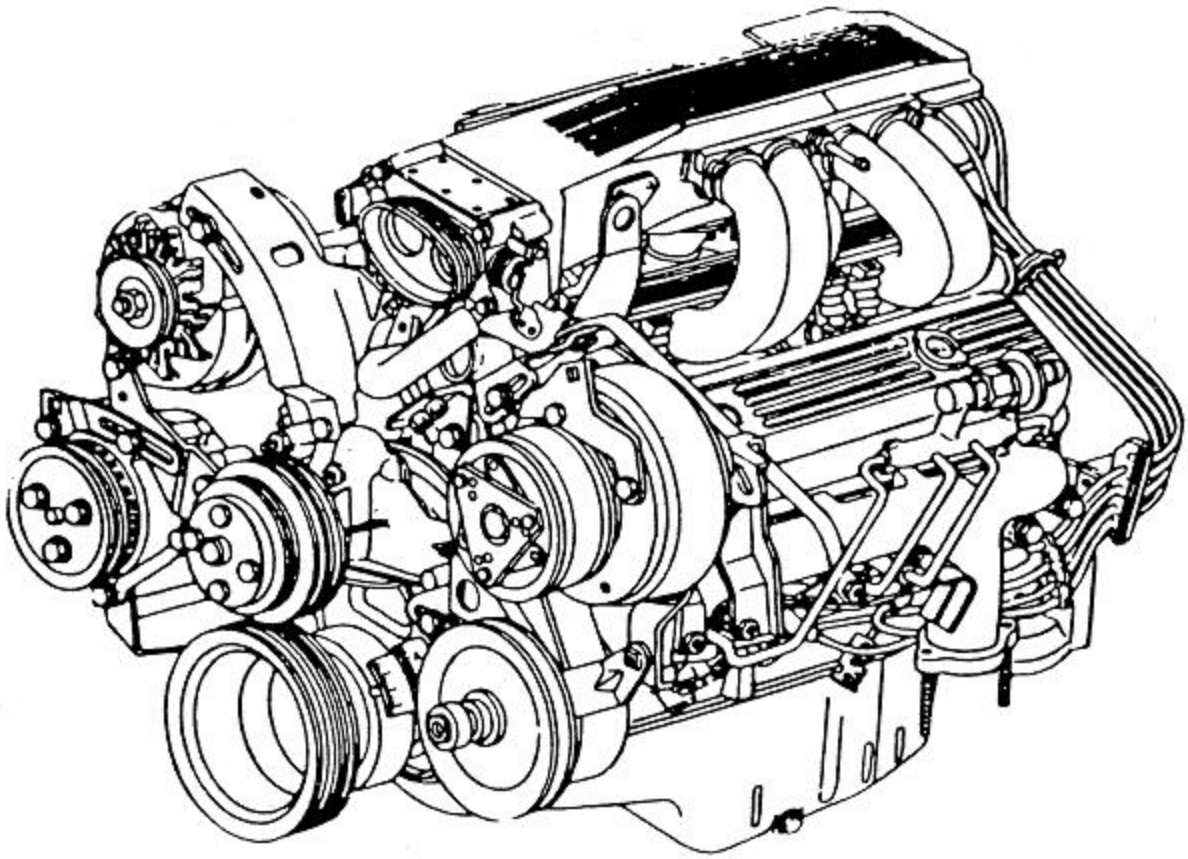
SunCoast Conversions

Tuned Port Fuel Injection Handbook



Technical Manual and Installation Guide for General Motors Tuned Port Fuel Injection

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TUNED PORT FUEL INJECTION

Adding Chevrolet's Tuned Port Electronic Fuel Injection system to the Small Block Chevrolet used in your Street Rod, Street Machine, Kit Car or daily driver will improve its drivability, performance, and gas mileage, in addition to giving the engine compartment a clean, "High-Tech" look. We have utilized a substantial number of these systems in our in-house Jaguar V-8 conversions since 1986 with excellent results and have compiled the following information in an effort to give you a basic introduction into the Tuned Port Electronic Fuel Injection system in general and, specifically, how to incorporate this system into your Street Rod, or for that matter any other vehicle powered by a small block Chevrolet Engine.

Chevrolet's Tuned Port Fuel Injection System, or TPI as it is more commonly referred to, first appeared on production vehicles in 1985 and, since then, has been used on all Corvettes and on many specially equipped Camaros and Firebirds. GM advertising claims of up to a 20% improvement in torque, horsepower, and mileage over equivalent carbureted engines have proven conservative if the various automotive enthusiast magazines' road and dyno tests are to be relied upon. As the following chart graphically illustrates, the horsepower and torque ratings of the basically very similar 350 cu.in. engine, utilized in all Corvettes since 1980, have increased substantially with only minor changes other than the fuel injection system. While a portion of the power improvements shown in the chart can be attributed to increases in compression ratio and decreases in engine friction especially in the later engines with roller tappet camshafts, the majority is due to the overall efficiency of the "Computer Controlled" Tuned Port Electronic Fuel Injection System.

CORVETTE 350" ENGINE SPECIFICATIONS

Year	Horsepower	Torque	Comp.Ratio	Notes
1980-1981	190 hp @4400 rpm	280 lb/ft @2400 rpm	8.2 to 1	4-barrel carbureted
1982-1984	205 hp @4200 rpm	290 lb/ft @2800 rpm	9.0 to 1	Cross-fire twin throttle body inj
1986-1987	230 hp @4000 rpm	320 lb/ft @3200 rpm	9.5 to 1	TPI w/aluminum heads
1988	245 hp @4300 rpm	340 lb/ft @3200 rpm	9.5 to 1	TPI w/aluminum heads and roller lifter camshaft.

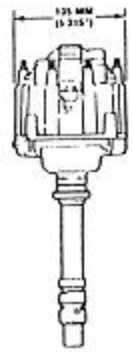
Gas mileage figures are harder to compare because of the effects of different rear end ratios, transmission types, tire sizes, vehicle weights, etc. etc. However, judging by our past experience with V-8 powered Jaguar sedans utilizing 350 cu.in. TPI engines and TH-700-R4 overdrive transmissions, we have found that these cars can consistently produce mileage figures 3 to 5 mpg better than similarly equipped (i.e. same transmission and rear axle ratio) carbureted 350" V-8 cars.

Obviously, the simplest and most expedient way of using a TPI system with your project is to obtain a complete Corvette, Camaro, or Firebird engine with a TPI unit already installed and use the complete assembly in your vehicle. It is also possible to find individual TPI units in salvage yards, at automotive swap meets, or in the classified section of your local newspaper, or Auto Trader-type publications. In either case, it is extremely important to be sure that you are getting ALL of the attendant sensors, relays, connectors and, especially, the COMPLETE wiring harness.

Further along, we will endeavor to itemize and explain the functions of these various components in an attempt to familiarize you with their function, appearance, and location.

MAT

MANIFOLD AIR TEMPERATURE SENSOR - The manifold air temperature sensor is located in a threaded boss on the underside of the TPI plenum. Identical (same GM part #) to the coolant temperature sensor, this unit sends information to the ECM on changes in inlet air temperature for which the ECM enriches or leans the fuel mixture according to predetermined calibrations stored in the ECM. It also uses a 2-wire connector similar to the one used on the Coolant Temperature Sensor.



CORVETTE
(85 and 86 Camaro/Firebird)

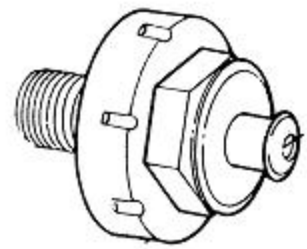
CAMARO / FIREBIRD
(87 and Later)

DISTRIBUTOR - The distributors used with TPI injector units are very similar to the HEI-type distributors used on electronically controlled throttle-body injected, or carbureted V-8 engines in that they have no internal advance mechanisms or vacuum advance control canisters. All spark timing is controlled by the ECM. The distributor supplies reference signals to the ECM for spark timing and information on engine rpm. The 4-pin connector plug, with which these distributors are connected to the basic wiring harness, while similar in appearance, is different enough that a non-TPI distributor will not plug into a TPI harness without changing the plug end. However, the color codes are the same and the non-TPI distributors will work with the TPI system. There may be some minor internal electronic differences between the two, but in the real world we have found no problem using the non-TPI units in conjunction with the TPI systems. NOTE: 1975 thru '80 HEI distributors with an external vacuum advance unit **WILL NOT WORK** in conjunction with a TPI system since the ECM requires a specific rpm input signal from the distributor!!! While all Corvettes use the large integral coil type HEI distributor, 1987 and later Camaro/Firebird units use a new type of distributor quite similar in size to the earlier point and condenser-type distributors that GM used prior to 1974. While smaller than the previous HEI-type distributors, it is still considered an HEI distributor, the main difference from the earlier HEI distributors being the use of an externally mounted coil. In most cases, you will use the distributor that comes with your TPI unit. We prefer, whenever possible, to use the Corvette style, larger HEI with the integral coil simply because it cleans up the installation and eliminates the coil, coil mounting bracket, and extra wiring. **NOTE: Any distributor used on the '87 and later roller lifter-type camshaft equipped engines must use a distributor gear designed to be compatable with the billet steel camshaft used in these engines. GM #10456413 is the correct gear for use on the earlier HEI large integral coil-type distributor. GM #10495062 is the correct gear to use on the later style, smaller HEI distributor that use a separate remotely mounted coil. If the distributor drive gear is not changed, the steel cam will chew up the stock iron distributor gear normally used on the earlier pre-roller cam distributors!**

ESC

ELECTRONIC SPARK CONTROL - The ESC has the capability of retarding the spark timing up to 20 degrees when the knock sensor detects detonation. This unit, which is slightly smaller and thinner than a pack of cigarettes and has a 5-pin wiring connector, is mounted in most GM applications, in a group with the 3 relays that are used for the fuel pump and the MAF power and burn-off circuitry, on the cowl or inner fender. We normally mount this unit along with the ECM underneath the passenger seat as it again simplifies the wiring process and eliminates clutter in the under hood area.

KNOCK SENSOR



KNOCK SENSOR - The knock sensor detects vibrations that are the acoustic "signature" of detonation and informs the previously-mentioned ESC which, in turn, directs the ECM to retard the timing in an attempt to eliminate the detonation. The combined effect of these two units can retard the ignition timing up to 20 degrees to compensate for bad fuel, high engine temperature, or any other combination of factors that produce detonation. This unit is normally mounted on the right side of the engine, in the coolant drain hole, just above the oil pan rail in front of the starter motor.

RELAYS - There are 3 ECM controlled relays which are an integral part of the TPI system. The fuel pump relay is controlled by the ECM and acts as a remote switch to route power to the electric fuel pump. A relay is necessary in this application because most high pressure fuel pumps can draw up to approximately 10 amps of current. The fuel pump relay is backed up by an oil pressure activated switch which maintains +12 volts at the fuel pump power terminal as long as the engine has oil pressure, which will allow the vehicle to start and continue running in the event of a fuel pump relay or partial ECM failure. This oil pressure activated, fuel pump control switch is mounted (depending on the year and model) either in a threaded port on the left side of the engine block just above the oil filter, or in conjunction with the oil pressure gauge sending unit in a fitting behind and to the left of the distributor assembly. The first indication that the fuel pump relay has failed and that the back-up switch has taken over fuel pump operation, would be extended cranking time before the engine eventually starts, accompanied by an illuminated "Check Engine/Service Engine Soon" Light. The other 2 relays are the MAF power relay, and the MAF burn-off relay. These twin relays supply current (1) through the MAF Power Relay to provide power to the MAF sensor when the engine is running, and (2) through the Burn-off Relay to burn-off contaminants on the MAF sensor's hot wire when the engine is shut off. In GM installations these 3 relays are usually mounted in a group with the ESC module on the cowl or inner fender panel. In our applications, we mount these relays along with the ESC module in the area of the ECM underneath the passenger's seat, to eliminate under-hood clutter and ease the wiring process.

FUEL PUMP/FUEL SYSTEM - In the original GM applications, the fuel injection pressure pump is installed inside the vehicle's fuel tank. Adapting this pump has never seemed to us a practical solution, unless you are installing the TPI system on a GM vehicle that utilizes a gas tank that would allow for the installation of a internal tank type pump. If you are installing the TPI system into a vehicle that was originally equipped with carburetors, or a even a throttle body fuel injection system it WILL be necessary to install a compatible high pressure port-fuel-injection-type pump. There are any number of fuel pumps which will serve the purpose. We can recommend the fuel pump from a '78-80 and '82-85 Datsun 280Z. The Nissan part number for this pump is 17011-P7211. In addition, these pumps are usually readily available from salvage yards, as are similar units from BMW, Mercedes Benz, Jaguar and many other late-model port-injected vehicles. Another source for quality fuel injection pumps that are compatible with the TPI system is Haltech Engine Management Systems, a Division of ITAC Systems, Inc., 3121 Benton Street, Garland, TX 75042, 214-494-3073.

The electric fuel pump used should be capable of maintaining at least 50 psi under full throttle and a return line MUST be plumbed back to the fuel tank/tanks if there is not one installed on the car! NOTE: If the fuel tank in your vehicle does not have provision for a return line, it is NOT necessary to modify the tank! By installing the appropriate size tee-fitting into the fuel feed line from the tank to the inlet side of the fuel pump and connecting the return line into this "suction" line at the newly installed tee, the need for a return line can be met without removing and modifying the fuel tank.

If you are installing your TPI system in a vehicle which was originally equipped with a carbureted engine and a mechanical fuel pump that was equipped with a factory installed return line, BE AWARE that many of these systems have a restriction in the return line that should be removed to eliminate the possibility of unnecessarily high pressures in this portion of the fuel system. These restrictions are often contained in the return line fitting on the gas tank sending unit mounting flange. If it is inconvenient to access this flange to remove the restriction, the return line can be re-routed to the fuel pump inlet line as described above.

A fuel pressure regulator is mounted on the rear of the right side of the TPI fuel rail. This non-adjustable regulator controls fuel pressure to maintain it at about 41 psi under high vacuum conditions such as idle, and up to 47 psi under low vacuum conditions such as full throttle operation. Adjustable fuel pressure regulators are available thru a number of aftermarket suppliers, for high performance applications.

Because of the high fuel pressures involved, we prefer to use braided stainless fuel lines along with threaded connectors as opposed to just using hose clamps and rubber hose, when making the connection between the TPI unit and the fuel pump! The pressure inlet of the TPI system is the fitting with the larger I.D. A return line MUST be connected from the gas tank to the smaller I.D. fitting. If you are utilizing braided stainless hose and fittings, it will be necessary to purchase aftermarket adaptor fittings which thread into the hose connections on the TPI manifold to allow the use of these improved hose and fitting assemblies, since the OEM connections utilize metric threads and O-ring type seals. These adapter fittings are available, either in a "male" configuration for installation into the fittings on the fuel rails of the TPI, or into the ends of the stock rubber hoses, which attach to the body/frame mounted steel fuel lines that come forward from the fuel tank, or in a "female" configuration for installation onto the end of the engine mounted steel tubing extensions, which are a part of all factory TPI fuel line installations.

The above-mentioned items are all what could be considered separate elements that are component parts of the TPI installation. Simply stated, the system will not work at its designed level of performance if any one of the above items is deleted! The following information will include some additional items which, while not required to make the system functional, are items that are utilized in the factory installation to make everything work as originally designed, which may be used, as necessary, or deleted if so desired, with no functional effect on the "real world" operation of the unit.

AIR INJECTION SYSTEM - If your state emission laws require the retention and use of this system, it is merely a matter of leaving it mounted to the motor and attaching the appropriate wiring connectors from the harness to the control valve. You will also have to provide the necessary connection points for the AIR tubes to the

exhaust system or obtain a set of "Ram's Horn" type manifolds with the proper threaded holes for the AIR plumbing. These were used on '75 thru '81 Corvettes and are available from GM under #372243. If it is desired to remove this system, it also presents no particular problem with the installation as the ECM, while controlling the operation of the AIR system's control valves, does not monitor their operation and therefore would be unaware of the deletion of the system.

EGR SYSTEM - Here again, your state's emission laws will come into play. The entire EGR system can be left on the motor to function normally as designed by merely making the proper harness connections and leaving all the components in their factory-installed positions. If it is desired to remove the EGR valve and its attendant electronically-controlled vacuum valve, it can be done without affecting the electronics or diagnostics of the system by making the proper connections within the harness.

PARK/NEUTRAL SWITCH - This switch, as its name indicates, is utilized to provide information to the ECM as to whether the transmission is in one of the drive gears or the park/neutral position. It does this by grounding a contact, which in the original GM application is an integral part of the neutral safety/backup light switch that, when grounded, informs the ECM that the transmission is in park or neutral. As with the EGR system, if the proper connections are made within the harness, this unit can also be deleted.

VEHICLE SPEED SENSOR - The VSS sends a pulsing voltage signal to the ECM which the ECM converts to a miles per hour reference. This sensor mainly controls the operation of the automatic transmission's Torque Convertor Clutch (TCC) system and also provides an input for the GM electronic cruise control unit. On all Corvettes and some of the later Camaros and Firebirds, this unit is mounted directly in the transmission extension housing where the speedometer drive gear sleeve would have been and provides the VSS signal for the above inputs and also for the electronic speedometer. In vehicles that utilized a speedometer cable, the VSS mechanism is a small unit mounted to the back of the instrument panel behind the speedometer and activated by the speedometer cable. In most Street Rod or similar installations this function is not required unless you would be interested in, having the TCC function totally as originally designed or, adapting a late GM electronic cruise control to the installation.

