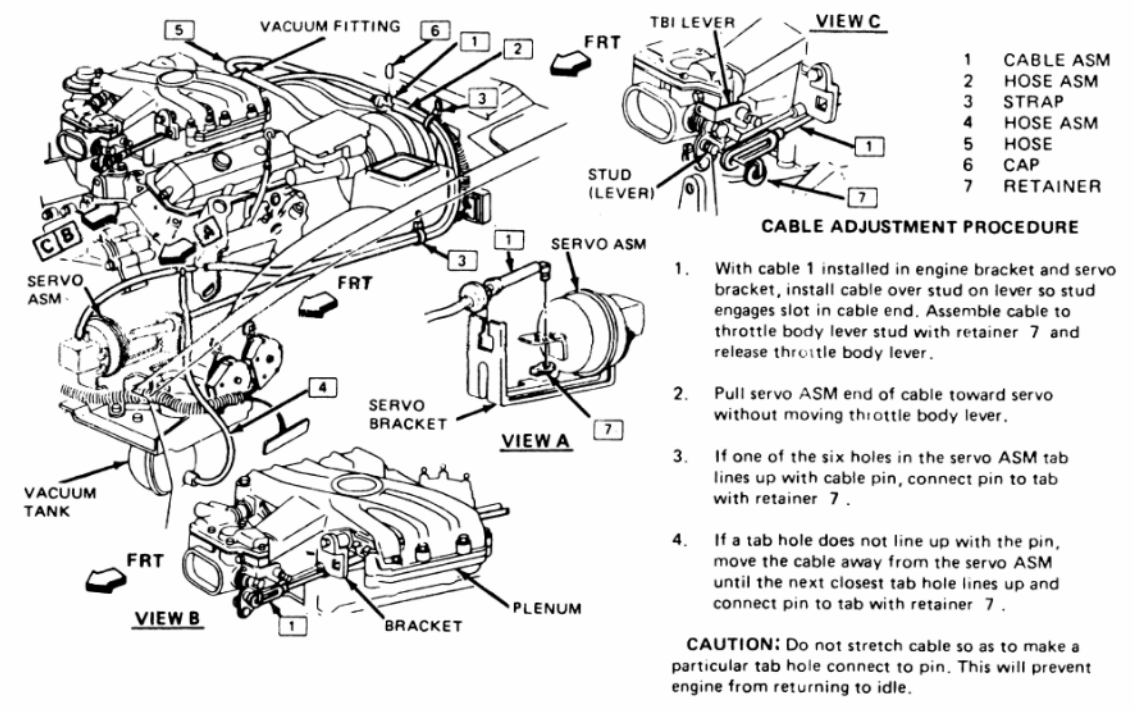



Fig. 5: Servo mounting on fuel injected 2.8L engines

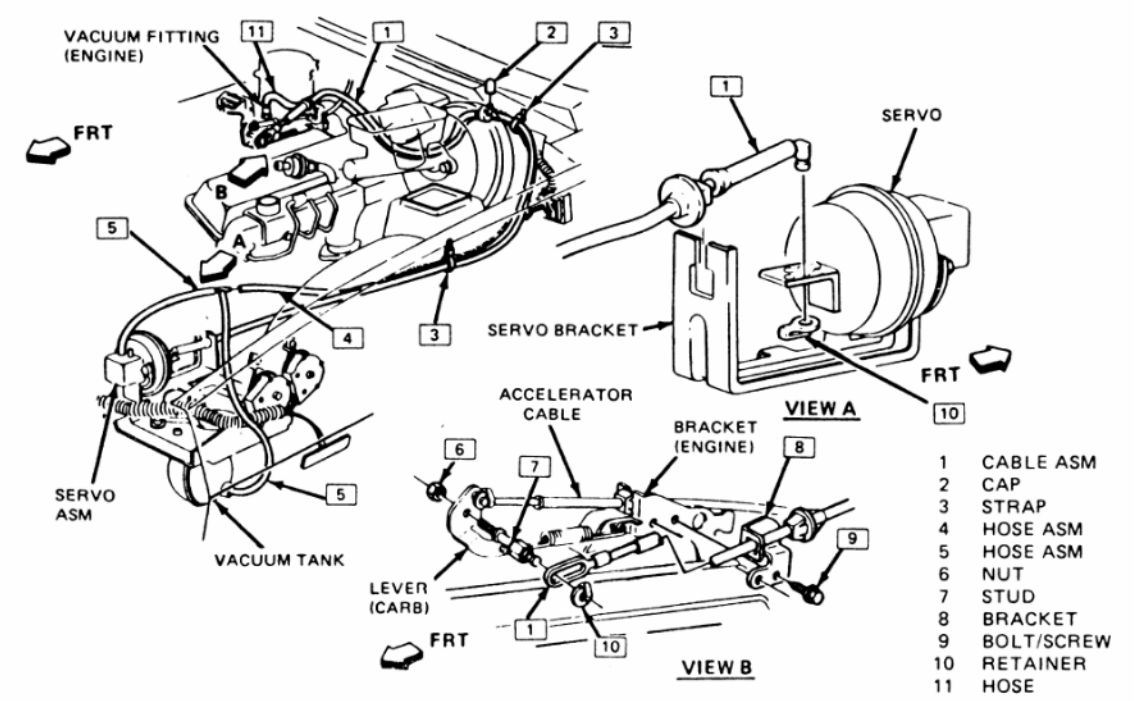



Fig. 6: Servo mounting on carbureted V6 and V8 engines after 1984

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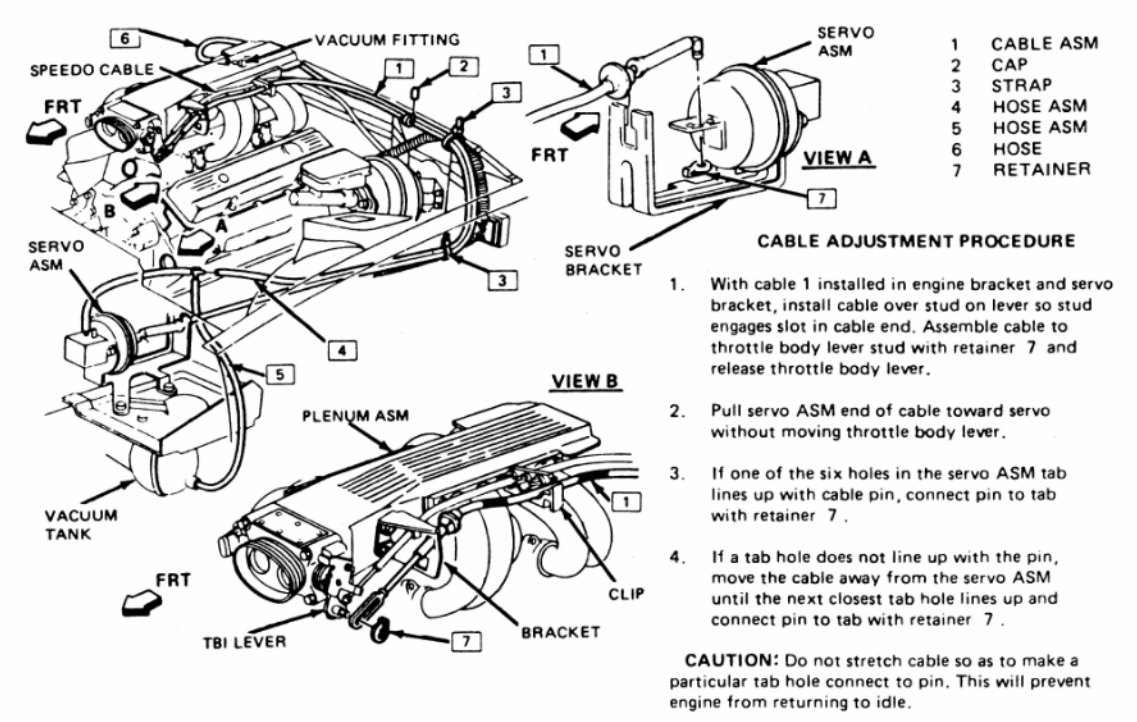



Fig. 7: Servo mounting on 1985-1990 Tuned Port Injection engines

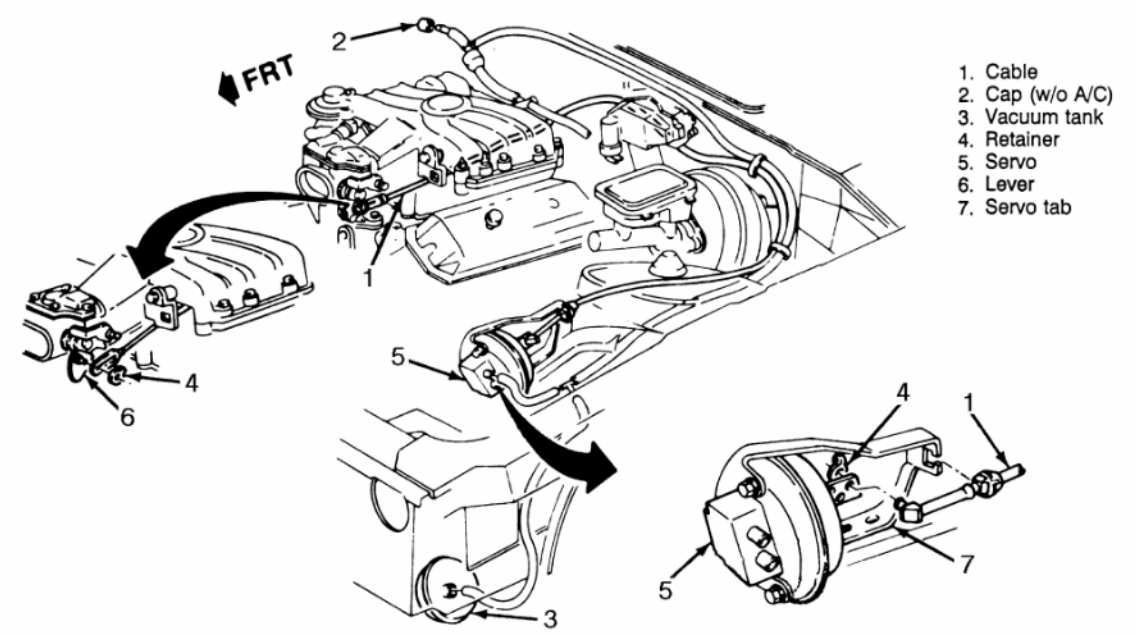



Fig. 8: Servo mounting on 3.1L engines

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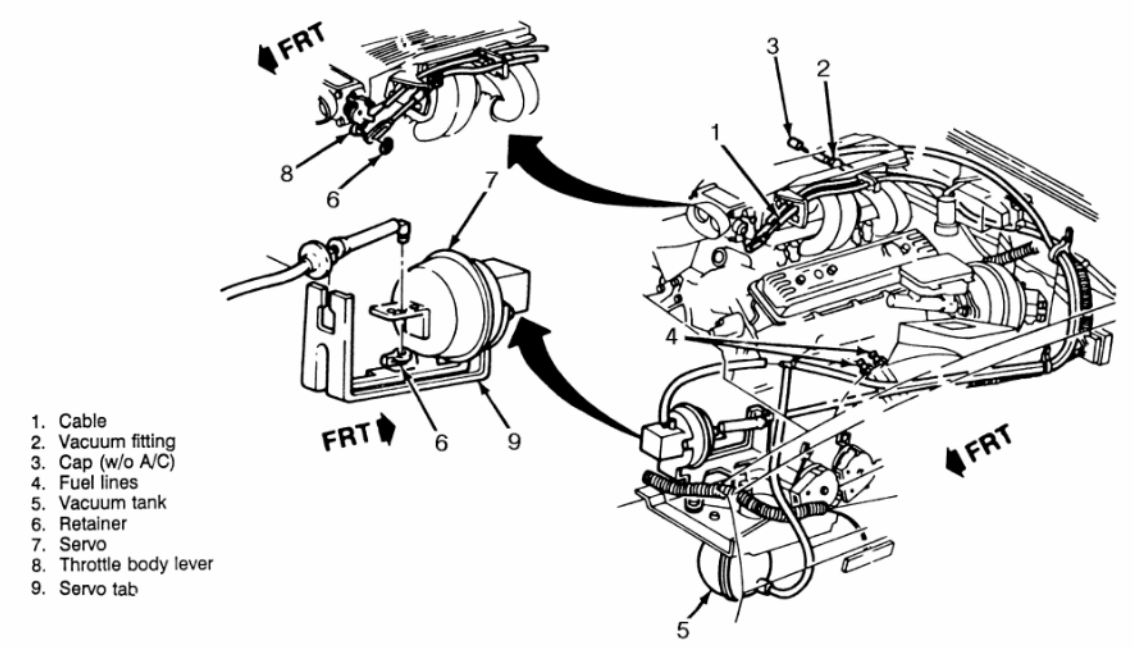



Fig. 9: Servo mounting on 1991-1992 Tuned Port Injection engines

## ADJUSTMENTS

*Do not stretch cables or chains to make pins fit or holes align. This will prevent the engine from returning to idle.*

## CABLE TYPE

1. Check that the cable is properly installed and that the throttle is closed to the idle position.
2. Pull the servo end of the cable toward the linkage bracket of the servo. Place the servo connector in one of the 6 holes in the bracket which allows the least amount of slack and does not move the throttle linkage.
3. Install the retainer clip. Check that the throttle linkage is still in the idle position.

## ROD WITH SCREW ADJUSTER

1. Inspect the rod assembly for proper attachment to the servo and throttle stud. Make certain the throttle is at idle.
2. Adjust the slotted bracket or the rod to obtain a clearance of 0.02-0.04 in. (0.5-1.0mm) between the throttle stud and the end of the bracket slot.
3. Install the retainer clip; make certain the throttle is still at idle.

## ROD WITH ADJUSTMENT HOLES

1. Inspect the rod to be sure it is securely connected to the servo and throttle linkage; make certain the throttle is at idle.
2. Install the retainer pin in the hole which provides the least slack between the servo bracket and the retainer.
3. Check the throttle; it must still be in the idle position.

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## CHAIN AND CABLE

### CHAIN AT THROTTLE

1. Check for proper installation of cable assembly. Inspect the throttle; it must be in the idle position.
2. Install the chain in the swivel so that the slack does not exceed $^1/_2$ the diameter of the ball stud.
3. Install the retainer on the swivel and make sure the throttle has not moved from idle.

### CHAIN AT SERVO

1. Check for proper installation of cable assembly. Inspect the throttle; it must be in the idle position.
2. Install the cable on the third link of the chain; adjust the jam nuts of the servo until there is no noticeable slack in the chain.
3. Tighten the jam nuts and check that the throttle has not moved out of the idle position.

## MODULE

### REMOVAL & INSTALLATION

### 1984-1992 MODELS

*The module is mounted next to the heater and A/C duct on most models, but is integral with the ECM on certain late-model engines.*

1. Disconnect the negative battery cable.
2. Remove the right side sound insulator.
3. Remove the module attaching screws and remove the module.
4. Disconnect the electrical connector.

To install:

5. Connect the electrical connector.
6. Install the cruise control module and the attaching screws.
7. Install the right side sound insulator.
8. Connect the negative battery cable.

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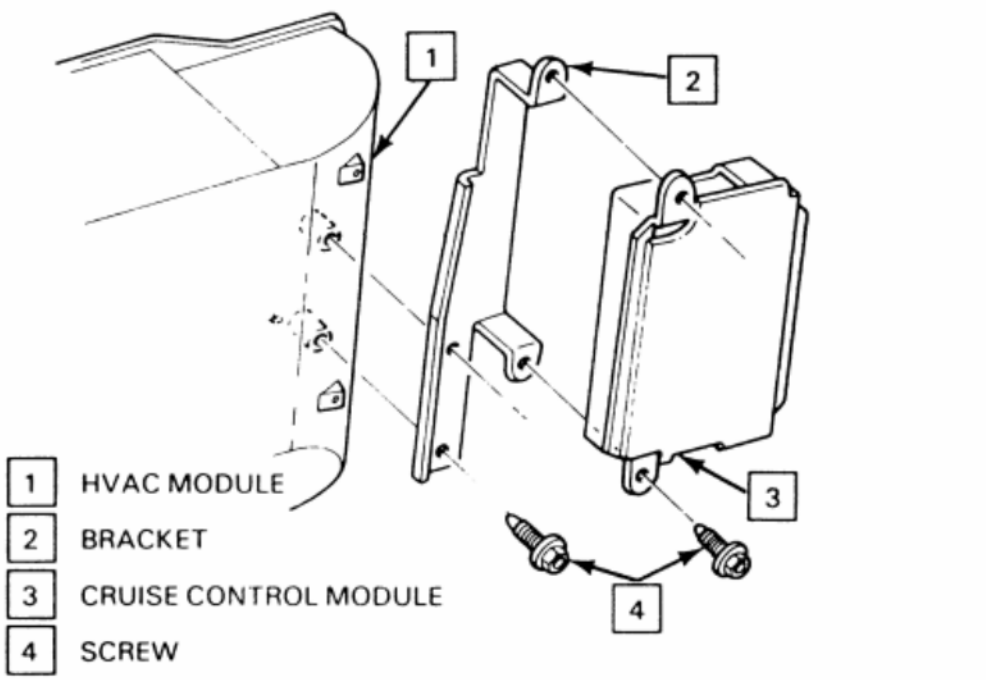



Fig. 1: mounting of cruise control module

## MULTI-FUNCTION LEVER

## REMOVAL & INSTALLATION

1. Disconnect the negative battery terminal.
2. Disconnect cruise control switch connector at the base of steering column. It may be necessary to remove an under dash panel or trim piece for access.
3. Make sure the lever is in the *OFF* position.
4. Pull the lever straight out of the retaining clip within the steering column.
5. Attach mechanic's wire or similar to the connector; gently pull the harness through the column, leaving the pull wire in place.

To install:

6. Attach the mechanic's wire to the connector. Gently pull the harness into place, checking that the harness is completely clear of any moving or movable components such as tilt column, telescoping column, brake pedal linkage, etc.
7. Position the lever and push it squarely into the retainer until it snaps in place.
8. Remove the mechanics' wire and connect the cruise control harness connector.
9. Reinstall any panels or insulation which were removed for access.
10. Connect the negative battery terminal.

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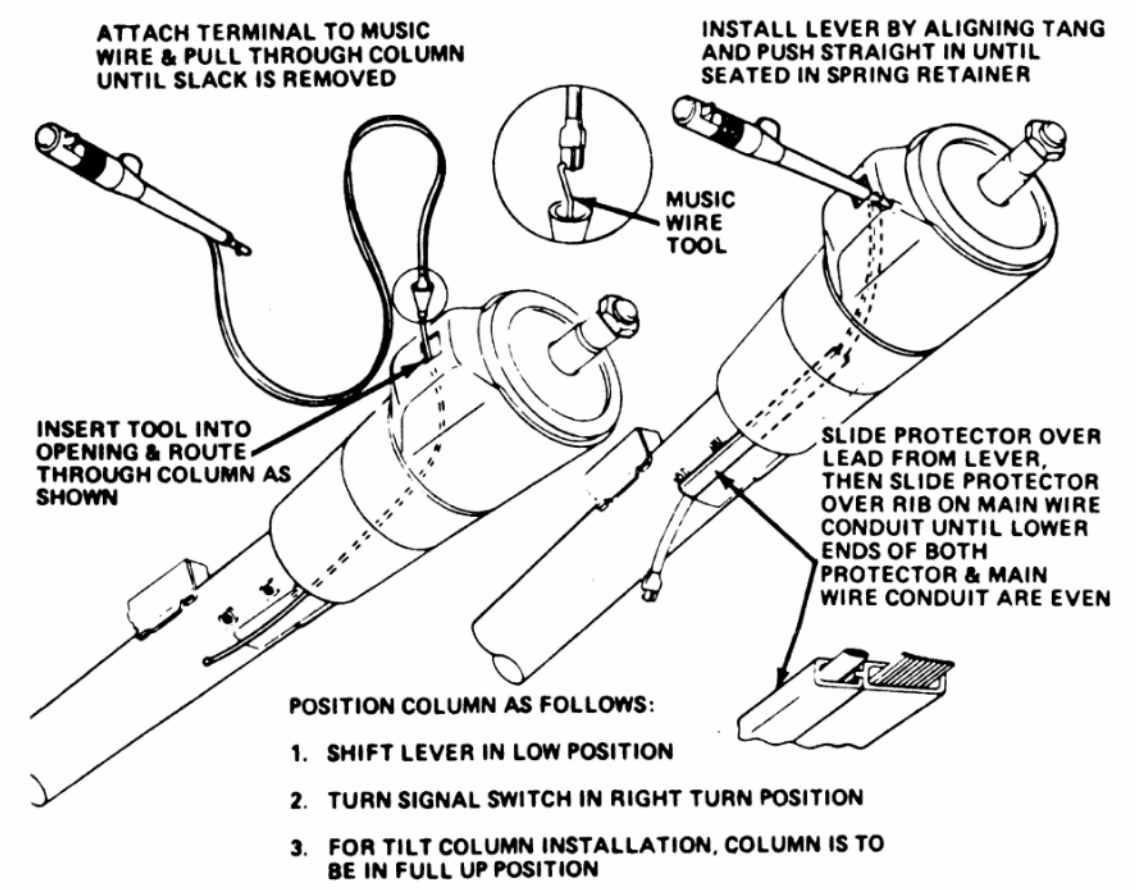


Fig. 1: Multi-function lever removal

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## ENTERTAINMENT SYSTEMS

## RADIO

## REMOVAL & INSTALLATION

1. Disconnect the negative battery cable.
2. Remove the heater/radio trim panel.
3. Remove the radio to console attaching screws.
4. Remove the radio and disconnect the electrical connector.

To install:

5. Connect the electrical connector.
6. Install the radio to console attaching screws.
7. Install the heater/radio trim panel.
8. Connect the negative battery cable.

*Always connect the speakers before applying power to the radio as radio damage may result.*

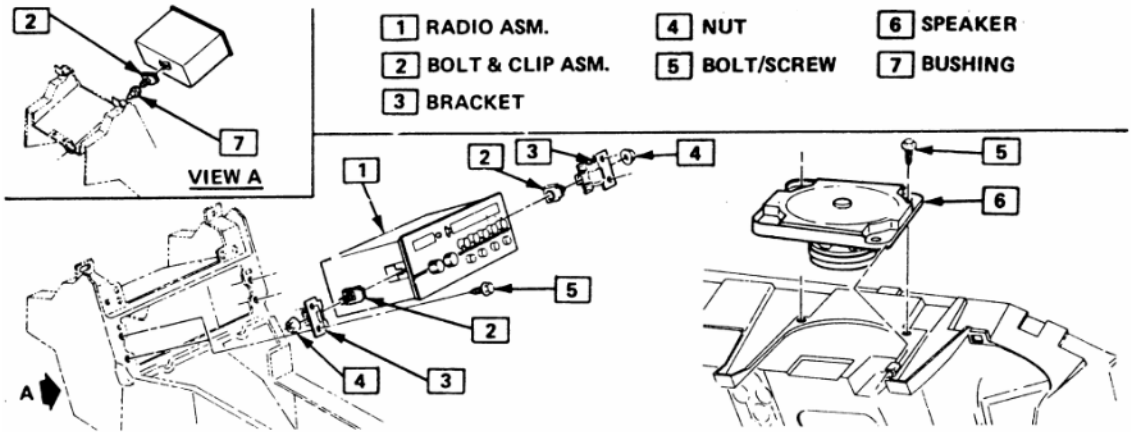



Fig. 1: Radio and front speaker removal

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Fig. 2: Removing the radio trim plate



Fig. 3: Remove the radio attaching screws

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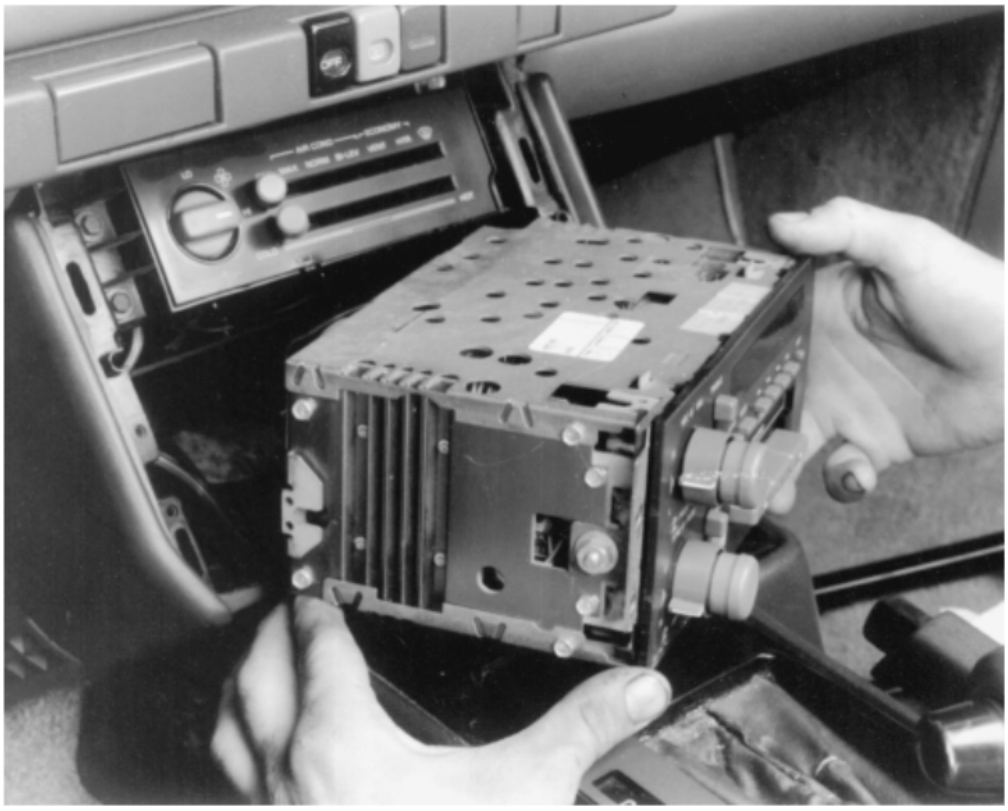


Fig. 4: Pull the radio out far enough to reach the connectors behind it

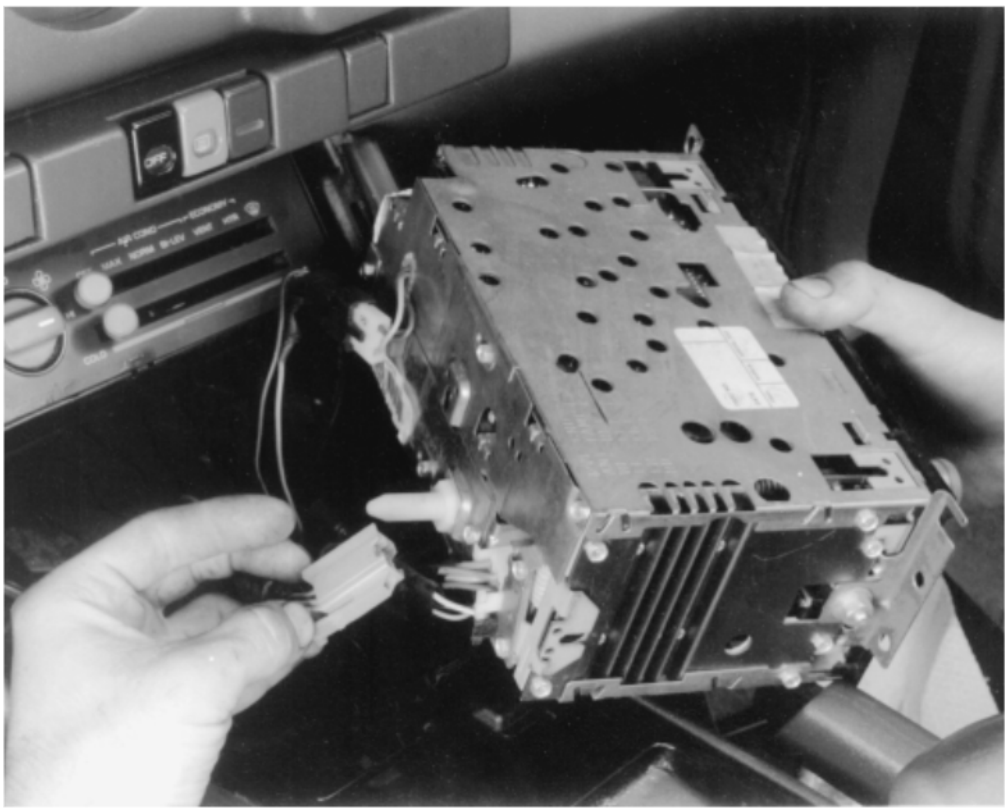


Fig. 5: Disconnecting the radio connectors

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## SPEAKERS

## REMOVAL & INSTALLATION

### FRONT

1. Remove the instrument panel pad.
2. Remove the speaker attaching screws.
3. Remove the speaker and disconnect the electrical connector.
4. Installation is the reverse of removal.

### REAR

1. Remove the coat hook screw and the coat hook.
2. Remove the speaker cover trim panel by pushing it straight up towards the roof.
3. Remove the speaker attaching screws and remove the speaker.
4. Disconnect the electrical connector.
5. Installation is the reverse of removal.

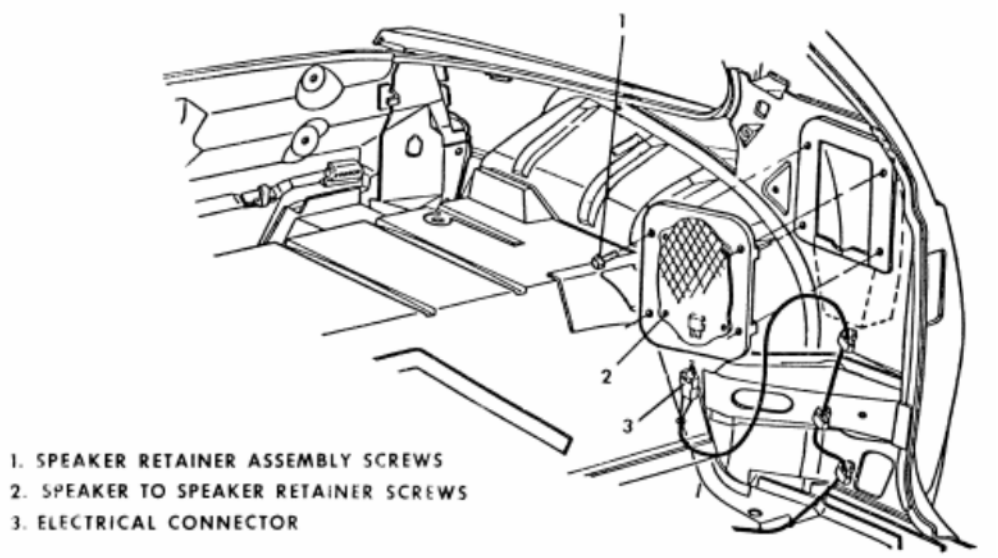



Fig. 1: Rear speaker removal

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## ANTENNA

## REMOVAL & INSTALLATION

*Placement of tape on the right inner door edge will help prevent scratches during the antenna removal and installation procedure.*

1. Disconnect the negative battery terminal.
2. Remove the right side lower instrument panel sound insulator and disconnect the antenna connection from the radio.
3. Raise and safely support the vehicle.
4. Disconnect the instrument panel harness from the radio.
5. Disconnect the power antenna lead, if equipped.
6. Disconnect the power antenna wire from the relay, if equipped.
7. Remove the right fender wheelhouse.
8. Loosen the fender-to-body attaching bolts and block the fender out.
9. Remove the antenna bezel and nut.
10. Remove the antenna assembly mounting screws.
11. Remove the grommet from the bulkhead and pull the harness from the vehicle interior.
12. Remove the antenna assembly from the vehicle.

*In some cases, if the vehicle is equipped with a power antenna, it may be repaired. Seek a professional radio shop for proper repair of the antenna assembly.*

To install:

13. Install the antenna assembly into the vehicle.
14. Install the grommet and the harness into the vehicle interior.
15. Install the antenna assembly mounting screws.
16. Install the antenna bezel and nut.
17. Remove the fender block, tighten the fender-to-body attaching bolts. Ensure any shims for the fender are reinstalled.
18. Install the right fender wheelhouse.
19. Lower the vehicle.
20. Connect the power antenna wire to the relay, if equipped.
21. Connect the power antenna lead, if equipped.
22. Connect the instrument panel harness to the radio.
23. Connect the antenna connection to the radio. Install the right side lower instrument panel sound insulator
24. Connect the negative battery cable.

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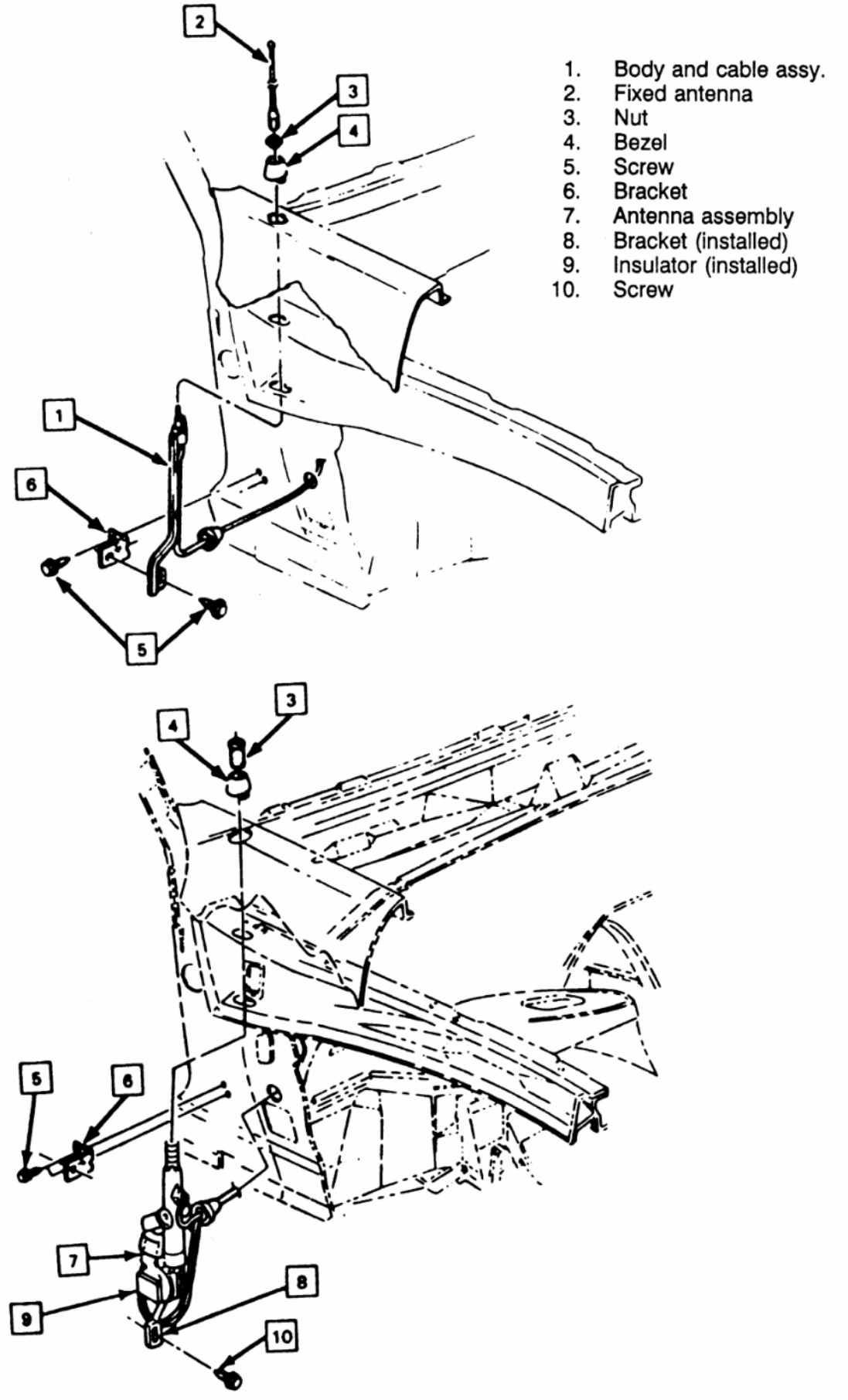



Fig. 1: Antenna mounting

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## WINDSHIELD WIPERS AND WASHERS

## BLADE AND ARM

## REMOVAL & INSTALLATION

## BLADE

If the wiper assembly has a press type release tab at the center, simply depress the tab and remove the blade. If the blade has no release tab, use a screwdriver to depress the spring at the center. This will release the assembly. To install the assembly, position the blade over the pin at the tip of the arm and press until the spring retainer engages the groove in the pin.

To remove the element, either depress the release button or squeeze the spring type retainer clip at the outer end together, then slide the blade element out. Just slide the new element in until it latches.

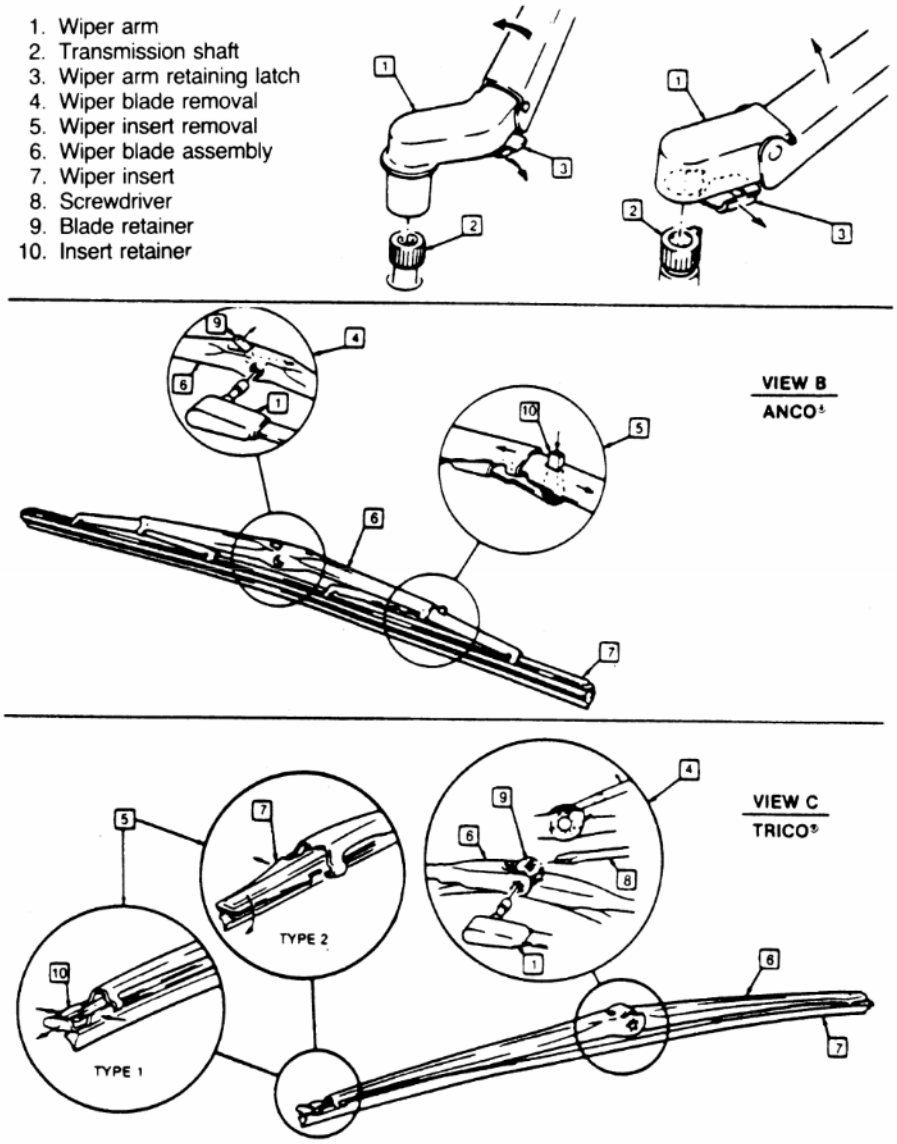



Fig. 1: Wiper arm and blade inserts

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Fig. 2: Most wiper blade and insert assemblies are retained with a lock tab

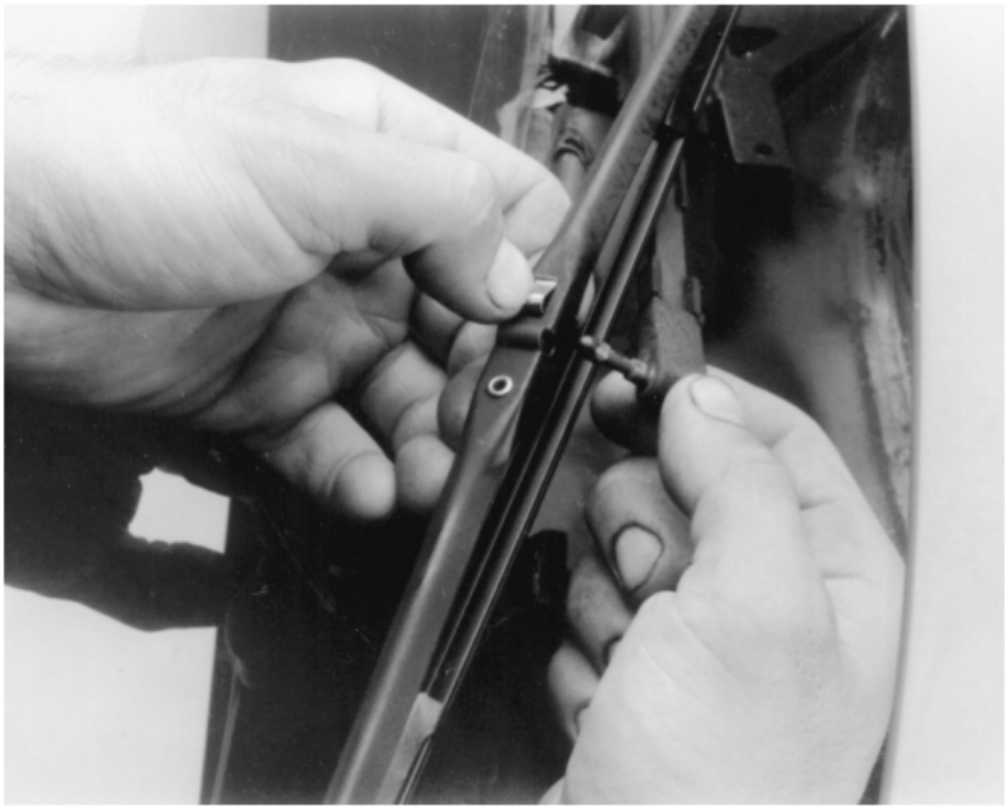


Fig. 3: Removing the wiper blade and insert assembly

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**ARM**

Removal of the wiper arms requires the use of a special tool, GM J-8966 or its equivalent. Versions of this tool are generally available in auto parts stores.

1. Insert the tool under the wiper arm and lever the arm off the shaft.

*Raising the hood on most later models will facilitate easier wiper arm removal.*

2. Disconnect the washer hose from the arm (if so equipped). Remove the arm.
3. Installation is in the reverse order of removal. Be sure that the motor is in the park position before installing the arms.

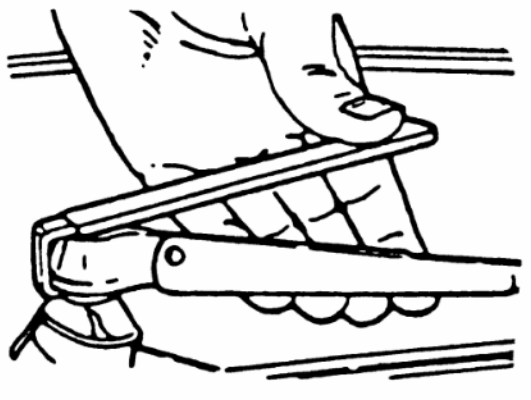


Fig. 4: Wiper arm removal tool

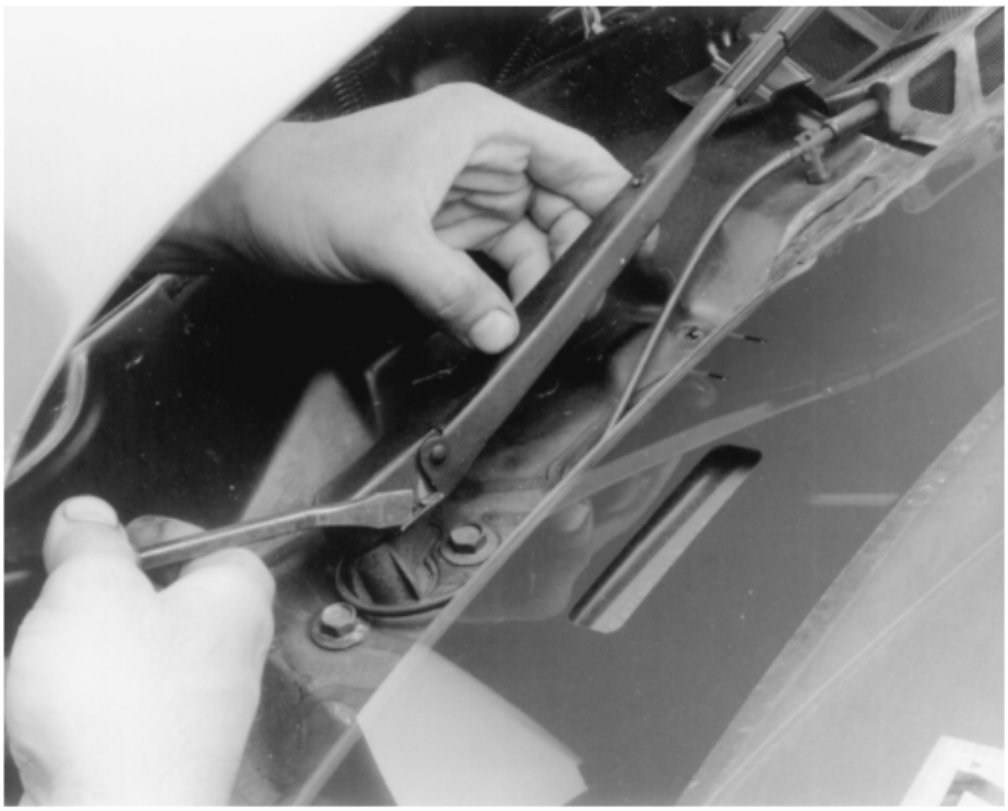


Fig. 5: Use a small prybar or screwdriver to lift the arm locktab

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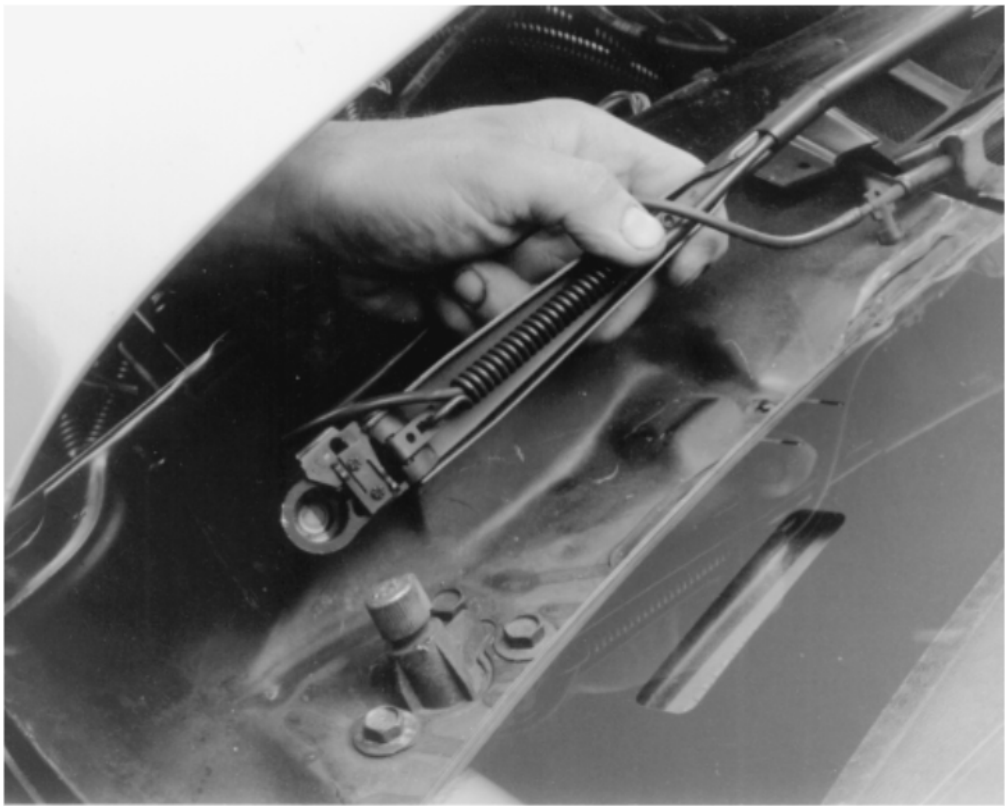


Fig. 6: Be sure to line up the splines on the driveshaft with the grooves in the arm when installing

## WINDSHIELD WIPER MOTOR

### REMOVAL & INSTALLATION

1. Disconnect the negative battery cable at the battery.
2. Remove the screen or grille that covers the cowl area.
3. Working under the hood, disconnect the motor wiring. Then, reach through the cowl opening and loosen, but do not remove, the nuts which attach the transmission drive link to the motor crank arm. Then, disconnect the drive link from the crank arm.
4. Remove the three motor attaching screws, and remove the motor, guiding the crank arm through the hole.

