Sı$MPLE$
DıGıTAL
$S$$YSTEM$ $EM-5$

Installation manual for Version V27-V30 software
Feb 6, 2024

Please read the entire manual before attempting any hookup or running of the system. If you are installing an E or F system, you will need to refer to the supplemental manuals for those systems.
Links:
http://www.sdsefi.com/EM5E20.pdf Spark control via multispark ignition boxes.
http://www.sdsefi.com/EM5F20.pdf Coil pack systems

For tech help call your dealer or call 403-671-4015 or 403-453-7687 and ask for tech help. When calling for help please let us know which system you have. See below for descriptions of different systems.

System Description
SDS EM-5 is available in 3 different models:

EM-5-D controls fuel injectors only.
EM-5-E controls fuel and ignition timing using a single ignition coil.
EM-5-F controls fuel and ignition timing using multiple ignition coils.

EM-5 is a microprocessor based, digital, programmable EFI system intended to control port type injectors. The EM-5 allows you to access all points in the engine operating map with the engine running and alter them according to your own specific needs utilizing a hand-held LCD programming box. As such, the system can be used on virtually any engine type or displacement.

SDS Components
Top left Mixture knob.
Top right SDS ECU.
Bottom left: SDS Programmer.
Bottom middle MAP sensor.
Bottom right Engine temp and Air temp sensors.

Theory of Operation
Air temperature, water temperature, manifold pressure, throttle position and rpm are all measured and taken into account by the EM-5 which determines how often and how long the injectors remain open. The EM-5 generates a precise triggering pulse which is fed to the injectors. The manifold pressure or throttle position value multiplied by the rpm value determines the primary pulse width.

Fuel System
In order for any EFI system to function properly, an adequate supply of fuel at the proper pressure must be present at the injectors. **This cannot be over stressed. Problems are invariably blamed on the electronics when in fact 99% of all running problems are due to mechanical deficiencies.**

Vehicles with Factory EFI
If horsepower is similar to factory outputs, fuel tanks, pumps, lines and injectors should be adequate when installing EM-5. When increased power is desired on factory equipped engines, some or all of the fuel system components may have to be upgraded.

Vehicles without Factory EFI
We recommend that vehicles originally fitted with carburetors have a fuel system as shown below.
Figure 1
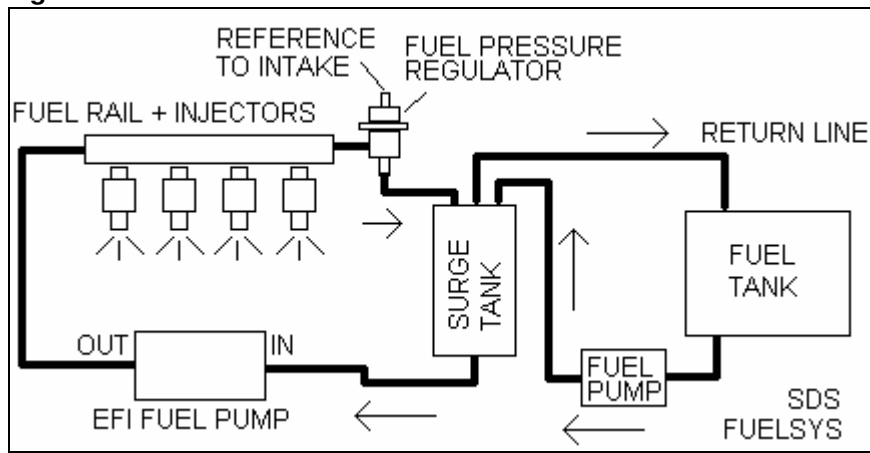
Two fuel pumps are required. One from the main fuel tank to the surge tank may be of the low pressure variety but must be capable of keeping the surge tank full during full throttle operation. Fuel lines should be at least 8mm (5/16 in.) ID on engines up to 600 hp and 10mm (3/8 in.) On engines over 600 hp. The fuel injection pump must be adequate to supply full rated fuel flow at maximum design pressure for a given output. Excess fuel not burned by the engine is returned through the regulator back through the surge tank, then back to the fuel tank. A fuel return line back to the tank is required.
The surge tank should always be mounted above the main EFI pump inlet so that fuel may gravity feed into this pump. Surge tanks ensure that the fuel supply will not be interrupted by air entering the EFI pump under high G situations. Fuel injected engines will not run properly with air in the system. The surge tank and fuel tank will not be pressurized by this system. The first pump is simply used to move fuel into the surge tank. The fuel tank will also need a vent.

New fuel lines may be run using rigid steel, copper or aluminum tubing. Flexible lines must be medium pressure hose intended for fuel injected applications. Working pressures can exceed 60 psi on turbocharged engines.

Fuel Pressure Regulator
The fuel pressure regulator is the component that determines the fuel pressure in the fuel injection system. It uses a spring against a valve to control the pressure, and any excess fuel delivered from the pump will exit the regulator for return to the fuel tank. Most regulators have a vacuum/boost reference to the intake manifold which keeps fuel pressure at a constant amount above the intake manifold pressure.

Most factory fuel pressure regulators will work fine even when the pump and injectors are upgraded, and most should also work fine if a turbo or supercharger is added. Usually the only reason to upgrade a fuel pressure regulator is to allow higher fuel pressure to increase the flow of the factory injectors. If an injector upgrade is necessary, then it is best to keep the stock regulator and select injectors that will give the required fuel flow at the stock regulator's pressure. We don't recommend the use of rising rate regulators with our system.

Increasing the fuel pressure does not provide much gain in flow through the injectors. For example a 36 lb/hr injector at 38 psi will flow about 42 lb/hr at 52 psi, and about 45 lb/hr at 60 psi. Also when the fuel pressure is increased the fuel pump flow will be reduced as well, since the pump is under more load.

Fuel Pumps

Many people are adding turbos and superchargers, so the factory fuel injection pump may not be capable of delivering enough fuel for horsepower demand. If in question, fuel flow can be checked from the pump. To check pump output, the fuel pressure regulator must also be connected, so it is easiest to do this on the vehicle. Testing the pump without a regulator is useless, since the pump is not under pressure. Measuring fuel flow should be done at the output of the fuel pressure regulator drain.

On turbo/supercharged engines fuel pressure increases with boost, so you should apply air pressure to the small hose fitting on the fuel pressure regulator using a pneumatic air regulator and gauge connected to an air compressor. Dial the air regulator up to the intended boost pressure. This is important because fuel pump flow will decrease as boost is increased.

Example: If you have a 4 cylinder engine with four 500cc/min injectors then you should have at least 2000cc(4*500) of fuel flow out of the regulator drain after 1 minute. Less than 2000cc would be ok, if the injector duty cycle was kept below 100%, so for example, if you had a maximum injector duty cycle of 60%, then you would need at least 1200cc flow after 1 minute. It's best to have extra flow capacity, to avoid running the engine lean.

The engine will not run properly if fuel flow is insufficient in any part of the system. A fuel pressure gauge is a good idea. If two EFI pumps are used they should be hooked in parallel, not series, to avoid cavitation. EFI fuel pumps will lose pressure if air is able to enter the inlet of the pump, so this will cause the engine to run lean and misfire.

Fuel Rails

The factory fuel rail is almost always adequate when increasing horsepower, so there is usually no need to replace the stock rail. The fuel rail provides a volume of fuel for the injectors and usually serves to hold down the injectors to the intake manifold. With barb style injectors, separate injector hold downs must be made but because of the flexibility of the hose, precise alignment to the rail is less important. With O-ring injectors, all injectors must be at the same depth and be perpendicular to the rail. Injector to rail spacing is also very critical with O-ring types. Details on fabricating intake manifolds and fuel rails are available on our website under the Tech section.

Injectors

Most injectors will work with SDS however the following injectors are not compatible:
MSD injectors 2011 or 2012.
Any Injector with a 2 amp open and .5 amp hold current cannot be used with SDS.

One important injector characteristic is the resistance or impedance of the injector coil winding. Low resistance injectors are characterized as peak and hold types. They will have a winding resistance from 1.7 to 4.7 ohms. Low impedance injectors require our external resistor pack. Injectors with impedances from 10 to 16.5 ohms (high) do not require the external resistors.

Don't expect super large injectors to offer stock idle quality or fuel economy. **The maximum size that we recommend for race and performance use** is 1.5 times the displacement of 1 cylinder in cc's per minute. So if you have a 2 liter, 4 cylinder engine with 500cc per cylinder displacement, the maximum injector size which will idle half decently would be a 750cc/min. injector. If you need more than this, you should consider the staged injector option, which uses 2 injectors per cylinder, but is only available for Rotary and 4 cylinder engines.

Injector flow rate

Consult the chart below to calculate injector flow rate required for a given Horsepower. We recommend running injectors to only 85% duty cycle, so be aware that you may need something about 15% larger than this chart shows. For V8 engines between 350 and 400 cu in. we recommend minimum 30 lb/hr injectors for best cold start enrichment. Engines over 400 cu in. we recommend 40 lb/hr or higher injectors.

.55 lb/hr/hp	**HORSEPOWER**	**AT 100% DUTY CYCLE**								
LB/HR	cc/MIN	4CYL	6CYL	8CYL		LB/HR	cc/MIN	4CYL	6CYL	8CYL
20	210	145	218	291		62	650	451	676	902
22	231	160	240	320		64	671	465	698	931
24	252	175	262	349		66	692	480	720	960
26	273	189	284	378		68	713	495	742	989
28	294	204	305	407		70	734	509	764	1018
30	314	218	327	436		72	755	524	785	1047
32	335	233	349	465		74	776	538	807	1076
34	356	247	371	495		76	797	553	829	1105
36	377	262	393	524		78	818	567	851	1135
38	398	276	415	553		80	839	582	873	1164
40	419	291	436	582		82	860	596	895	1193
42	440	305	458	611		84	881	611	916	1222
44	461	320	480	640		86	901	625	938	1251
46	482	335	502	669		88	922	640	960	1280
48	503	349	524	698		90	943	655	982	1309
50	524	364	545	727		92	964	669	1004	1338
52	545	378	567	756		94	985	684	1025	1367
54	566	393	589	785		96	1006	698	1047	1396
56	587	407	611	815		98	1027	713	1069	1425
58	608	422	633	844		100	1048	727	1091	1455
60	629	436	655	873						

Installation, sensor mounting & hookup

Hall sensor mounting ("E" & "F" models)
Consult the supplement manual for this information.

Temperature Sensor Mounting & hookup
The standard water and air temperature sensors are GM with 3/8 NP threads. Optional Bosch or Dale sensors use different threads listed below. The water temperature sensor needs to be mounted in cylinder head or thermostat housing so that it can read water temperature during warmup INDEPENDENT of the water flow controlled by the thermostat. Air cooled engines use a Bosch CHT sensor which should be mounted to the cylinder head casting.

The air temperature sensor should be mounted in the air filter/ throttle body inlet area on naturally aspirated engines. On turbo/supercharged applications, the sensor should be mounted in the intercooler discharge (after intercooler) pipe or throttle body inlet area. Mounting the air temperature sensor in the intake manifold is not the best idea due to heat soak concerns and longer response times.

On engines with high vibrations or when mounting in the intake manifold using GM sensors, it is a good idea to put a drop of epoxy between the plastic cage and thermistor to prevent possible vibration failures of the thermistor wires.

Before drilling into an area, be sure to check that wires from the sensor will clear things like pulleys and exhaust pipes and that drilling will not damage anything underneath. The area should be at least 5mm (.200 in.) thick and should be pilot drilled with a smaller than finish size drill bit first. When drilling and tapping, grease can be applied to the drill or tap to trap most of the cuttings. Clean all these cuttings out before installing the sensor. On sensors using tapered threads (GM and Dale), use Teflon tape to seal the threads before screwing in the sensor. Tapered thread sensors should screw into the hole 1/2 to 3/4 of the way with a short wrench and light to moderate pressure. Make sure you don't tap too deep or too shallow. Don't over-tighten. Sensors using straight threads don't need Teflon tape on the threads but should have a copper, aluminum, nylon washer or rubber O-ring used under the wrenching head to seal against the drilled mounting surface which should be relatively flat.
The drill and tap size for each sensor is listed below:
GM 3/8" NPT- Tapered 18 threads per inch. Drill pilot holes ¼", 3/8", final drill 37/64"
Bosch 12 X 1.5mm straight thread. Drill pilot hole ¼", final drill 10.5mm
Dale 1/8" NPT- Tapered 27 threads per inch. Drill pilot hole ¼", final drill 11/32"
Bosch CHT 10 X 1.0mm straight thread. Drill ¼" pilot hole, final drill 9mm.

