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PSI POWER SOLUTIONS, INC.

Certified LSI Engine with IMPCO *SPECTRUM* System

Fuel/Control System Diagnostics

Offered by Power Solutions, Inc.

The Fuel System

- Computer controlled
- Closed Loop
- Adaptive Learn
- Drive By Cable
- Sequential multi port gas fuel injection for 4.3 Liter
- Single point gas fuel injected throttle body for 3.0 Liter
- LPG Fuel Options
- On Board Diagnostics

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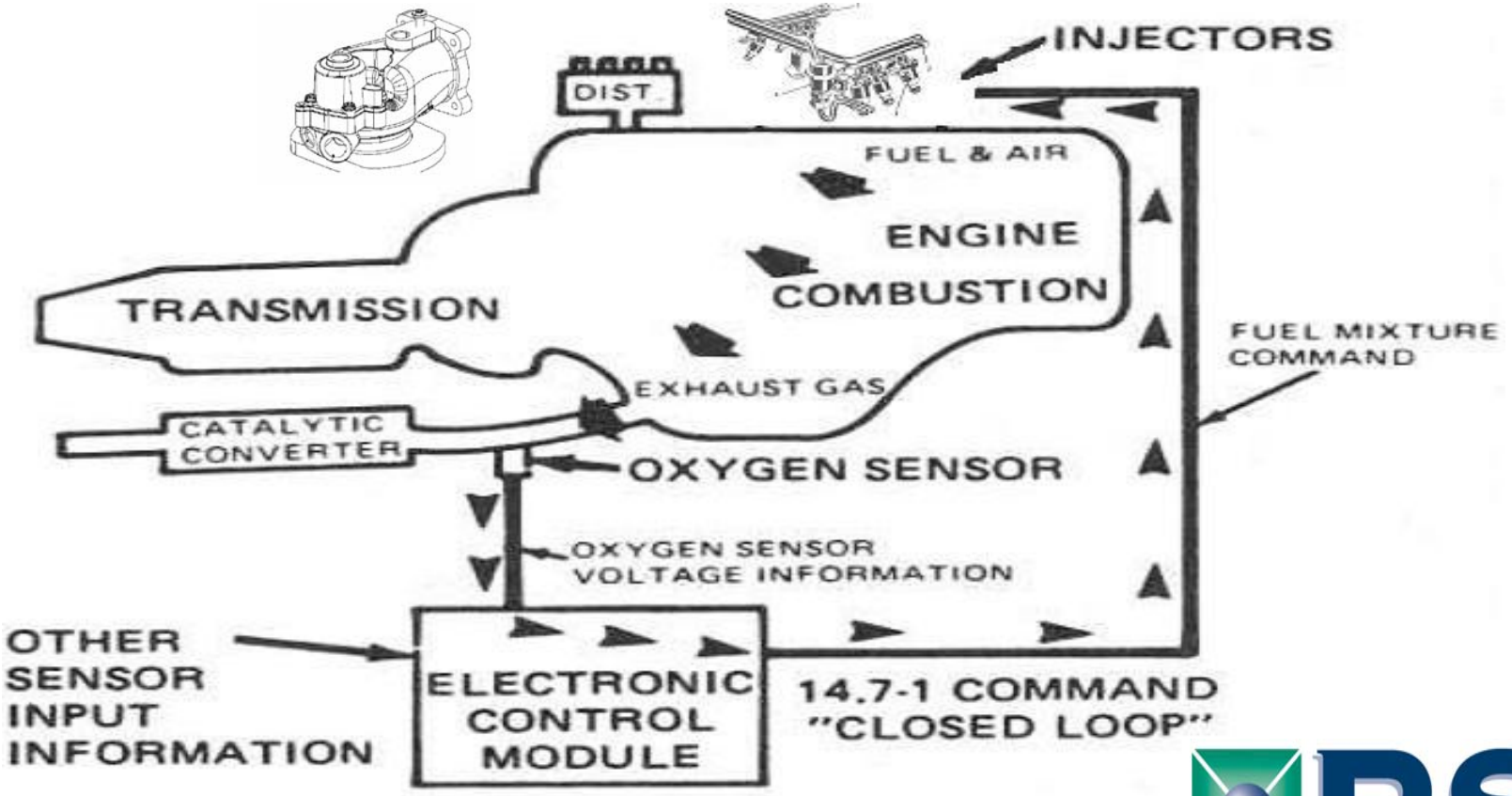
Closed Loop Fuel Control

3.0 Throttle Body **4.3 Injector Rail**



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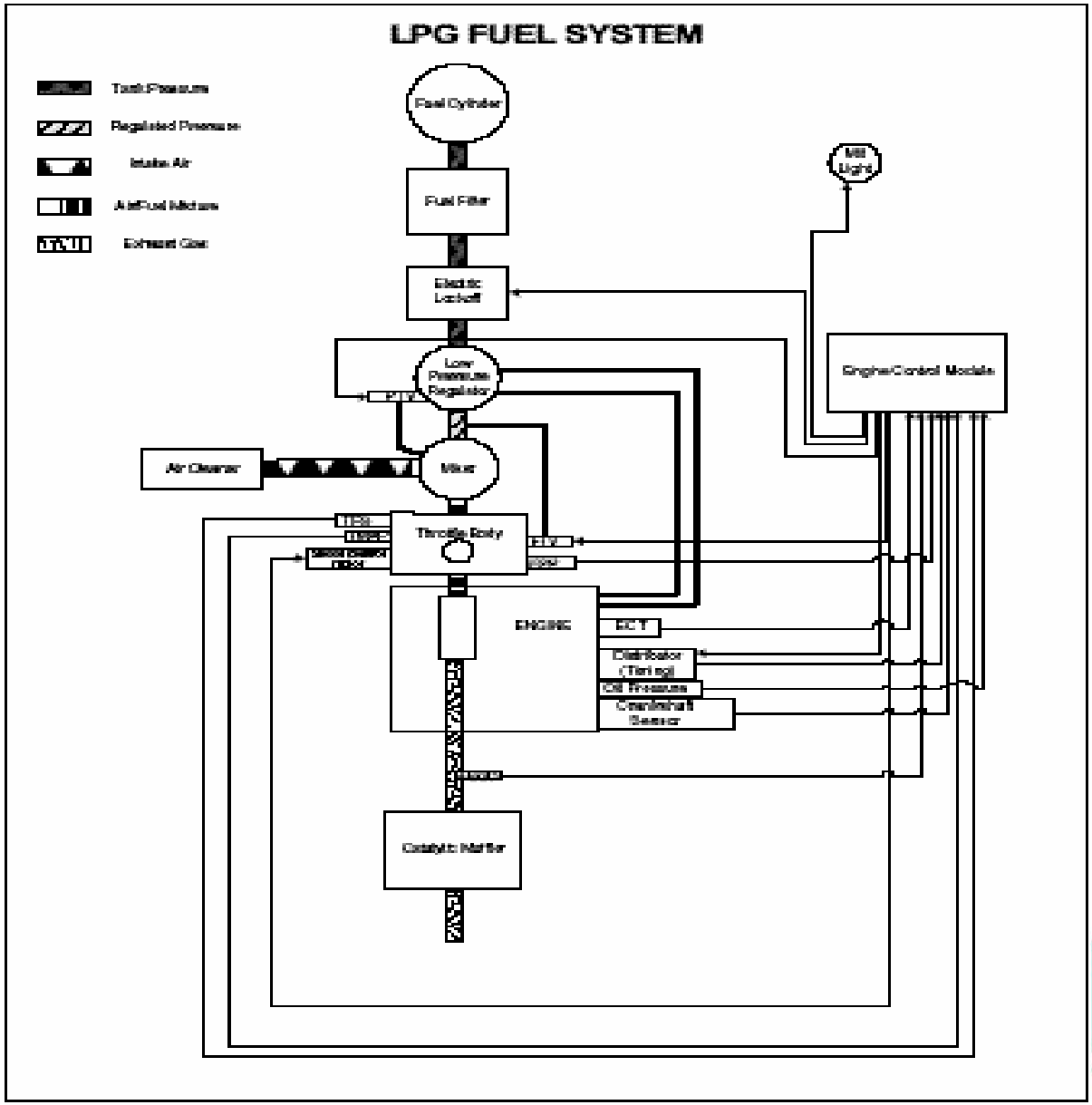

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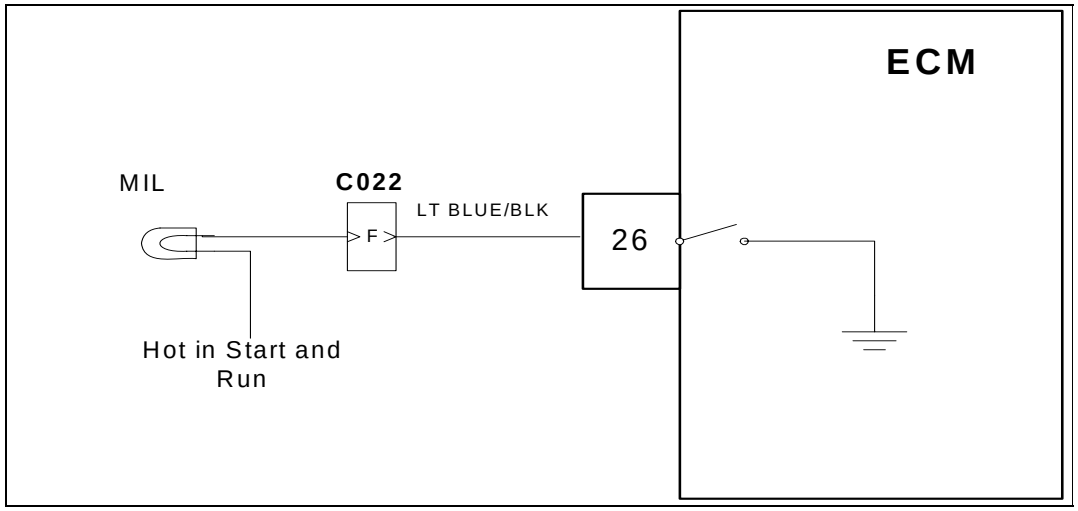
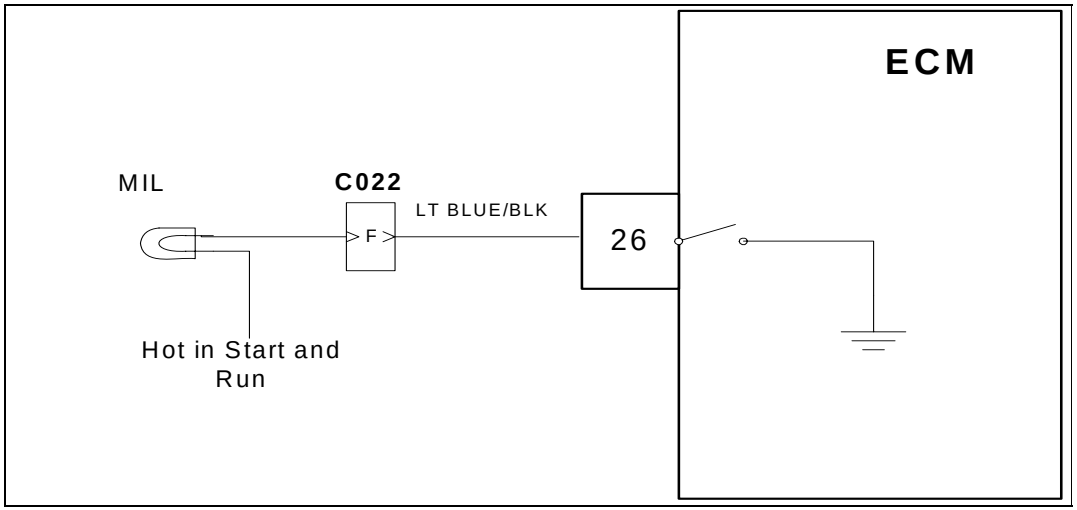
MIL (Malfunction Indicator Lamp)



Notifies the driver of a problem with the emission control system.

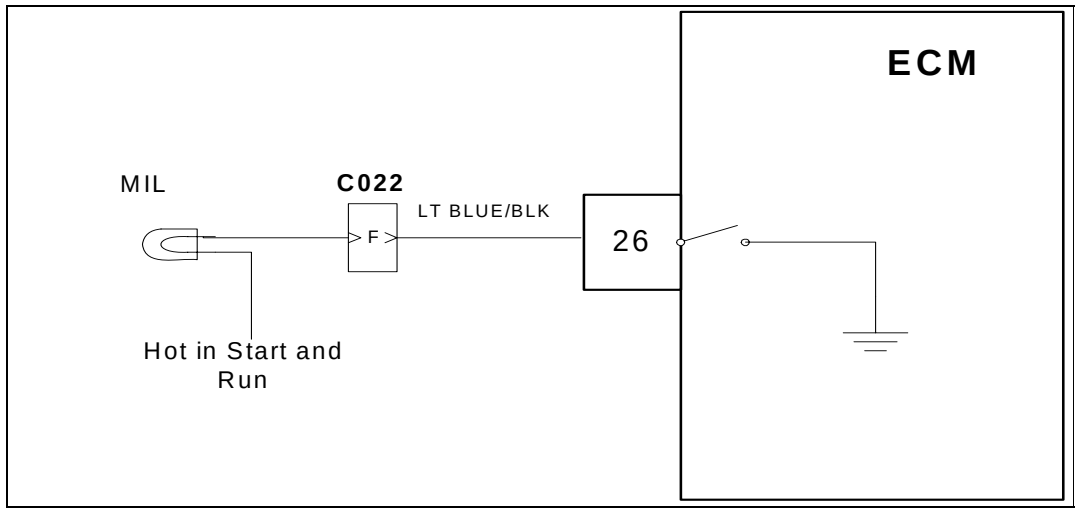


Most engine control system related problems that affect emissions or driveability of the vehicle will set a (DTC) Diagnostic Trouble Code and illuminate the Malfunction Indicator Lamp.

The lamp should come on when the key is in the ON position and the engine is not running (Bulb Check Function)

Once the engine is in start or run mode, the lamp should go off.

If the lamp illuminates while the engine is in the start or run mode, there is a current Diagnostic Trouble Code.



Power is supplied to the bulb through the ignition switch.

The ECM provides ground to illuminate the lamp.

It will also display DTC's that have been stored due to a system malfunction. (Blink Code Function)

Diagnostic Trouble Codes (DTC)

Diagnostic Trouble Codes are set when the Spectrum ECM (Electronic Control Module) runs a diagnostic self-test and the test fails.

If the system continues to fail the test, the lamp will stay illuminated and the DTC is current **(Active).**

All DTC's are stored as (**Historical Faults)** until they are cleared.

All DTC's except the ECM related DTC's will automatically clear from memory if the DTC does not reset within 100 consecutive engine run cycles.

While a Diagnostic Trouble Code is current for a sensor, the ECM may assign a default "limp home" value and use that value in its control strategy.

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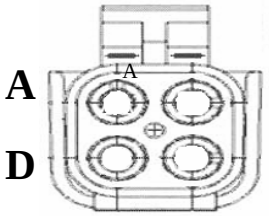
Blink Code Function



Diagnostic Link Connector

If you do not have access to a laptop computer, it is still possible to access the Diagnostic Trouble Codes stored in the memory of the Spectrum system ECM using a diagnostic jumper and the MIL. With the key off connect diagnostic pins **A** and **D**. Turn the ignition on but do not start the vehicle. The Malfunction Indicator Lamp (MIL) will begin to flash. The MIL displays three digit codes by flashing the first digit, pausing, then flashing the second digit, pausing, and then flashing the third digit. The MIL will first display a 166 three times. Code 166 indicates that the ECM based diagnostic routines are functioning. Then, any Diagnostic Trouble Codes stored in memory will display three times each. The MIL will then start over with the code 166.

