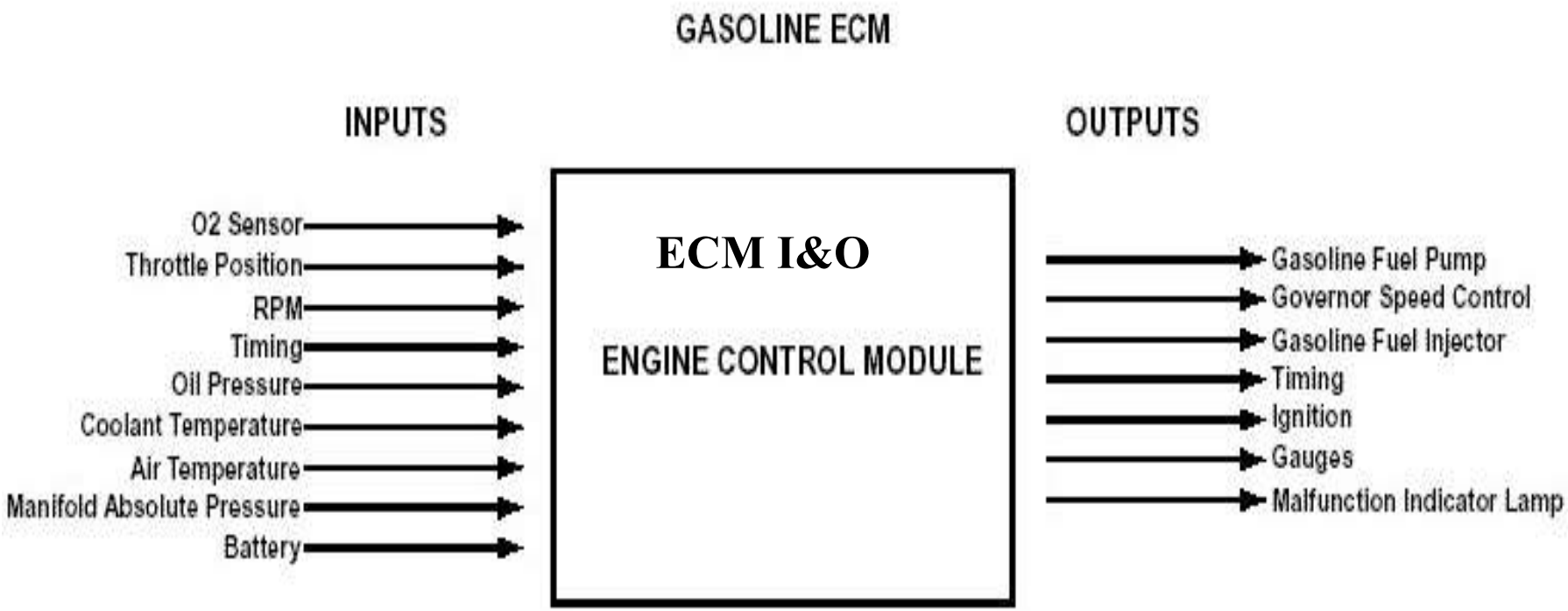
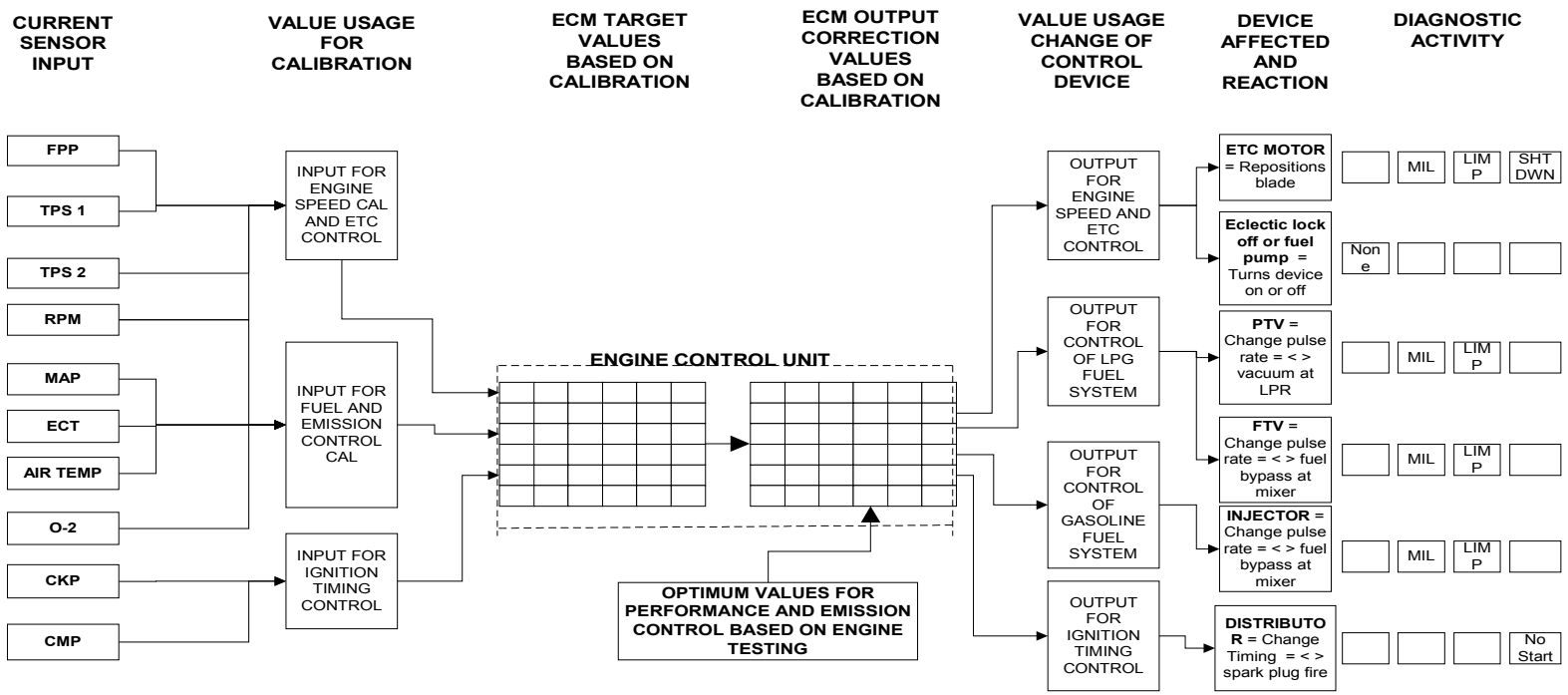
E – Control Training Programm

The Fuel System

- Computer controlled
- Adaptive Learn
- Closed Loop
- Drive By Wire
- Multi Port (MPFI)
- LPG Fuel Options
- On Board Diagnostics
- Speed options


GASOLINE ECM
INPUTS
OUTPUTS
O2 Sensor
Throttle Position
RPM
Timing
Oil Pressure
Coolant Temperature
Air Temperature
Manifold Absolute Pressure
Battery
ECM I&O
ENGINE CONTROL MODULE
Gasoline Fuel Pump
Governor Speed Control
Gasoline Fuel Injector
Timing
Ignition
Gauges
Malfunction Indicator Lamp

ENGINE MANAGEMENT SYSTEM CHART ELECTRONIC THROTTLE CONTROL



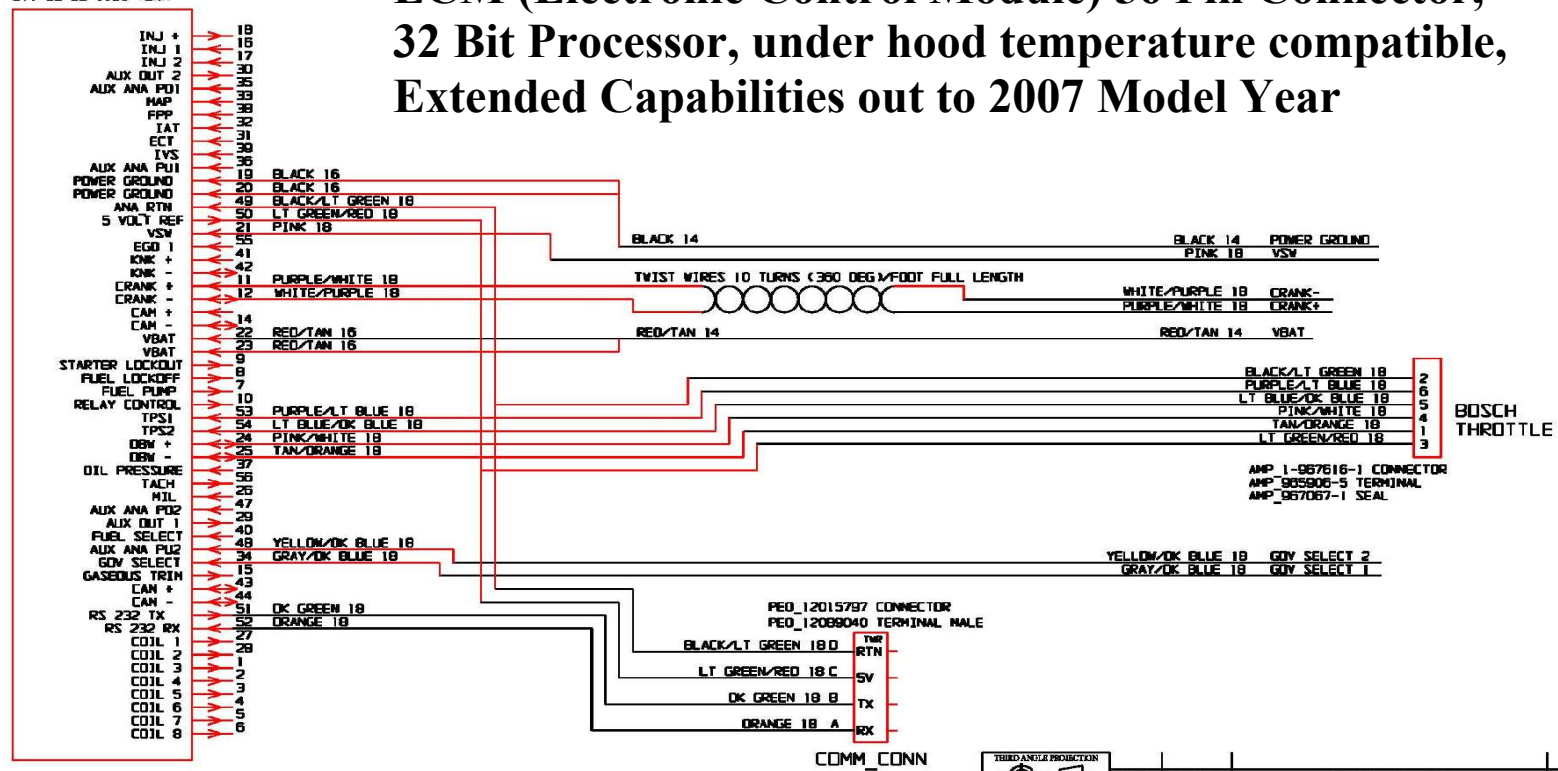
FPP = Foot Pedal Position **=** Actual position of the operators desired RPM
TPS 1 = Throttle Position Sensor 1 **=** Actual position of the Throttle Blade
TPS 2 = Throttle Position Sensor 2 **=** Verifies actual and target blade angles used to protect from engine runaway condition
MAP = Manifold Absolute 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
ETC = Electronic Throttle Control = Controls engine speed by positioning the blade in the throttle bore used for engine control
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