Typically we do not provide an engine temp sensor for systems sold for Nissan and VW, since the factory engine temp sensor is compatible (Bosch), so we only provide the air temp sensor. You may have to solder wires to your factory sensor connector in these cases since the SDS connector might not fit.
Hookup: Check the cables for WT or AT written on the gray sheath. Plug in the WT marked cable to the engine temp sensor. Plug in the AT marked cable to the air temp sensor.
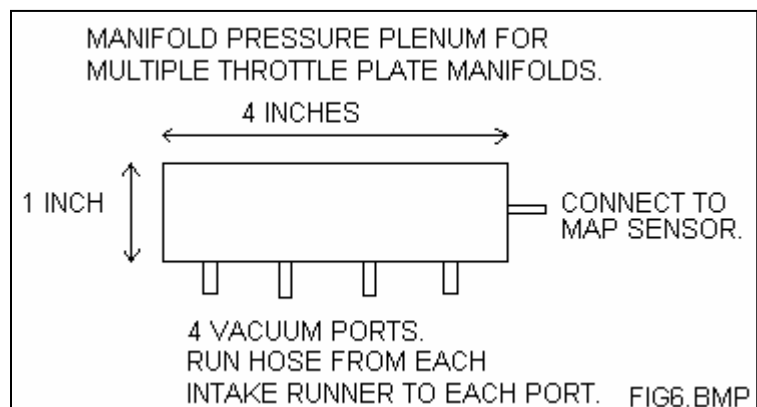Air cooled engines: The harness has a single white, 20 gauge wire that connects to the Bosch cylinder head temp sensor.

Use a cable tie to secure the temp sensor cable close to the sensor to prevent vibration breakage.

Map Sensor Mounting & hoookup
The MAP sensor if used, should be mounted in a moisture free area close to the intake manifold and connected using a length of 7mm (3/16 in.) Vacuum hose to the intake manifold. If the engine has the stock fuel pressure regulator with a vacuum reference port, you can place a "T" fitting in this line to connect the MAP sensor.

The placement of a .025 to .035 inch orifice in the vacuum hose may be required on some installations to reduce MAP fluctuations. A .025 to .035 inch MIG welder tip can be used.

MANIFOLD PRESSURE PLENUM FOR MULTIPLE THROTTLE PLATE MANIFOLDS. 4 INCHES. 1 INCH. CONNECT TO MAP SENSOR. 4 VACUUM PORTS. RUN HOSE FROM EACH INTAKE RUNNER TO EACH PORT. FIG6.BMP

Always try to mount the MAP sensor with the vacuum port facing down, which helps prevent water or moisture from entering the MAP sensor.

If you are running multiple throttle bodies you should have a vacuum line from each intake runner connected to a small plenum chamber, and then run a vacuum line from the plenum chamber to the MAP sensor. This gives the MAP sensor a more stable vacuum signal, which will make tuning the SDS much easier.

Hookup: On the main harness there will be a 3 pin green(1bar) or black(2&3bar) weather pack plug. The gray cable will be marked MAP on the gray cable sheath near the connector. Plug this into the MAP sensor.

Throttle position sensor mounting & hookup
The throttle position sensor(TPS) provides acceleration enrichment much like the accelerator pump jet in a carburetor. Extra fuel is added when the throttle is moving open. Systems not using a MAP sensor rely on the TPS for both acceleration enrichment and load sensing.

Hookup Using Stock or OEM Throttle Positio Sensors
The SDS EM-5 must use a potentiometer type TPS. Most engines after roughly 1985 will usually have a potentiometer type TPS. Older engines may have a TPS with just switches inside, and this type cannot be used.
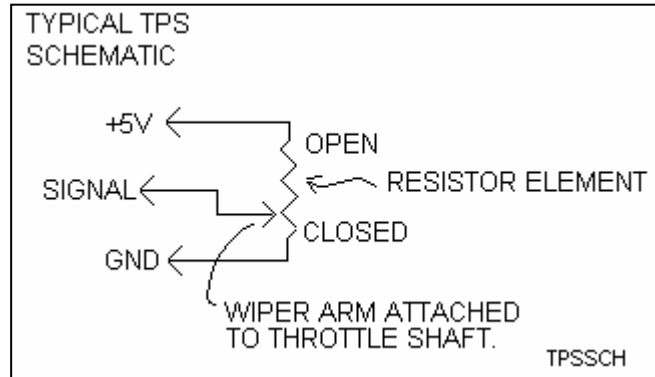
The following procedure to determine correct wire hookups should only be attempted by people who know how to use an ohmmeter and understand basic electronic theory.

Incorrect hookup of the TPS wires to the wiring harness can seriously damage the EM-5 and TPS. This damage is not covered under warranty.

You can determine the connections of the factory TPS using the following information:
The TPS should be in a closed throttle position.
Across the +5V and GND terminals: A constant resistance, usually between 3000 to 10,000 ohms. **Resistance has very little or no change if the throttle is moved !**
From the SIGNAL terminal to GND terminal: Low resistance usually 0 to 500 ohms. Resistance will increase as the throttle is opened.
From the SIGNAL terminal to the +5V terminal: High resistance usually about 80% to 100% of the total resistance of the TPS. Resistance will decrease as the throttle is opened.
NOTE:
Some TPS's have a fourth terminal which is either a closed or wide open switch. This switch will make contact with one of the + or ground terminals of the TPS only when the throttle is fully closed or fully opened. This terminal will not be connected to the SDS system.
TPS connections to SDS:
+5V to SDS red wire
Signal to SDS white or green wire.
GND to SDS black wire.
Your system has included a 3 pin plug and 3 snap-in pins to plug into the main wiring harness plug labeled TPS. You can use these pins and the plug to make an adapter using the stock TPS connector, or you can cut off the plug on the SDS TPS cable and directly wire it to the stock TPS plug. It is best to solder and heatshrink these connections. The TPS cable should be tie-wrapped to the throttle body, etc. so the wires don't break.

Voltage check of the TPS:
You can verify proper connection of the TPS to the EM-5. You must have the EM-5 power and ground wires connected. The EM-5 must have power. Using a voltmeter placed on voltage scale, connect the (-) lead to the black wire to TPS, place the (+) lead to the signal wire of the TPS, and you should see a voltage of less than 1.5 Volts at closed throttle and voltage should increase as the throttle opens. Voltage should be greater than 3.8 volts at wide open throttle.

Mounting the SDS supplied Throttle Position Sensor
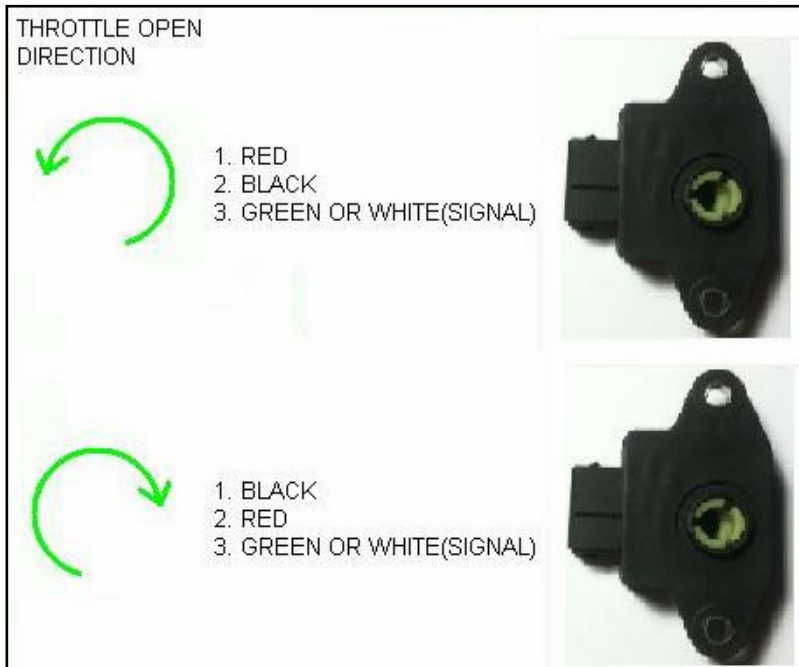
The TPS fits 5/16 "D" shaped shafts common on Japanese and European cars, as well as some aftermarket throttle bodies. Wiring connections vary depending on direction. Refer to diagram below.

Mounting bolt spacing for the TPS is likely different from the spacing on the throttle body, so an adapter bracket may need to be fabricated. Usually 1/8" plate aluminum is a good material for this. Also the throttle shaft may be too long, so either the shaft could be cut, or the TPS could be mounted with spacers between the TPS and the mounting plate. The TPS is able to rotate approximately 100 degrees, and the throttle body will only rotate about 80 to 90 degrees. The TPS should be mounted such that the throttle will not force the TPS to rotate beyond it's limits. This will damage the TPS. Make sure the TPS is about 5 degrees above it's bottom limit with the throttle butterfly fully closed.

EM-5 Mounting
The EM-5 must be mounted in a moisture free location inside the vehicle. Use the mounting tabs to secure it to the chassis. The EM-5 should be mounted at least 3 feet away from the ignition coil and wires if possible, preferably behind a metal firewall.
Important! Mount the EM-5 with the wires exiting out the bottom. If water comes in through the firewall, then the water will drip off the wires at the lowest point and cannot go up into the EM-5. The EM-5 is not waterproof.

System Wiring Hookup
EM-5 connectors
         Inj drive Main harness Hall   Programmer

ECUPLUGS.JPG

It is best to install the wiring but not tie it down fully until later, in case some of the wiring needs to be relocated. Once the engine is running and there are no major problems, all wiring can be secured with cable ties. All connections in the engine compartment should be supported in such a way as to prevent vibration from working directly on the wires, sensors and connector plugs. Never run wires through jagged firewall holes unless a grommet is used.

SDS wiring should be kept as far away as possible from the following engine parts:
1. **Spark plug wires.**
2. **Ignition coil and it's wiring.**
3. **Exhaust header.**
4. **Alternator wires.**
5. **Radiator electric fan and wiring.**

Some tips about ground wires:

1. Grounds should be permanent and never be switched.
2. Don't ground other electronics at the same terminal as the EM-5 grounds.
3. Make sure the grounds have a very good connection.
4. Sand off any paint on the chassis.
5. Try to avoid extending ground wires, which could cause noise problems.
6. Do not run EM-5 ground wires to the engine block.
7. It is ok to run grounds to the battery terminal only if the battery is less than 4 ft. or 1 Metre from the EM-5.
8. Poor grounds may cause the engine to flood with gas.

General wiring diagram
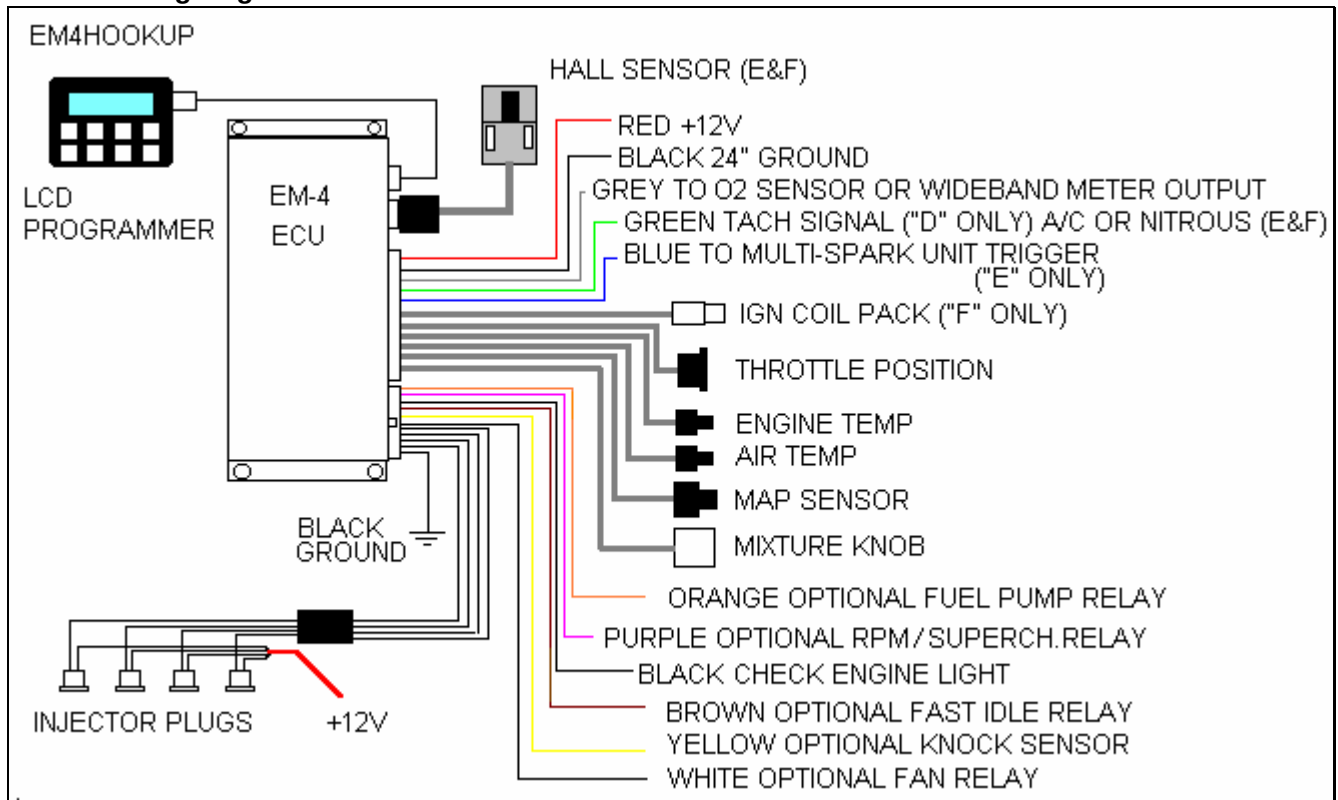
Main Wiring Harness connections
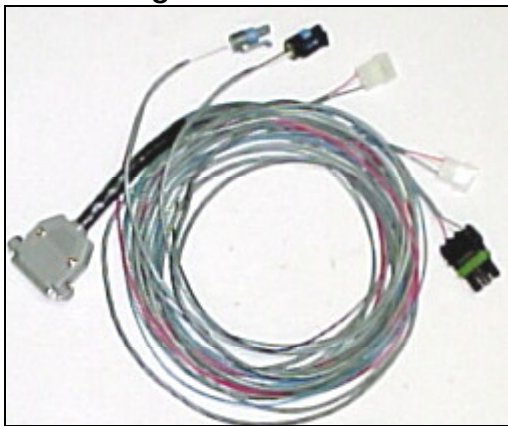
MAINHARN.JPG

Main harness shown here has a 25 pin connector and connects the ECU to all the sensors. Typically 6 feet in length for most wires except MAP sensor and mixture knob cables which are 57".