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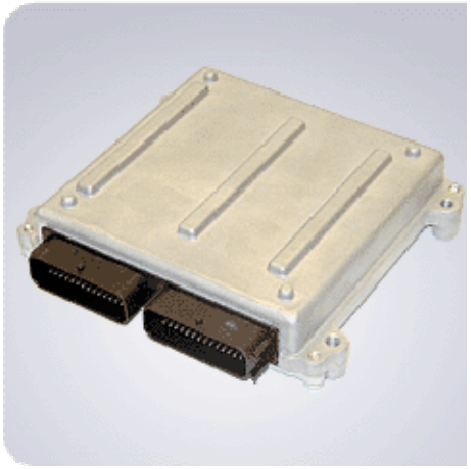
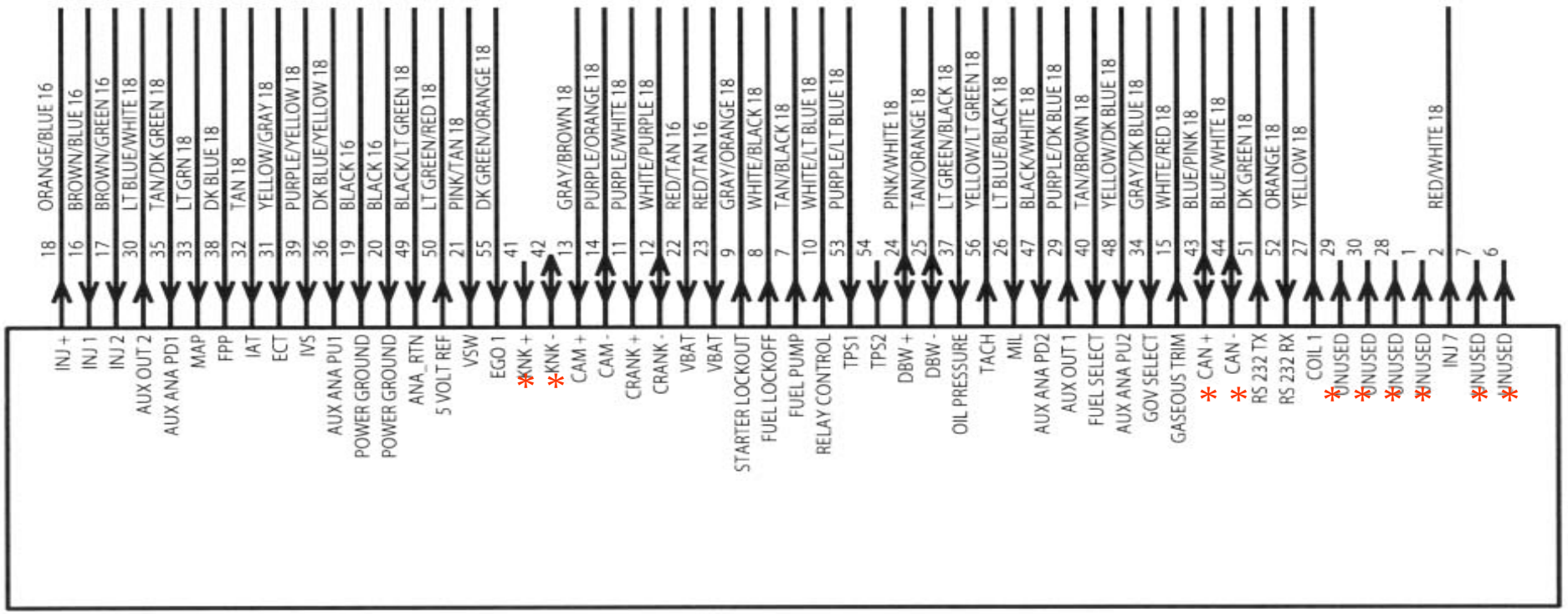


ECM (Electronic Control Module) 56 Pin Connector

32 Bit Processor

Under hood temperature compatible

Extended Capabilities out to 2007 Model Year



ECM Non Volatile Memory

Diagnostic Trouble Codes will be cleared from the system ECM memory by moving the ignition key to the OFF position and removing the (F1) system battery fuse for at least 15 seconds.

This will erase all of the Diagnostic codes stored in the computer memory including the adaptive learn.

It will not erase the fuel calibration.

It will not erase the computer serial identification

It will not erase the internal hour meter

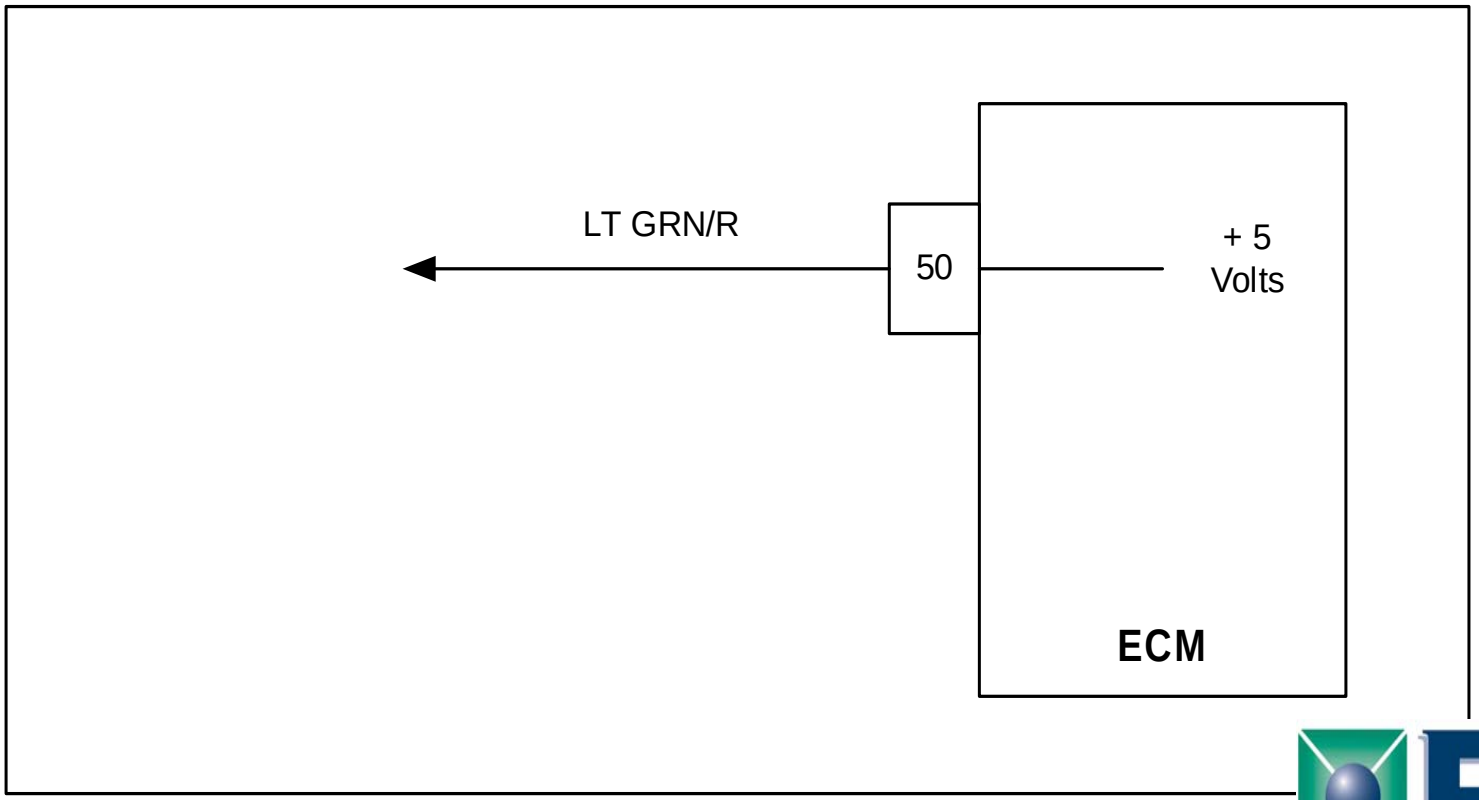
ECM Flash Memory

Flash programming helps minimize the risk of ESD damage

ECM fuel calibrations are downloaded to the ECM using the diagnostic link connector

Software calibration updates are available for in field use without disassembling the ECM to replace an E-PROM

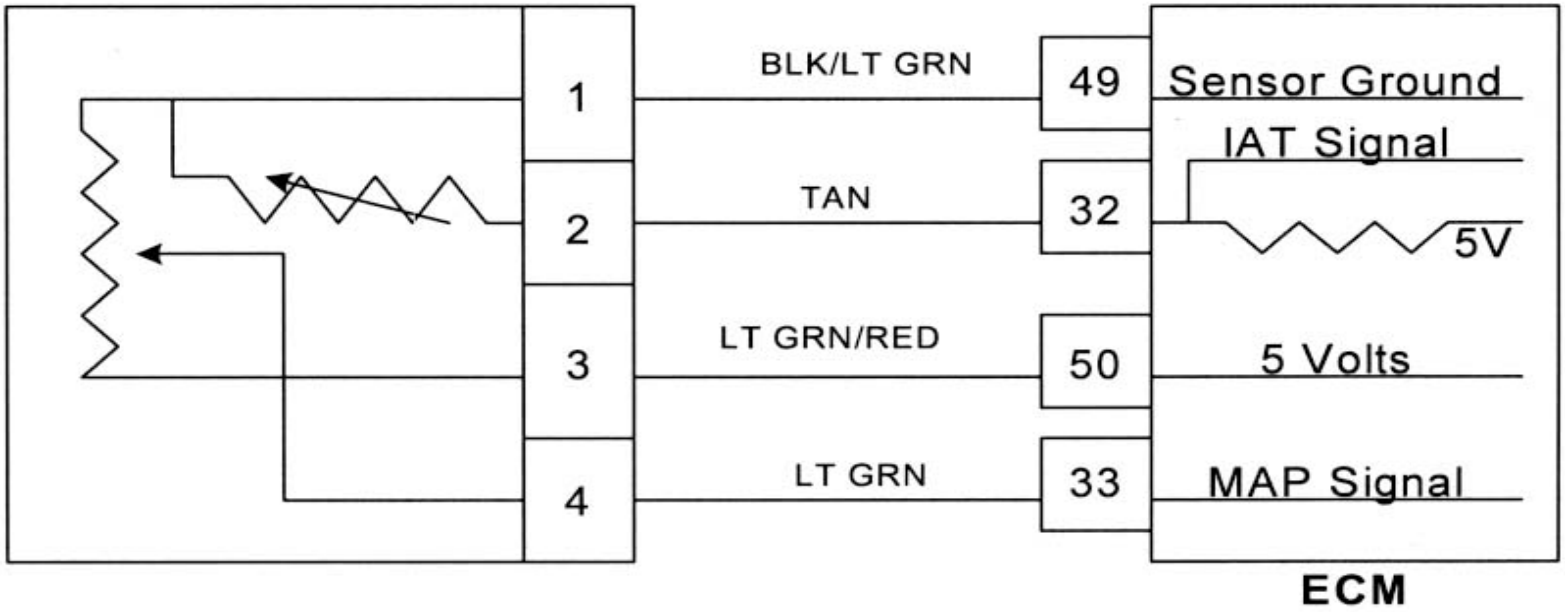
ECM Provides an external 5 volt reference to engine sensors



ECM also provides an internal 5 volt reference

Sensor load creates a voltage drop at the internal resistor

Voltage drop is used by the ECM to determine sensor value



* Internal reference shown pin 32

*External reference shown pin 50

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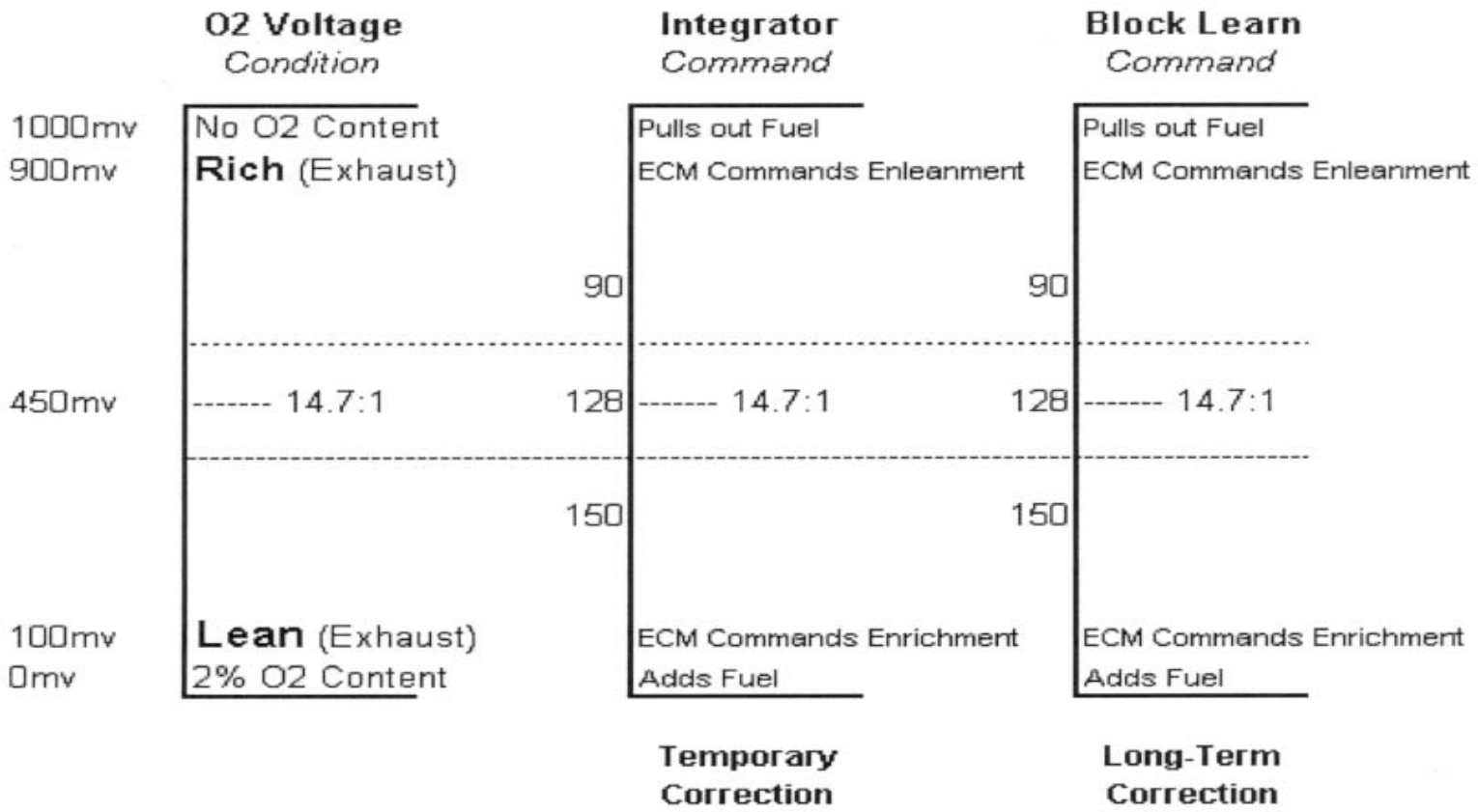
Adaptive Learn



Adaptive (Block) Learn

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ESD (Electrostatic Discharge)

Electronic components used in control systems are often designed to carry very low voltage, and are very susceptible to damage caused by electrostatic discharge.

It possible for less than 100 volts of static electricity to cause damage to some electronic components. By comparison, it takes as much as 4,000volts for a person to even feel the zap of a static discharge.

There are several ways for a person to become statically charged. The most common methods of charging are by friction and by induction.

An example of charging by friction is a person sliding across a truck seat, in which a charge of as much as 25,000 volts can build up.

Charging by induction occurs when a person with well insulated shoes stands near a highly charged object and momentarily touches ground.

Static charges of either type can cause damage, therefore, it is important to use care when handling and testing: electronic components.

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Using a Laptop Computer to Diagnose the Spectrum System

Minimum System Requirements

Pentium II 450 Processor

Win98SE, 2000 and XP Operating Systems

64 MB Ram for Win98

128 MB Ram for Win2000

256 MB Ram for WinXP

Serial Port (RS232) or USB 1.1 or 2.0 connection

USB interface for Win2000 and XP only.