CHECK ENGINE/SERVICE ENGINE SOON-INDICATOR LIGHT - The "Check Engine/Service Engine Soon" Light is the ECM's method of alerting the driver to a problem in the electronics circuitry of the fuel injection system. In original GM applications, this light is usually contained in the indicator light cluster in the instrument panel. It is also possible to merely add an aftermarket indicator light mounted anywhere it is convenient to serve this function. We HIGHLY RECOMMEND the inclusion of this light during your wiring process. Basically, if the ECM disagrees with a particular sensor input, it will turn on the "Check Engine/Service Engine Soon" Light and, at the same time, set and store a trouble code in the ECM's memory so that you can check the appropriate sensor and circuitry for possible problems. Just because the light comes on, does not mean that there is necessarily a part failure, but only that the ECM is reading inputs outside the normal pre-programmed parameters that it expects to see. In a lot of cases, the "Check Engine" Light will extinguish itself during continued operation if there is no serious problem, and, in many cases, will extinguish itself after the engine has been turned off and restarted. In both these cases, however, the ECM will store a trouble code for future diagnostic purposes. If the light goes on and stays on and does not extinguish itself, especially after a restart, it usually indicates a problem with one of the sensors or the circuitry and should be checked according to procedures outlined in the GM shop manual covering the SPECIFIC YEAR AND MODEL TPI system that you are using. While this manual is designed to supply you with all the necessary information you will need to properly install and wire the TPI system in your vehicle without the need for a GM manual, we would be less than candid if we did not tell you that these GM shop manuals offer the definitive source of information on diagnosing problems with the TPI system. The proper year and model manual is especially helpful in troubleshooting problems because of their step-by-step diagnostic charts which are organized in reference to ECM trouble codes. Order forms for the appropriate manuals can usually be obtained from your local Chevrolet/Pontiac dealer's Service Department. Should your local dealer be unable or unwilling to help, you can also write for order forms to the Publisher of these manuals: Helm, Inc., P.O. Box 07130, Detroit, MI 48207. Their information number is 313-883-1430. Helm Inc. also has a toll-free order line for credit card use only (800-782-4356).

COOLANT FAN CONTROL RELAY - In the original GM installations, all TPI engines utilize an electric cooling fan. This fan is controlled by the ECM relative to temperature input from the Coolant Temperature Sensor and other sources. Unfortunately, in our opinion, GM has seen fit to activate this fan at a much higher temperature level than we like to use so, for the most part, we use this circuit merely as a backup circuit for the electric fan which is also required on most non-OEM TPI installations because the location of the TPI air inlet ducting precludes the use of an engine driven fan in most installations. We prefer to operate the electric fan either on a full-time basis or wired through an aftermarket thermostat which turns it on at approximately 200°F and off at approximately 185°F as opposed to the factory turn-on point of from 220°-234°F, depending upon the year and model of the vehicle from which the system originated. NOTE: If you are using an electric engine cooling fan in your installation, it should also be wired to run whenever the AC compressor clutch is engaged!

COOLANT FANS - We have found that the electric fans, used on '84 and later Corvettes and '85-87 Camaros and Firebirds, are quite adequate for cooling any small block engine equipped with an adequate sized radiator. We have always mounted this fan in a custom sheet metal shroud to best utilize its air-moving potential. If one of these fans cannot be obtained in a salvage yard, it can be ordered from GM in 3 pieces as follows: Motor #22074968, Housing #22049527, and Fan #22067444. If this GM fan will not fit your application because of clearance considerations, there are many different aftermarket units with more compact dimensions that can be used.

As the preceding information indicates, Chevrolet's Tuned Port Electronic Fuel Injection System presents a "whole new ball game" for today's performance oriented automotive enthusiast. We hope you have found the foregoing helpful in understanding the system, its terminologies and the areas that require attention, both when obtaining a complete TPI engine or an individual TPI unit, and also when installing it in your Street Rod.

The information contained in the balance of this manual includes specific wiring details, broken down by color codes, circuit numbers, enumeration of the circuits that must be included, those that may be deleted, and how to delete them without creating false trouble codes. In addition, there are short-cuts and installation hints included that we have utilized while doing our in-shop installations.

TPI WIRING INFORMATION

In the preceding segment of this manual, we have attempted to give you a broad overview of the Tuned Port Electronic Fuel Injection System along with information on parts interchangeability and also tried to point out some of the important differences between various year and model systems. The remainder of this manual is designed to give you, in conjunction with the previously provided information the specifics needed to adapt the TPI system and all its components to vehicles other than those in which it was factory installed. In the following pages we have endeavored to assemble, in an organized manner, all the details of the various electrical connections, appropriate part numbers for replacement components and any other relative information that will assist you in the adaptation process. All the information that follows specifically applies to '86-89 TPI systems with a Mass Air Flow sensor. Rather than just providing you with a few schematics, some installation notes, and our "good luck" wishes, our intent is to try to impart as much information as is practical, on the individual circuits and components involved, so as to allow you, through an increased familiarity with the TPI system, to determine the exact final hook-up that will work best for your individual application. If you are using a complete factory harness that has been removed intact from the donor vehicle you should find most of the connections listed in the following pages already in place, which will substantially simplify the rewiring process, and require you to merely "thin out" the harness by removing unnecessary or unwanted wires and make the few connections necessary to join the TPI harness with your vehicles existing wiring.

ECM TERMINAL CONNECTIONS

The following information is a listing of the 56 terminal locations (one 24 terminal, and one 32 terminal) in the two plastic connectors which attach the main wiring harness to the ECM. A graphic representation of these connectors appears on illustration page A-1, in conjunction with an identification chart with locations keyed in the same alpha-numeric manner (i.e. A-1, B-2, C-3, D-4 etc.) as the following listings. Each listing will be

indicated by its alpha-numeric position (physical location in the ECM terminal connector), will have information relative to the color code(s) of the wire used in that terminal, the appropriate GM Circuit number(s) and name(s), and the primary and, in some cases, the secondary connection point(s) plus information about related wiring (i.e., in the case of a circuit where the ECM provides a ground, we will also explain where the power source for that component originates, etc.). Also, we will indicate if the circuit in question can be deleted and, when removed, what type of connections should be made to keep that particular circuit from creating problems with other circuits or setting false trouble codes by its removal. By referring to schematic pages I thru IV at the rear of these instructions, while reading through the ECM terminal section, you will be able to gain an overall understanding of the TPI wiring system and how to adapt it to your individual requirements. You may, occasionally, find different color wires in the individual ECM terminal connections than the ones listed here. While color codes are important in tracing different wires in a harness, the point must be made here, that even more important than the color codes are the circuit numbers and their proper connection points. Simply stated, if the circuit in question has the proper termination points, the color codes are merely a helpful convenience. We strongly suggest that all circuits be doublechecked with a continuity tester to make absolutely sure that each individual circuit is properly connected.

Be very careful when wiring the relays. While the actual circuits involved are the same, the relay terminals' positions as indicated by the letters, A, B, C, etc. are different due to the use of different style relays and connectors on different year vehicles, in what we shall refer to as 1st Design and 2nd Design relays. NOTE: '88 and '89 Camaro and Firebird systems use 2nd Design relays for the MAF power and MAF burn-off relays, and a 1st Design relay for the fuel pump application. Be especially careful when wiring these particular systems! The areas affected in the following information are indicated by a terminal listing for both the 1st and 2nd Design styles. The differences are also reflected by the two different Page IV schematics included at the rear of these instructions and by the illustration of the readily apparent physical differences in appearance between the two connector types as shown on illustration page A-2 at the end of these instructions. There is also information relating to year and model applications, and the appropriate part numbers, of the 1st and 2nd Design relays on page 32.

NOTE: ***REMOVE THE ECM FROM THE HARNESS CONNECTORS*** before doing any circuit testing or modifications, **AND** be sure to solder all connections!!!

A-1 DARK GREEN/WHITE Circuit #465 **FUEL PUMP RELAY CONTROL**

Connected to Terminal "C" (1st Design) or "D" (2nd Design) of the fuel pump relay. This circuit allows the ECM to activate the fuel pump relay by supplying a +12V through this terminal. The fuel pump power circuit is provided by a connection to relay Terminal "E" (1st Design) or "A" (2nd Design) of the +12V (Circuit #340) wire directly from the Battery Fuse (Fuse #1). In addition, Terminal "B" (1st Design) or "F" (2nd Design) of the fuel pump relay should be connected to the common ganged ground circuit from ECM connector Terminals A-12, D-1, D-3, D-6, and D-10 which is, in turn, connected to a secure engine ground. A wire should be connected from the fuel pump relay Terminal"A" (1st Design) or "E" (2nd Design) to the fuel pump positive terminal and also to ECM Terminal B-2 (Circuit #120). This connection to the fuel pump from Terminal "A" or "E" is, in turn, powered to run the pump when the ECM connection at A-1 is powered, to activate the relay. The connection at B-2 provides an input to the ECM to acknowledge that the pump has power. A wire should also be connected from Terminal "D" (1st Design) or "C" (2nd Design) of the fuel pump relay, to Terminal "G" of the ALDL connector. This connection will allow you to power up the fuel pump by supplying +12V to this terminal of the ALDL connector for test purposes.

A-2 BROWN Circuit #436 **AIR SWITCH (PORT SOLENOID)**

Connected to the Port Solenoid Connector (Gray) of the AIR valve. This circuit allows the ECM to activate the port solenoid portion of the AIR valve assembly by supplying a ground through this terminal. The +12v feed to this connector is supplied from a fused, switched source via the "gages" fuse in the original application. For our rewiring purposes, we shall refer to this fuse circuit as Fuse #3 and Circuit #39. If the AIR system is retained with the installation, a wire should also be connected from this terminal to Terminal "C" of the ALDL connector

to duplicate the factory hookup. This ALDL connection will allow you to activate the Port Solenoid, by jumpering ALDL terminal "C" to ground for diagnostic purposes. As mentioned earlier in this manual, while the ECM controls this circuit, it does not monitor it, so the AIR system and this circuit can be eliminated with no negative effects on ECM operation or diagnostics.

DELETE if removing AIR pump and valve assembly.

A-3 DARK GREEN/YELLOW Circuit #428 **CANISTER PURGE CONTROL**

Connected to Emission Canister Purge control connector (Red) Terminal "B". This circuit allows the ECM to activate the CCP (Controlled Canister Purge) evaporative emission canister purge control solenoid by providing a ground through this terminal. If this circuit is used, the +12V feed portion is derived from the same (gages) fuse (Fuse #3 Circuit #39) referred to as the +12V supply source for the AIR port solenoid as indicated in listing A-2 above. Here again, while the ECM controls this circuit, it does not monitor the action of the CCP system so this system, and its circuit, can be removed without affecting ECM operation or diagnostics.

DELETE if not using evaporative emission canister.

A-4 GRAY Circuit #435 **EGR SOLENOID CONTROL**

Connected to the EGR Control Solenoid connector Terminal "B". This circuit allows the ECM to control the operation of the EGR solenoid by providing a ground through this terminal. When the EGR solenoid is activated, or turned "on" by this process, it closes the vacuum passage to the EGR valve, thus making it inoperative, supplying no EGR to the engine. Conversely, when the ground is removed from this terminal, it turns the EGR solenoid "off" which opens the vacuum passage to the EGR valve which, in turn, opens the valve and allows the EGR function to the engine. When the EGR function is commanded by the ECM, this "on-off" process takes place many times a second in what is referred to as a pulse-width-modulated duty cycle. The EGR solenoid is powered by (gages) Fuse #3 Circuit #39. If you are removing the EGR system, this circuit can be deleted if the park/neutral switch connector (B-10) is connected to the ganged common ground wire circuit connected to ECM terminals A-12, D-1, D-3 D-6, and D-10. When Terminal B-10 is grounded in this manner, it effectively defeats the EGR system's self-diagnostics and therefore does not allow the ECM to illuminate the "Check Engine/ Service Engine Soon" light or set a trouble code to indicate a problem with the EGR system. For more information see B-10.

DELETE if removing EGR valve and control solenoid.

A-5 BROWN/WHITE Circuit #419 **CHECK ENGINE/SERVICE ENGINE SOON LIGHT CONTROL**

Connected to the "Check Engine/Service Engine Soon" Light. This circuit allows the ECM to provide a ground to the "Check Engine/Service Engine Soon" Light, thus illuminating the light to alert the driver to possible problems with the ECM, individual sensors or wiring. Power for this light should be provided from the "gages" fuse (Fuse #3-Circuit #39). WE HIGHLY RECOMMEND THE INCLUSION OF THIS CIRCUIT, in the re-wiring process as this light is an important part of the system's self-diagnostics. For more information on the "Check Engine/Service Engine Soon" Light, see page 16 and the Trouble Codes Section on page27.

A-6 PINK/BLACK Circuit #439 **+12V IGNITION FEED**

Connected to a switched +12V source. This circuit provides power to the ECM from a +12V switched source (the ignition switch) fused by a 10 amp fuse. Power should be available at this terminal when the ignition key is in the "run" and "start" positions. Depending on the type of wiring system that exists in the vehicle into which you are installing the TPI system, you will have to either "tap into" the appropriate wire in the ignition switch harness, or make the necessary connection at the main fuse block. For our rewiring purposes, this fuse will be referred to as the ECM fuse (or Fuse #2). In the factory hook-up, this Circuit #439, which provides power from Fuse #2 to this terminal, also provides power to the ESC module Terminal "B", and in vehicles equipped with a VATS decoder module to Terminal A-1 or "S" (depending on year and model) of that module. When we rework

the harness for the Non-OEM installation, we power the ESC module from the "gages" fuse (Fuse #3-Circuit #39). This effectively makes the ECM the only component supplied with power from Fuse #2.

A-7	TAN/BLACK	Circuit #422	**Automatic Trans TCC CONTROL**
		Circuit #422	**Manual Transmission 0-D CONTROL**
		Circuit #456	**Manual Transmission SHIFT LIGHT CONTROL**

Connected to the TH-700-R4 automatic transmission 4-pin connector (Terminal "D"). This circuit allows the ECM to control the TCC function by providing a ground through this terminal. We DO NOT recommend using the ECM to activate the TCC function in the OEM manner since this requires the inclusion of a functional VSS system. A much simpler solution is to use one of the many aftermarket kits that are available to effect TCC lockup without the use of a computer. Our method of accomplishing this is detailed at the back of this manual in the "Miscellaneous Information" section. If you ARE using the ECM to activate the TCC function, a wire should be connected from this terminal to the ALDL connector (Terminal "F"). This connection allows you to activate the TCC function by supplying an external ground to this ALDL terminal to verify TCC operation. On Corvettes equipped with a manual 4-speed plus overdrive transmission, this terminal allows the ECM to provide a ground to the overdrive relay which in turn, activates the overdrive solenoid in the transmission. On some Camaros and Firebirds equipped with manual transmissions, this terminal is connected to the dash panel mounted "Shift Light" and allows the ECM to illuminate this light by supplying a ground to this terminal: DELETE if you are not using the ECM to control the TCC function or if you are using a transmission which does not incorporate a TCC.

A-8	ORANGE	Circuit #461	**SERIAL DATA**

Connected to terminal "E" and in some applications, also Terminal "M" of the ALDL connector. This Circuit provides, what is referred to as, "Serial Data" output. "Serial Data" is the term used to describe the data stream of information transmitted by the ECM from this terminal to the ALDL terminals "A" and "M" in the form of a variable voltage (2-5V) signal representing words and other information which is in turn decoded by a computer chip in the SCAN tool into a form which can be displayed on the SCAN tools' read-out screen.

A-9	WHITE/BLACK	Circuit #451	**DIAGNOSTIC TERMINAL**

Connected to Terminal "B" of the ALDL connector. This circuit is referred to as the "Diagnostic Test" circuit. The ECM will enter one of four diagnostic modes depending on the resistance value placed between ALDL Terminal "B" and ALDL Terminal "A". Terminal "A" of the ALDL connector should be connected to the ganged common ground circuit comprised of ECM Terminals A-12, D-3, D-6, and D-10 which is, in turn, connected to a secure engine ground. Grounding Terminal "B" of the ALDL by "jumpering" it to Terminal "A", with the ignition key turned to the "on" position, engine NOT running, causes the ECM to enter the "Diagnostic Mode". For more information, see the section on Trouble Codes on page 33.

A-10	BROWN	Circuit #437	**VSS SIGNAL**

Connected to the VSS buffer. Input from the VSS buffer provides a miles-per-hour reference to the ECM which it uses to control the TCC function. The ECM applies and monitors +12V on this circuit. The VSS buffer, which alternately grounds this circuit when the drive wheels are turning, effectively "pulses" this supplied voltage. The ECM then calculates vehicle speed based on the time between "pulses". This pulsing action takes place 2,000 times per mile. If the VSS is not used, ECM Terminal B-10 (the park/neutral switch connection) should be grounded to the ganged common ground wire circuit from ECM Terminals A-12, D-1, D-3, D-6, and D-10 which is, in turn, connected to a secure engine ground. With B-10 grounded, the VSS system's self-diagnostics will not set a trouble code to indicate a VSS problem. For more information, see page 16.

DELETE if VSS is not used.

A-11	BLACK BLACK/PINK	Circuit #476 or Circuit #452	**ANALOG GROUND**

Connected to Terminal "B" of the MAF sensor. This circuit provides the analog ground for the MAF sensor. **DO NOT connect to common engine/chassis ground.**

A-12 BLACK/WHITE Circuit #450 **SYSTEM GROUND**

Connected to Terminal "B" (1st Design) or "F" (2nd Design) of the fuel pump relay and should also be connected to the ganged common ground wire circuit from ECM Terminals D-1, D-3, D-6, and D-10 which are, in turn, connected to a secure engine ground.

B-1 ORANGE Circuit #340 **+12V BATTERY FEED**

This terminal should be connected through a 20 amp fuse which, for our rewiring purposes, we shall refer to as the Battery Fuse (Fuse #1), directly to a constant NON-SWITCHED +12V source (i.e. battery). The wire from this terminal can be ganged with the similarly colored wire from ECM Terminal C-16 as is indicated by the same Circuit #340. Also connected to this same +12V source should be fuel pump relay Terminal "E" (1st Design) or "A" (2nd Design), MAF sensor power relay Terminal "E" (1st Design), or "A" (2nd Design), MAF sensor burn-off relay Terminals "C" and "E" (1st Design), or "A" and "D" (2nd Design), and one side of the oil pressure activated fuel pump backup switch.