To install:

5. Position the motor, guiding the crank arm through the hole, and install the 3 motor attaching screws.
6. Connect the drive link to the crank arm and connect the motor wiring.

*The motor must be in the park position before assembling the crank arm to the transmission drive link(s).*

7. Install the screen or grille that covers the cowl area.
8. Connect the negative battery cable at the battery.

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Fig. 1: Removing the cowl screen

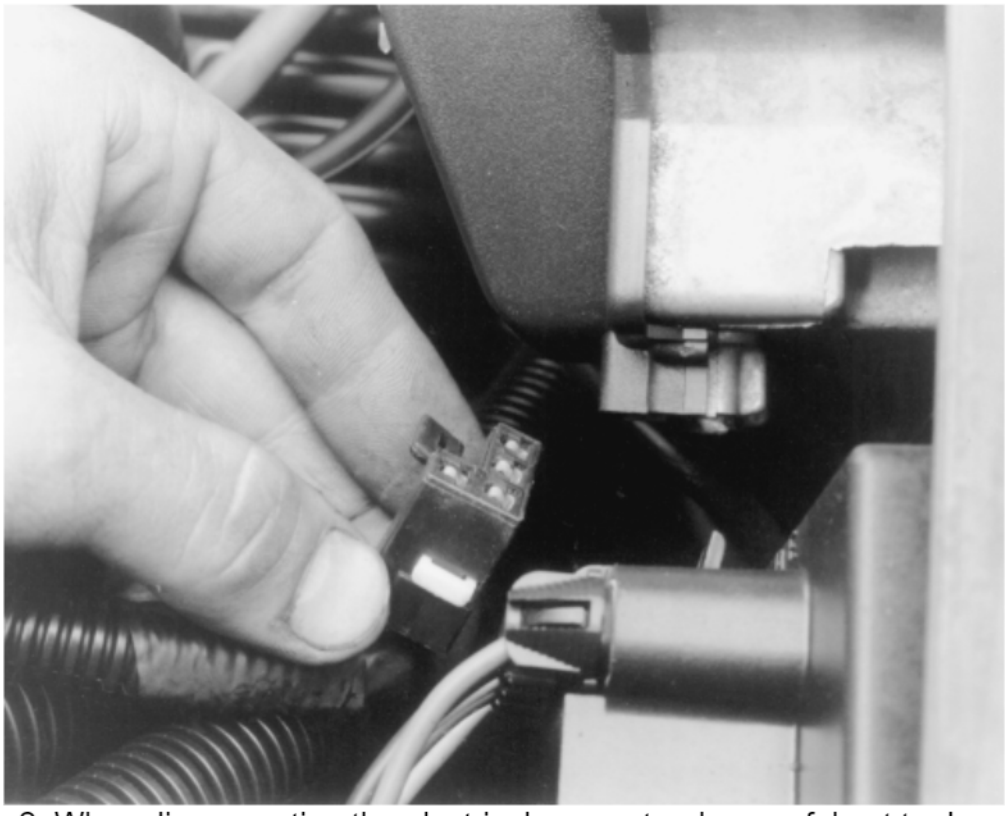


Fig. 2: When disconnecting the electrical connector, be careful not to damage the retaining tang

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Fig. 3: Disconnecting the drive link from the crank arm

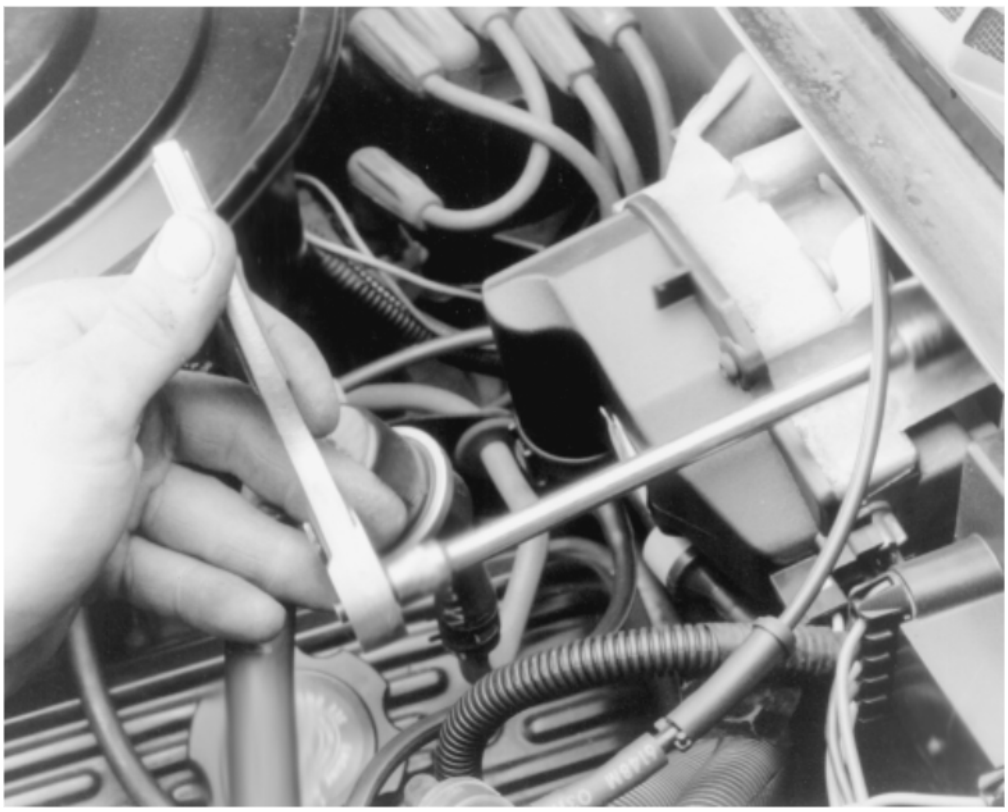


Fig. 4: Removing the motor attaching bolts

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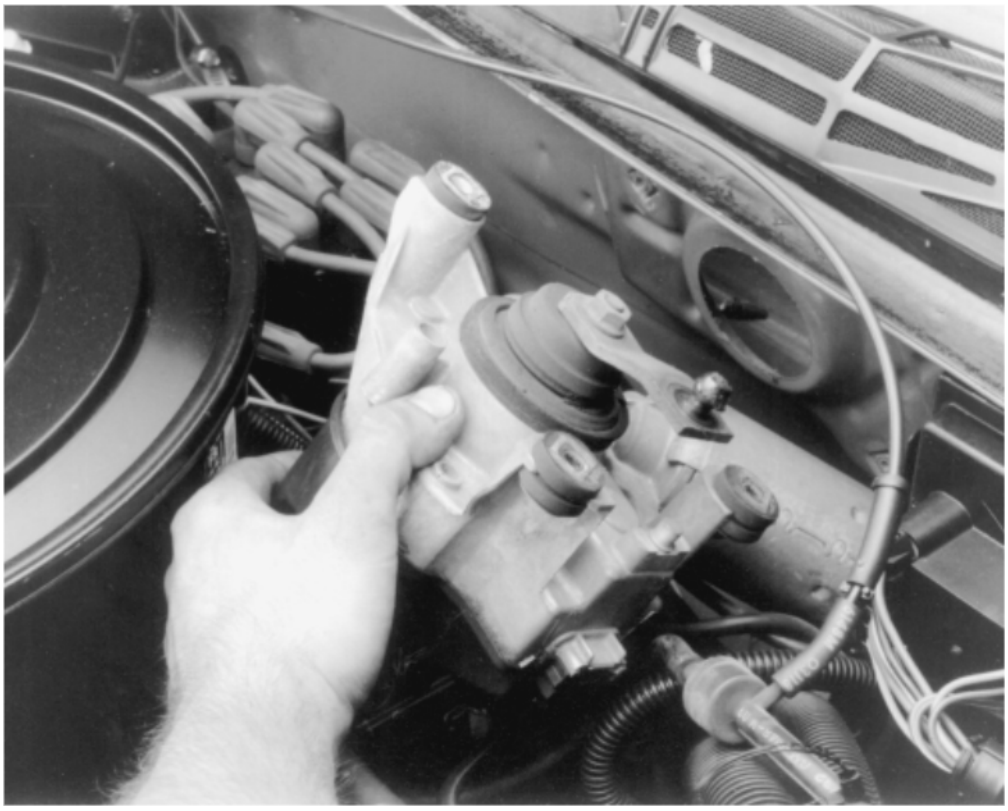


Fig. 5: Removing the wiper motor from the cowl

## REAR WINDOWS WIPER MOTOR

### REMOVAL & INSTALLATION

1. Remove the wiper arm blade using tool J-8966 or equivalent.
2. Remove the nut and spacer on the wiper motor shaft.
3. Raise the lid and remove the lift window trim panel.
4. Disconnect the electrical connectors to the wiper motor.
5. Remove the rivets holding the motor support to the lift window panel and remove the assembly from the car.
6. To remove the motor, remove the screws retaining wiper motor to motor support.

To install:

7. Position the motor onto the motor support and install the screws.
8. Install the motor support with the motor onto the lift window panel and secure it with rivets or nuts/bolts.
9. Connect the electrical connectors to the wiper motor.
10. Install the lift window trim panel and lower the lid.
11. Install the nut and spacer on the wiper motor shaft.
12. Install the wiper arm blade.

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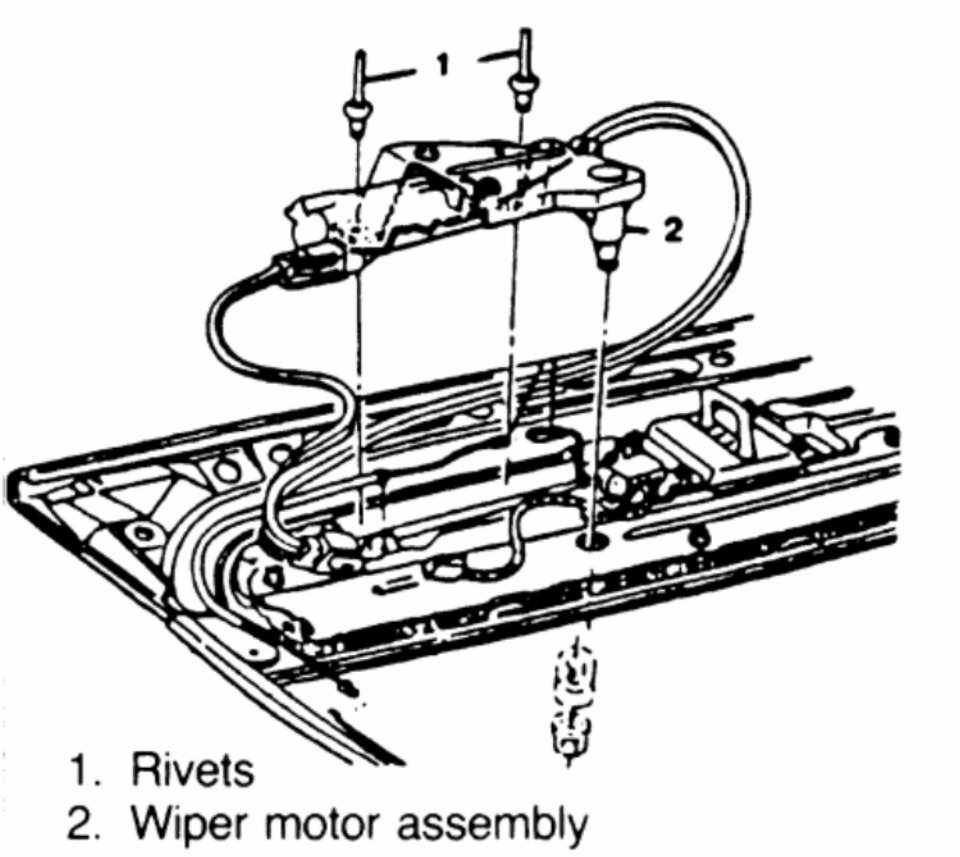



Fig. 1: Rear wiper motor assembly

## WIPER LINKAGE

### REMOVAL & INSTALLATION

1. Remove the wiper arms and blades. Remove the cowl screen or grille.
2. Disconnect the wiring from the wiper motor. Loosen, but do not remove the nuts which attach the transmission drive link to the motor crank arm. Then, disconnect the drive link from the arm.
3. Remove the transmission-to-body attaching screws from both the right and left sides of the car.
4. Guide the transmissions and linkage out through the cowl opening.

To install:

5. Guide the transmissions and linkage in through the cowl opening.
6. Install the transmission attaching screws to both the right and left sides of the car.
7. Connect the drive link to the arm. Tighten the nuts which attach the transmission drive link to the motor crank arm. Connect the wiring to the wiper motor.
8. Install the cowl screen or grille.
9. Install the wiper arms and blades.

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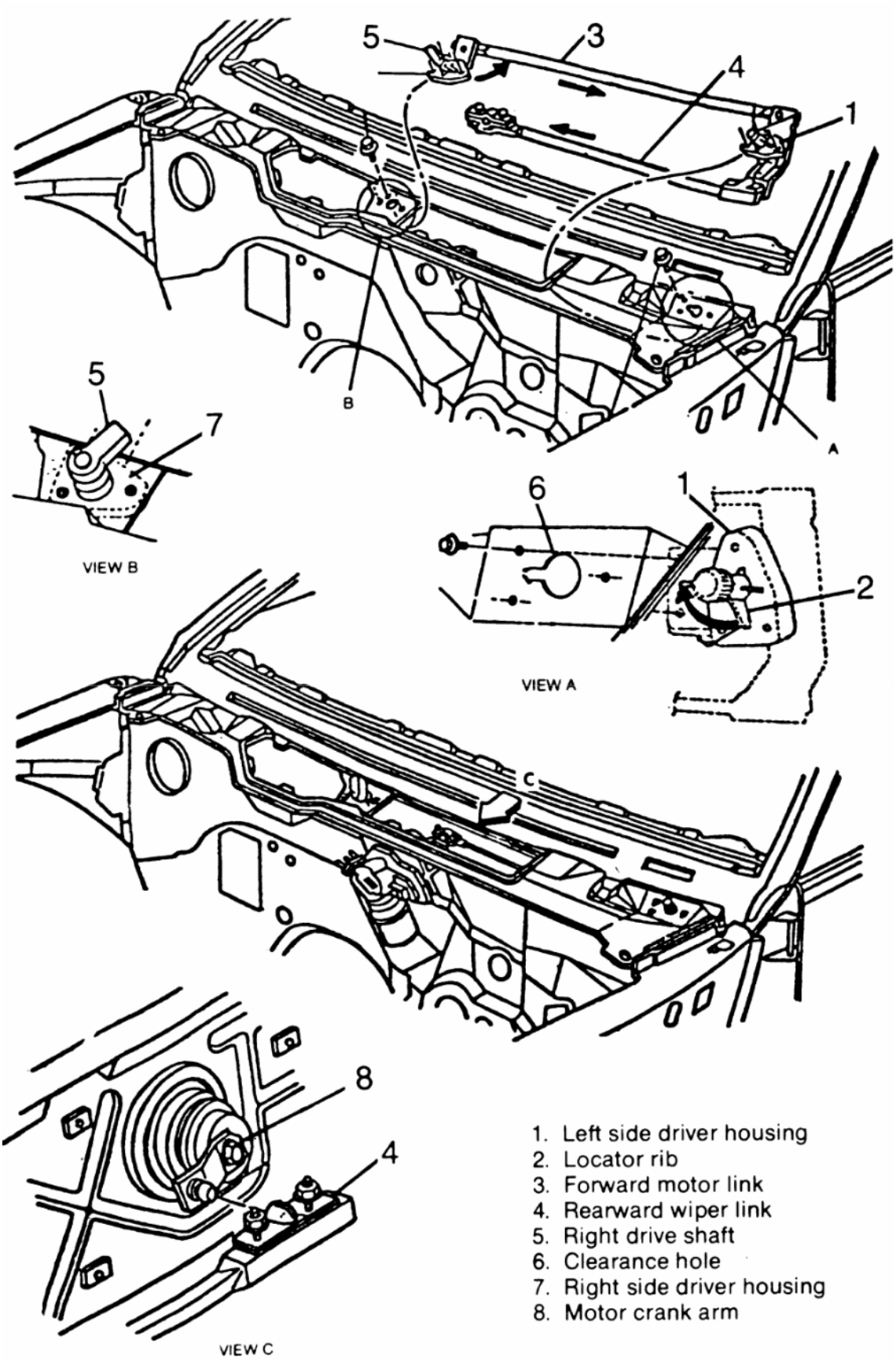



Fig. 1: Windshield wiper linkage assembly

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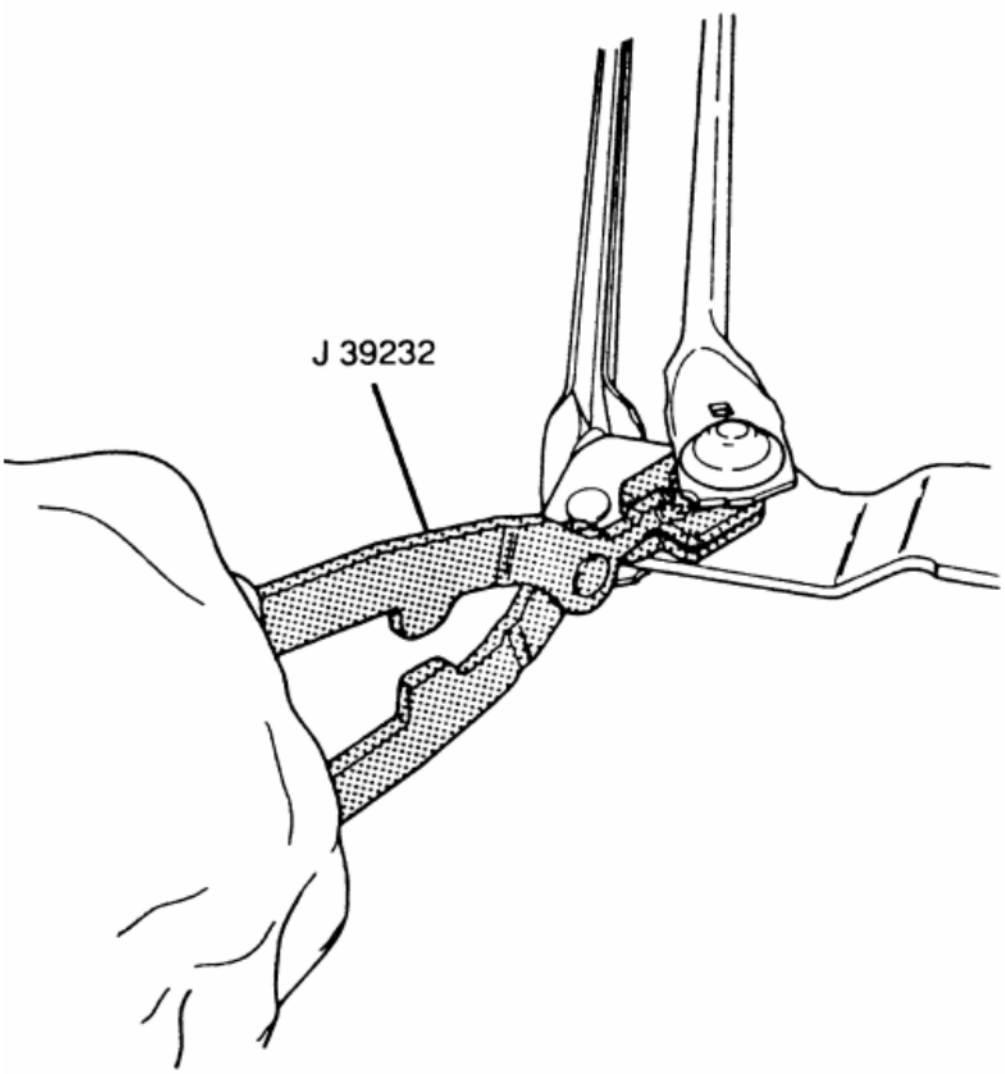



Fig. 2: Using the wiper linkage separator

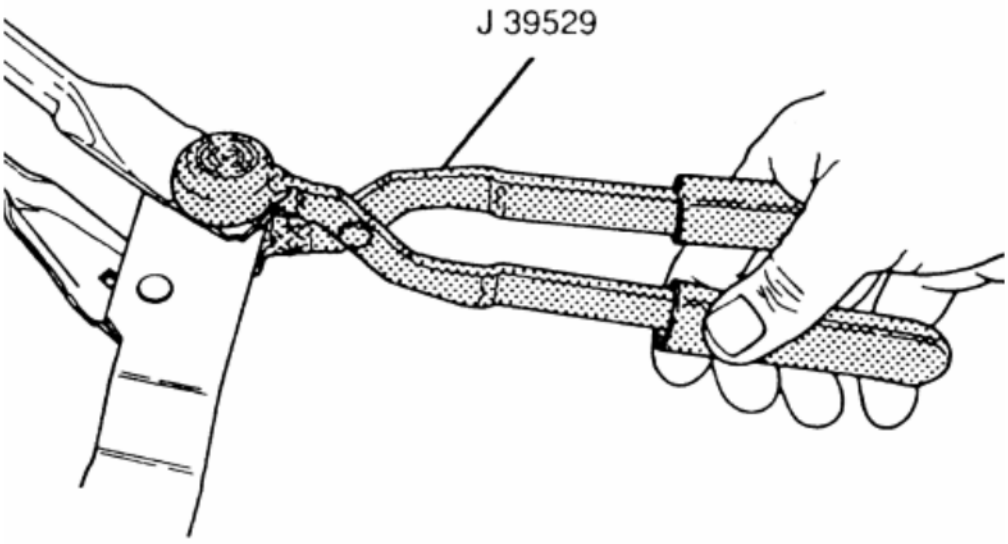



Fig. 3: Wiper linkage installer

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## WASHER FLUID RESERVOIR

## REMOVAL & INSTALLATION

1. Drain the reservoir.
2. Disconnect the washer pump electrical connector, if equipped.
3. Disconnect the hoses.
4. Remove the attaching bolts and remove the reservoir.
5. Installation is the reverse of removal.

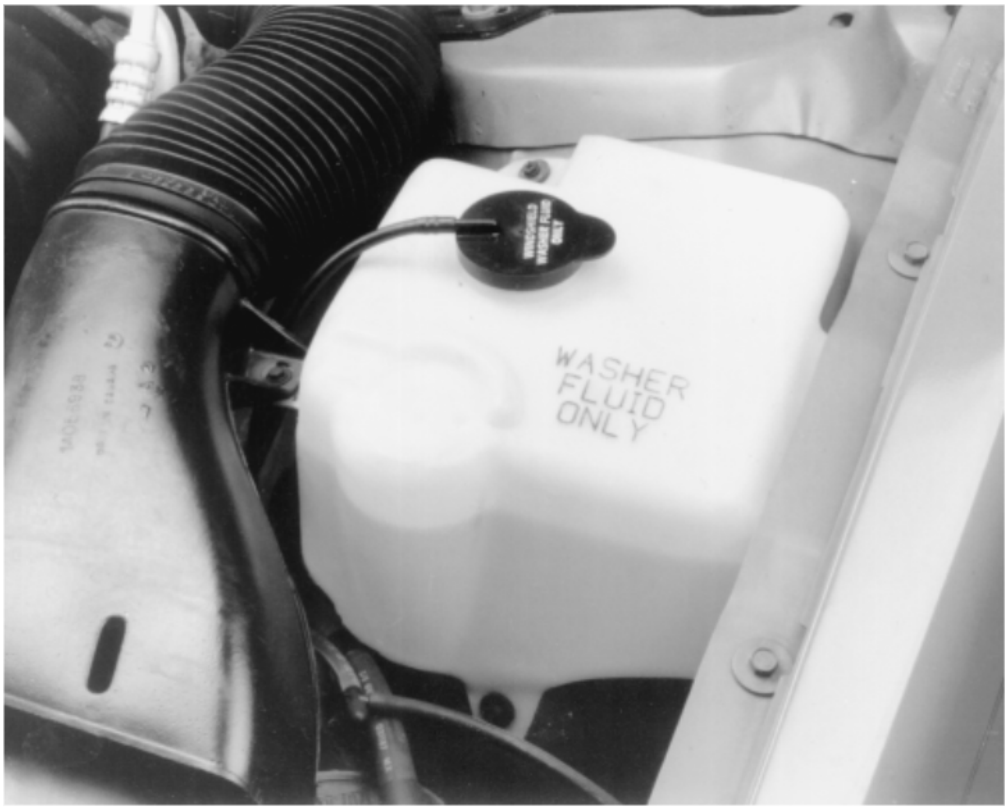



Fig. 1: A common washer reservoir location

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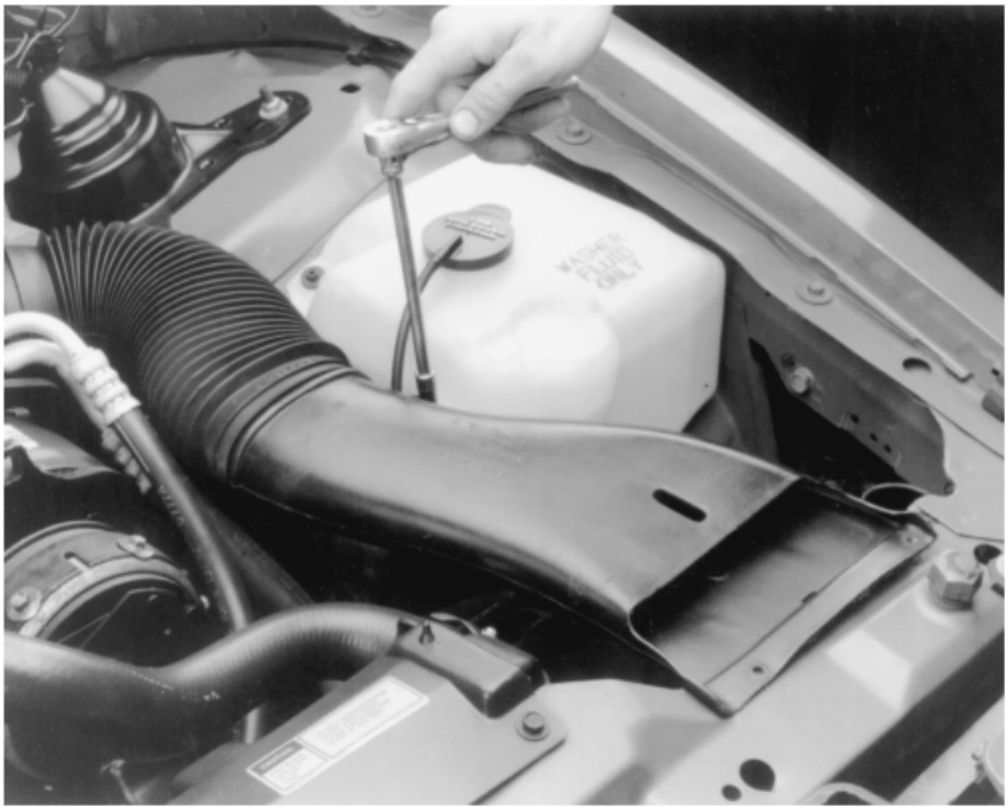
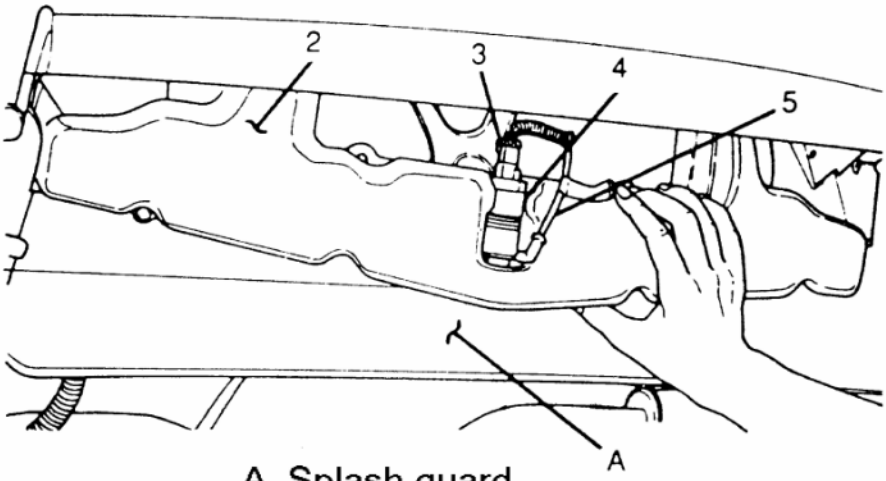


Fig. 2: Removing the washer reservoir attaching screws




A. Splash guard
2. Washer reservoir
3. Electrical connector
4. Washer pump
5. Washer hose assy

Fig. 3: Washer reservoir removal

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## WASHER PUMP

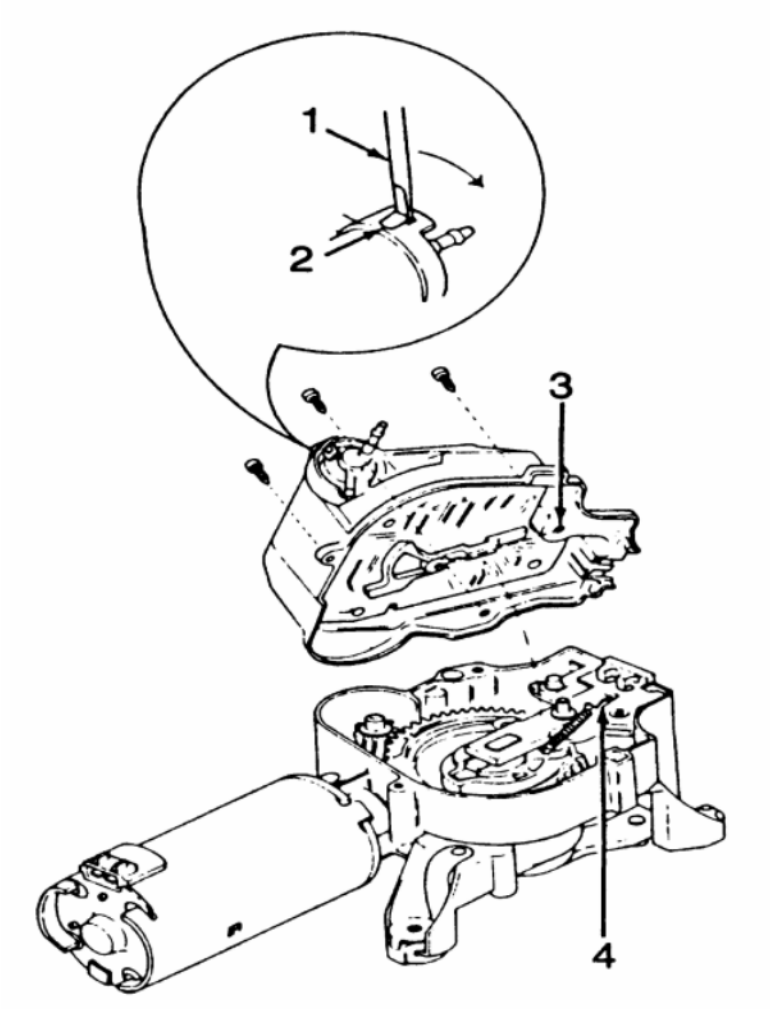
## REMOVAL & INSTALLATION

### PUMP ON WIPER MOTOR

1. Using a screwdriver, lift the washer pump retainer clip on the wiper motor cover.
2. Pull the washer pump from the cover.

To install:

3. Position the washer pump to the cover. Be sure to push the washer pump all the way into the female socket.
4. Install the washer pump retainer clip on the wiper motor cover.




1. Screwdriver (rotate)
2. Retaining clip
3. Align cam arm with this hole
4. Wiper in park position

Fig. 1: Washer pump removal on models with the pump mounted on the wiper motor

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## PUMP IN WASHER TANK

1. Drain the washer tank and disconnect the wire connectors.
2. Disconnect and remove the reservoir
3. Remove the washer pump from the reservoir.
4. Installation is the reverse of the removal procedure. Ensure pump is pushed fully into the reservoir.

## INSTRUMENTS AND SWITCHES

## INSTRUMENT CLUSTER

## REMOVAL & INSTALLATION

## SPORT COUPE MODEL

1. Disconnect the negative battery cable.
2. Remove the instrument cluster bezel.
3. Remove the cluster attachment screws.
4. Pull the cluster out. Disconnect the speedometer cable and electrical connections.
5. Remove the cluster lens.
6. Install the cluster lens.
7. Connect the speedometer and electrical connections.
8. Push the cluster in.
9. Install the cluster attachment screws.
10. Install the instrument cluster bezel.
11. Connect the negative battery cable.

## BERLINETTA MODEL

1. Disconnect the negative battery cable.
2. Remove the instrument cluster bezel.
3. Remove the 8 steering column trim cover screws and trim cover.
4. Remove the right and left hand pod attaching screws at the bottom front of each pod. Pull the pods rearward and disconnect the electrical connection.
5. Remove the 5 cluster lens screws and lens.
6. Remove the 2 steering column bolts and lower the column.
7. Pull the instrument cluster rearward and disconnect the electrical connection. Remove the instrument cluster.
8. To install, position the instrument cluster into place.
9. Connect the electrical connection and push the cluster forward.
10. Lift the column and install the 2 steering column bolts.
11. Install the lens and install the 5 cluster lens screws.
12. Connect the electrical connection to each pod and push forward. Install the right and left hand pod attaching screws at the bottom front of each pod. Pull the pods rearward and disconnect the electrical connection.
13. Install the trim cover and install the 8 steering column trim cover screws.
14. Install the instrument cluster bezel.

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15. Connect the negative battery cable.

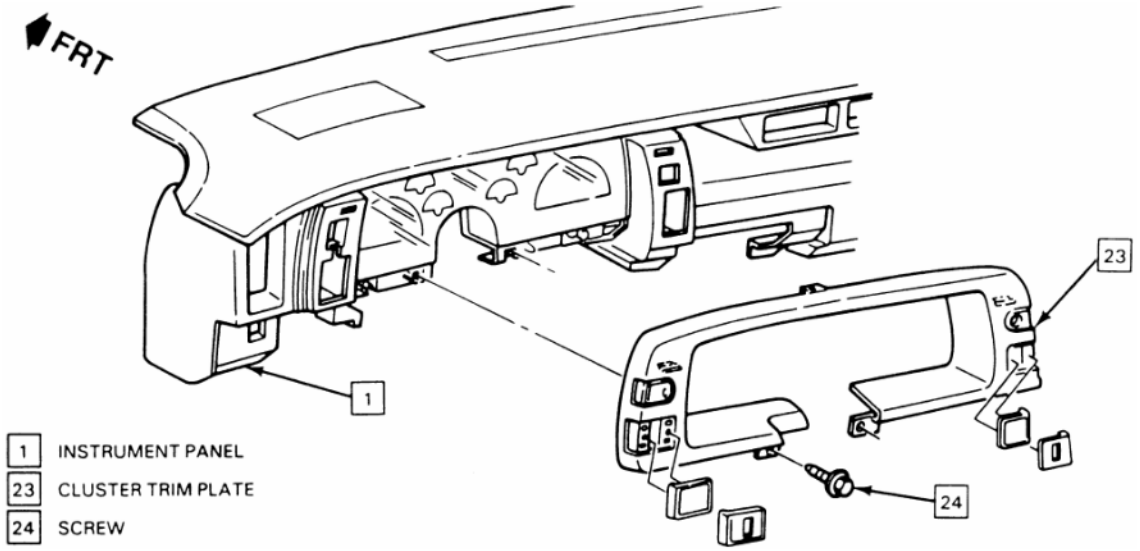



Fig. 1: Instrument panel trim plate removal

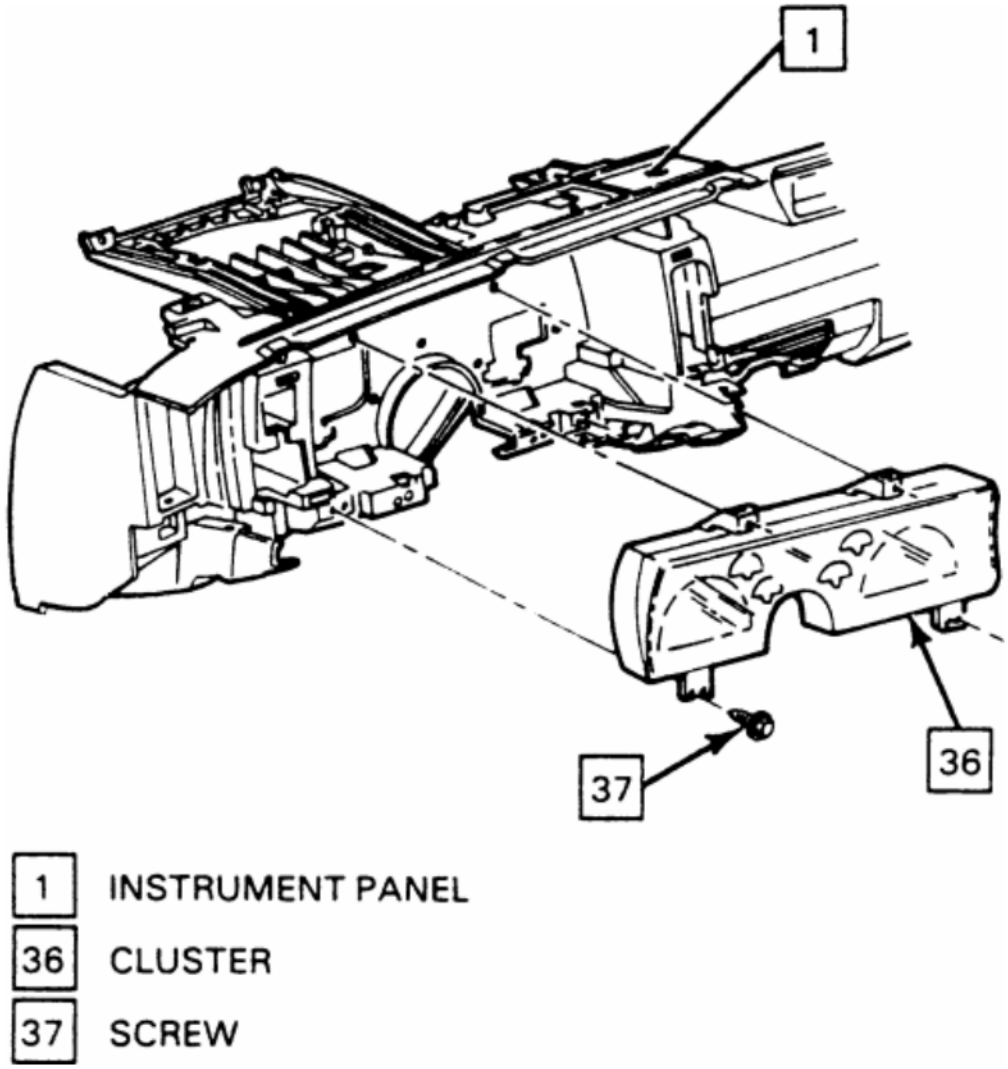



Fig. 2: Instrument panel cluster removal

## SPEEDOMETER, TACHOMETER AND GAUGES

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*Federal law requires that the odometer in any replacement speedometer/odometer must register the same mileage as that registered on the removed speedometer/odometer. Service replacement speedometer/odometers and odometer modules with the mileage preset to actual vehicle mileage are available through the dealer. In nearly all cases, the mileage continues to accumulate in the odometer memory even if the odometer does not display mileage. This mileage can usually be verified by the dealer. Contact the dealer for instructions to receive a replacement speedometer/odometer with preset mileage. If the actual vehicle mileage cannot be verified, the dealer will supply a speedometer/odometer with a display set to zero miles. In addition, an odometer mileage sticker is supplied with the replacement odometer. The sticker must display the estimated vehicle mileage and is to be affixed to the driver's door.*

### REMOVAL & INSTALLATION

1. The gauges can be removed from the cluster assembly by:
    a. Removing the cluster lens.
    b. Removing the printed circuit board from the back of the cluster.
    c. Removing the gauge attaching screws.
2. Installation is the reverse of removal.

## SPEEDOMETER CABLE

### REMOVAL & INSTALLATION

1. Disconnect the negative battery cable at the battery.
2. On models without cruise control, disconnect the speedometer cable strap at the power brake booster. On models with cruise control, disconnect the speedometer cable at the cruise control transducer.
3. Remove the instrument cluster trim plate.
4. Remove the instrument cluster attaching screws and pull the cluster out far enough to gain access to the rear of the speedometer head.
5. Reach beneath the cable connection at the speedometer head, push in on the cable retaining spring, and disconnect the cable from the speedometer.
6. Slide the old cable out of the speedometer cable casing. If the cable is broken, remove the cable from both ends of the casing. Using a short piece of the old cable to fit the speedometer connection, turn the speedometer to increase the speed indicated on the dial and check for any binding during rotation. If binding is noted, the speedometer must be removed for repair or replacement. Check the entire cable casing for extreme bends, chafing, breaks, etc., and replace if necessary.

To install:

7. Wipe the cable clean using a lint free cloth.
8. If the old casing is to be reused, flush the casing with petroleum spirits and blow dry with compressed air.

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9. Lubricate the speedometer cable with an appropriate lubricant, being sure to cover the lower thirds of the cable.
10. Insert the cable into the casing, then connect the cable and casing assembly to the speedometer.
11. Install the instrument cluster, then install the cluster attaching screws.
12. Install the instrument cluster trim plate.
13. On models without cruise control, connect the speedometer cable strap at the power brake booster. On models with cruise control, connect the speedometer cable at the cruise control transducer.
14. Connect the negative battery cable at the battery.

## WIPER SWITCH

### REMOVAL & INSTALLATION

*The wiper switch is part of the multi-function lever, located on the steering wheel column.*

1. Disconnect the electrical connector of the multi-function lever, located under the instrument panel.
2. Remove the protective cover from the wire.
3. Grasp the lever firmly, twist and pull (the tang on the lever must align with the socket) the lever straight out.
4. Pull the wire through the steering column.

To install:

5. Slide a music wire tool through the steering column and connect the lever wire to the tool wire; pull the wire through the steering column.
6. Push the control lever into the spring loaded socket (be sure to align the tang).
7. Install the protective cover to the wire.
8. Connect the electrical connector of the multi-function lever.

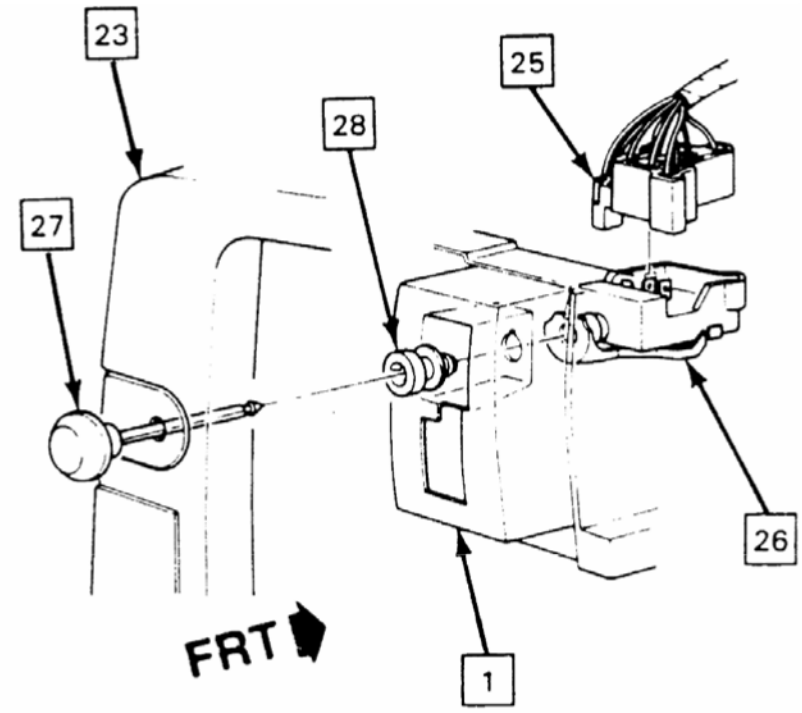
## HEADLIGHT SWITCH

### REMOVAL & INSTALLATION

1. Disconnect the negative battery cable at the battery.
2. Remove the four screws from inside the defroster duct (instrument panel pad securing screws).
3. Remove the screws which are under the lip of the instrument panel pad.
4. Remove the instrument panel pad.
5. On models equipped with air conditioning, remove the instrument panel cluster bezel and the cluster.
6. Remove the radio speaker bracket.
7. Pull the headlamp switch knob to the *ON* position, depress the locking button for the knob and shaft (located on the switch), and remove the knob and shaft.
8. Remove the switch bezel (retainer).

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9. Disconnect the wiring from the switch and remove the switch.
10. To install, position the switch into place and connect the wiring to the switch.
11. Install the switch bezel (retainer).
12. Push the headlamp switch knob into the switch. (It may be necessary to depress the knob release button.
13. Install the radio speaker bracket.
14. On models equipped with air conditioning, install the instrument panel cluster bezel and the cluster.
15. Install the instrument panel pad.
16. Install the screws which are under the lip of the instrument panel pad.
17. Install the four screws from inside the defroster duct (instrument panel pad securing screws).
18. Connect the negative battery cable at the battery.




| | |
|---|---|
| 1 | INSTRUMENT PANEL |
| 23 | CLUSTER TRIM PLATE |
| 25 | ELECTRICAL CONNECTOR |
| 26 | SWITCH |
| 27 | SWITCH KNOB |
| 28 | NUT |

Fig. 1: Headlight switch removal

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## CONSOLE MOUNTED SWITCHES

## REMOVAL & INSTALLATION

1. Disconnect the negative battery cable.

*The switches are secured in the console by simple spring clips. To remove them, simply pull or carefully pry them up and out of the console.*

2. Unsnap the switch from the console.
3. Remove the electrical connector from the switch.
4. Installation is the reverse of removal.

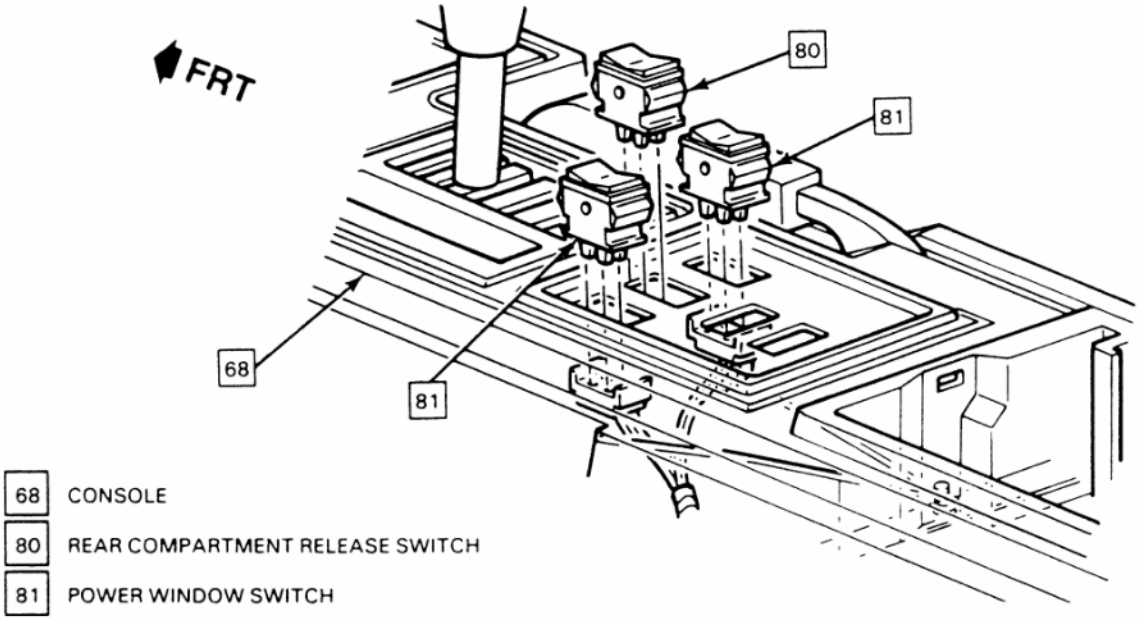



Fig. 1: Console mounted accessory switches

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## LIGHTING

## HEADLIGHTS

## REMOVAL & INSTALLATION

1. Remove headlamp bezel retaining screws and remove bezel.
2. Disengage spring from the retaining ring with a cotter pin removal tool and remove two attaching screws.
3. Remove retaining ring, disconnect sealed beam unit at wiring connector and remove the unit.