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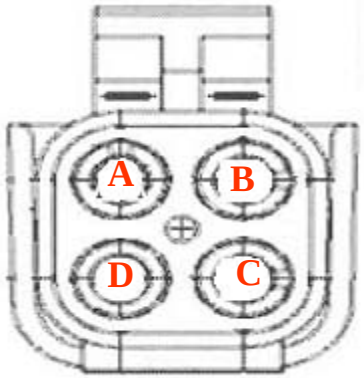
Diagnostic Link

RS 232

Diagnostic Link Connector (DLC)



Pin	Wire Color	Function
A *	Orange	RS232 RX
B	Dark Green	RS232 TX
C	Lt Green/Red	5 Volt Ref
D *	Black/Lt Green	Ana Rtn

* **Blink Code Mode**

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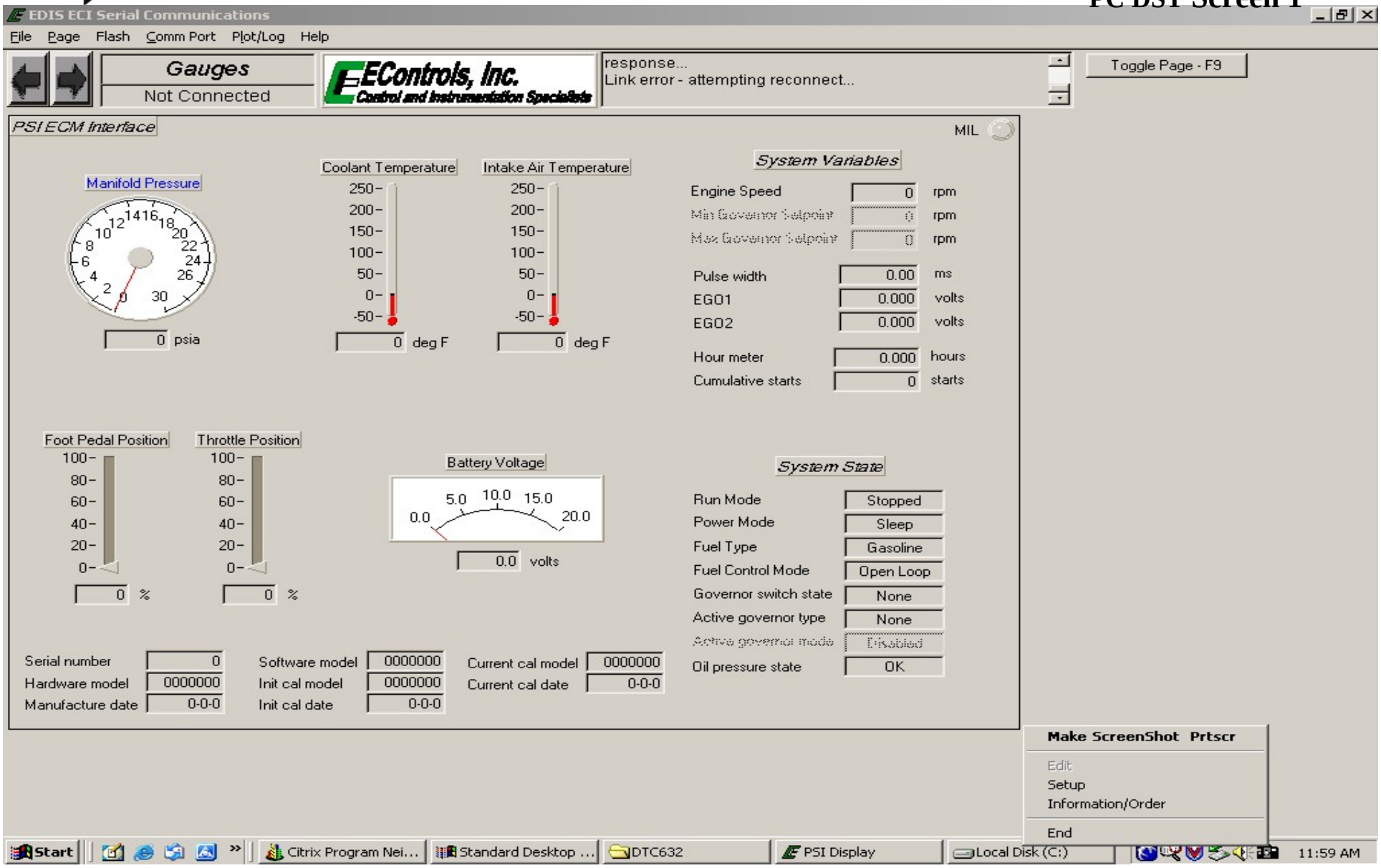
PC DST Screen 1



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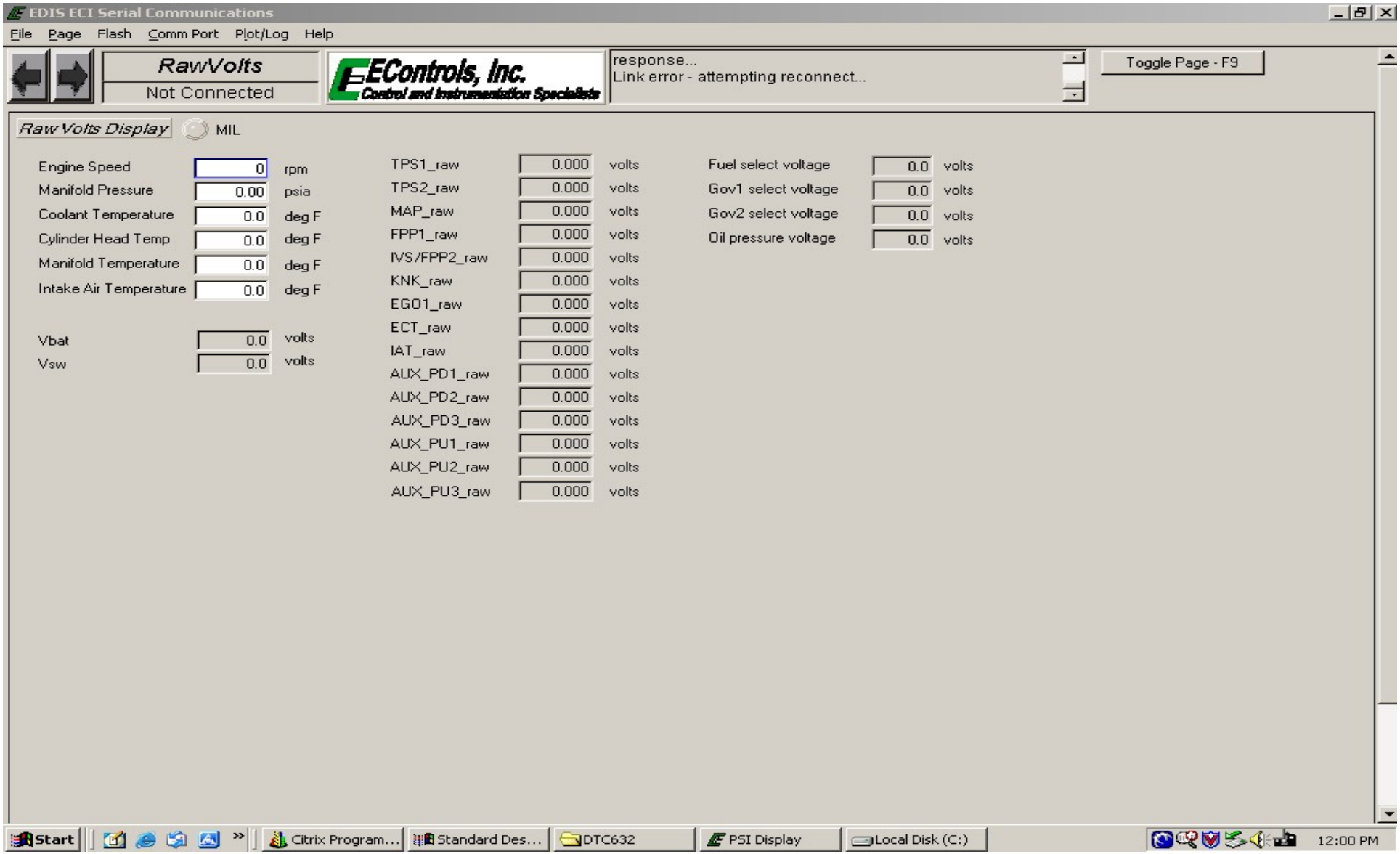
PC DST Screen 2



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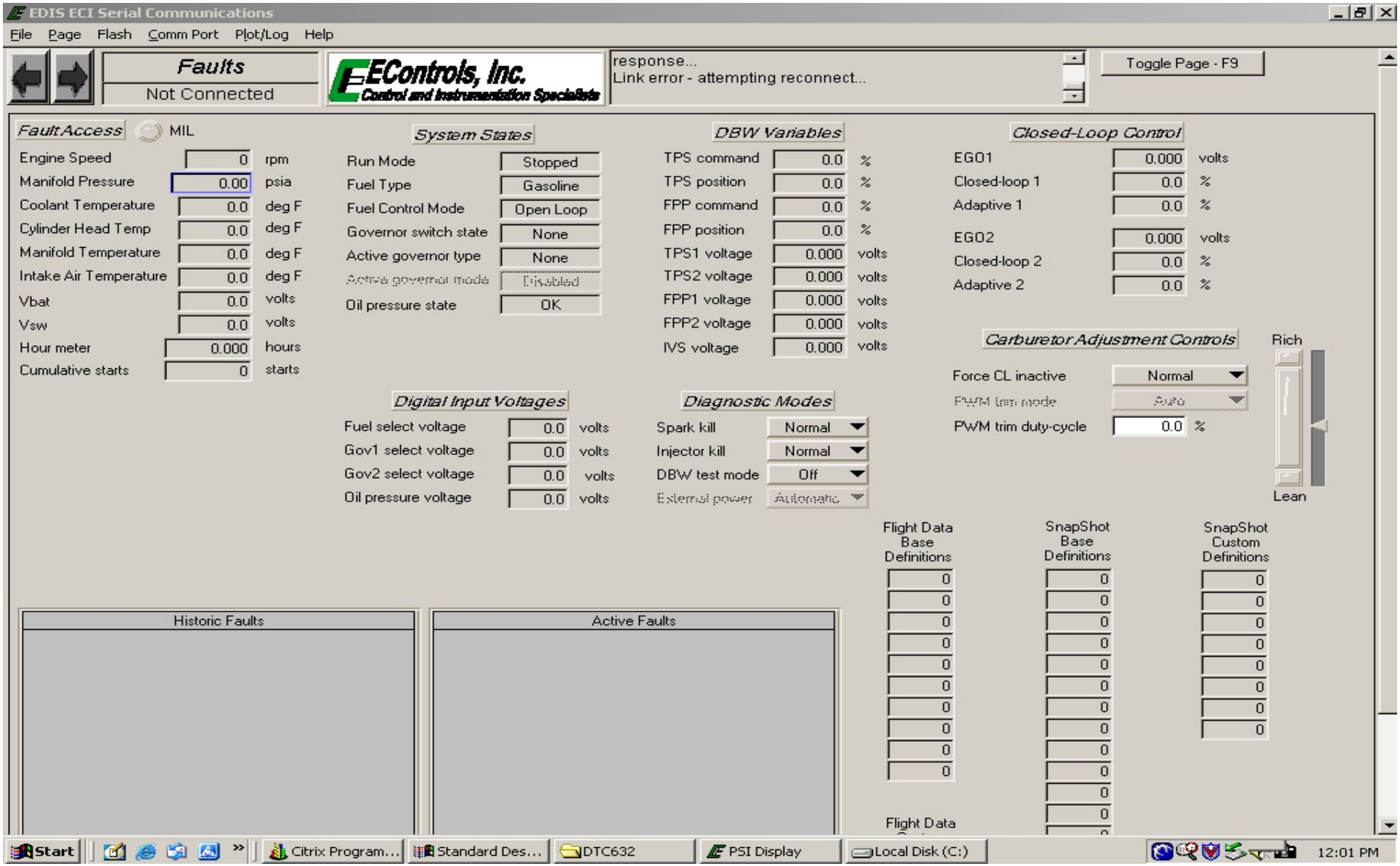
PC DST Screen 3



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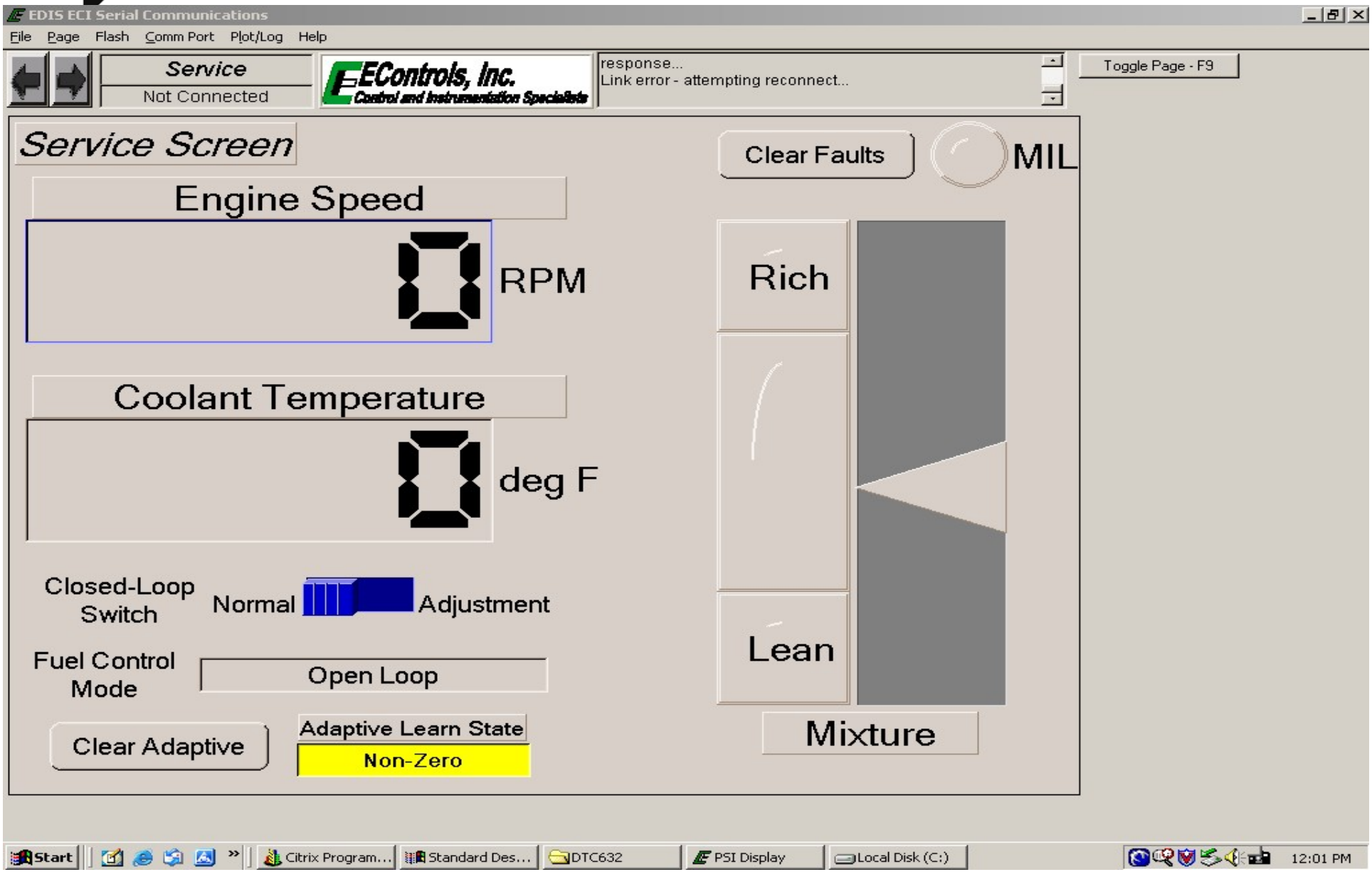
PC DST Screen 4