B-2 TAN/WHITE or RED Circuit #120 **FUEL PUMP SIGNAL**

Connected to the wire which runs from Terminal "A" (1st Design) or "E" (2nd Design) of the fuel pump relay and to the fuel pump power terminal and is also connected to the junction of similarly colored wires that connect to the MAF sensor power relay Terminal "C" (1st Design) or "D" (2nd Design), and the other side of the previously mentioned (Terminal B-1) oil pressure activated fuel pump backup switch. The ECM uses this circuit to monitor the status of the electric fuel pump. There should be +12V on this circuit whenever the engine is running or being cranked over by the starter motor and the ECM is receiving distributor reference pulses, OR whenever the oil pressure activated fuel pump backup switch is closed by engine oil pressure. In addition, the ECM provides +12V to Terminal A-1 for 2 seconds after the ignition key is turned "on" without waiting for distributor reference pulses, to enable the fuel pump to run and build up the required pressure for the engine to start (sort of a pre-start priming action). This 2-second interval is also monitored and controlled by this circuit, The monitoring of this circuit also allows a trouble code to be set (Code "54") and the check engine light to come on if the fuel pump relay is defective or if fuel pump voltage is otherwise lost when the engine is running.

B-3 BLACK/RED Circuit #453 **EST REFERENCE**

Connected to one of the four wires which run as a group to the 4-pin distributor plug. This circuit provides a reference ground between the ECM and the distributor ignition module to assure there is no voltage drop between these two components.

B-4 THIS TERMINAL IS NOT USED.

B-5 PURPLE/WHITE Circuit #430 **DISTRIBUTOR REFERENCE**

Connected to one of the four wires which run as a group to the 4-pin distributor plug. This circuit provides the ECM with rpm and crankshaft position input. Should this circuit become open or grounded, the engine will not run because the ECM will not pulse the injectors.

B-6 WHITE, PURPLE or DARK BLUE Circuit #963 **VATS** (Pass-Key)

Connected to Terminal "P" or "A-2" (depending on year and model) of the VATS decoder module. This circuit provides input from the VATS decoder module which the ECM requires before it will pulse the injectors on

vehicles that are factory equipped with a VATS system. If there is no wire in this terminal position, the harness being used is from a vehicle that was not equipped with a VATS system and the following information DOES NOT apply!! If there IS a wire in this terminal position, the harness being used was from a vehicle equipped with a VATS system and MUST have the MEM-CAL replaced with one from a system that did not utilize VATS, or you must add an aftermarket VATS-defeater unit to the system. This is explained in detail on page 3. Once the replacement MEM-CAL is substituted in the ECM, this circuit can be deleted. NOTE: If there IS a wire in this terminal, and a non-VATS MEM-CAL is not substituted, or if a VATS defeater is not added to the system, the engine WILL NOT START!!! If you are using any '89 system, which will be equipped with a VATS module you cannot install an '86-88 non-VATS MEM-CAL because the replacement would not be properly calibrated for the '89 system's cold-start specifications since the '89 system does not use a separate cold-start valve as do the '86-88 units. In this case it is necessary to use an aftermarket VATS defeater unit or a custom MEM-CAL that will provide the correct cold start calibration and also have the VATS system input requirement overridden. **NOTE: Without some sort of cold start enrichment the engine will be VERY hard to start!**

B-7 BLACK Circuit #485 **ESC SIGNAL**

Connected to Terminal "C" of the ESC module plug. This circuit provides input from the ESC module to the ECM which the ECM uses to control spark timing (knock retard) input to the ECM. The ESC module should be powered by a connection from the gages fuse (Fuse #3-Circuit #39) to ESC module Terminal "B". In the OEM hook-up, this +12V feed is normally routed through Circuit #439, the ECM fuse (Fuse #2 for our rewiring purposes). While doing the rewiring, we prefer to provide the power for the ESC through Circuit #39, the "gages" (Fuse #3) as this effectively isolates the ECM as the only component fused by the ECM fuse (Fuse #2). ESC module Terminal "D" should be connected to the ganged common ground wires from ECM Terminals A-12, D-1, D-3, D-6, and D-10 which, in turn, should be connected to a secure engine ground. ESC Terminal "E" should be routed directly to the engine block mounted "Knock-Sensor" unit.

B-8 GREEN or GREEN/YELLOW Circuit #59 **A/C SIGNAL**

Connected to the positive terminal of the AC compressor clutch wiring plug. Connected in this manner, this circuit will provide a +12V input to the ECM to inform it that the AC compressor clutch is engaged and the ECM will then proceed to adjust the idle speed, by controlling the ISC unit, to compensate for AC compressor clutch engagement.

DELETE if not using an air conditioning system.

B-9 THIS TERMINAL IS NOT USED.

B-10 ORANGE/BLACK Circuit #434 **PARK/NEUTRAL SIGNAL**

Connected to the park/neutral switch connector Terminal"B". When the transmission selector lever is placed in the "park" or "neutral" position, this switch completes the circuit from this terminal to ground. Should you elect not to install a park/neutral switch, this terminal must be connected to the ganged common ground wire circuit terminals that include A-12, D-1, D-3, D-6, and D-10. Grounded this way, it effectively informs the ECM that the transmission is in neutral and also eliminates trouble codes that would be set if the VSS and EGR circuits are deleted or not properly connected. The VSS and EGR circuits diagnostics are such that they will not set a trouble code if the transmission is in "park" or "neutral". Grounding Terminal B-10 effectively "fools" the ECM by telling it the transmission is always in neutral. Conversely, should you elect to use and wire the park/neutral switch, as designed, the lack of VSS and EGR inputs WILL light the "Check Engine/Service Engine Soon" Light whenever the ECM does not see the proper inputs, thus requiring both a functional VSS and EGR system.

B-11 THIS TERMINAL IS NOT USED.

B-12 DARK GREEN Circuit #998 **MAF INPUT**

This manual concerns itself ONLY with 1986 thru 1989 TPI systems which use a Mass Air Flow Sensor!
The advantage of using a system that incorporates a Mass Air Flow sensor, such as the '86 thru '89 units, is that the system is self-adjusting, within certain design limits, to different displacement engines or modified engines with a higher air flow capability such as would be required when improved cylinder heads or performance camshafts are utilized during the engine build-up. We have, in fact, installed these units on engines as large as 406 cu.in. and find that they work extremely well even with the larger displacement. 1990 and later Corvette, Camaro, and Firebird systems are now being installed without this Mass Air Flow Sensor. The **VERY** important difference in these systems is that by designing them to be used without a Mass Air Flow sensor, they are calibrated with what is referred to as a "Speed Density System" and it is necessary to use these systems on the specific displacement engines for which they were originally designed and calibrated, i.e. a 305" system on a 305" engine and the 350" system on a 350" engine! These "Speed Density" systems use a MAP (Manifold Absolute Pressure) sensor instead of a MAF (Mass Air Flow) sensor.

You may have noted that we did not include the 1985 TPI system. While the 1985 unit also uses a Mass Air Flow sensor, it is basically a one-year only system as far as the electronics are concerned in that it utilizes an ECM (Electronic Control Module) and burn-off circuitry that are not compatible with the later '86 thru '89 systems. In addition, the self-diagnostic capabilities of this first year unit are not as sophisticated as the later '86 thru '89 units. For these reasons we prefer not to use them. In terms of drivability and performance, there is no perceptible difference between the '85 systems and the later '86 thru '89 systems. The differences are more noticeable in terms of serviceability and factory or after-market parts availability. ONCE AGAIN, THIS MANUAL DEALS WITH THE '86 THRU '89 SYSTEMS ONLY! The desirable '86 thru '89 units can be identified by the ECM I.D. number which is 1227165 for all applications Corvette, Camaro, or Firebird 305" or 350". The 1985 system can be identified by the ECM I.D. number which is 1226870, for all 305" and 350" systems.

NOTE: While the #1226870 and #1227165 are not electronically interchangeable, they are physically interchangeable in that they both have the same type of harness connectors with the same number of terminals (one 24 pin connector, and one 32 pin connector). Since the I.D. on these ECM units consists of a stick-on tag, which can easily be removed, it is very important to be sure you are getting the correct unit. Both ECM units have a 1 3/4" x 5 1/2" access plate on one side. On the 1226870 ECM, the access plate is at the extreme opposite end of the unit from the harness connectors. On the 1227165 ECM, the access plate is offset a fraction of an inch from the center of the unit. When the access plate is removed from the 1227165 ECM, there is a very clearly-defined removable MEM-CAL visible, whereas on the 1226870 ECM unit, removing the access plate makes visible a number of separate microchips and substantial printed circuitry.

Although the ECM is the same for all these '86 thru '89 units, the system is fine tuned to the vehicle/engine/transmission combination in which it is installed by the use of a specific "PROM" (Programmable Read Only Memory) unit which is a part of a removable "MEM-CAL" insert which is plugged into the ECM. In most cases the "MEM-CAL", which is in the ECM that comes with the engine/harness assembly that you start with, will work adequately for normal driving. If the "MEM-CAL" is missing from your ECM, or if you're interested in optimizing the performance of your unit, we can recommend GM Part #16082183 for 305", or #16075399 for 350" and larger displacement engines. In addition, there are numerous aftermarket companies supplying upgraded "MEM-CAL" units for higher output or specialized performance applications.

All 1986 and later Corvettes, some 1988 and all 1989 and later Camaro/Firebirds, are equipped with a theft deterrent system called the Vehicle Anti-Theft System or VATS (later known as the "Pass-Key" system). When equipped with this system, the vehicle's ignition key contains a small resistor pellet, the resistance of which must match the special VATS decoder installed in the vehicle. If the decoder does not see the proper resistance, it will not send the correct signal to the ECM and, accordingly, the ECM will not enable the injectors to pulse "ON" to inject fuel into the engine, thus not allowing the engine to start. If you are not sure what year or model vehicle the TPI system and harness you are using is from, check for a wire (various color codes are used depending on year and model) in terminal B-6 of the 24 terminal ECM connector. If there is no wire installed in this location, the vehicle from which the harness was removed was not equipped with a VATS system and can be used as is. If the harness has a wire installed in terminal B-6, the vehicle was equipped with a VATS system and the MEM-CAL in the ECM must be replaced with one from a vehicle which was not equipped with a VATS system

Connected to MAF sensor connector Terminal "C". The ECM provides +5V on this circuit to the MAF sensor, and monitors the changes in voltage caused by the MAF sensor's adjustments to maintain a constant 212°F temperature of the "Hot-Wire".

C-1 DARK GREEN/WHITE Circuit #335 **FAN RELAY CONTROL**

Connected to Terminal "B" (Ist Design) or "F" (2nd Design) of the fan control relay. This circuit allows the ECM to control the operation of the engine cooling fan relay by grounding this terminal, thus providing ECM control of the electric cooling fan operation. We suggest hooking up this circuit when an electric fan is used, even if another method of controlling the fan relay is used (i.e. manual switch, engine mounted temperature switch, etc.) to provide a back-up circuit to insure fan operation in the remote chance that one of the other control circuits may malfunction. NOTE: If you are using an electric engine cooling fan in your installation, it should also be wired to run whenever the AC compressor clutch is engaged, this can be most easily accomplished by adding a second fan control relay to the system. This second relay should be activated by the same circuit (Terminal "B-8"-Circuit #59) which provides the ECM with the AC "on" signal. NOTE: A second relay is required for this application because the stock fan relay is activated by supplying a ground, whereas the AC "on" signal is a +12V input thus requiring the use of a second relay, to allow either circuit to independently control the fan operation.

DELETE if not using an electric fan.

C-2 BLACK/PINK Circuit #429 (DIVERT SOLENOID) **AIR SWITCH**

Connected to the Divert Solenoid Connector (BLACK) of the AIR valve. This circuit allows the ECM to activate the Divert Solenoid portion of the AIR valve assembly by supplying a ground through this terminal. The +12V feed to this connector is supplied via the "gauges" fuse (Fuse #3- circuit #39). As indicated earlier, while the ECM controls this circuit, it does not monitor it, so the AIR system and this circuit can be eliminated with no negative effects on ECM operation or diagnostics.

DELETE if removing AIR valve and pump assembly.

C-3 LIGHT GREEN/BLACK	Circuit	#444	**IAC**	"B"	LO
C-4 LIGHT GREEN/WHITE	Circuit	#443	**IAC**	"B"	HI
C-5 LIGHT BLUE/WHITE	Circuit	#441	**IAC**	"A"	HI
C-6 LIGHT BLUE/BLACK	Circuit	#442	**IAC**	"A"	LO

These four wires run directly, as a group, to the 4-pin IAC unit connector mounted on the injector throttle body assembly and allow the ECM to control engine idle speed by moving the IAC valve to control air flow around the throttle plates. It does this by sending voltage "pulses" referred to as "counts" to the proper motor winding to either activate the "in" or "out" operation of the valve. **DO NOT**, under **ANY** circumstances apply +12V battery voltage across the IAC terminals! Doing so will permanently damage the motor windings!

C-7 BLACK/BLUE Circuit #925 **A/T O-D SWITCH SIGNAL**
Circuit #905 **M/T O-D REQUEST**

This circuit is sometimes used, in Corvette installations, to provide an override of the TCC function if the shift selector is in a position other than overdrive. If there is a wire in this terminal position, and you are using the ECM and a VSS to control the TCC function, grounding this terminal to the common ganged ground circuit (A-12, D-1, D-3, D-6, D-10), will not allow the TCC function to operate below 40 mph. In systems originally used in Corvettes with manual 4-speed plus electronically controlled overdrive transmissions, this circuit receives input from a control button on the shift lever or console which connects to this same terminal, to activate and deactivate the overdrive function of the manual transmission.

DELETE If you are not using the ECM to control the TCC function or if you are using a transmission which does not incorporate a TCC.

C8 DARK GREEN or LIGHT BLUE Circuit #446 **A/T 0-D 4TH GEAR**

BLACK/BLUE or LIGHT BLUE Circuit #902 **M/T 0-D REQUEST (4-SPD Man w/OD)**

Connected to the TH-700-R4 transmission 4-pin connector (Terminal "B") in some applications, and provides input to the ECM to signal 4th gear (OD) engagement. In some Corvette manual 4-speed plus overdrive applications, this circuit is connected to a switch which prohibits overdrive engagement when the transmission is in 1st (low) gear.

NOTE: The circuits controlled by ECM Terminals C-7 and C-8 are sometimes not used at all in some years and models and on other years and models, the manual transmission functions may be in different combinations than those indicated here (i.e. in some year/model combinations C-8 is used as an M/T O.D. request instead of C-7 etc.). Since the vast majority of non-OEM usage will be with an automatic transmission, this will not normally create a problem. This information is provided in an attempt to be as comprehensive as possible, and does again point out that it is a good idea to have a GM shop manual available for the specific year/model vehicle from which you have obtained the harness assembly.

C-9 THIS TERMINAL IS NOT USED.

C-10 YELLOW Circuit #410 **COOLANT TEMPERATURE SIGNAL**

Connected to the coolant temperature sensor. This circuit provides coolant temperature input to ECM.

C-11 THIS TERMINAL IS NOT USED.

C-12 TAN Circuit #472 **MAT SIGNAL**

Connected to the MAT sensor. This circuit provides inlet air temperature input to the ECM.

C-13 DARK BLUE Circuit #417 **TPS SIGNAL**

Connected to the 3-pin TPS connector (Terminal "B"). This circuit provides TPS input voltage to the ECM, allowing the ECM to determine the amount of throttle opening, since the input voltage signal changes relative to throttle opening.

C-14 GRAY Circuit #416 **TPS +5V REFERENCE**

Connected to the 3-pin TPS connector (Terminal "C"). This circuit provides the +5V reference signal to the TPS.

C-15 DARK GREEN Circuit #935 **EGR DIAGNOSTIC SWITCH**

Connected to the EGR diagnostic switch on the EGR valve assembly. This circuit allows the ECM to monitor EGR operation. The EGR diagnostic switch which threads into the EGR valve base is normally open when cold, and closes with heat, provided by the exhaust gas when the EGR is operating. The ECM monitors the operation of this switch and will set a trouble code (32) and light the Check Engine/Service Engine Soon light if it sees input outside its preprogrammed parameters. If you are removing the EGR system, this circuit can be deleted if the park/neutral switch connector (B-10) is connected to the ganged common ground wire circuit connected to ECM terminals A-12, D-1, D-3, D-6, and D-10. Also see ECM Terminal A-4 listing for more information.

DELETE if not using the EGR valve.

C-16 ORANGE Circuit #340 **+12V BATTERY FEED**

This terminal should be connected through a 20 amp fuse which, for our rewiring purposes, we shall refer to as the Battery Fuse (Fuse #1), directly to a constant NON-SWITCHED +12V source (i.e. battery). The wire from this terminal can be ganged with the similarly colored wire from ECM Terminal B-1 as is indicated by the same

Circuit #340. Also connected to this same +12V source should be fuel pump relay Terminal "E" (Ist Design) or "A" (2nd Design), MAF sensor power relay Terminal "E" (Ist Design) or "A" (2nd Design), MAF sensor burn-off relay terminals "C" and "E" (Ist Design) or "D" and "A" (2nd Design), and one side of the oil pressure activated fuel pump back up switch.

D-1 BLACK/WHITE Circuit #450 **SYSTEM GROUND**

Connected to the ganged common ground wire circuit along with ECM Terminals A-12, D-3, D-6, and D-10 which are, in turn, connected to a secure engine ground.

D-2 BLACK Circuit #452 **TPS, CTS, MAT**
+5v RETURN

Connected to the 3-pin TPS connector (Terminal "A"). This circuit is the common +5V return line for the TPS, MAT, and CTS, which is also connected to the MAT, and coolant temperature sensor (CTS) connectors.

D-3 BLACK/WHITE Circuit #450 **SYSTEM GROUND**

Connected to the ganged common ground wire circuit along with ECM terminals A-12, D-1, D-6, and D-10, which are, in turn, connected to a secure engine ground.

D-4 WHITE Circuit #423 **EST CONTROL**

Connected to one of the four wires that run as a group to the 4-pin distributor plug. This circuit allows the ECM to trigger the HEI distributor ignition module. This is the circuit that the ECM uses to actually control timing by advancing or retarding the spark relative to the reference signal it gets from circuit #430, preprogrammed timing data stored in the MEM-CAL, and input from the ESC Circuit #485.