33000547

PSIECM

ECI
211 PC 56 2S 0 009 CONNECTOR
211 A 56 7007 LOCKING CAM
211 A 56 0008 COVER
211 CC 2S 1120 TERM

ECM (Electronic Control Module) 56 Pin Connector, 32 Bit Processor, under hood temperature compatible, Extended Capabilities out to 2007 Model Year



NOTES:
ALL WIRE IS SAE J1128 TXL TYPE
HARNESS TO BE LABELED WITH ECI PART NUMBER AND REVISION
SUPPLIER PN ECI E1601000A

MATERIAL:

UNLESS SPECIFIED OTHERWISE
1-PLACE DIM: +/-.060; 2-PLACE DIM: +/-.030;
3-PLACE DIM: +/-.010; ANGLE DIMENSIONS : +/- 1°
GEOMETRIC DIMENSIONS PER ASME Y14.5M-1994

THIRD ANGLE PROJECTION

REV:	DATE:	DESCRIPTION	BY:

DRAWN BY: K.SATERA
DRAW DATE: 3/10/04
APPD / DATE:

POWER SOLUTIONS INC.

NAME: HARNESS,GENERIC GOVERNOR CONTROL UNIT

ENGINEERING NO: ---------

PRODUCTION NO: 33000547

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.

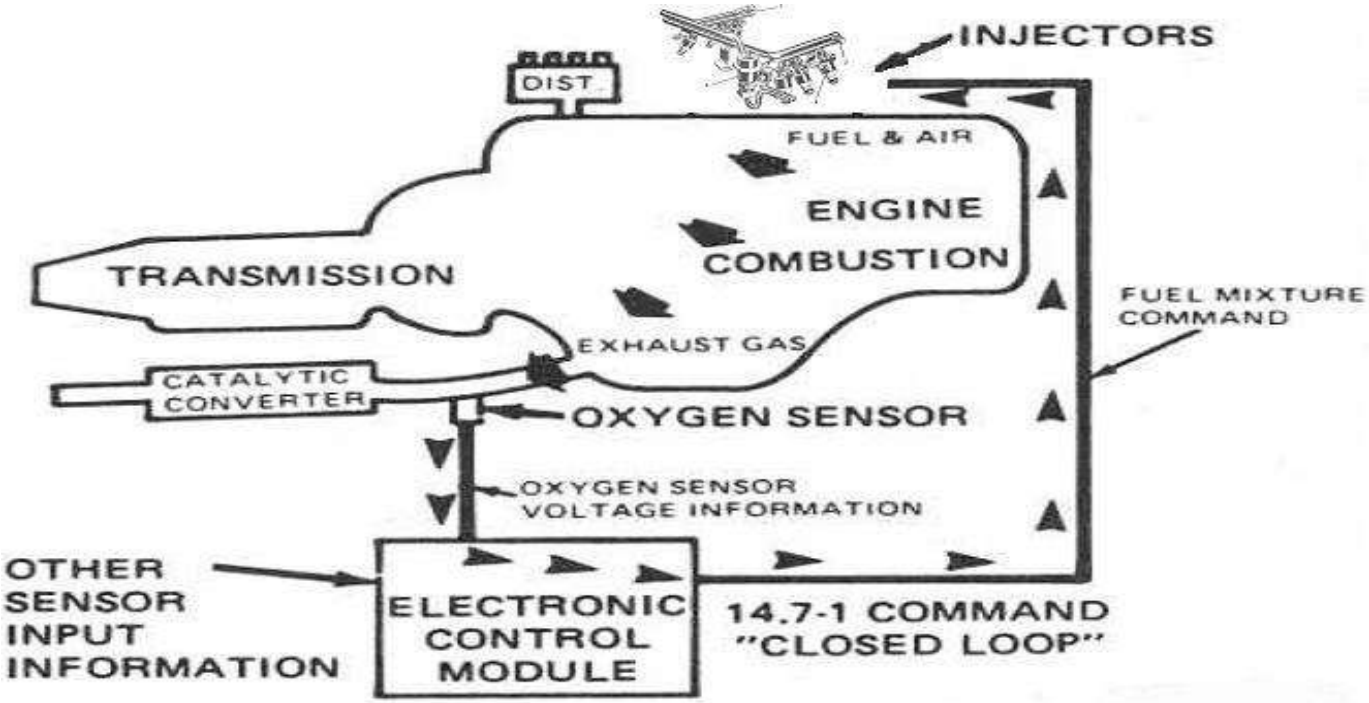
This will erase all of the Diagnostic codes stored in the computer memory including the adaptive learn.

•It will not erase the fuel calibration.

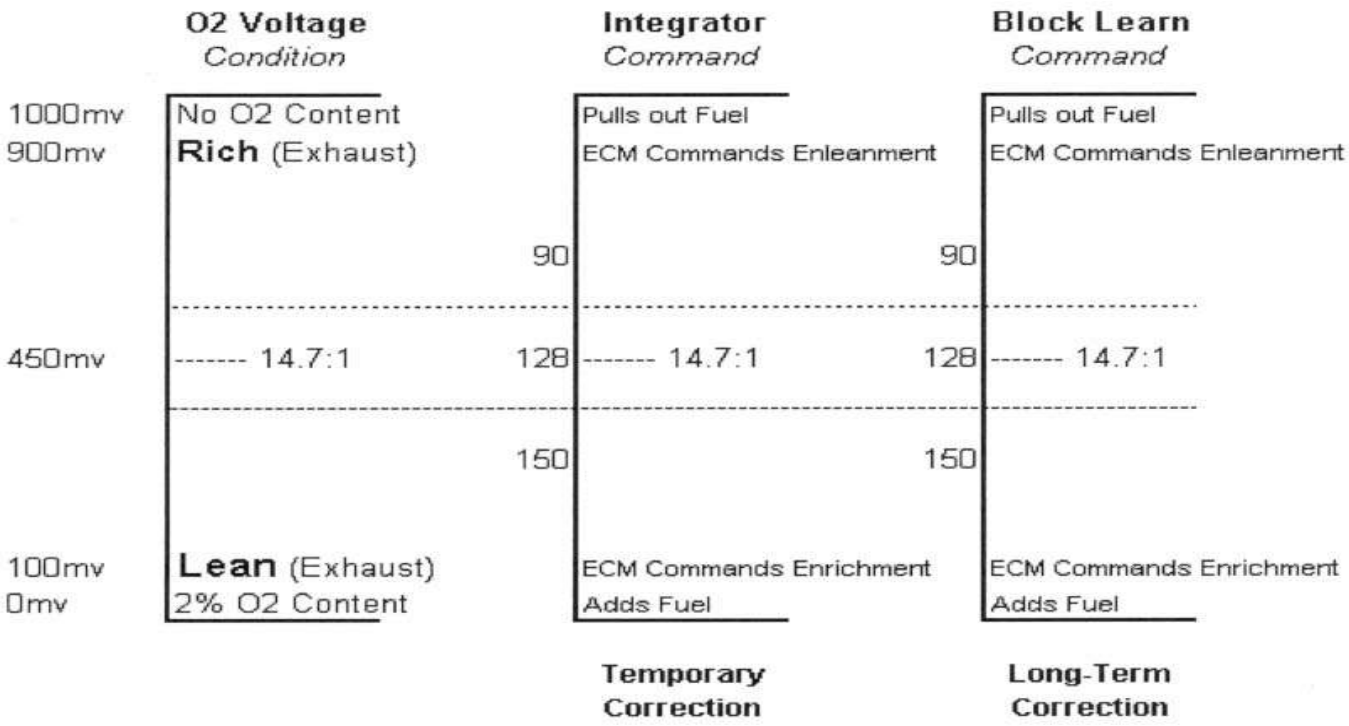
•It will not erase the computer serial identification