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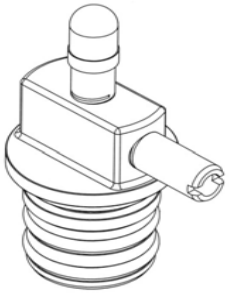
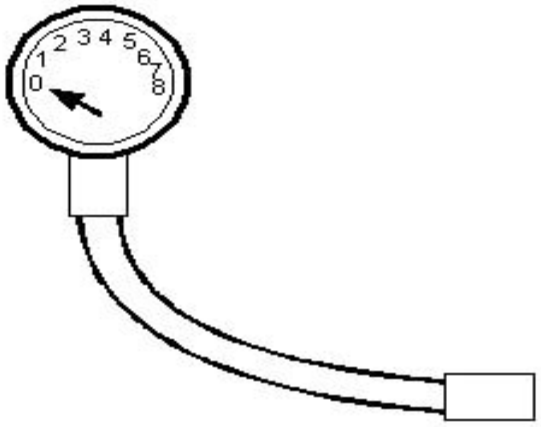
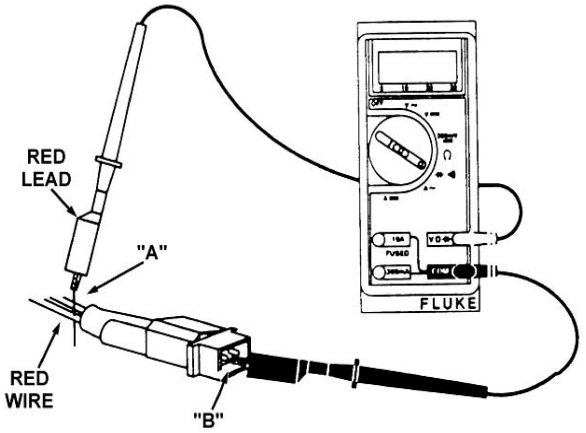
ITK-2 Pressure Test Kit



AF4-31105



Fuel Injection Pressure Gauge



High Impedance DVOM with Duty Cycle %

12 Volt Test Lamp

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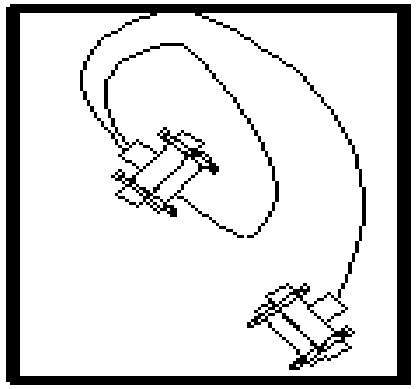
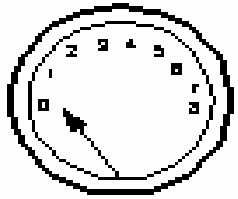
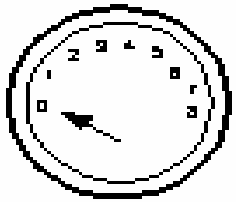
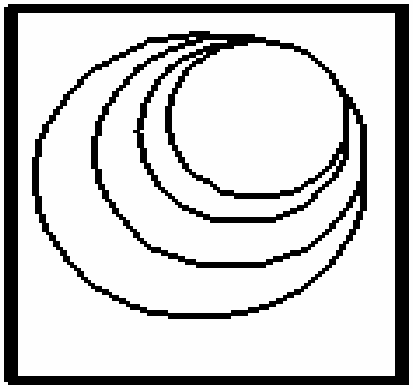
SPECTRUM SPECIAL TOOL KIT



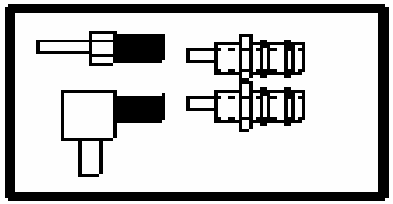
PDA TO Harness Cable

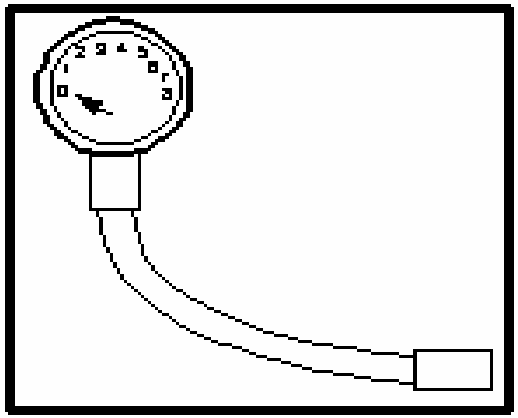






VACUUM HOSE





GASOLINE PRESSURE TEST GUAGE

MISC
FITTINGS
O-RINGS

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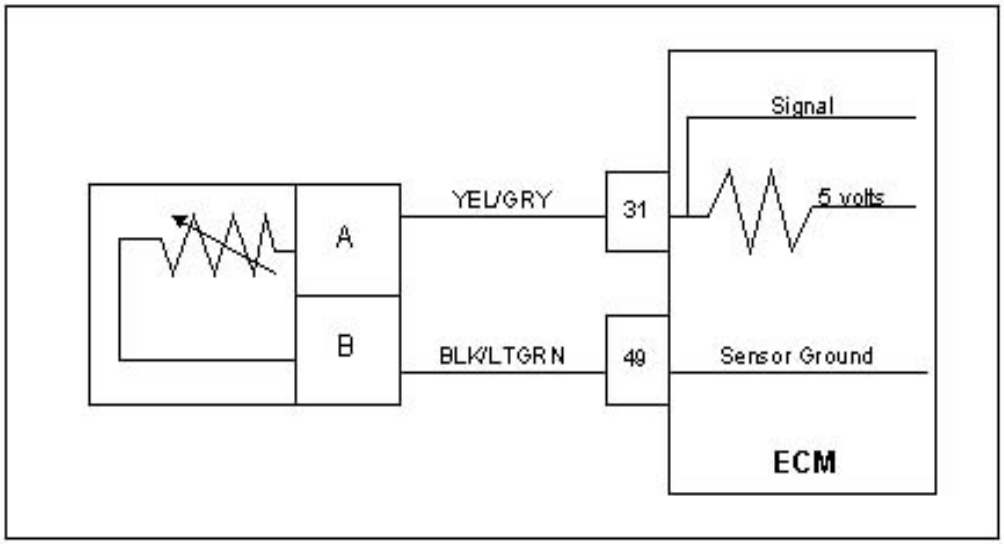
Using the DTC Schematic:

Pin numbers, connector letters and wire colors

DTC 122-ECT Low Voltage



Provides additional test criteria for the DTC

What function the DTC is designed to indicate

When the ECM runs the diagnostic sensor test

MIL reaction to the DTC

How the ECM will react during the fault

Conditions for Setting the DTC

- Engine Coolant Temperature
- Check Condition-Engine Running
- Fault Condition- ECT sensor voltage less than 0.05
- MIL-On during active fault and for 2 seconds after active fault
- Adaptive-Disabled during active fault
- Closed Loop-Enabled

Circuit Description

The ECT (Engine Coolant Temperature) sensor is a temperature sensitive resistor located in the engine coolant. It is used for the engine airflow calculation, gasoline cold enrichment and to enable other temperature dependant features. The ECM provides a voltage divider circuit so that when the coolant is cool, the signal reads higher voltage, and lower when warm.
This fault will set if the signal voltage is less than 0.05 volts anytime the engine is running. The ECM will use a default value for the ECT sensor in the event of this fault.

Provides some general circuit operation

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Using the DTC chart:

The chart starts with the MIL check to validate the MIL function.

The chart ends with the instruction to remove any test equipment (except the DST) Diagnostic Scan Tool. Additional specific instructions are provided depending on the DTC to verify a successful repair.

DTC 122- ECT VOLTAGE LOW

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	▪ Key On ▪ DST (Diagnostic Scan Tool) connected to ▪ System Data Mode Does DST display ECT voltage of 0.05 or less?		Go to step (3)	Intermittent problem Go to Intermittent section
3	▪ Key Off ▪ Disconnect the ECT wire harness connector ▪ Key ON Does the DST display ECT voltage of 4.9 volts or greater?		Go to step (4)	Go to step (5)
4	Replace ECT sensor. Is the replacement complete?		Go to Step (8)	-
5	▪ Key OFF ▪ Disconnect ECM wire harness connector ▪ Check for continuity between ECT sensor connector signal pin A and ECT sensor ground pin B Do you have continuity between them?	–	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to step (6)
6	▪ Check for continuity between ECT sensor connector signal circuit pin A and engine ground. Do you have continuity?	–	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to step (7)
7	Replace ECM. Refer to ECM replacement in the Engine Controls Section. Is the replacement complete?	-	Go to step (8)	-
8	▪ Remove all test equipment except the DST. ▪ Connect any disconnected components, fuses, etc. ▪ Using the DST clear DTC information from the ECM. ▪ Turn the ignition OFF and wait 30 seconds. ▪ Start the engine and operate the vehicle to full operating temperature ▪ ▪ Observe the MIL ▪ Observe engine performance and driveability ▪ After operating the engine within the test parameters of DTC-122 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

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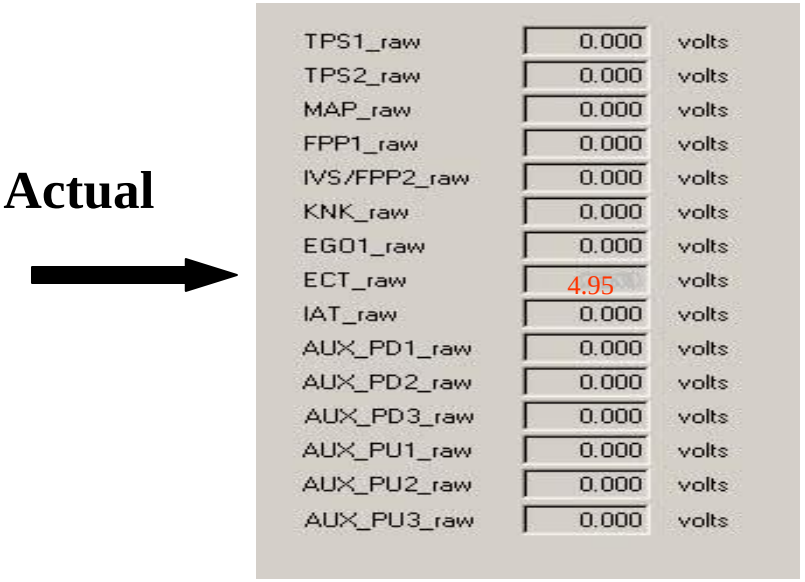
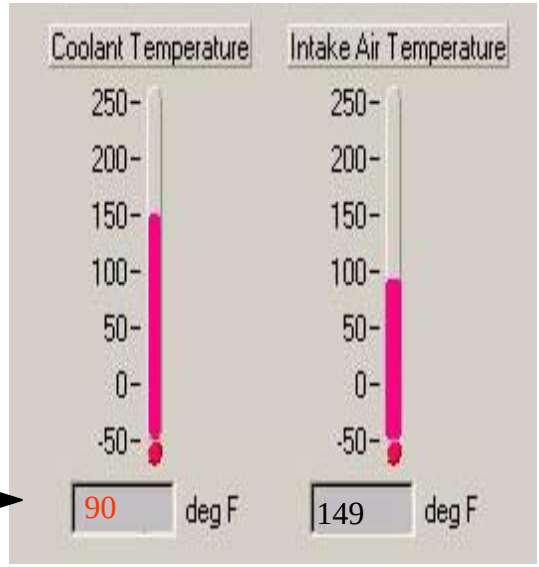
Actual



Default Value



The ECM provides default values for critical sensor inputs to protect the engine system from possible damage.

If a DTC for a sensor is current, the gauge screen display value for that sensor may be a default value. The voltage value in the “raw” voltage screen will be the actual sensor voltage.

Always use the voltage value when performing diagnostics unless directed otherwise by the diagnostic chart.

ECM Protection Systems

Certain DTC codes that set will result in system power reduction, or complete engine shutdown.

The ECM is programmed to do this in the event a failure is determined to cause possible risk to the operator, damage to the engine or catalytic converter.

Some code groups will provide a warning to a possible shutdown

Example:

DTC 113-IAT Higher than expected 1

DTC 114-IAT Higher than expected 2

DTC 113-IAT Higher Than Expected 1 (Bosch® TMAP)

Conditions for Setting the DTC

- l Intake Air Temperature
- l Check Condition-Engine Running
- l Fault Condition-Intake Air Temperature greater than 200 degrees F. and engine RPM greater than 1000
- l MIL-On
- l Adaptive-Disabled during active fault
- l Power Derate (Level 1)

Circuit Description

The TMAP is a combined IAT (Intake Air Temperature) and MAP (Manifold Absolute Pressure) sensor. A temperature sensitive resistor is used in the TMAP located in the intake manifold of the engine. It is used to monitor incoming air temperature, and the output in conjunction with other sensors is used to determine the airflow to the engine. The ECM provides a voltage divider circuit so that when the air is cool, the signal reads higher voltage, and lower when warm. The IAT is a calculated value based mainly on the IAT sensor at high airflow, and influenced more by the ECT (Engine Coolant Temperature) at low airflow. This fault will set if the Intake Air Temperature is greater than 200 degrees F. with engine RPM greater than 1000. Power Derate 1 will be enforced during this fault. Maximum throttle position is limited to 50% and the MIL lamp will be on.

Diagnostic Aids

* This fault will set when inlet air is much hotter than normal. The most common cause of high inlet air temperature is a problem with the inlet air system. Ensure that the air inlet is not obstructed, modified or damaged.

* Inspect the air inlet system for cracks or breaks that may allow unwanted under hood air in to the air inlet system

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DTC 114-IAT Higher Than Expected 2 (Bosch® TMAP)

Conditions for Setting the DTC

- Intake Air Temperature
- Check Condition-Engine Running
- Fault Condition-Intake Air Temperature greater than 210 degrees F engine RPM greater than1000
- MIL-On for active fault and for 15 seconds after active fault
- Adaptive-Disabled during active fault
- Engine Shut Down

Circuit Description

The TMAP is a combined IAT (Intake Air Temperature) and MAP (Manifold Absolute Pressure) sensor. A temperature sensitive resistor is used in the TMAP located in the intake manifold of the engine. It is used to monitor incoming air temperature, and the output in conjunction with other sensors is used to determine the airflow to the engine. The ECM provides a voltage divider circuit so that when the air is cool, the signal reads higher voltage, and lower when warm.
The IAT is a calculated value based mainly on the IAT sensor at high airflow, and influenced more by the ECT (Engine Coolant Temperature) at low airflow. This fault will set if the Intake Air Temperature is greater than 210 degrees F and engine RPM is greater than 1000. The MIL lamp will be on during this active fault and the engine will shut down

Intermittent problems

Intermittent problems may be the most difficult to resolve.

Before starting the diagnostic procedures for intermittent DTC follow these preliminary checks:

•ECM ground connections must be clean, tight, and in their proper location.

•Vacuum hoses for splits, kinks and proper connections

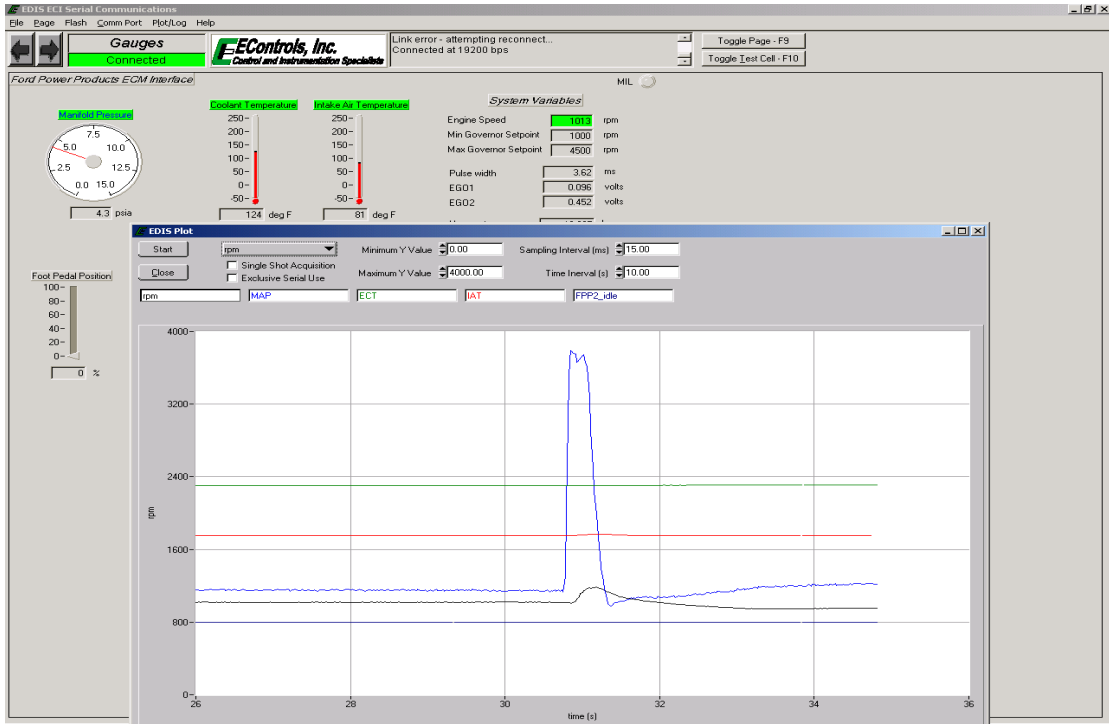
•Air leaks at the throttle body, throttle control unit and intake manifold sealing surfaces

•Ignition wires for cracking, hardness, proper routing and carbon tracking

•Wiring for proper connections, pinches, cuts.