D-5 TAN/BLACK Circuit#424 **BYPASS**
Connected to one of the four wires that run as a group to the 4-pin distributor plug. At about 400 rpm, this circuit applies +5V to the HEI ignition module which switches timing control from the HEI ignition modules internal calibration to the ECM. This circuit includes a separate harness connector, referred to as the "Set-Timing" connector. When disconnected, the "Set-Timing" connector provides a method of setting the base ignition timing on the engine, by eliminating ECM control of the spark timing. When the ignition timing has been set and the "Set-Timing" connector is reconnected, you will find the "Check Engine/Service Engine Soon" Light will be illuminated and a code ("42") set in the ECM memory. This is normal and indicates the ECM's self diagnostic capabilities are functioning properly. For more information on Trouble Codes and instructions on the proper procedure to use to remove Code "42" or other Trouble Codes from the ECM's memory, see the section on Trouble Codes, on page 33.

D-6 TAN Circuit #413 **OXYGEN SENSOR GROUND**

Connected to the ganged common ground wire circuit along with ECM Terminals A-12, D-1, D-3, and D-10, which are, in turn, connected to a secure engine ground. This circuit provides the ground for the Oxygen Sensor.

D-7 PURPLE Circuit #412 **OXYGEN SENSOR SIGNAL**

Connected to the Oxygen Sensor. The ECM uses this circuit to supply a voltage of approximately .45 volts between this terminal and its appropriate ground connector (D-6). The Oxygen Sensor varies the voltage within a range of about 1.0 volts if the exhaust is rich, down through about .10 volt if the exhaust is lean. The Oxygen Sensor acts like an open circuit and produces no voltage when it is below 600°F. Accordingly, a cold sensor or a break in this circuit causes the system to remain in "open loop" operation.

D-8 THIS TERMINAL IS NOT USED.

D-9 THIS TERMINAL IS NOT USED.

D-10 BLACK/WHITE Circuit #450 **SYSTEM GROUND**

Connected to the ganged common ground wire circuit along with ECM terminals A-12, D-1, D-3, and D-6, which are, in turn, connected to a secure engine ground.

D-11 DARK BLUE Circuit #732 or **A/C PRESSURE**
DARK GREEN Circuit #992 or **FAN SWITCH**
GRAY Circuit #731
(Color code and circuit # vary with different vehicles.)

Connected to the air conditioning pressure fan request switch. This circuit is part of the electric cooling fan control system. In the factory hook-up there is a normally closed pressure sensitive switch installed in the high pressure side (the line between the AC compressor and the condenser) of the air conditioning system. When this switch sees pressure exceeding 233 psi, it opens the contacts to inform the ECM of the high pressure condition. The ECM, in turn, grounds Circuit #335 (ECM Terminal C-1) to activate the fan relay which powers the engine cooling fan. When high side pressure drops below 185 psi, the switch again closes and the ECM, in turn, removes the ground from Circuit #335 to make the fan inoperative. It is not necessary to incorporate this circuit when rewiring for a non-OEM application. Simply connect this terminal to the common ganged ground circuit (A-12, D-1, D-3, D-6, and D-10) as the factory does when the vehicle is not equipped with air conditioning. This allows the ECM to control the fan circuit from engine coolant temperature alone. NOTE: If you are using an electric engine cooling fan in your installation, it should also be wired to run, whenever the AC compressor clutch is engaged. This can be most easily accomplished by adding a second fan control relay to the system that is activated by the same circuit (B-8) which provides the ECM with the AC "on" signal. NOTE: A second relay is required for this application because the stock fan relay is activated by supplying a ground, whereas the AC "on" signal is a +12V input thus requiring the use of a second relay, to allow either circuit to independently control the fan operation.

D-12 BLACK Circuit #900 **MAF BURN-OFF RELAY CONTROL**

Connected to the MAF Sensor Burn-off Relay Terminal "B" (1st Design) or "F" (2nd Design). The MAF Sensor uses a "hot-wire" to determine air flow by measuring the current required to maintain this thin wire at a constant temperature as intake air flow passes over it. Due to contaminants which are always present in the atmosphere, a residue may build up on this sensing wire. To remove this residue, a burn-off cycle is incorporated whenever the ignition is turned off after the engine has been running for a specified period of time. The ECM then grounds this terminal to activate the burn-off relay, to provide adequate voltage to the "Hot-Wire" to heat it to approximately 1,000°F and, effectively, remove any contamination.

D-13 THIS TERMINAL IS NOT USED.

D-14 THIS TERMINAL IS NOT USED.

D-15 LIGHT BLUE or BLACK/PINK Circuit #467 **INJ 1-3-5-7**

Connected to Fuel Injectors 1, 3, 5, and 7.

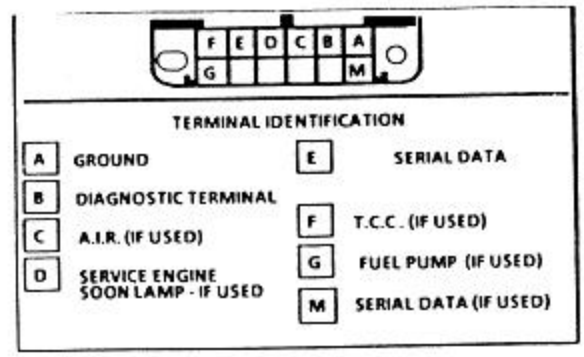
D-16 LIGHT GREEN or BLACK/GREEN Circuit #468 **INJ 2-4-6-8**

Connected to Fuel Injectors 2, 4, 6, AND 8.

Circuits #467 and #468 allow the ECM to "pulse" the fuel injector solenoids at the correct time and, for the proper duration, by grounding these terminals. By dividing the injectors and attendant wiring into two groups, the possibility of one defective injector or circuit shutting down the entire system, is avoided. Power for these two sets of injectors is provided through two separately fused circuits: Circuit #639, protected by fuse INJ-1 (Fuse #4) for the 1, 3, 5, and 7 injectors, and Circuit #839, protected by fuse INJ-2 (Fuse #5) for the 2, 4, 6, and 8 injectors, both circuits using PINK/BLACK or BLACK wire and both circuits being fused with 10 amp fuses.

ALDL CONNECTOR INFORMATION

ALDL PIN CONNECTIONS



The following is a listing of the ALDL connector terminal locations and the circuits to which they are connected.

TERMINAL "A" **GROUND CIRCUIT** #450.
Connected to common ground circuit from ECM Terminals A-12, D-1 D-3, D-6, and D-10 which are, in turn, connected to a secure engine ground.

TERMINAL "B" **DIAGNOSTIC ENABLE CIRCUIT** #451.
Connected to ECM Terminal A-9.

TERMINAL "C" **AIR SOLENOID CIRCUIT** #436.
Connected to ECM Terminal A-2 if utilizing the AIR system.

TERMINAL "D" **NOT USED**

TERMINAL "E" **SERIAL DATA CIRCUIT** #461.
Connected to ECM Terminal A-8.

TERMINAL "F" **TCC CIRCUIT** #422.
Connected to ECM Terminal A-7 if utilizing an ECM controlled TCC system

TERMINAL "G" **FUEL PUMP TEST CIRCUIT** #490.
Connected to fuel pump relay Terminal "D"(lst Design) or Terminal "E" (2nd Design)

TERMINAL "M" **SERIAL DATA CIRCUIT** #461
Also connected to ECM Terminal A-8, in some applications.

NOTE: Because of the use of different intermediate plugs and harnesses between the ECM and the ALDL connector on different make and year vehicles, the color codes on the wires attached to the ALDL terminals will not always match the codes on the appropriate wires from the ECM. What is important here, once again, is not the color codes, but the connection of the proper circuits to the proper terminals!!!

FUSES

We suggest the installation of at least 6 new fuses in the wiring process. They are as follows:

FUSE #1 **BATTERY FUSE** 20A Connected in line between the battery (+) terminal and ECM Terminals B-1 and C-16

FUSE #2 **ECM FUSE** 10A Connected to ECM Terminal A-6

FUSE #3 **GAUGE FUSE** 10A Connected, as necessary, to all other Circuit #39 powered components that require a +12V feed source, i.e. Check Engine/ Service Engine Soon Light Circuit, TCC Solenoid Circuit, CCP Solenoid Cir cuit, AIR Solenoid Circuit, EGR Solenoid Circuit, ESC Module Circuit, etc.

FUSE #4 **INJ-1 FUSE** I0A Connected to Circuit #639 to power injectors 1, 3, 5, and 7.

FUSE #5 **INJ-2 FUSE** I0A Connected to Circuit #839 to power injectors 2, 4, 6, and 8.

FUSE #6 **FUEL PUMP FUSE** 15A Connected in-line in the fuel pump volt feed wire (Circuit #120) which runs from the fuel pump relay Terminal "A" (Ist Design) or "E" (2nd Design) to the fuel pump (+) terminal.

Fuses #2 thru #5 should be fed from a switched +12V source that has power when the ignition switch is in the "run" and "start" positions. See ECM Terminal A-6 for more information.

In addition, depending on the circuits you are using, you may want to add the following fuses.

FUSE #7 **FAN RELAY** 5A Connected to fan relay Terminal "C" (Ist Design) or "D" (2nd Design) (Circuit #250). This fuse can also be fed from the same power source as Fuses #2 thru #5.

FUSE #8 **COLD START** 3A Connected in-line in cold start Circuit #806 (not required with '89 systems).

FUSE #9 **FAN POWER** 30A Connected in-line between the fan motor and fan relay terminal "A" (Ist Design) or "D" (2nd Desi gn) (Circuit #936)

GROUND CONNECTIONS

The following is a list of ECM terminals and other components that are connected to common engine ground:

ECM Terminals A-12
D-1
D-3
D-6
D-10

ALDL Terminal "A", MAF Sensor Terminal "A", ESC Module Terminal "D"
Fuel Pump Relay Terminal "A" (Ist Design) or "F" (2nd Design)
MAF Sensor Power Relay Terminal "B" (Ist design) or "F" (2nd design)

ADDITIONAL CONNECTIONS

The following connections do not fall under the heading of either ECM Connections, ALDL connections, Fuse connections, or Ground connections. If you are working with an existing factory harness, you should find these connections are already in place and this information can be used to doublecheck the connections.

Circuit #993 - **RED or PURPLE**
MAF sensor Terminal E is connected to MAF Sensor Power Relay Terminal "A" (Ist Design) or "E" (2nd Design)

Circuit #994 - **DARK BLUE**
MAF Sensor Terminal "D" is connected to MAF Sensor Power Relay Terminal "D" (Ist Design) or "C" (2nd Design) and MAF Sensor Burn-Off Relay Terminal "A" (Ist Design) or "E" (2nd Design)

GLOSSARY

AC	Air Conditioning
AIR	Air Injection Reaction System
ALCL	Assembly Line Connecting Link
ALDL	Assembly Line Diagnostic Link
AT	Automatic Transmission
CCP	Controlled Canister Purge
CTS	Coolant Temperature Sensor
ECM	Electronic Control Module
EGR	Exhaust Gas Recirculation
ESC	Electronic Spark Control
EST	Electronic Spark Timing
HEI	High Energy Ignition
IAC	Idle Air Control
MAF	Mass Air Flow
MAP	Manifold Absolute Pressure
MAT	Manifold Air Temperature
MEM-CAL	Memory Calibrator
MPG	Miles Per Gallon
MPH	Miles Per Hour
OEM	Original Equipment Manufacturer
P/N	Park-Neutral
PROM	Programmable Read-Only Memory
RPM	Revolutions Per Minute
TCC	Torque or Transmission Converter Clutch
TPI	Tuned-Port Injection
TPS	Throttle Position Sensor
V	Volt
VATS	Vehicle Anti-Theft System
VSS	Vehicle Speed Sensor

OPEN-LOOP - When the engine is first started, the system goes into "open-loop" operation. In "open-loop", the ECM calculates the Air/Fuel ratio based on inputs from the coolant and MAF sensors. The system remains in "open-loop" until the following three conditions are met:

1. Coolant temperature above 105°F.
2. Oxygen sensor has varying output voltage (indicating it is hot enough to operate properly).
3. A specific amount of time (preprogrammed into the MEM-CAL) has elapsed.

CLOSED-LOOP - When all of the above conditions are met, the system goes into "closed-loop" operation. In this mode, the ECM calculates the Air/Fuel ratio based mainly on input from the oxygen sensor and maintains the Air/Fuel ratio at the desired 14.7 to 1.

LIMP-MODE or FUEL BACK-UP MODE - In this mode, the system operates on a fuel back-up logic programmed into the CAL-PAK portion of the MEM-CAL to control the engine if the ECM or other specific sensors fail. As indicated by the "limp-mode" designation, engine performance is substantially less than it should be.

TROUBLE CODES

The following is a list of trouble codes that can be set by the ECM to indicate problems with either the sensor or the wiring of specific circuits. Grounding Terminal "B" of the ALDL connector by "jumpering" it to Terminal "A", with the ignition key turned to the "on" position engine NOT running causes the ECM to enter the "Diagnostic Mode". In the diagnostic mode, the ECM will display a code "12" by flashing the "Check Engine/Service Engine Soon" Light (Code "12" indicates the system is operational). A code "12" consists of one flash followed by a short pause, then two flashes in quick succession. This code will be flashed three times. If there are other trouble codes present, they will flash in a similar manner. If no other trouble codes are stored, Code "12" will continue to flash until the ground is removed from the Diagnostic Terminal. Trouble codes can only be obtained with the engine stopped. Grounding the Diagnostic Terminal with the engine running puts the ECM into the "Field Service Mode". In the "Field Service Mode", the "Check Engine/Service Engine Soon" Light will show whether the system is in open or closed-loop. In open-loop, the "Check Engine/Service Engine Soon" Light flashes 2 1/2 times per second, in closed-loop it flashes once per second. The other diagnostic modes are most easily accessed by the connection of a SCAN tool to the ALDL connector and by then placing the SCAN tool in the appropriate diagnostic mode, as directed by the instruction manual for the specific SCAN tool being used. For more information on SCAN Tools, see the section on the ALDL connector on Page 6. To remove any stored trouble codes and extinguish the "Check Engine/Service Engine Soon" Light, it is merely necessary to remove the 20A Battery Fuse (Fuse #1), for a period of 30 seconds. After the fuse is replaced, the light will go out and any trouble codes will have been removed from the ECM's memory. ALWAYS BE SURE that the ignition key is turned "off" whenever you remove any fuse in this system!

TROUBLE CODE 12
Code 12 indicates the ECM is "on" and sees no reference pulses from the distributor. This is a normal code with the ignition "on" and the engine not running, and is used for verification of ECM operation during the "Diagnostic Circuit Check". Code 12 is not stored in the ECM's memory and will only flash when ALDL Terminal "B" is "jumpered" to ground (ALDL Terminal "A") with the ignition "on" and the engine not running.

TROUBLE CODE 13 ***OXYGEN SENSOR - OPEN CIRCUIT***
Code 13 indicates an "open" in the oxygen sensor circuit (Circuit #412) or a possible defective oxygen sensor unit.

TROUBLE CODE 14 ***COOLANT TEMPERATURE - HIGH TEMP. INDICATE***
Code 14 indicates a defective coolant temperature sensor or a short to ground in Circuit #410.

TROUBLE CODE 15 ***COOLANT TEMPERATURE - LOW TEMP. INDICATED***
Code 15 indicates a defective coolant temperature sensor or an "open" in Circuit #410. If a Code 21 or 23 is set along with Code 15, Circuit #452 should also be checked for an "open" condition.

TROUBLE CODE 21 ***TPS SENSOR - VOLTAGE HIGH***
Code 21 indicates a problem with the TPS sensor or an "open" in Circuit #452.

TROUBLE CODE 22 ***TPS SENSOR - VOLTAGE LOW***
Code 22 indicates a defective or misadjusted TPS sensor or a short to ground or "open" in Circuits #416 and #417.

TROUBLE CODE 23 ***MAT SENSOR - LOW TEMP. INDICATED***
Code 23 indicates a defective MAT sensor or an "open" in Circuits #452 or #472.

TROUBLE CODE 24 **VSS**

Code 24 indicates a defect in the VSS or an "open" or short to ground in Circuit #437. If ECM Terminal B-10 is connected to the ganged common ground circuit (A-12, D-1, D-3, D-6, and D-10), Code 24 will not set even though there is a nonfunctional or defective VSS circuit; conversely if Terminal B-10 is NOT connected to ground and there is no functional VSS system the ECM will set a Code 24 when the vehicle is driven!

TROUBLE CODE 25 ***MAT SENSOR - HIGH TEMP. INDICATED***

Code 25 indicates a defective MAT sensor or a short to ground in Circuit #472.

TROUBLE CODE 32 ***EGR***

Code 32 indicates a malfunctioning EGR valve, a malfunctioning EGR temperature diagnostic switch, or an "open" or short to ground In Circuit #935 or #999 (depending on year and model). If the EGR system is not used, ECM Terminal B-10 should be connected to the ganged common ground circuit (A-12, D-1, D-3, D-6, and D-10). If Terminal B-10 is connected in this manner, Code 32 will not set even if the EGR is missing or nonfunctional; conversely if Terminal B-10 is NOT connected to ground and the EGR system is removed the ECM will set a Code 32 when the vehicle is driven!

TROUBLE CODE 33 ***MAF - HIGH AIR FLOW***

Code 33 indicates a defective MAF sensor or a problem in the MAF circuitry.

TROUBLE CODE 34 ***MAF - LOW AIR FLOW***

Code 34 indicates a defective MAF sensor or a problem in the MAF circuitry.

TROUBLE CODE 36 ***MAF - BURN-OFF***

Code 36 indicates a problem in the MAF burn-off circuitry.

TROUBLE CODE 41 ***CYLINDER SELECT ERROR***

Code 41 indicates a faulty or incorrect MEM-CAL or an "open" in Circuit #450 at ECM Terminal D-3. ECM #1227165 is used in different engine/vehicle applications other than the '86-89 TPI V-8 usage. When used in these other systems MEM-CAL units with different calibrations are used and ECM Terminal D-3 Is not connected to ground.

TROUBLE CODE 42 ***EST***

Code 42 indicates a faulty ignition module or an "open" or short to ground in Circuit #424, or a short in Circuit #423. A Code 42 should always be present after the "set timing" connector has been disconnected to set engine base timing. As previously mentioned, removing Fuse #1 for 30 seconds will clear the code from the ECM's memory.

TROUBLE CODE 43 ***ESC***

Code 43 indicates a faulty ESC module, a faulty knock sensor, or a problem in the related wiring circuits.