For "F" systems (coil pack) there will be a gray 6ft cable marked "CP", with a black weather pack plug. This cable must be connected to the coil pack's input cable.

Main harness black 20 gauge (computer ground).   Ground to vehicle chassis close to the EM-5.
Important! Makes sure this connection is good. This is the most important connection in the system.

Red 20 gauge   Key switched. Fused with 1 to 5 Amp fuse. **Do not connect to the accessory circuits, such as radio circuits, heater or interior lights, since key switched power would be cutoff during engine cranking.** Note if EM-5 power is obtained directly from the battery, a switch should be placed in line to prevent the battery from being run down over time.

Plug in the mixture knob.
Blue wire (EM-5E only) To multi-spark box trigger wire(usually white).
Green 20 gauge For EM-5D(fuel only systems): This wire must connect to ignition coil negative terminal. If a multi-spark box system is running the ignition then the green wire should connect to the TACH output terminal on the multi-spark box. If the factory computer remains somewhat functional you may also get a tach signal from the factory diagnostic plug.
Green 20 gauge, Pin 13, For EM-5E or EM-5F models: This wire can do 3 different functions.
1. Air conditioning sense. Connect to A/C clutch, then SDS can turn on Radiator fan + fast idle.
2. Nitrous Retard. Will retard timing when at high throttle when this input sees +12V.
3. Launch Rev limiting. Retards timing and limits engine rpms by cutting spark when this input sees +12 volts.
See Options section in E or F supplement manuals for more details.

Yellow 20 Gauge, Main harness Yellow wire goes to tachometer. This wire provides a 12volt square wave tach signal intended to drive most tachometers. Some factory import tachs that were connected to ignition coil minus terminal may not work with this signal. One solution is to connect this yellow wire to MSD 8920 tach adapter then the 8920 will drive the tachomter.

Gray 20 gauge and O2 sensor or Wideband meter hookup
On the SDS main harness there is a single gray 20 gauge wire which you can connect to an O2 sensor or to a wideband mixture meter. Connection is required when you want to use Closed loop, O2 logging and Lean Warning functions in the SDS computer. The SDS can run without an O2 sensor if this is desired. We do not supply connectors to fit the O2 sensors, so you must cut off the connectors and install your own.
Single wire/unheated O2: Just connect the gray wire to the sensors wire. No way to go wrong here. Just make sure the exhaust where you mount the sensor is actually grounded. Do an ohms test from the engine to the sensor body. Should have less than 100 ohms. If higher thatn 100 ohms you will have to run a ground wire onto the exhaust or else use a 4 wire sensor.

GM three wire/heated: Connect Gray SDS wire to black wire on the sensor. Brown wires, one goes to chassis ground and the other to switched 12 volts. The brown wires run a heater element inside the sensor.

Bosch sensors: Connect Gray SDS wire to black wire on the sensor. White wires, one goes to chassis ground and the other to switched 12 volts. The white wires run a heater element inside the sensor.

Spartan2 by 14point7: Red to switched +12V. Green wire on spartan cable to SDS gray 20ga wire. Black to ground, near the SDS ground. See O2 Type section, set to "PLX/AEM OLD".

AEM wideband: Follow the instructions with the kit. The Gray wire on the SDS main harness must connect to the white wire on the AEM meter's harness. The wideband signal will allow SDS to read the A/F ratio and also perform closed loop correction. **Set the AEM rotary switch to the P0 position.**

On PLX units older than 2012, connect the filter capacitor across the two lower pins of the white connector. This helps filter noise to give better readings.

Innovate: See the manual to setup analog output. Set SDS to PLX. Using Innovate PC interface software program the analog output for 0 volts at 10:1, 5 volts at 20:1. Connect the analog output wire from the Innovate unit to the gray 20 gauge SDS wire on the main harness.

 Wideband other brands: Please consult their manual.
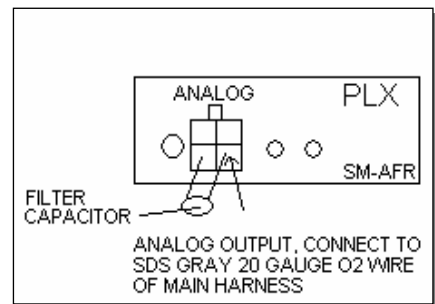
Connections from Injector Drive Harness
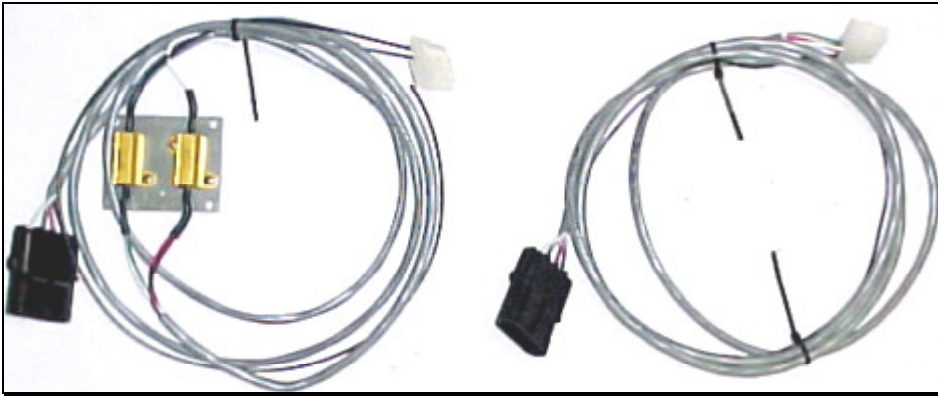
DRIV.JPG

The injector drive harness has a white plastic plug that connects out to the injector harness as well as optional relays or optional knock sensor. The system comes with one of the above harnesses. Left shows low impedance drive harness with resistors. Right shows high impedance drive harness which has no resistors. (4 cylinder shown).

Black 18 gauge injector ground(s):   Ground to vehicle chassis close to the EM-5. 6 and 8 cylinder models will have two ground wires. 4 cylinder models have one ground wire. **If not grounded the SDS system will appear to be working but will have no fuel, so will not start the engine.** Some E&F models will have no spark or have ignition problems. In some cases the SDS may be used for ignition only but this ground still must be connected for the ignition outputs to function properly.

Resistor Pack Mounting
Systems for use with low impedance injectors have a resistor pack in the injector drive harness, which goes from the EM-5 to the injector harness. Systems for use with high impedance injectors will not have a resistor pack. This is an aluminum plate with gold colored resistors mounted to it. This pack should be mounted in the engine compartment, usually to the firewall in a location between the wiring grommet and the injector harness using sheet metal or machine screws. Be careful drilling holes through any sheet metal without first checking if there is something like a hose or brake line on the other side. Be aware that this resistor pack can get very hot under high duty cycle conditions and the aluminum plate acts as a heat sink for the resistors. For this reason, make sure that it is mounted clear of any components which might be affected by this heat or close to any components such as the exhaust which might not permit adequate cooling of the pack.

Injector harness   Programmer cable
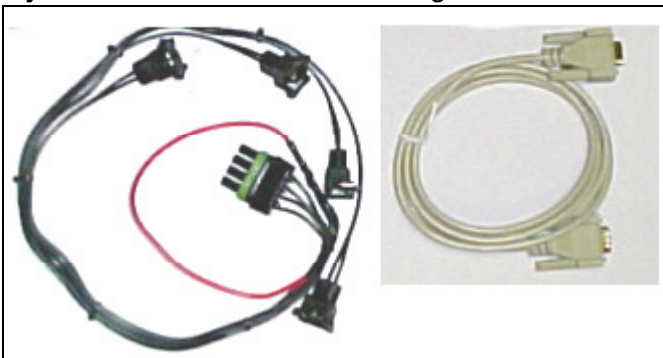
INJPROG.JPG
The Injector harness plugs into the injector drive harness and into the fuel injectors on the engine. Harness is not numbered since SDS batch fires the injectors. It does not matter which plug goes to which cylinder. Injector harness 14 gauge red wire(s) to +12 key/ignition circuit with 10 A or higher fuse.

Programmer cable connects the EM-5 to the programmer.

Connect any optional relay wires. See information in following pages of this manual.

Check Engine Light
The EM-5 can control a check engine light, L.E.D. or lamp or in the event of certain sensor problems or failures. You can either use the supplied SDS check lamp or connect to your factory dash lamp.

Connecting to a factory Check Engine Light:
In most cases this should be possible to do. Locate the stock check engine light wire using a factory wiring diagram. Turn on key power in the vehicle, then touch the check engine light wire to chassis ground, if the light comes on then the SDS output will be compatible. The SDS output is a ground switch, it does not put out 12 volts. Most factory ecu's are the same. Cut off the black wire from the SDS check light and insert the pin into the white terminal as shown in the photo. Connect the other end of the black wire to the factory check engine light wire.

Using the SDS supplied lamp
Mount the lamp for best visibility for the driver. Drill a 1/4" hole for the lamp. Feed the wire through the hole from the front side of the panel. You will need to connect the lamp's red wire to a fused 12 volt circuit. The black wire from the check light needs to be inserted in the drive harness white plug pin 11, see photo. 3RD position from the right on the top row. On older EM-5 models this wire was pink, and has been changed to black in Oct 2008.
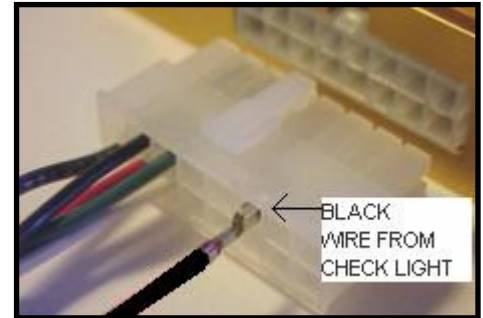
Adding a key switched circuit
On some vehicles with a limited number of fuses or circuits, you may want to add additional key switched circuits to power new devices such as a fuel pump, injectors or coil pack. This can easily be done using a relay(not-included) and fuses as shown in the following diagram. This may prevent overloading the existing key switched circuit with too many devices requiring key switched power. The relay will only add less than one-tenth of an amp on the existing key switched circuit. This is a good idea for supplying power to EM-5F coil pack units. Always use a fuse close to the battery to prevent electrical fires! We recommend an automotive type relay capable of switching 30 Amps or more.

SINGLE DEVICE

FUSE CLOSE TO BATTERY.

TO KEY SWITCHED +12V

85
30
86
87 POWER TO SINGLE DEVICE
RELAY

MULTIPLE DEVICES

FUSE CLOSE TO BATTERY.

TO KEY SWITCHED +12V

85
30
86
87
FUSES   EXAMPLES:
FUEL PUMP
INJECTORS
COIL PACK
RELAY
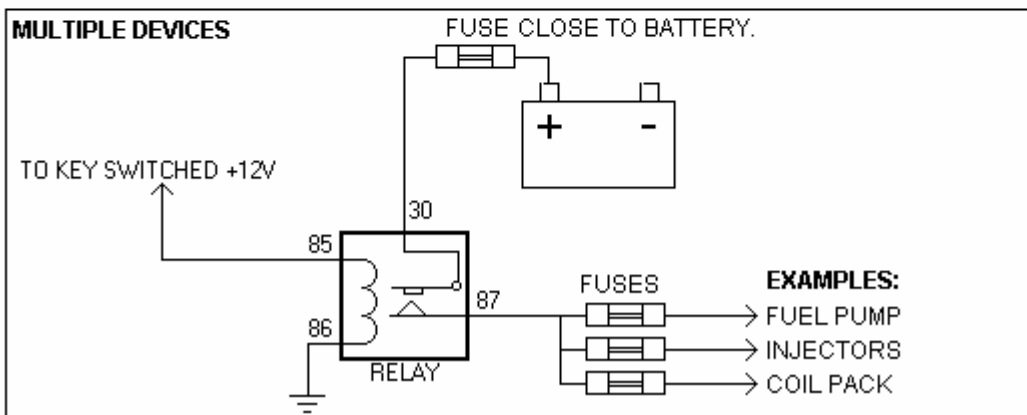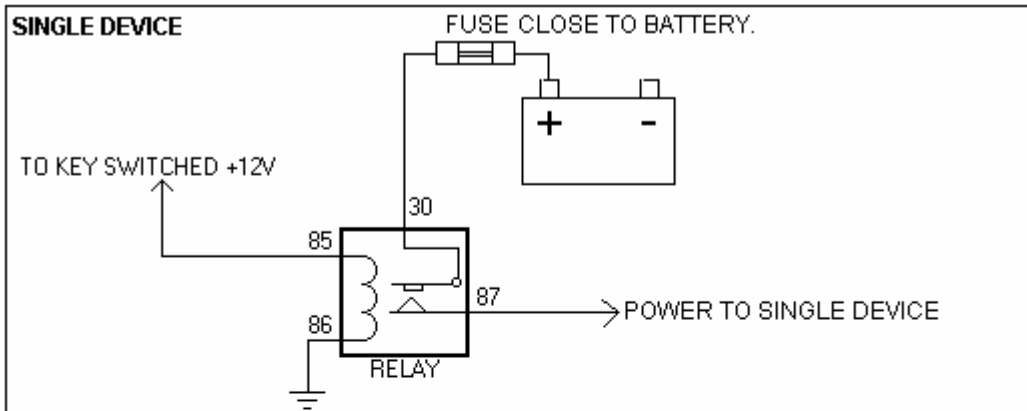
Options section

Optional Fuel Pump Relay
SDS units can be equipped with an optional output to control a relay to switch the fuel pump off when the engine is not turning over. This feature is designed to prevent the pump from emptying the tank in a serious accident. The pump relay is energized for 2.8 seconds when power is turned on to pressurize the fuel rail until the EM-5 detects crank rotation. If the engine stalls the EM-5 will shut off the relay in 2.8 seconds. There is nothing programmable for the fuel pump relay.