•Sensor connectors for damage, corrosion and contamination

Intermittent Problems



Graphing the Voltage Values

The system diagnostic monitoring software includes graphing and data logging capability. These features greatly enhance the ability to diagnose and repair intermittent problems with the system. The graphing feature allows sensor inputs and select control output variables to be plotted in real-time while the engine is running.

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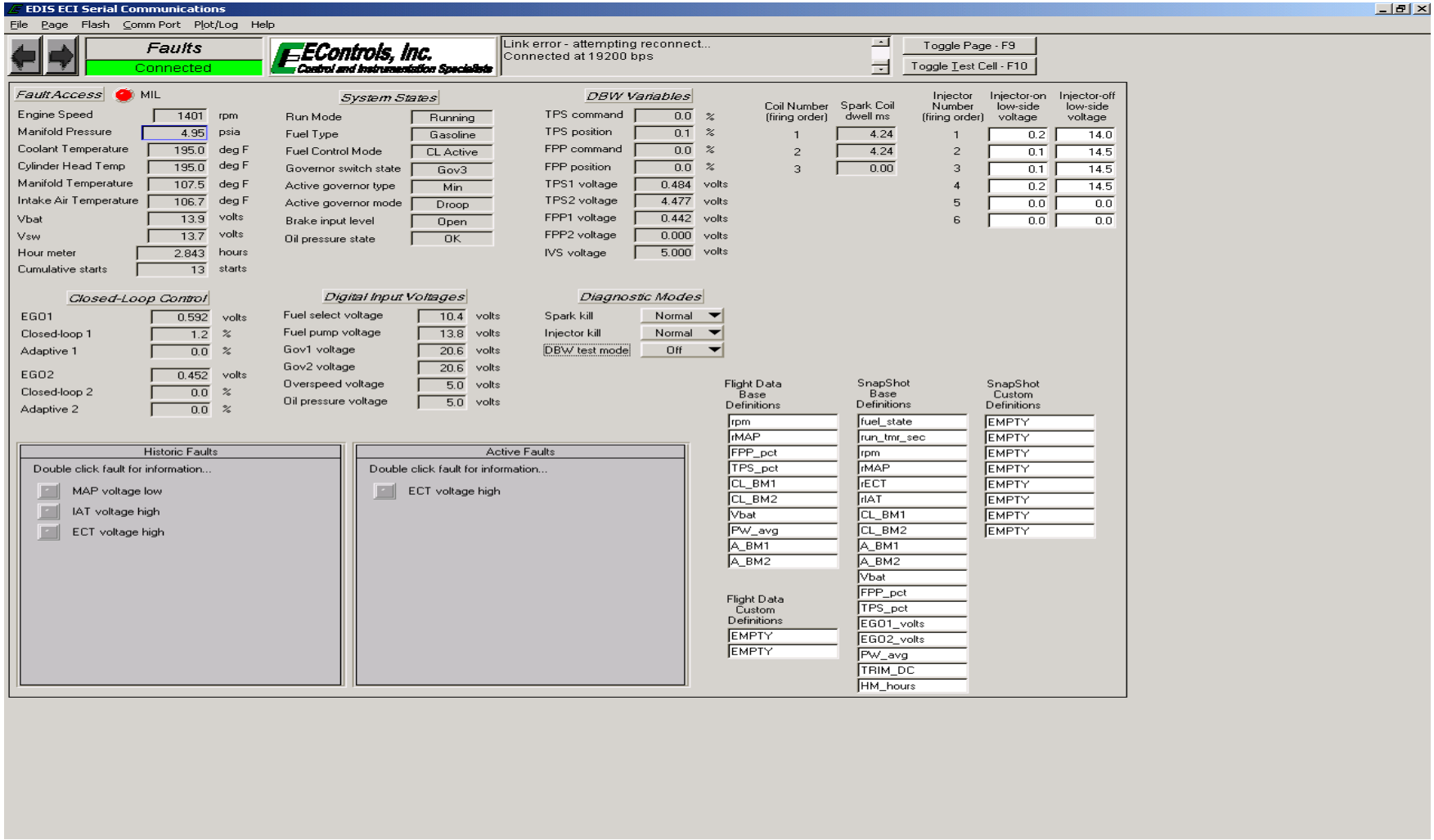

The System Fault screen is used to view and clear DTC's

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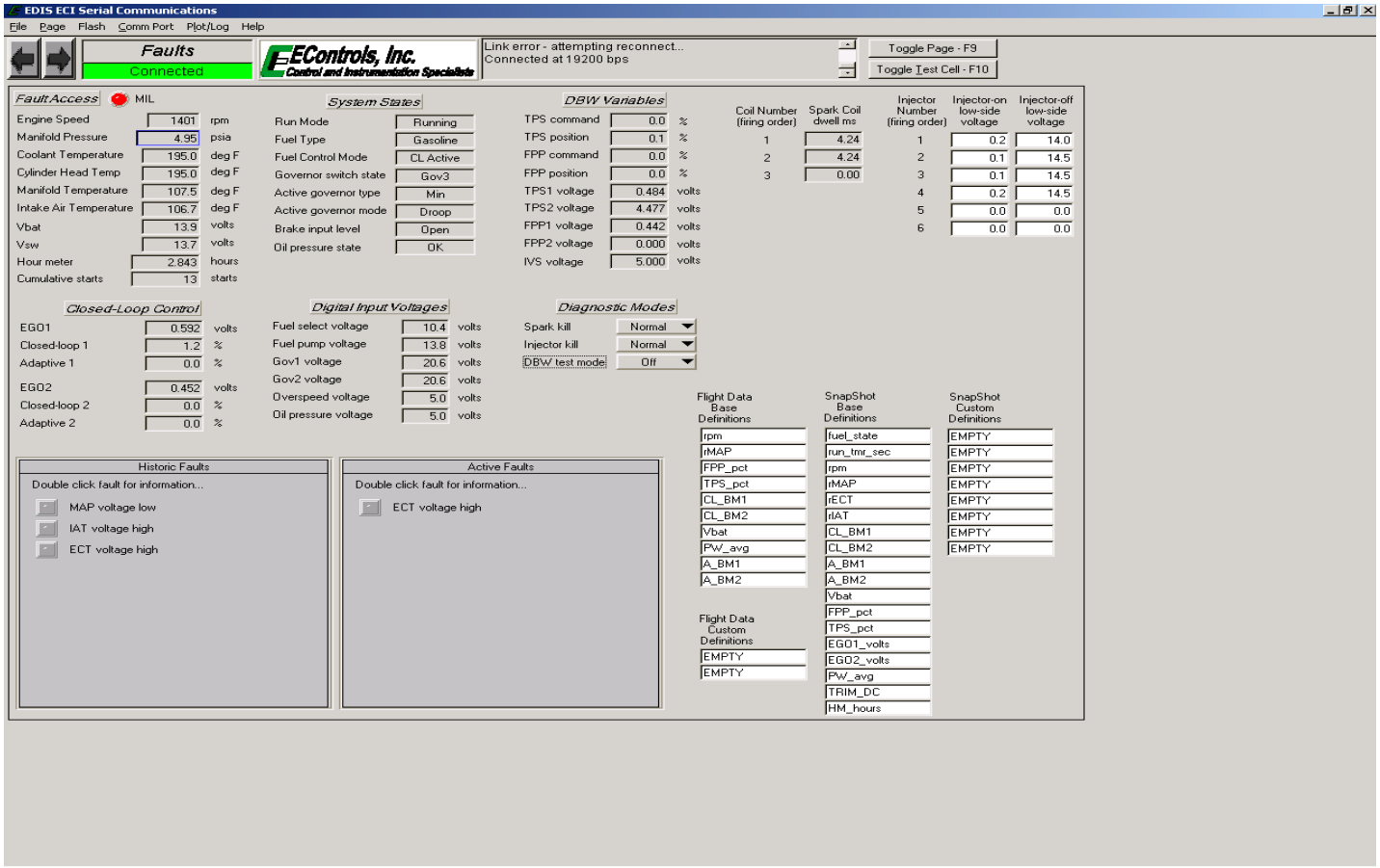

Checking Diagnostic Trouble Codes

The System Fault screen contains a listing of all of the **historic** and **Active** DTC set within the system. If a DTC is stored in memory, the screen will display that fault in the history column. If the fault is active it will also show up in that column.

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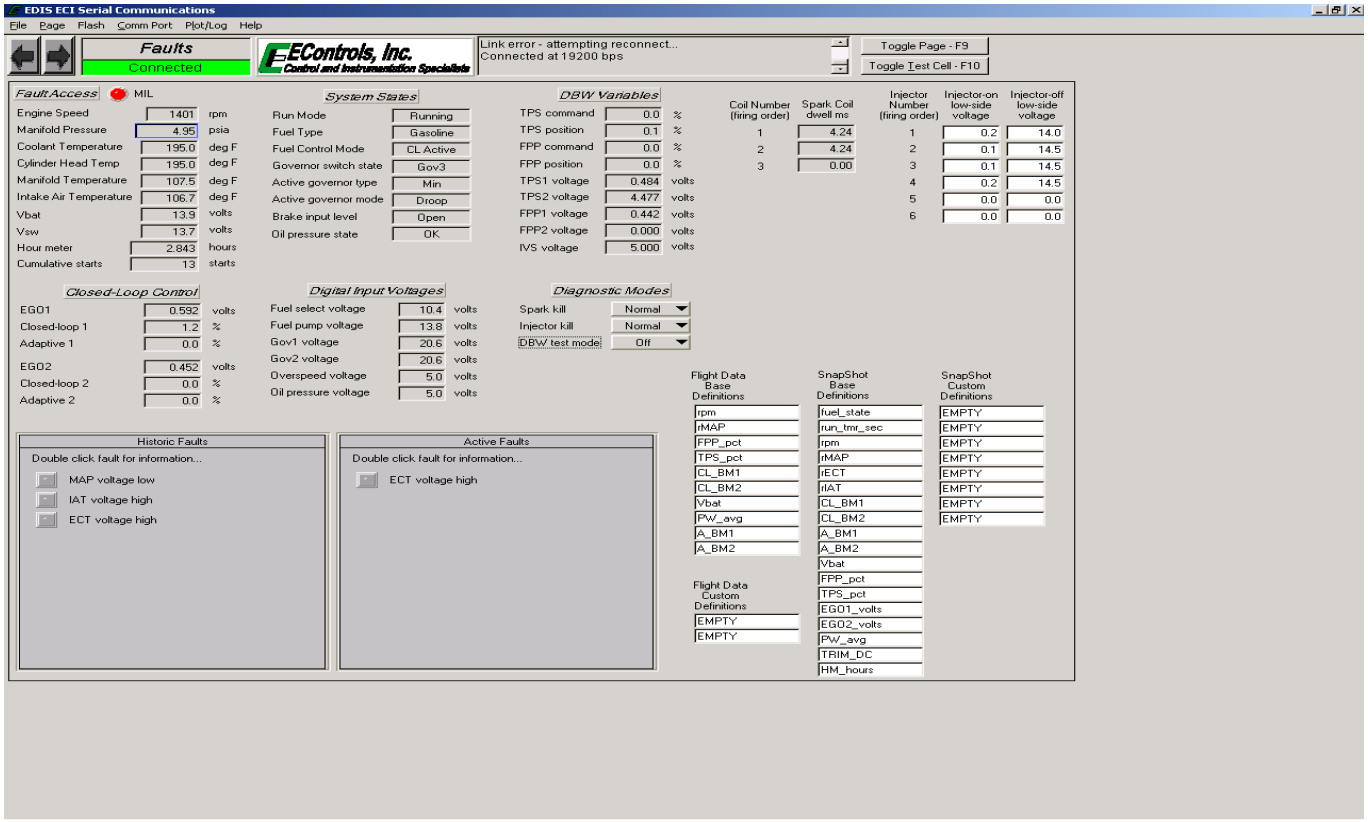

Clearing Diagnostic Trouble Codes

To clear a DTC from memory use the arrow keys or mouse to move then Press the Enter key to clear the fault from memory. **NOTE:** Record faults before erasing them for reference during diagnostics.