•It will not erase the internal hour meter

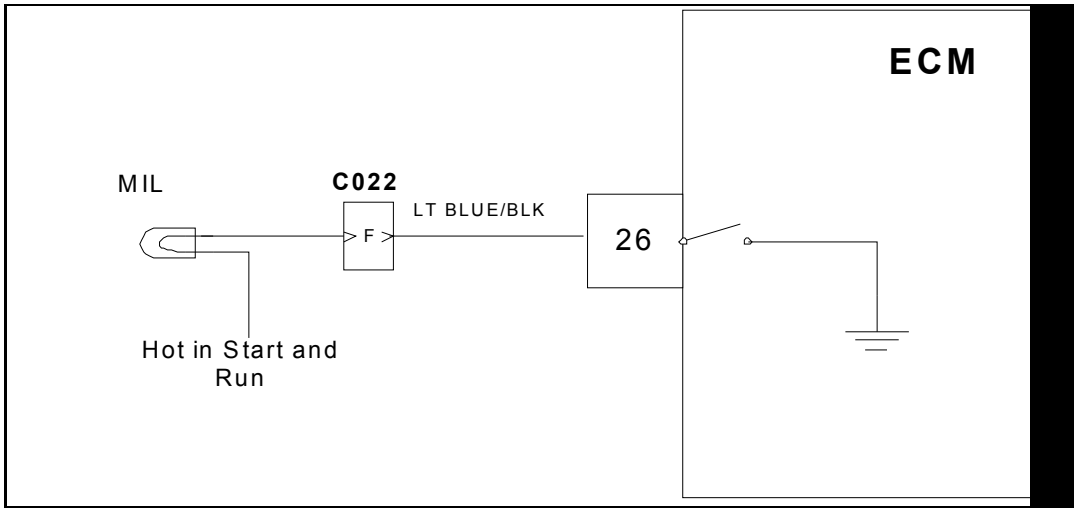
Closed Loop Fuel Control



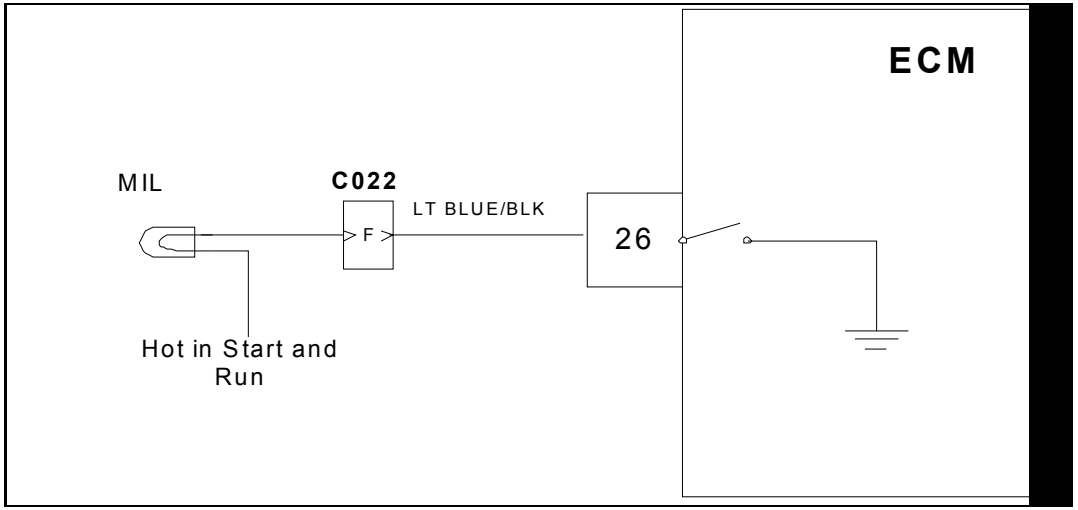
Adaptive Learn



MIL (Malfunction Indicator Lamp)

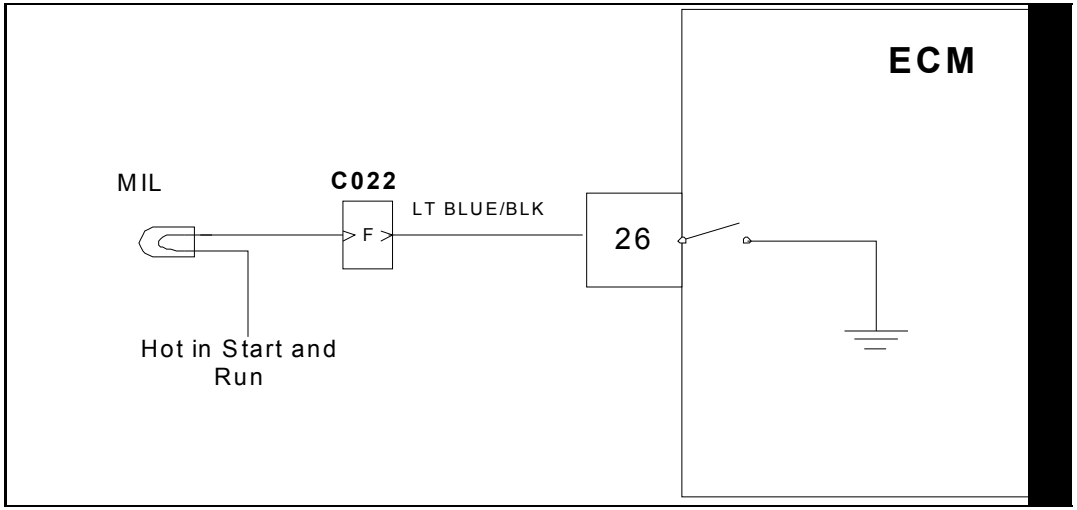


Notifies the driver of a problem with the emission control system.



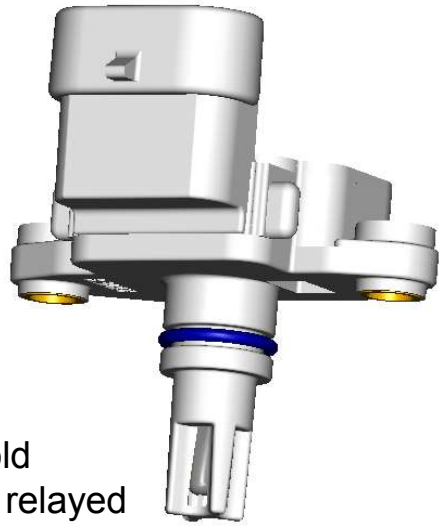
Most engine control system related problems that affect emissions or driveability of the vehicle will set a (DTC) Diagnostic Trouble Code and illuminate the Malfunction Indicator Lamp.

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)

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.

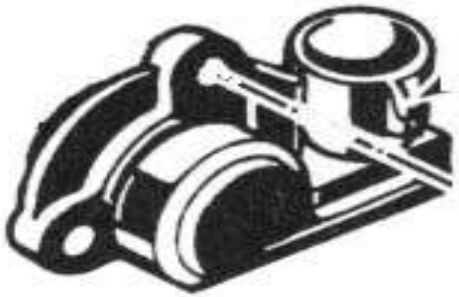
Air Inlet Temperature

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.

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.

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.)

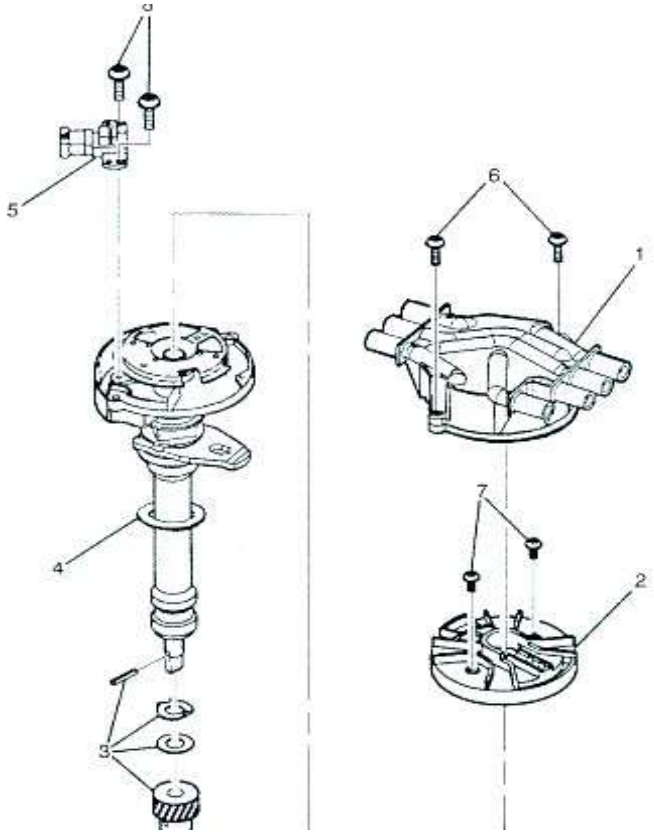
The drive by wire system utilizes **2 Throttle Position Sensors** located **within** the electronic throttle. The TPS is a variable resistor. **TPS1** will read low voltage when closed and **TPS2** will read high voltage when closed. The TPS1 and TPS2 percentages are calculated from these voltages. Although the voltages are different, the calculated values for the throttle position percentages should be very close to the same. The TPS is not serviceable or replaceable. In the event of a TPS failure, the electronic throttle must be replaced.

FPP (Foot Pedal Position)

The Foot Pedal Position sensor uses a variable resistor to determine signal voltage based on pedal position. Less depression of pedal results in lower voltage, and greater depression results in higher voltage.

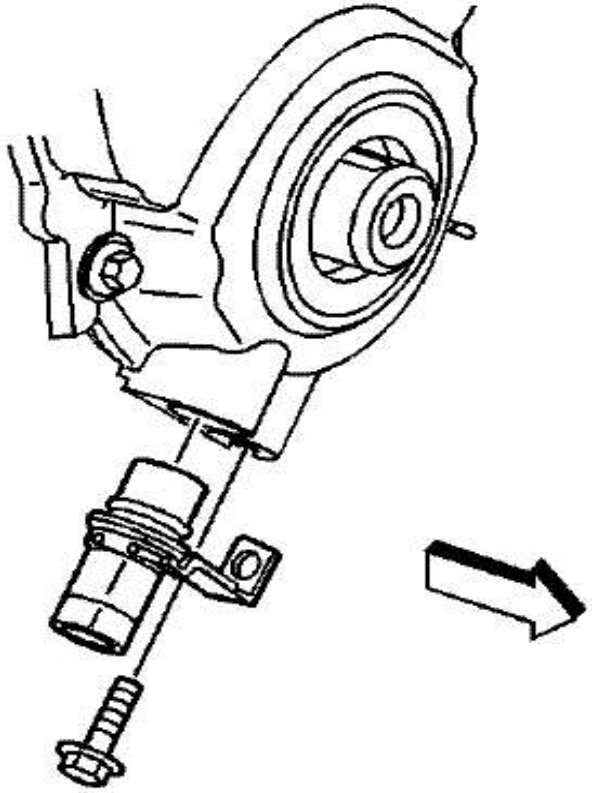
Camshaft Position Sensor (CMP)

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



Crankshaft Position Sensor (CKP)

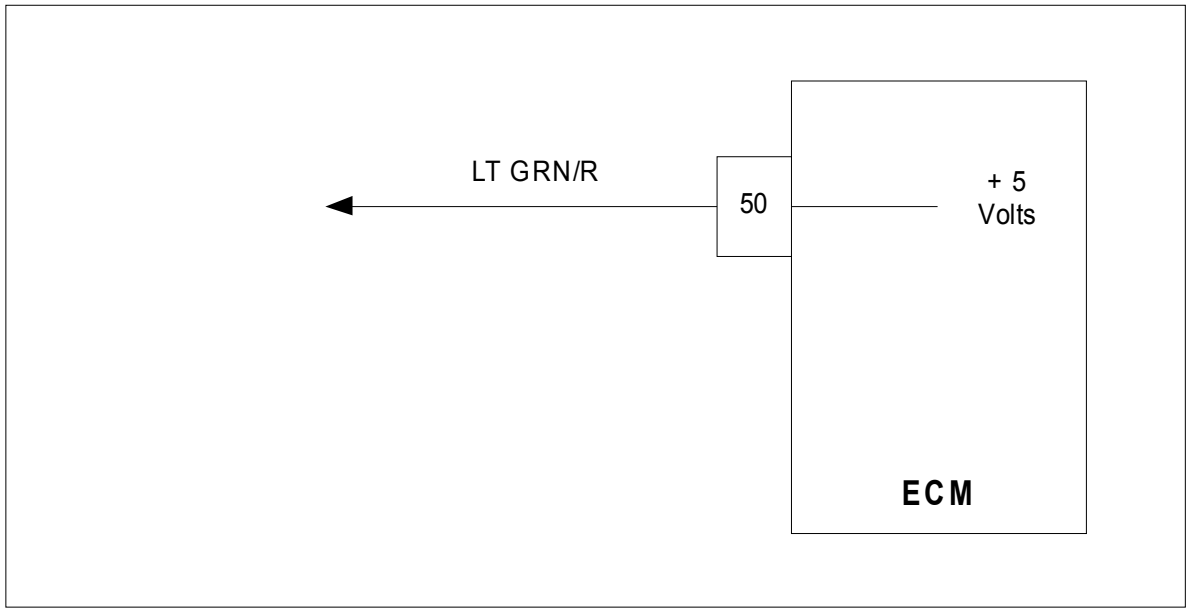
The CKP (Crankshaft Position Sensor) is a magnetic transducer mounted on the engine block adjacent to a pulse wheel located on the crankshaft. It determines crankshaft position by monitoring the pulse wheel. The Crankshaft position sensor is used to measure engine RPM and its signal is used to synchronize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



Heated Oxygen Sensor (HO2S)

The H O2 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 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.