Relay wiring is as follows:
Pins 85 to key switched 12 volts. This allows the fuel pump to be shut off when the key is turned off.
Pin 87 to the fuel pump positive terminal. 16 gauge wire or heavier recommended.
Pin 86 to orange wire coming from the white injector drive harness plug.
Pin 30 can be run to a spare fused circuit. If you don't have a spare circuit you can connect pin 30 to the battery, but place a 15 Amp fuse in line close to the battery. 16 gauge wire or heavier recommended.
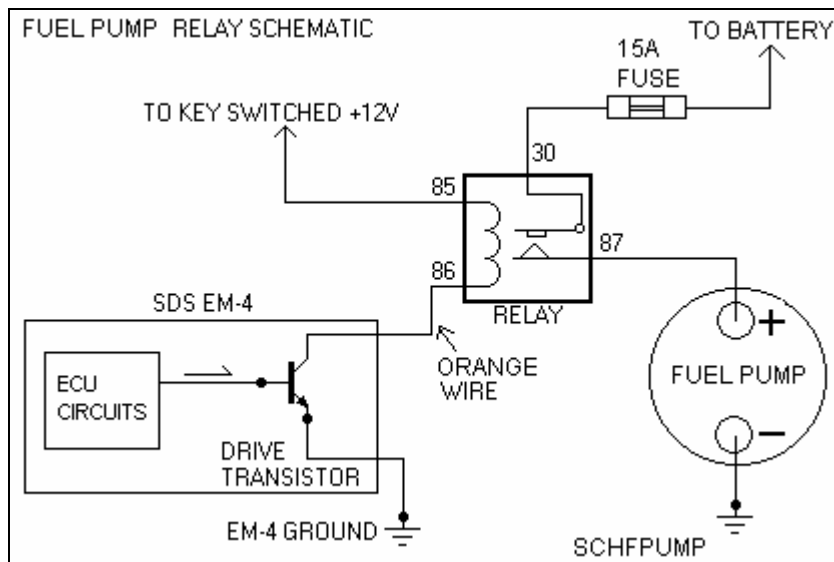
Optional Fast Idle
The fast idle option consists of a solenoid valve which connects to the intake manifold via 5/16 vacuum hose and a relay controlled by the EM-5 via the engine temperature sensor. When the engine temperature reaches the preset point, set in the window, FAST IDLE SWITCH, the relay closes the solenoid to allow normal idle speed. Below this temperature, the solenoid is open bypassing additional air around the throttle plate. The point of solenoid closing (off) is adjusted under the FAST IDLE SWITCH parameter by using the +1 and -1 buttons. Note that the -1 button raises the temperature set point and the +1 button lowers it. The cut off point would usually be set between 100 and 140F on most engines.
FISOL.JPG
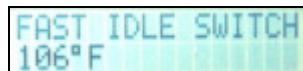
 FASTID.JPG

Relay connections are as follows:
Pins 30 and 85 to key switched 12 volts. On SDS supplied relays 30 and 85 should have a wire soldered across them, so this will save you making an extra connection.
Pin 87 to solenoid.
Pin 86 to brown wire coming from the white injector drive harness plug.
The solenoid mounting flange must be grounded.

If the fast idle rpm is higher than desired, a restrictor can be placed in the other port hose to cut down the air volume bypassed. The MAP sensor automatically compensates for the extra air being admitted by the solenoid valve.

FAST IDLE RELAY SCHEMATIC
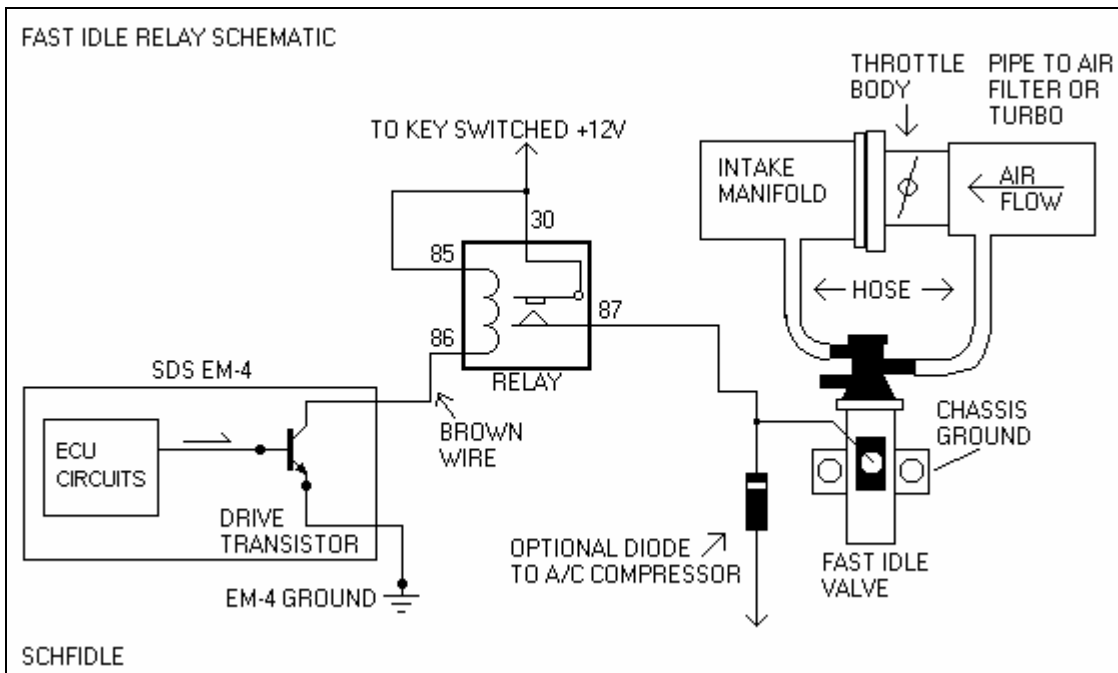
*Note: Optional diode is not required if Pin 13 A/C sense wire is connected to the A/C clutch positive wire. Only use diode on "D" (fuel only) type SDS systems.

Air Conditioning Solenoid
The a/c solenoid is used to speed up the idle when the a/c compressor is running. This valve is the same valve that is used for fast idle operation. If you have the fast idle option installed, then there will be no need for a second solenoid valve. If you don't have the fast idle option then you will need the valve, and it's terminal must connect to the a/c clutch (+) wire, and the solenoid body must be grounded. Hose connections are the same as for the fast idle relay option above.

For EM-5D (fuel only)
You can install a diode connected between the fast idle valve and the a/c clutch (+) connection. See the fast idle diagram. The diode allows current to flow from the a/c clutch over to the valve. If the fast idle circuit is turned on, then the diode will block any current from the fast idle circuit from going to the a/c clutch.

For EM-5E and EM-5F if you have fast idle option and/or radiator fan relay option:
You can use the PIN 13 green wire input for A/C sensing, and this input will activate the radiator fan relay and can also activate the fast idle relay when the A/C is operating. See the E or F supplement manuals for more information.

This option is not suitable for TP load sensing systems(no MAP sensor), because of the inability to compensate for the extra load on the engine.

Optional RPM Relay
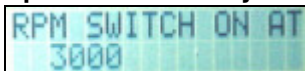
RPM.JPG

The rpm switch control option allows the user to select the rpm where switch is activated. This option may be used to switch anything rpm dependant on and off, especially single stage variable valve timing and supplemental induction valves.

To program rpm operation, go to the RPM SWITCH ON AT window in the programmer located to the right of the magnet window. The rpm that you wish to turn the switch on at is selected with one of the four + or - buttons. Below the rpm that you have selected, the switch is in the normal or low speed mode (off), when the rpm reaches the selected value, the relay is activated (on).

Relay wiring is as follows:
Pins 85 to key switched 12 volts.
Pin 87 to the solenoid positive terminal. 16 gauge wire or heavier recommended.

Pin 86 to purple wire coming from the white injector drive harness plug.
Pin 30 can be run to a spare fused circuit. If you don't have a spare circuit you can connect pin 30 to the battery, but place a 15 Amp fuse in line close to the battery. 16 gauge wire or heavier recommended.
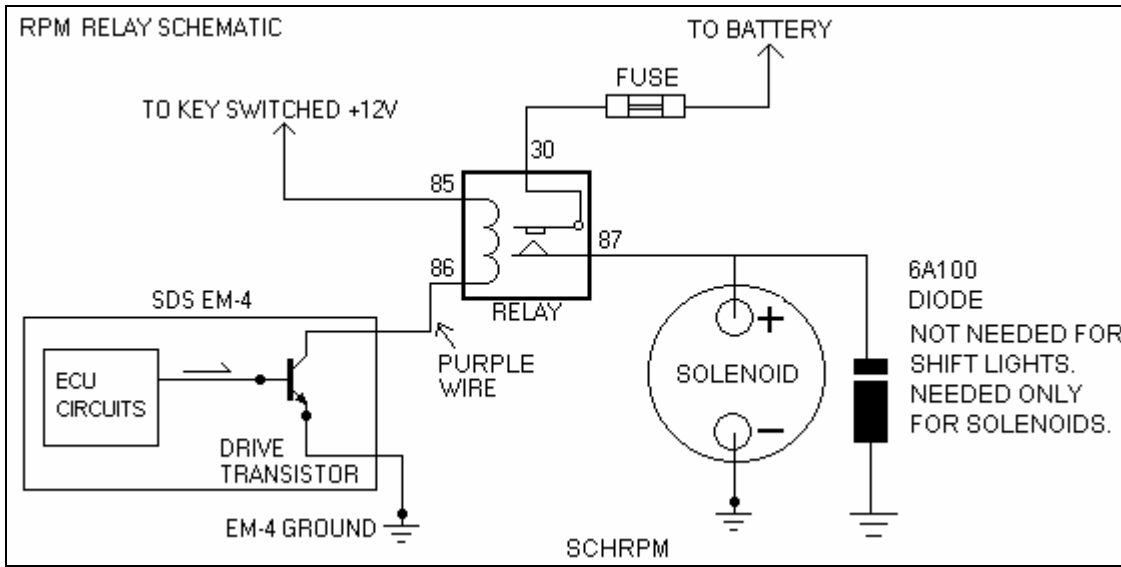
Optional Radiator Fan Relay
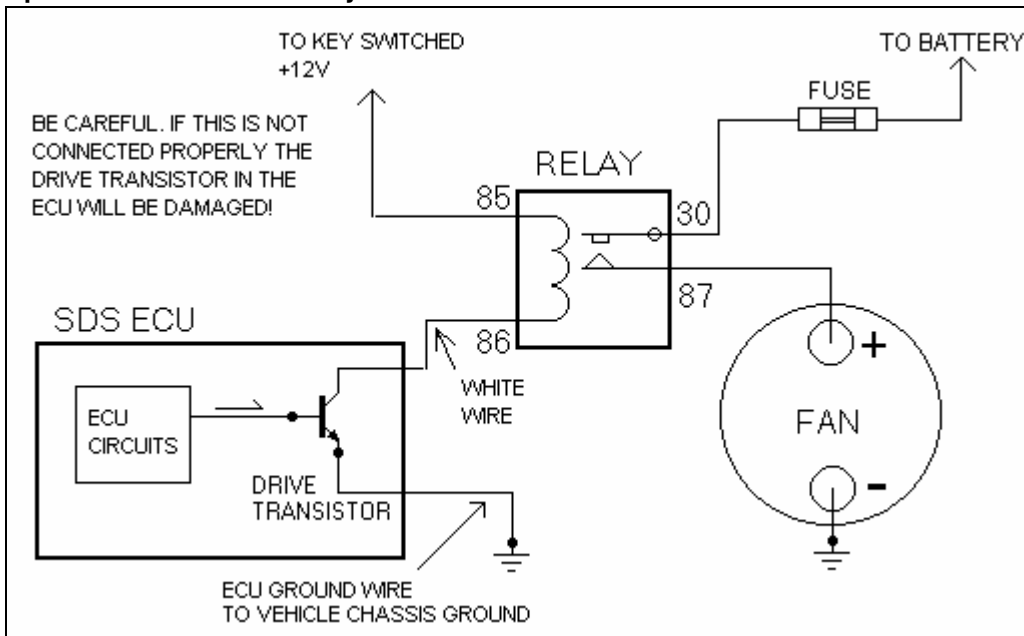
Fuse rating will depend on the current draw of the fan(s). 15 Amp may be fine for most applications. If two fans are used a 20 Amp fuse may be needed.