TROUBLE CODE 44 ***OXYGEN SENSOR LEAN MIXTURE INDICATION***

Code 44 indicates a defective oxygen sensor unit, Circuit #412 shorted to ground, or the existence of some other condition (i.e. low fuel pressure, fuel contamination, etc.) which would cause a lean mixture condition.

TROUBLE CODE 45 ***OXYGEN SENSOR RICH MIXTURE INDICATION***

Code 45 indicates a defective oxygen sensor unit or some other condition (i.e. **high fuel pressure, leaking injector, fouled spark plug, etc.**) which would cause a rich mixture condition.

TROUBLE CODE 46 ***VATS***

Code 46 indicates a problem with the VATS module or circuitry. If the engine will not start and a Code 46 is present, the MEM-CAL must be changed to one from a vehicle which was not originally equipped with a VATS (86-88 Camaro-Firebird). For more information on VATS, see ECM Terminal Listing B-6 and also page 3.

TROUBLE CODE 51 *MEM-CAL ERROR*
Code 51 indicates an incorrect or improperly installed MEM-CAL.

TROUBLE CODE 52 *CAL-PAK ERROR*
Code 52 indicates a faulty or incorrect CAL-PAK.

TROUBLE CODE 53 *SYSTEM OVER VOLTAGE*
Code 53 indicates system voltage in excess of 17.1V for more than 2 seconds.

TROUBLE CODE 54 *FUEL PUMP CIRCUIT - LOW VOLTAGE*
Code 54 indicates a defective fuel pump relay, low voltage (below 2V) on Circuit #120, or the loss of voltage (for more than 1.5 seconds) to the fuel pump while the engine is running.

NOTE: In addition to the above indicated individual possible problem areas, all trouble codes except #51, 52, and 53 could also have a defective ECM listed as one of the possible reasons for the trouble code being displayed. This is another place to indicate to you that you should consider having on hand the proper year and model GM service manual. The trouble code information above is provided as a basic reference. The individual service manuals provide extensive, detailed diagnostic procedures for further trouble-shooting the problem areas indicated by the above codes.

ENGINE HARNESS ROUTING

By ganging the appropriate +12V feed and common ground wires, and mounting the ECM, ALDL connector, ESC module, and the Fuel Pump, MAF Power and Burn-Off relays in a group, along with the required extra fuses beneath the passenger seat, under the dash, or in any similar, concealed, yet accessible location it is possible to reduce by nearly 50% the number of wires which must be routed through the firewall to the engine compartment. The following information is provided to indicate which wires need to be routed through the firewall when the previously mentioned components are mounted, as a group, somewhere inside the passenger compartment. In addition to simplifying the wiring process, relocating these components to the interior of the vehicle, effectively reduces the under-hood clutter, and removes these electrical items from the extremes of weather and temperature they would be exposed to in the under-hood environment.

There are two groups of wires which can be ganged and routed as one wire for rewiring purposes. The +12V feed wires to ECM Terminals B-1 and C-16 can be routed as one wire from Fuse #1. The wires from Terminals A-12, D-1, D-3, D-6 and D-10, can be routed as one wire to a secure engine ground, (We highly recommend attaching this common ground wire directly to the engine block or cylinder head to eliminate any possibility of a voltage drop in the ground connection.)

The wires which must be run through the firewall are listed below by ECM terminal location, color code, circuit number, and application with any additional information that may be necessary. As previously mentioned, there may be some variation in the color codes involved in some of the circuits depending on model and year.

C-14	Gray	416	+5 volt reference signal
C-13	Dark Blue	417	TPS signal **TPS Conn.**
D-2	Black	452	+5 volt ground return Connector
C-10	Yellow	410	Coolant temperature signal
C-12	Tan	472	MAT sensor signal

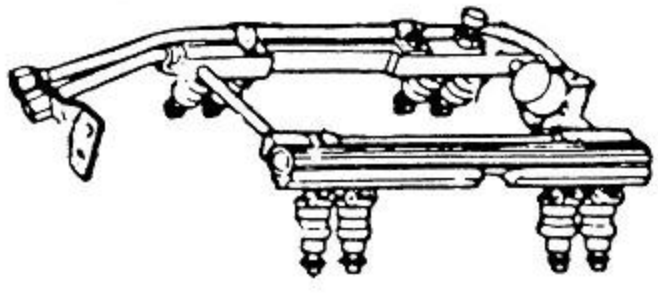
such as the previously mentioned GM Part #16075399, OR an aftermarket VATS defeater module MUST be added to the system. As this is being written, the cost of a new NON-VATS "MEM-CAL" from a GM dealer is approximately half the cost of a VATS defeater module. Taking this into consideration, plus the fact that the Camaro/Firebird wiring harness is longer in the area between the ECM and the engine sensors than the Corvette harness, we prefer to use 1986 and up Camaro/Firebird harnesses from vehicles that were not equipped with a VATS system. As previously mentioned, there are ways to neutralize the VATS system but we have found it much simpler to merely select the correct TPI/ECM/harness assembly initially. Actually, any factory TPI harness can be modified to work correctly, but since, as just mentioned, the Corvette harness is substantially shorter than the Camaro/Firebird harness, in some installations all of the wires to the ECM may have to be lengthened to allow the mounting of the ECM in a convenient location inside the passenger compartment or trunk of the vehicle. We have found the area underneath the passenger seat to be the preferred location, for many applications.

While we're talking about reworking wiring harnesses, the following recommendation **CANNOT BE OVER STRESSED**. Any harness modifications **MUST BE SOLDERED**, and we highly recommend the use of **heat-shrink type tubing** in conjunction with the soldered joint, to avoid the possibility of corrosion! Because of the low voltages used, poor connections or corrosion of any kind will wreak havoc with this system as is detailed later in the Oxygen Sensor Information section.

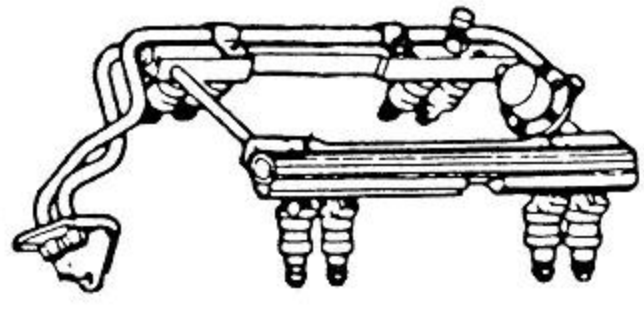
While we prefer to use factory-type wiring harnesses and modify them as necessary to work in the Jaguar and other non-OEM applications, we should mention that there are also a number of aftermarket wiring harness assemblies that are available to simplify the installation of TPI units into cars other than those in which the TPI systems were factory installed. One of the major reasons we prefer to use the stock harness is that it can usually be obtained along with the fuel injection system/engine assembly at the time of purchase making it "free" whereas the aftermarket harness assemblies, run in the $500.00-$600.00 price range.

If you are interested in using an aftermarket type of harness, we would suggest that you do some research into the different types available. One definite recommendation we can make, however, is to make absolutely sure that the harness you use has what is referred to as "closed loop" capability, and does not operate the injection system in either the "open loop" or "limp mode". Notwithstanding the claims of the manufacturers of these harnesses, operating in either of these modes may drastically affect the efficiency and fuel mileage of the system! For a TPI, or any other similar electronically-controlled system, to function in the "closed loop" mode, there MUST be an oxygen sensor in the system.

INJECTOR ASSEMBLIES



CORVETTE INJECTOR ASSEMBLY



CAMARO/FIREBIRD INJECTOR ASSEMBLY

Corvette and Camaro/Firebird TPI systems also differ in that the fuel line connections exit on different sides of the engine. The Corvette system's lines exit near the front of the right cylinder head and face forward, whereas the Camaro/Firebird system's connections exit toward the front of the left cylinder head and face toward the left side of the engine. The Corvette's fuel line position is compatible with accessory mounting combinations which

D-4		White	423	EST	
B-5		Purple/White	430	Reference	To 4-wire HEI
D-5		Tan/Black	424	By-pass	distributor plug
B-3		Black/Red	453	Ref low	

C-3	Light Green/Black	444	IAC coil "B" Lo	
C-4	Light Green/White	443	IAC coil "B" Hi	To IAC
C-5	Light Blue/White	441	IAC coil "A" Hi	connector
C-6	Light Blue/Black	442	IAC coil "A" Lo	

D-15	Light Blue or Black/Pink	467	1-3-5-7 injector drive
D-16	Light Green or Black/Green	468	2-4-6-8 injector drive
	Pink/Black (+12V from Fuse #4)	639	1-3-5-7 injector power
	Pink/Black (+12V from Fuse #5)	839	2-4-6-8 injector power
D-7	Purple	412	Oxygen sensor signal
A-11	Black or Black/Pink	452	Analog ground

5 WIRE HARNESS for MAF SENSOR

B-12	Dark Green	998	MAF signal input
D-12	Black	900	Burn-off control to
	Red or Purple	993	Runs from terminal "A" (1st design) or "E" (2nd design) of MAF power relay to term sensor"E" of MAF sensor
	Dark Blue	994	Runs from terminal "A" (1st design) or "E" (2nd design) of MAF Burn-off relay and term. "D" (1st design) or "C" (2nd design)of MAF Power relay to term. "D" of MAF sensor.
B-1	Orange	340	+12V feed from
C-16	Orange	340	battery via Fuse #1

A-12	Black/White	450	
D-1	Black/White	450	
D-3	Black/White	450	Common ground
D-6	Tan	413	
D-10	Black/White	450	

B-8	Green or Green/Yellow	59	A.C. signal-should be spliced into A.C. Comp. +12V feed wire

C-1	Dark Green/White		Must be included if cooling fan relay control is desired.
	Tan/White	120	To oil pressure activated fuel pump back-up switch
	Blue or White	496	Knock Sensor Wire
	Purple	806	Cold start circuit (a fused feed wire from the starter solenoid circuit)

The following wires should be added to the harness going forward to the engine compartment as necessary if any of these systems are being utilized.

Dark Green	935	EGR Diagnostic
Green/Yellow	428	CCP
Black/Pink	429	AIR Divert Solenoid
Gray	435	EGR control
Brown	439	AIR Port Solenoid
Pink/Black	39	+12V feed to components controlled by circuits #428, 429, 439, 435 as necessary.

PART NUMBERS

The following part numbers are specifically applicable to '86-89 TPI systems with a MAF sensor. If the harness you are working with has relays, etc. attached, they can be used as is. If you are missing any components we suggest you try to obtain the specific pieces from a dealer, after informing him of the specific year, and model of the harness you are working with. If you are not sure of the year or model, the following is a list of GM part numbers that work with the applicable notes. When specific years and models are indicated, this is per GM parts manuals. If we are aware of interchangeability, it is so noted after each item:

NOTE: "Y" indicates Corvette usage, "F" indicates Camaro/Firebird usage.

General Motors Part Numbers

Coolant Temperature Sensor		25036979
Manifold Air Temperature Sensor		25036979
Cold Start Thermo Time Switch (not used in '89 systems)	(86-88)	14084318
Throttle Position Sensor		17111606
Idle Air Control	(86-88)	17111288
	(89)	17112193
Mass Air Flow Sensor	(86-87)	14094712
	(88-89)	10055877
Knock Sensor	(86)	1997562
	(87-89)	1997699
Oxygen Sensor	(86-87)	25105107 or
	(88-89)	25105901
ESC Module		16022621
		16052391

Oil Pressure Activated Fuel Pump Back-Up Switch	(86"F"-86-87"Y")	25036553	(2-Term.)
	(87-88"F")	25037045	(2-Term.)
	(88"Y")	25036936	(2-Term.)
	(89"F")	10096207	(3-Term.)
	(89"Y")	1647136	(3-Term.)

RELAYS

MAF Power	86 "Y" & 86-87 "F"	10067925 (Ist Design)
	87-89 "Y" & 88-89 "F"	14089936 (2nd Design)
MAF Burn-Off	86"Y" & 86-87 "F"	10094701 (Ist Design)
	87-89'Y" & 88-89"F"	14089936 (2nd Design)
Fuel Pump	86-87"Y" & 86"F"	14078915 (Ist Design)
	87-89"F"	10094701 (Ist Design)
	88-89"Y"	14089936 (2nd Design)
Engine Cooling Fan	86-87"Y" & 86-87"F"	10038311 (Ist Design)
	88-89"Y" & 88-89"F"	14089936 (2nd Design)

NOTE: Part #10094701 replaces #14078907 which was a very commonly used 1st Design relay.

MISCELLANEOUS INFORMATION

GM Part #10054223 is a throttle cable that will work in many non OEM installations where the stock Camaro/ Corvette throttle cables aren't quite long enough. When using this cable, it may be necessary to enlarge the throttle cable mounting hole in the cowl to allow the plastic "snap-in" mounting clips to be installed. The throttle cable mounting hole in the cable mounting bracket on the left side of the TPI plenum unit must also be slightly enlarged to allow for the proper fit of this cable's housing end.

GM Part #10159564 is a complete intake manifold gasket set which also contains all the necessary TPI gaskets.

Radiator Hoses

The upper radiator hose required for the TPI conversion must be 1 1/4" I.D. rather than the more commonly used 1 1/2" I.D. hose used on most older Chevrolet systems. We have successfully used the Camaro/Firebird TPI upper hose (GM #14076062 or Dayco #71203) on many of our installations. When using this hose the upper radiator inlet fitting must also be 1 1/4" diameter. The lower radiator hose in most applications can remain unchanged.

Heater Hoses

Because of the configuration of the TPI intake manifold and manner of accessory location (i.e. alternator and AC compressor), there is no room for a heater return hose in the water pump area as would be the case on a carbureted engine. Therefore, the appropriate 5/8" heater hose fitting should be installed in the right side, or lower radiator tank. The heater hose fitting from the throttle body also uses a 5/8" hose which should be routed to the heater valve.

Oil Pressure Port

Again, because of the configuration of the TPI intake manifold, it is necessary to use an angled adapter fitting to gain access to the 1/8" pipe threaded (oil pressure) port at the back of the block near the distributor. The GM Part number for this adapter which is angled at 105 degrees is #14078987. There are two fittings which can be added to this connector which will allow the installation of two switches or sending units, as necessary - GM part #14047850 or part #14078988.

If you are using a Corvette or '88 and up Camaro/Firebird TPI engine assembly in your project, BE AWARE that since these engines use a single serpentine drive belt, the water pump is designed to rotate in the opposite direction when compared with older style water pumps! Thus, if you remove the serpentine belt drive in favor of individual pulley and belt combinations, that are used on many older Chevrolet engines and many Street Rod accessory drive combinations, it will be necessary to replace the water pump with an earlier style normal rotation unit!

If you are utilizing a late model ('87 or later) Small Block Chevrolet that is equipped with rocker covers attached with four bolts down the center of the cover, in conjunction with 1981 and earlier Corvette-style "Rams-Horn" exhaust manifolds, check for interference between the exhaust manifolds and the lower edge of the rocker cover. This interference can be eliminated by the removal of a small amount of metal from the exhaust manifold in the area where it contacts the rocker cover. This interference is most pronounced when using the "Corvette" style cast magnesium rocker covers.

If you are using a fuel pump other than a stock GM in-tank style pump, be sure to properly mount it utilizing rubber insulators to avoid noise and vibration.

BE SURE to remove the ECM from the harness connectors before doing any circuit testing or modifications **AND** be sure to **solder ALL** harness connections. Use only the **original GM type relays** as they have built-in diodes to eliminate problems with voltage spikes. Along this same line, when wiring the A.C. Compressor be sure to use a GM-type twin pin electrical connector as these are also equipped with a diode, wired between the two terminals. These diode equipped A.C. Compressor electrical connectors can be found on any late GM vehicle with an ECM controlled carburetor/fuel injection system.

GM uses a plastic mounting bracket to mount the ECM in the vehicle. If your system does not have one attached to the ECM when you get it, this bracket can be ordered under GM #14073420.

Ignition Timing

We have found a base ignition timing setting of 8°-10° to work with most combinations. The set-timing connector must be disconnected to allow this procedure to be done accurately. For more information, see the "Final Adjustments" section at the end of this manual.

Anti-Theft Capabilities

If it is desired to add an anti-theft capability to your system, the addition of a hidden "on-off" toggle switch wired into any of the following circuits will effectively accomplish this since an open condition in any one of these circuits will not allow the engine to start.

Circuit	#120	Fuel Pump +12V Power Circuit
Circuit	#430	Distributor Reference Circuit
Circuit	#439	ECM Power Circuit

TH-700-R4 LOCKUP CONVERTER WIRING INFORMATION

If you are going to be using a TH-700-R4 automatic overdrive transmission in conjunction with your TPI fuel injection system installation, we strongly recommend that the torque converter lockup function be retained since the transmissions' cooling capability is adversely affected when the vehicle is operated for long periods in overdrive, without the TCC engaged. In addition, operating the vehicle in overdrive with the TCC engaged, lowers engine rpm and improves gas mileage.

The majority of 700's that were originally used behind TPI engines have three wires coming from the 4-pin electrical connector on the left side of the transmission. If your trans has less, more, or different color codes than the ones listed here, it will be necessary for you to obtain a GM service manual for the year/model transmission you are working with to properly identify the components and wiring hook-up for your unit. Due to the large number of variations from year-to-year and model-to-model of the stock 700 wiring hook-ups, it is HIGHLY RECOMMENDED that you obtain a GM manual and identify the type you are working with!

The following wiring color code information assumes that you have obtained the appropriate wiring connector that plugs into the TH-700-R4 automatic transmission from the same TPI equipped vehicle from which you obtained the fuel injection wiring harness.

The purple wire (Terminal "A") is the +12 volt feed to the system. The blue, or in some applications dark green, wire (Terminal "B") is connected to the fourth gear (overdrive) switch in the valve body. This normally closed switch opens whenever the transmission shifts into fourth gear; this informs the ECM that the transmission is operating in the overdrive mode. The tan wire with a black tracer stripe (Terminal "D") is the ground wire for the TCC solenoid. In the original factory installation this wire is connected to the ECM and when all preprogrammed requirements for TCC operation are met, the ECM grounds this connection to complete the circuit and activate the TCC solenoid in the transmission's valve body which then hydraulically actuates the clutch in the torque converter. Terminal "C" remains unused in this four connector plug. For our rewiring purposes only the purple wire (Terminal "A") will be used to provide a +12 volt feed to the TCC solenoid. The ground side of the circuit is provided by the method described below.