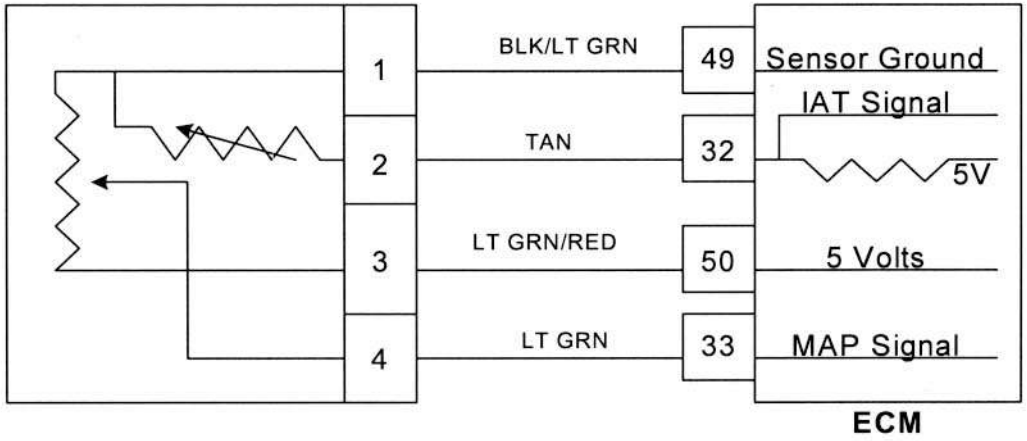
ECM Provides an external 5 volt reference to engine sensors



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

Using a Laptop Computer to Diagnose the Spectrum System

Minimum System Requirements

Pentium Processor

Win95, 98, 2000 and XP Operating Systems

32 Megs Ram

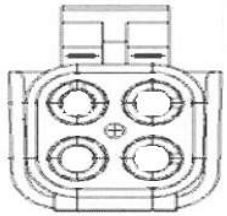
Serial Port (RS232) Connection

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 50 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.

Blink Code Function



Diagnostic Link Connector

If you do not have access to a laptop computer, it is still possible to ac
Codes stored in the memory of the Spectrum system ECM using a dia
With the key off connect diagnostic pins **A** and **D**. Turn the ignition on but do not start the vehicle.

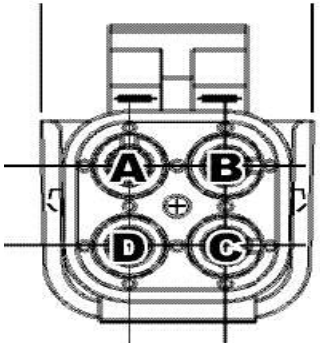
The Malfunction Indicator Lamp (MIL) will begin to flash. The MIL displays three digit codes by flashing the first digit, pausing, then flashing the second digit, pausing, and then flashing the third digit.

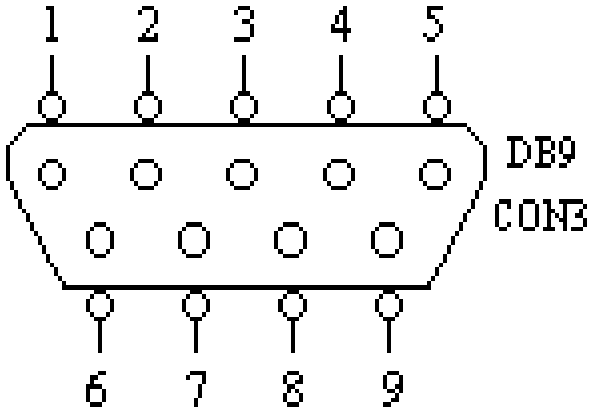
The MIL will first display a 166 three times. Code 166 indicates that the ECM based diagnostic routines are functioning. Then, any Diagnostic Trouble Codes stored in memory will display three times each. The MIL will then start over with the code 166.

RS 232

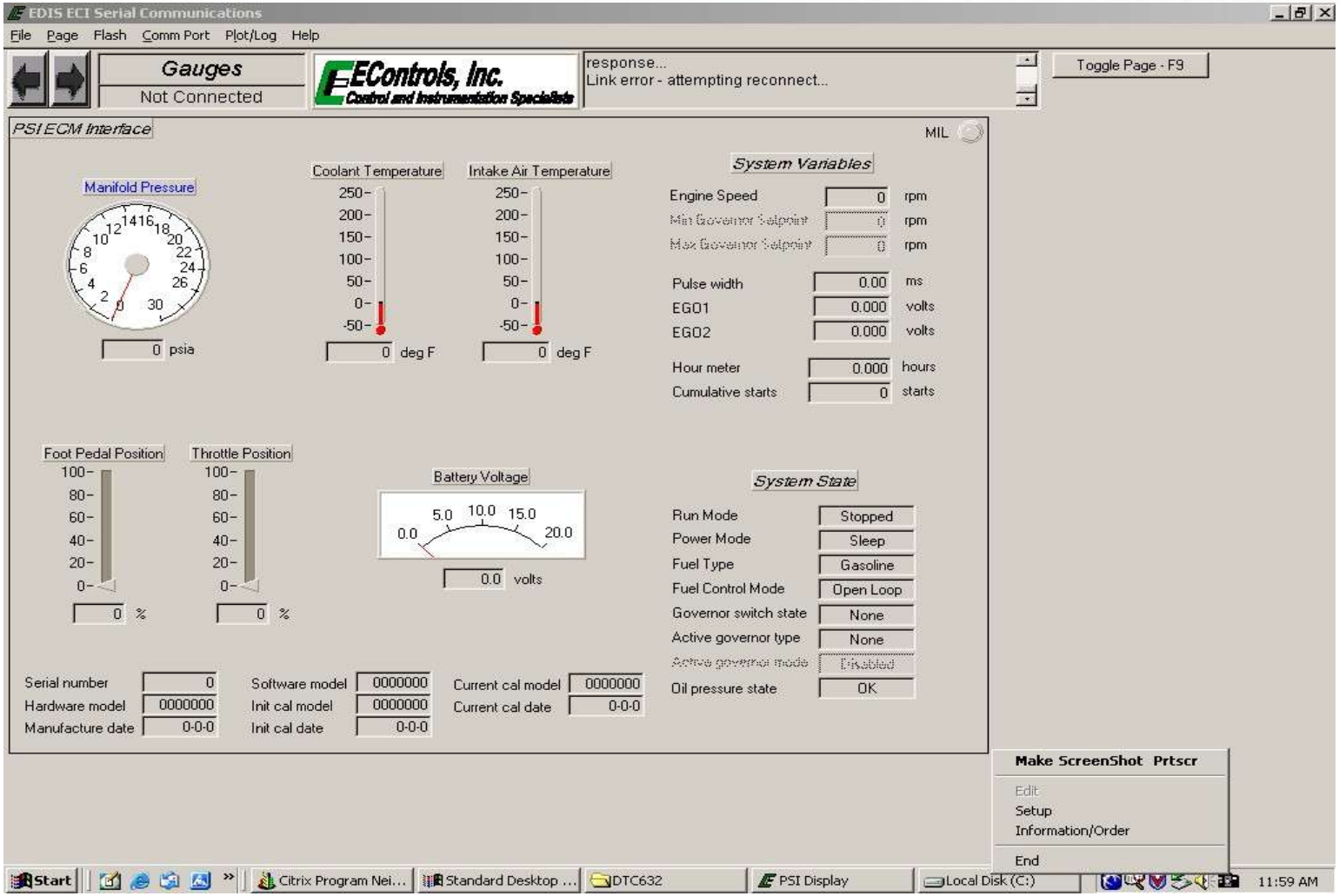
Diagnostic Link

Diagnostic Link Connector (DLC)