Fig. 1: Headlight removal - the lower bezel mounting screws only need to be loosened, not removed

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Fig. 2: Remove the upper bezel screws

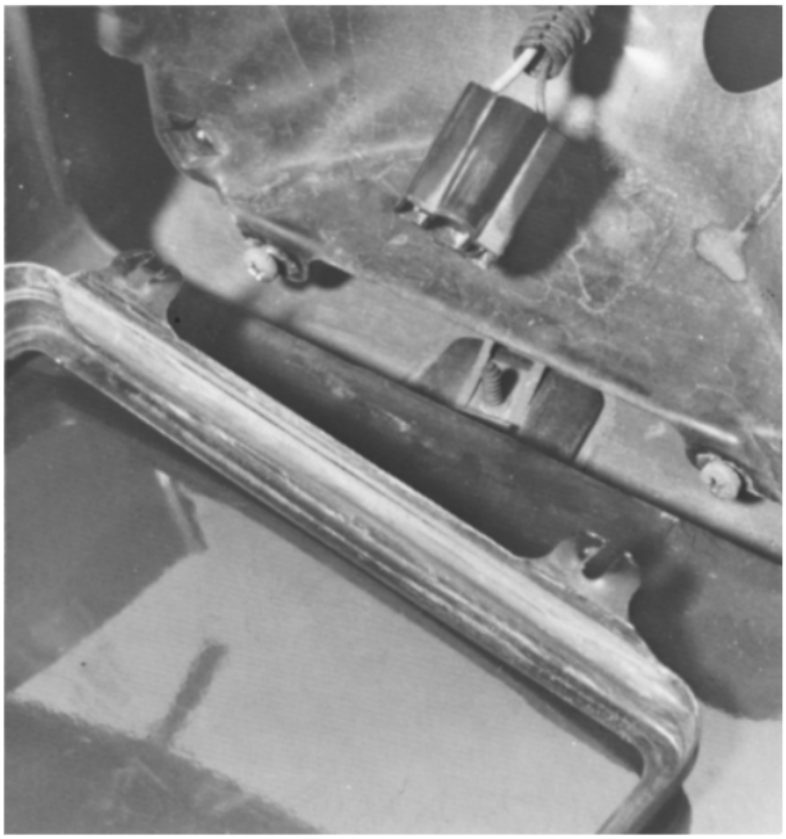


Fig. 3: Headlight and bezel removed and notice the lower bezel screw slots for ease of removal

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Fig. 4: Plug headlight in and ensure the headlight is right side up

4. To install, attach the connector to replacement unit and position the unit in place making sure the number molded into the lens face is at the top.

*In the dual headlamp installation the inboard unit (No. 1) takes a double connector plug, the outboard unit (No. 2) takes a triple connector plug.*

5. Position retaining ring into place and install the retaining ring attaching screws and spring.
6. Check operation of unit and install the headlamp bezel.

**AIMING THE HEADLIGHTS**

The headlights must be properly aimed to provide the best, safest road illumination. The lights should be checked for proper aim and adjusted as necessary. Certain state and local authorities have requirements for headlight aiming; these should be checked before adjustment is made.

**CAUTION** - About once a year, when the headlights are replaced or any time front end work is performed on your vehicle, the headlight should be accurately aimed by a reputable repair shop using the proper equipment. Headlights not properly aimed can make it virtually impossible to see and may blind other drivers on the road, possibly causing an accident. Note that the following procedure is a temporary fix, until you can take your vehicle to a repair shop for a proper adjustment.

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Headlight adjustment may be temporarily made using a wall, as described below, or on the rear of another vehicle. When adjusted, the lights should not glare in oncoming car or truck windshields, nor should they illuminate the passenger compartment of vehicles driving in front of you. These adjustments are rough and should always be fine-tuned by a repair shop which is equipped with headlight aiming tools. Improper adjustments may be both dangerous and illegal.

For most of the vehicles covered by this information, horizontal and vertical aiming of each sealed beam unit is provided by two adjusting screws which move the retaining ring and adjusting plate against the tension of a coil spring. There is no adjustment for focus; this is done during headlight manufacturing.

*Because the composite headlight assembly is bolted into position, no adjustment should be necessary or possible. Some applications, however, may be bolted to an adjuster plate or may be retained by adjusting screws. If so, follow this procedure when adjusting the lights, BUT always have the adjustment checked by a reputable shop.*

Before removing the headlight bulb or disturbing the headlamp in any way, note the current settings in order to ease headlight adjustment upon reassembly. If the high or low beam setting of the old lamp still works, this can be done using the wall of a garage or a building:

1. Park the vehicle on a level surface, with the fuel tank about $^1/_2$ full and with the vehicle empty of all extra cargo (unless normally carried). The vehicle should be facing a wall which is no less than 6 feet (1.8m) high and 12 feet (3.7m) wide. The front of the vehicle should be about 25 feet from the wall.

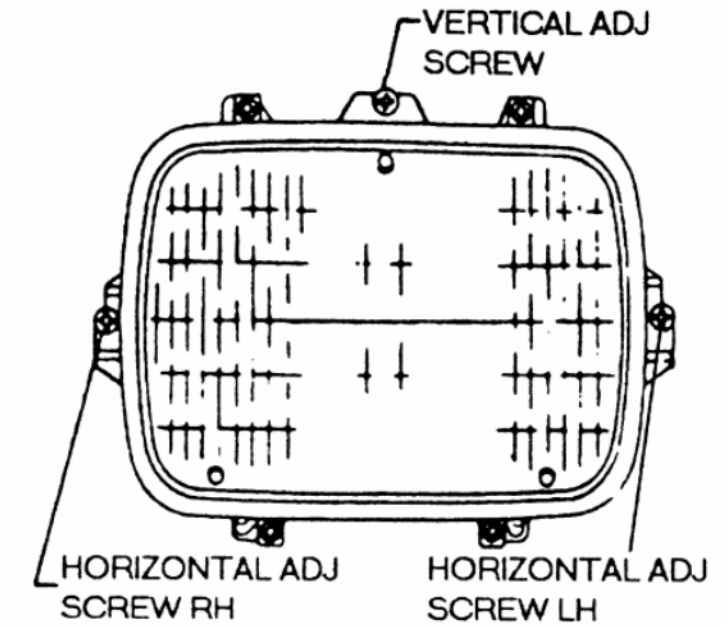



Fig. 5: Location of the aiming screws on most vehicles with sealed beam headlights

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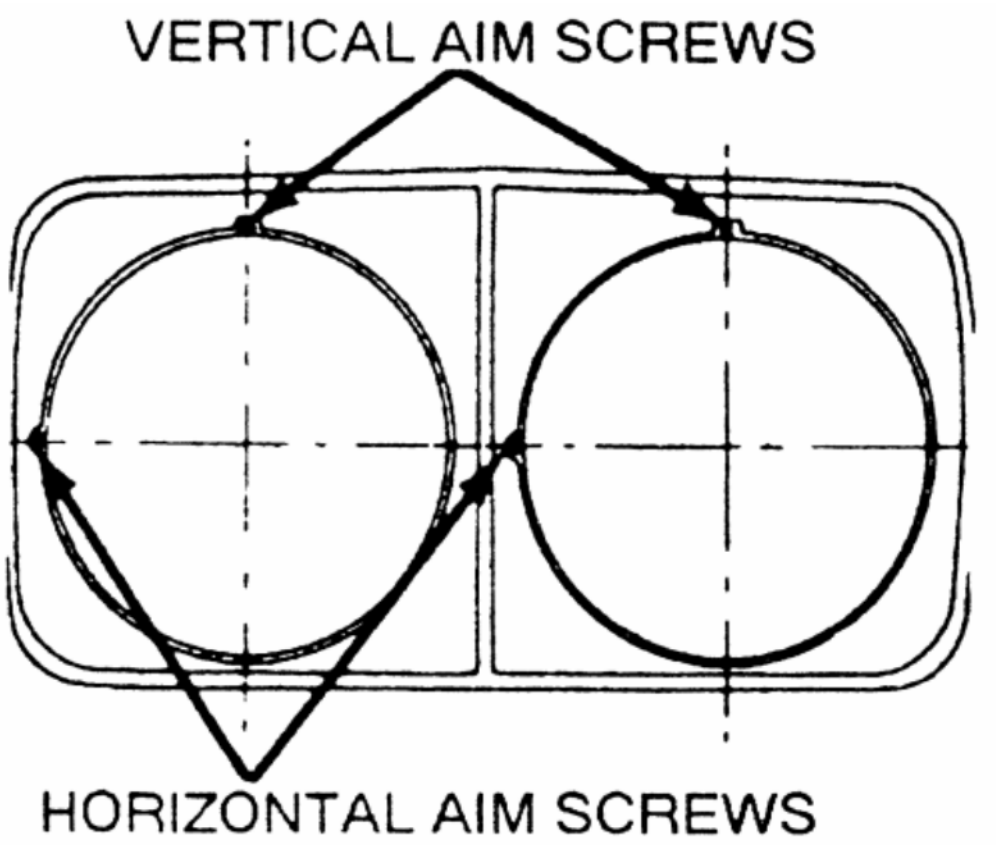


Fig. 6: Dual headlight adjustment screw locations - one side shown here (other side should be mirror image)

2. If aiming is to be performed outdoors, it is advisable to wait until dusk in order to properly see the headlight beams on the wall. If done in a garage, darken the area around the wall as much as possible by closing shades or hanging cloth over the windows.
3. Turn the headlights *ON* and mark the wall at the center of each light's low beam, then switch on the bright lights and mark the center of each light's high beam. A short length of masking tape which is visible from the front of the vehicle may be used. Although marking all four positions is advisable, marking one position from each light should be sufficient.

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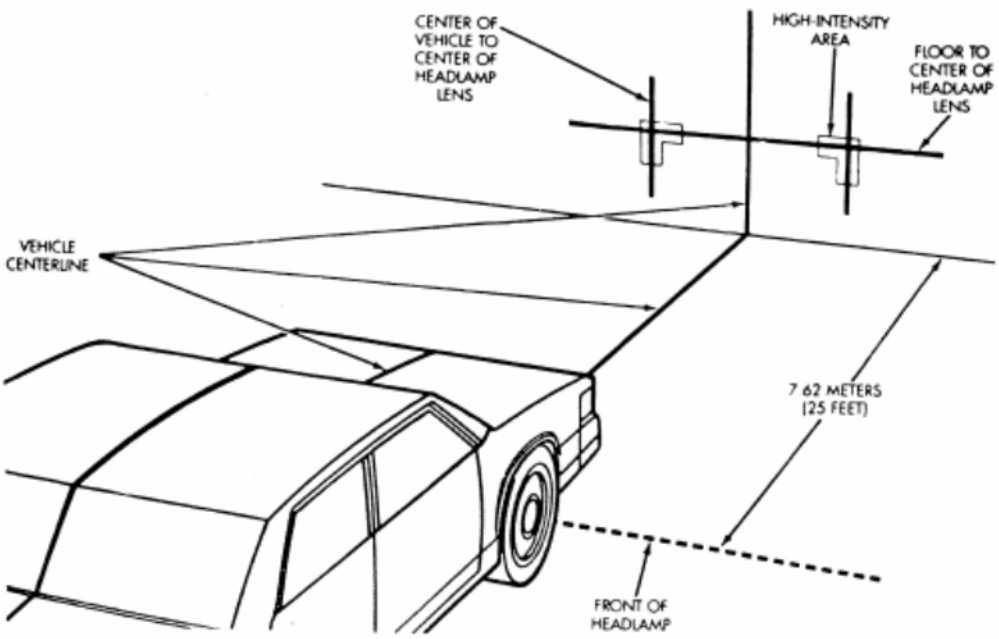



Fig. 7: Low-beam headlight pattern alignment

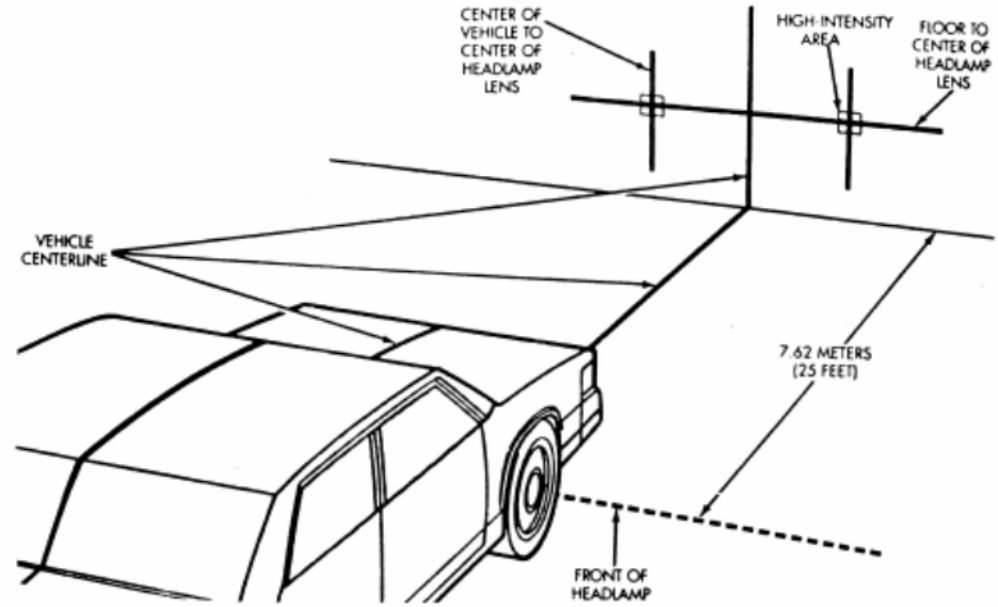



Fig. 8: High-beam headlight pattern alignment

4. If neither beam on one side is working, and if another like-sized vehicle is available, park the second one in the exact spot where the vehicle was and mark the beams using the same-side light. Then switch the vehicles so the one to be aimed is back in the original spot. It must be parked no closer to or farther away from the wall than the second vehicle.
5. Perform any necessary repairs, but make sure the vehicle is not moved, or is returned to the exact spot from which the lights were marked. Turn the headlights *ON* and adjust the beams to match the marks on the wall.
6. Have the headlight adjustment checked as soon as possible by a reputable repair shop.

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## SIGNAL AND MARKER LIGHTS

## REMOVAL & INSTALLATION

### FRONT PARKING AND TURN SIGNAL

Reach around to the back side of the light assembly and unlock the bulb holder/wiring harness by grasping the bulb holder/wiring harness and turning it counterclockwise approximately $^1/_4$ turn.

1. Remove the bulb holder/wiring harness assembly.
2. To install, insert the bulb holder/wiring harness assembly into the light assembly and locking the holder by turning it $^1/_4$ turn clockwise.

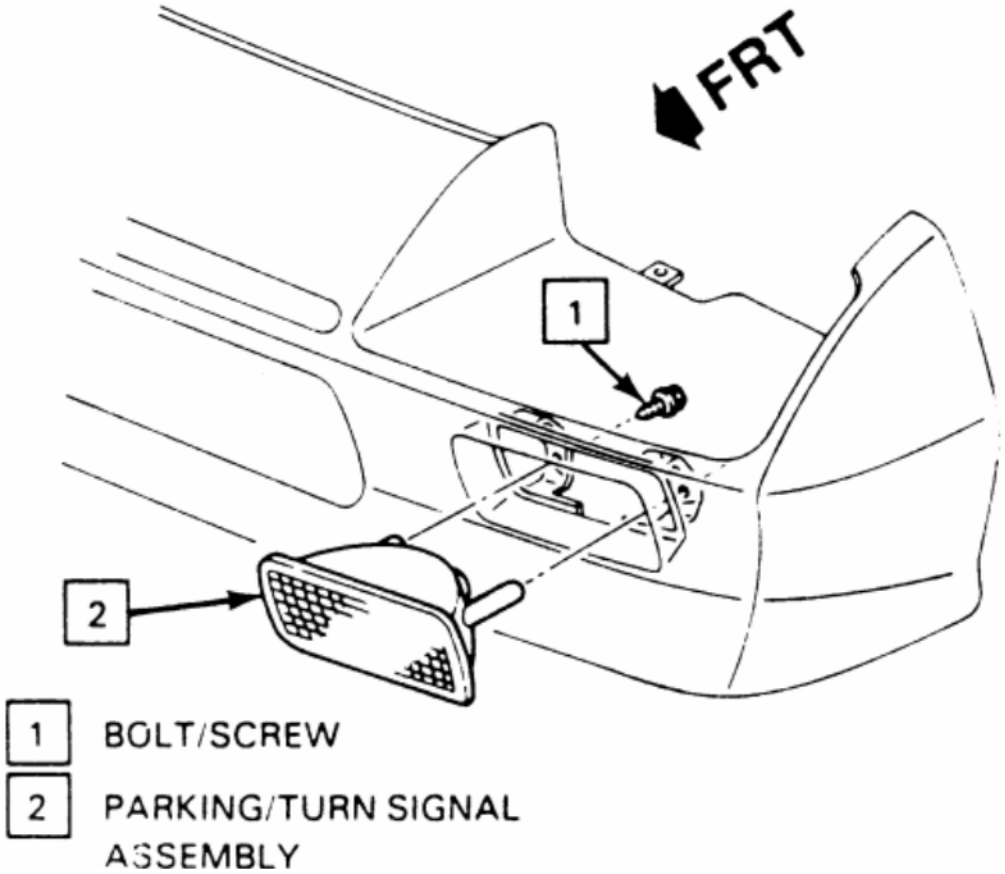



Fig. 1: Typical front turn signal lamp mounting

### FRONT MARKER LIGHTS

1. Remove the six screws from the filler panel under the front fascia.
2. Remove the filler panel.
3. Remove the socket from the lamp assembly.
4. Remove the bulb from the socket.
5. Installation is the reverse of removal.

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Fig. 2: Remove the six filler panel bolts

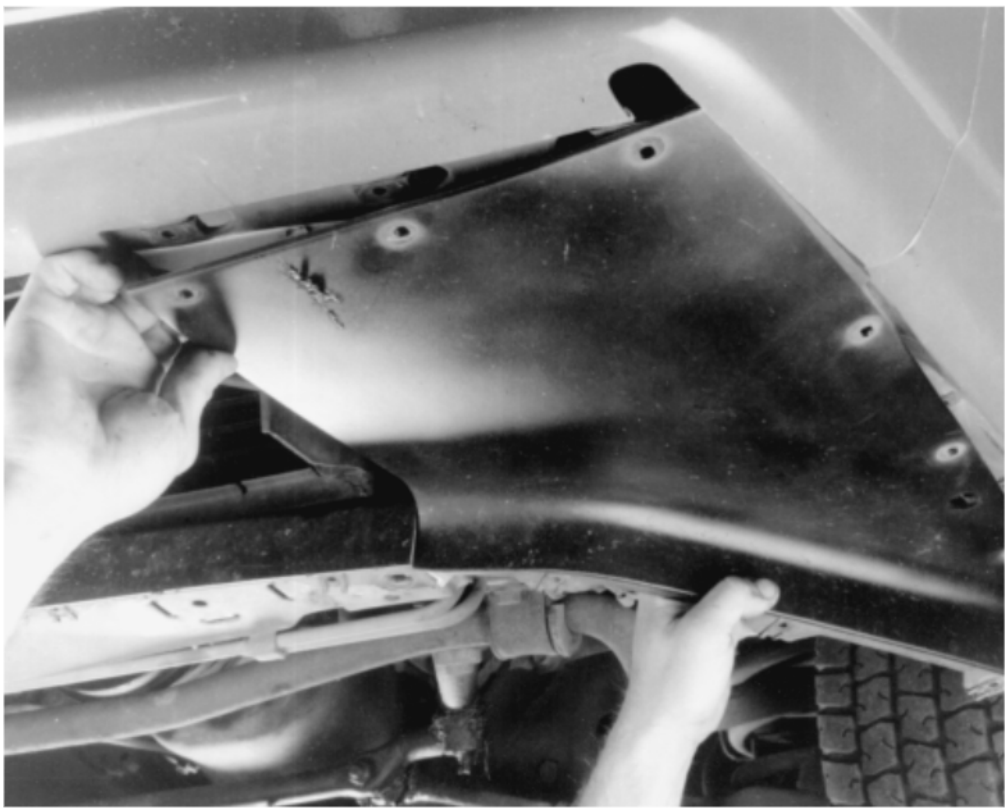


Fig. 3: Removing the filler panel from the vehicle

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Fig. 4: Once the filler panel has been removed, the front side marker light can be replaced

## REAR MARKER LIGHTS

1. Open the hatch.
2. Remove the fasteners from the rear trim panel.
3. Remove the trim panel.
4. Remove the socket from the lens assembly.
5. Remove the bulb from the socket.
6. Installation is the reverse of removal.

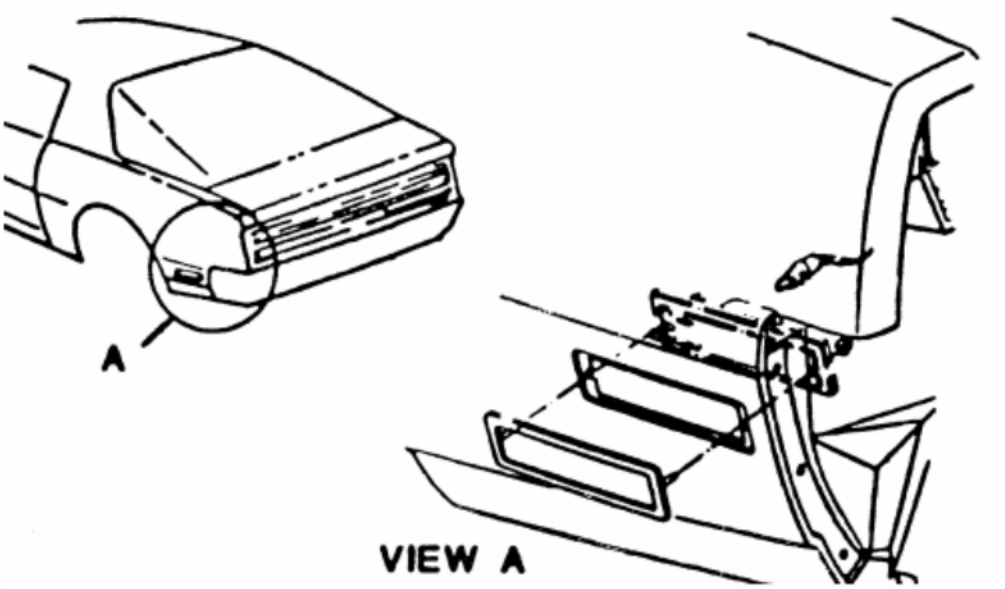



Fig. 5: Exploded view of the side marker lamp assembly

## REAR TURN SIGNAL, BRAKE AND PARKING LIGHTS

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1. Remove the rear compartment trim assembly.
2. Remove the plastic wing nuts from the tail lamp assembly.
3. Remove the tail lamp assembly.
4. Remove the socket(s) from the assembly.
5. Remove the bulb(s) from the socket(s).
6. Installation is the reverse of removal.



Fig. 6: Remove the tail light bezel attaching screws



Fig. 7: There are attaching screws hidden in the rear corner

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Fig. 8: Push the thumb-lock and turn the lamp assembly to remove

## HIGH MOUNT BRAKE LIGHT

### 1986 MODELS

1. Remove the screw securing the cover.
2. Remove the cover.
3. Remove the bulb.
4. Installation is the reverse of removal.

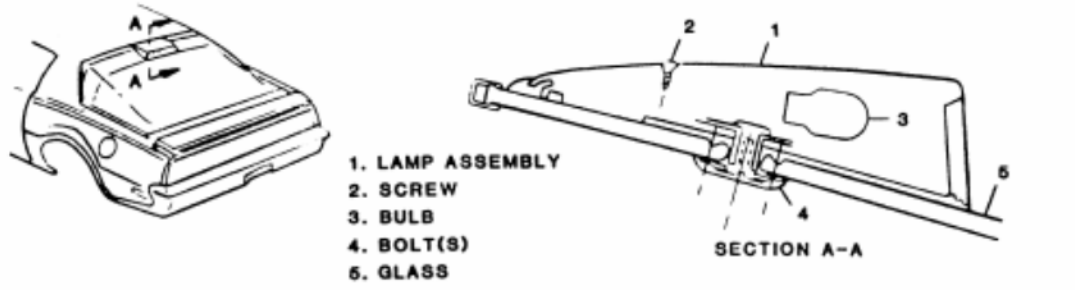



Fig. 9: Third brake light on 1986 models

### 1987-1990 MODELS

1. Remove the screws securing the lens assembly.
2. Remove the bulb from the lamp assembly.
3. Installation is the reverse of removal.

### 1991-1992 MODELS

1. Remove the two screws from the lamp assembly.
2. Remove the lamp assembly from the bracket.
3. Remove the bulb from the socket.

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4. Installation is the reverse of removal.

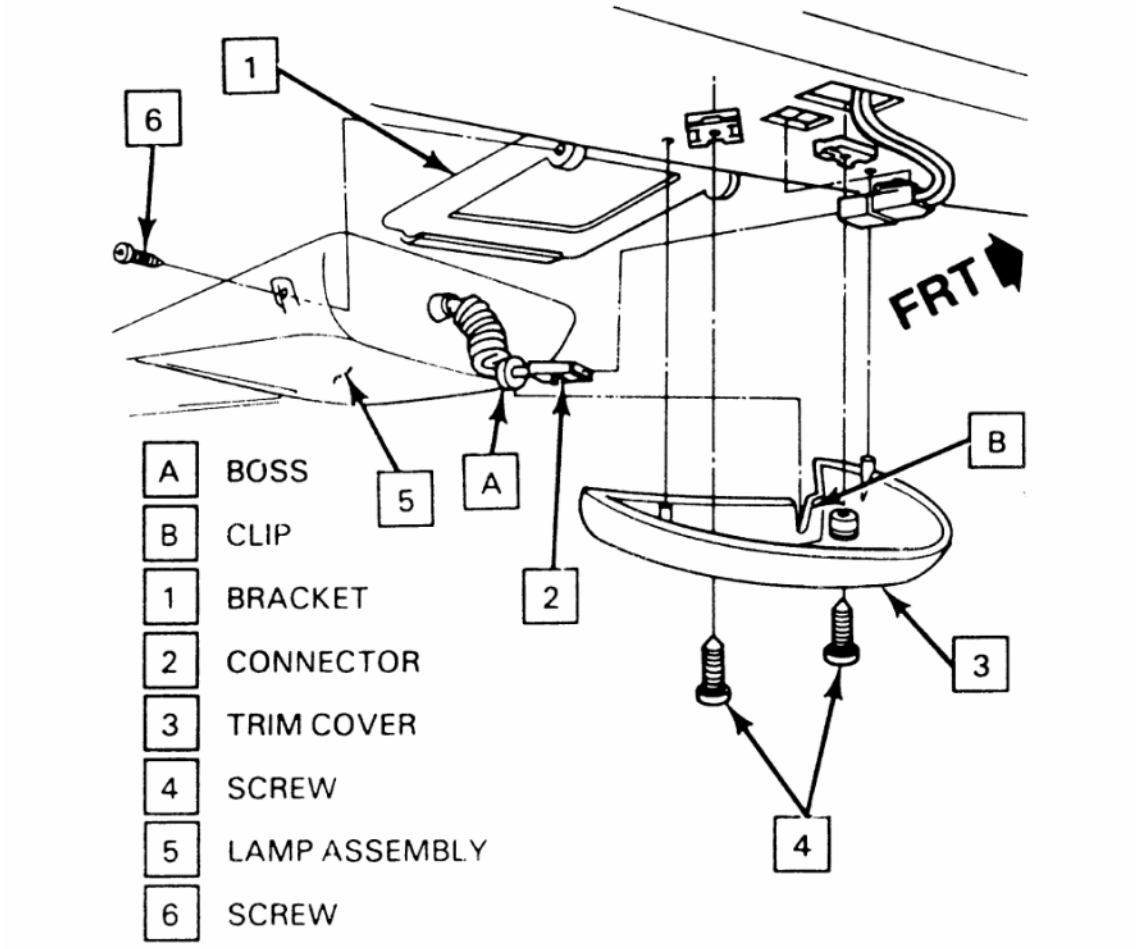



Fig. 10: Third brake light on 1991-1992 models

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## DOME LIGHT

1. Remove the courtesy lamp fuse.
2. Remove the lens by gently squeezing the edge and pulling down.
3. Remove the bulb.
4. Installation is the reverse of removal.

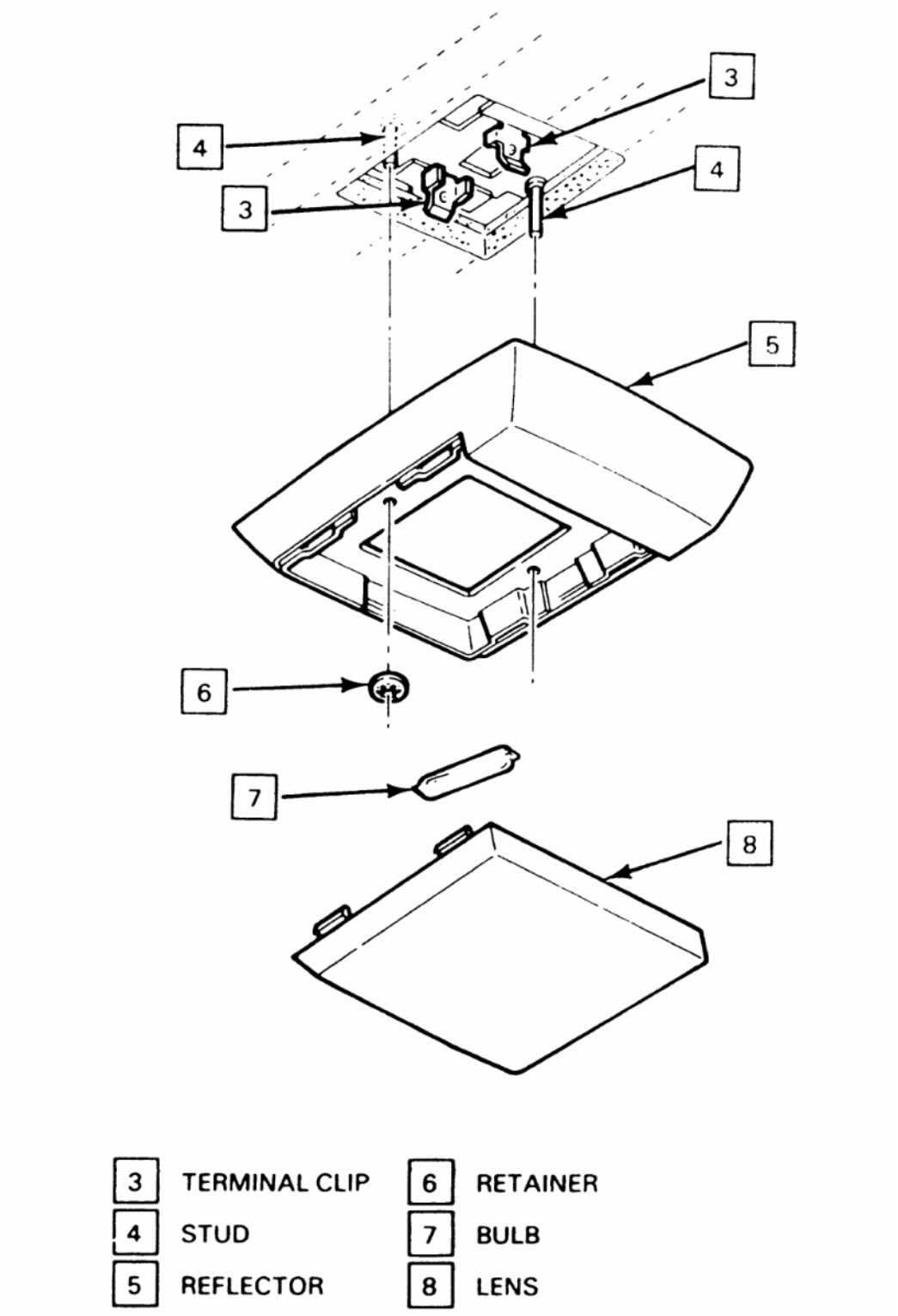



Fig. 11: Dome lamp assembly

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## PASSENGER AREA LAMPS

The passenger area courtesy lamps can be replaced by first removing the appropriate trim panel, then removing the bulb from the socket. Most panels are fastened by screws or snap-fasteners. Be careful not to force the trim panel off, as you may damage it. Do not pry with tools which may damage the panel, use tools designed for panel removal only.

## LICENSE PLATE LIGHTS

1. Remove the screws securing the lamp assembly to the bumper.
2. Remove the bulb from the socket.
3. Installation is the reverse of removal.

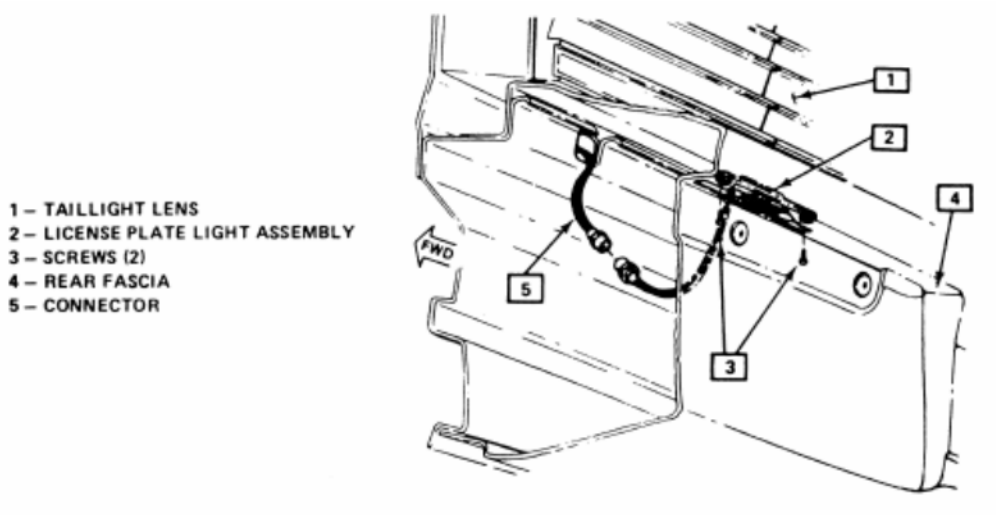



Fig. 12: License plate lamp

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## FOG LIGHTS

## REMOVAL & INSTALLATION

1. Remove the two screws attaching the lamp assembly to the front impact bar.
2. Remove the lamp assembly from the impact bar.
3. Disconnect the electrical connector.
4. Remove the two lens attaching screws.
5. Remove the bulb.
6. Installation is the reverse of removal.

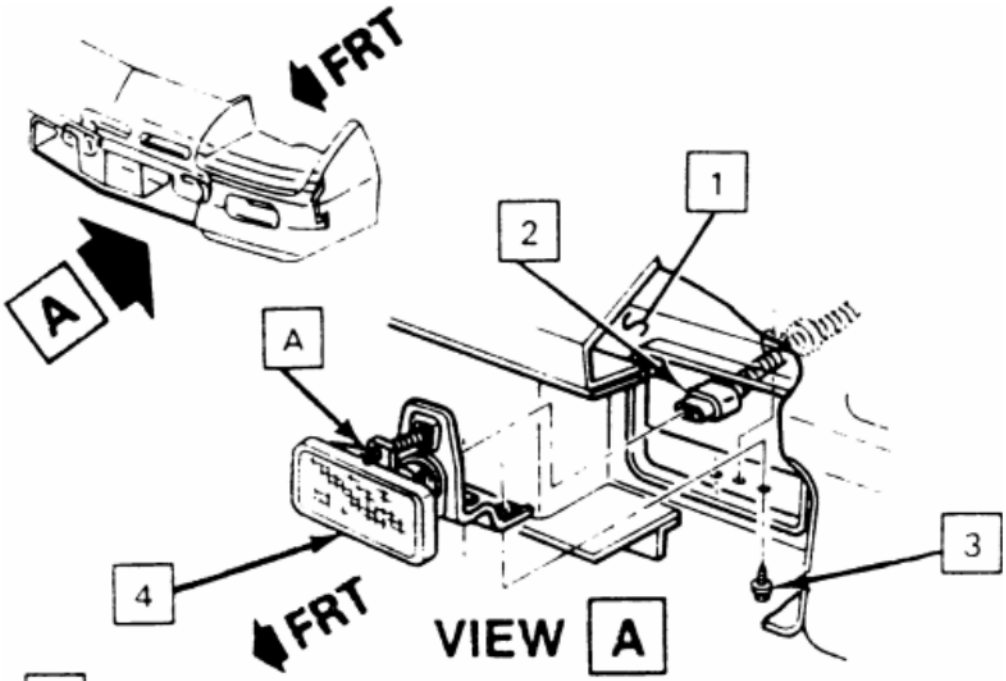



Fig. 1: Typical fog light mounting

## AIMING

*Check with your local authorities before performing this procedure. Most areas have standards for proper adjustment. We recommend, for safety, that the adjustment always be checked by a reputable shop.*

1. Prepare the vehicle as follows:
    a. Make sure all components are in place.
    b. Make sure the vehicle has a $^{1}/_{2}$ tank of fuel or less.

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c. Move the vehicle to a level area and park 25 feet (7.6 m) away from a target screen.
2. With the fog lamps on, measure from the center of the fog lamp assembly to the ground line.
3. Top edge of the high intensity zone should be 4 inches (102 mm) below the centerline of the fog lamp assembly.
4. Adjust if necessary.

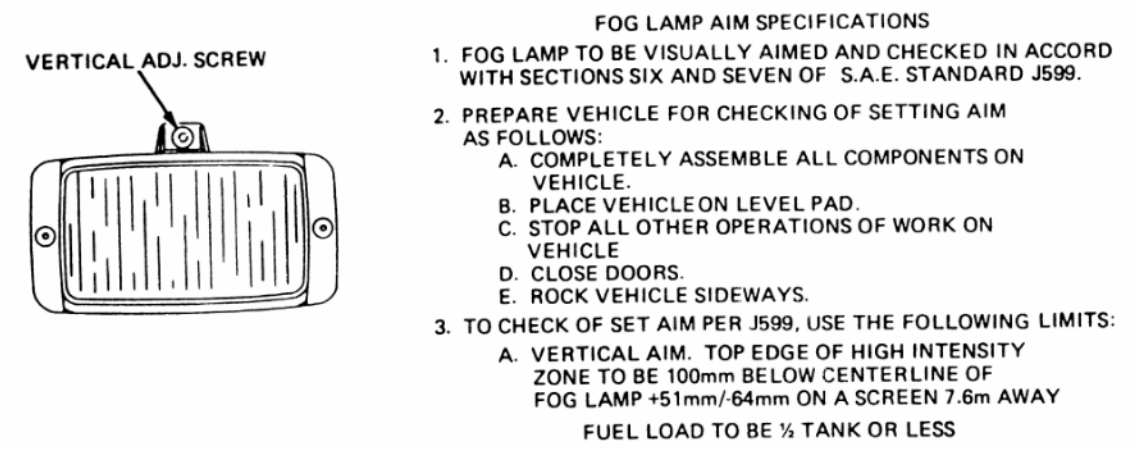


Fig. 2: Fog lamp aiming

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## FUSE BLOCK

The fuse block on some models is located under the instrument panel next to the steering wheel and is a swing down unit. Other models have the fuse block located on the left side of the dash.

Each fuse block uses miniature fuses which are designed for increased circuit protection and greater reliability. The compact fuse is a blade terminal design which allows easy pull-out/push-in removal and replacement.

Although the fuses are interchangeable, the amperage values are not. The values are usually molded in bold, color coded, easy to read numbers on the fuse body. Use only fuses of equal replacement valve.

A blown fuse can easily be checked by visual inspection or by continuity checking.

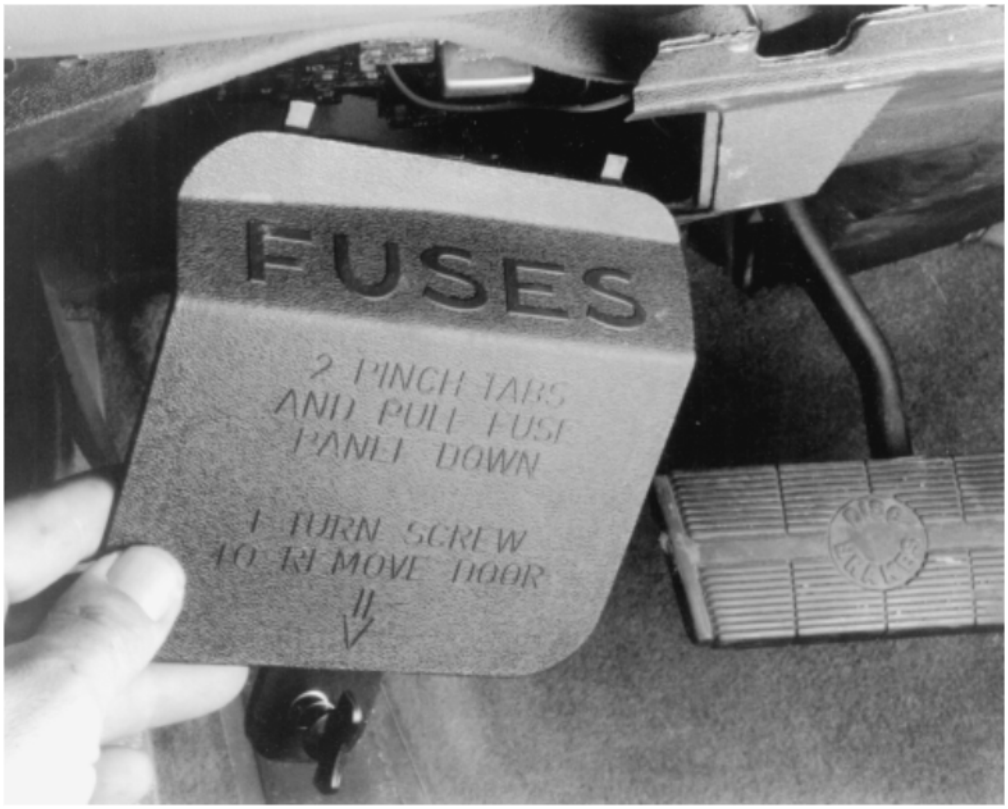


Fig. 1: The fuse block is located behind this access panel

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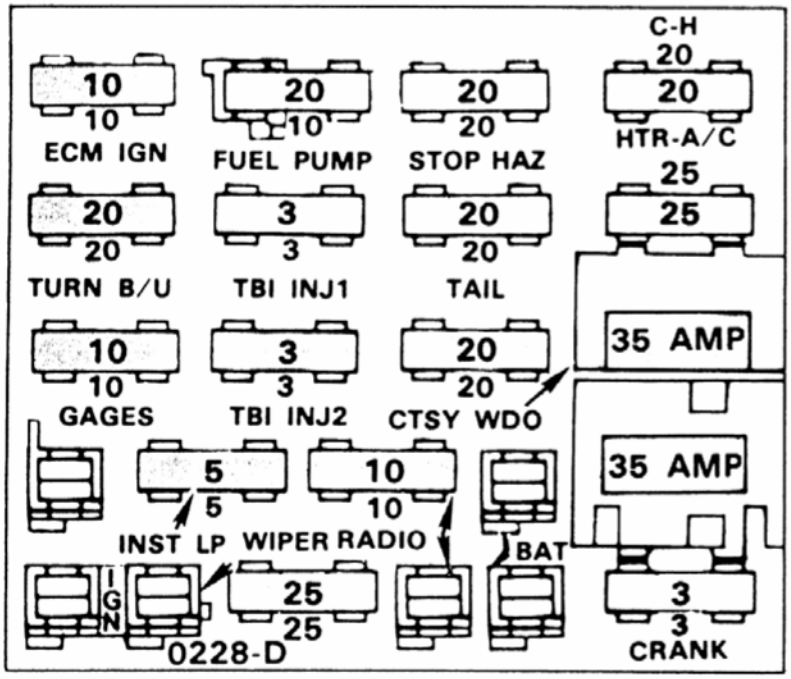



Fig. 2: Fuses on 1982-1984 models

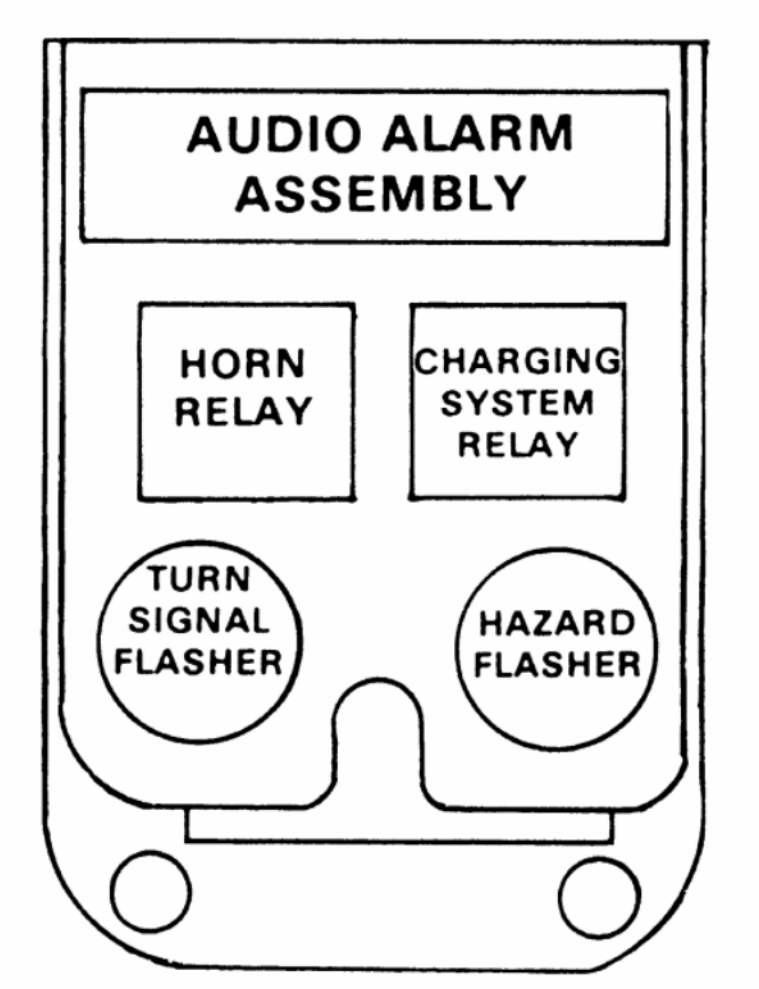



Fig. 3: Convenience center on 1982-1984 models

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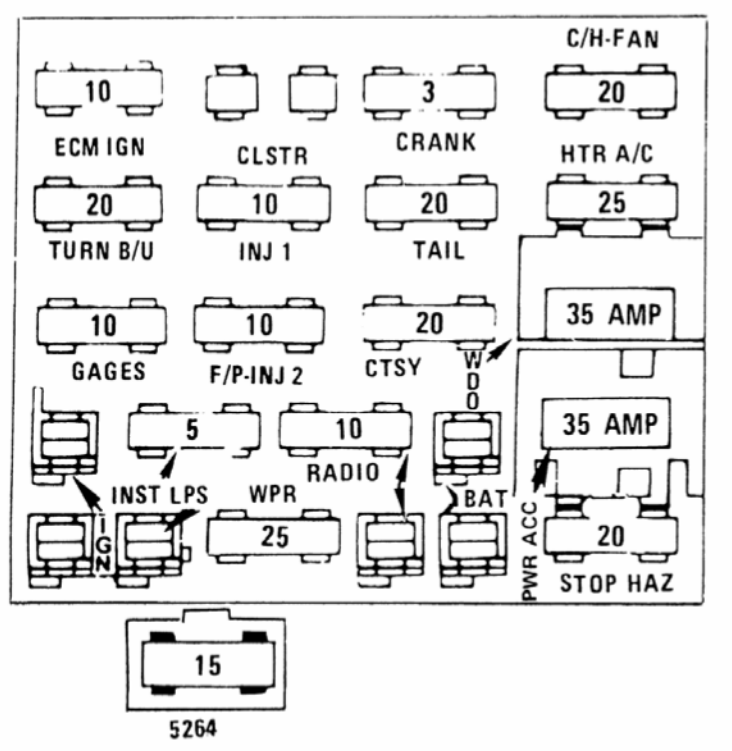



Fig. 4: Fuses on 1985-1989 models

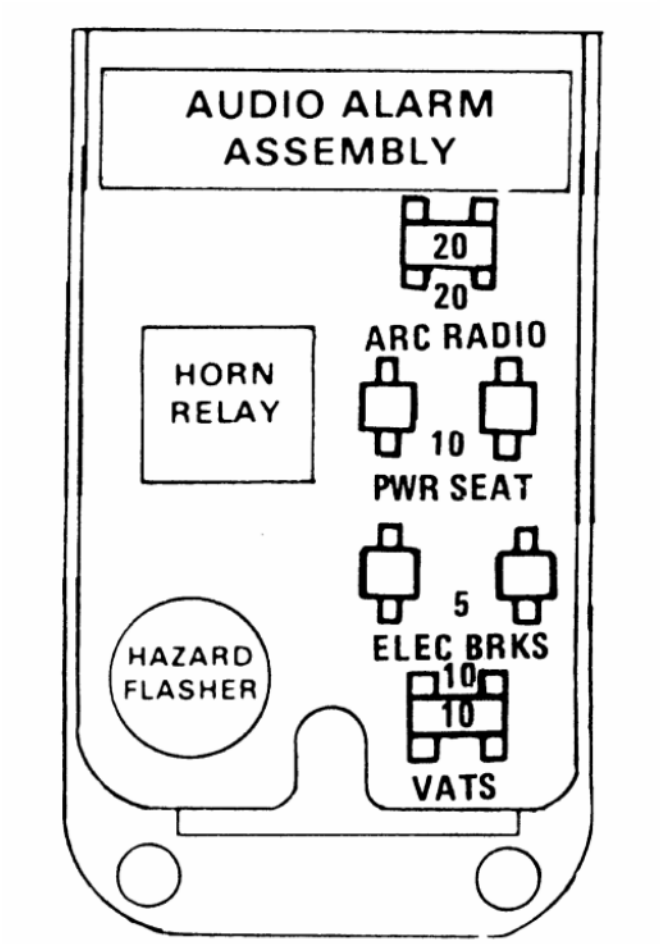



Fig. 5: Convenience center on 1985-1989 models

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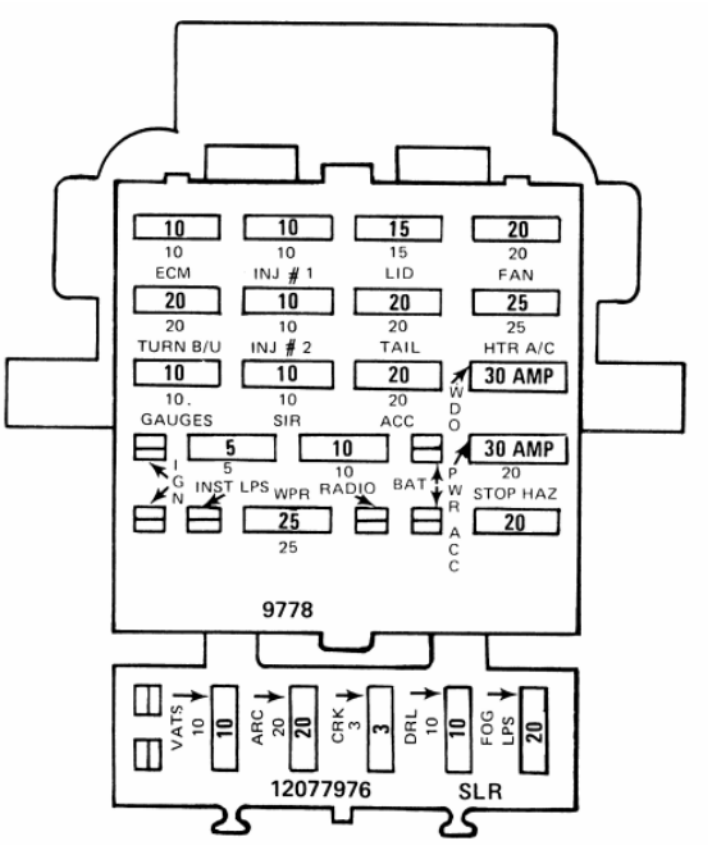



Fig. 6: Fuses on 1990-1992 models

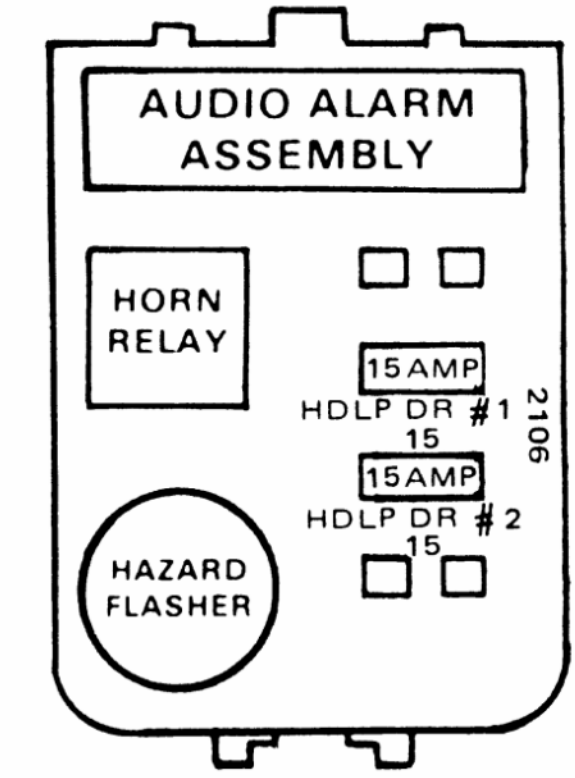



Fig. 7: Convenience center on 1990-1992 models

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## FUSIBLE LINKS

In addition to circuit breakers and fuses, the wiring harness incorporates fusible links to protect the wiring. Links are used rather than a fuse, in wiring circuits that are not normally fused, such as the ignition circuit. The fusible links are color coded red in the charging and load circuits to match the color coding of the circuits they protect. Each link is four gauges smaller than the cable it protects, and is marked on the insulation with the gauge size because the insulation makes it appear heavier than it really is. The engine compartment wiring harness has several fusible links. The same size wire with a special Hypalon insulation must be used when replacing a fusible link.