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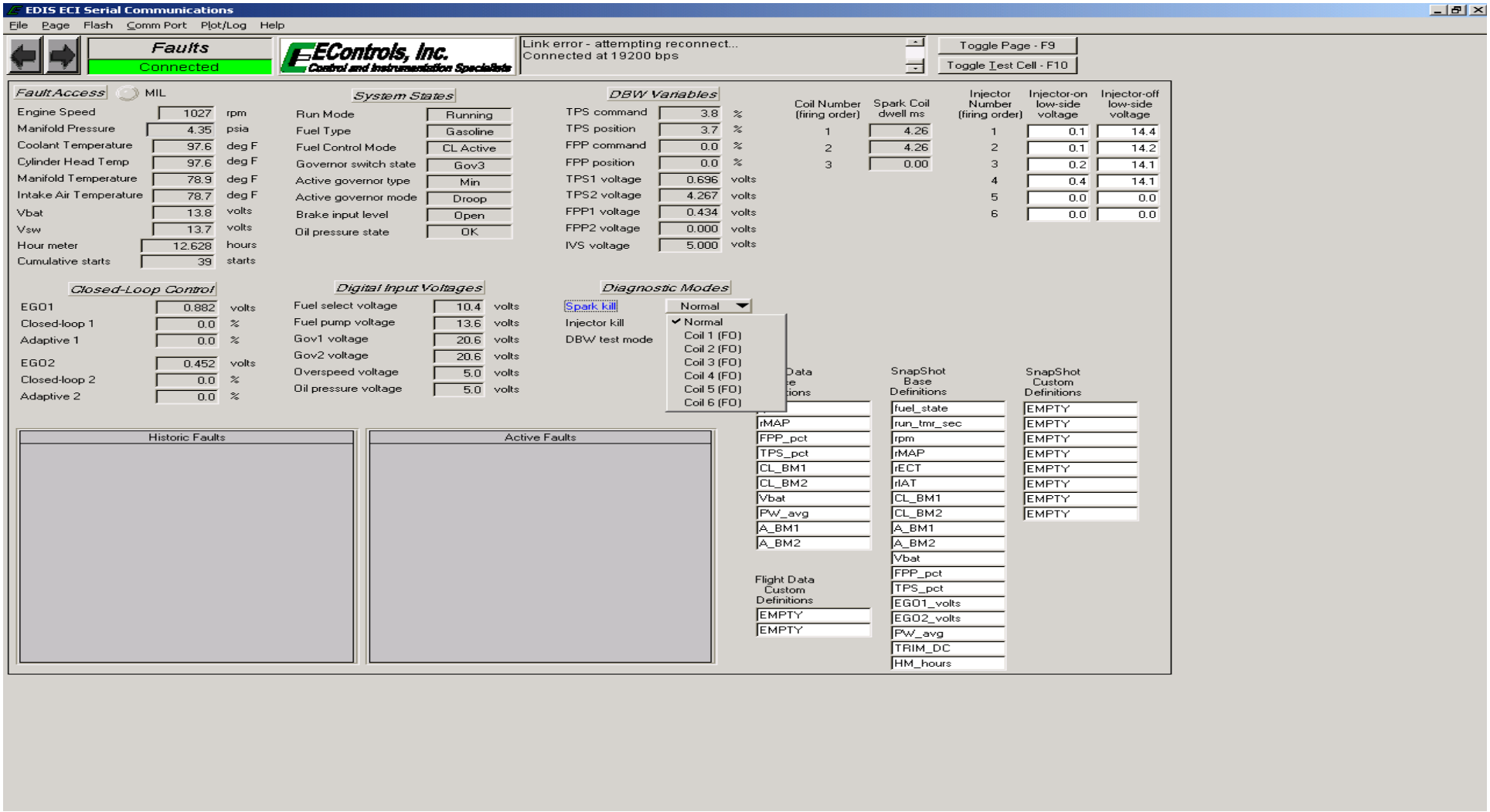
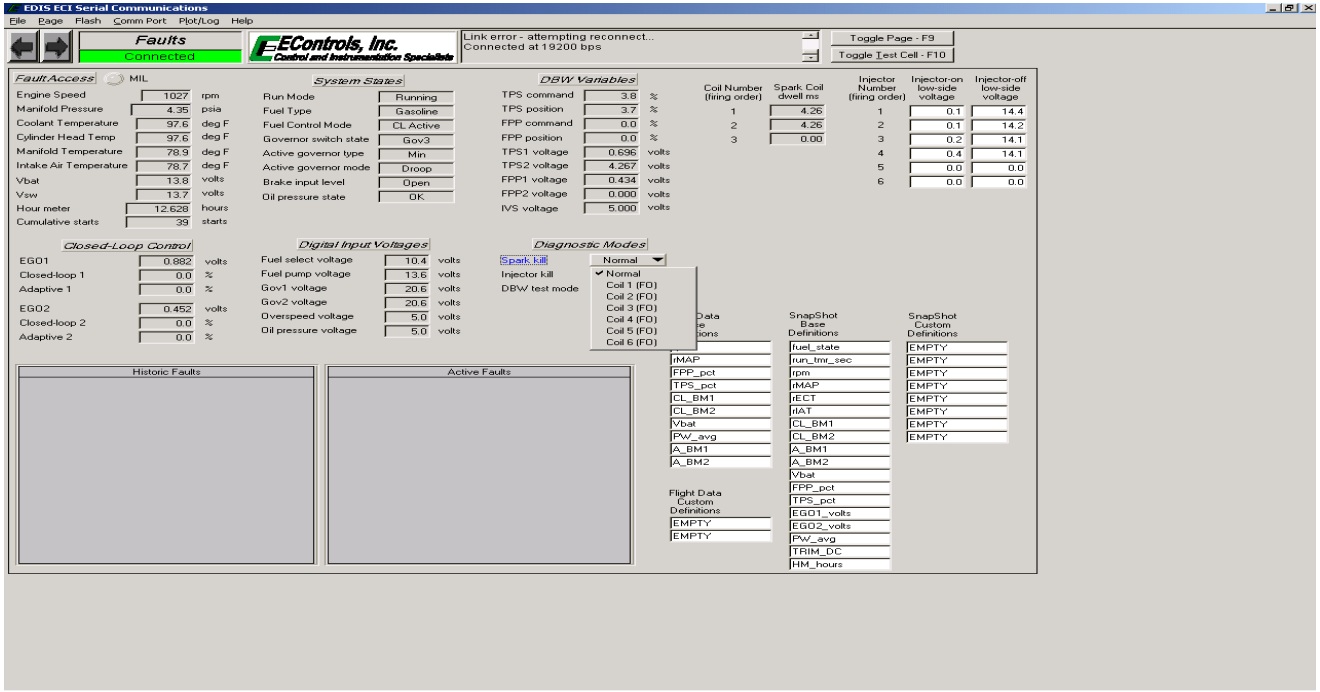


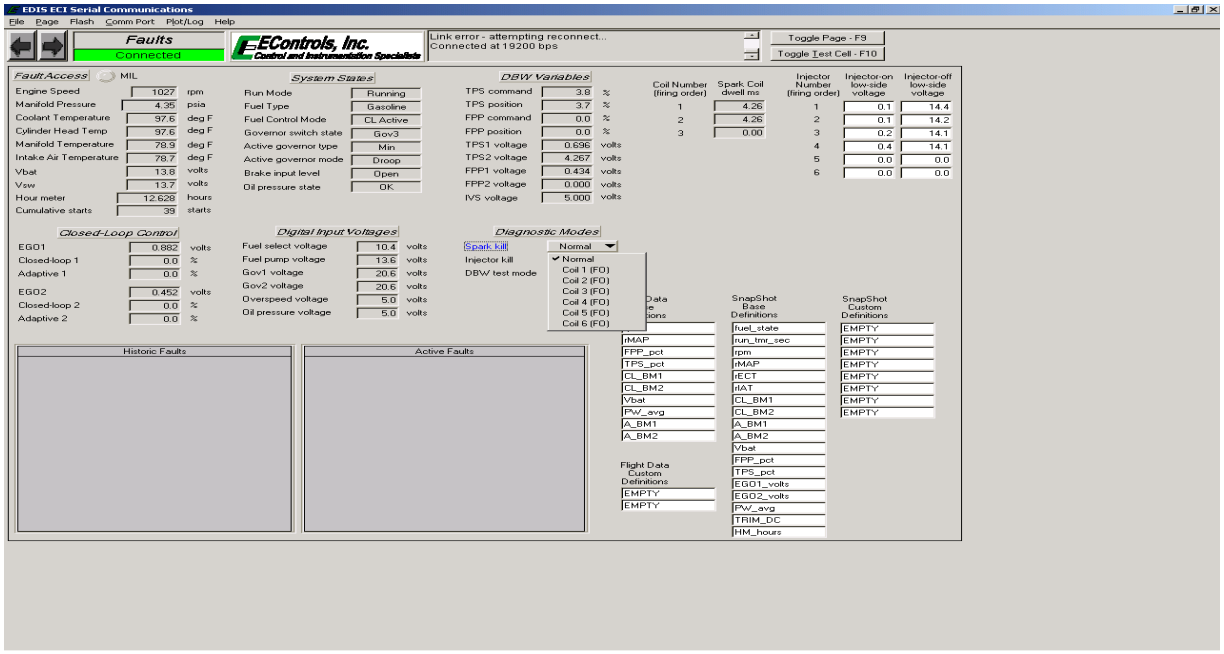
Ignition System Test

Spark Kill



The Spark Kill diagnostic mode allows the technician to disable the ignition on individual cylinders. If the Spark Kill diagnostic mode is selected with the engine running below 1000 RPM, the **minimum throttle command will lock into the position it was in when the test mode was entered** (similar to IAC disabled in automotive systems. If the Spark System Test mode is selected with the engine running above 1000 RPM, the throttle will continue to operate normally.

Spark Kill Continued

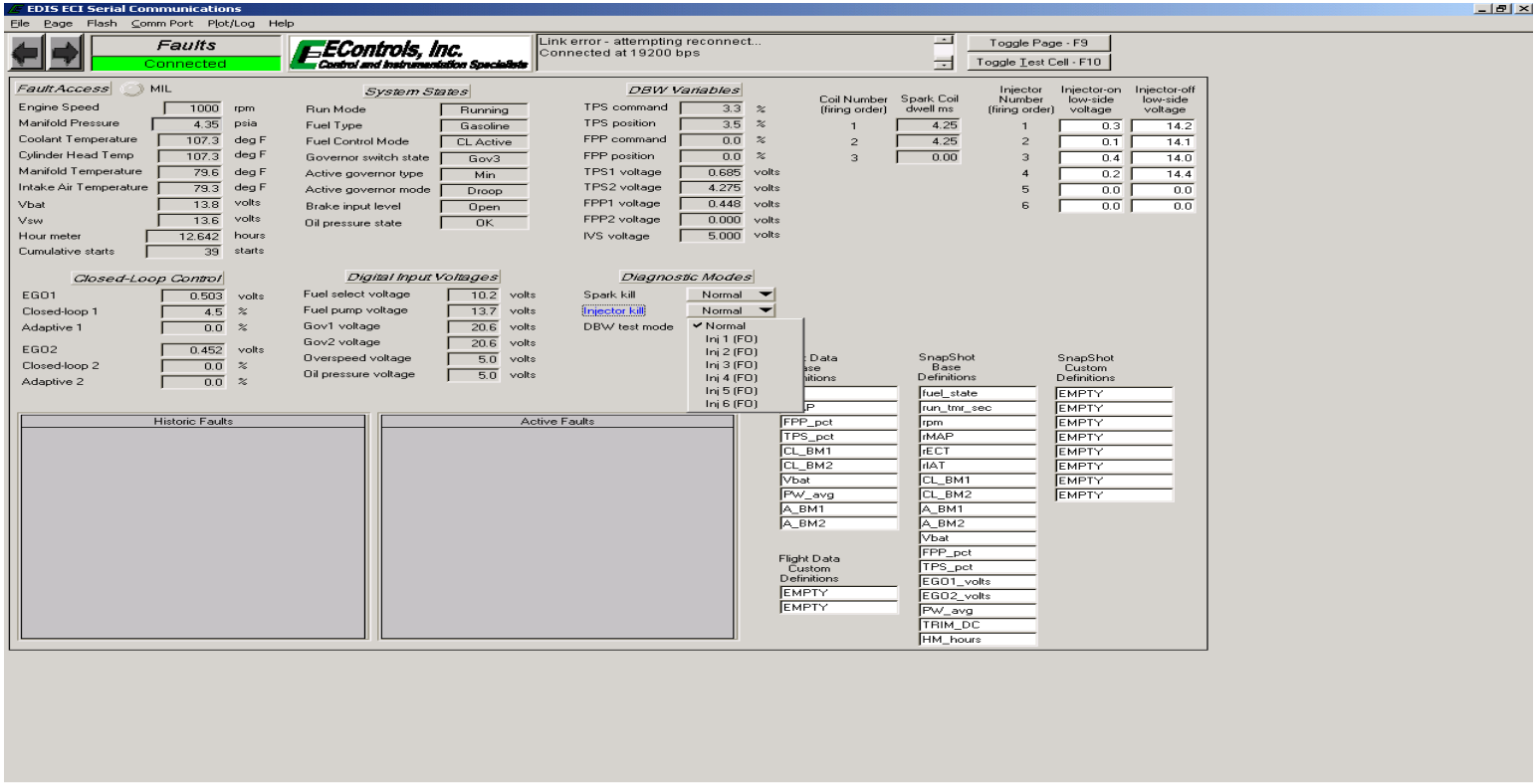


Disabling Ignition Outputs

To disable the ignition system for an individual cylinder, use the mouse to highlight the “Spark Kill” button and select the desired coil. The spark output can be re-enabled by using the mouse to highlight the “Spark Kill” button and selecting “Normal”. If the engine is running below 1000 RPM, the spark output will stay disabled for **15 seconds and then re-set.** If the engine is running above 1000 RPM, the spark output will stay disabled for **5 seconds and then re-set.** This test mode has a timeout of 10 minutes. Record the rpm drop related to each spark output disabled.

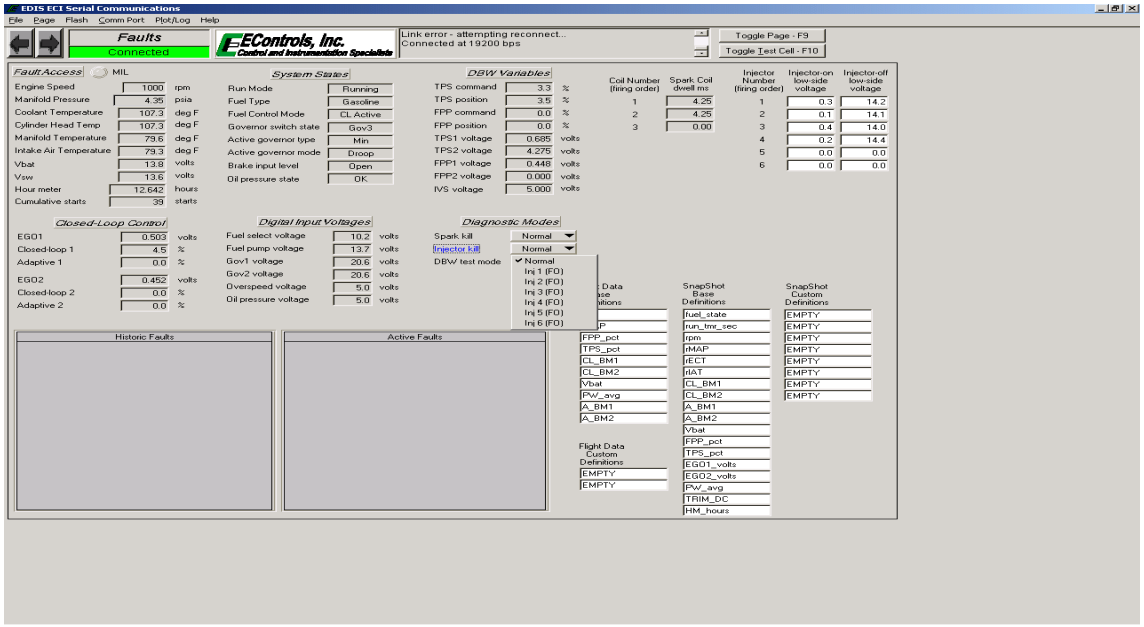
The Spark outputs are arranged in the order which the engine fires, not by cylinder number.

Injector Kill



The Injector Kill mode is used to disable individual fuel injectors. If the Injector Kill mode is selected with the engine running below 1000 RPM, the **minimum throttle command will lock into the position it was in when the test mode was entered** (similar to IAC disable in automotive systems) If the Injector Kill mode is selected with the engine running above 1000 RPM, the throttle will continue to operate normally.

Disabling Injectors



To disable an injector, use the mouse to select the desired. The word “Normal” will change to the Injector you have selected. The injector driver can be re-enabled by selecting again. If the engine is running below 1000 RPM, the injector driver will stay **disabled for 15 seconds** and then re-set. If the engine is running above 1000 RPM, the injector driver will stay **disabled for 5 seconds** and then re-set. Record the drop in rpm.