The EM-5 reads the engine temperature and refers to the programmable points to turn the fan relay on or off. There are two parameters for adjusting the switch point of the fan relay. The two parameters are:
RADIATOR FAN ON   RADIATOR FAN OFF
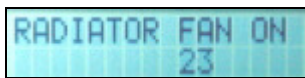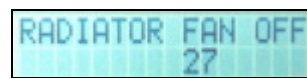
RAD1.JPG   RAD2.JPG

Each has a number beside it that does **not** correspond to temperature. **The lower the value the hotter the switch point, so if you set the values to zero the fan will never turn on.**

Important: Your RADIATOR FAN OFF value should be at least 2 or more higher than the RADIATOR FAN ON value.
Good examples of programmed values:
FAN ON 24, FAN OFF 26. This is ok.

FAN ON 21, FAN OFF 25. This is ok.
FAN ON 21, FAN OFF 23. This is ok.

Bad examples of programmed values:
FAN ON 21, FAN OFF 22.
FAN ON 21, FAN OFF 19.
Due to software protection in this case the fan may turn on, but software will not allow the fan to turn off again. This is to prevent the relay from oscillating, or in other words, switching on and off rapidly causing poor operation, electrical noise and damage to the relay.

Adjusting:
Warm up the engine by driving the car around for at least 30 minutes, longer if in a cold climate. Stop driving the car but leave it idling for about 2 to 4 minutes. Increase the RADIATOR FAN ON value until you hear the fan come on. Watch the engine temp gauge on dash, when it comes back down to normal, then change the RADIATOR FAN OFF value until the fan turns off.

It is safest to start with a higher value, that way the fan will switch on at a colder temperature, so you don't overheat the engine.

Approximate values for different temperature sensors:

Sensor	FAN ON value
GM	19-25
Bosch	30-38
Ford	27-35

If you change the FAN ON value, make the FAN OFF value 4 higher.

If you need to test the relay and wiring you should set the RADIATOR FAN ON value to 254 and the RADIATOR FAN OFF value to 255 and the relay should be on and the fan should be running.

End of installation section.

General system information

EM-5 Reset
Any time that the power is shut off or interrupted to the EM-5, or if interference prevents the software from running properly, the EM-5 will automatically perform a reset. This takes about 0.5 seconds. When this happens, the SDS EFI startup screen will appear in the LCD window. Reset can also be caused by the switching of high current devices such as electric pumps, motors or solenoids. These devices cause high voltage spikes that are difficult to filter. Filtering can sometimes be successful if a rectifier diode is placed across the offending solenoid, motor etc. The striped end(cathode) of the
diode should connect to the (+) terminal and the other side of the diode to the (-) terminal.

Shutting off Power and Memory
Programmed values are stored in the EM-5 microprocessor in EEPROM memory which holds the values in memory when power is turned off. As soon as you change a value with the programmer, it is permanently changed and stored in EEPROM memory. Disconnecting the vehicle battery will have no effect on the SDS system.

Disconnecting the LCD Programmer
Set the **VALUES LOCK** to the **ON** position before disconnecting the programmer. It is also a good idea to shut off the engine before unplugging the programmer. No data will be lost. Data is stored in the EM-5.

Injector Drivers
Drive transistors may be triggered in ones, pairs, threes or fours depending on application. SDS is a non-sequential system like many OEM systems used in the 80's and early 90's.

Staged Injection Option
Staged injection is available for Wankel and 4 cylinder engines only. Staged injection allows your engine to run on one injector per cylinder (or rotor in the case of Wankel engines) at low load and two injectors at high load. The point of switching is preset and is non-programmable by the user. At a predetermined pulse width of 8 milliseconds for example, the primary injector pulse width would be halved to 4 milliseconds and the secondary injectors would also be brought on line at 4 milliseconds. As such, no special programming is required.

It is important to have injectors of the same flow rate in both locations so that there is no bump in the fuel curve. Throttle bodies and intake manifold must be arranged so that air is always flowing past all of the injectors all of the time.

Injector harnesses are marked for primary and secondary if this is important on a particular system.

Air Temperature (AT)
The air temperature correction map is pre-programmed when delivered, and is not normally user accessible. It provides an absolute density correction relating to cues from the air temperature sensor. AT is displayed in GAUGE mode.

Mixture Knob (KNOB)
The mixture knob controls the overall mixture across all ranges. In effect, it adds or subtracts a percentage to the injector pulse width. From the straight up or 12 o'clock position, the mixture can be leaned roughly 50% by turning the knob fully counter clockwise or 50% richer by turning it fully clockwise.

The knob is very useful in determining a rich or lean condition. It is important to leave the knob in its final position once programming is complete. Precise return of the knob to an exact position can be noted in gauge 2 mode under KNOB. A +%, 0, or -% indicates rich, neutral or lean position. The knob may be disconnected if desired. This will leave the setting at 0%, so it is important to complete proper programming with the knob at 12 o'clock if the knob is to be disconnected.

A common use for the mixture knob is to quickly adjust the mixture richer or leaner for running on the dyno. Then you can see if there is a gain or loss in power. If you found for example, that the engine gained power with the knob at +5% richer, then next step would be to add 5% to the RPM FUEL values in the rpm ranges where the power was higher. Then you can adjust the knob back to 0%.

Tach signal
Some external data loggers or tachometers may require a 5 volt tach signal. A 5 volt tach signal is available at

pin 12 on the main harness connector. No wire is installed at the factory, but a wire can be added. Remove the screws holding together the plastic DB connector cover. Solder a 20 or 22 gauge wire onto pin 12 to connect to the external device needing the signal. Diagram shows location of pin12. Pins are numbered on plugs, but are often difficult to read. Note: This signal is not available on EM-3 models.
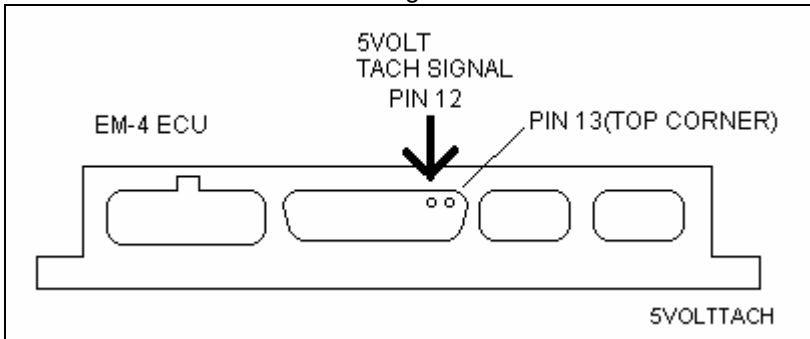
System electrical current draw
EM-5 ecu: 70mA no relay options.106mA with 4 relay options active.
EM-5F coil pack current draw 4cyl, 3.2amps @ 6000 rpm. 6cyl, 3.2amps @ 4000 rpm.
Injector current, 4cyl high impedance 2.2amps @ 80% duty cycle.
Injector current, 4cyl low impedance 3.6amps @ 80% duty cycle.

LCD Programmer
The programmer allows you to access all points within each parameter and change values to program to the system. When powered up, SDS EFI should appear in the LCD window. From here, parameters may be called up by pressing the right or left parameter select buttons (< or >). As each parameter is gone through, the next parameter will appear in the window. "D" models do fuel only, E&F do fuel and ignition.

Parameters will appear in the programmer window in the following order from left to right:
GAUGE 1
GAUGE 2
GAUGE 3
GAUGE 4
TACH 1/0(D only) or MAGNET SEEN/NOT SEEN (E, F only)
CRANK IGN RETARD (E&F only)
FUEL TRIMS (4 WINDOWS) OPTIONAL INTENDED FOR AIRCRAFT ONLY.
LEAN WARNING
A/C FAST IDLE or NITROUS RETARD (E, F only)
PIN 13 INPUT (E, F only)
O2 TYPE (standard or multiple wideband selections)
IDLE FUEL AMOUNT
IDLE TP LOCATION
RADIATOR FAN ON
RADIATOR FAN OFF
FAST IDLE SWITCH
RPM SWITCH ON AT
FUELCUT BELOW TP
FUELCUT/RPM
FUELCUT/MANPRESS
VALUES LOCK ON/OFF
CLOSED LOOP ON/OFF
CL LO RPM LIMIT
CL HI RPM LIMIT
CL MAP LO
CL MAP HI
KNOCK MAX RPM (E, F only)
KNOCK SENSE (E, F only)
KNOCK RETARD (E, F only)
MAGNET POSITION (E, F only)
START CYCLES
START 32 points

RPM IGN (E,F only)   38 points
IGN RET-ADV/LOAD (E,F only)   64 points
ENGINE TEMP 32 points
MANIFOLD PRESS or TP   64 points
RPM FUEL   38 points
ACC PUMP SENSE
ACC PUMP LO RPM
ACC PUMP HI RPM
then, back to GAUGE.

The parameters will automatically loop back to the opposite end upon reaching one of the end selections. **By holding down either the right or left parameter select buttons for more than 2 seconds, ranges will advance at the rate of 8 per second until the button is released at the desired location.** The << button advances left at 20 frames per touch and can be held down for extremely fast scrolling.

Within each parameter, there are a number of ranges with a corresponding value number beside it. This value number is the one that will be changed to alter the injector pulse width. ie. RPM FUEL 5250, 57. RPM FUEL is the parameter, 5250 is the range and 57 is the value. The value number may be any number between 0 and 255 on most parameters, however some parameters have limits. **The larger the number, the more fuel will be injected at that parameter and range.**

To change a value, use one of the 4 buttons labeled +1, +10, -1, -10. Each button will change the value in the window each time it is depressed by that amount. IE. With a 57 in the window, Pressing the -10 button once will change the value to 47. The +10 and -10 buttons should only be used for quick, radical adjustments. **Again, by holding down these buttons for more than 2 seconds, values may be changed quickly to the desired figure.** Don't play with these unless you want to change the value.
The VALUES LOCK feature must be selected OFF in order to adjust any values.

Gauge Modes

Calling up the gauge modes allows you to see in real-time, the sensor inputs to the EM-5. This is useful for diagnosing sensor problems as well as programming. **If you encounter a strange problem or misfire, always select the gauge modes first to see if everything makes logical sense.** Most problems can be quickly diagnosed here if you understand the system. Gauge modes update at approximately twice per second.

Gauge1 mode
If you are in any parameter in the LCD Programmer you can push the GAUGE button to jump to gauge1 mode. Push the GAUGE button again and the programmer will jump back to the parameter that you came from.
Gauge1 mode can be accessed by pressing the gauge button once.

Gauge1 mode: Manifold pressure Engine temperature	
G1.JPG	
Engine RPM's Air temperature	
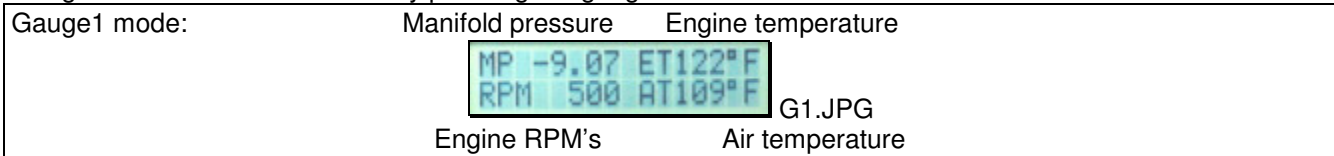
MP displays engine vacuum in inches mercury on normally aspirated engines. On turbo and supercharged engines MP displays vacuum(inHG) and boost(PSI) on turbo engines. When on boost there will be no sign preceding the MP reading. The MP reading will change to ERR if the map sensor loses its connection on the ground or power wires. If you see ERR check the connector at the sensor and also check the wires for breakage The sensor may have failed also. ET and AT are engine and air temp readings which will also read ERR if the circuit is broken. For MAP and temp sensors, ERR will stay displayed even if the fault was momentary. You can attempt to clear ERR by pressing the +10 button when in Gauge1 mode. If the ERR clears, then the problem was intermittent, and if the ERR stays displayed then there is a problem such as a broken wire or damaged sensor.

Gauge2 mode
Gauge 2 mode can be accessed by pressing the right button (>) once when in gauge 1 mode.

Gauge2 mode: Mixture knob Acceleration pump	
G2.JPG	
Injector duty cycle Ignition timing(E&F only)	
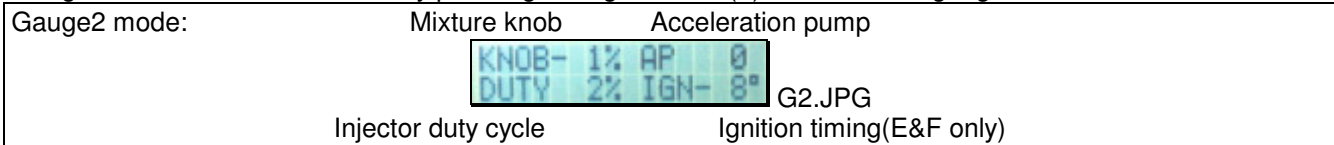
AP indicates the acceleration pump feature which adds extra fuel as the throttle opens. AP should read zero when the throttle is steady. The AP number should increase above zero as the throttle is opening. If AP reads a value higher than zero when the throttle is stable the throttle position sensor may be faulty.
If you need to get to gauge2 from any parameter you can do the following. Push GAUGE, then the > button to get to gauge2, then the < button back to gauge1, then push GAUGE button to return to the previous parameter.