*For more details, see the information on fusible links at the beginning of this section.*

The links are located in the following areas:

1. A molded splice at the starter solenoid *Bat* terminal, a 14 gauge red wire.
2. A 16 gauge red fusible link at the junction block to protect the unfused wiring of 12 gauge or larger wire. This link stops at the bulkhead connector.
3. The alternator warning light and field circuitry is protected by a 20 gauge red wire fusible link used in the battery feed-to-voltage regulator number 3 terminal. The link is installed as a molded splice in the circuit at the junction block.
4. The ammeter circuit is protected by two 20 gauge fusible links installed as molded splices in the circuit at the junction block and battery to starter circuit.

## REPLACEMENT

1. Determine the circuit that is damaged.
2. Disconnect the negative battery terminal.
3. Cut the damaged fuse link from the harness and discard it.
4. Identify and procure the proper fuse link and butt connectors.
5. Strip the wire about $^{1}/_{2}$ in. (13mm) on each end.
6. Connect the fusible link and crimp the butt connectors making sure that the wires are secure.
7. Solder each connection with resin core solder, and wrap the connections with plastic electrical tape.
8. Reinstall the wire in the harness.
9. Connect the negative battery terminal and test the system for proper operation.

## CIRCUIT BREAKERS

Various circuit breakers are located under the instrument panel. In order to gain access to these components, it may be necessary to first remove the under dash padding. Most of the circuit breakers are located in the convenience center or the fuse panel.

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## BUZZERS, RELAYS, AND FLASHERS

The electrical protection devices are located in the convenience center, which is a swing down unit located under the instrument panel. All units are serviced by plug-in replacements.

## TURN SIGNAL FLASHER

The turn signal flasher is located inside the convenience center. In order to gain access to the turn signal flasher, it may be necessary to first remove the under dash padding.

## HAZARD FLASHER

The hazard flasher is located inside the convenience center. In order to gain access to the turn signal flasher, it may be necessary to first remove the under dash padding.

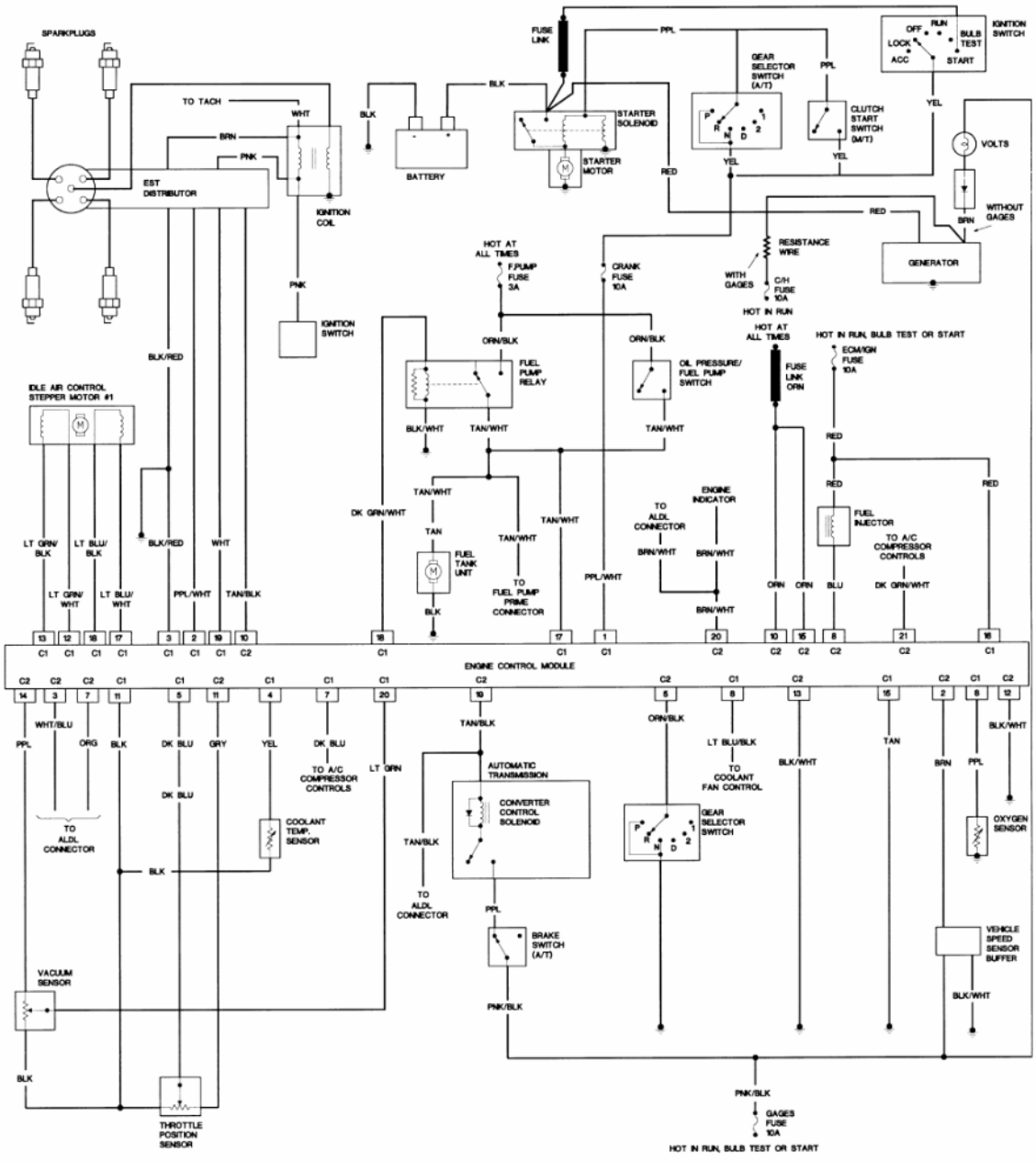
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## WIRING DIAGRAMS

## WIRING DIAGRAMS

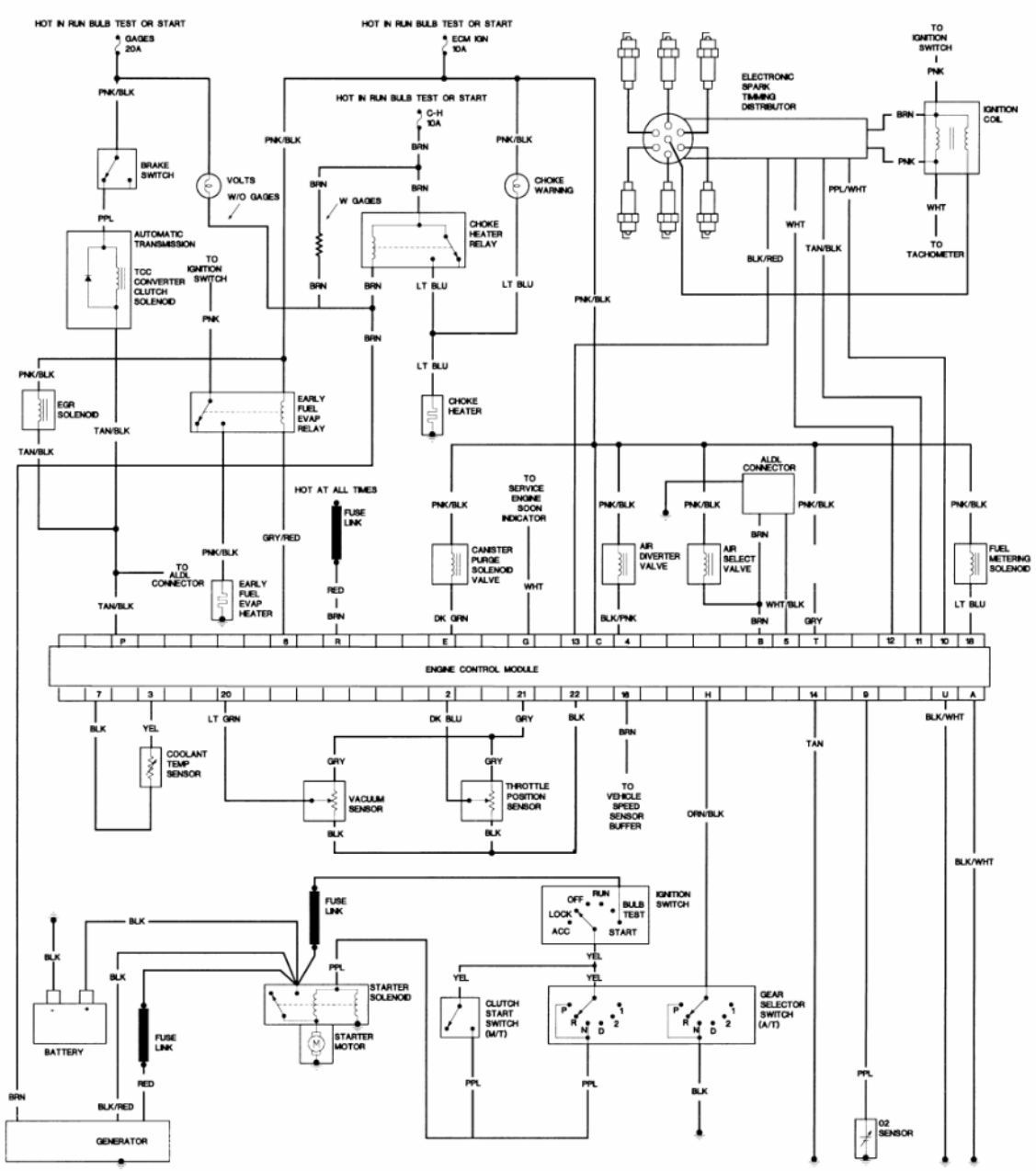
The following wiring diagrams are provided to help troubleshoot electrical problems and as a an additional source to help understand the complex wiring utilized by these vehicles. No attempt has been made to illustrate most components as they physically appear, instead, representations are used to simplify the diagram. When working on a system, locate the component and use the wire color codes to help trace the circuit.

### 1982 2.5L ENGINE WIRING



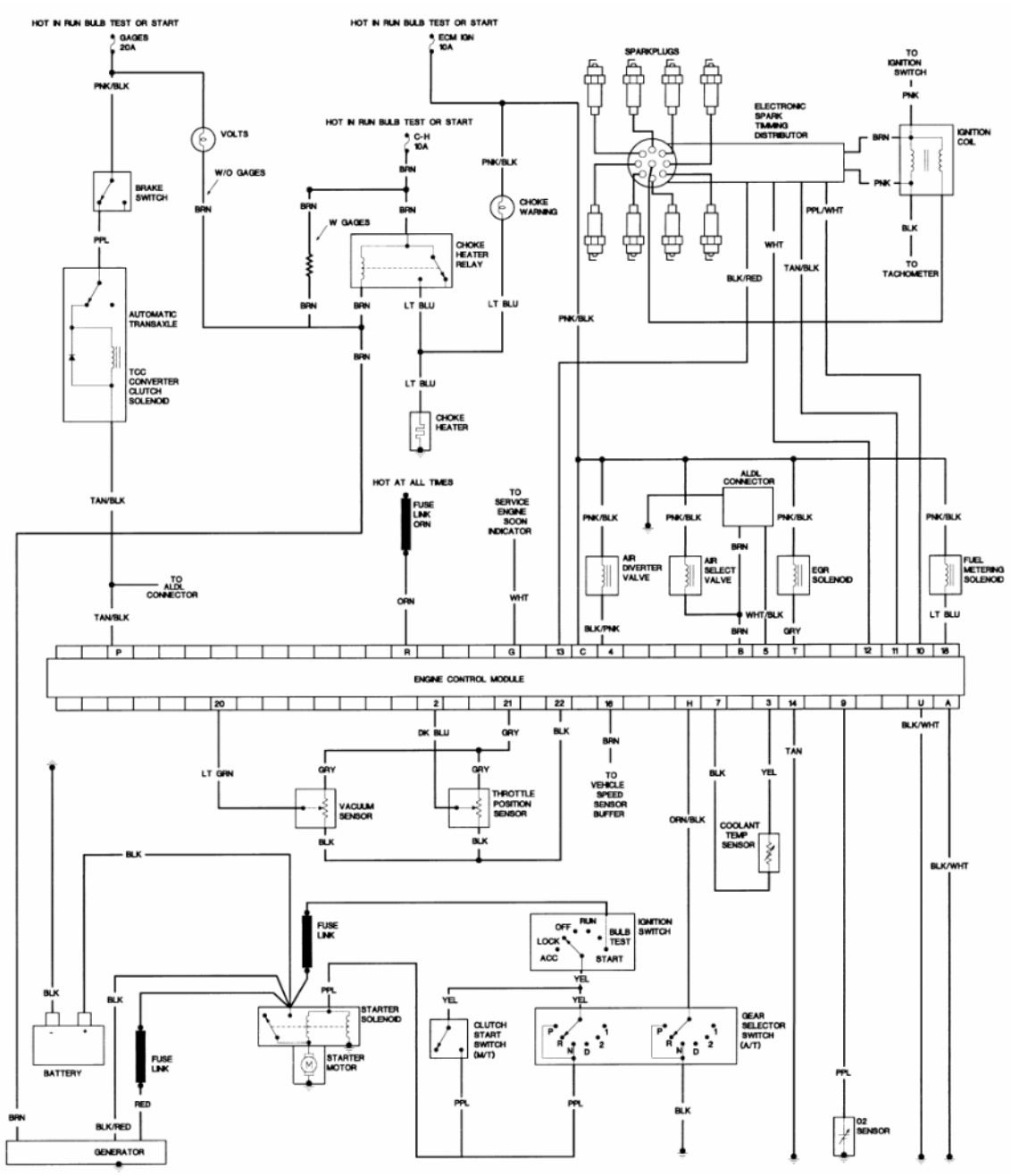

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## 1982 2.8L ENGINE WIRING



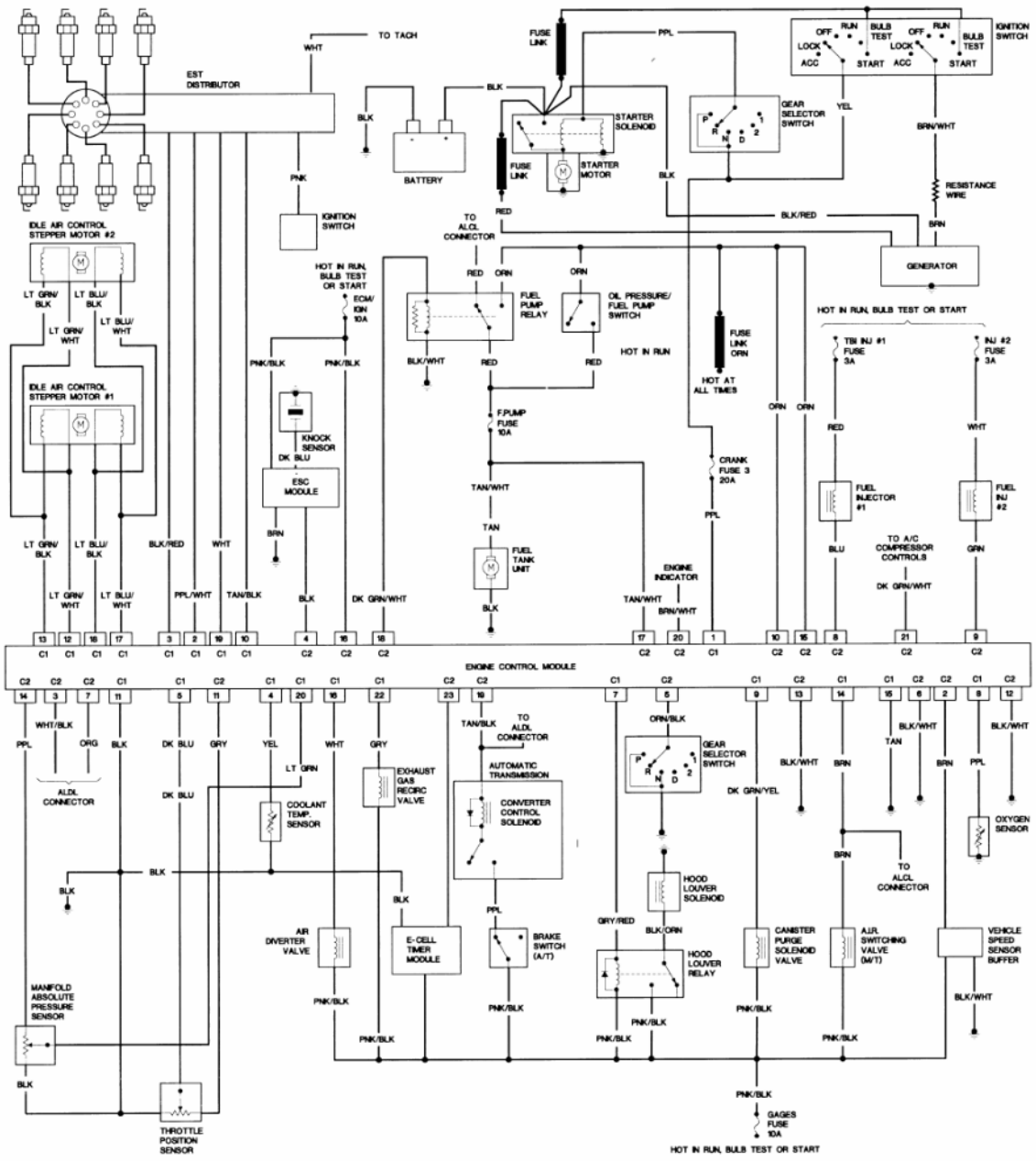

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## 1982 5.0L CARBURETED ENGINE WIRING



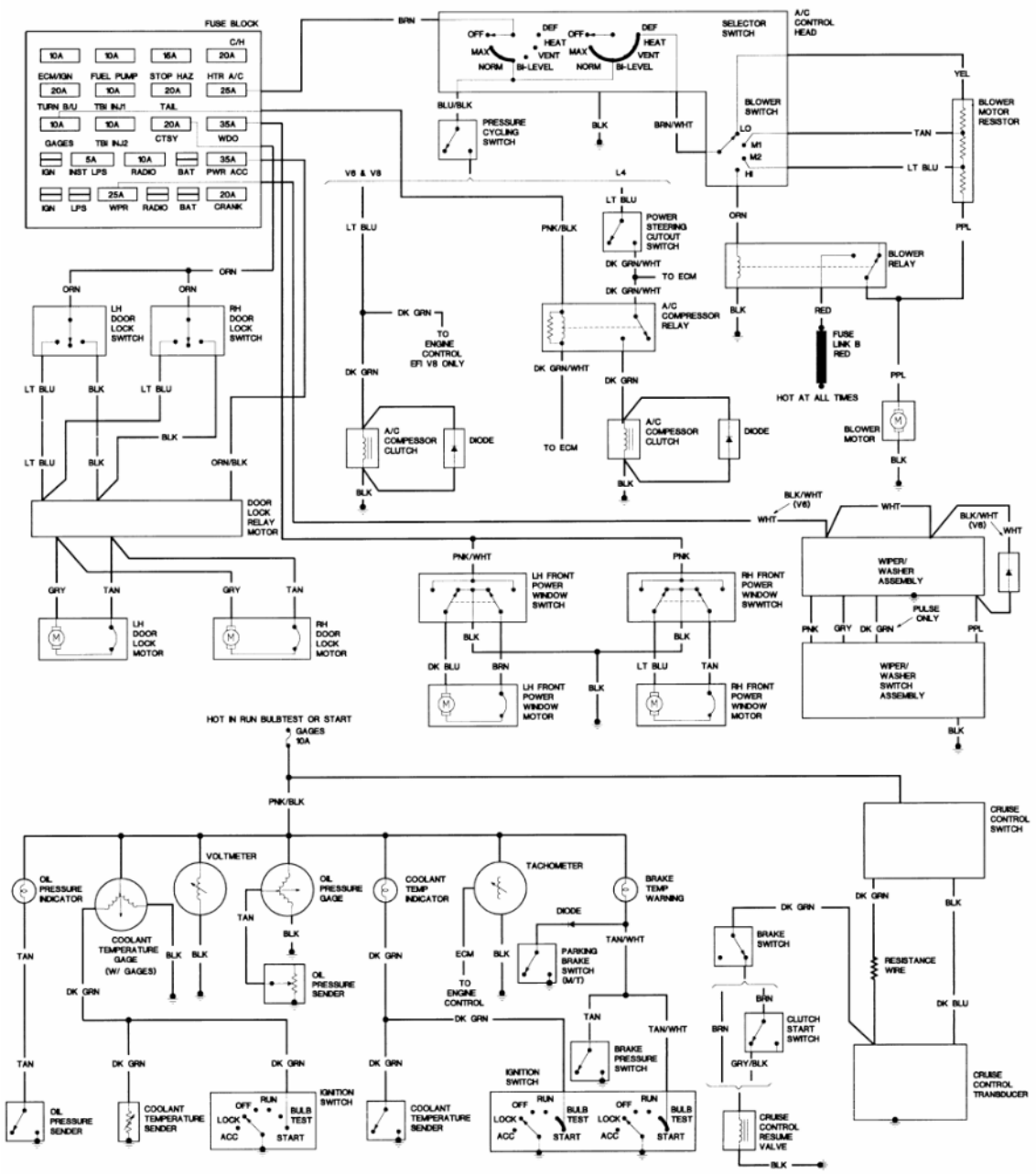

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## 1982 5.0L CROSSFIRE INJECTION ENGINE WIRING



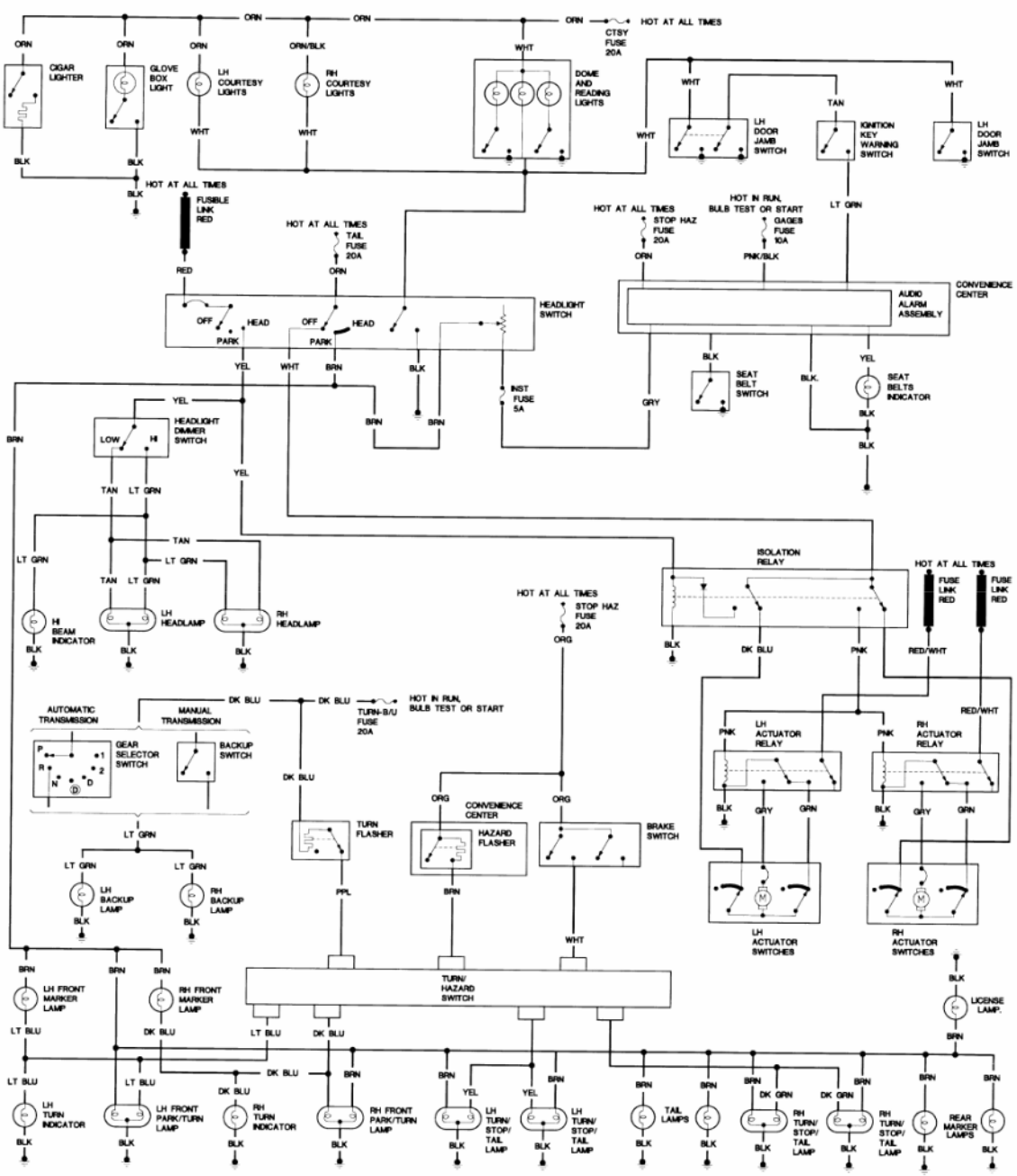

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## 1982 BODY WIRING



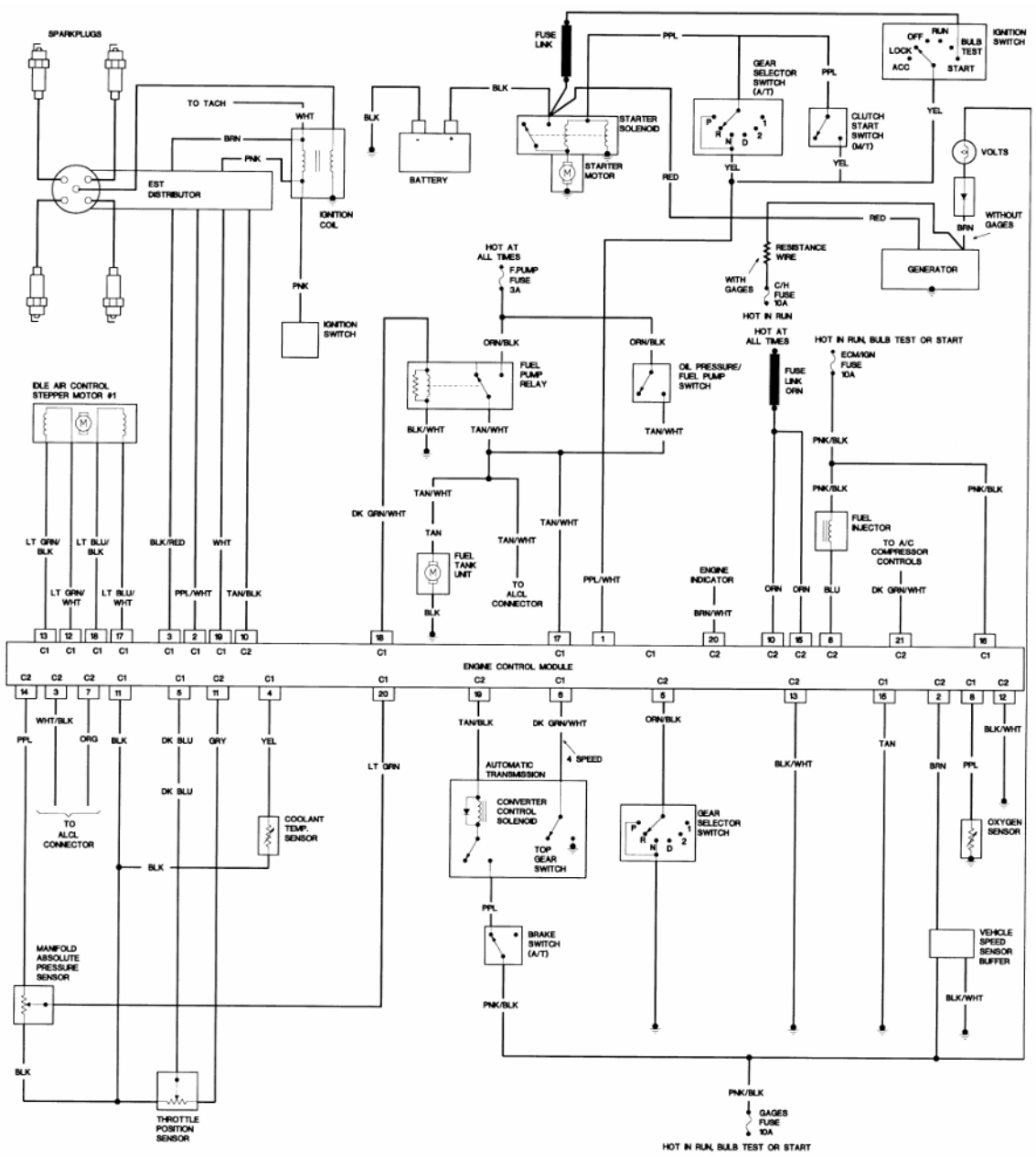

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## 1982 BODY WIRING, CONTINUED



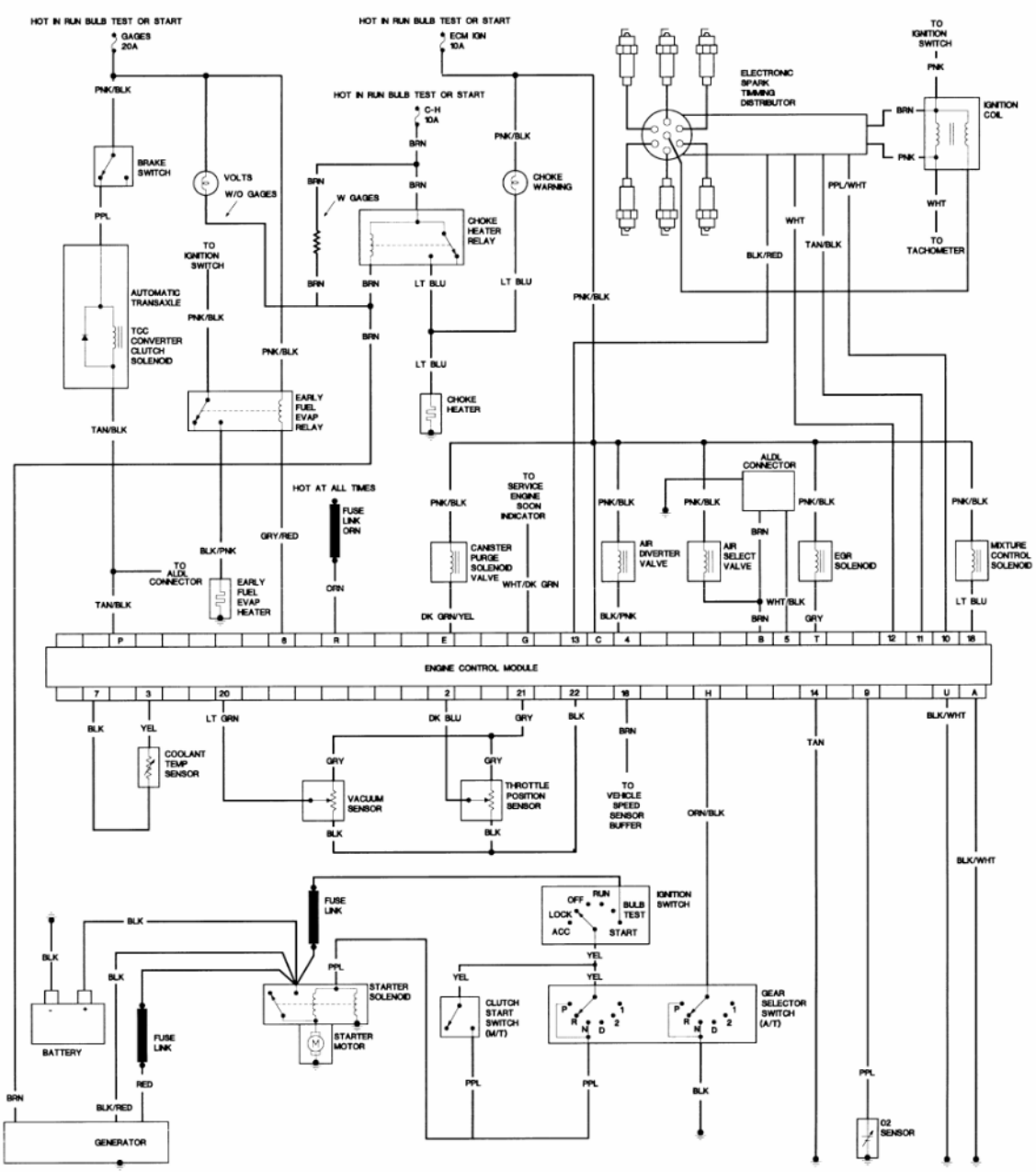

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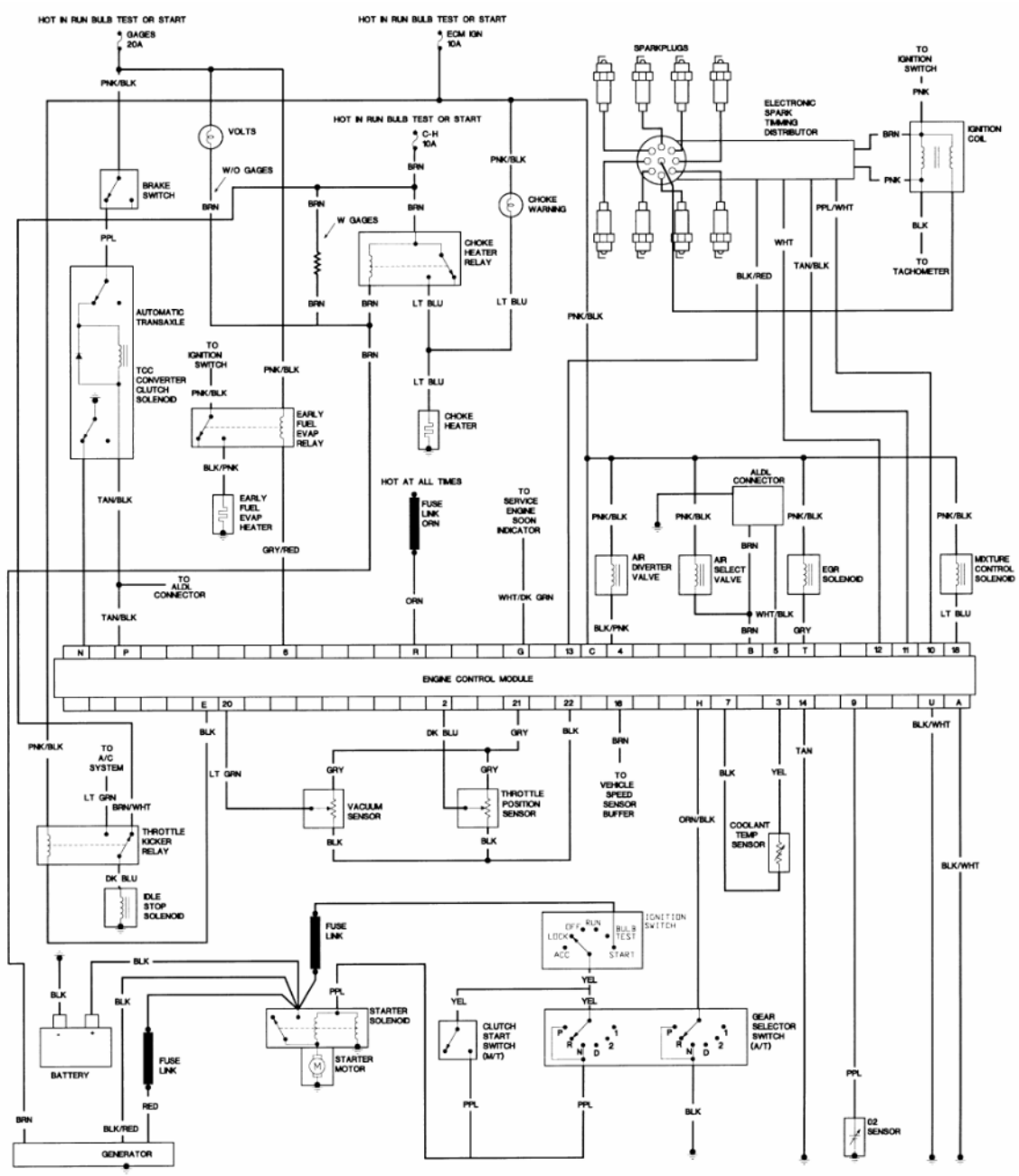

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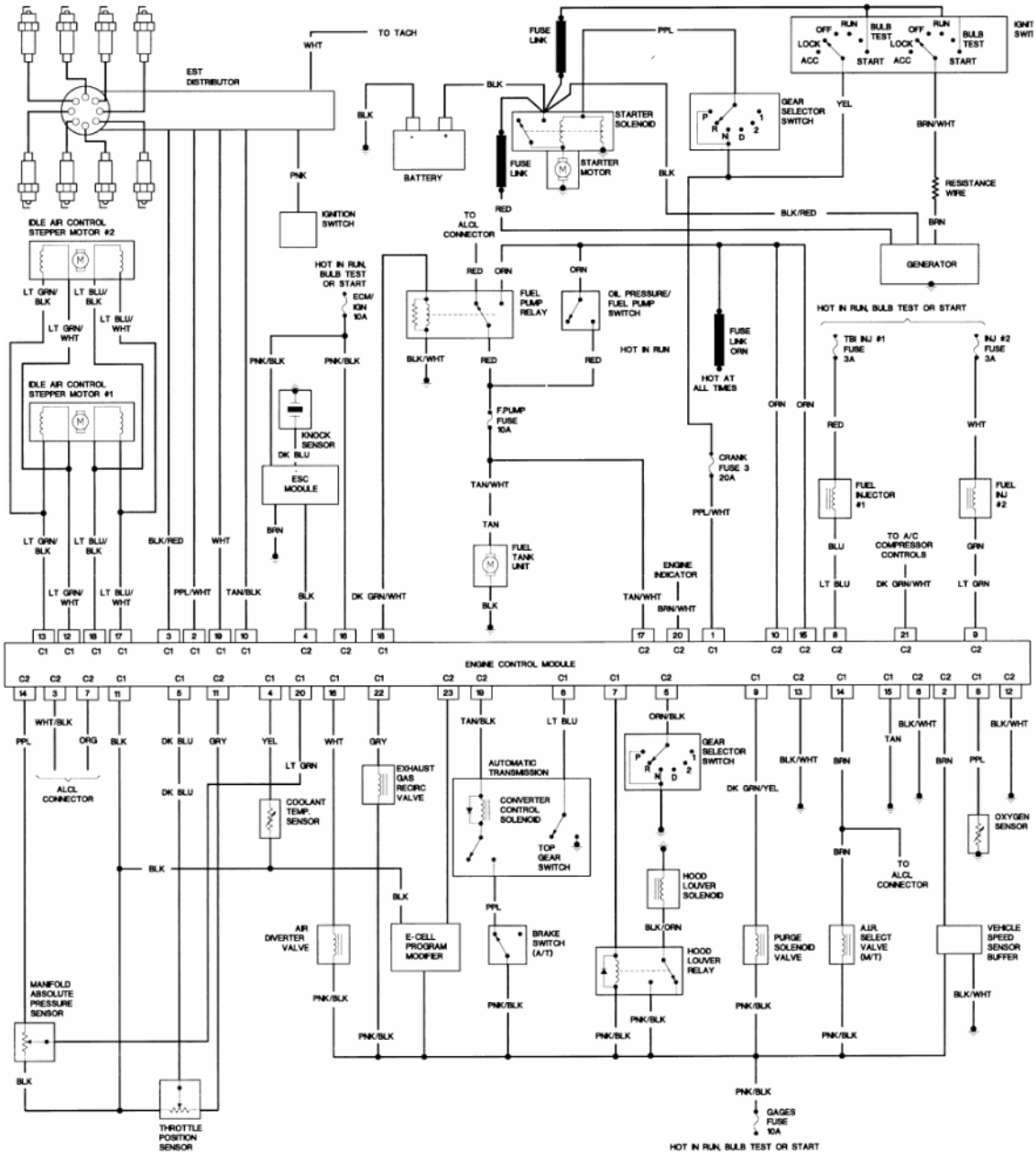

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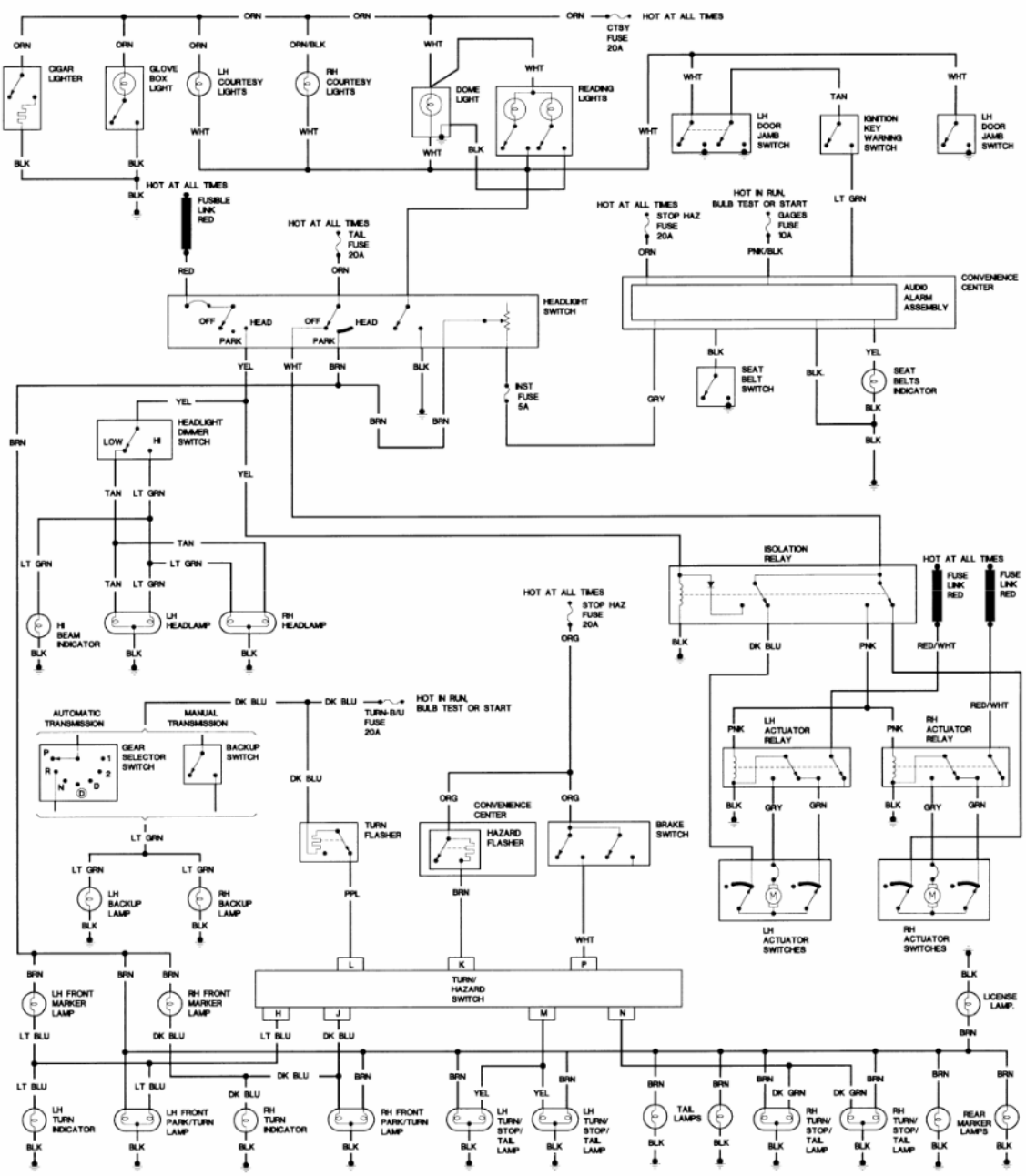