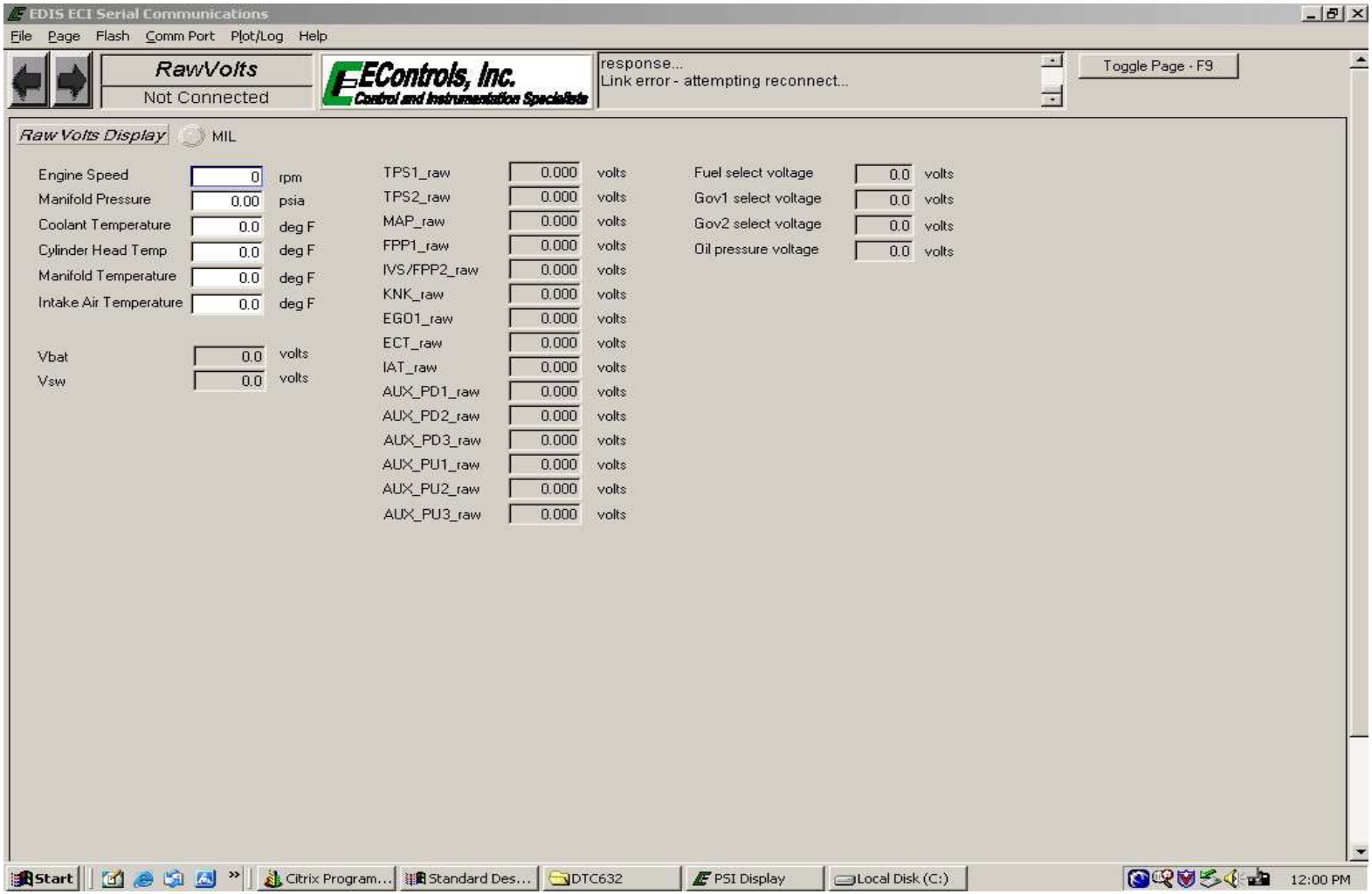




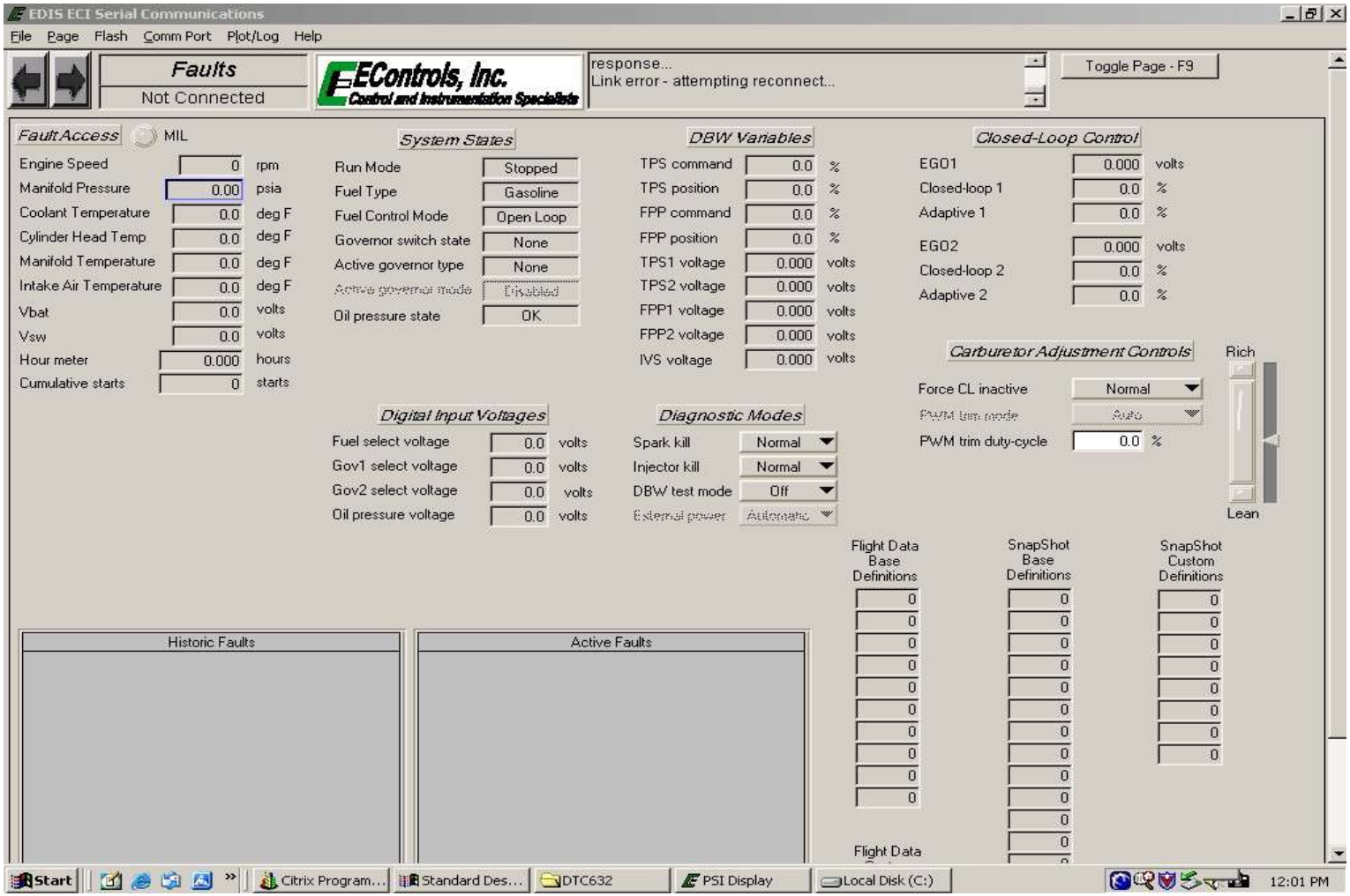
Pin	Wire Color	Function
A	Orange	RS232 RX
B	Dark Green	RS232 TX
C	Lt Green/Red	5 Volt Ref
D	Black/Lt Green	Ana Rtn


EDIS ECI Serial Communications
File Page Flash Comm Port Plot/Log Help
Gauges
Not Connected
EControls, Inc.
Control and Instrumentation Specialists
response...
Link error - attempting reconnect...
Toggle Page - F9
PSI ECM Interface
MIL
Manifold Pressure
0 psia
Coolant Temperature
0 deg F
Intake Air Temperature
0 deg F
System Variables
Engine Speed 0 rpm
Min Governor Setpoint 0 rpm
Max Governor Setpoint 0 rpm
Pulse width 0.00 ms
EGO1 0.000 volts
EGO2 0.000 volts
Hour meter 0.000 hours
Cumulative starts 0 starts
Foot Pedal Position
0 %
Throttle Position
0 %
Battery Voltage
0.0 volts
System State
Run Mode Stopped
Power Mode Sleep
Fuel Type Gasoline
Fuel Control Mode Open Loop
Governor switch state None
Active governor type None
Active governor mode Disabled
Oil pressure state OK
Serial number 0
Hardware model 0000000
Manufacture date 0-0-0
Software model 0000000
Init cal model 0000000
Init cal date 0-0-0
Current cal model 0000000
Current cal date 0-0-0
Make ScreenShot Prtscr
Edit
Setup
Information/Order
End
Start
Citrix Program Nei...
Standard Desktop ...
DTC632
PSI Display
Local Disk (C:)
11:59 AM