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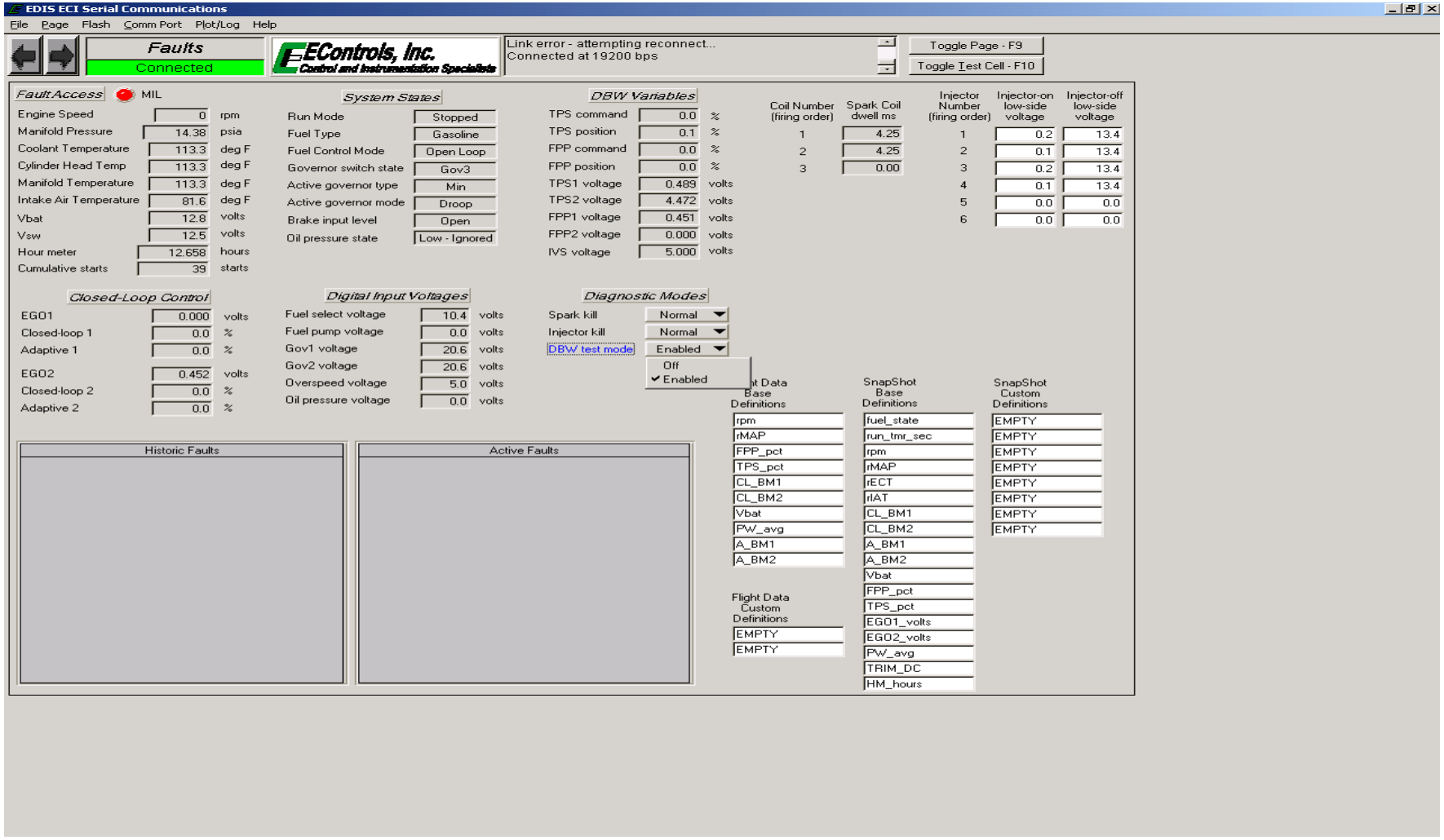
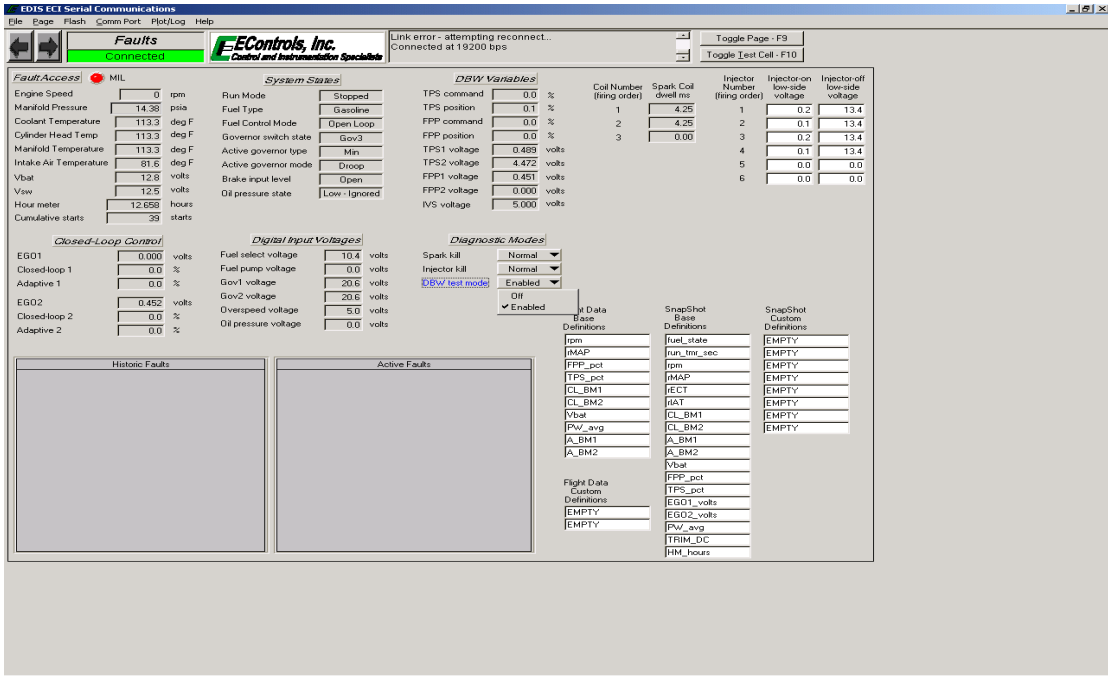
Throttle Test



Drive By Wire Test Mode



To select this test mode the engine must be off but the key must be in the **ON** position.

The DBW (Drive By Wire) test mode allows the technician to control the throttle directly with the foot pedal or throttle input and is used during some diagnostic routines specified to the FPP and TPS sensors. Drive by cable (DBC)systems may also call for the use of this function for diagnostics.

FPP position displays the current position of the foot pedal as a percentage. FPP volts display the voltage which the ECM is reading from the FPP sensor.

TPS Command displays the commanded throttle position expressed as a percentage, which is being sent to the throttle. TPS Position is the actual percent of throttle opening

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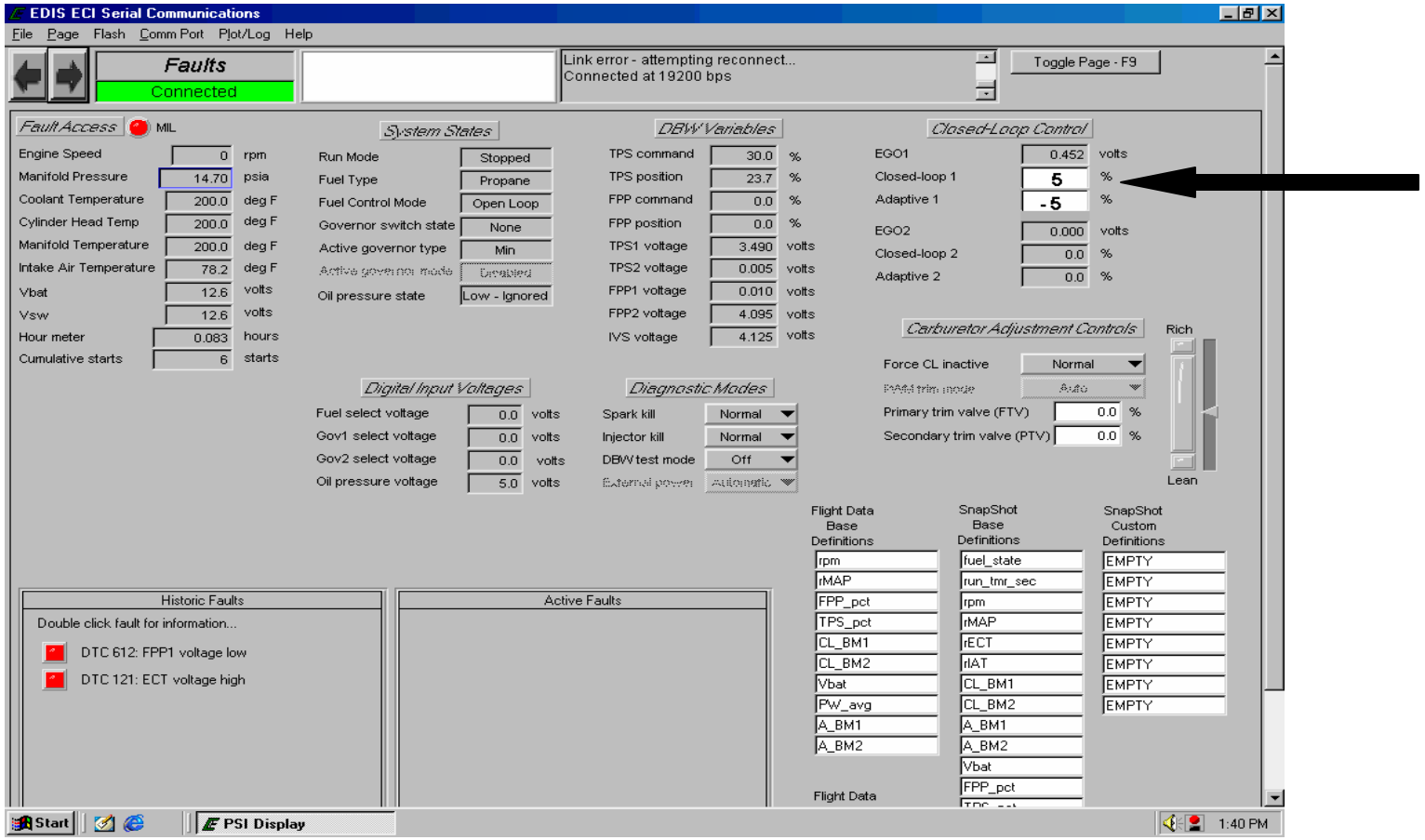
Total Fuel Correction Sum



The total fuel correction is calculated by adding the Closed Loop 1 and Adaptive 1 values. In the example above we have a closed loop 1 value of (5) and an adaptive 1 value of (-5). In this case the total fuel correction would be zero.

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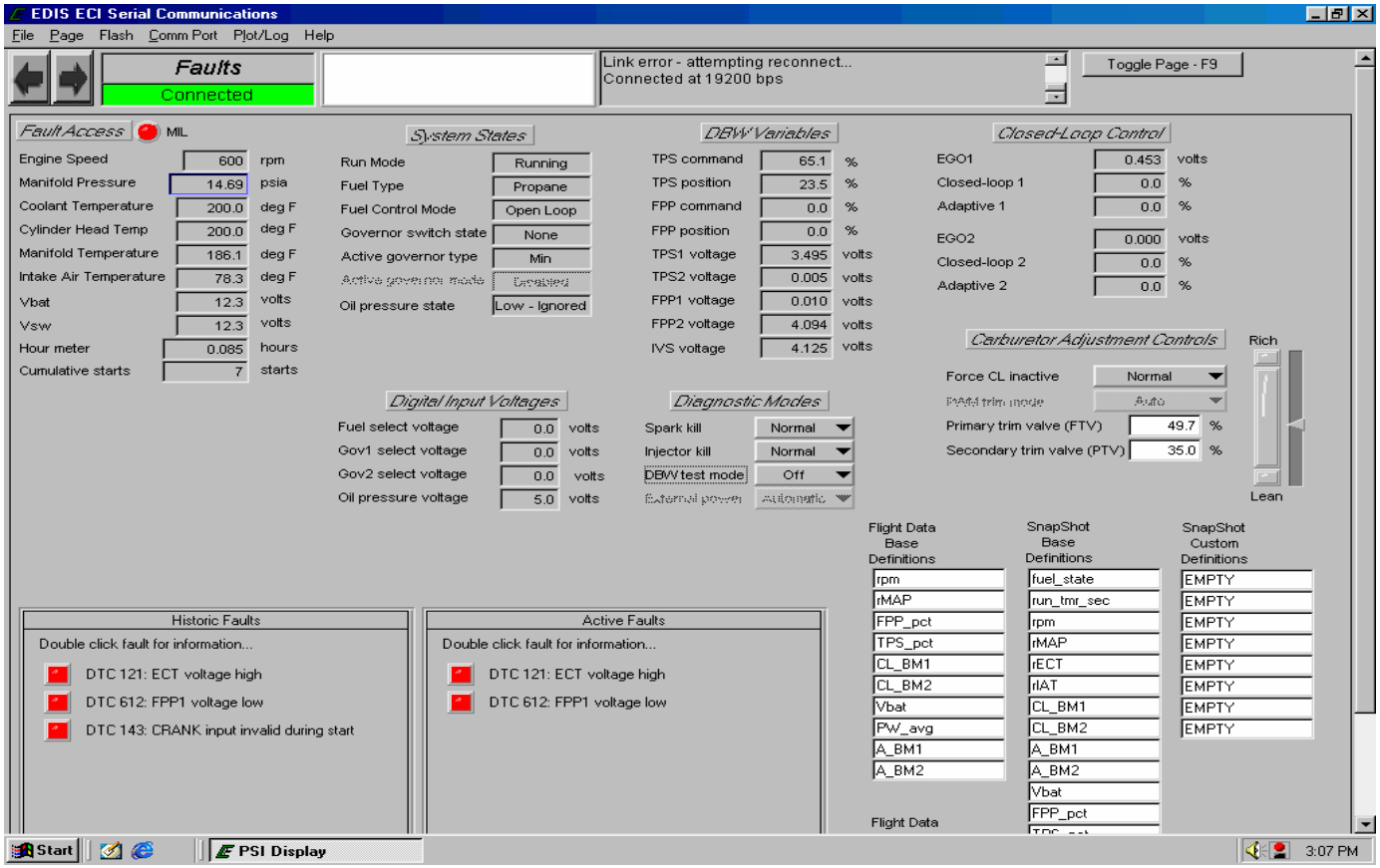
Multiple Code Set



In the event of a multiple code set, always start the DTC diagnostic with the lowest numerical code first. The DTC strategy is set up to provide a logical diagnostic path to the most efficient repair. As shown in the example above, repairing DTC 121 may also correct DTC 612

Diagnostic Communication Error

The ECM 5 volt reference circuit powers the Spectrum diagnostic link cable. In the event that the 5 volt reference signal is open or shorted to ground, you will not be able to connect to the system. If you are unable to connect, follow the quick checks listed below:

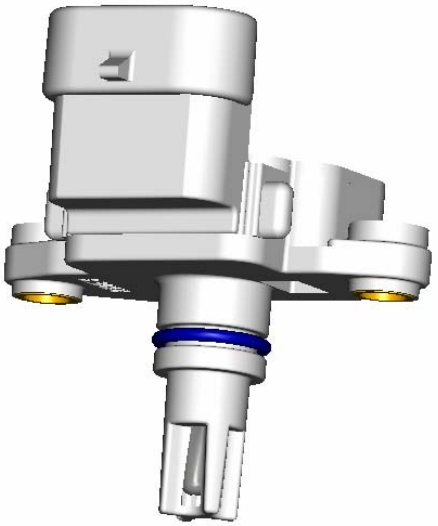
Be sure you are using the correct password and latest software for the system you are connecting to.

Check the ECM system power and ground circuits. Refer to DTC 261 for the power schematic. Also check for +12 switched power at ECM pin 21 with the ignition key on.

Check for power at the DLC connector for +5 volts between pins C (LT GRN/RED) and pin D (BLK) with the ignition key in the on position.

You may still be able to retrieve a code using the blink code function if none of the above recommendations prove useful. In the event of a 5 volt reference signal malfunction, DTC 531 or 532 should set. If you find one of these codes using the blink code function, follow the DTC diagnostic chart recommendations in the DTC section of this manual.

TMAP SENSOR



The TMAP is a combined IAT (Intake Air Temperature) and MAP (Manifold Absolute Pressure) sensor. A temperature sensitive resistor is used in the TMAP located in the intake manifold of the engine. It is used to monitor incoming air temperature, and the output in conjunction with other sensors is used to determine the airflow to the engine.

Manifold Absolute Pressure (MAP) Sensor

The Manifold Absolute Pressure Sensor monitors the changes in intake manifold vacuum which result from engine load variations. These pressure changes are relayed to the electronic control unit in the form of electrical signals.

The sensor also indicates the changes in atmospheric pressure due to changes in altitude.

The manifold air pressure sensor is mounted to the intake manifold.

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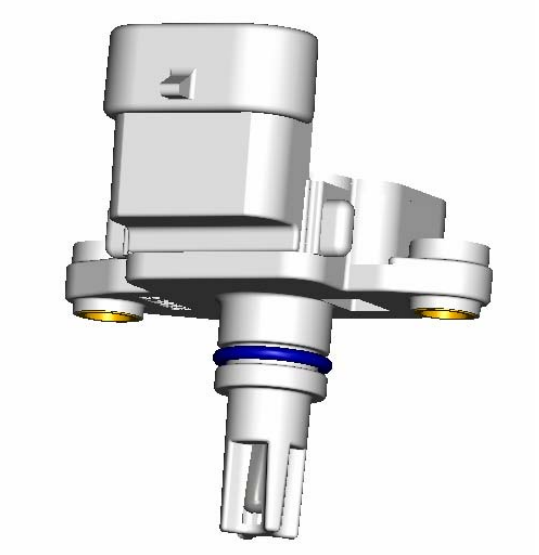
TMAP SENSOR

Air Inlet Temperature



The Air Temperature Sensor is variable temperature sensitive resistor. The IAT sensor monitors the manifold air temperature which is a factor in air density measurement. The engine air/fuel ratio is maintained constant even though the engine air density varies.