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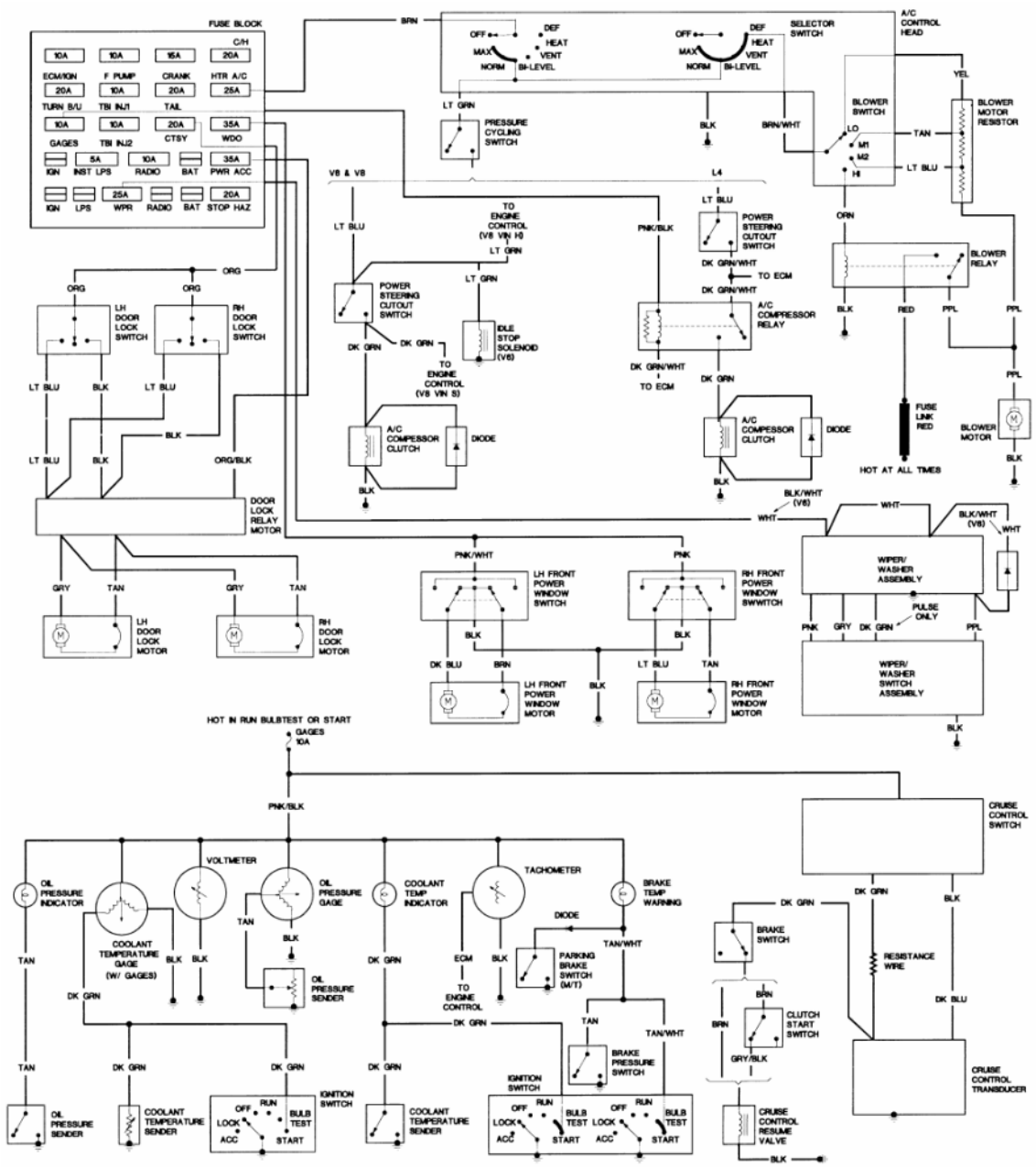

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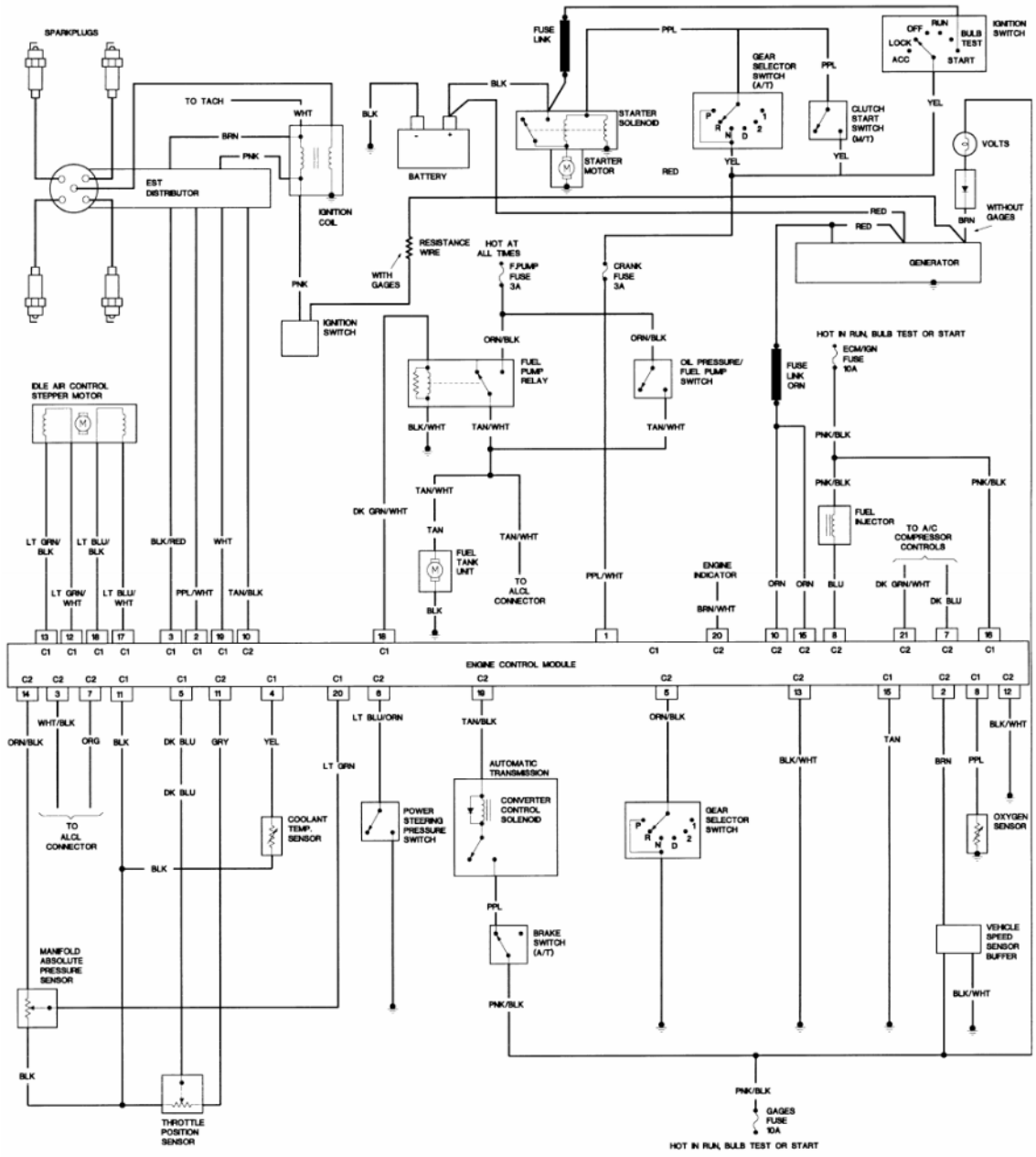

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## 1983 BODY WIRING, CONTINUED



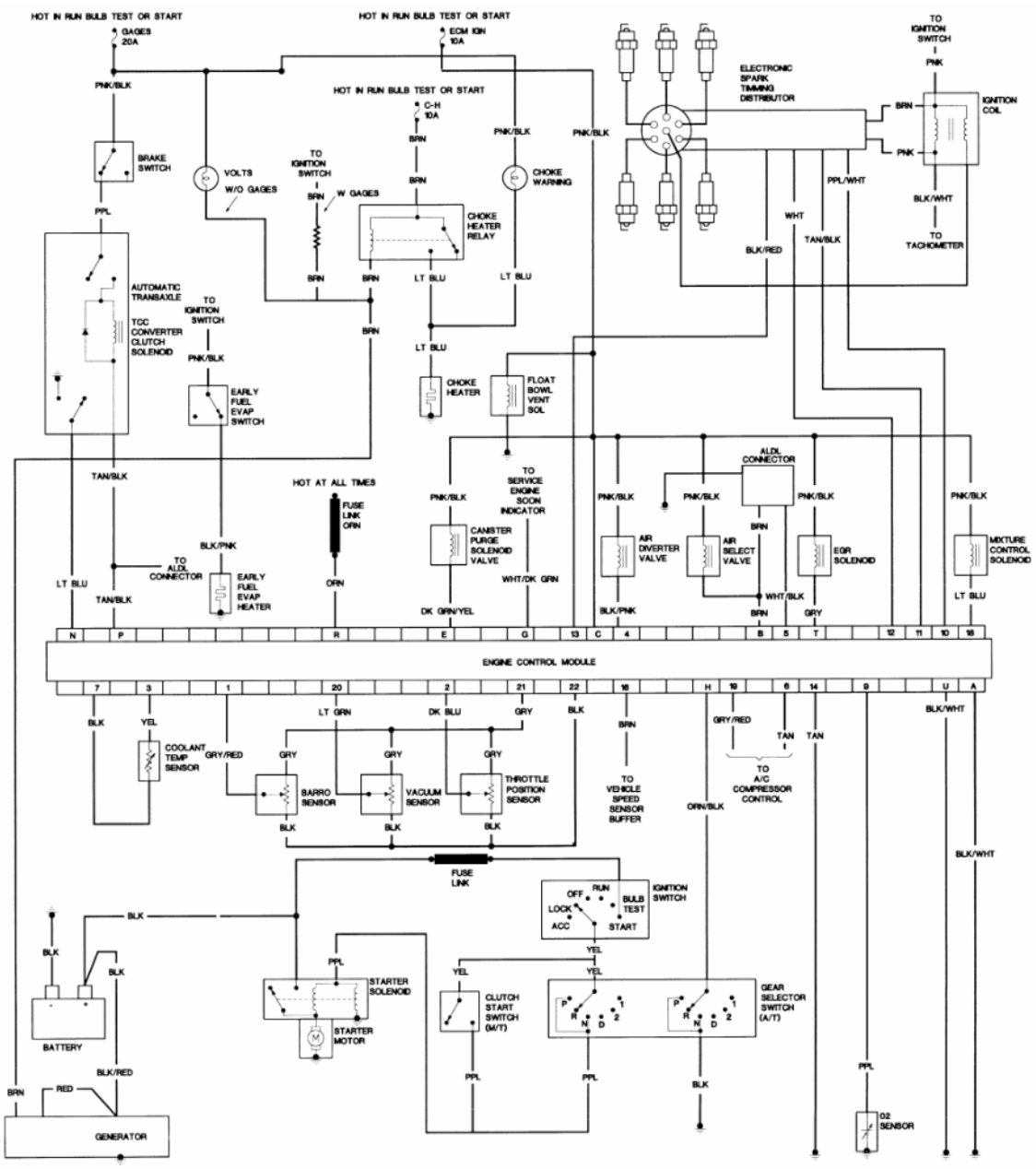

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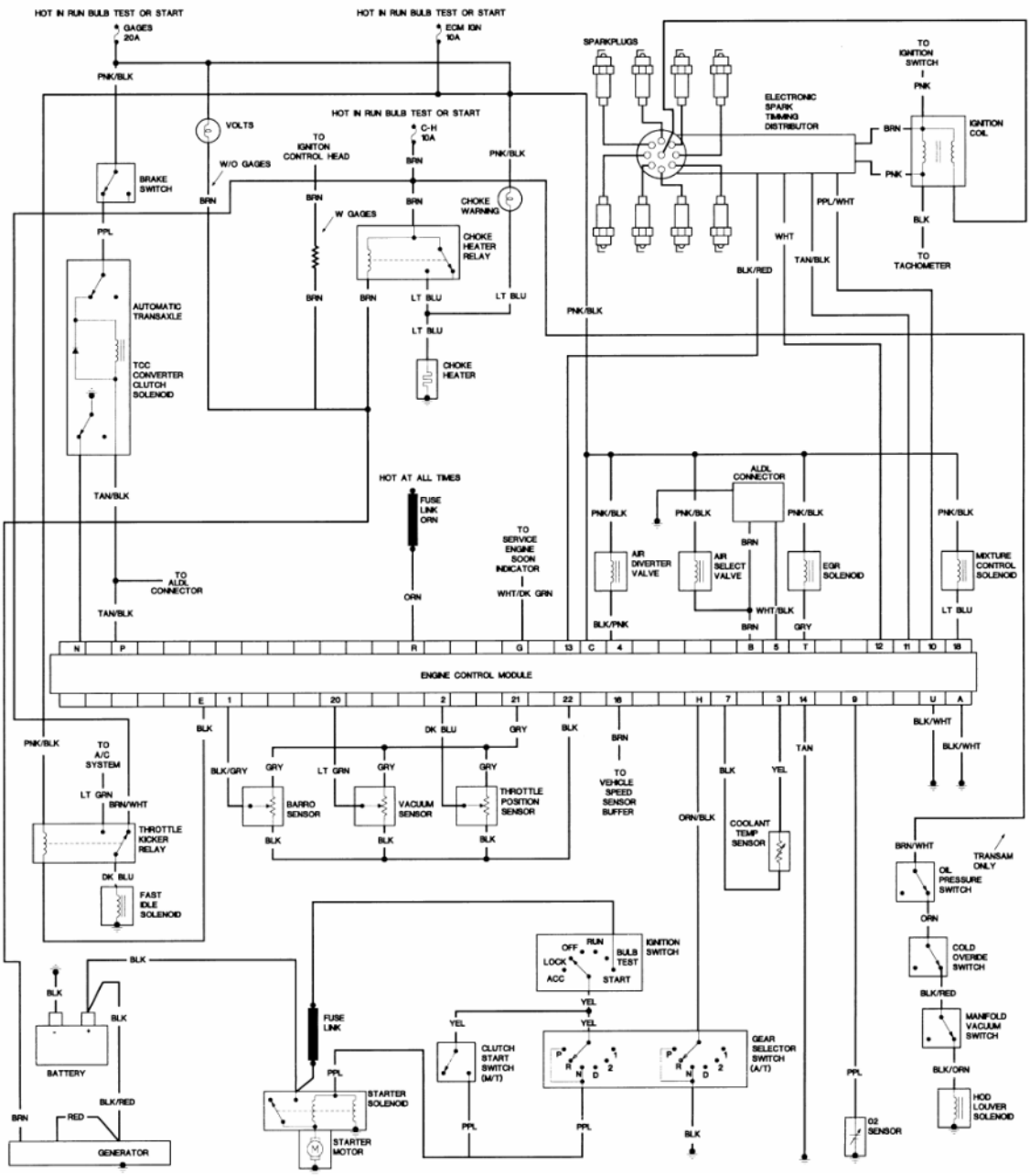

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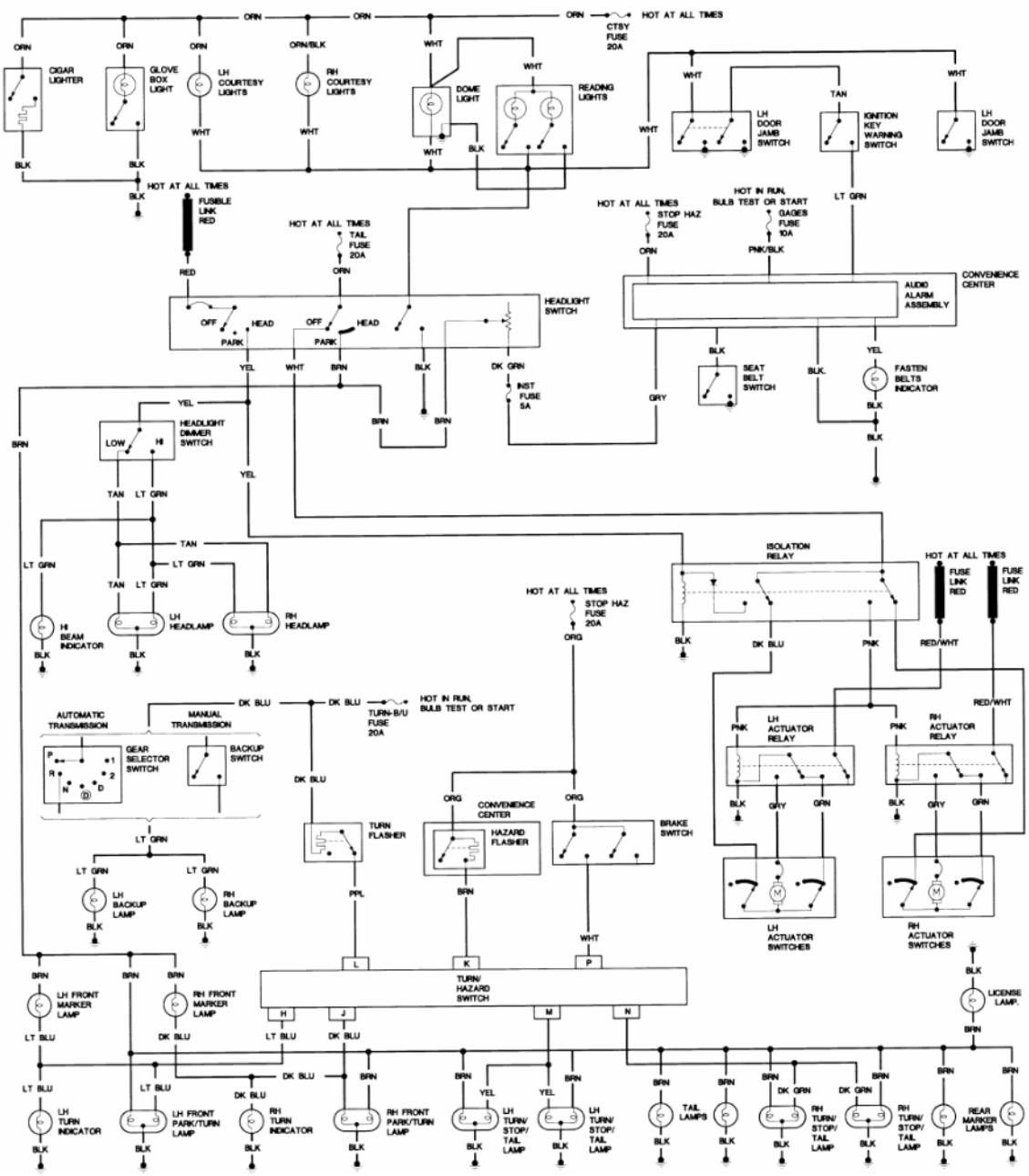

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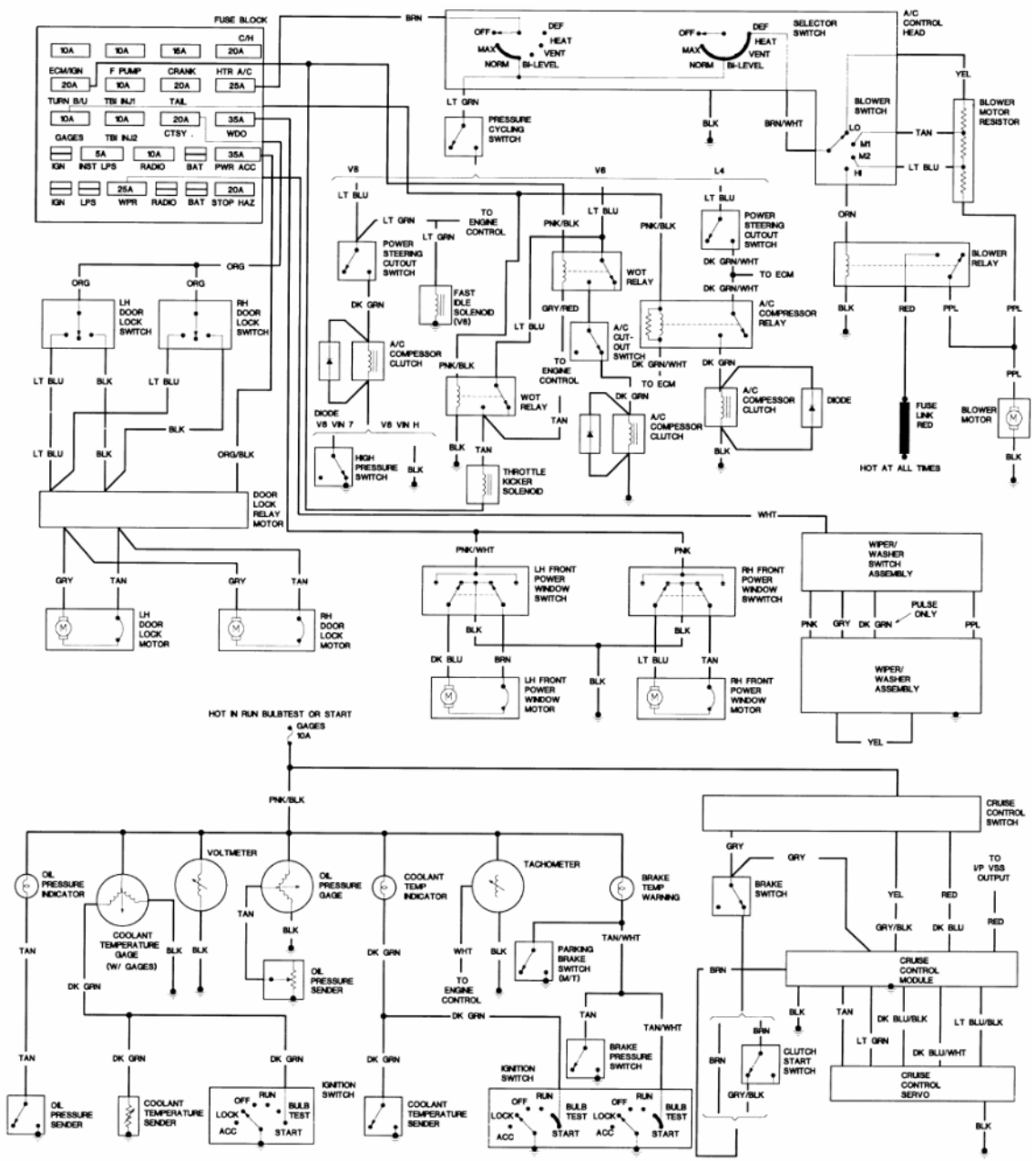

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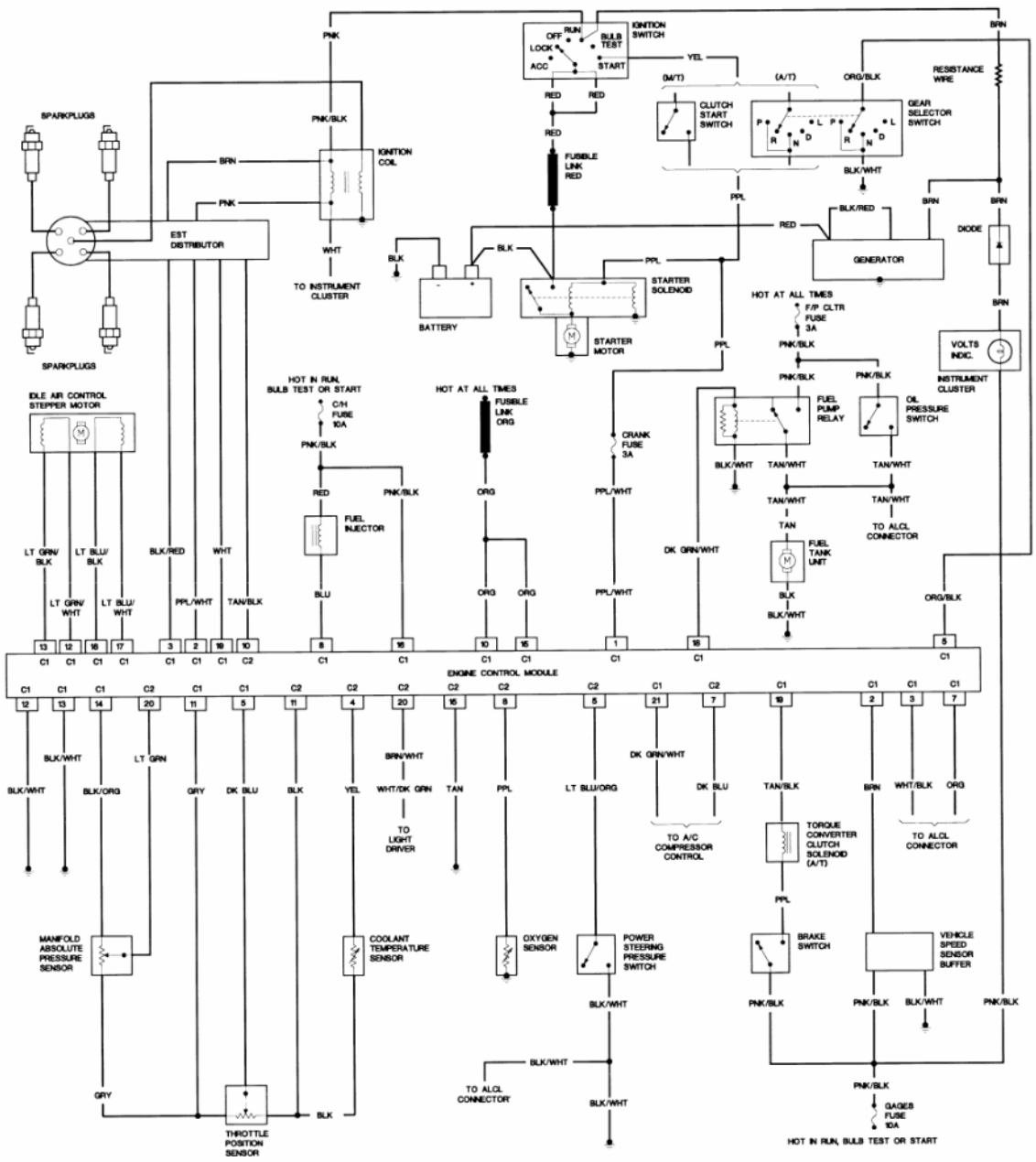

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## 1984 BODY WIRING, CONTINUED



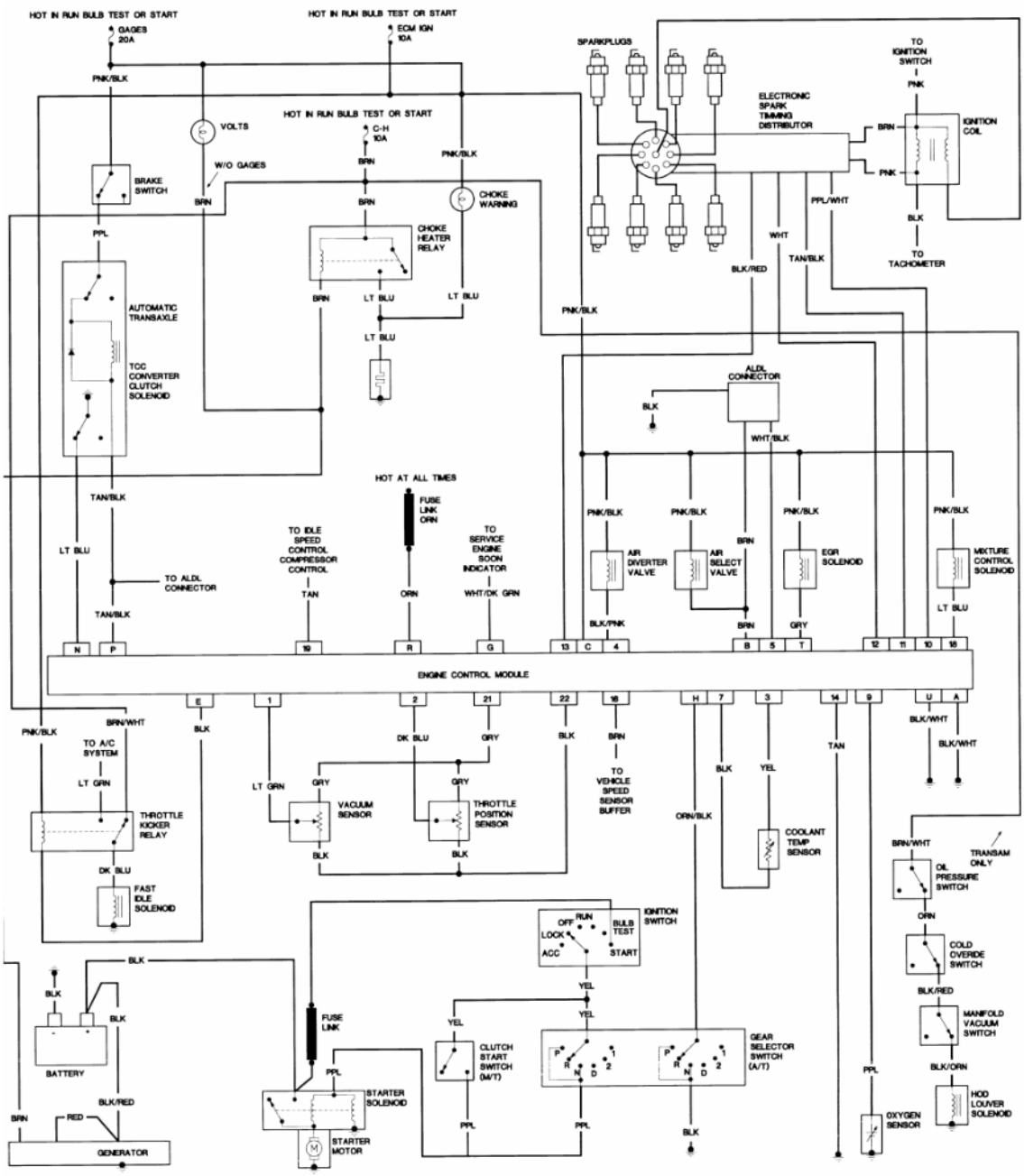

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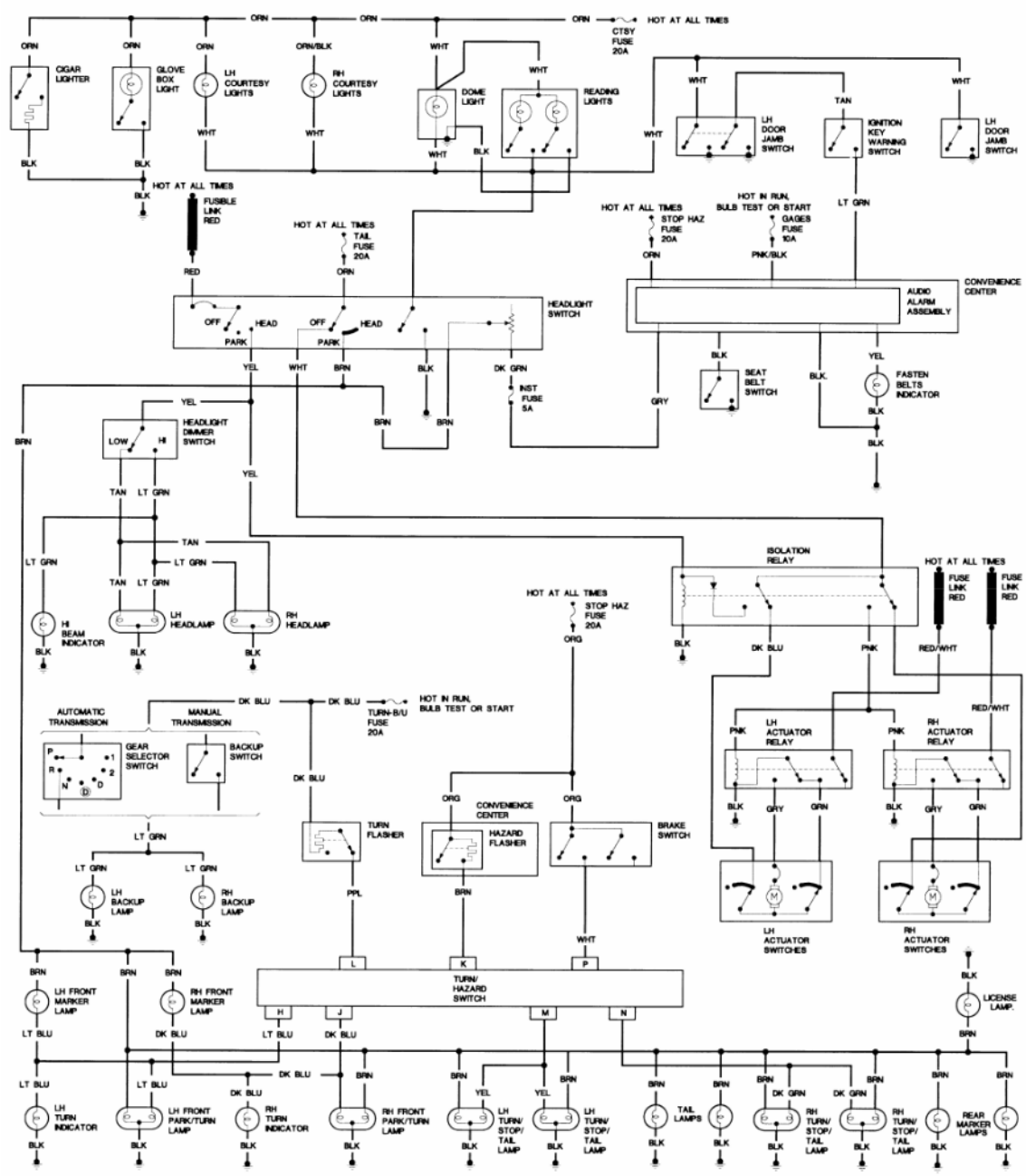

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## 1985 5.0L CARBURETED ENGINE WIRING



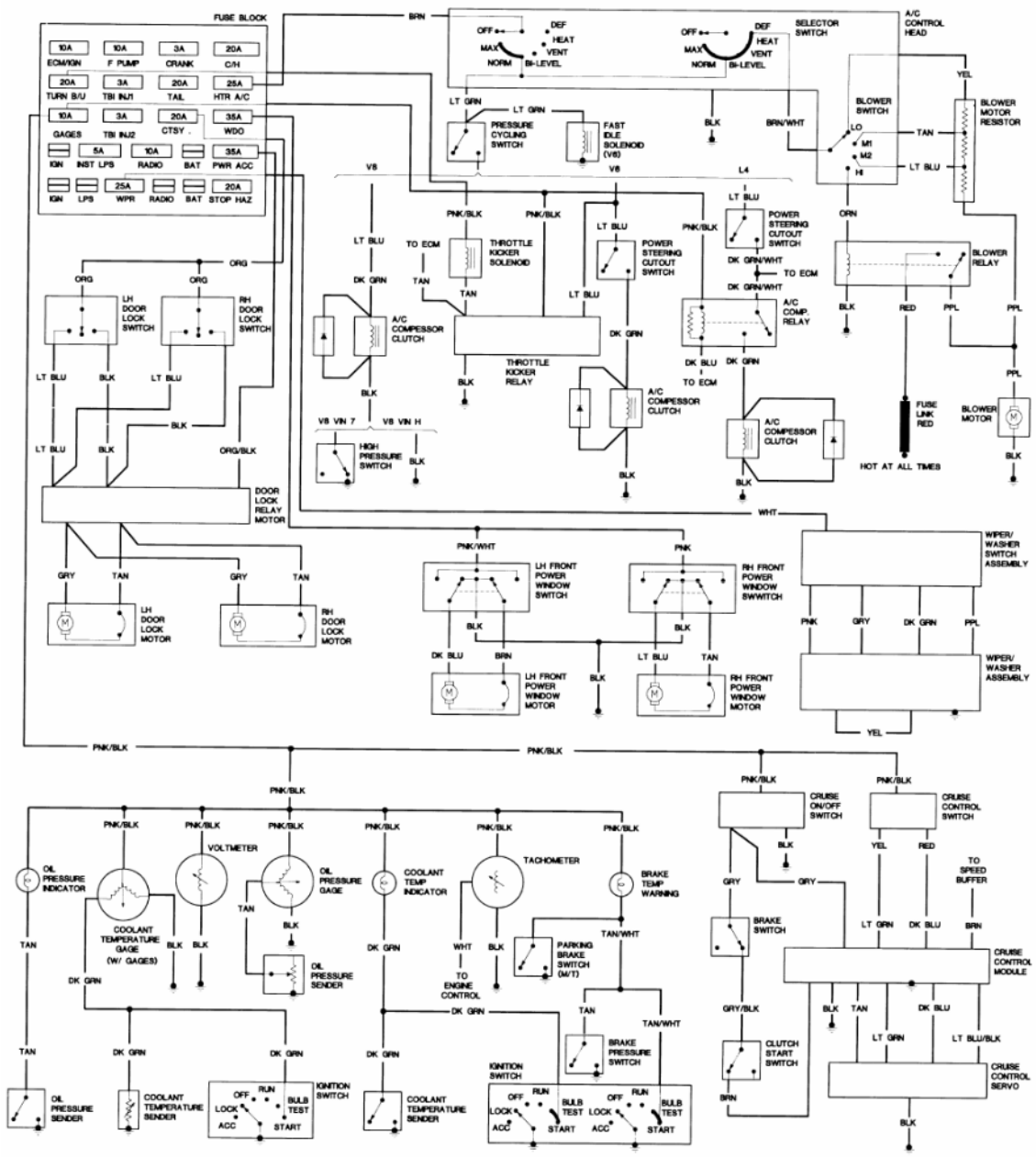

cardiagn.com

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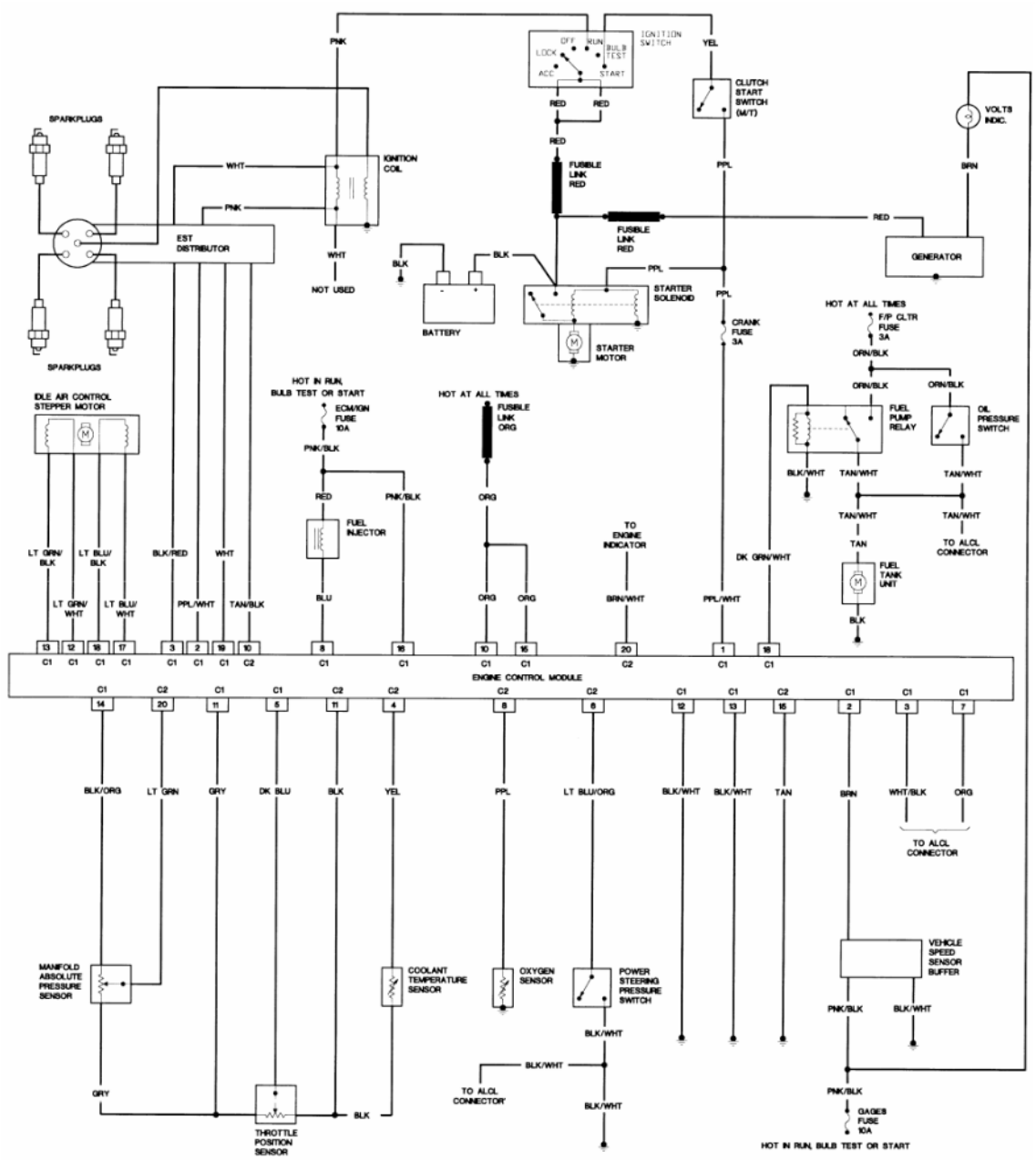

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## 1985 BODY WIRING, CONTINUED



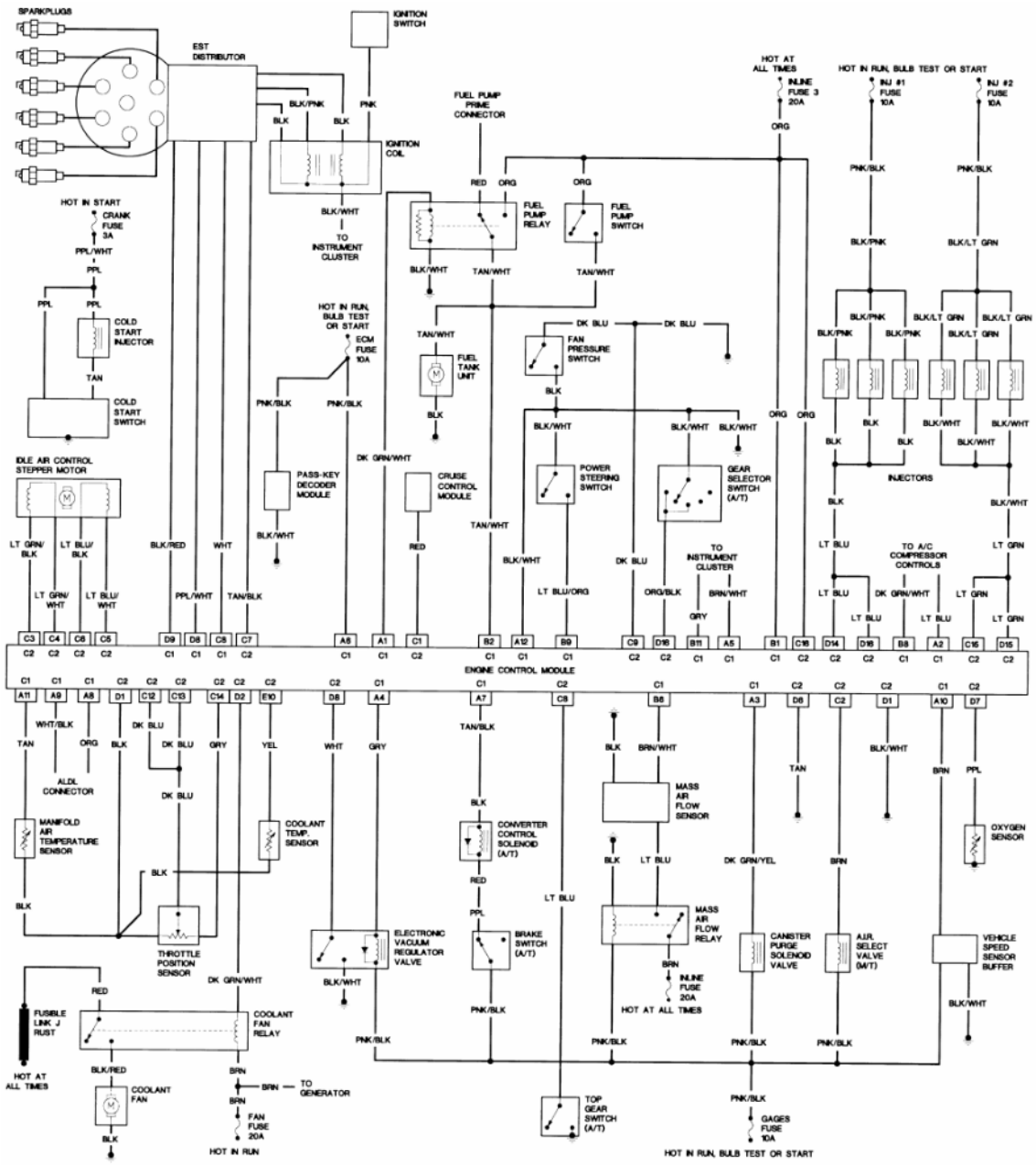

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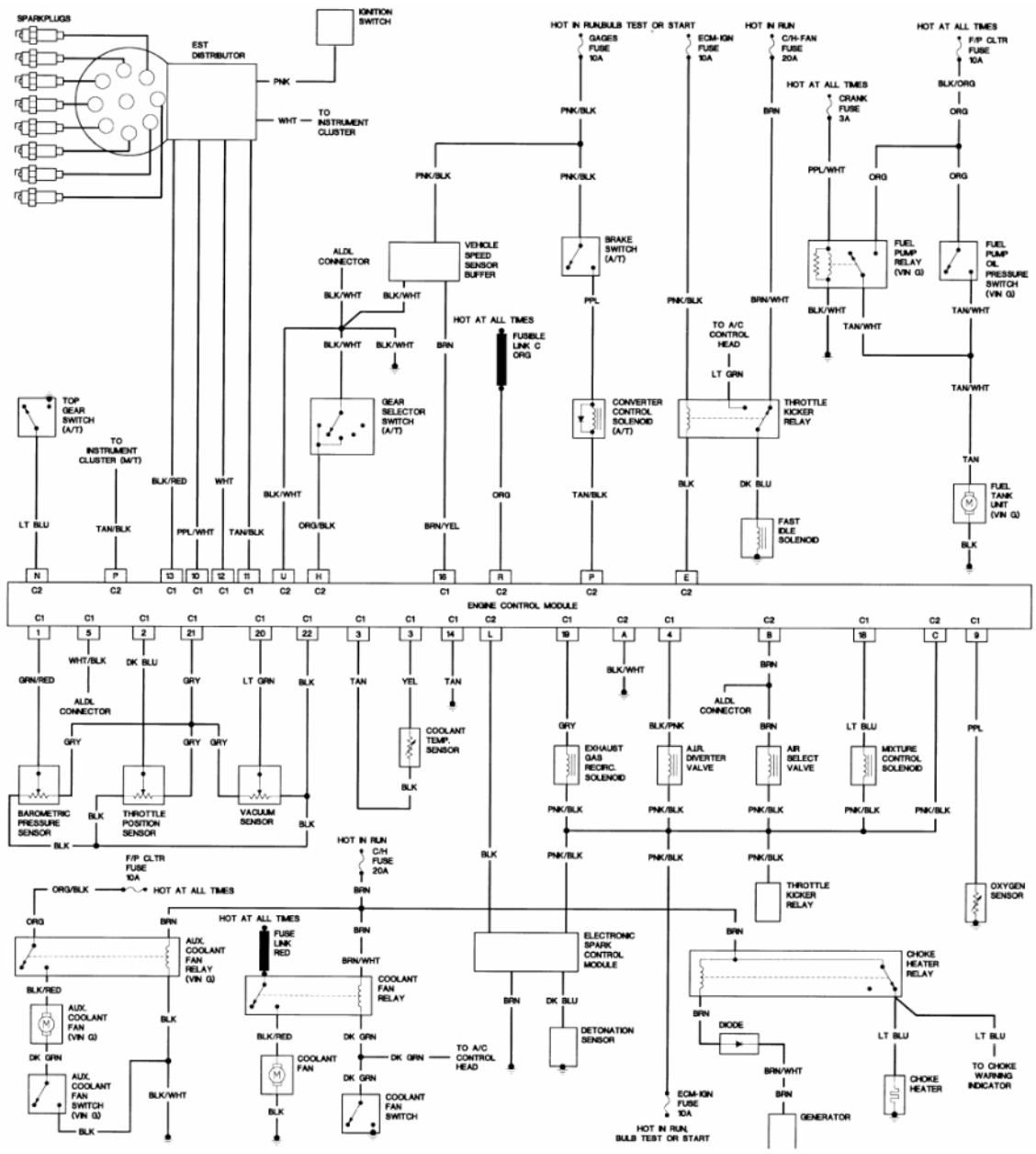