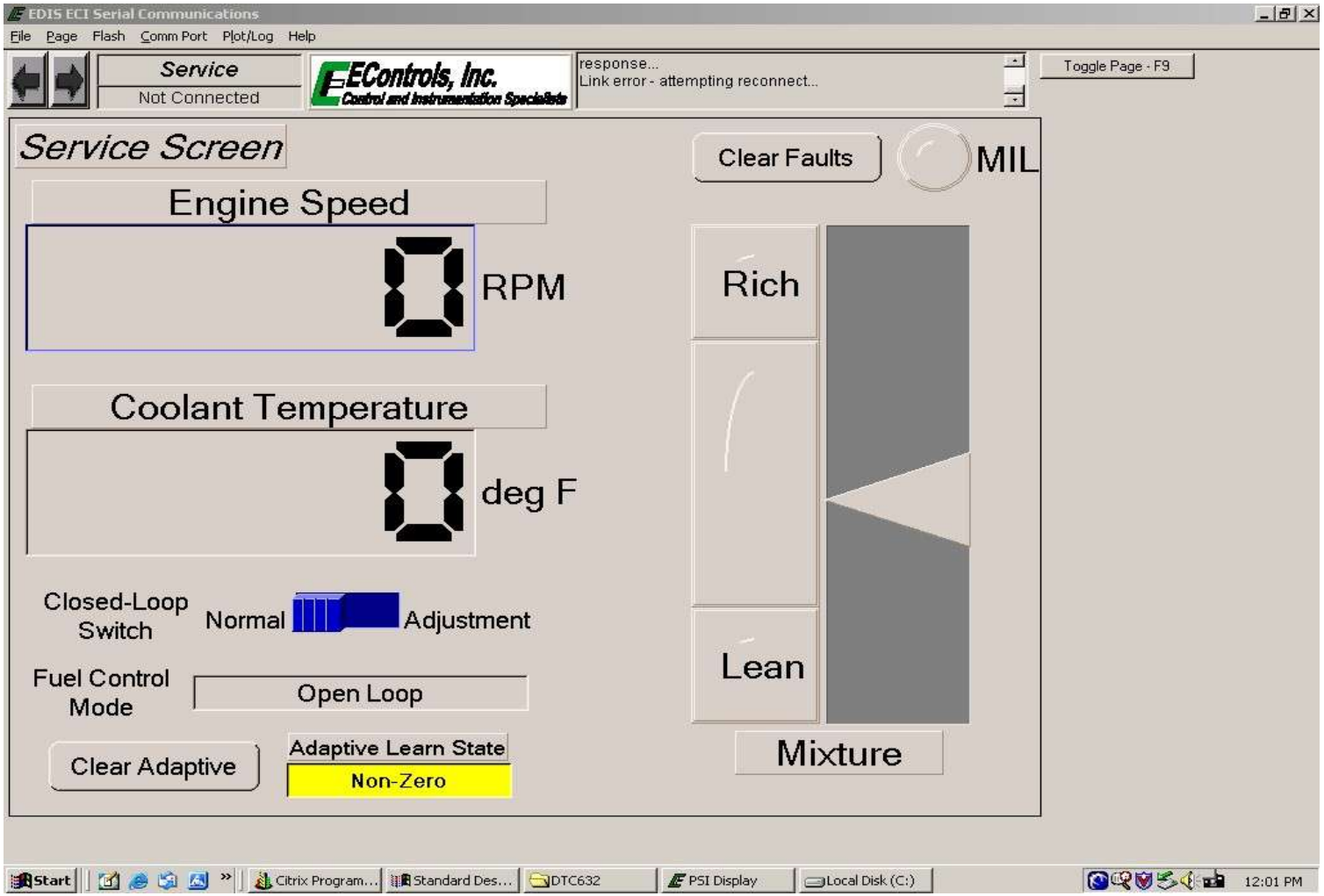
DST Screen 1


EDIS ECI Serial Communications
File Page Flash Comm Port Plot/Log Help
RawVolts
Not Connected
EControls, Inc.
Control and Instrumentation Specialists
response...
Link error - attempting reconnect...
Toggle Page - F9
Raw Volts Display
MIL
Engine Speed 0 rpm
Manifold Pressure 0.00 psia
Coolant Temperature 0.0 deg F
Cylinder Head Temp 0.0 deg F
Manifold Temperature 0.0 deg F
Intake Air Temperature 0.0 deg F
Vbat 0.0 volts
Vsw 0.0 volts
TPS1_raw 0.000 volts
TPS2_raw 0.000 volts
MAP_raw 0.000 volts
FPP1_raw 0.000 volts
IVS/FPP2_raw 0.000 volts
KNK_raw 0.000 volts
EGO1_raw 0.000 volts
ECT_raw 0.000 volts
IAT_raw 0.000 volts
AUX_PD1_raw 0.000 volts
AUX_PD2_raw 0.000 volts
AUX_PD3_raw 0.000 volts
AUX_PU1_raw 0.000 volts
AUX_PU2_raw 0.000 volts
AUX_PU3_raw 0.000 volts
Fuel select voltage 0.0 volts
Gov1 select voltage 0.0 volts
Gov2 select voltage 0.0 volts
Oil pressure voltage 0.0 volts
Start
Citrix Program...
Standard Des...
DTC632
PSI Display
Local Disk (C:)
12:00 PM

DST Screen 2


EDIS ECI Serial Communications
File Page Flash Comm Port Plot/Log Help
Faults
Not Connected
EControls, Inc.
Control and Instrumentation Specialists
response...
Link error - attempting reconnect...
Toggle Page - F9
Fault Access
MIL
Engine Speed 0 rpm
Manifold Pressure 0.00 psia
Coolant Temperature 0.0 deg F
Cylinder Head Temp 0.0 deg F
Manifold Temperature 0.0 deg F
Intake Air Temperature 0.0 deg F
Vbat 0.0 volts
Vsw 0.0 volts
Hour meter 0.000 hours
Cumulative starts 0 starts
System States
Run Mode Stopped
Fuel Type Gasoline
Fuel Control Mode Open Loop
Governor switch state None
Active governor type None
Active governor mode Disabled
Oil pressure state OK
DBW Variables
TPS command 0.0 %
TPS position 0.0 %
FPP command 0.0 %
FPP position 0.0 %
TPS1 voltage 0.000 volts
TPS2 voltage 0.000 volts
FPP1 voltage 0.000 volts
FPP2 voltage 0.000 volts
IVS voltage 0.000 volts
Closed-Loop Control
EGO1 0.000 volts
Closed-loop 1 0.0 %
Adaptive 1 0.0 %
EGO2 0.000 volts
Closed-loop 2 0.0 %
Adaptive 2 0.0 %
Carburetor Adjustment Controls
Force CL inactive Normal
PWM trim mode Auto
PWM trim duty-cycle 0.0 %
Rich
Lean
Digital Input Voltages
Fuel select voltage 0.0 volts
Gov1 select voltage 0.0 volts
Gov2 select voltage 0.0 volts
Oil pressure voltage 0.0 volts
Diagnostic Modes
Spark kill Normal
Injector kill Normal
DBW test mode Off
External power Automatic
Flight Data Base Definitions
SnapShot Base Definitions
SnapShot Custom Definitions
Historic Faults
Active Faults
Start
Citrix Program...
Standard Des...
DTC632
PSI Display
Local Disk (C:)
12:01 PM

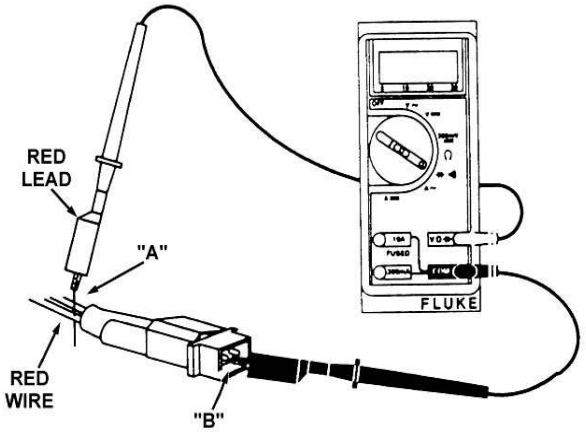
DST Screen 3

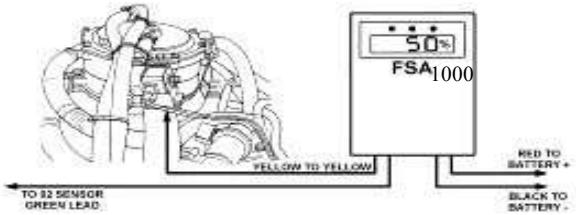

EDIS ECI Serial Communications
File Page Flash Comm Port Plot/Log Help
Service
Not Connected
EControls, Inc.
Control and Instrumentation Specialists
response...
Link error - attempting reconnect...
Toggle Page - F9
Service Screen
Clear Faults
MIL
Engine Speed
RPM
Rich
Coolant Temperature
deg F
Closed-Loop Switch
Normal
Adjustment
Fuel Control Mode
Open Loop
Lean
Clear Adaptive
Adaptive Learn State
Non-Zero
Mixture
Start
Citrix Program...
Standard Des...
DTC632
PSI Display
Local Disk (C:)
12:01 PM

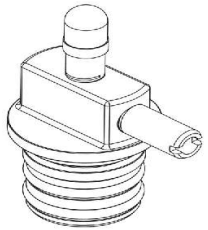
DST Screen 4

FSA-1 Fuel System Analyzer

FSA-1000

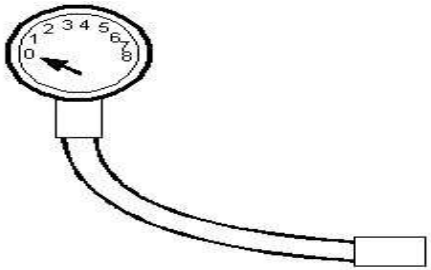






12 Volt Test Lamp

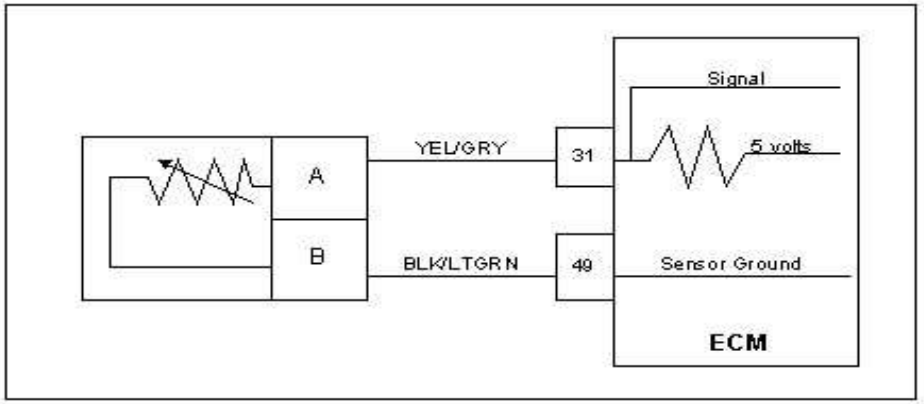
High Impedance DVOM with Duty Cycle %



Fuel Injection Pressure Gauge

Using the DTC Schematic:

Pin numbers, connector letters and wire colors



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.

Using the DTC chart:

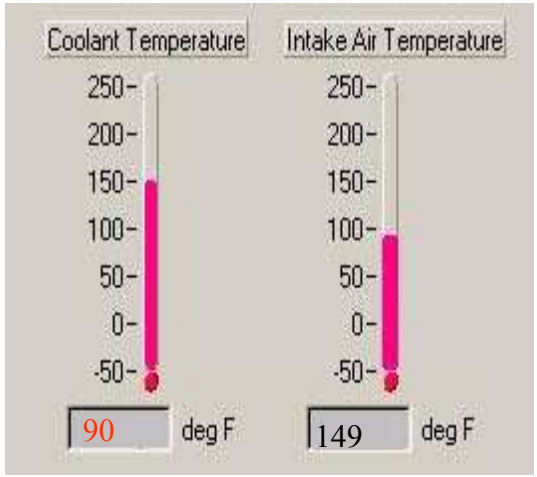
The chart starts with the MIL check to validate the MIL function.

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.

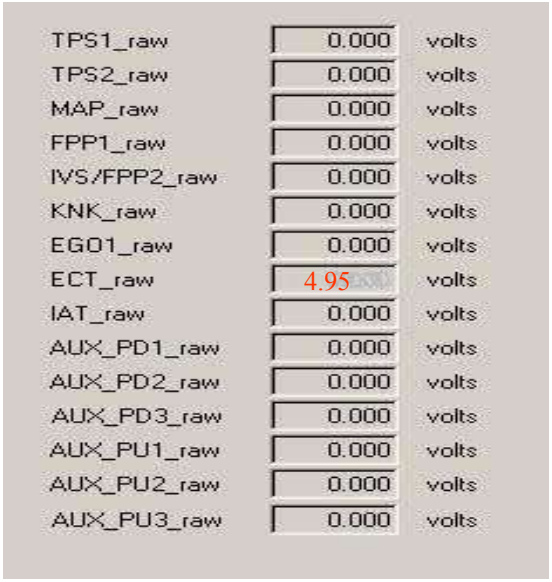
DTC 122- ECT VOLTAG E LOW

Step	Action	Value(s)	Yes	No
1	Didyou perform the On-Board (OBD) System Check?	-	*Go to Step (2)*	*Go to OBD System Check Section*
2	▪ KeyOn ▪ 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	▪ KeyOFF ▪ 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*

Default value



Actual



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

- Intake Air Temperature
- Check Condition-Engine Running
- Fault Condition-Intake Air Temperature greater than 210 degrees F. and engine RPM greater than 1000
- MIL-Will flash at 2 Hz (twice per second) during active fault
- Adaptive-Disabled during active fault
- Closed Loop-Enabled,
- 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 210 degrees F. and engine RPM is greater than 1000, then Power Derate 1 will be enforced. During this fault, maximum throttle position is 50% and the MIL light will flash twice per second.