There are a number of ways to rewire a 700 to obtain the TCC function when the transmission is used in an application without an ECM, or when ECM control of the TCC operation is not deemed desirable. The method we use is as follows: after removing the transmission pan, disconnect, remove and discard the wire which runs from the fourth gear switch to the 4-pin connector in the transmission case. Remove the fourth gear switch and replace it with GM #8627332 or "Standard Ignition" Part #PS-131 which is a normally-open switch that is physically very similar to the original switch being removed. The stock fourth gear switch is a normally-closed switch. (In order to gain access to the fourth gear switch to remove it with a socket-wrench, it will be necessary to remove the 1-2 Accumulator housing which is attached to the transmission case with 3 metric bolts with a 10MM hex-head. Be careful not to damage the gasket!) Then remove the TCC solenoid ground wire (Black) from the 4-pin wiring connector and connect it to the new switch. If your transmission has a 4-3 downshift switch in the +12V feed wire (Tan) side of the circuit, as most do, retain it. The fourth gear switch (1 elec. term.) is the one on the extreme right end (passenger side) of the rear of the valve body and the 4-3 downshift switch (2 elec. term.) is the unit directly inboard of the fourth gear switch, Rewired in this way, the TCC will operate only in fourth gear (OD) and will stay locked up whenever overdrive is engaged. Some 700's other than the Corvette, Firebird, or Camaro units, use a fourth gear switch or a third gear switch which is normally open and can be used as is. If yours has a normally-open third gear switch, it can be moved to the fourth gear port and the third gear port plugged with a 1/8" pipe plug. This is not the only method that will accomplish TCC control without an ECM, but we have found it to be effective, foolproof and, by far, the least expensive procedure, even though it does require the removal of the transmission pan. There are other methods and, in fact, some aftermarket kits are available to control the TCC function using external wiring and switches that do not require the removal of the transmission pan. One such kit is produced by B&M Automotive Products, 9152 Independence Avenue, Chatsworth, CA 91311 (818-882-6422) and is available through most Speed Shops, Street Rod Shops, or any auto parts outlet that handles the B&M product line under #80217. If driver control of the TCC function is desired, it is merely necessary to place a push-button or on/off toggle switch in the +12 volt TCC feed line (purple wire) to the 4-pin connector in the transmission. In the OEM application this positive +12 volt feed line is also routed through a normally-closed switch, that is activated by the brake pedal, to remove current from the circuit, and thereby unlock the converter clutch, whenever the brakes are applied. For safety considerations, it is desirable to retain a switch in the system with this function. If it is impractical to install an extra switch in the brake pedal area, this function can be obtained by using a normally closed relay, activated by a feed wire from the switched side of the existing brake light switch. As the preceding information again indicates, it is a VERY good idea to have the proper GM manual handy during this rewiring process.

FINAL ADJUSTMENTS

After getting your TPI injected engine running there are 3 basic adjustments that should be made to insure proper operation. These adjustments should be made in the exact sequence detailed below, with the engine warmed to normal operating temperature.

SETTING INITIAL TIMING

The initial base timing is set, after disconnecting the set-timing connector, by manually rotating the distributor, to adjust the timing to 8°-10°. NOTE: The set-timing connector is the snap-apart connector in the tan wire with a black tracer that is contained in the 4-wire harness which runs from the distributor to the ECM. Separating this connector will cause a Code 42 to be storedin in the memory of the ECM. The memory should be cleared after setting the timing, and re-connecting the set-timing connector, by removing Fuse #1 for 30 seconds.

MINIMUM IDLE SPEED ADJUSTMENT

The idle stop screw is used to regulate the minimum idle speed of the engine. It is adjusted at the factory, then is covered with a cup plug to discourage unnecessary readjustment. We recommend checking and readjusting the base idle speed, as part of the basic set-up procedure. Before checking minimum idle speed be sure the ignition timing is correct and, be sure the throttle body is clean around the throttle plates.

1. Pierce the idle stop screw cup plug with an awl, and apply lever-age to remove it.

2. With the IAC electrical plug still connected, ground diagnostic Terminal "B" of the ALDL connector by jumpering it to Terminal "A".

3. Turn ignition to "ON" position. Do not start engine! Wait at least 3O seconds.

4. With ignition still "ON" disconnect the IAC electrical connector.

5. Disconnect the distributor set-timing connector.

6. Start engine and allow to go "Closed Loop". (With the ALDL diag-nostic terminal grounded the "Check Engine" light will blink 2½ times per second while in "Open-Loop" and slow to once per second when the system changes over to "Closed-Loop".)

7. Remove the ground from the ALDL diagnostic terminal.

8. Adjust idle stop screw with a ¼" drive #T20 "TORX" socket or similar driver to obtain 450-500 rpm in Park or Neutral.

9. Turn ignition "OFF" and reconnect electrical connector at IAC motor.

10. Remove Fuse #1 for 30 seconds to remove Code 42 from memory.

ADJUST TPS SENSOR (throttle position sensor)

I. Plug SCAN tool into ALCL connector OR connect a Digital Volt Meter between Circuit #417 (+) (Dark Blue wire in TPS 3-wire harness) and Circuit #452 (-) (Black wire in TPS 3-wire harness).

2. Loosen TPS Sensor mounting screws. (#T25 "TORX").

3. With ignition "ON" manually adjust TPS Sensor to obtain a reading of .54 ±.O8 volts (.46 to .62 volts).

4. Tighten screws, then recheck reading to insure adjustment has not changed.

NOTE: If the TPS sensor was removed for any reason during the installation process it should be adjusted BEFORE starting the engine for the first time, and will then have to be READJUSTED AFTER the Minimum Idle Speed adjustment is made!

EMISSION CONTROLS

A word about emission controls: recent changes in the Federal Emission Control laws that apply to automobiles are making it increasingly difficult to obtain the required emission compliance paperwork necessary in many states, to either register or sell a vehicle or to pass an annual vehicle emission inspection. Accordingly, we highly recommend that you retain all the appropriate emission controls when installing a TPI engine. With all emission equipment installed and functioning properly, a TPI conversion will pass any current state's emission requirements with ease, and with practically no adverse effect on performance.

DISCLAIMER

The foregoing information has been compiled by ***SunCoast Conversions*** from various sources, including General Motors' Service Manuals, Performance Enthusiast-Oriented Automotive Periodicals, such as Hot Rod, Car Craft, and Popular Hot Rodding magazines, and various automotive trade publications, in addition to input from numerous GM service technicians and our personal conversion installation experiences, and is being supplied to our customers to familiarize them with the Tuned Port Electronic Fuel Injection System and its incorporation into Street Rod or similar type vehicles. This information is, to the best of our knowledge, correct and accurate, however ***SunCoast Conversions*** accepts no responsibility for the interpretation and use of this information by any person or persons.

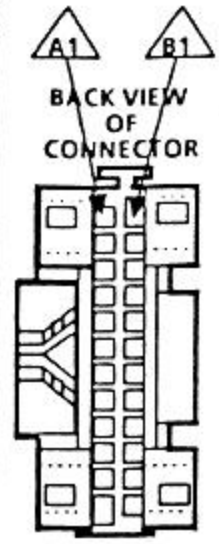
TECHNICAL ASSISTANCE

If after **THOROUGHLY** reading over this manual you need additional assistance or have any questions, we will gladly provide any help we can. **Please Call** our **Tech Line** at **1-813-639-7735 Monday through Friday 9AM-5PM.**

JIM JOHNSON
SunCoast Conversions

PORT FUEL INJECTION ECM CONNECTOR IDENTIFICATION

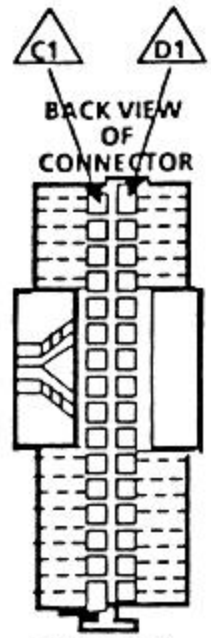
CIRCUIT	PIN	WIRE COLOR
FUEL PUMP RELAY CONTROL	A1	GRN/ WHT
AIR SWITCH (PORT)	A2	BRN
CANISTER PURGE CONTROL	A3	GRN/ YEL
EGR CONTROL	A4	GRY
"SERVICE ENGINE SOON" CONTROL	A5	BRN/ WHT
IGN	A6	PNK/ BLK
M/T OVERDRIVE OR A/T TCC CONTROL	A7	TAN/ BLK
SERIAL DATA	A8	ORN
DIAG. TERM.	A9	WHT/ BLK
SPEED SENSOR SIGNAL	A10	BRN
ANOLOG GROUND MAF 5V RETURN	A11	BLK/ PNK
SYSTEM GROUND	A12	BLK/ WHT



24 PIN A-B CONNECTOR

WIRE COLOR	PIN	CIRCUIT
ORN	B1	BATT.12.VOLTS
RED	B2	FUEL PUMP SIGNAL
BLK/ RED	B3	EST REF LOW
	B4	NOT USED
PPL/ WHT	B5	DISTRIBUTOR REFERENCE
WHT	B6	VATS
BLK	B7	ESC SIGNAL
GRN/ YEL	B8	A/C SIGNAL (OFF) (ON) (60)
	B9	NOT USED
ORN/ BLK	B10	PARK/NEUTRAL P/N SW.SIGNAL (A/T) D
	B11	NOT USED
DK GRN	B12	MAF SENSOR (INPUT)

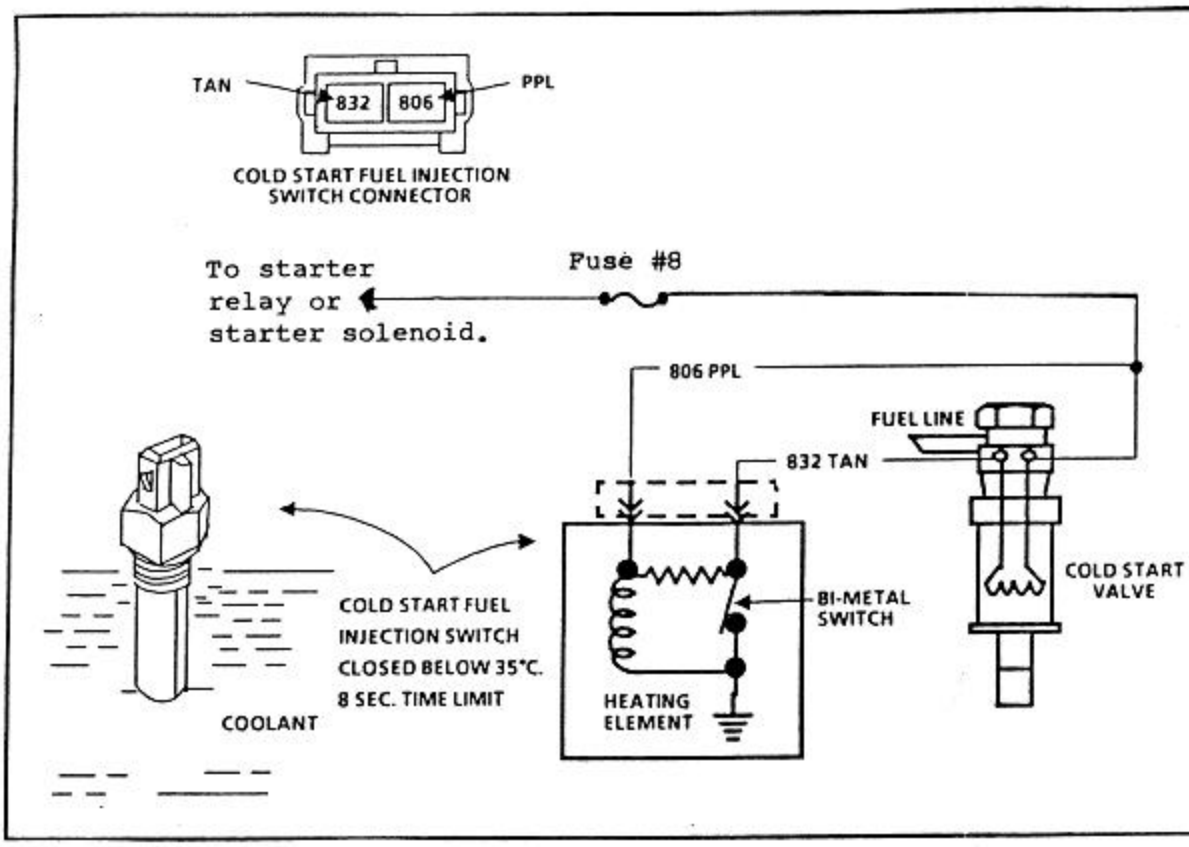
FAN RELAY CONTROL	C1	DK GRN/ WHT
(CONVERTER) AIR CONTROL	C2	BLK/ PNK
IAC "B" LO	C3	LT GRN/ BLK
IAC "B" HI	C4	LT GRN/ WHT
IAC "A" HI	C5	LT BLU WHT
IAC "A" LO	C6	LT BLU BLK
A/T OVERDRIVE SWITCH SIGNAL	C7	BLK/ BLU
M/T O.D. REQUEST	C8	BLK/ BLU
NOT USED	C9	
COOLANT TEMP. SIGNAL	C10	YEL
NOT USED	C11	
MAT SIGNAL	C12	TAN
TPS SIGNAL	C13	DK BLU
TPS 5 VOLT REFERENCE	C14	GRY
EGR DIAG SWITCH	C15	DK GRN
BATTERY	C16	ORN



32 PIN C-D CONNECTOR

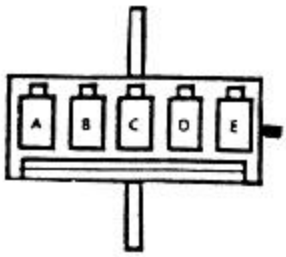
BLK/ WHT	D1	SYSTEM GROUND
BLK	D2	TPS,CTS,MAT 5V RETURN
BLK/ WHT	D3	SYSTEM GROUND
WHT	D4	EST CONTROL
TAN/ BLK	D5	BYPASS
TAN	D6	GRN'D. (0_2)
PPL	D7	02 SENSOR SIGNAL
	D8	NOT USED
	D9	NOT USED
BLK/ WHT	D10	SYSTEM GROUND
DK GRN	D11	A/C PRESSURE FAN SWITCH
BLK	D12	MAF BURN-OFF RELAY CONTROL
	D13	NOT USED
	D14	NOT USED
LT BLU	D15	INJ.1.3.5.7.
LT GRN	D16	INJ.2.4.6.8

NOTE: Terminals A-7, C-7, C-8, B-6 are not used in all factory installations so, depending on which vehicle the harness came from, there may be no wire in these terminals. One combination of color codes is shown, depending on the year/model there may be some differences: see text for more info.

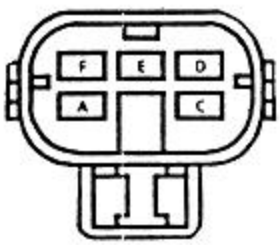


Shown above is the wiring schematic for all '86-88 systems that utilize a separate cold-start injector. The connection indicated "to starter relay or starter solenoid" should be wired in such a way as to have +12V power in this circuit (Circuit 806) only when the starter motor is cranking the engine.

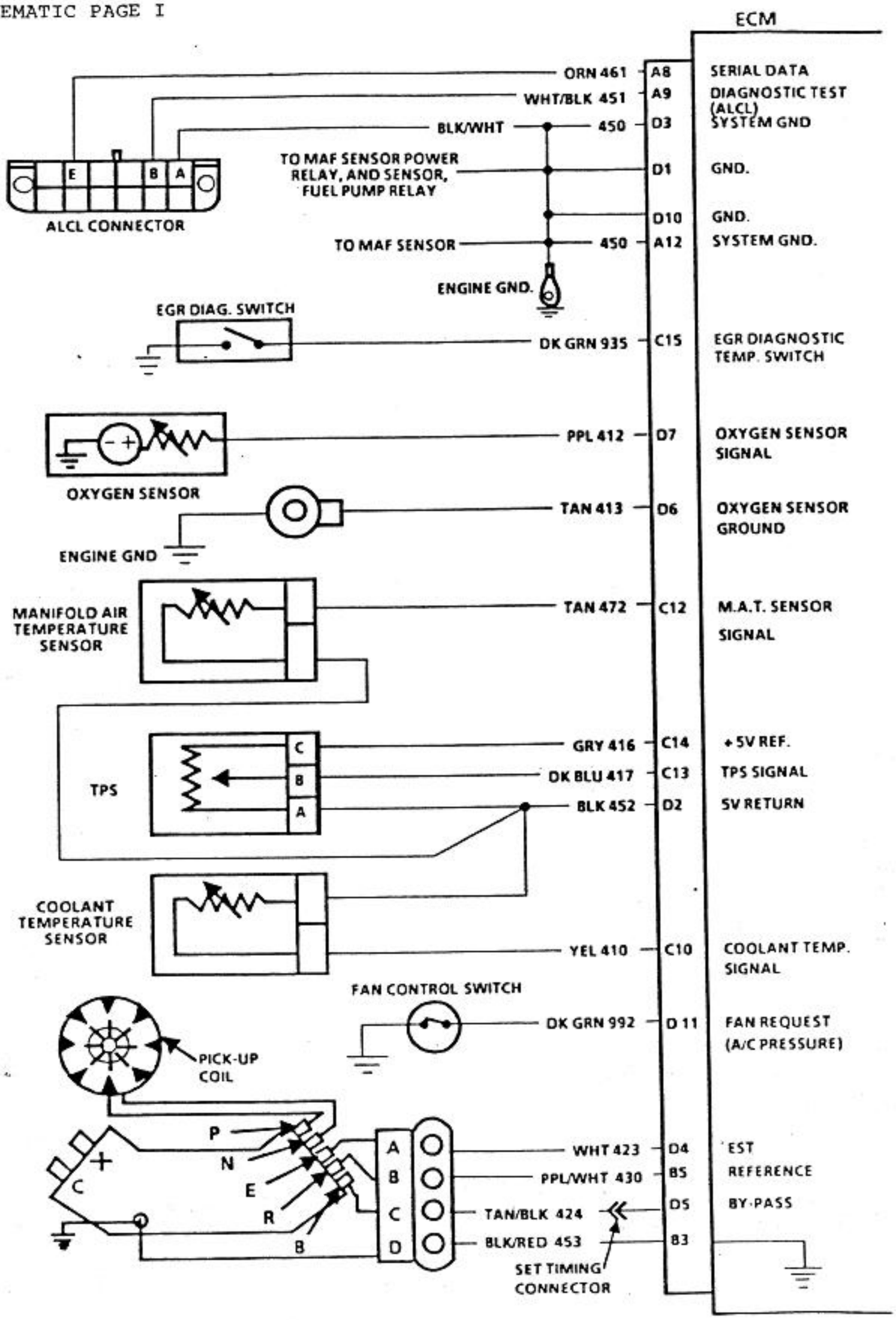
Illustrated below is the connector for the 1st Design relays.