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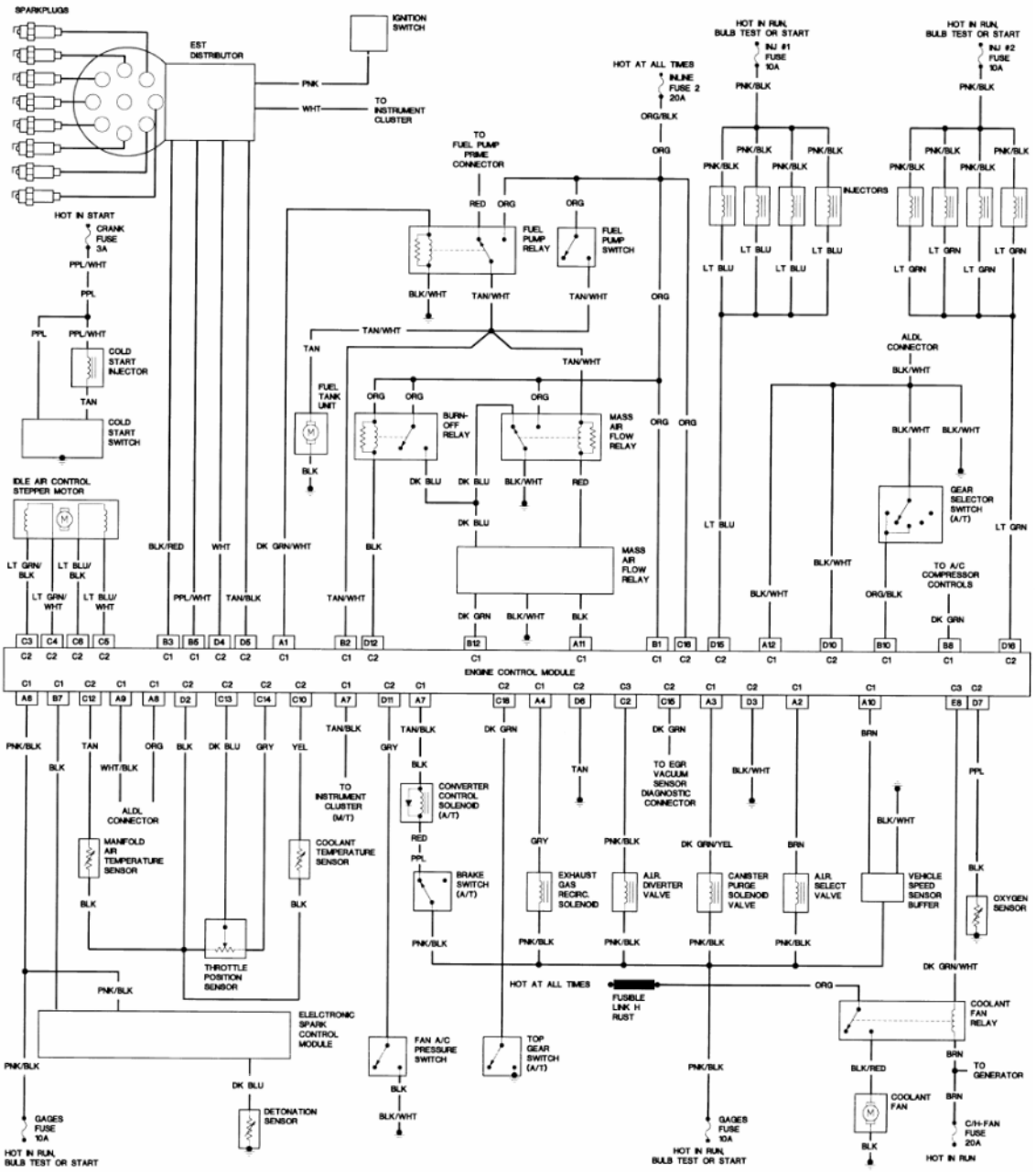

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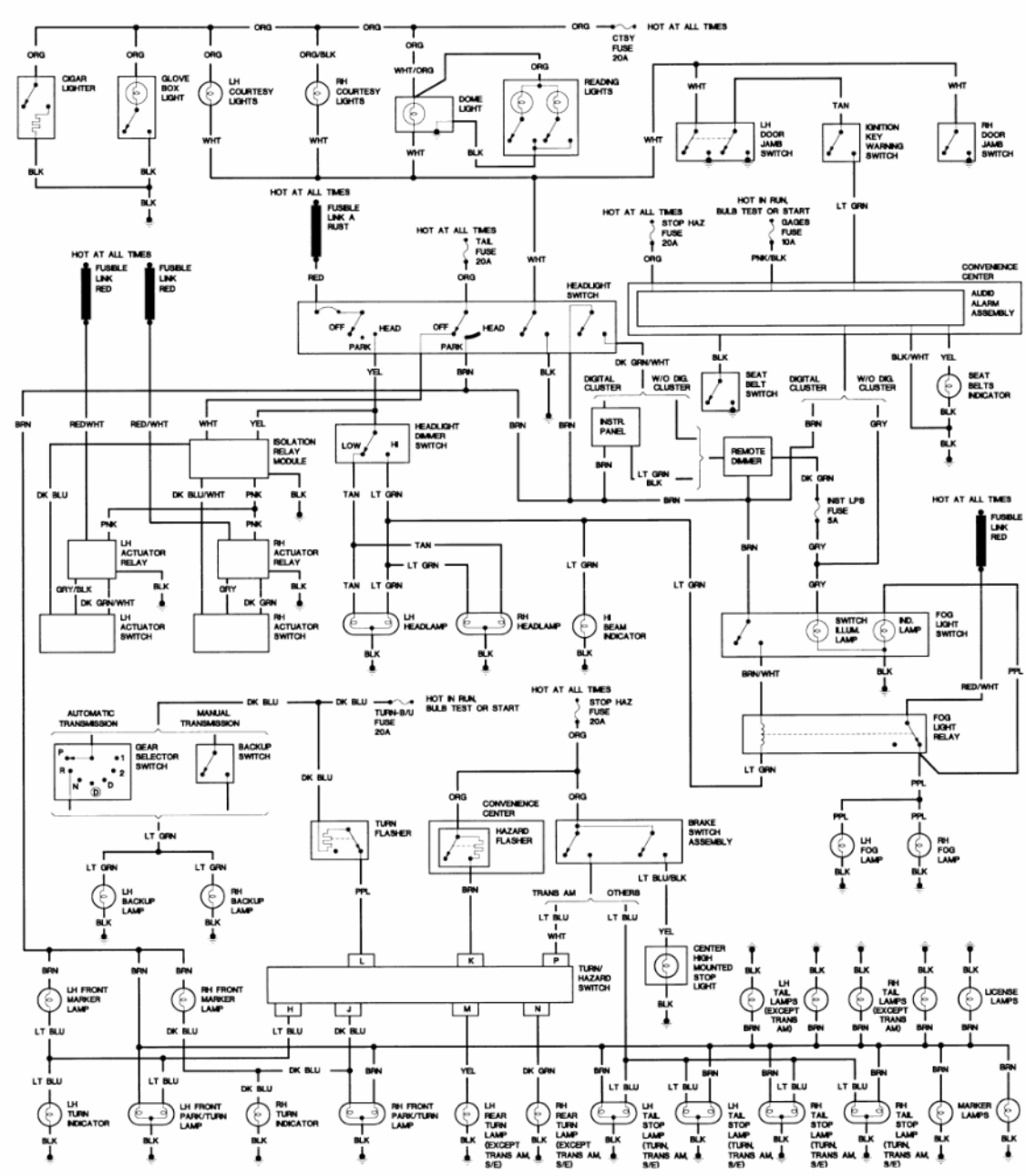

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## 1986 5.0L TUNED PORT INJECTION ENGINE WIRING



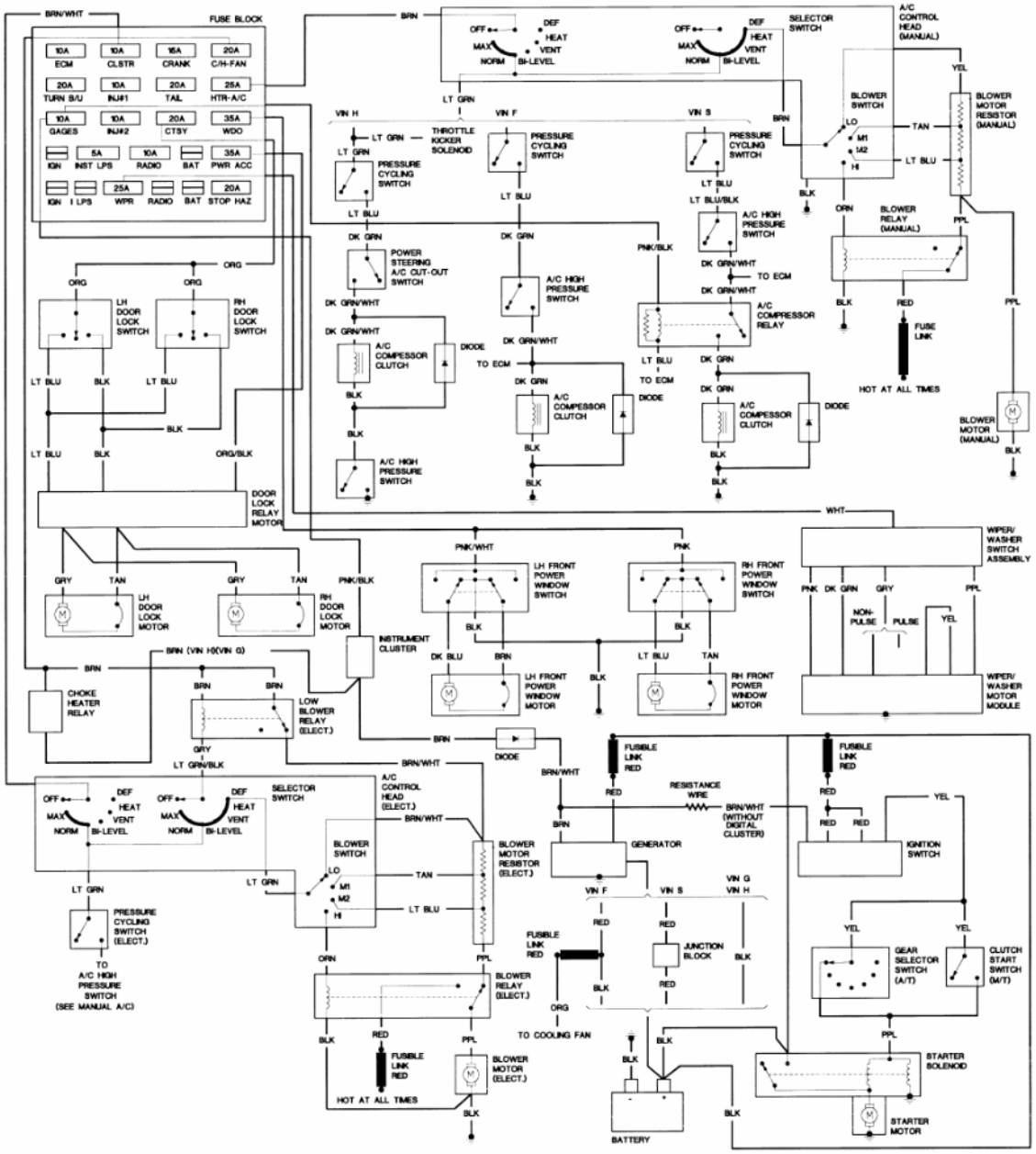

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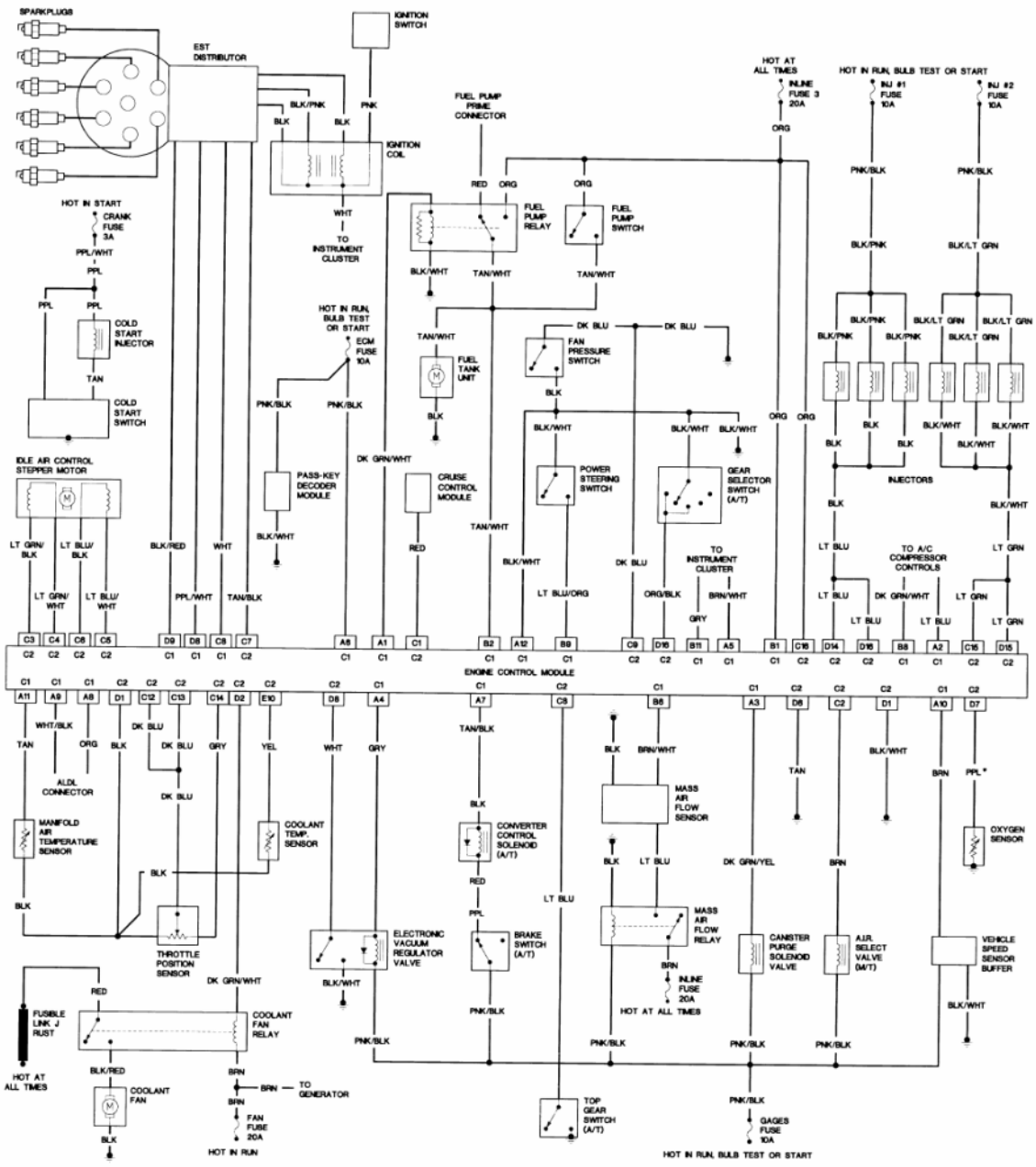

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## 1986 BODY WIRING CONTINUED



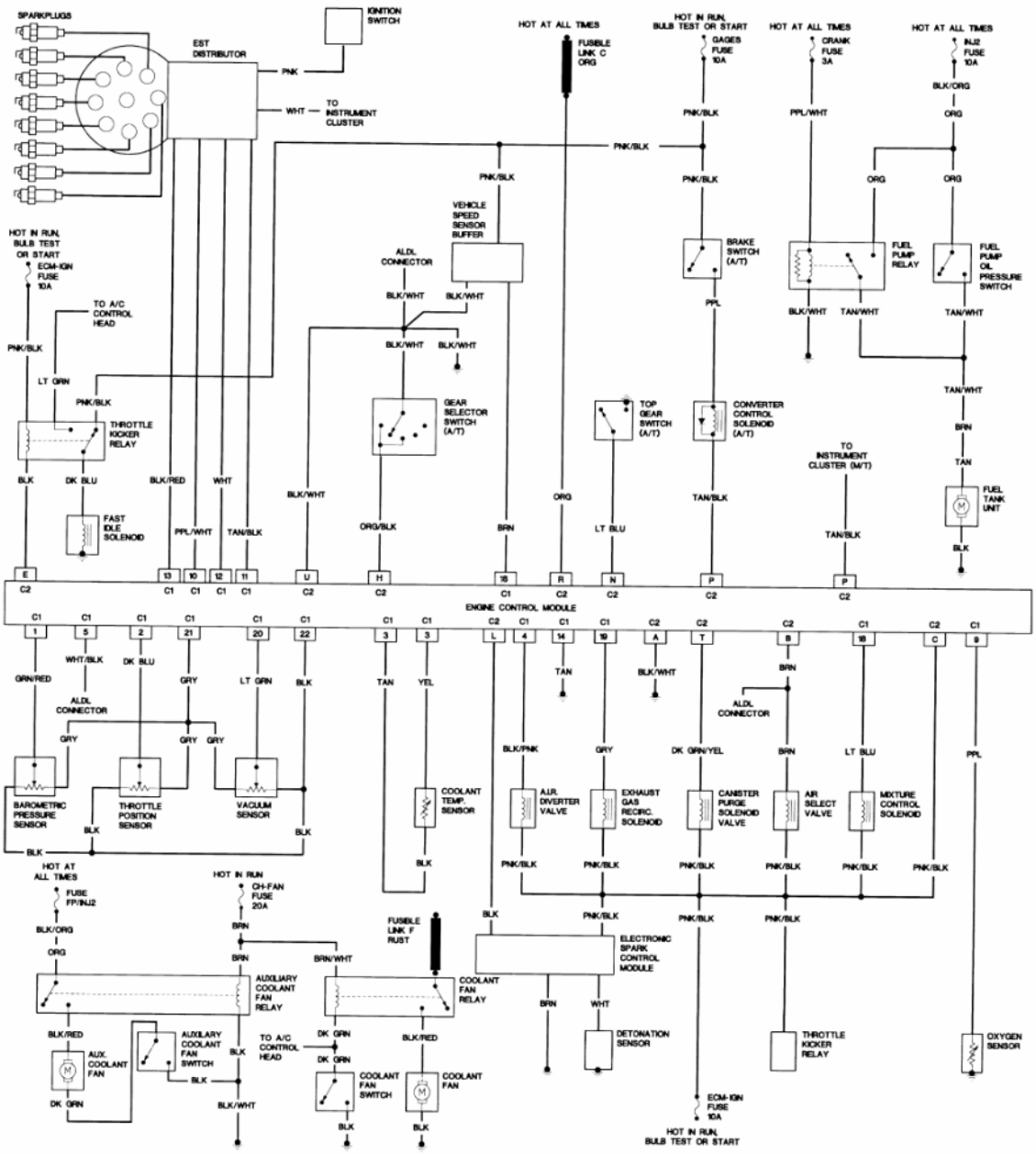

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## 1987 2.8L FUEL INJECTED ENGINE WIRING



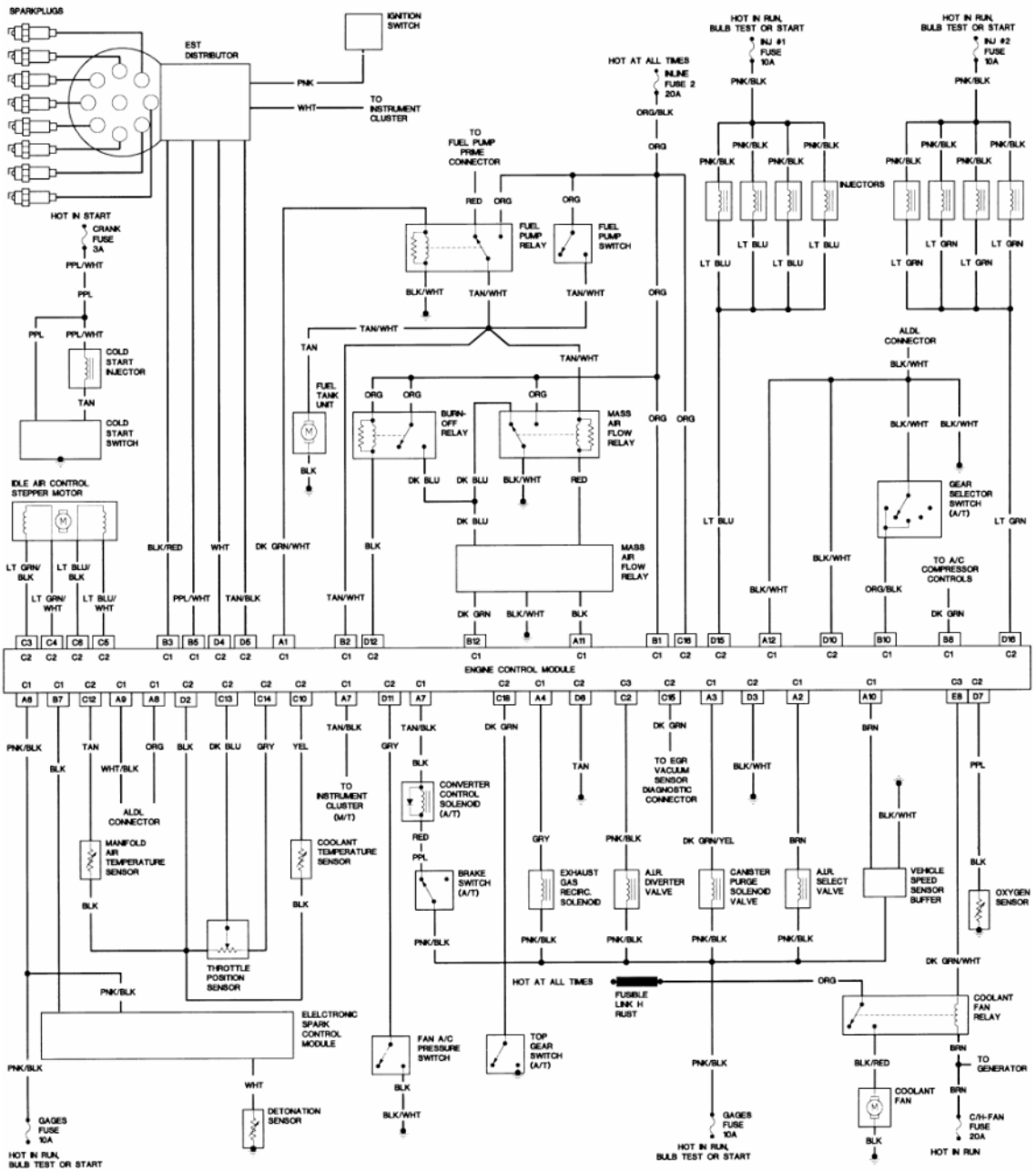

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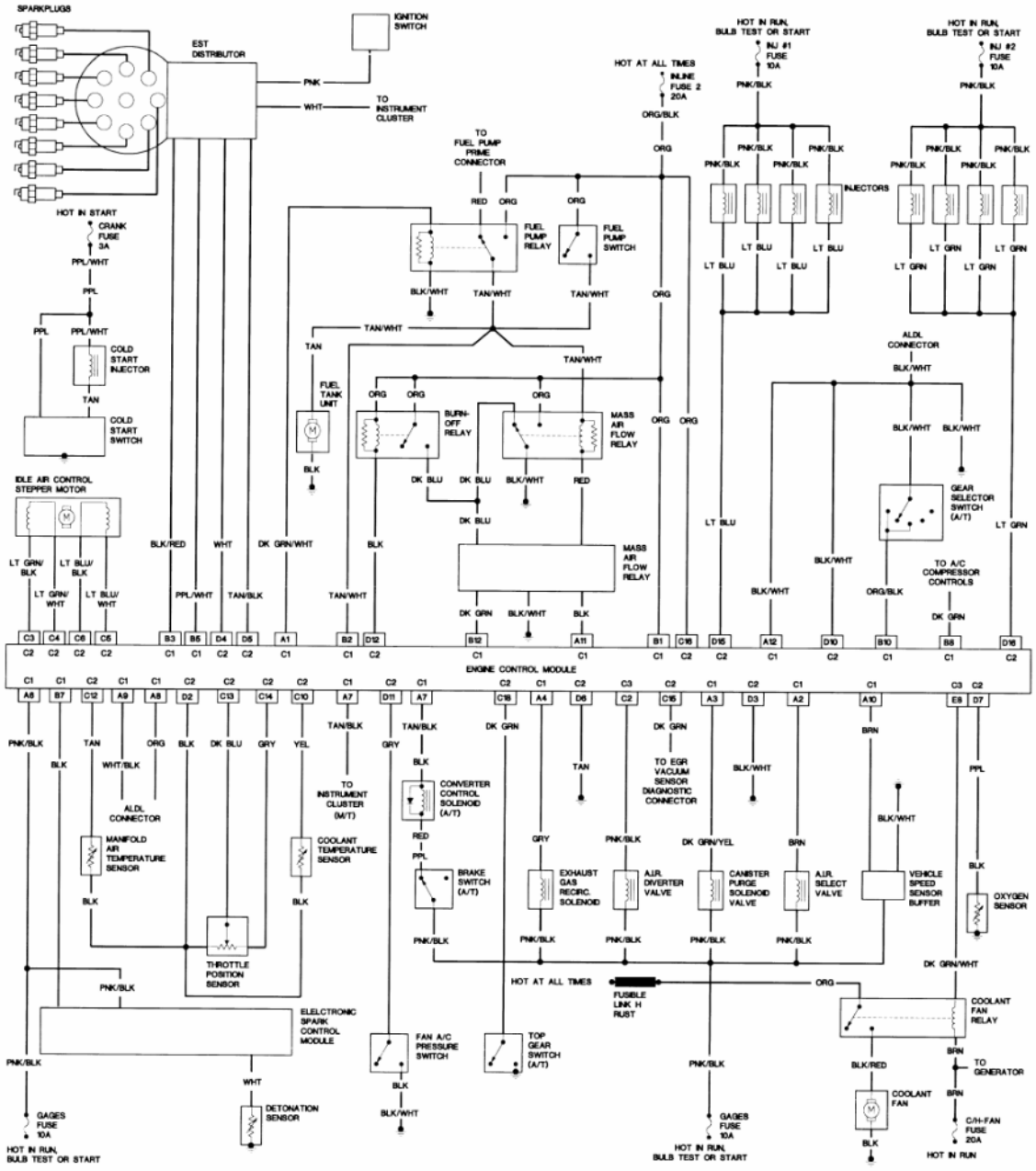

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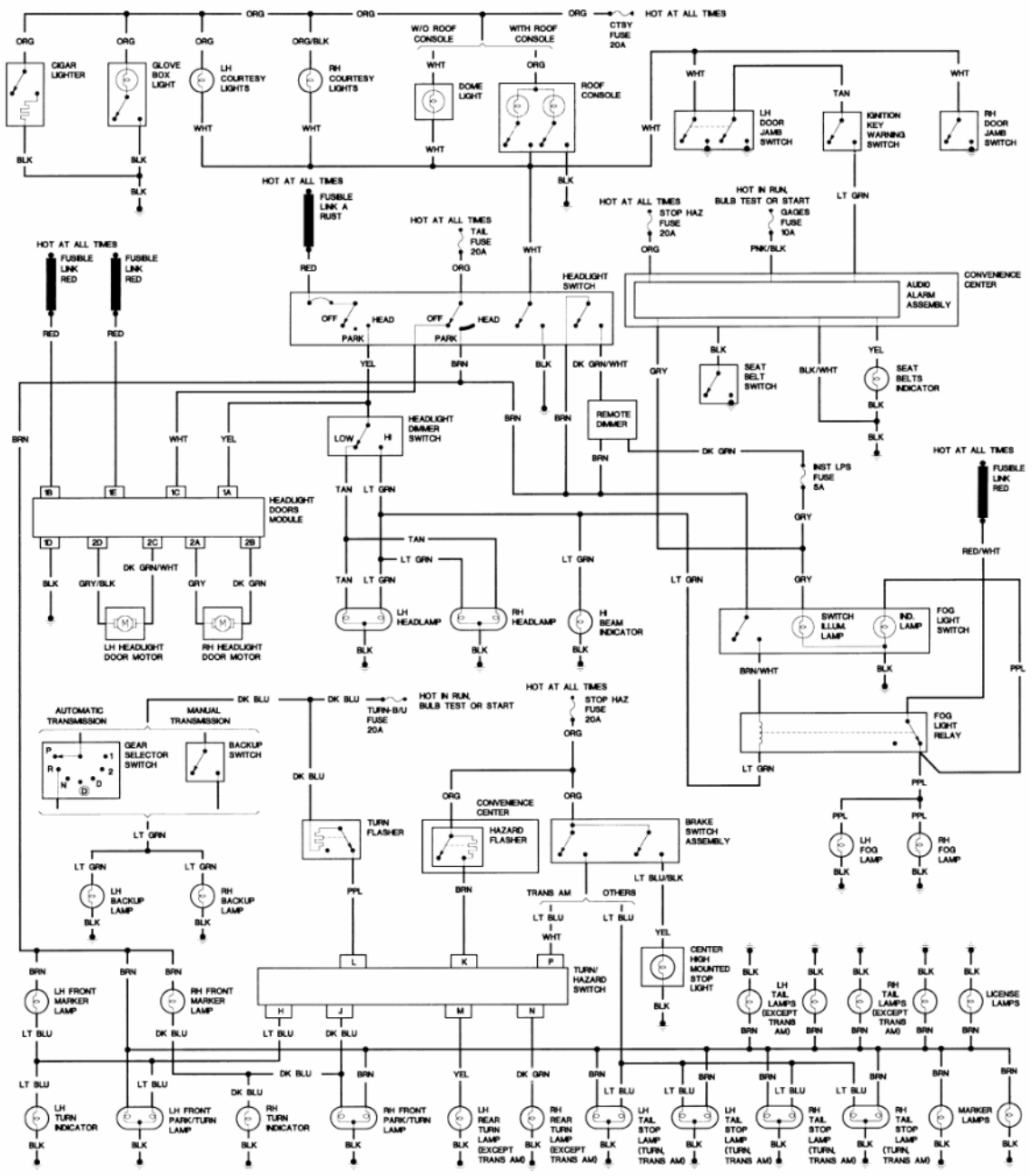

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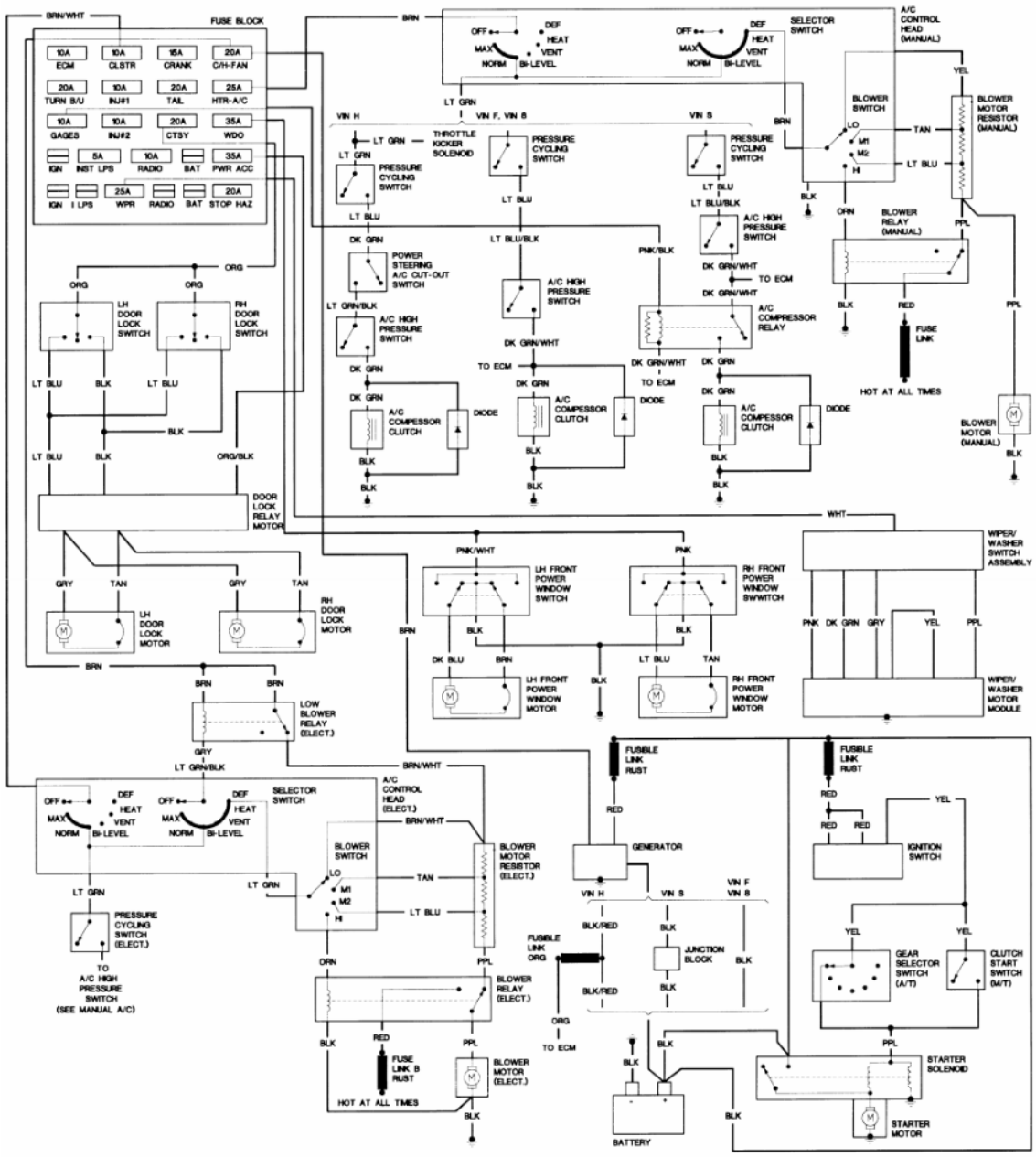

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## 1987 BODY WIRING



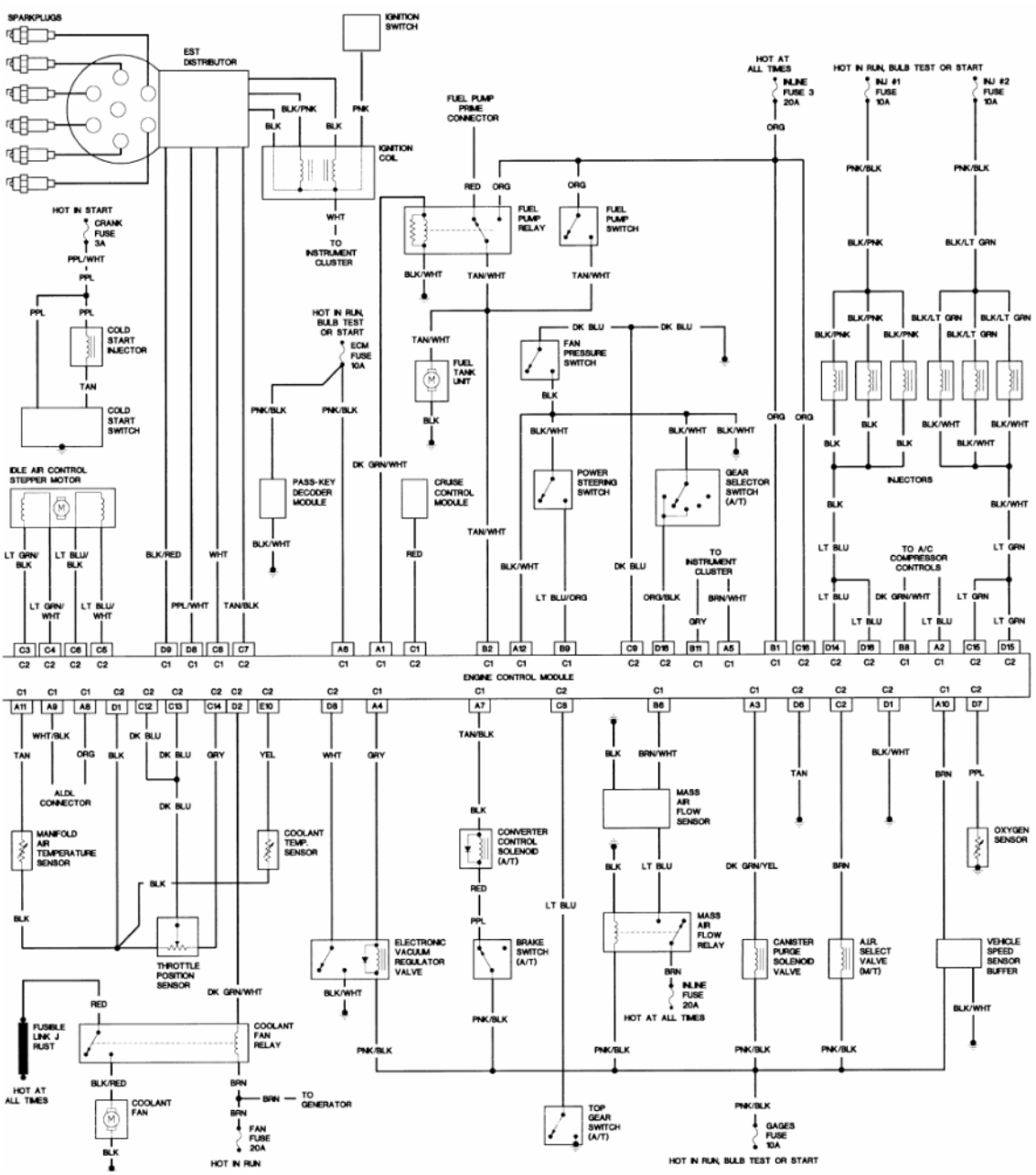

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## 1987 BODY WIRING, CONTINUED



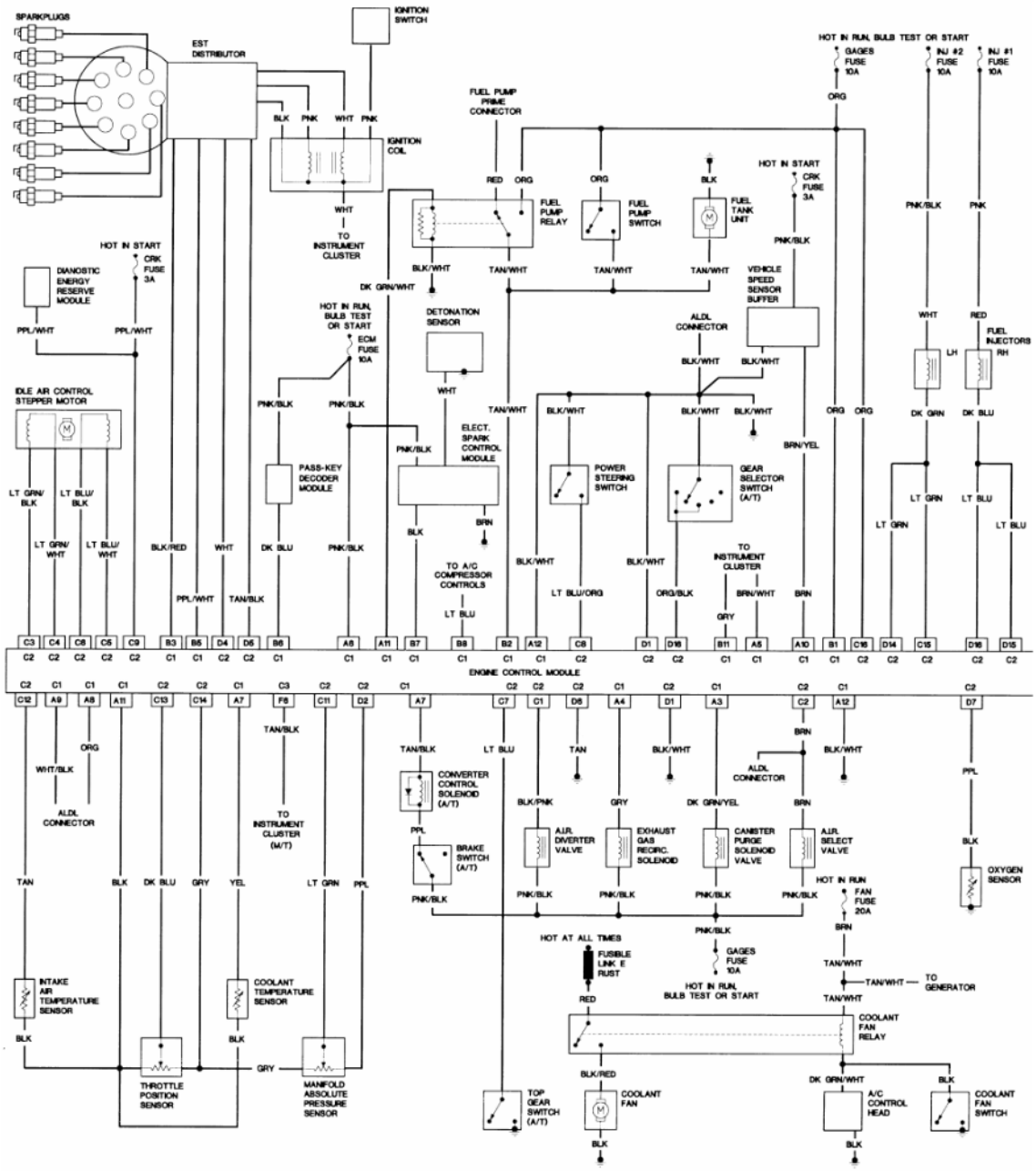

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## 1988 2.8L ENGINE WIRING



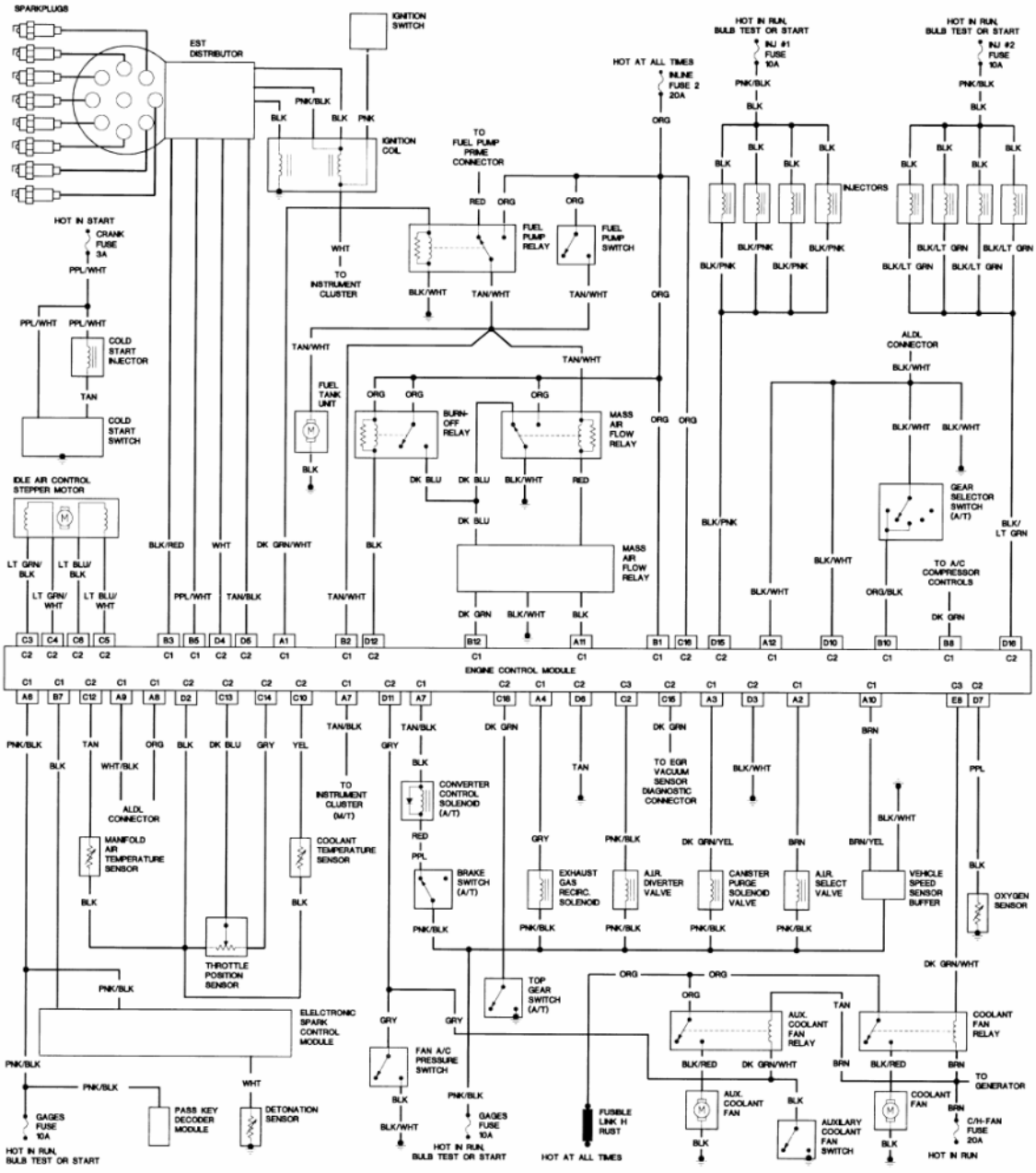

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## 1988 5.0L THROTTLE BODY FUEL INJECTION ENGINE WIRING



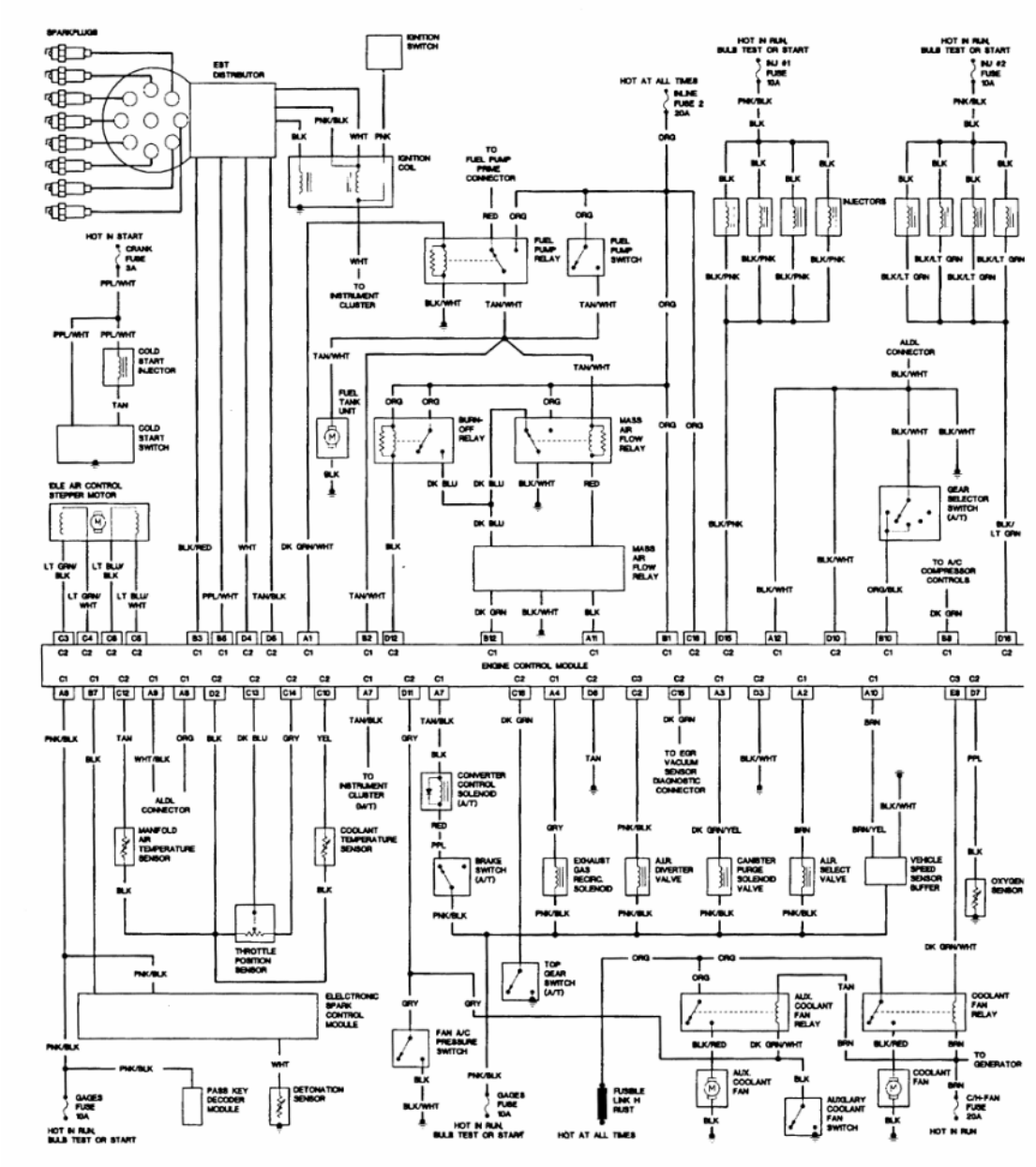

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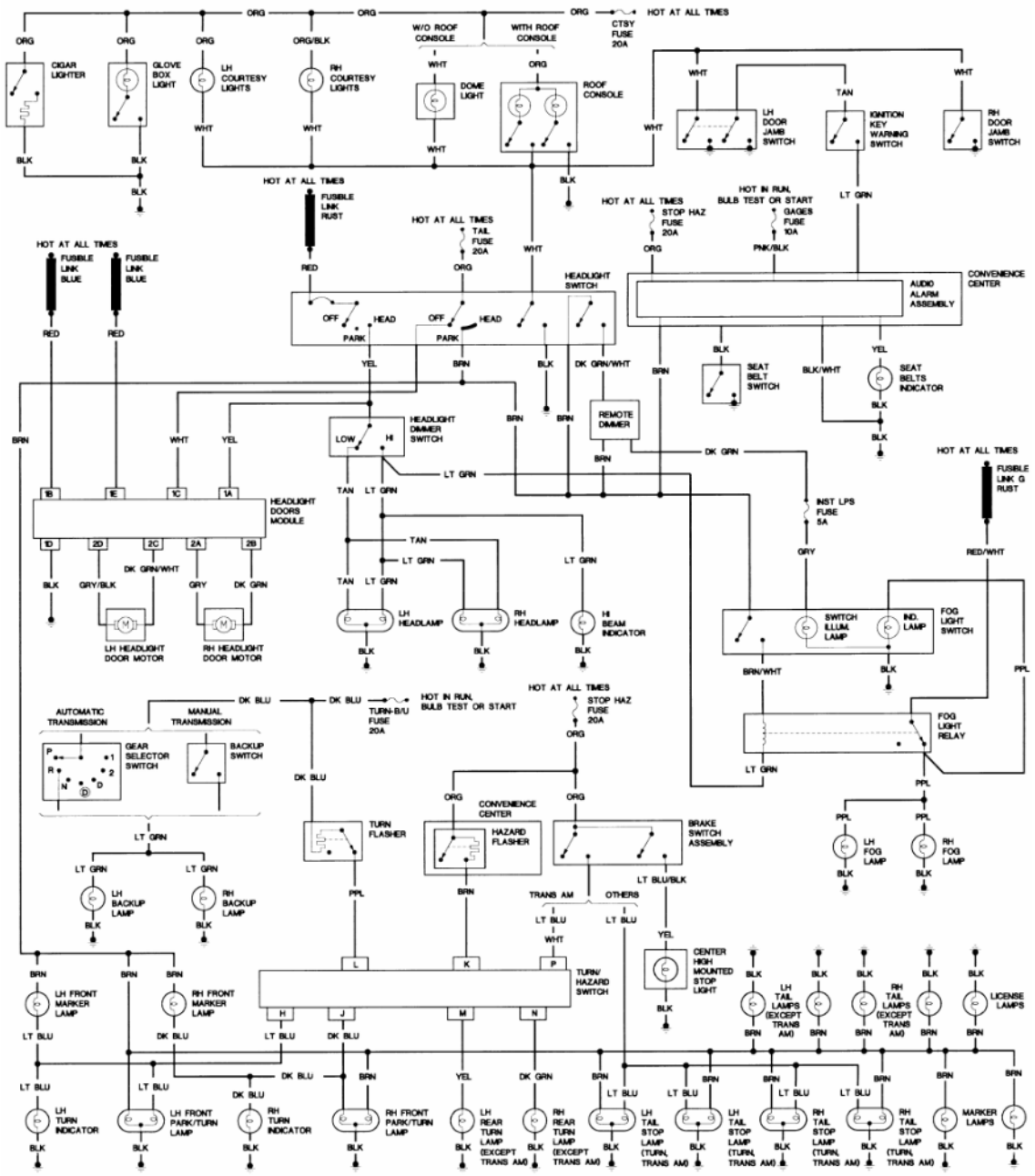