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

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 220 degrees F. and engine RPM greater than1000
- MIL-On for active fault and for 15 seconds after active fault
- Adaptive-Disabled during active fault, Closed Loop-Enabled 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 220 degrees F and engine RPM is greater than 1000. The MIL will be on during this active fault and the engine will shut down

Intermittent problems

Intermittent problems are 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

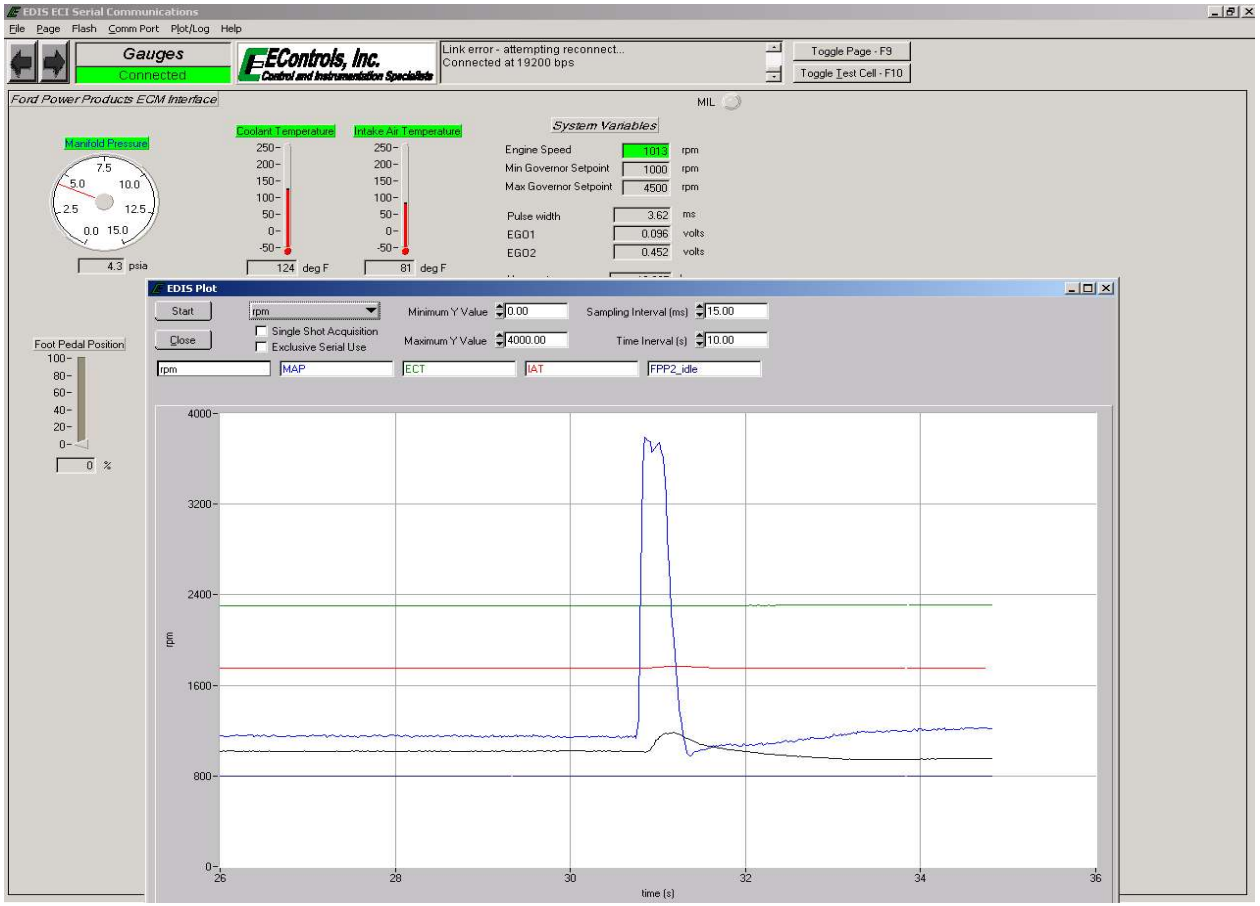
•Air leaks at the throttle body, throttle control unit and intake manifold sealing surfaces

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

•Wiring for proper connections, pinches, cuts.

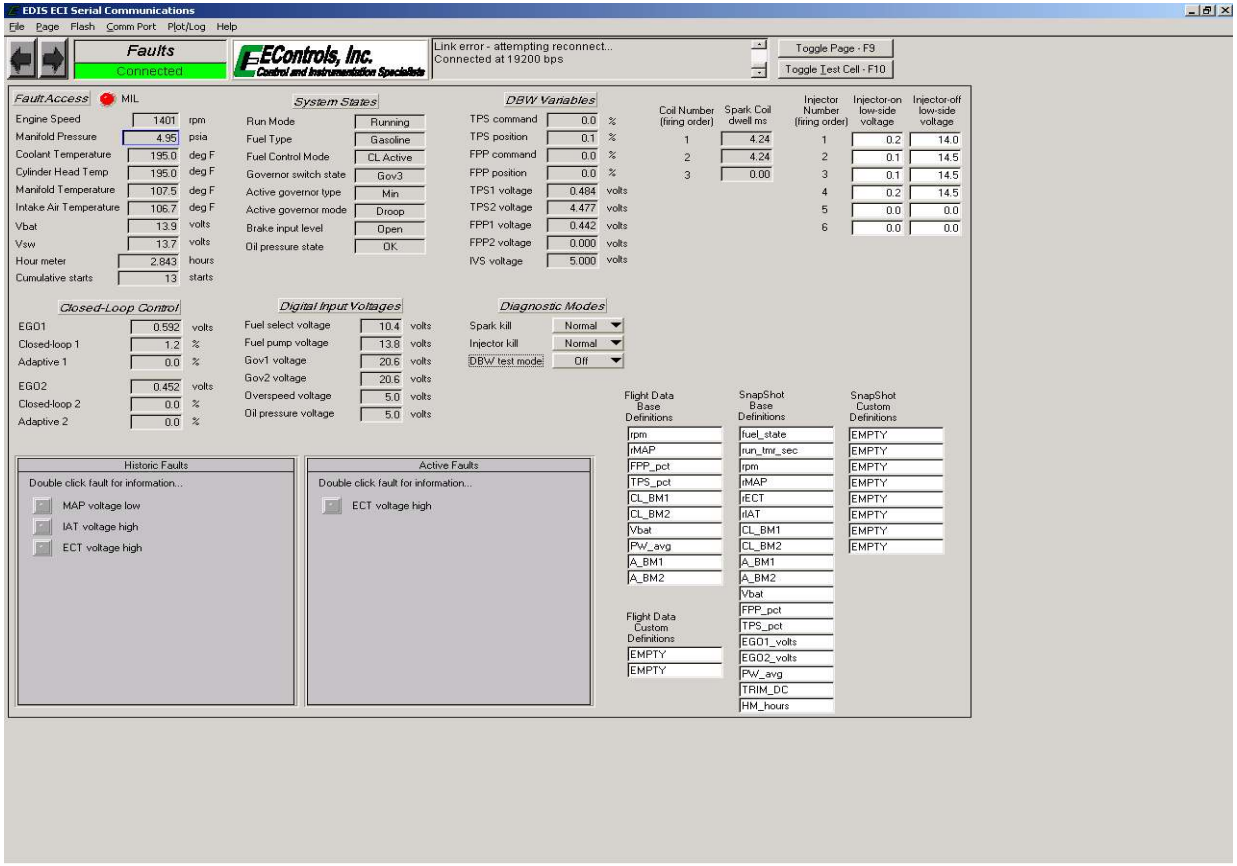
•Sensor connectors for damage, corrosion and contamination

Intermittent problems



Graphing the values and voltages can be a very useful tool in doing intermittent diagnosis.

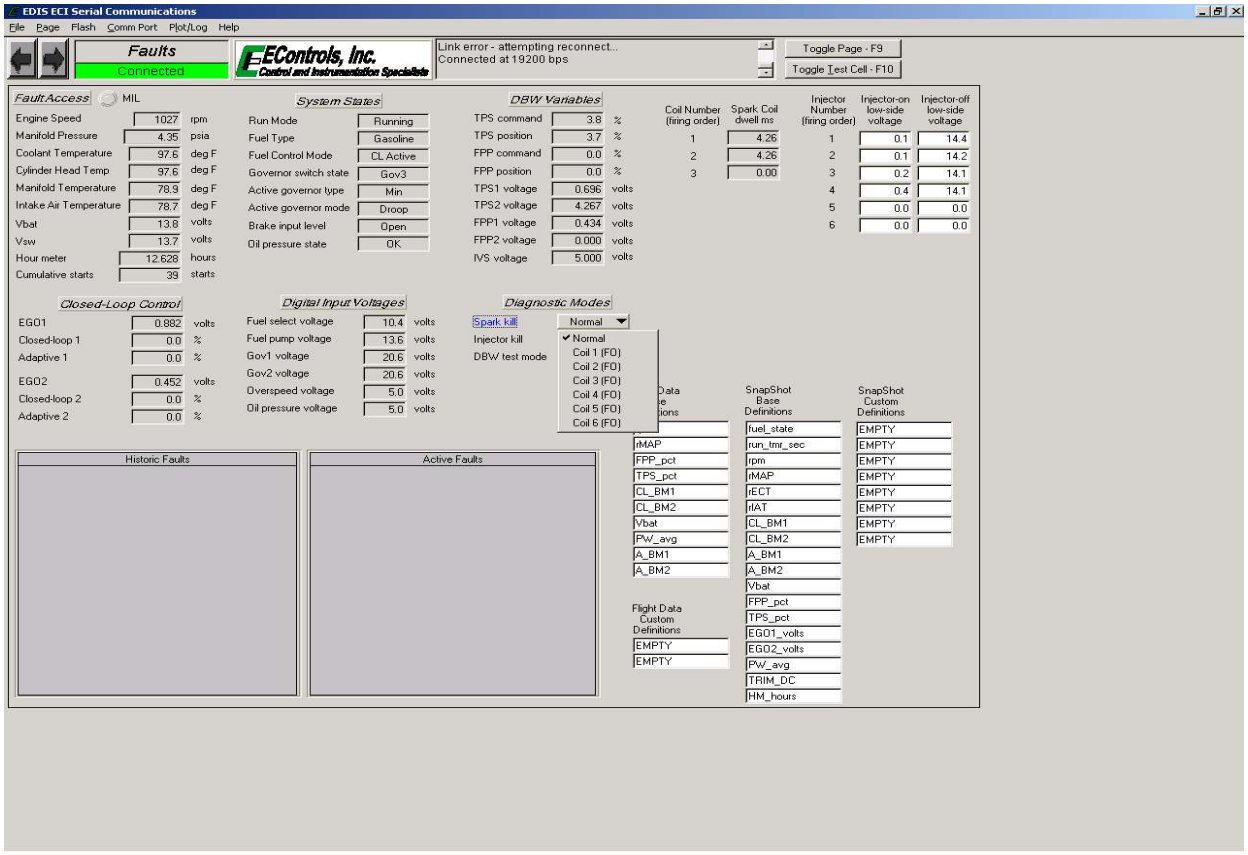
The system diagnostic monitoring software includes graphing and data logging capability. These features enhance the ability to diagnose and repair intermittent problems with the system. The graphing feature allows sensor inputs and select control output variables to be plotted in real-time while the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