IGN (**only on E & F models**).
 IGNBTDC.JPG
A negative sign indicates that the ignition timing is before TDC. Ignition is normally BTDC.

 IGNATDC.JPG
A positive sign indicates that the ignition timing is after TDC. If timing is after TDC then ignition programming could be wrong, or the knock sensor could be too sensitive, or knock sensing could be sensing engine noise. Having ignition timing after TDC will cause major loss off power and possible engine damage.

Duty cycle**(DUTY)** refers to the amount of time that the injector remains open in relation to how much time is available at that rpm before the next injection cycle begins. If the DUTY % reading is higher than 100% while at wide open throttle and the mixture is lean, then larger injectors are required.
If the engine is missing or running rough check DUTY for unstable readings. This may mean a bad sensor or wiring or a bad value programmed. DUTY could read above 100% if the system is programmed too rich.
The maximum continuous duty cycle should never exceed 85%.
If any fuel cut parameters are met, then fuel will be cut off from the engine and the duty display will show CUT RPM, CUT TP or CUT MAP to let you know which one caused fuel to be cut off.

Gauge3 mode
Gauge3 mode is accessed by pressing the right button (>) once, when in Gauge 2 mode.
Top line displays battery voltage and throttle position (TP).

Second line displays either O2 voltage or A/F ratio is displayed, depending on which type of sensor is selected under the O2 TYPE parameter. For standard O2 sensor, voltage is displayed, and if connected to a wideband meter, the A/F ratio is displayed in increments of .2 .

Guage3 mode:	Battery voltage	Throttle position
	BAT12.7V TP 2	
	O2 13.5	
	A/F ratio or O2 voltage	
G3V14.jpg		
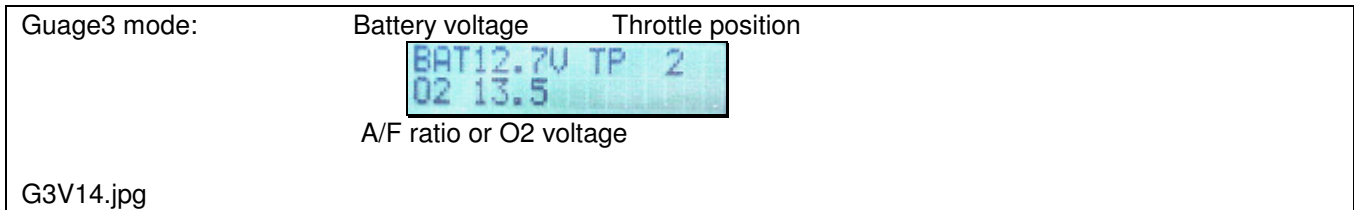
Gauge4 mode
Gauge4 mode is accessed by pressing the right button (>) once, when in Gauge 3 mode.
This gauge mode displays the most popular engine information on one screen. Manifold pressure, RPM, O2 voltage(or A/F ratio), and ignition timing.

Guage4 mode:	Manifold Pressure	Ignition timing
	MP -22.2 IGN-12°	
	RPM 1000 O2 .84V	
	Engine RPM's	A/F ratio or O2 voltage
G4V16.jpg		
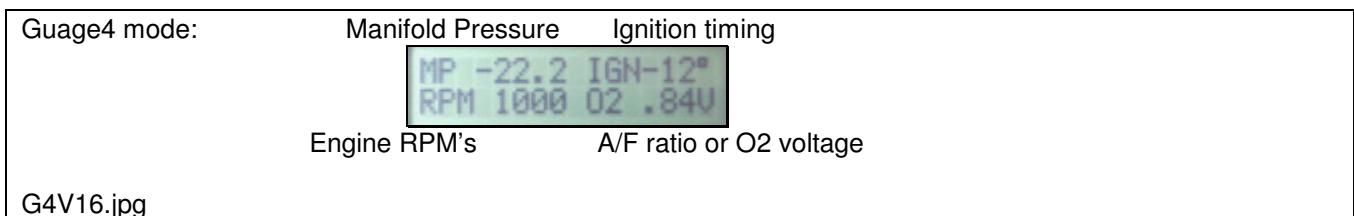
For more information on these functions, consult the section on Diagnosing Sensor Problems.

Retro-fit/software upgrade situations
EM-3 models: A V17 upgrade is not practical for EM-3 models, since the only addition is the Launch Rev limiting feature, which cannot be used in the EM-3. For ease of software management at SDS, we may produce V17 for the EM-3. V16 upgrades will remain available for the EM-3, for those who wish to upgrade. EM-3's do not have an auxiliary transistor option, so these must use the RPM output for check engine light operation.

EM- 4 models shipped prior to April 23, 2007 do not have an auxiliary output transistor installed to drive the check engine light output. This could be added if the ecu is sent back to us. But there is an alternative; The EM-4 has the ability to use two different output terminals to drive the Check Engine Light. In software upgrade situations the RPM relay output can be used, however if the RPM output is used for RPM relay purposes, then you must add the auxiliary transistor driver or send the ecu back to us for this to be done.

The Lean Warning feature can function in all EM-3 AND newer computers since this is only a software change. The only requirement is an O2 sensor connected.

End of general information section.

SDS Fuel Tuning

Important programming and tuning tips

1. If you have a system that uses throttle position for load sensing (no MAP sensor) then skip ahead and read the Throttle Position section before tuning the RPM FUEL values.
2. CLOSED LOOP should be turned OFF, and it is normally off when shipped from the factory.
3. We highly recommend using a mixture meter to aid in tuning.
4. Mixture meters do not read properly until the oxygen sensor gets up to 600 deg F. Unheated O2 sensors (1 wire) do not get hot enough at idle, so run the engine under load for at least 1 minute. Heated sensors (3 & 4 wire) may work at idle after a few minutes of idling. If the engine has no muffler, O2 warmup may take longer.
5. Let the engine reach full operating temperature before fine tuning any MAP, TP or RPM values. If you try reprogramming while the ECU is still adding extra fuel for warmup, you are wasting your time and getting off track.
6. You must vary only one parameter at a time and observe the meter. If you change rpm and MAP, you don't know which parameter is affecting the air/fuel ratio. Hold MAP constant and vary rpm or vice versa, never both.
7. Make absolutely sure that fuel pressure is staying where it should, that all injectors flow the same volume, have good patterns and that injectors and pumps have sufficient flow rates to feed your engine at full power. No amount of programming will fix inadequate fuel flow caused by a mechanical problem.

Use caution at full throttle/high boost with severe misfiring. You can melt the pistons if the mixture is too lean. Always go richer first with the knob to see if the misfiring gets worse.

The fuel tuning has been written in the sequence that we recommend tuning the system. RPM FUEL first, followed by Manifold Pressure (or Throttle Position), Acc pump, Engine Temp, Start, closed loop and fuel cutoffs/limits.

The amount of fuel injected by the EM-5 is determined by the values in rpm fuel, manifold pressure(or throttle position), acc pump, engine temperature, start, air temperature. Once, the engine is at full operating temperature the main values that determine the fuel mixture are RPM FUEL and Manifold Pressure. Most of the Manifold Pressure values can be left at their factory settings when the RPM FUEL values are set properly. RPM FUEL values are where programming should begin.

Dyno Tuning

Whether you use a chassis or engine dyno, we have found the easiest way to tune is to do a baseline run with the mixture knob at 0%. On turbo engines, turn the boost for initial runs to the minimum possible. Back out of the throttle if the meter shows a bad lean condition or if any severe misses are encountered. If the engine will make it up to redline on the baseline run, do the next pull at +10% on the knob. You can now superimpose the two torque curves to see where you picked up or lost torque due to the richer mixture. Keep richening the mixture in 10% increments until torque drops off from the previous run. Note where in the curve that the gains and losses were evident. Now you can fix the peaks and valleys with the programmer and return the knob to 0% for some stabilized pulls. For quick, full throttle setup, load up the engine at each 1000 rpm break point and keep richening the mixture at that rpm point with the programmer until torque starts to fall off. Adjust for maximum torque at each point. Fill in the 250 rpm steps between each 1000 rpm point with a smooth transition of values. Once the engine is tuned well at full throttle/low boost conditions, the boost may be slowly increased. Any lean condition now at the higher boost as indicated by the mixture meter or a loss of torque can likely be attributed to improper Manifold Pressure values.

RPM FUEL

 rpmfuel14.jpg

The rpm band is divided into 38 ranges, usually 250 rpm apart. **This parameter is where the main fuel programming is done in SDS systems**. The variables which ultimately determine the RPM FUEL values are engine displacement, injector flow rate and volumetric efficiency of the engine. Volumetric efficiency varies with RPM, so as a result RPM FUEL values will vary accordingly. Also if a richer mixture is desired at certain RPM's then the RPM FUEL value will need to be increased.

Each RPM FUEL window is also used to display captured average O2 sensor readings to aid in tuning the engine. See the O2 logging section for more information.

If you know your injector flow rate then the RPM FUEL CHART will give the approximate RPM FUEL value to enter for your engine. You also need to know the engine displacement to use this chart. Injector flow rate is in cc's per minute. If your flow rate is in pounds per hour, multiply by 10 to convert to cc's per minute. For example a 30 lb/hr injector would convert to roughly 300cc/min. Take your engine displacement and divide by the number of cylinders to get your displacement per cylinder. Cross your injector flow rate with your displacement per cylinder to find your RPM FUEL value. Enter this value right from idle rpm to redline rpm as a starting point. This chart is applicable for gasoline. If you are using Methanol, double the fuel value in the box. For systems using **staged injection** with two injectors per cylinder, use the flow rate of only one injector.

The value from the RPM FUEL CHART will often be roughly 20% too high at low rpm's, and roughly 20% too low at high rpm's, so it is best to monitor the air/fuel ratio with a mixture meter, then make fine adjustments to get the best mixture at all rpm's.

If you don't know the flow rate of your injectors, you could assume a flow rate of around 200 to 250cc/min on normally aspirated engines. On turbo engines flow rates vary, and are usually between 300 to 400cc/min. If you estimate that the flow rate is too high, then the mixture will end up to be too lean, because the RPM FUEL value from the RPM FUEL CHART would be too low. A mixture meter will help when flow rate is unknown, and be careful not to run lean under high throttle and high RPM. If you find the engine stumbles at medium or full throttle, then this means that the RPM FUEL values are either too low(lean condition) or too high(over-rich), so just keep making adjustments to the RPM FUEL values until the engine will tolerate full throttle.

RPM FUEL CHART

APPROXIMATE RPM FUEL VALUES vs CYLINDER DISPLACEMENT AND INJECTOR FLOW RATE

		INJECTOR FLOW RATE cc/min								
		200	300	400	500	600	700	800	900	1000
	300	113	75	56	45	38	32	N/A	N/A	N/A
CYL	400	150	100	75	60	50	43	38	33	N/A
SIZE	500	188	125	94	75	63	54	47	42	38
cc	600	N/R	150	113	90	75	64	56	50	45
	700	N/R	175	131	105	88	75	66	58	53
	800	N/R	N/R	150	120	100	86	75	67	60

N/R=NOT RECOMMENDED. **Important! If using the 3.5 bar MAP sensor, you must multiply the RPM FUEL CHART number by 1.2. If using the 5 bar MAP sensor, you must multiply the RPM FUEL CHART number by 1.66. This is due to required lower manifold pressure numbers for these sensors.**
Other tips for tuning RPM FUEL values:

1. It is important to note that the number of injections are doubled when the rpm is doubled regardless of the values entered. See figure 4.
2. Often people have their RPM FUEL values very incorrect and then find themselves having to re-slope the entire 64 manifold pressure values, which can lead to further problems. When the RPM FUEL values are setup correctly the majority of manifold pressure values can be left unchanged, thus greatly simplifying tuning of the engine.

3. If you double the RPM FUEL value, then this will double the pulse width of the injector pulse. If you wanted to make the mixture 10% richer then you could simply add 10% to the RPM FUEL value, so if the RPM FUEL value was 80, and is then changed to 88, this would add 10% more fuel to the mixture.