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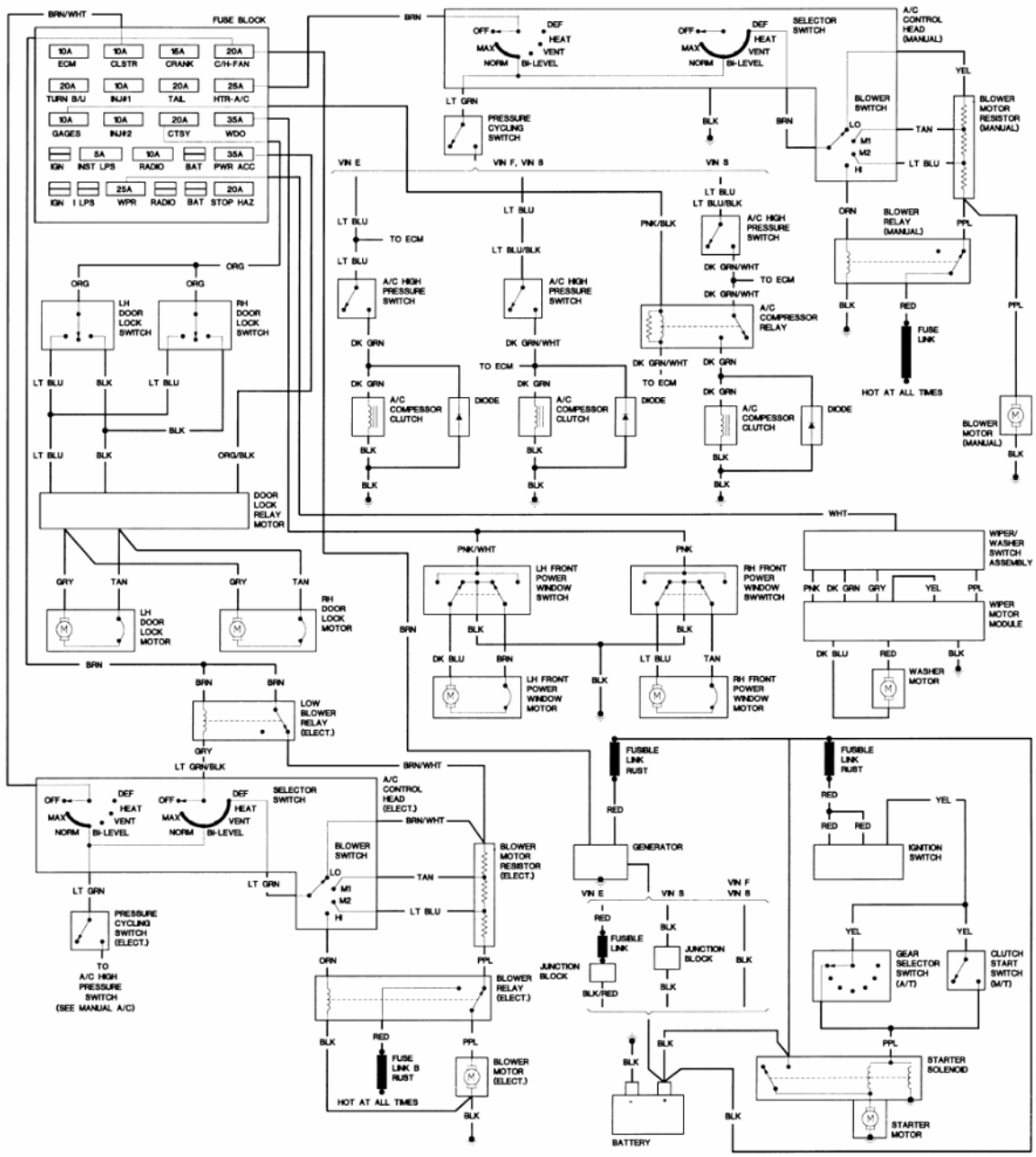

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## 1988 BODY WIRING



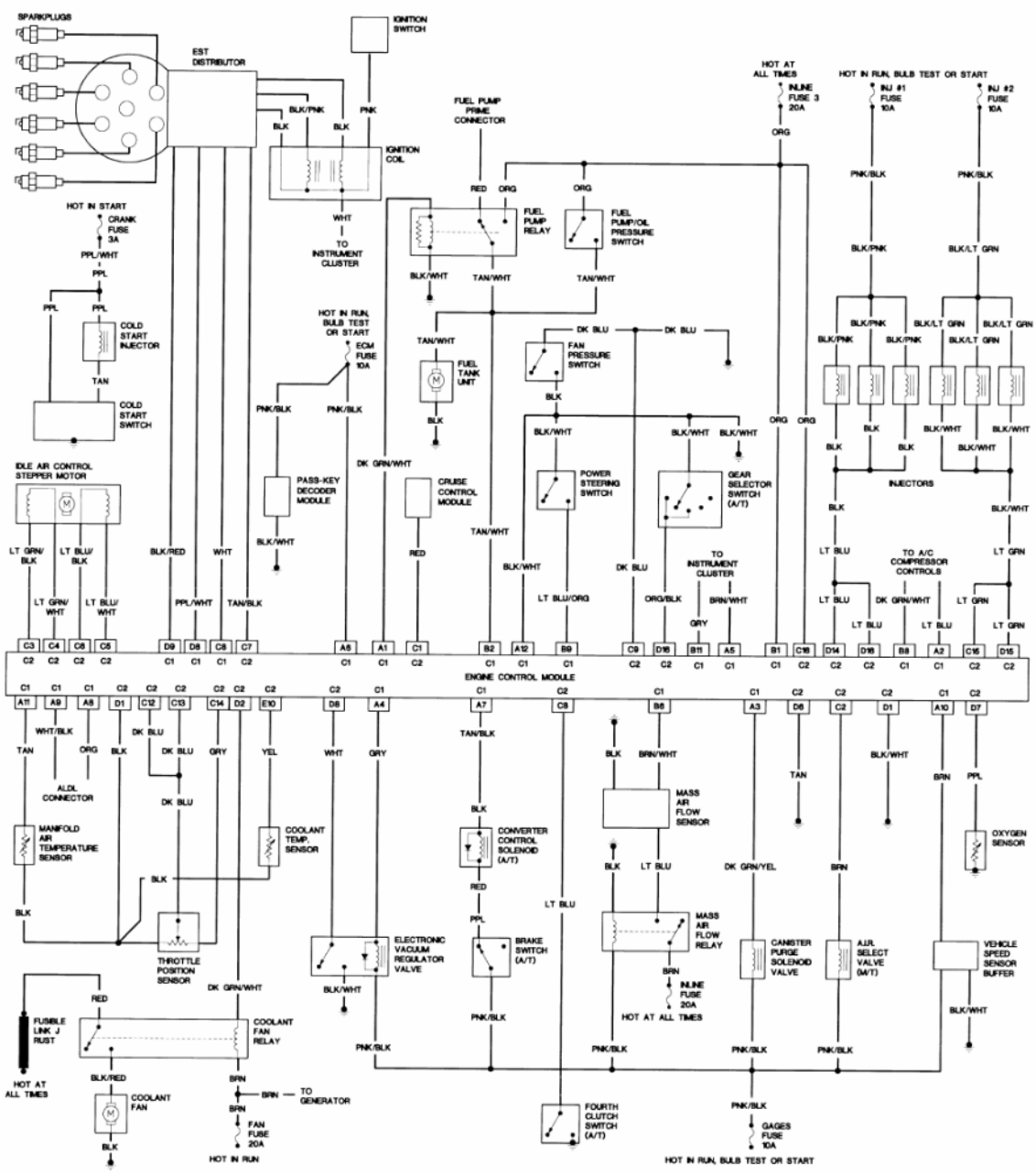

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## 1988 BODY WIRING, CONTINUED



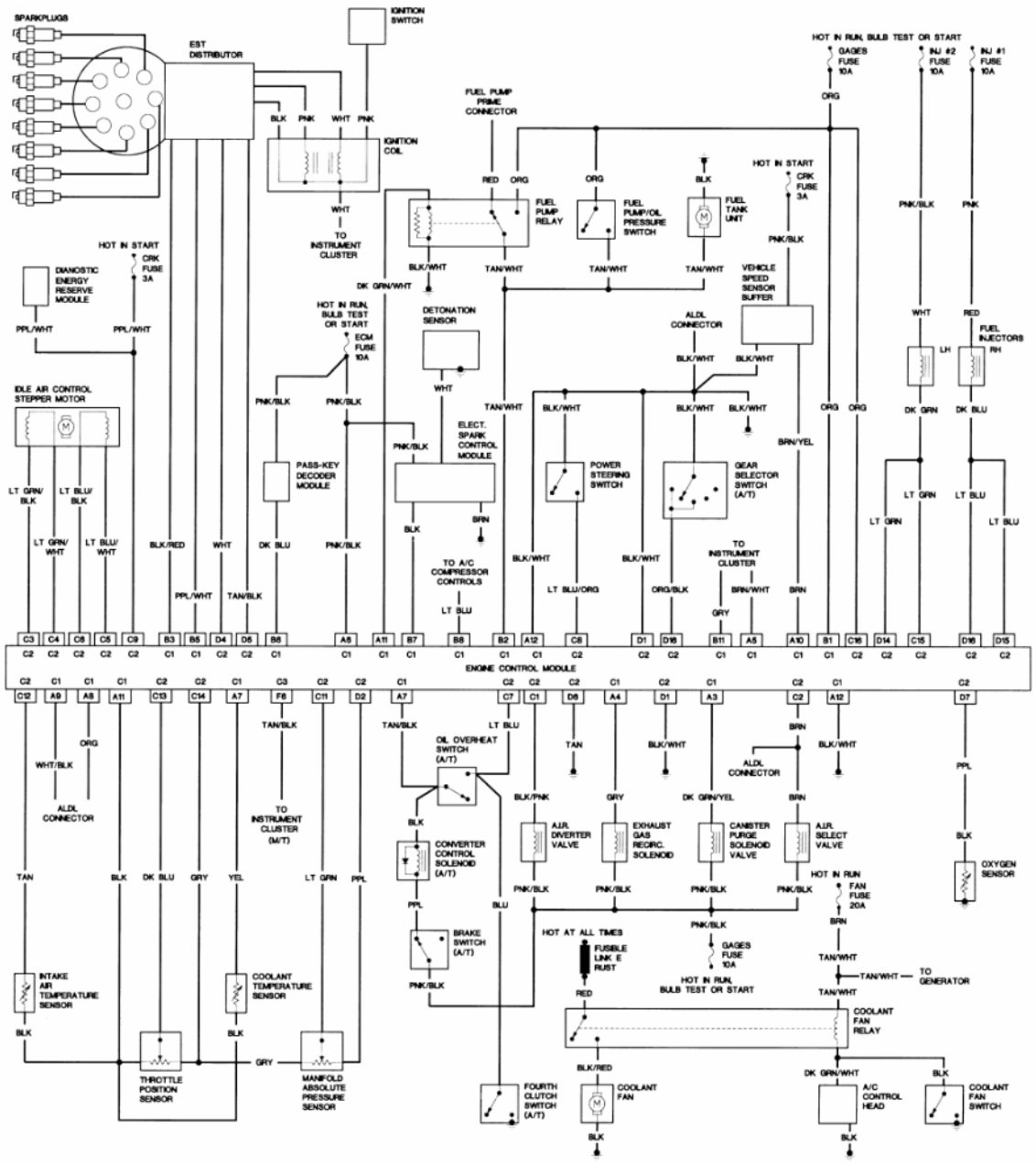

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## 1989 2.8L ENGINE WIRING



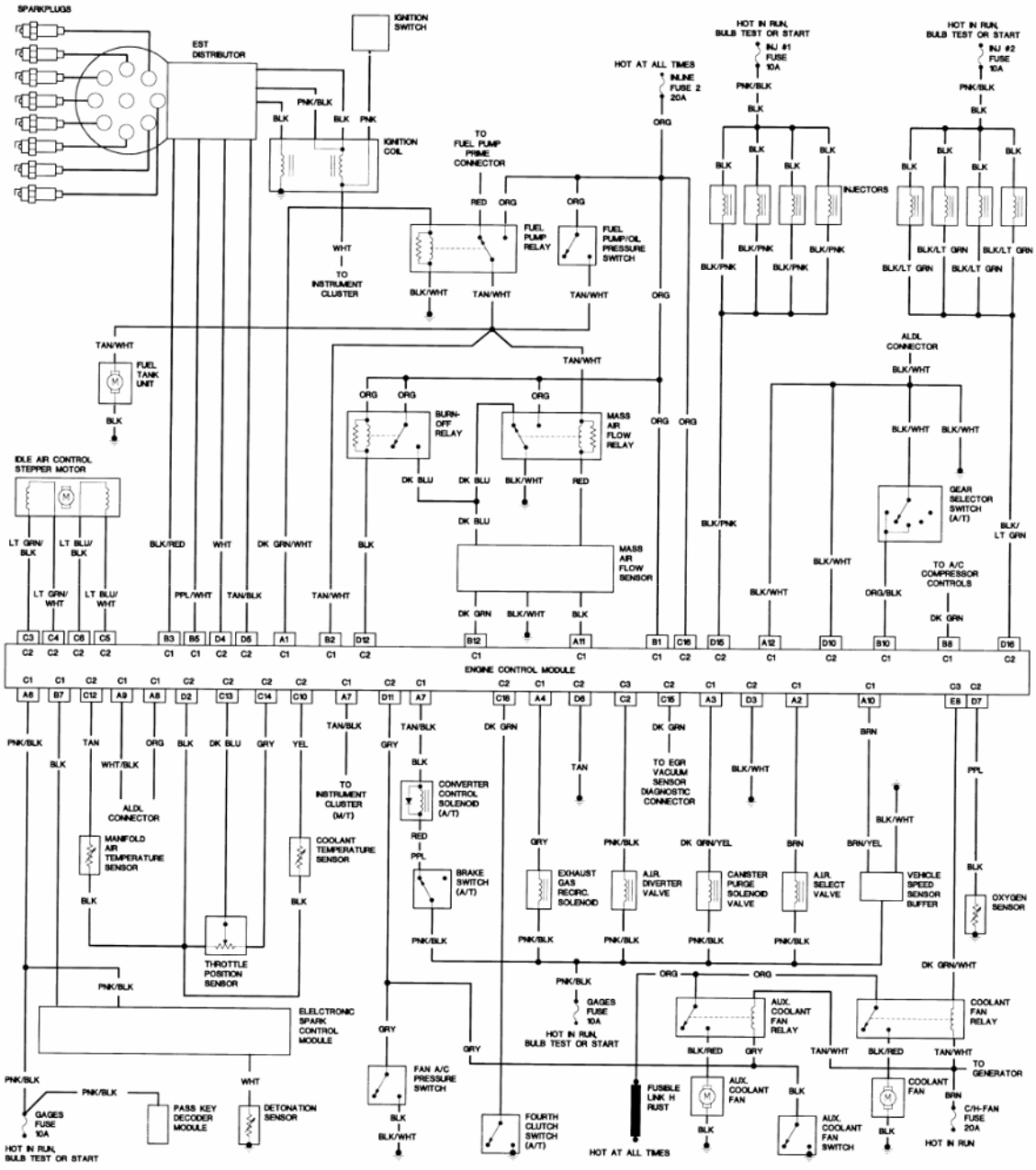

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## 1989 5.0L THROTTLE BODY FUEL INJECTION ENGINE WIRING



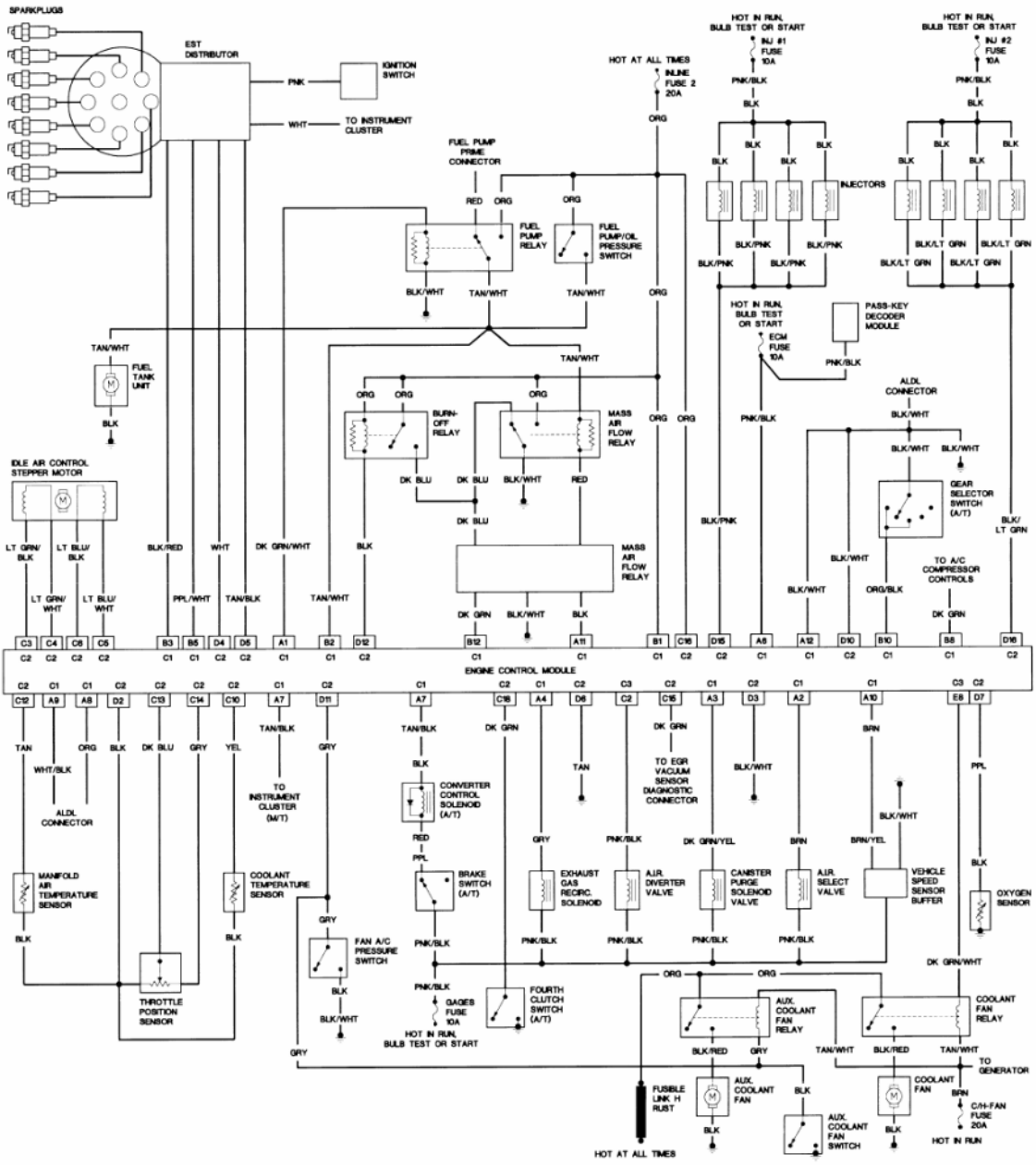

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## 1989 5.0L TUNED PORT INJECTION ENGINE WIRING



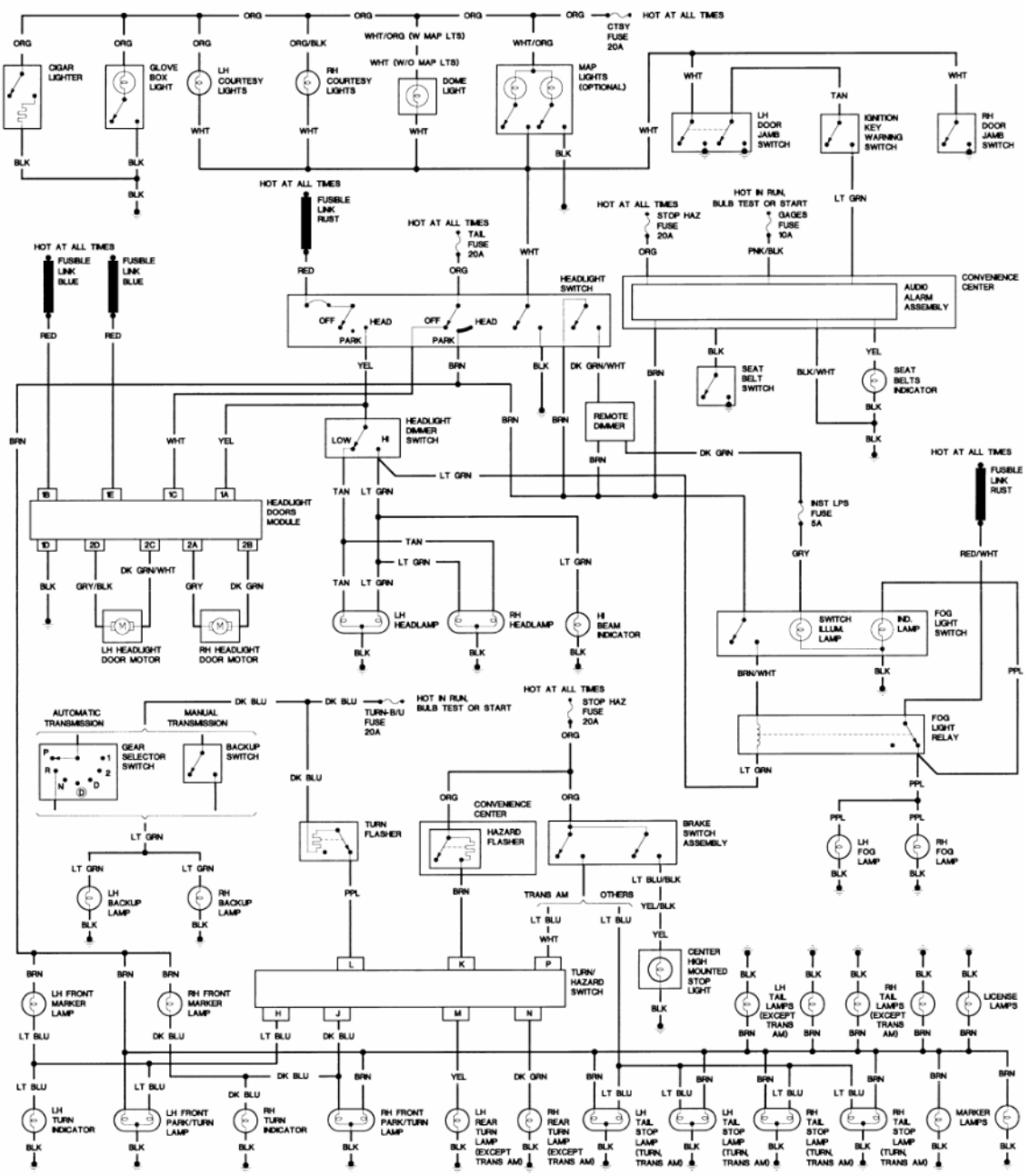

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## 1989 5.7L TUNED PORT INJECTION ENGINE WIRING



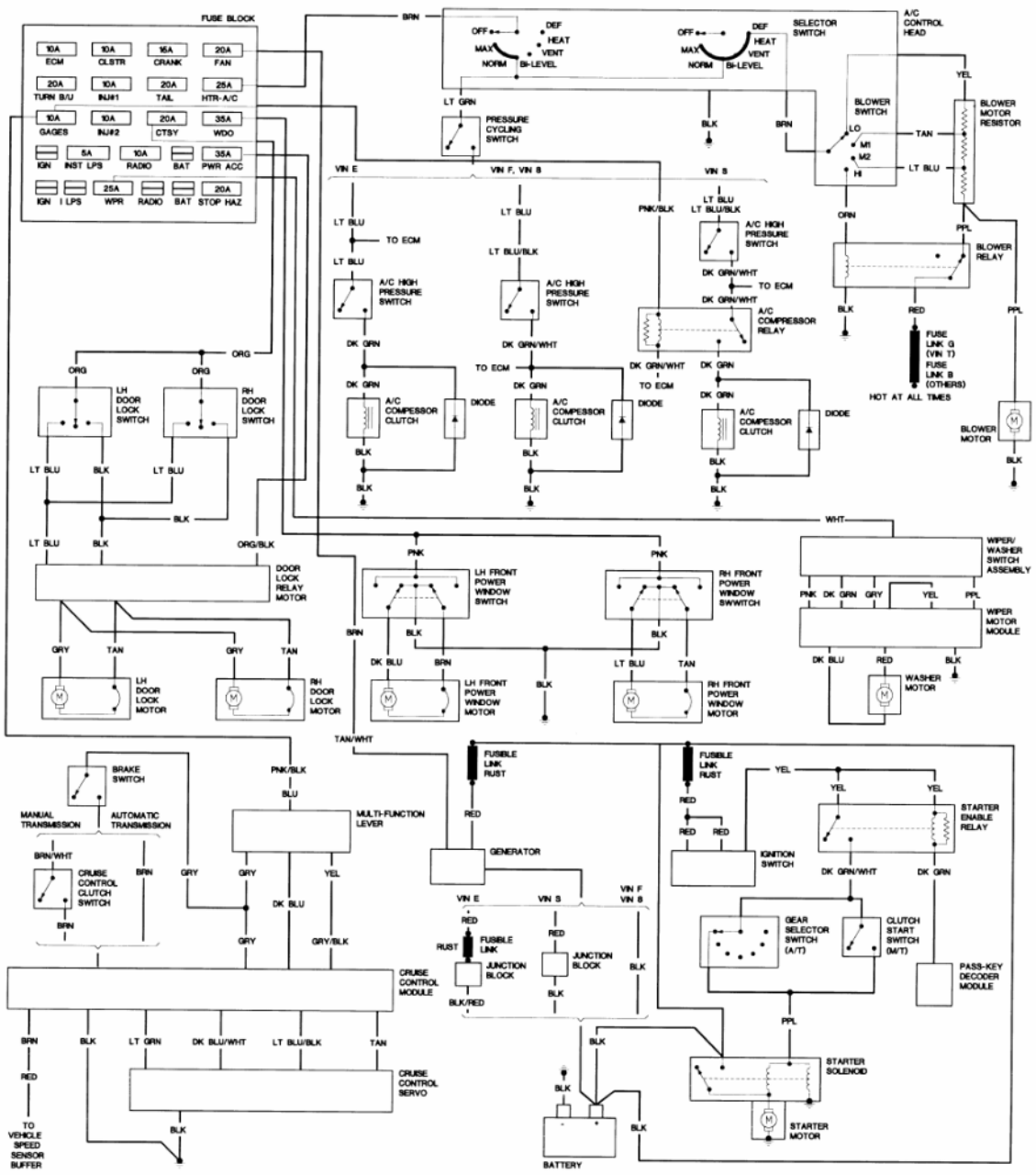

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## 1989 BODY WIRING



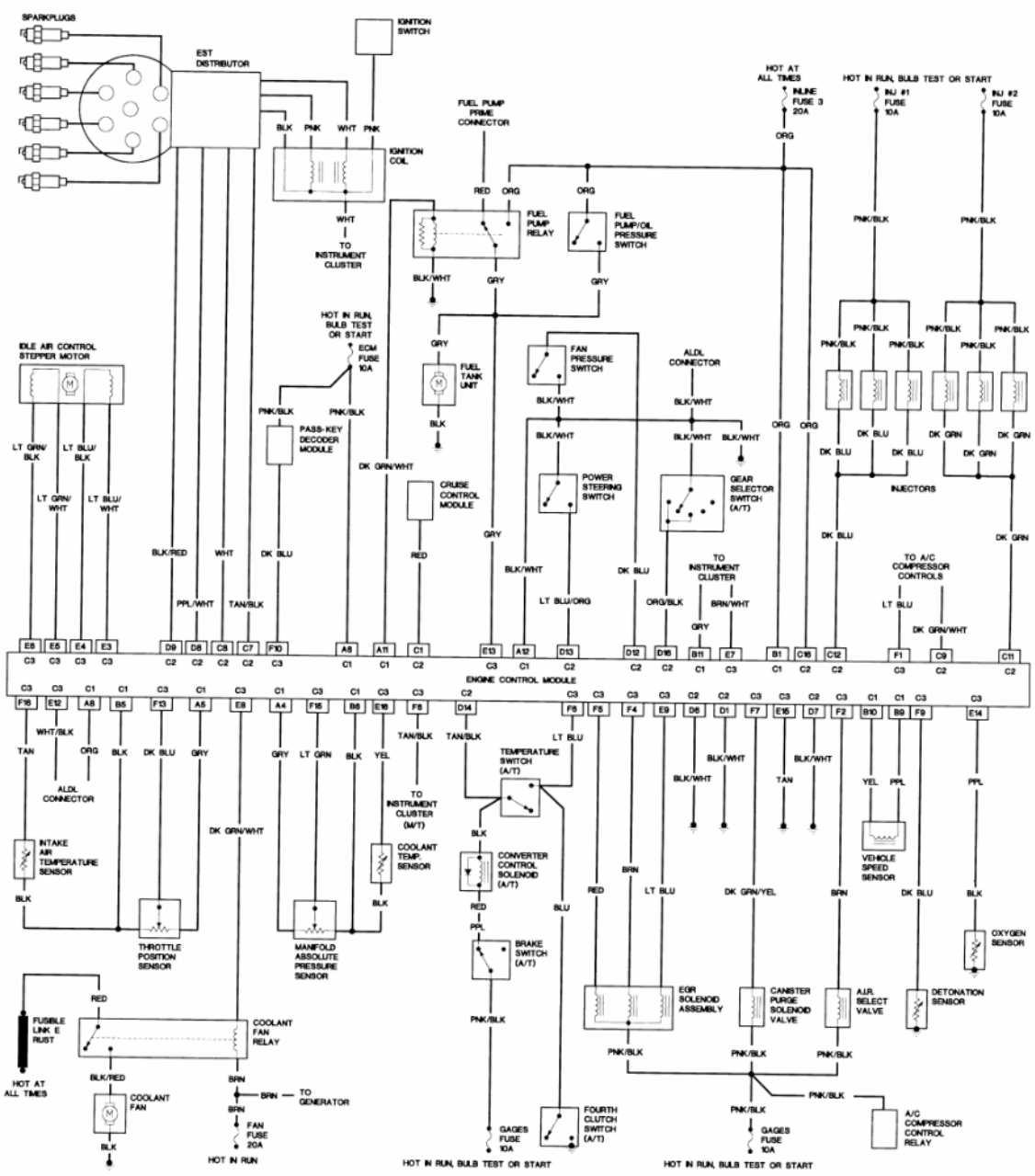

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## 1989 BODY WIRING, CONTINUED



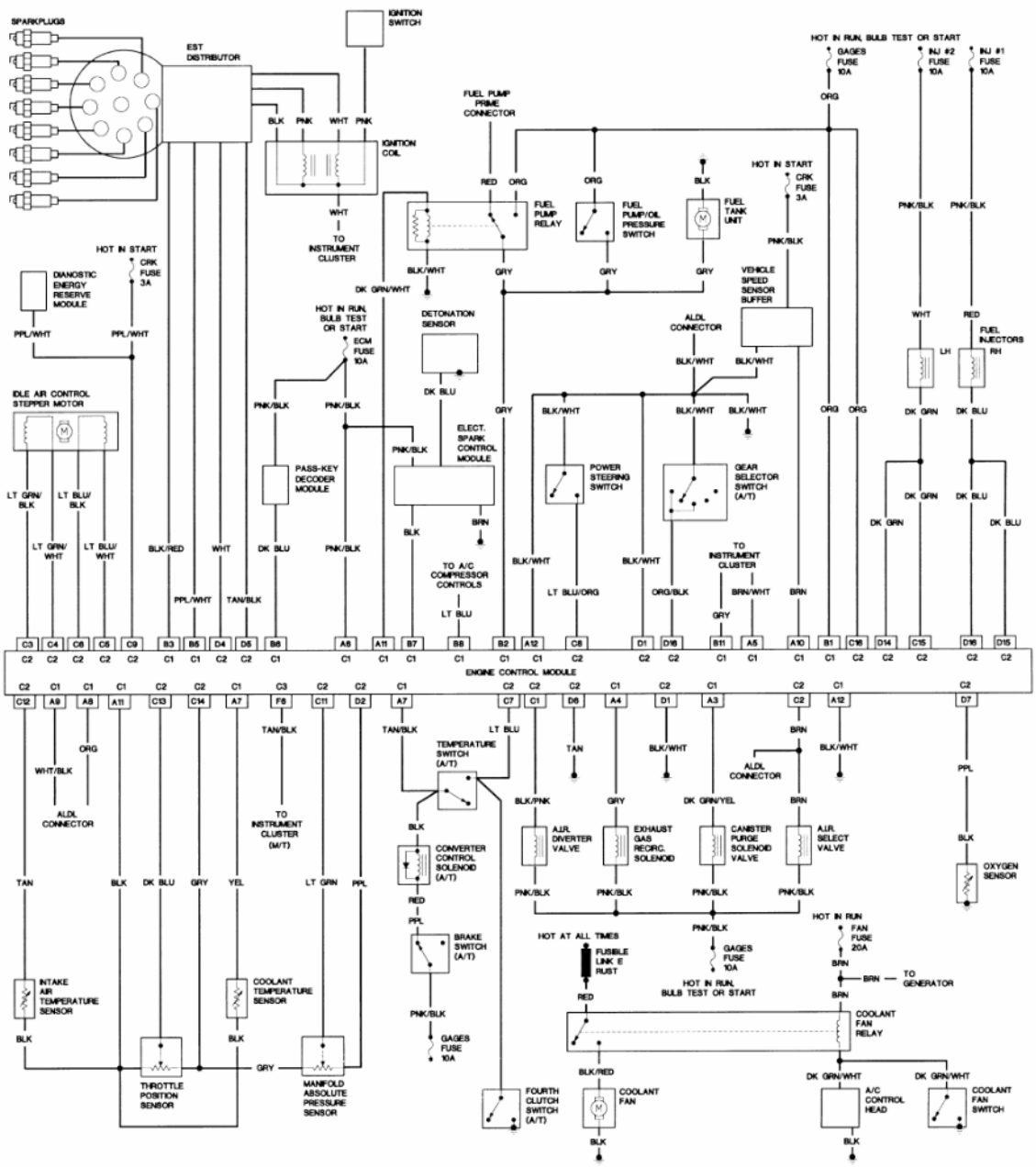

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## 1990 3.1L ENGINE WIRING



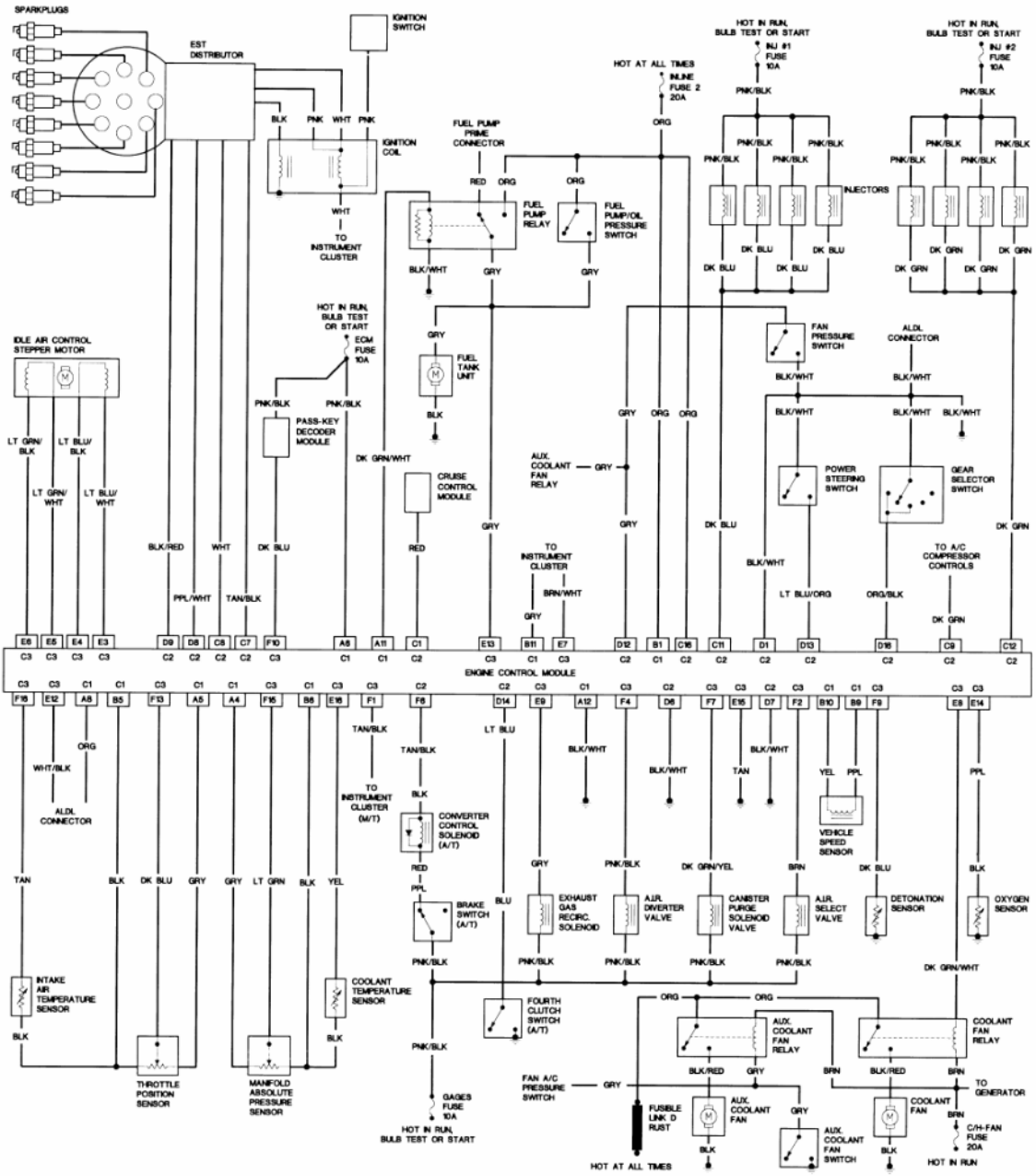

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## 1990 5.0L THROTTLE BODY FUEL INJECTION ENGINE WIRING



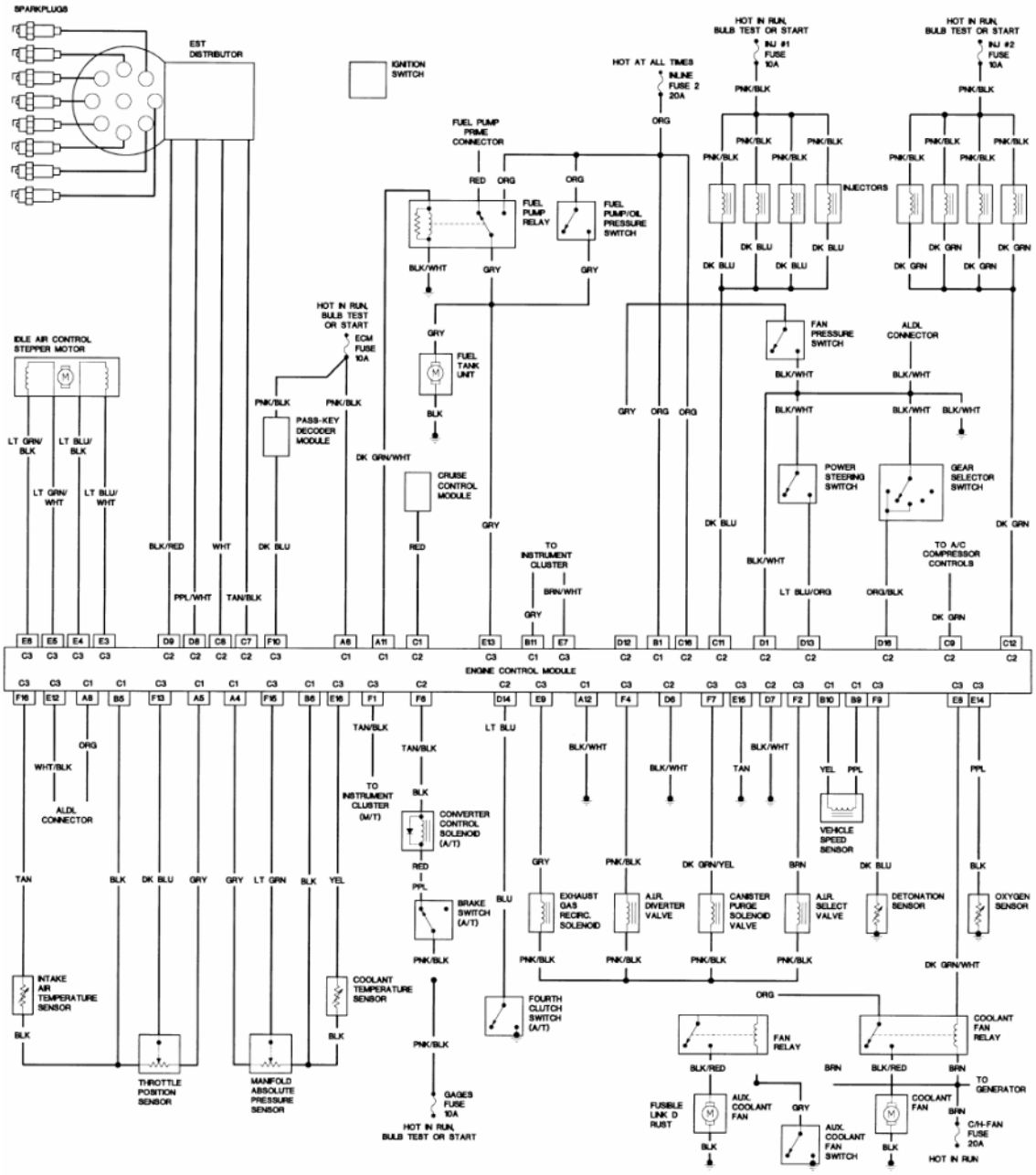

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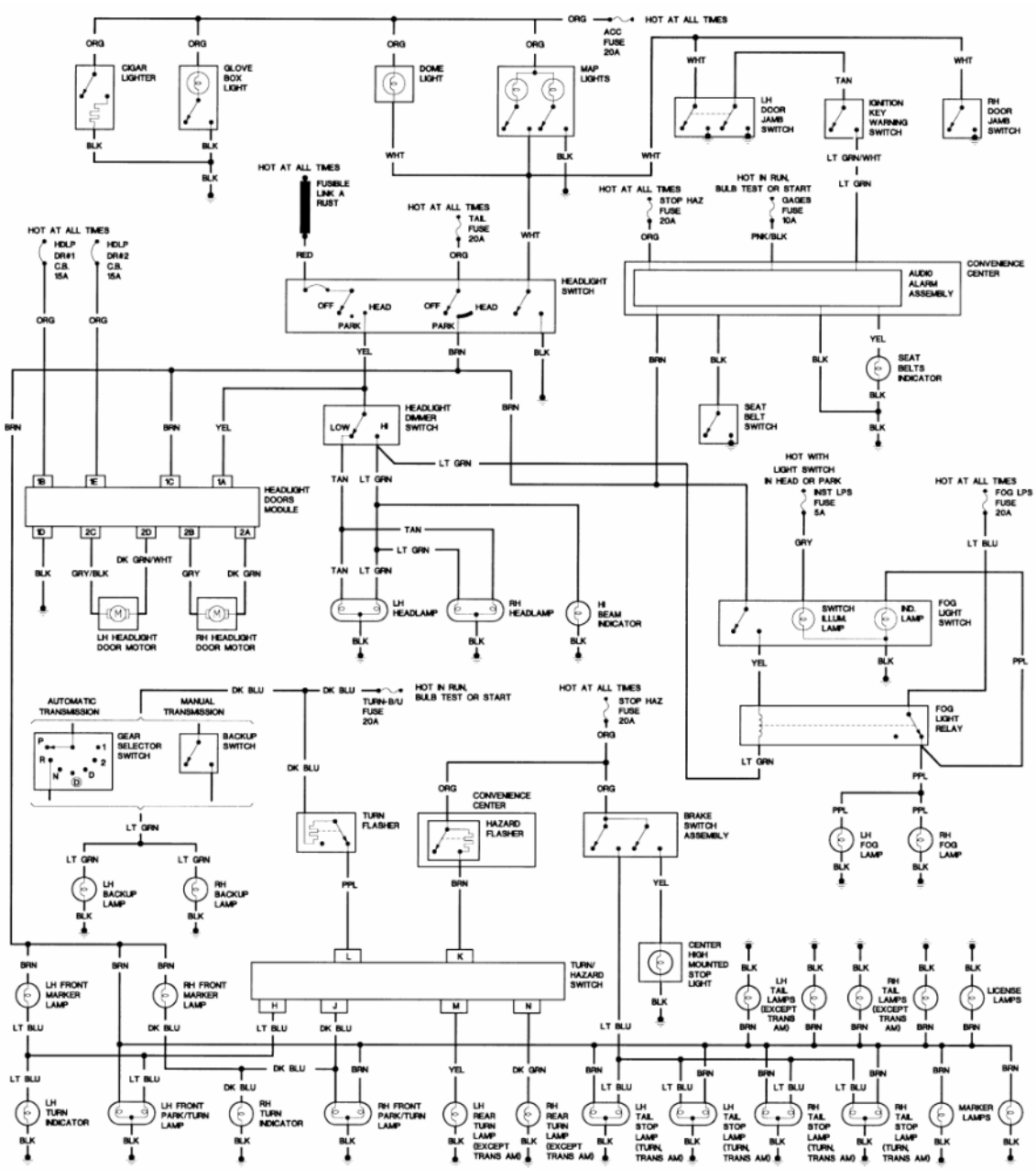