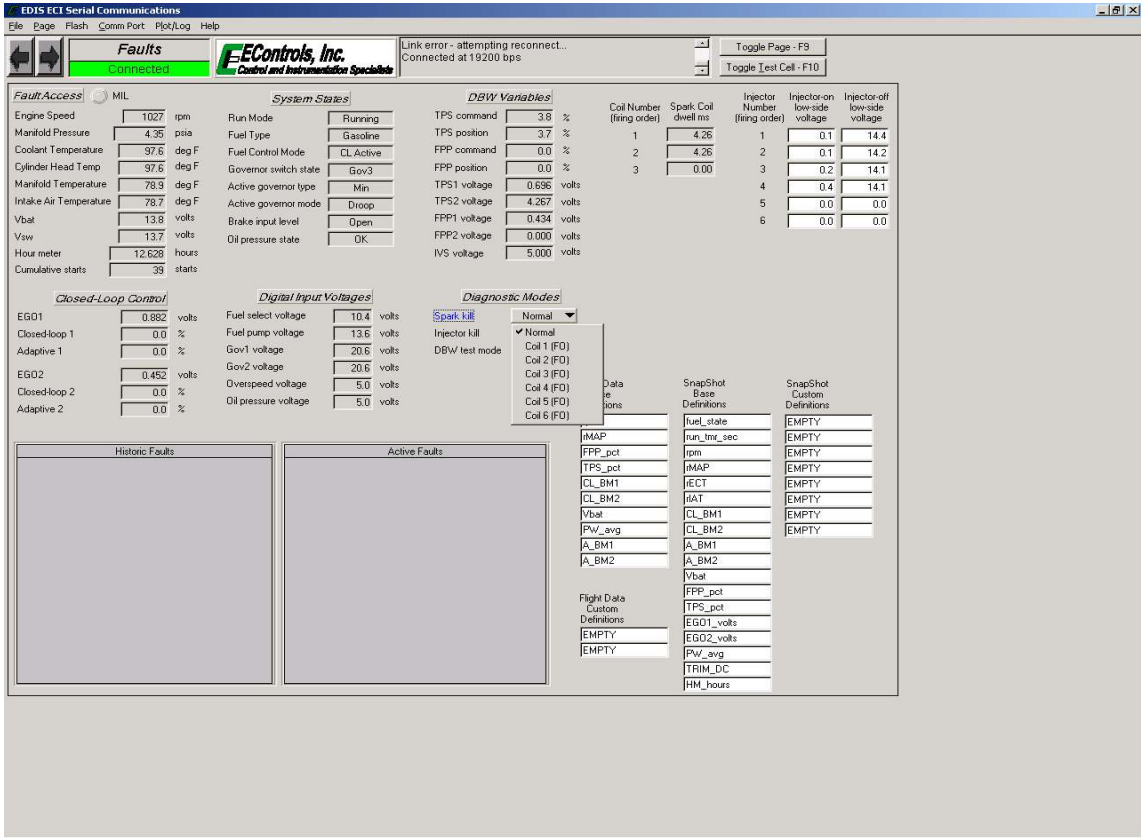
The System Fault screen is used to view and clear DTC's, which have been set.

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.



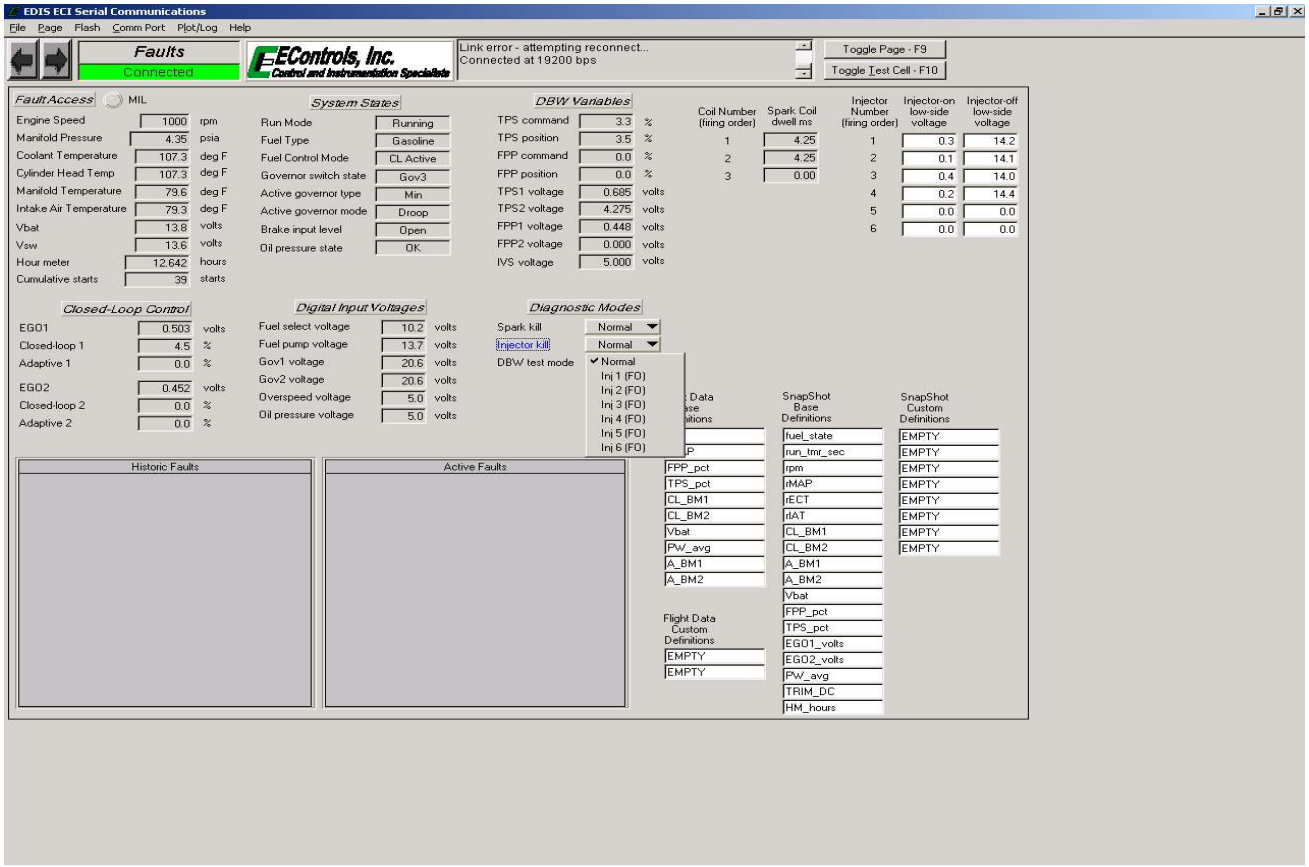
The Spark Kill diagnostic mode allows the technician to disable the ignition on individual cylinders. If the Spark Kill diagnostic mode is selected with the engine running below 1000 RPM, the **minimum throttle command will lock into the position it was in when the test mode was entered** (similar to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



Disabling Spark Plugs

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 reset.** 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.



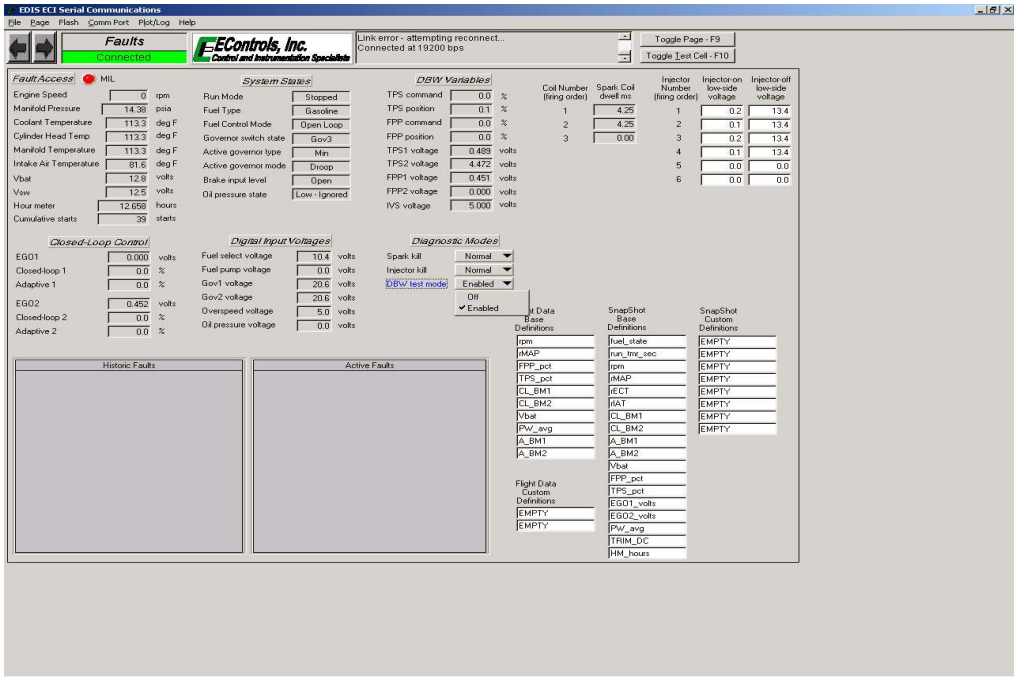
Injector Test

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.

Throttle Test

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 the diagnostic routines specified for FPP and TPS for Spectrum systems that use DBW.

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



Final Questions
& Comments