Illustrated below is the connector for the 2nd Design relays.



SCHEMATIC PAGE I



mount the alternator on the left side of the engine whereas the Camaro/Firebird system's fuel lines position work well with combinations which mount the alternator on the front of the right cylinder head, the power steering pump low on the left front corner of the block, and the air conditioning compressor on the left cylinder head and utilize individual V-belt drives for each accessory, where the Corvette system is normally used with a serpentine belt drive. 1988 and later Camaro/Firebird TPI systems also use a serpentine belt drive, but the accessories are positioned differently than the Corvette units.

Also, Corvette engines with aluminum cylinder heads have a unique EGR plumbing arrangement because of the lack of exhaust crossover passages in the aluminum cylinder heads. The lack of these crossover passages require the routing of exhaust gases to the intake manifold via a tube that connects to the right hand exhaust manifold.

The TPI side runners or, as they are more commonly referred to, "Ram Tubes" are interchangeable between different years and models, with the understanding that there are specific left and right side units and also an awareness that '89 and later systems are not equipped for a cold start valve, and, therefore, the left side ram tube assembly does not have the required mounting provision for the cold start valve assembly, and the '89 and later intake manifolds do not have the proper internal passages to allow the '86-88 cold start system to function properly.

All intake manifolds interchange to any Small Block Chevrolet but, as mentioned, '89 and later manifolds have no provision for a cold start valve assembly. Intake manifolds, used on '87 and later engines with cast iron heads, have the two center intake manifold bolt hold-down holes drilled at a different angle than earlier engines. These manifolds can be used on the early engines if the bolt holes in question are milled or otherwise opened up to allow the mounting bolts to be installed.

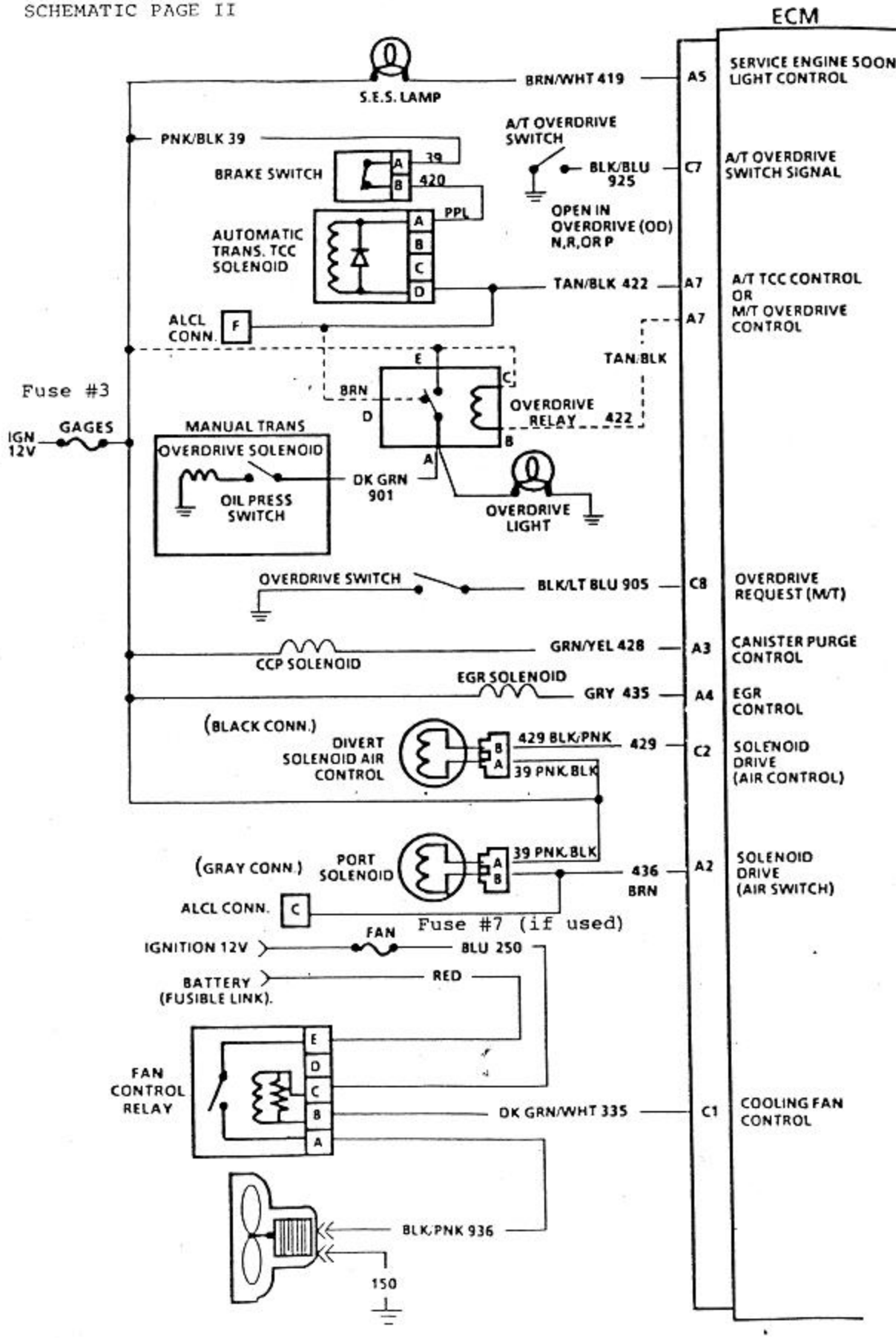
All of the fasteners used on the TPI system utilize metric threads and most of the bolts used to assemble the individual components of the TPI system use "TORX"-type heads. The intake manifold is held to the cylinder heads with standard 3/8"-16 USS bolts, however, these too have a "TORX"-type head. The intake manifold hold-down bolts require the use of a #T45 "TORX" driver and the bolts which hold the balance of the TPI system together utilize a #T40 "TORX" driver. In addition, some of the TPI assembly hardware occasionally utilize bolts with 10MM, 13MM and 15MM size hex heads.

All intake plenum assemblies are interchangeable, and Corvettes use an aluminum plenum extension (GM #10108425) which extends over the distributor that can be used to replace the easily broken, plastic unit used on the Camaro/Firebird systems.

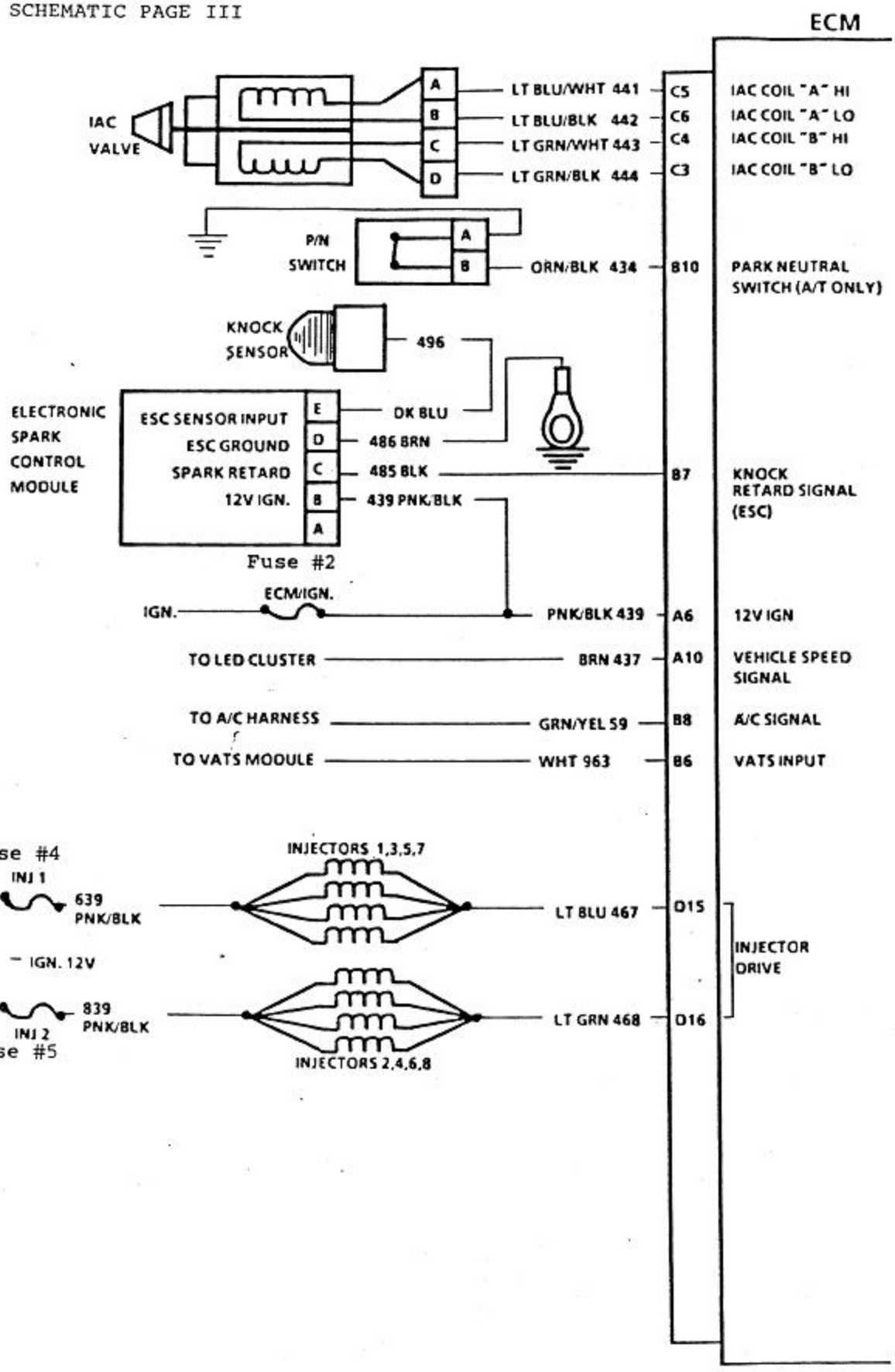
All the throttle body assemblies are interchangeable, however the '89 units use a different attachment point for the throttle cable than the earlier units, which can create additional problems with the throttle linkage hook-up in most non-OEM applications.

If your prior knowledge of TPI systems is limited to some quick looks under the hoods of various Corvettes and Camaros, the names and acronyms of the following parts may seem foreign and unusual to you but their functions are really quite familiar. Whether an engine is equipped with a carburetor or fuel injection, it still needs the correct mixture of air and fuel to run. The functions of most of the following components allows them to work together to accomplish this end. For example, a carburetor has a choke mechanism to enrich the fuel mixture when starting a cold engine. Chevrolet's TPI uses a 9th injector and an engine temperature sensor to perform the same function. In the following paragraphs, we will attempt to explain the various functions of the major components of the TPI system and, where appropriate, how to accommodate them to a non-OEM application.

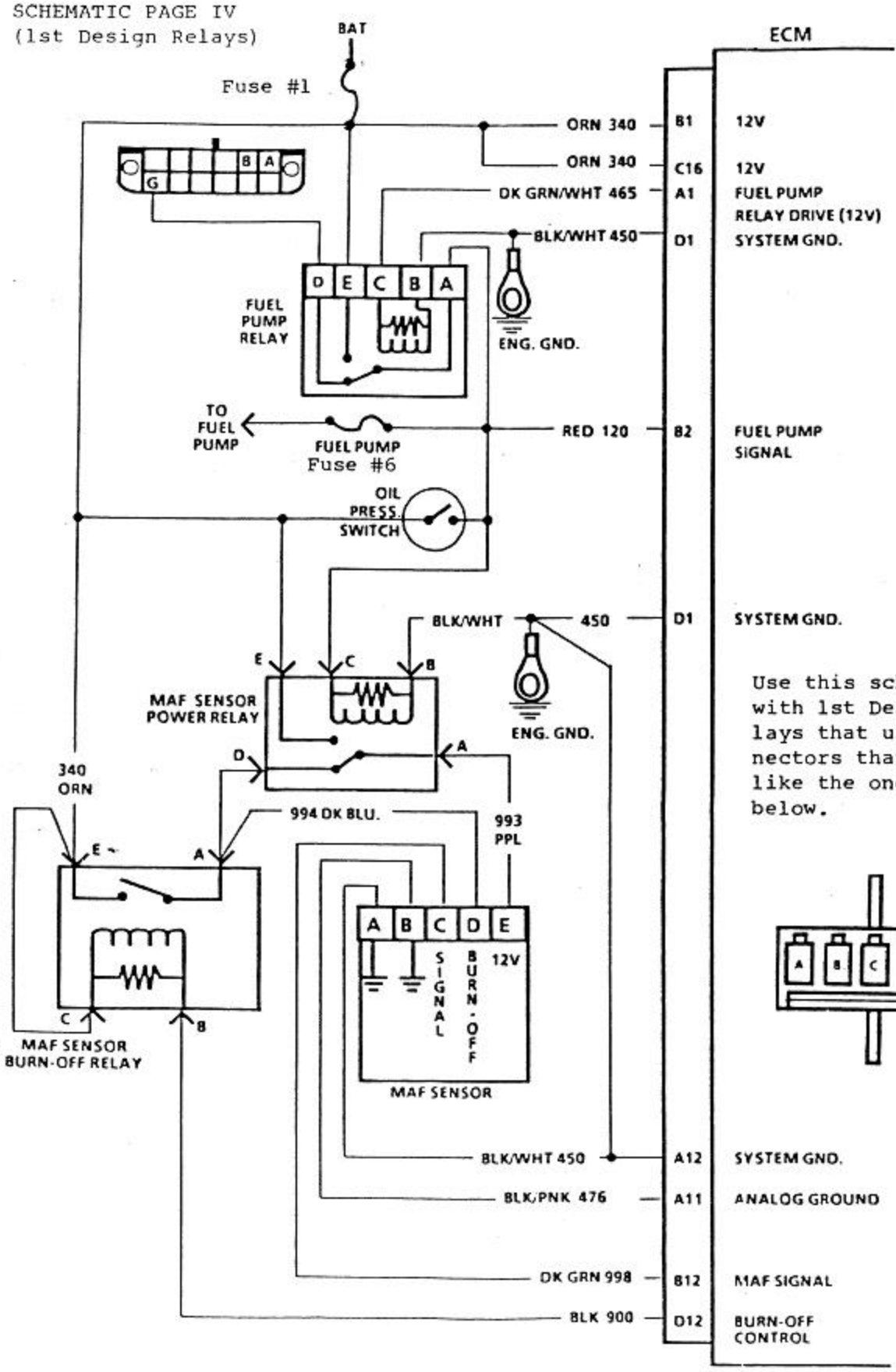
SCHEMATIC PAGE II



SCHEMATIC PAGE III

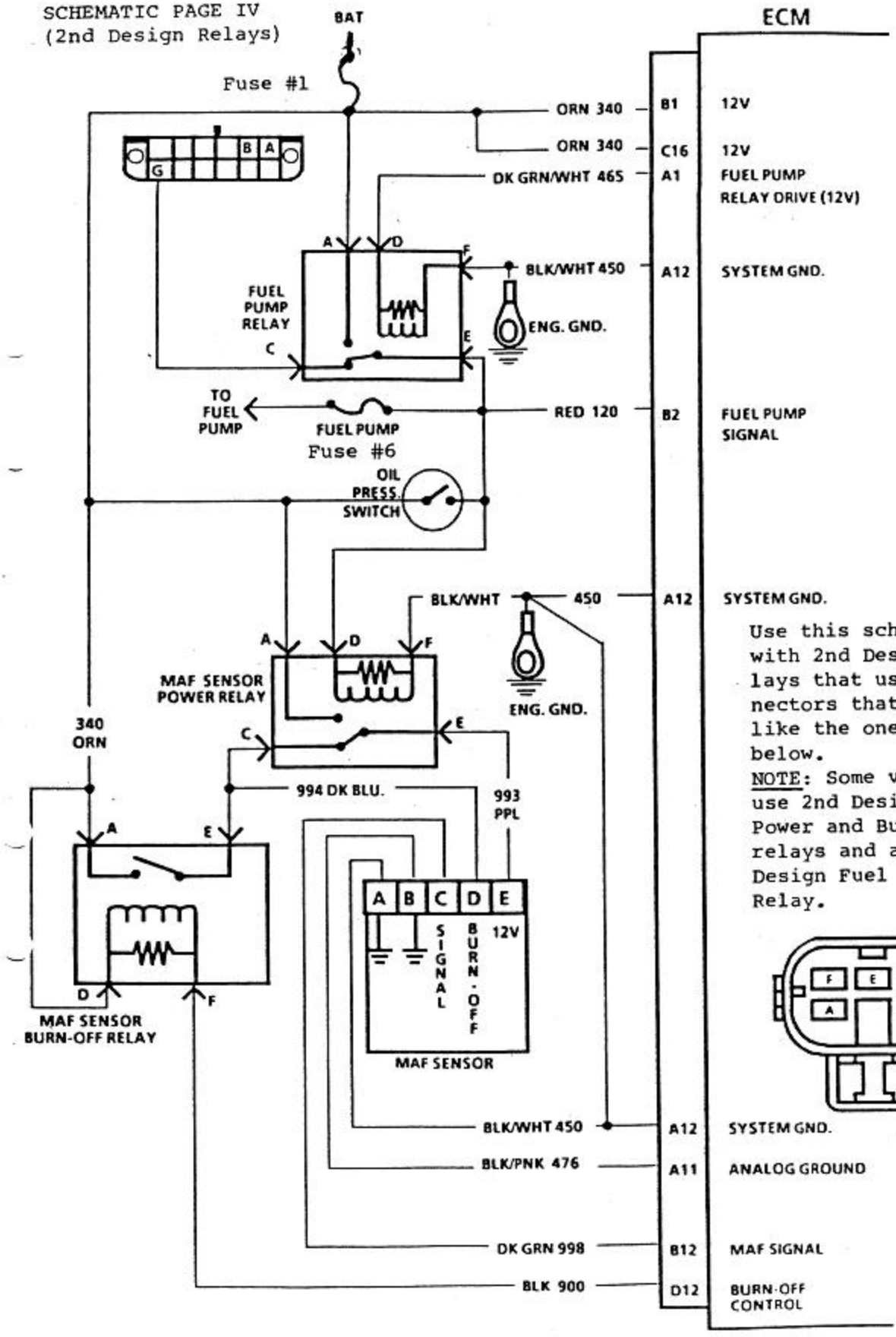


SCHEMATIC PAGE IV
(1st Design Relays)