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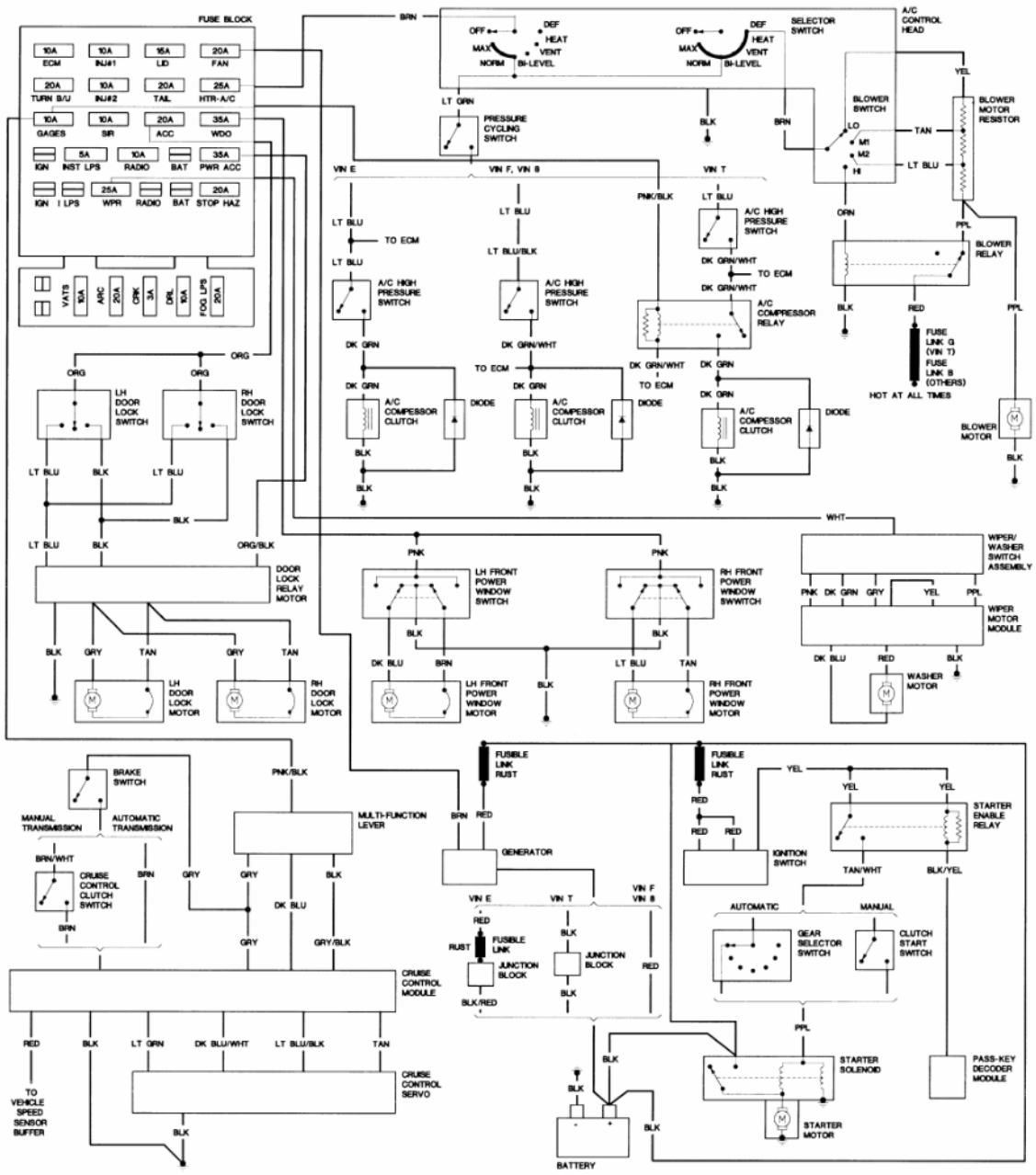

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## 1990 BODY WIRING



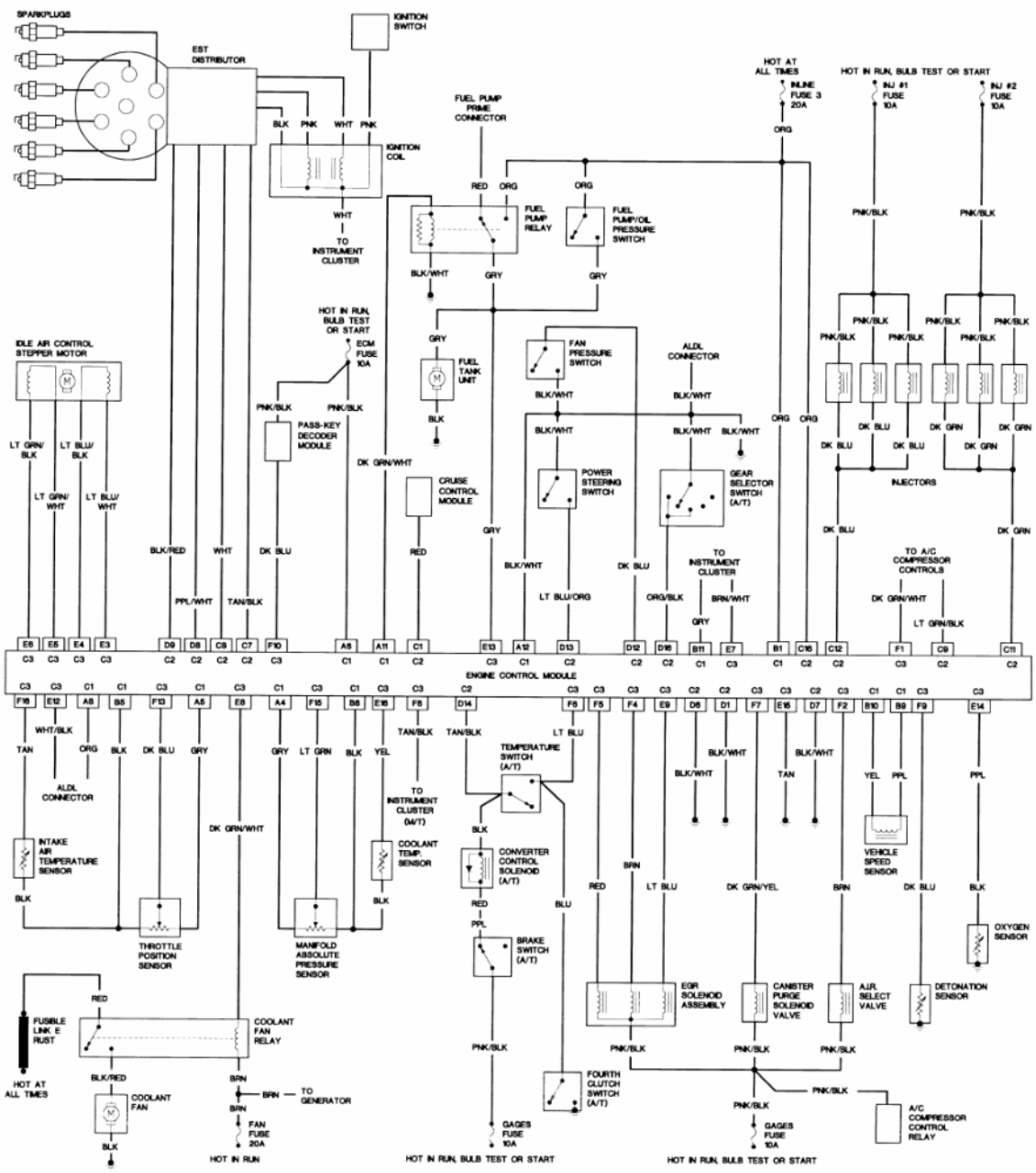

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## 1990 BODY WIRING, CONTINUED



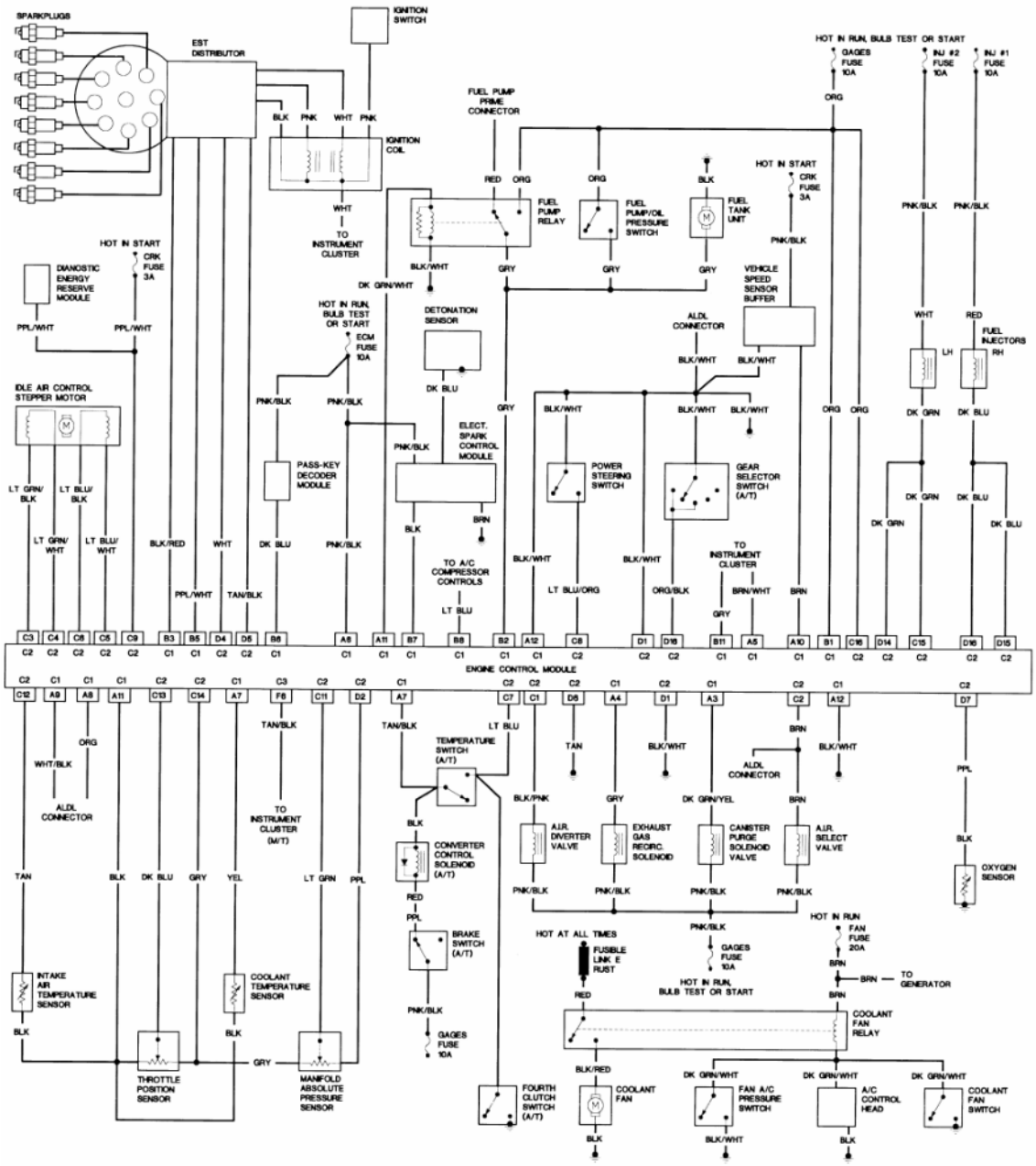

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## 1991 3.1L ENGINE WIRING



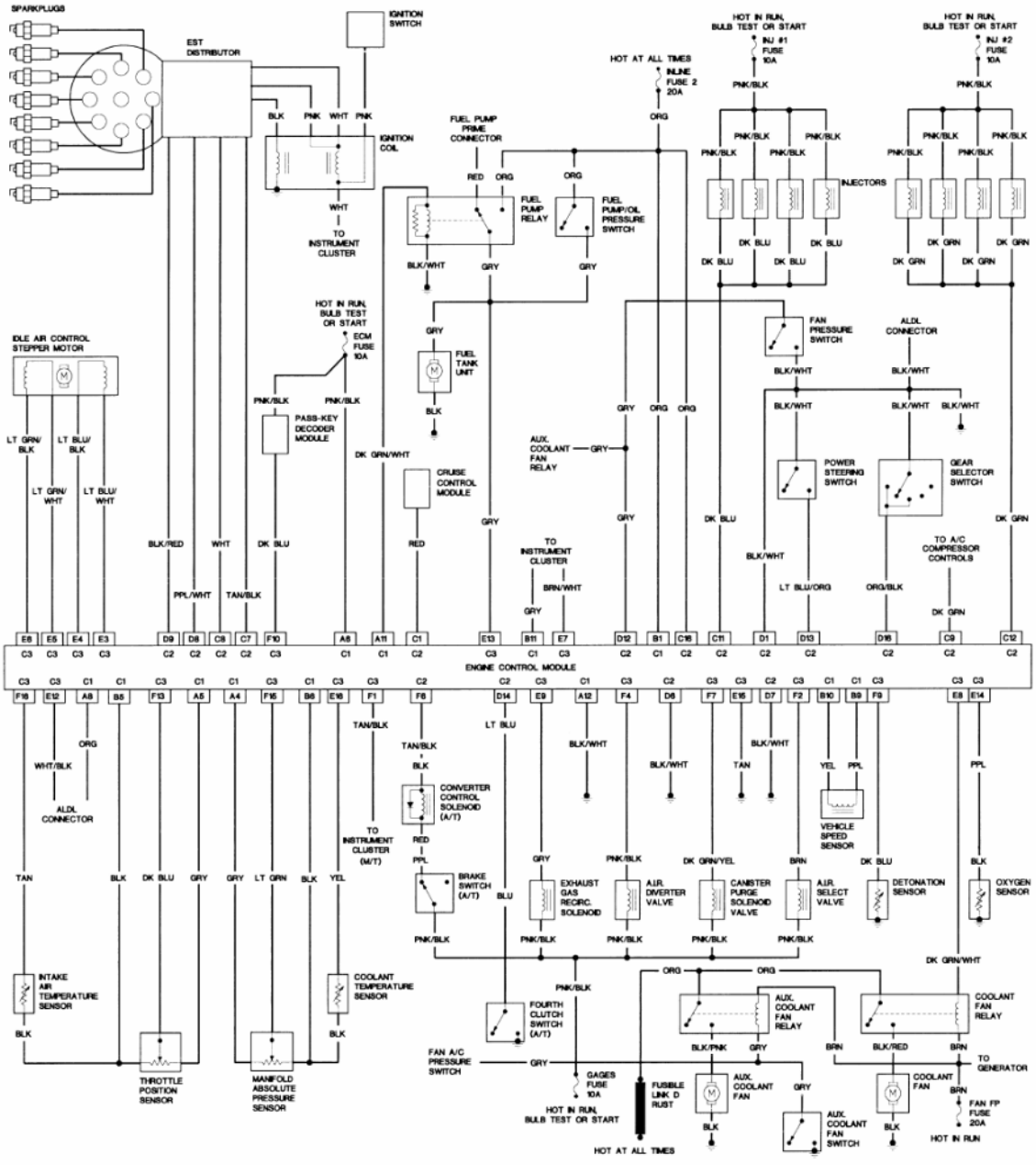

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## 1991 5.0L THROTTLE BODY FUEL INJECTION ENGINE WIRING



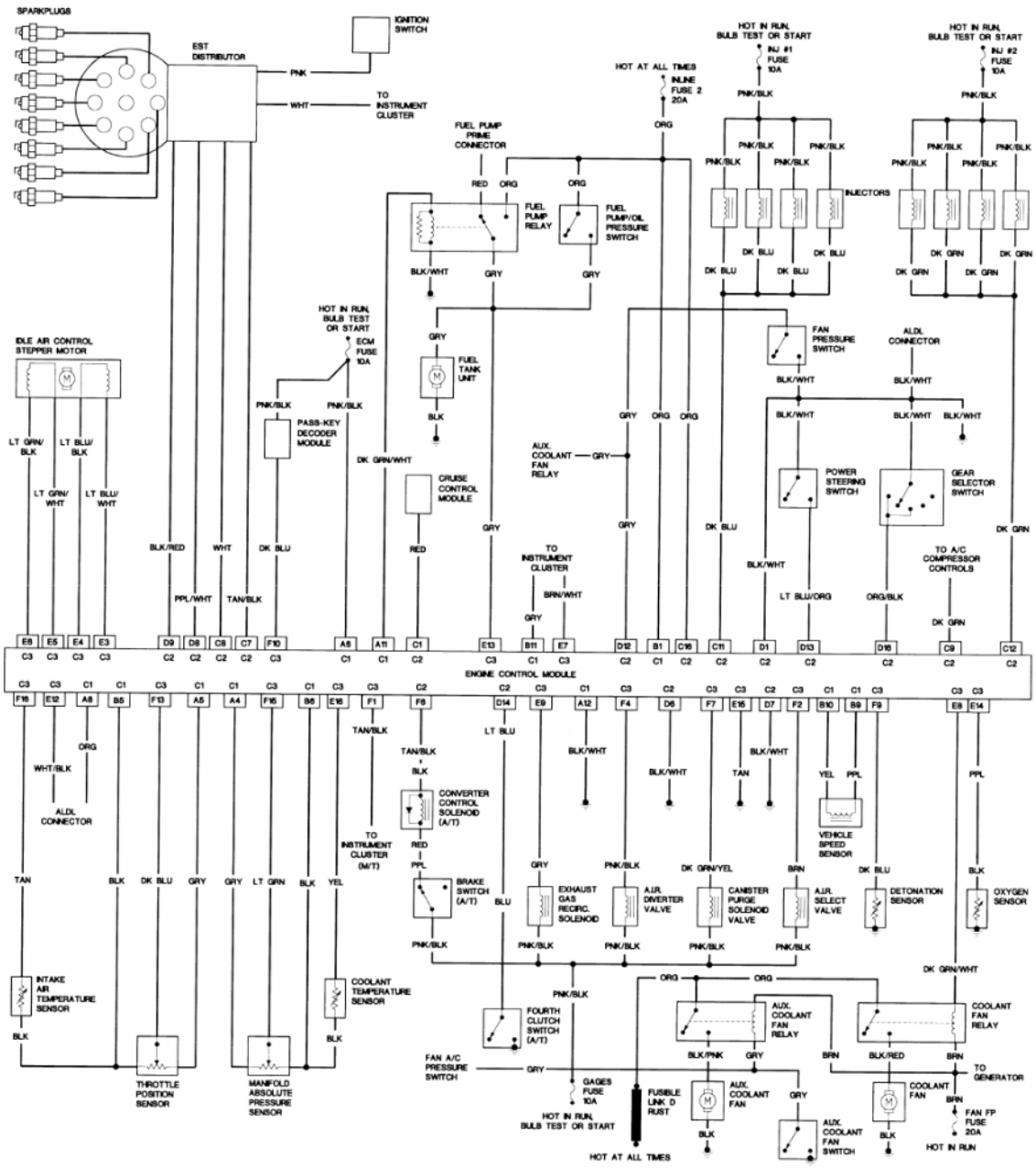

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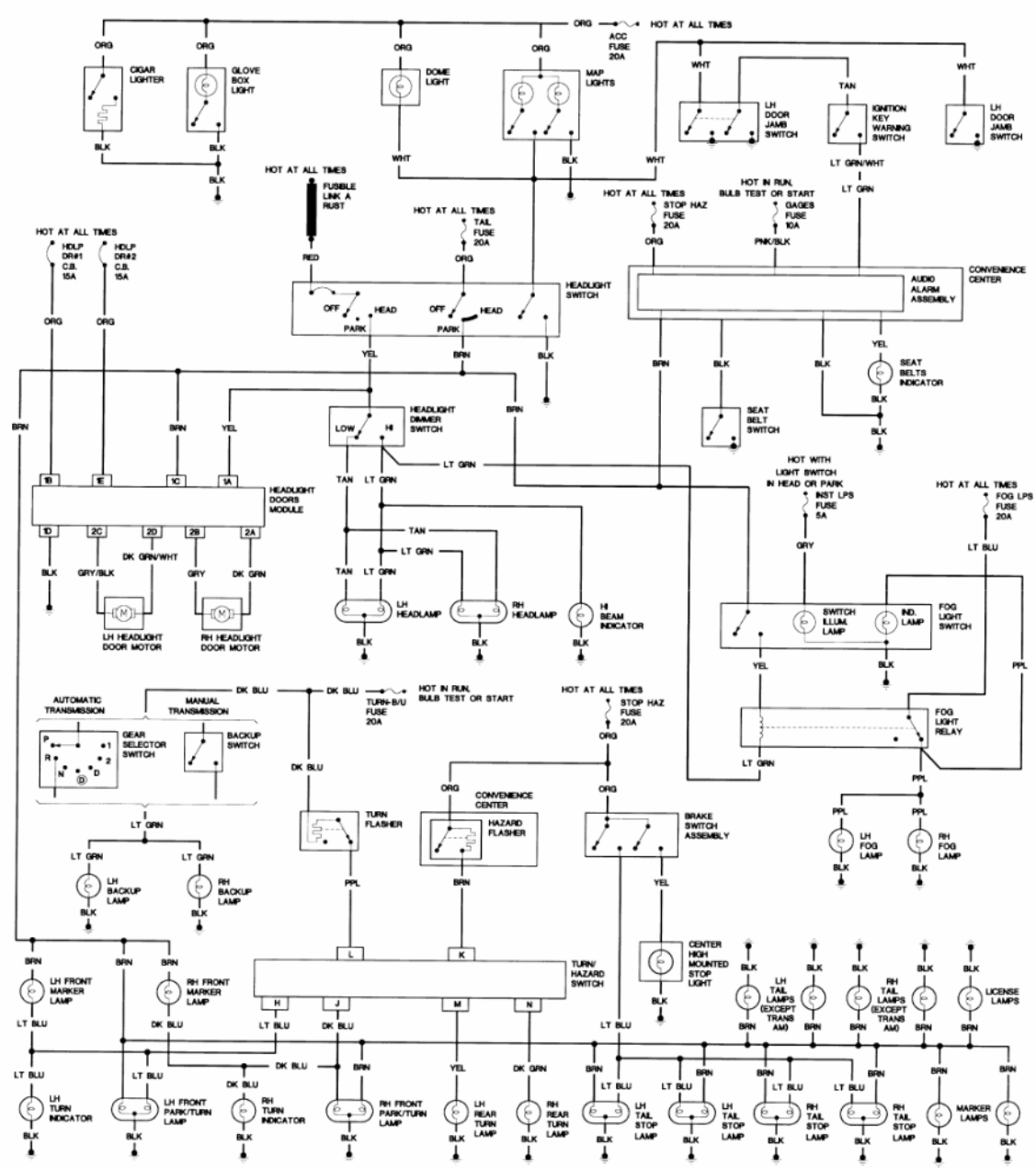

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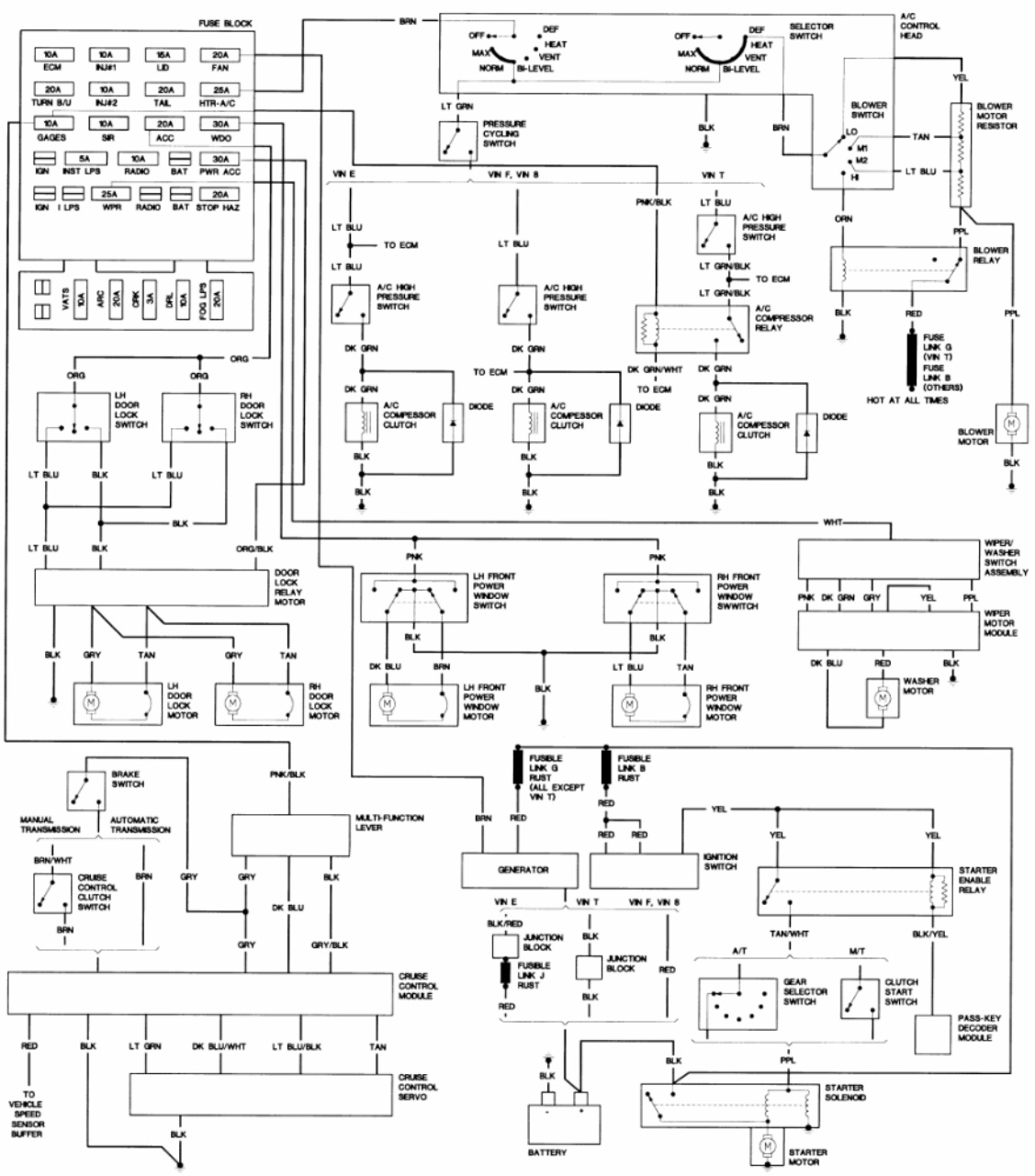

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## 1991 BODY WIRING



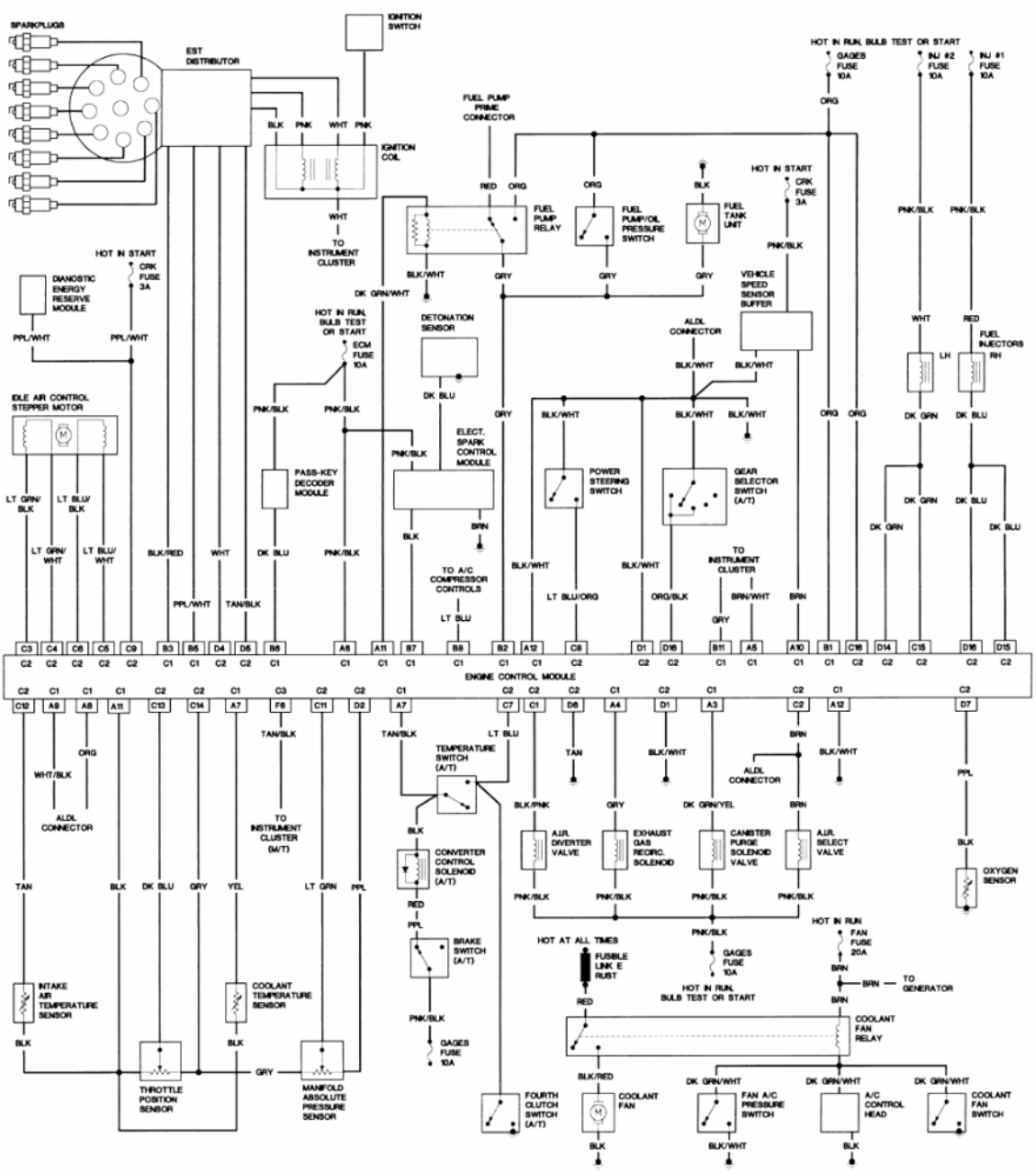

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## 1991 BODY WIRING, CONTINUED



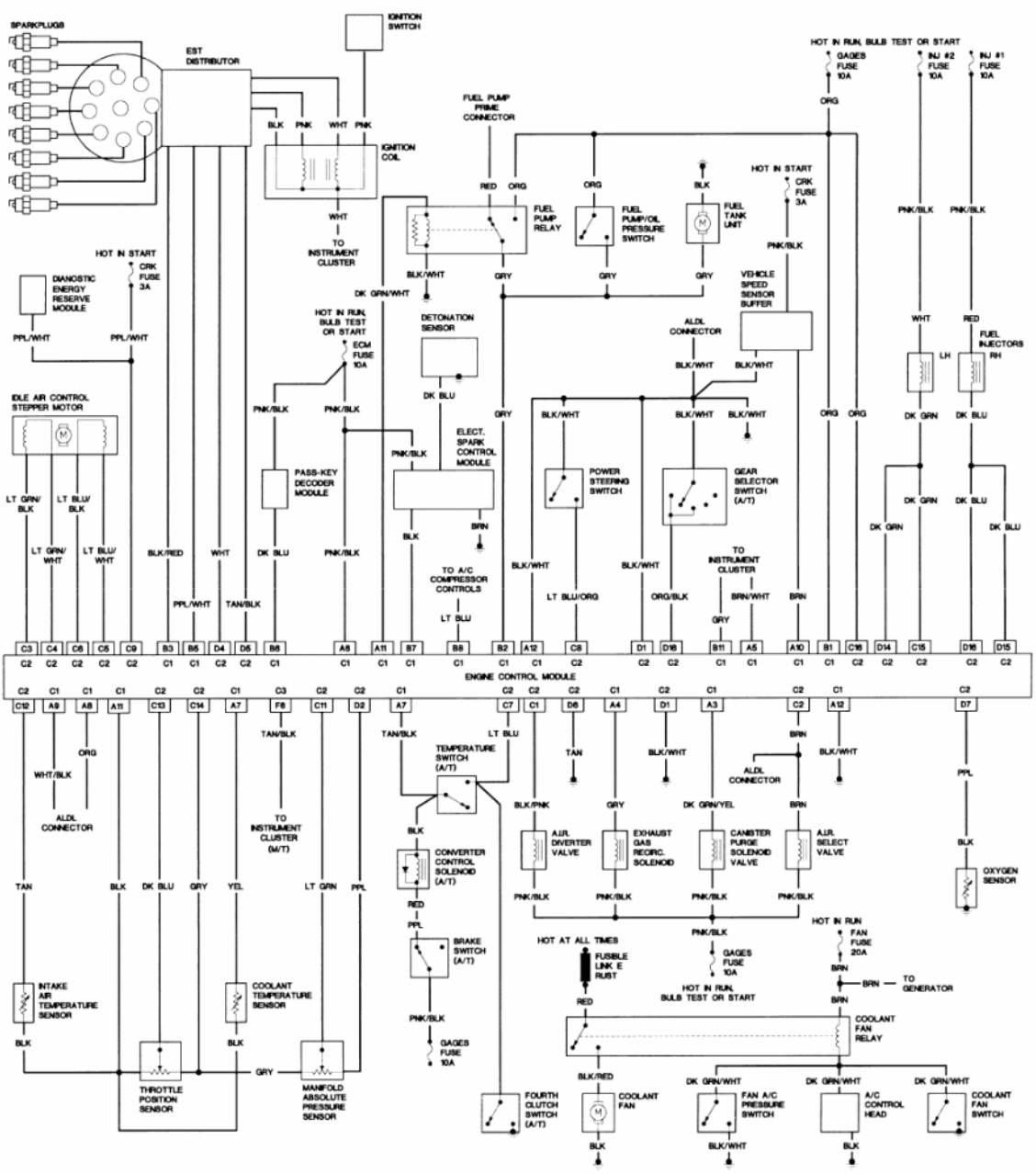

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## 1992 5.0L THROTTLE BODY FUEL INJECTION ENGINE WIRING



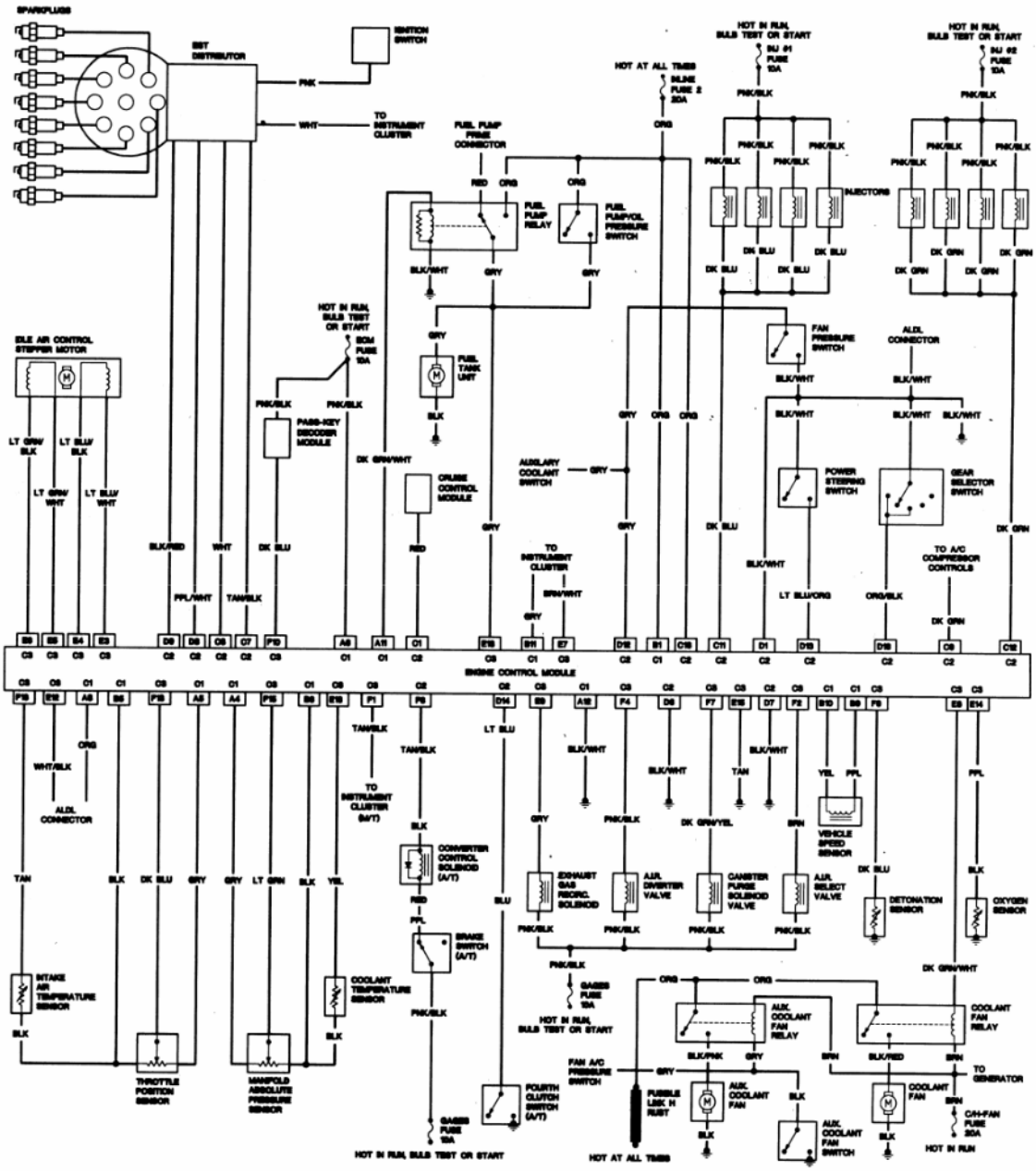

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## 1992 5.0L TUNED PORT INJECTION ENGINE WIRING



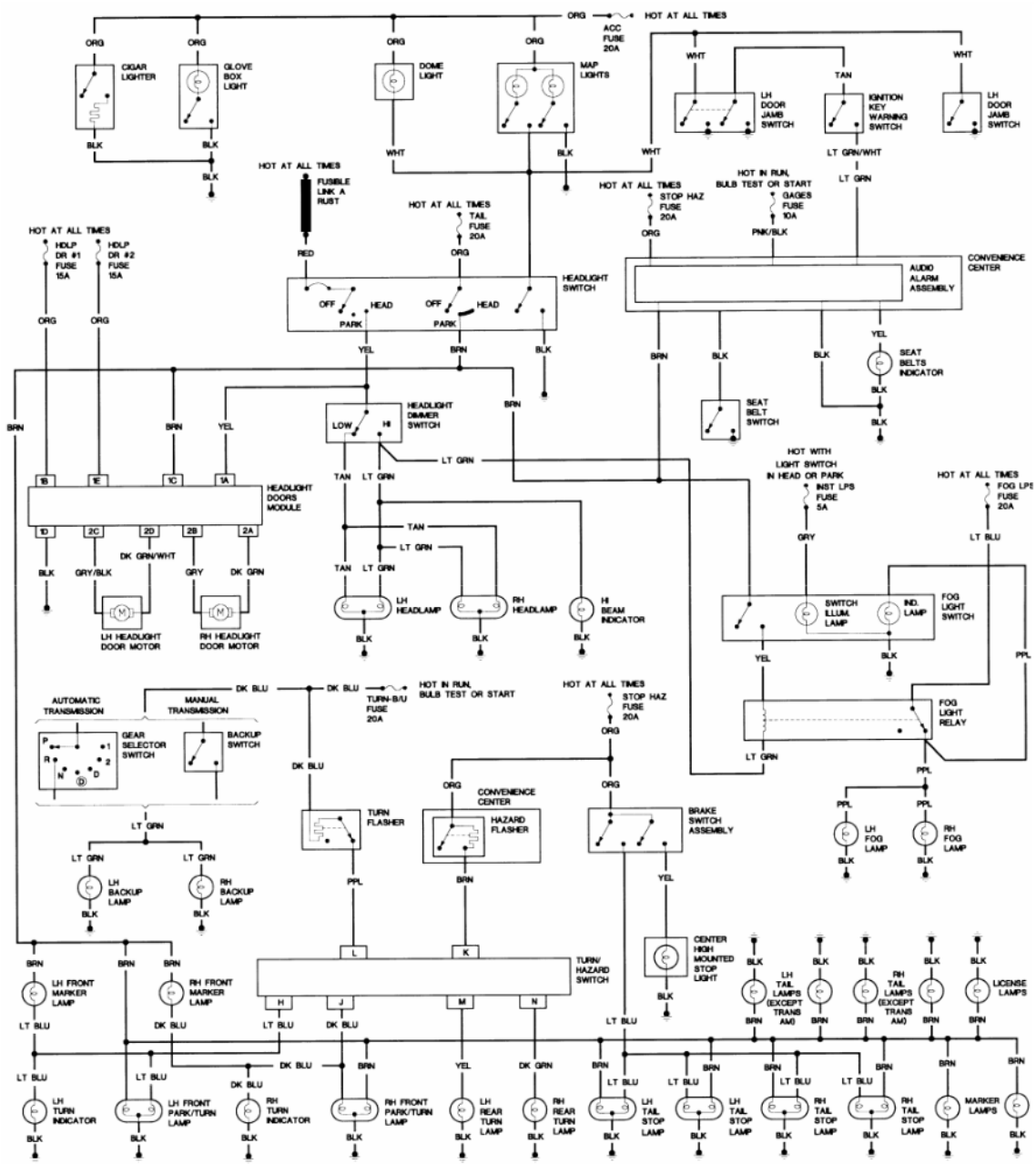

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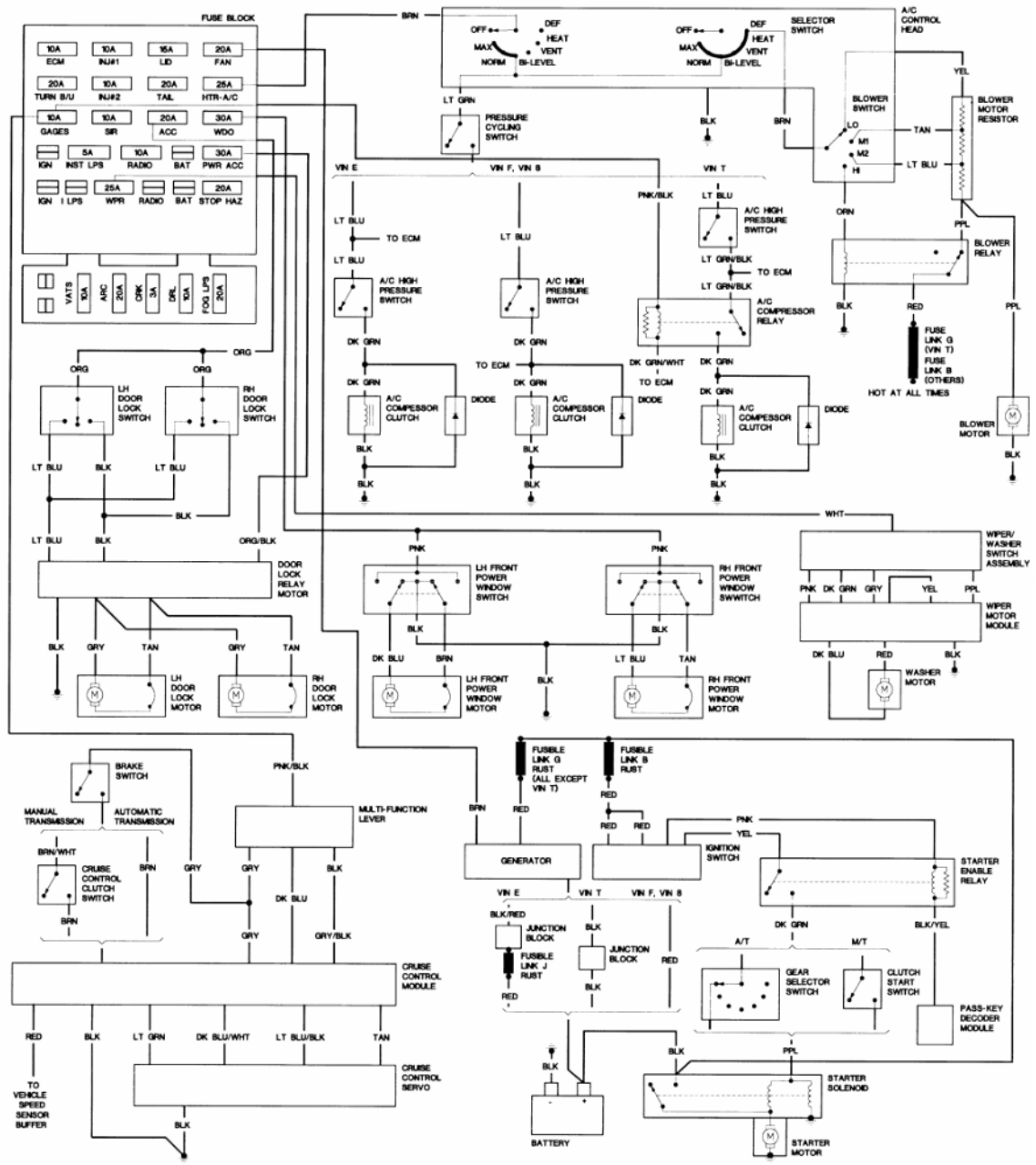

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## 1992 BODY WIRING




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## 1992 BODY WIRING, CONTINUED




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