Figure 4

INJECTOR PULSE FREQUENCY vs. RPM

INJECTOR OPEN HERE

RPM=2000

TIME →

RPM=4000

WHEN THE ENGINE RPM RISES THE SDS ECU INCREASES THE FREQUENCY OF THE INJECTIONS AS SHOWN HERE. RPM FUEL VALUES NEED ONLY INCREASE OR DECREASE DUE TO AIR PUMPING EFFICIENCY FO THE ENGINE.
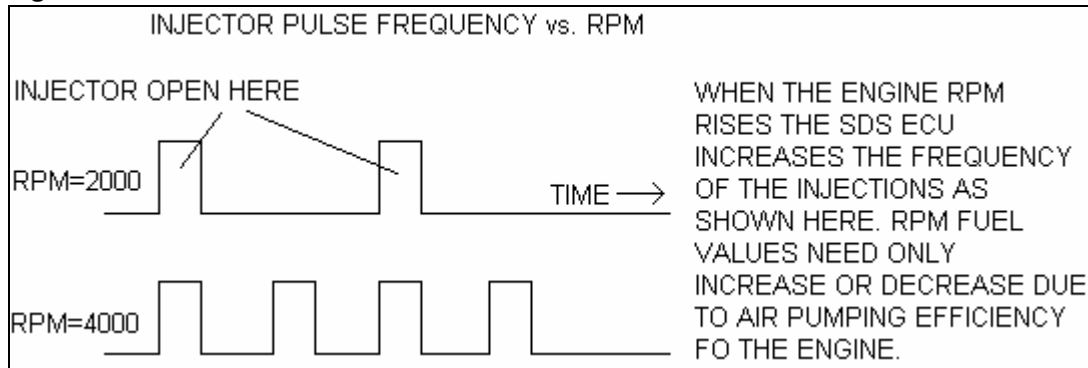
Startup Procedure

Make sure that fuel at the correct pressure is present at the injectors. Turn on ignition and computer power. Crank the engine, rotate mixture knob while cranking. If engine does not fire, see troubleshooting section. You may also have to increase the START values to get the engine to fire, especially if you have small injectors(less than 30lb/hr or 300cc/min).

Once the engine is running, use the mixture knob to get a smooth idle. Let the engine warm up to normal operating temperature. Once warmed up, attempt to set the knob near the center position (12 o'clock). To do this will most likely require adjustments to the RPM FUEL values. If the knob is on the rich side of 12 o'clock, the RPM FUEL values are too low and vice versa.

On E and F systems, you must set the MAGNET POSITION parameter as soon as the engine is idling smoothly before performing any other adjustments. Refer to your E or F supplement manual.

Fine tuning RPM FUEL values

To get the best compromise programming setup for your application, you will have to decide which areas are of most importance. If you have a race engine, usually fuel economy and emissions are of less importance than maximum power, so you can setup the A/F ratios to be around 12 to 1 everywhere. On a performance street engine, both power and economy are usually important and emissions may be as well.

Tuning may be done on a dyno or driving the vehicle. Dyno tuning is preferable when maximum power is paramount, as this allows the quantitative measurement of increases or decreases due to both ignition timing and air to fuel ratio changes. Fuel economy and throttle response parameters are best tuned by driving the car on the road, and most street cars can be safely tuned on the street with the aid of the meter.

Accidentally running lean at full throttle or high boost would be harmful to the engine. The engine may run pretty smooth even though the mixture is too lean, but there would be loss of power from the lean condition. Try turning the mixture knob richer and if you find the power picks up then you will need to increase the RPM FUEL values.

RPM FUEL values are best adjusted when the engine is under load. On naturally aspirated engines you should have about ¾ or full throttle when setting the RPM FUEL values. **For turbo and supercharged applications it is safest to turn down or minimize boost to less than 7 psi to adjust RPM FUEL values.** Best tuning is done using a wideband mixture gauge so that the Air/Fuel ratio is around 11.5 to 12.5 to 1 at all

AIR/FUEL 11.5 TO AIR/FUEL 12.5

RPM's. 11.5 is better for race engines and continuous high load engines. 12.5 is better for short term runs at high load.
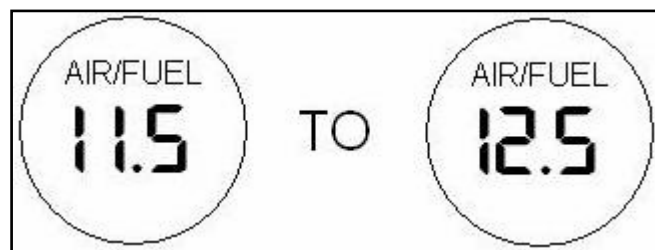
 If at ¾ to full throttle you see the mixture gauge higher(leaner) than 13.0 then its best to increase RPM Fuel values at those RPM's until the meter reads as shown above.

O2 Logging

This is a great feature in SDS for capturing the air/fuel ratio in each RPM range. Logged readings are stored in RAM memory and are then displayed in each RPM FUEL range window, which makes tuning easy. If you see that the O2 logged reading is too rich or lean in a range, then you can change that rpm fuel value.

Logging with WMS wideband or Standard O2.

O2 logging requires that the SDS gray wire is connected to either a standard heated or unheated O2 sensor, or for best results, a wideband O2 meter. Several brands are, see below. A standard O2 sensor will work adequately, but standard O2 sensors do not give accurate readings in the rich region, and only O2 voltage is logged, not air/fuel ratio.

O2 TYPE
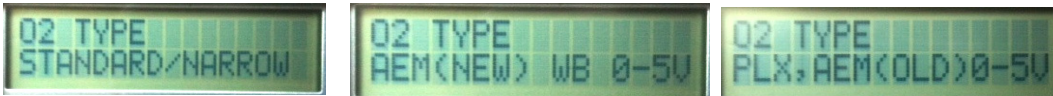
This is for selecting which type of O2 sensor. Proper selection is important in order for closed loop and O2 logging to operate properly. Press +1 or -1 to change to the type that you have.

There are four selections with for O2 Type:

1. "NONE" Select this when the SDS gray wire is not connected to an O2 sensor.

2. "Standard/Narrow" is for conventional type of O2 sensors, heated or unheated.

3. "AEM(NEW) WB 0-5V" for AEM wideband 2nd generation models.

4. "PLX,AEM(OLD) 0-5V" for PLX wideband meters and AEM 1st generation wideband meters.

Other brands:

Autometer: Use the PLX setting. The meters output will need to be defined. In the autometer gauges setup, set bgd range lo to 10.0, and bgd range hi to 18.0 .

LM-1/LC-1 Innovate: Use the PLX setting. In the Innovate software you will need to define settings for the analog output. Enter 1.0V at AFR 11.7:1, and 5.0V at AFR 20:1.

Note: When O2 Type is set to STANDARD, O2 logging, Gauge3 and Gauge 4 modes will not display A/F ratio, but instead will display O2 voltage.

How O2 logging works

O2 logging begins automatically whenever the throttle position is greater than position 20. There is nothing to turn on or enable. Use Gauge3 mode to see the current throttle position.

As the engine enters each new rpm range, several samples of O2 voltage are taken and the average of these samples are held in RAM memory in the processor. Then, as you scroll through the RPM FUEL values, the logged readings are displayed on the right hand side of the LCD programmer display.

Tips for best use:

The engine should be warmed up to normal running temperature before observing results.

O2 logging will work well if the O2 sensor is placed within 3 feet/1metre of the engine. Placement further than this may cause delayed readings and RPM fuel values affecting the O2LOG reading in the next highest RPM range, but logging will still be useful.

Throttle should be held quite stable to give repeatable accurate results, since unsteady throttle will trigger the ACC PUMP feature, which adds extra fuel.

O2 logging should be done in 3rd or 4th gear so that RPM's are not increasing too rapidly. O2 logging may not occur if engine rpm's increase too rapidly, so logging in neutral, 1st and 2nd gear may result in no data logged due to very quick engine acceleration.

On the first attempt of O2 logging, ranges that are not logged show **--.-** in the display(wideband) and .0V(standard O2). Old data will remain in the computer until it is overwritten by new data, and if not enough samples are gathered in any particular rpm range, then old logged data will still be displayed from a prior run.

Remember to view O2 data before turning off the engine, since O2 logged data is only held in RAM memory, and will be lost when power is shut off to SDS.

Erasing logged O2 data:

Pressing the –1 button on the programmer while in Gauge1 mode will clear all O2LOG data. Best to erase logged data before doing another run.

Correcting the mixture using a wideband meter:

If O2LOG readings are leaner than 14.0 at full throttle and or high RPM, then fuel numbers(rpm fuel or manifold pressure) should be increased to richen the mixture.

Once O2 data is logged, the Air/Fuel ratio is likely not what you desire, so changes must be made. Simple math using the following formula will give a correction factor to get the desired Air/fuel ratio.

Correction = Logged A/F divided by desired A/F

Example #1: At 3250 RPM say, we have an RPM FUEL value of 108. The O2LOG shows an A/F ratio of 14.7, but we would like to make the A/F ratio 13.5.

Correction=14.7/13.5

Correction= 1.09.

Now we multiply the RPM FUEL value by 1.09.

108 x 1.09=117.7. Round off to 118.

Example #2: At 3250 RPM say, we have an RPM FUEL value of 108. The O2LOG shows an A/F ratio of 12.5, but we would like to make the A/F ratio 13.5.

Correction=12.5/13.5

Correction= 0.93

Now we multiply the RPM FUEL value by 0.93.

108 x 0.93=100.44. Round off to 100.

With a wideband sensor, best power will occur with an A/F ratio of 12.5:1 to 13.0:1.

Correcting the mixture using a standard O2 sensor: Testing with a single wire GM O2 sensor shows maximum power with O2 voltages of approximately .76 or higher. If O2 logged voltage is less than .60V then fuel values should be increased. Logged voltage of .50 is equivalent to 14.7 A/F ratio, so to arrive at a 13.0 A/F you can multiply the fuel value by 1.13.

On turbo engines: RPM FUEL values should be adjusted at lowest boost pressure setting. If you then raise boost to higher pressure, and need to change the A/F ratio, you can multiply the correction on the MANIFOLD PRESSURE fuel value instead of RPM FUEL, so this way you only affect mixture at these higher boost pressures.

Lean Warning

This feature allows some protection against a lean condition at higher throttle openings. You must have an O2 sensor or wideband meter that has an analog output connected to the SDS main harness gray wire for this feature to operate. This feature may not be reliable with leaded fuels since they affect operation of O2 sensors. If enabled, the system will monitor the O2 sensor voltage, and when throttle position is 35 or higher, and if the mixture is leaner than approximately 14 to 1 for 2 seconds, then an ERR message will be displayed in Gauge3 and Gauge4 modes in place of A/F or O2 volts. Also this will turn on the check engine light output on the ecu. The ERR message and check light remain until you manually clear them by pressing +10 while in Gauge1 mode. The ERR message and check light also clear when SDS is powered down.

There are 3 settings for this parameter:

1. Disabled. Correct setting when no O2 sensor is connected to the SDS ecu.

2. Enabled. Turns on Check light, and displays ERR in Gauge modes. Does not add fuel.

3. Enabled + add fuel. This does the same as the Enabled setting, plus when the ERR occurs, 25% will be added to the fuel mixture above throttle position 35. This may help prevent engine damage by allowing the tuner time to acknowledge the problem and close the throttle. To clear the ERR message press +10 while in

Gauge1 mode, then this will remove the extra 25% fuel. Then further tuning or troubleshooting should be done.

Below shows the ERR message in either Gauge3 or Gauge4 modes:
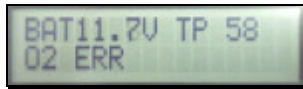
If you see the message "**Off. See O2 Type!**", then you need to check another parameter O2 Type, and change it's setting for the type of O2 sensor or wideband meter connected. The Lean Warning will not function if O2 Type setting is "NONE". This should be obvious.

Manifold Pressure(MAP) (MANIFOLD PRESS or MP)

 MP.JPG

There are 64 programmable ranges in the manifold pressure chart for adjusting fuel. Data in the manifold pressure chart determines the relationship between vacuum and boost and the amount of fuel injected. Standard EM-5 systems have a negative sign preceding all vacuum numbers in inches of mercury, all boost numbers are in psi and have no sign in front of them. There are 5 different MAP sensors used with the system which cover a different range of pressures. All units are pre-programmed with a standard MAP value chart depending on the MAP sensor used. These values should be close, so most initial programming is usually done on the RPM FUEL values. MAP values generally increase in a linear fashion as manifold pressure increases.

The more open the throttle is, the higher the manifold pressure, so the manifold pressure values must be higher, so the SDS delivers a longer injection pulse to get more fuel into the cylinder. See the diagram below. By adjusting the manifold pressure values from their default, you can change the mixture of the engine at different pressures to achieve best power or economy.
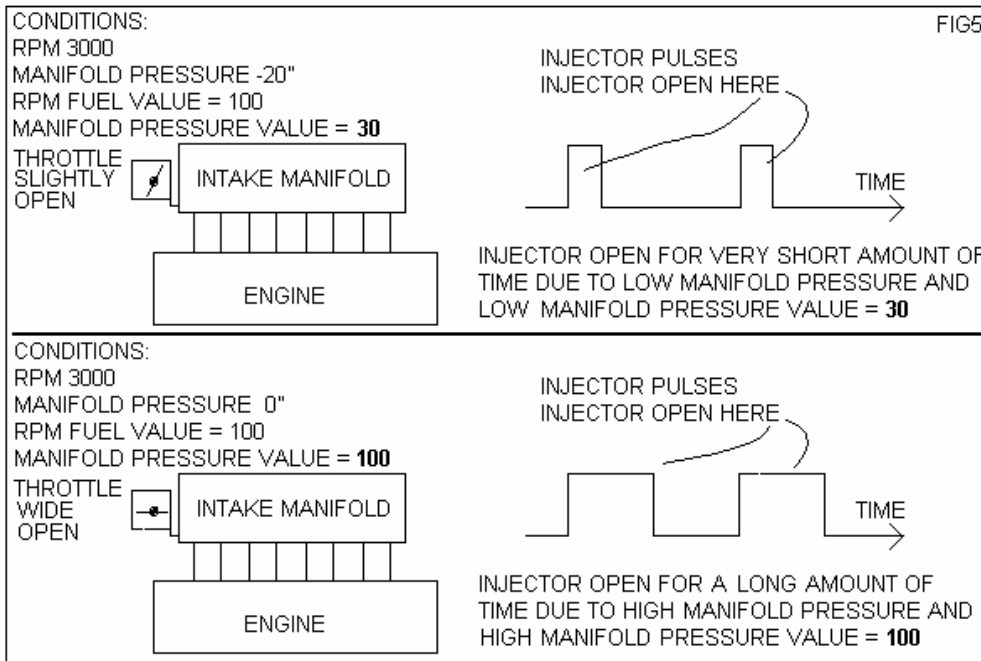
Use gauge1 mode to see what manifold pressure range the engine is running in, then use the < > keys on the programmer to move to the range you want, then you can try adjusting the values if desired. Below we will explain different areas of tuning MAP sensor values. These are divided into sections, idle, part throttle, full throttle/low boost, high boost, deceleration.