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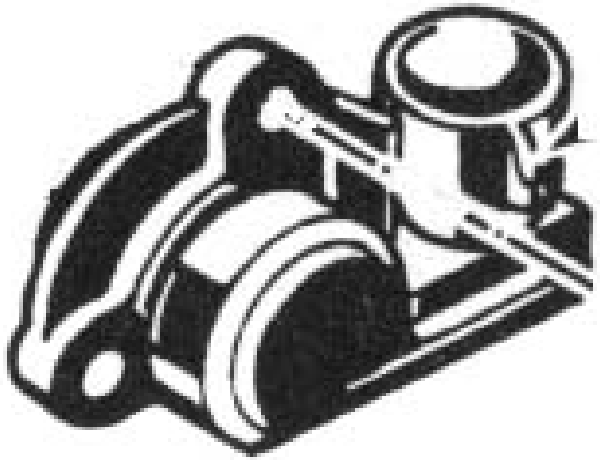
TPS (Throttle Position Sensor)



The Throttle Position Sensor is connected to the throttle shaft. Movement of the shaft causes the throttle shaft to rotate (opening or closing the throttle blades). The sensor tracks the shaft movement and position (closed throttle, wide open throttle, or any position in between), and transmits an electrical signal to the electronic control module. The electronic control module monitors the (throttle position) to aid in determining the fuel requirement for the particular situation (idle, acceleration, etc.)

Heated Oxygen Sensor (HO2S)

The HO2S sensor is used to determine if the fuel flow to the engine is correct by measuring the oxygen content in the exhaust gas. The sensor generates voltage in the absence of oxygen, when the sensor reaches an operating temperature of above 600 degrees F.
The output voltage is zero to approximately one volt. The ECM uses this voltage information to correct the air fuel fuel mixture.

The Spectrum system uses a 4 wire sensor that includes a built in 12 volt heating element. This allows the sensor to operate independently of the exhaust gas temperature.

ECT (Engine Coolant Temperature)

The ECT (Engine Coolant Temperature) sensor is a temperature sensitive resistor located in the engine coolant. It is used for the engine airflow calculation, gasoline cold enrichment, spark advance and to enable other temperature dependent features.

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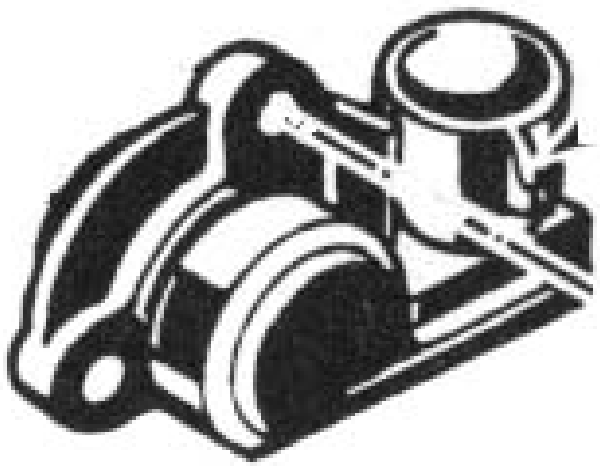
FPP (Foot Pedal Position)



The Foot Pedal Position sensor uses a variable resistor to determine signal voltage based on pedal position. The sensor is very similar to the TPS.

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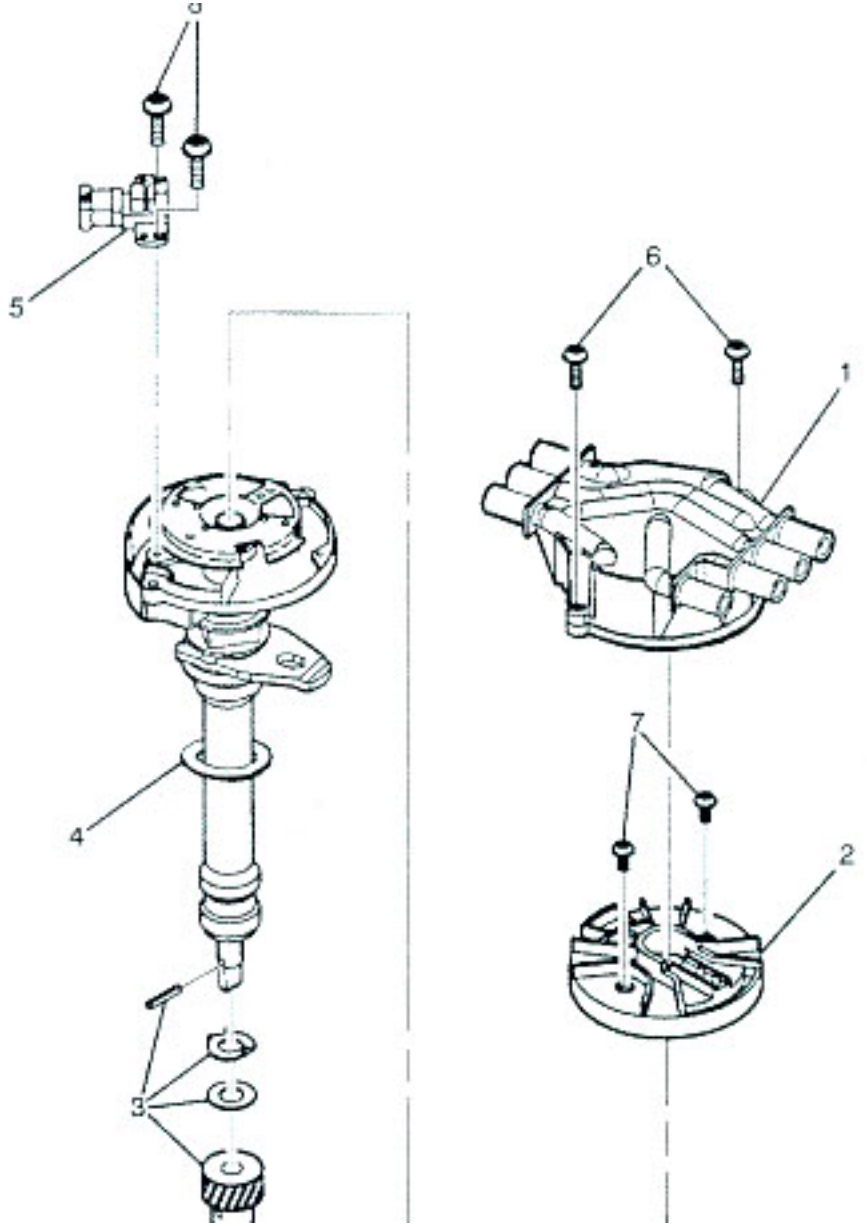
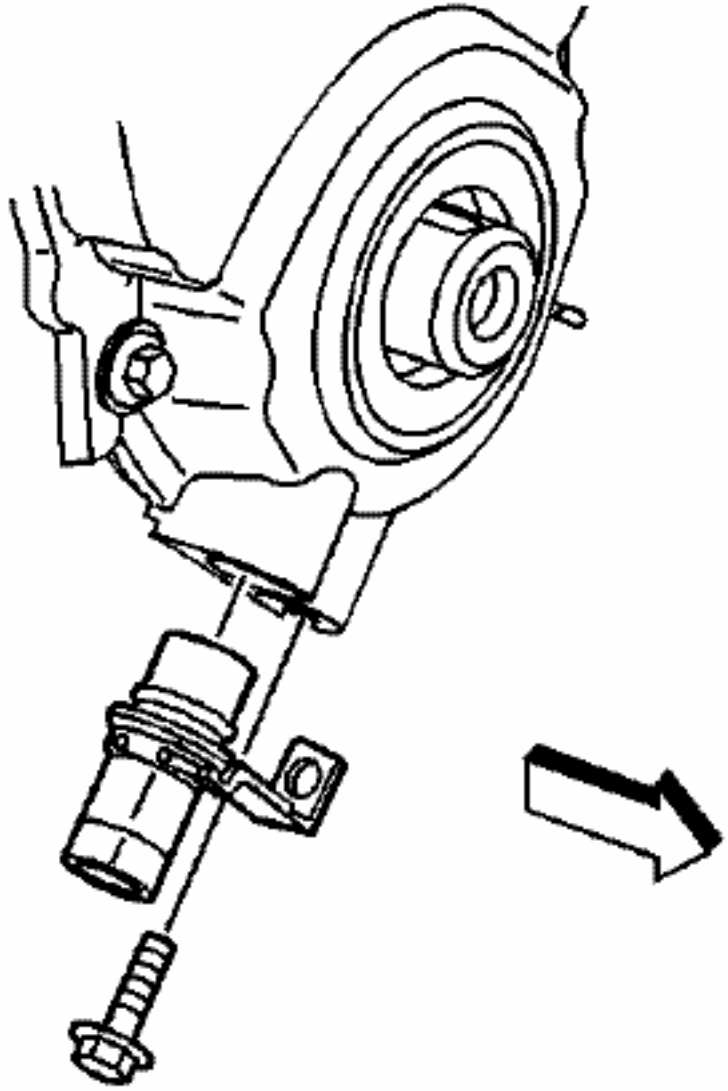
4.3 Camshaft Position Sensor (CMP)

The CMP (Camshaft Position Sensor) is used to synchronize the fuel and ignition timing systems.



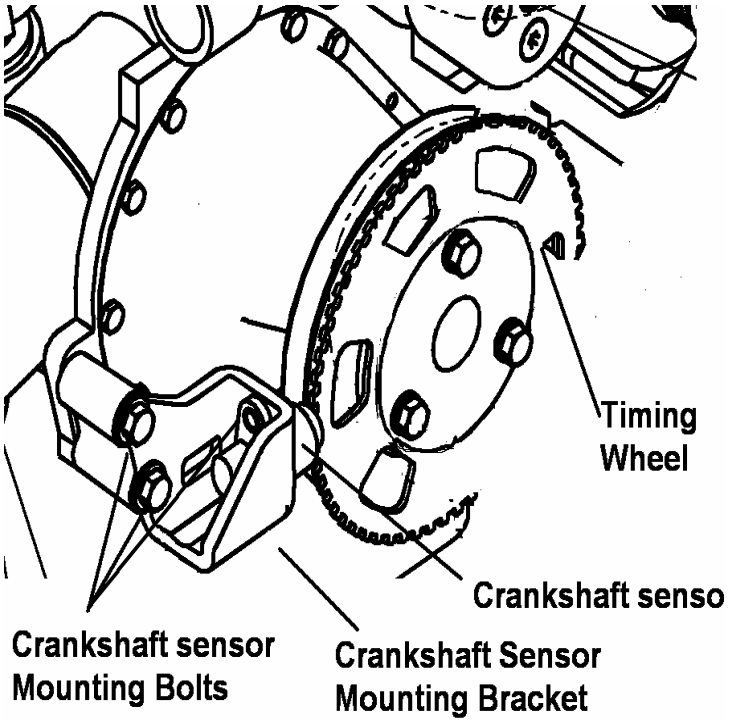
4.3 Crankshaft Position Sensor (CKP)



The CKP (Crankshaft Position Sensor) is a magnetic transducer mounted on the engine block adjacent to a pulse wheel located on the crankshaft. It determines crankshaft position by monitoring the pulse wheel. The Crankshaft position sensor is used to measure engine RPM and its signal is used to synchronize the ignition system.

3.0 Crankshaft Position Sensor (CKP)

The CKP (Crankshaft Position Sensor) is a magnetic transducer is bracket mounted on the front of the engine block. The timing wheel is connected to the crankshaft pulley. The CKP measures RPM and # 1 cylinder position by counting the missing teeth in the timing wheel



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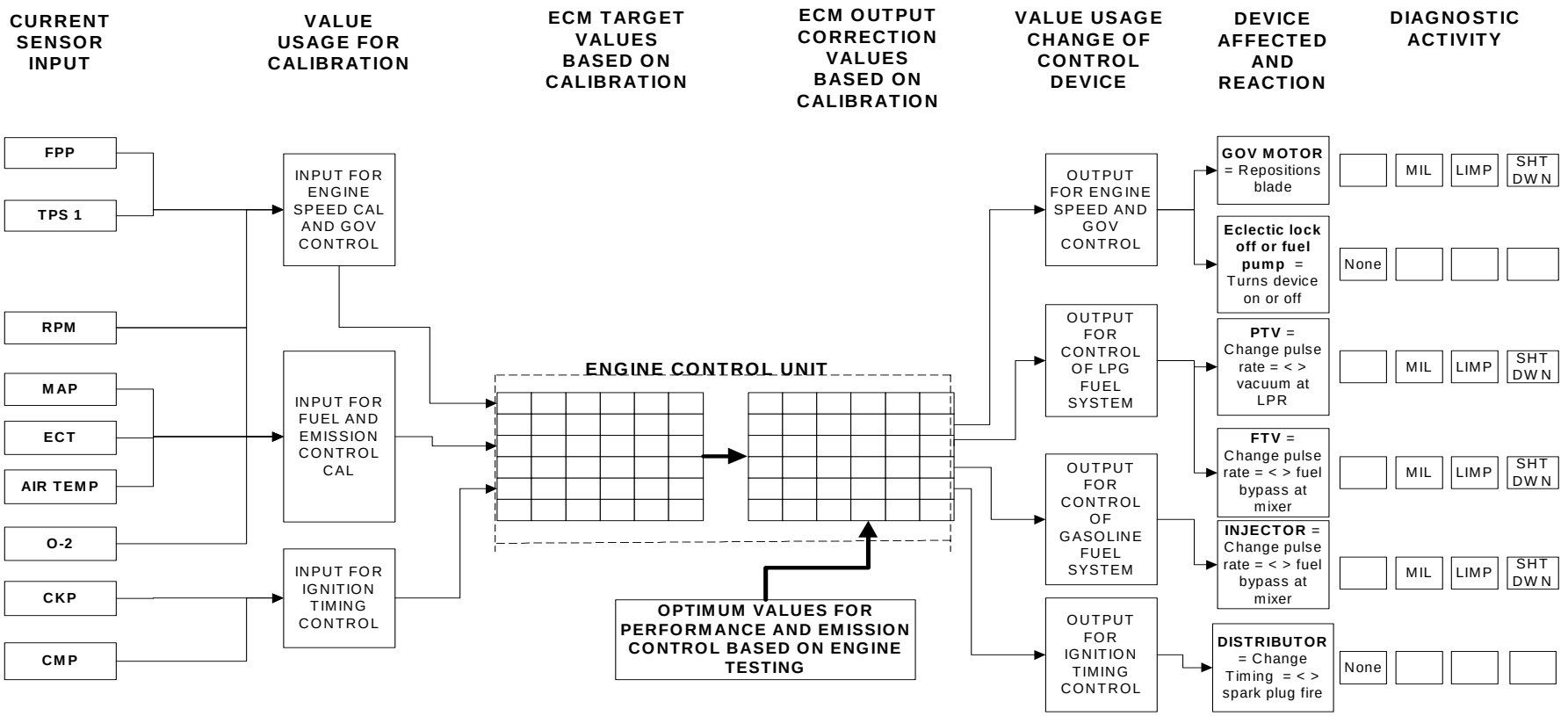
ENGINE MANAGEMENT SYSTEM CHART DRIVE BY CABLE THROTTLE CONTROL



FPP = Foot Pedal Position **=** Actual position of the operators desired RPM
TPS 1 = Throttle Position Sensor 1 **=** Actual position of the Throttle Blade
MAP = Manifold Absolute Pressure = Barometric Pressure at start up, and engine load when running used to determine fuel control, timing
Air Temp = Air temperature at the air inlet to the engine used to determine the air/fuel charge
ECT = Engine Coolant Temperature **=** Temperature values used to determine the air/fuel charge
RPM = Revolution Per Minute **=** Revolutions of the engine used to determine ETC control, fuel control, timing
EGO-2 = Exhaust Gas Oxygen Sensor **=** Determines the amount of oxygen present in the exhaust stream used for emission control
CKP = Crankshaft Position Sensor **=** Determines which piston is at TDC used to determine fuel control, timing
CMP = Camshaft Position Sensor **=** Determines the position of the valve train to the crankshaft used to determine fuel control, timing
PTV = Pressure Trim Valve = Control vacuum to the atmospheric side of the LPR to increase or decrease fuel flow to the mixer
FTV = Fuel Trim Valve = Allows fuel to by mixer to richen the fuel mixture