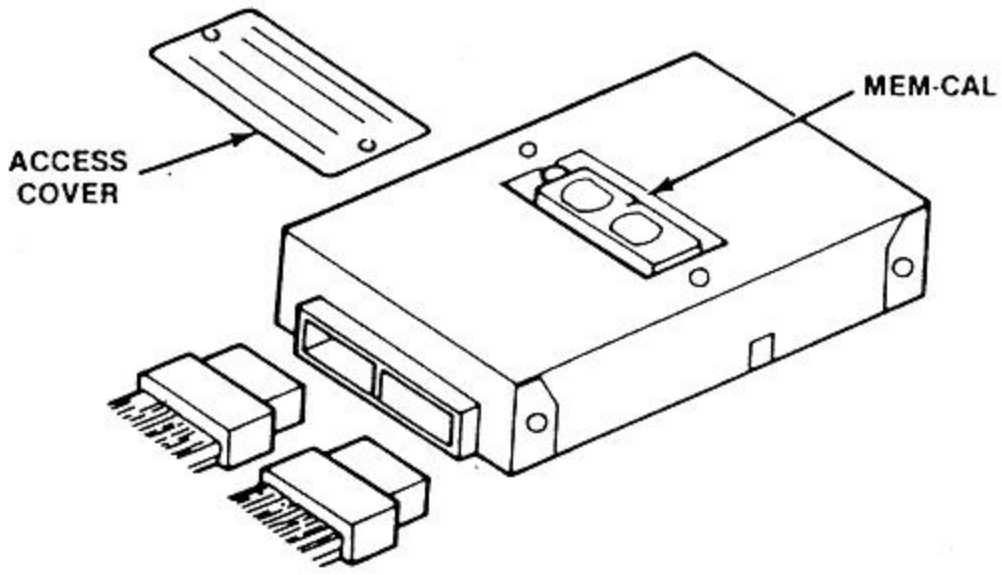
Use this schematic with 1st Design relays that use connectors that appear like the one shown below.

SCHEMATIC PAGE IV
(2nd Design Relays)



Use this schematic with 2nd Design relays that use connectors that appear like the one shown below.

NOTE: Some vehicles use 2nd Design MAF Power and Burn-off relays and a 1st Design Fuel Pump Relay.

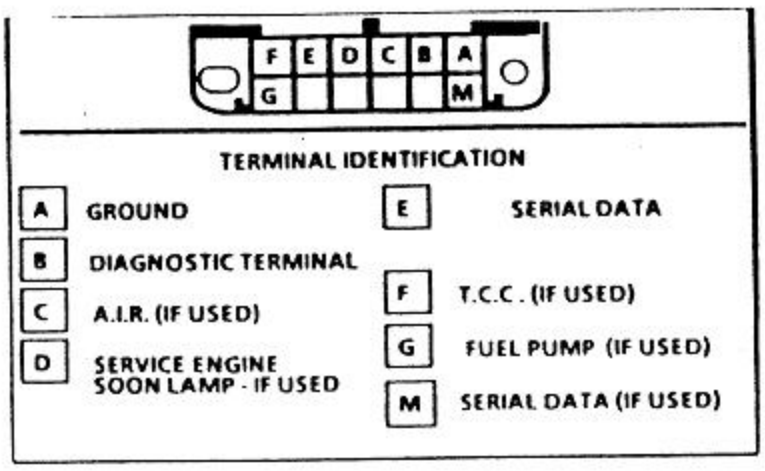


**ECM
MODULE
#1227165 Shown**

ELECTRONIC CONTROL MODULE - The ECM, commonly referred to as the "brain" of the system is, in fact, a computer and is capable of making over 600,000 commands per second. In later year systems, it is also referred to as the Engine Control Module since some vehicles have an additional computer unit which is known as a Body Control Module (BCM), which is involved in the control of various non-engine or drive train functions. The ECM receives information about the engine's operating conditions from various sensors and then calculates the optimum spark timing and fuel mixture according to preprogrammed values. The ECM controls the fuel mixture by varying the duration of time that the 8 injector solenoid valves are open. This time period is referred to as the "pulse length" and is measured in milliseconds. General Motors "smart" ECM's have memory and learning ability and can remember changes that produce peak performance. The ECM is calibrated to a specific vehicle and engine combination by a removable PROM (Programmable Read Only Memory) which in the '86 thru '89 ECM's, is part of a removable insert referred to as a "MEM-CAL" (Memory-Calibrator). The "MEM-CAL" contains the calibrations needed for a specific vehicle/engine combination as well as the back-up fuel control circuitry required should the ECM unit become damaged or faulty. This back-up fuel circuitry is contained in a chip similar to the PROM, referred to as the CAL-PAK, that is also contained within the MEM-CAL assembly. The CAL-PAK is programmed to allow fuel delivery in the event of a PROM or ECM malfunction. This back-up fuel control capability is commonly referred to as the "Limp-Mode".

It has been our experience, when installing TPI systems in Jaguars, that the most practical place to mount the ECM is underneath the passenger's seat. In this location it simplifies the initial wiring procedure and, later on, allows easy access for "MEM-CAL" or ECM replacement, if necessary, or other diagnostic and trouble-shooting purposes. Depending on the particular vehicle into which you are installing the TPI system, this location may or may not work for your application.

ALDL CONNECTOR



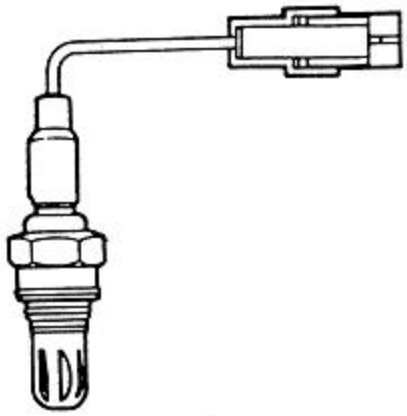
ALDL CONNECTOR - The Assembly Line Diagnostic Link (also known as the ALCL or Assembly Line Connecting Link) has terminals which are used in the assembly plant to check that the engine is operating properly before it is shipped. This connector also allows a technician to troubleshoot the system by attaching what is known as a "SCAN" tool to the ALDL connector and access all important information relative to the

operation of the various control circuits within the ECM. These "SCAN" tools are available from most tool retailers such as Snap-On, MAC, etc. In fact, Sears now lists one in its tool catalog. Prices start around $400. Most of these units can be described as "hand-held" in terms of size. One of the more common units, marketed by the OTC Division of the Sealed Power Corporation and sold under the "Monitor 2000" trade name, measures 3-3/4" x 7-1/2", is 1-1/2" thick, and weighs only 1 lb-2 oz. In addition to having LED or LCD screens which display "real time" information while the engine is running, most "SCAN" tools can be attached to printers for recording data and can even be interfaced (with special software) to your home Personal Computer. There is, in fact, a recently released software package that comes equipped with the proper cables to allow direct connection between the ALDL connector and your IBM PC or PC-compatible computer and takes the place of the "SCAN" tool itself, and uses the PC's CRT monitor to display the information that would normally be displayed in the readouts of the "SCAN" tool. Because of its portability, a "lap-top" type computer is recommended with this combination, however it can be used with a standard desk-top PC. Through the use of specific plug-in modules, these "SCAN" tools can be adapted to almost any year or model vehicle which uses an ECM controlled engine. In the GM applications, the ALDL connector is usually installed underneath the dash where it can be easily accessed by a technician. We have found it simpler, and more expedient to install it near the ECM underneath the passenger's seat, as this puts it out of view while still keeping it accessible for diagnostic purposes, in addition to simplifying the re-wiring process.

MAF SENSOR

MASS AIR FLOW SENSOR - The MAF sensor measures the amount of air passing through the engine. Chevrolet's Tuned Port Injection system uses a "hot wire" type MAF sensor that determines air flow by measuring the current required to maintain a heated wire at a constant temperature as intake air passes over the wire. The MAF sensor is the chief compensating feature in Chevrolet's TPI. This unit must be mounted between the air cleaner assembly and the TPI throttle body. The MAF sensor is the one piece of the TPI system that seems to give the most problems as far as positioning and mounting in almost all non-factory applications. We have found that by using '85-89 Pontiac Firebird air intake components, i.e., air cleaner, air box, and ducting that we can end up with a "factory" look for this usually troublesome area of TPI installations. While this procedure adds some additional work to the installation, we feel it results in a professional looking installation with a "factory look". Obviously, the particular clearance problems dictated by the specific installation you are working with will determine the location of the MAF sensor and it's attendant ducting. The farthest we have seen the factory mount the MAF from the throttle body is approximately 15 inches and we have always tried to maintain this as a maximum distance when repositioning the MAF sensor. Placing the MAF sensor farther away than this may create some drivability problems!

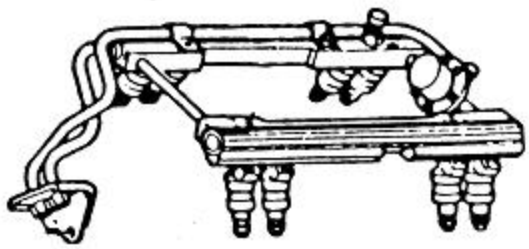
The MAF is also the sensor that is the most likely part of the entire system to be missing or damaged. Be sure to obtain one in your "package deal" when purchasing either a TPI unit or a complete engine with a TPI installed as they are in excess of $300 when purchased new from a GM dealer. Also be sure that the MAF sensor has a 5-pin connector. While attending numerous swap meets we have encountered quite a few unscrupulous vendors trying to sell "complete" TPI units with a V-6 3-pin type MAF sensor. They are very close in size and appearance to the V-8 MAF sensor unit but will absolutely not work with the V-8 system! In addition to the 5-pin connector, the correct MAF sensor has I.D. cast into it indicating that it is manufactured by BOSCH of Germany whereas the 3-pin 6-cylinder type unit has I.D. indicating it is manufactured by the A.C. Delco Division of GM.



OXYGEN SENSOR ASSEMBLY

OXYGEN SENSOR - The exhaust oxygen sensor is mounted in the exhaust manifold where it can monitor the oxygen content of the exhaust gas stream. It does this by measuring the amount of oxygen molecules in the exhaust. This sensor allows the system to function in the feedback or "closed loop" mode. The oxygen sensor improves drivability by providing input to the ECM causing the ECM to adjust the fuel injector pulse-width settings to produce an ideal 14.7:1 air/fuel ratio. When the oxygen sensor is removed or disabled, the TPI system operates in its "open loop" mode at pre-programmed settings. In the "open loop" mode the ECM will compensate for changes in engine and air temperature as determined by its preset calibrations but cannot fine-tune the fuel mixture. In way of reiterating the need for soldered connections and care in eliminating corrosion from the various connections in the TPI system, the total functional variation that the oxygen sensor circuit measures is from about .1 volt for a lean condition to about 1.0 volt for a rich condition, thus spanning a total voltage variation of approximately nine-tenths of one volt!!! In the factory application the oxygen sensor is mounted in the exhaust manifold. If your level of fabrication experience is such, it is possible to remove the oxygen sensor boss from the late model factory manifold and install it in the earlier Corvette-style "Rams-Horn" type exhaust manifolds that work on many Street Rod applications. It is also possible to obtain an aftermarket weld-in type of boss that can be installed in the exhaust down-pipe just below the exhaust manifold, or header. Should you decide to fabricate your own mounting boss, the threads on the oxygen sensor are metric, 18MM-1.50 to be exact, and the area around the threaded hole must be flat since the sensor uses a sealing washer. It is important that if the oxygen sensor cannot be mounted in the exhaust manifold that it be mounted in the downpipe as close as possible to the manifold since, for the system to go "closed loop", the oxygen sensor must reach an operating temperature of 600°F.

FUEL INJECTOR ASSEMBLY

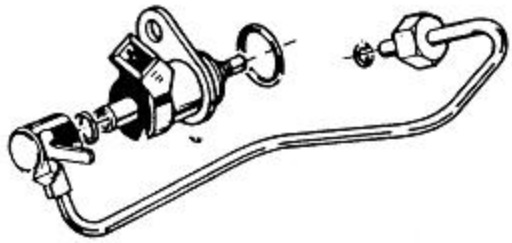


INJECTORS - The system uses 8 primary injectors which are wired and fused in 2 groups of 4, one group is for cylinders 1, 3, 5, and 7, and the other group for 2, 4, 6, and 8, quite logically referred to as the odd and even injectors. GM wires and fuses four of these injectors together and when we install the system, we duplicate the fusing on the outside chance that should one injector short out and blow the fuse for that bank, the injectors on the other bank, will continue to function, thus allowing the engine to continue running. In a comment on the reliability of these units, we have never experienced an injector failure, nor have we talked to any GM technicians

who have. The biggest problem that was prevalent when these injection systems were first introduced, that being clogged injector nozzles, has been just about solved by the oil companies with the introduction of special detergents in their gasoline products.

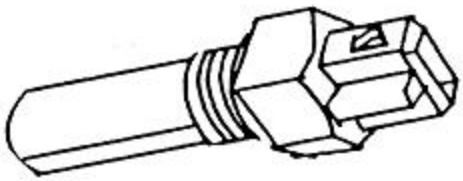
Injectors are manufactured by Rochester, MULTEC, Lucas, and Bosch and have different fuel flow rates between the 305" and 350" engines, and different rates between injectors provided by one manufacturer or another for the same application. According to GM, the injectors should be retained with their specific engines and not interchanged. While we agree that the injectors should be matched to their specific engine, if at all possible, we have found that if they are interchanged in sets, i.e., 305" injectors installed in 350" engines, they will work quite adequately due to the adjustability engineered into the MAF controlled TPI systems. If there is any noticeable difference, it would only appear under full throttle maximum output conditions. In the real world, if engine rpm is kept below 4500, we have not seen any noticeable difference either performance or mileage-wise by using 305" injectors in 350" or even larger displacement engines. We would caution, however, that the injectors only be switched in sets, i.e., do not mix 305" and 350" injectors in the same engine since the system has no way of determining fuel delivery rates for individual cylinders.

COLD START ASSEMBLY



COLD START INJECTOR - This 9th injector is located between cylinders #3 and #5 on the left side of the intake manifold on '85 thru '88 units. The 1989 and later injector systems are calibrated differently to compensate for the lack of a cold start injector. The cold start injector enriches the fuel mixture for up to 8 seconds during cold cranking. It is wired directly into the starter solenoid circuit, is controlled by the Thermal Time Sensor, and operates ***ONLY*** when the starter is cranking the engine over.

THERMAL SENSOR

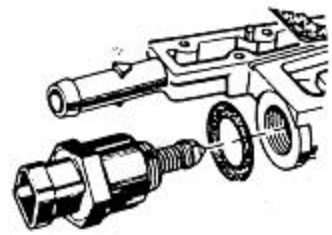


THERMAL TIME SENSOR - This temperature sensitive sensor activates the cold start injector when cranking a cold engine. This sensor is not used in '89 systems. The time period during which it allows the cold start injector to inject additional fuel into the engine is based, inversely, on the temperature of the engine below 95°F, i.e., above 95°F there is no additional fuel injected by the cold start injector. As the temperature drops, the time period during which the cold start injector is engaged, to inject extra fuel, is increased to a maximum of 8 seconds at -5°F. This sensor is threaded into the front of the intake manifold in the area below the thermostat housing. It uses a 2-wire connector with a spring clip very similar to the type used on the fuel injectors.

TPS

THROTTLE POSITION SENSOR - The TPS informs the ECM if the throttle blades are closed, or whether the throttle blades are open and, if open, how far they are open. It also sends information on the rate of change in the throttle opening. This unit is mounted on the right side of the throttle body assembly with 2 TORX head machine screws, has a 3-wire connector and is actuated by a tang on the throttle shaft, that engages a lever on the TPS. Basically, the TPS is a potentiometer which informs the ECM with a voltage reading proportional to throttle opening from .54 volts at idle to approximately 5 volts at full throttle. This is the only sensor in the TPI system that can be manually adjusted. It should be adjusted with the throttle plates closed, using a digital volt meter or a "SCAN" tool for a reading of .54±.08 volts. (See "Final Adjustments" on Page 34.)

IAC



IDLE AIR CONTROL - This control device uses a small stepper motor which operates an adjustable tapered valve that maintains engine idle speed at closed throttle by controlling the amount of air which is allowed to bypass the closed throttle valves in the twin bores of the throttle body. The engine's idle speed is determined by the calibration in the "MEM-CAL", and is not mechanically adjustable beyond setting what is referred to as base idle, which in most stock applications is approximately 500 rpm. This base idle is set by removing the 4-wire connector from the IAC unit, to eliminate ECM control and adjusting the throttle plate stop screw which is on the top left side of the throttle body assembly. The IAC unit is on the right side of the throttle body below, and slightly forward of, the TPS sensor. (See "Final Adjustments on Page 34.)

CTS

COOLANT TEMPERATURE SENSOR - This sensor, which is mounted alongside the Thermal Time Sensor at the front of the intake manifold below the thermostat housing, sends information on the engine temperature to the ECM which enriches or leans the fuel mixture as required by predetermined calibrations stored in the ECM. It utilizes a 2-wire connector.