Idle:

Best to adjust RPM FUEL values first to get the best idle mixture. For the most stable idle you will need a rich mixture as shown here. If you have a wideband meter a good target mixture for idle is 13 to 13.5. Often times people try to target 14.7:1 for idle mixture but this will often give an unstable idle speed. Also don't adjust fuel numbers because the engine is idling too fast. If the engine is idling too fast then adjust the airflow on the throttle plate assembly, then recheck and adjust the RPM FUEL ranges where the engine is idling. Usually keeping RPM FUEL numbers from 500 through 1250 equal is also a good idea. This will help keep the idle from surging up and down.
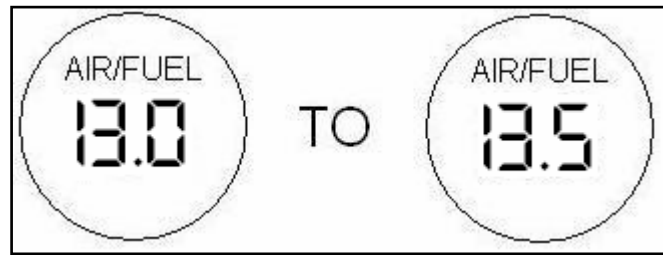
If idle still seems a bit unstable, then you may need to also adjust a few MANIFOLD PRESSURE values to improve smoothness. To do this, press the Gauge button to see gauge1 mode, note the MP reading on the top left. Then scroll left and into the manifold pressure values, just above and below where the engine is idling at, and make the values all equal. We have done this by default around –20" vacuum, but some adjustment might be needed. If the MP fluctuates over more than 3 ranges, you may have to install a .025 to .035 inch orifice in the MAP sensor line to help average and stabilize vaccum seen by the SDS computer.

Engines with race cams which idle between 8 and 15 inches vacuum, may need to use two parameters called IDLE TP LOCATION and IDLE FUEL AMOUNT to set the idle mixture, and have a stable idle. The reason for this is, if you adjust the MAP value for a good idle, that same MAP value may not be proper during part throttle running. Better to adjust the RPM FUEL value and try not to adjust the MAP values in this case.

Normally aspirated engines with less than 12 inches of idle vacuum will be more difficult to tune and might run better if changed to TP load sensing which eliminates the MAP sensor.

<u>Part throttle:</u>
Best fuel economy can be achieved by slightly lowering some of the MANIFOLD PRESSURE values. On most engines between about -15" and -8" inches vacuum you can lower the values to improve fuel economy. Use gauge1 mode to see what manifold pressure range the engine is running in. Using a wideband mixture gauge you can lower the values until the mixture gauge reads in the 13.0 to 15.0 range. If you lower the values too much then the engine may run rough or misfire, then you should then increase the values until the engine runs smooth again. On race engines we recommend a rich mixture at part throttle.

Part throttle in lower RPM ranges with high performance camshaft(s):
Hot cams usually create more engine vacuum just above idle, so tuning may be difficult because adjustments of Manifold Pressure values may also affect idle mixture, so try not to change manifold pressure values by more than 15%. It may be better to change RPM fuel values instead in the lower RPM ranges to correct the mixture. Getting the best mixture in all operating ranges may not be possible, and a milder cam may be the best solution on street cars.

<u>Full throttle on Normally aspirated/Low boost:</u>
Hopefully the RPM FUEL values were set while in this manifold pressure range, so no adjustments should be needed here. Mixture should be rich here.

High boost/above 7psi:
Mixture must be rich. Some engines may respond really well to a turbo or supercharger and may need the MANIFOLD PRESSURE values increased at higher boost levels. Also at higher boost you may want a richer mixture for maximum power and to help keep the pistons cool. Use of a wideband mixture gauge is advised for this. If the mixture reads lean then values should increased.
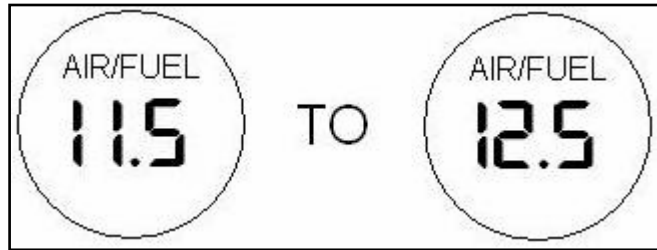
Deceleration:
It is normal for mixture gauges to read lean under deceleration, there will be no damage to the engine. If you wish to shut the fuel off during deceleration, this can be accomplished by entering 1's in the high vacuum ranges of MANIFOLD PRESSURE(usually -24" to -28"). See the sample fuel values pages. If the engine has bucking or surging while decelerating, then also use the FUELCUT BELOW TP parameter to try to get rid of the surging

Slowly revving up the engine in neutral:
While this serves no practical purpose, you may desire to make the engine smooth. At higher rpm's with no load on the engine, the engine will have high vacuum, so under the MANIFOLD PRESSURE values between -25 inches and -22 inches you may need to adjust the values. Just be sure not to mess up the mixture at idle, since idle is far more important. Also don't adjust the RPM FUEL values just for the purpose of neutral revving the engine. The mixture will need to be 13.5 or lower(richer) similar to idle mixture.

Throttle Position (TP or Throttle pos)
This section applies only to systems not using a MAP sensor. If your system uses a MAP sensor then you can skip this section. In this case the TPS is used to sense load on the engine in place of the MAP sensor. TP load sensing is used only on normally aspirated race engines with very high performance camshafts.

TP values multiplied by the RPM FUEL value results in the primary pulse width, so the more air being admitted by the throttle plates, the higher the corresponding TP value should be. Values in the Throttle Position parameter are much less predictable than MAP values, so it is difficult to pre-program a proper set of values for every application. We have a number of steps to follow for successful setup of the TP values.

Step #1
Look at Gauge 1 mode in the top left corner of the LCD. There are the letters TP with a 1 or 2 digit number, which tells you what position the throttle is in. With the throttle closed you should see a TP of somewhere between 2 and 12. When the throttle is fully opened, the TP should be between 45 and 63. If you see a TP of 1 or 64, this means that the throttle position sensor may be hitting the end of it's rotation and may be damaged, so you should try to reposition the TP sensor body so the TP in gauge 1 does not go below 2 or above 63.

Step #2
Note the TP in gauge1 mode with the throttle wide open. Let's say for example, that the TP is at position 50. In the LCD programmer scroll to Throttle Position 50, and adjust the value to 100. You should scroll to position 51 through 64 and make them all 100 also. Adjust the 3 throttle position values below wide open (47,48,49 in this example) also to a value of 100. There is not much change in airflow into the engine near full throttle, so that is why these values can all be the same.

Step #3
You can now adjust the values from throttle position 46 and lower. Decrease the Throttle Position value by 2 at each lower position. In this example Throttle Position 46 set to 98, position 45 to 96, position 44 to 94, and continue this trend down to position 32 where the value should be 70.

Step #4
You can now adjust the values from throttle position 31 and lower. Decrease the Throttle Position value by 3 at each lower position. In this example Throttle Position 31 set to 67, position 30 to 64, position 29 to 61, and continue this trend down to position 22 where the value should be 40.

Step #5
You can now adjust the values from throttle position 21 and lower. Decrease the Throttle Position value by 1 at

each lower position. In this example, Throttle Position 21 set to 39, position 20 to 38, position 19 to 37, and continue this trend down to closed throttle position. If any values end up below 28 then increase them up to 28. Steps 3 through 5 will get the values roughly setup to allow tuning of the RPM FUEL values, which should be set at wide open throttle.

Step #6
Now it is time to tune the RPM FUEL values. Read the RPM FUEL section carefully and tune all the RPM FUEL values. Part throttle performance may not be the best even after setting up the RPM FUEL values, but you can go back into the Throttle Position values at various part throttle locations, and do fine adjustments to get the best part throttle running.

Step #7
Mid-throttle tuning. Depending on the type of race car, you need good part throttle response in a certain RPM range. For example, a road race car may operate from 5000 to 8000 rpm's, so part throttle running is important in this range. **Watch out for lean mixtures.** You should fine tune the Throttle Position values between about ½ to ¾ throttle for best operation in the above RPM range. **Make sure the mixture is rich.** The values entered in steps 3 through 5 may not be right for ½ to ¾ throttle, since different throttle body configurations and sizes have a significant effect on the throttle position values in the part throttle region.

You don't have to operate the engine at every throttle position. The quick method is to pick a few different throttle positions to run the engine, and when you have these different throttle position values set correctly, you can fill in the values between the properly tuned positions.

Step #8
Low-throttle tuning. Any vehicle will need to drive around at slow speeds and therefore must run at low rpm's and low throttle. You will probably need to adjust the Throttle Position values for low speed operation from just above the idle position up to about 1/3 throttle. Adjust these Throttle Position values with the engine running between about 1500 to 3000 RPM.

Step #9. Final step.
Idle. Since both the RPM FUEL and Throttle position values determine the amount of fuel injected you can adjust either RPM FUEL or the Throttle Position values to adjust idle mixture, but it is best not to get the Throttle position value below a value of 28. If the mixture is still too rich then you can also drop the RPM FUEL values from 500 to about 1500 RPM's.

IDLE TP LOCATION and IDLE FUEL AMOUNT are disabled to avoid redundant use. They appear as SPARE/NOT USED in the programmer.

IDLE TP LOCATION and IDLE FUEL AMOUNT

IDLEF.JPG

IDLETP.JPG

For engines with low vacuum at idle but still using a MAP sensor. If you have a stock camshaft in the engine, you should not use these two parameters. Leave them set to NOT IN USE and skip ahead to the next section.
To set to NOT IN USE press the -1 button in the IDLE TP LOCATION parameter until NOT IN USE appears. Engines using a MAP sensor that have low vacuum at idle tend to be difficult to get a smooth consistent idle due to fluctuating MAP sensor readings. These two parameters when set properly will allow the system to read the IDLE FUEL AMOUNT value instead of the MANIFOLD PRESSURE value, only when the throttle is closed during idle condition.

Normally the EM-5 is shipped with these features showing NOT IN USE in the programmer. To use these features you need to go to the IDLE TP LOCATION and press the +1 button. Then you will see the number 2 appear. This window is to tell the EM-5 what position the throttle is in at idle. Use gauge 3 mode to see what the TP number is, and then go back to IDLE TP LOCATION and adjust it until it is equal or 1 number higher than the TP number in gauge 3. Make sure the throttle springs are in good shape and that the throttle returns consistently to the same position. Watch gauge 3 mode to check this.

The IDLE FUEL AMOUNT value will now be used in place of the MANIFOLD PRESSURE value, so since TP is completely stable at idle the EM-5 can produce a very constant fuel pulse to keep the idle constant. You can adjust the IDLE FUEL AMOUNT to get the mixture right. The RPM FUEL values also affect the mixture too. IDLE FUEL AMOUNT should usually have a value of about 35 to maybe as high as 50 on engines with radical

cams.

Once the throttle is opened up above the IDLE TP LOCATION setting, then the system goes back to reading the MANIFOLD PRESSURE values again.

To avoid an over-rich condition during deceleration or coasting downhill, you should make use of the FUELCUT BELOW TP settings.

Acceleration Pump (ACC PUMP)

ACCS.JPG   ACCL.JPG   ACCH.JPG

ACC PUMP values help give smooth throttle response when the throttle opens. There are three adjustments to make for the acceleration pump. Adjustment should be done when the engine is at normal operating temperature.

The ACCPUMP LO RPM value controls action from 0 to 1875 rpm. With the engine idling, quickly open the throttle. If the engine hesitates, change the value. If the hesitation is worse, you have changed the value the wrong way. Find the value that gives the best quick throttle response.

Next is to adjust the ACC PUMP SENSE. This is very important just out of the idle range. Set this control by opening the throttle slowly from the idle position. Adjust for the smoothest acceleration. 1 is least sensitive, 8 is most sensitive. Small engines with large throttle plates may require a larger value here as will engines with heavy flywheels.

The ACCPUMP HI RPM setting controls action above 1875 rpm. This parameter is best setup while driving the car in it's most common rpm operating range. Snap the throttle open quickly. If the engine hesitates, change the value. If the hesitation is worse, you have changed the value the wrong way. Repeat this procedure until engine response is acceptable.

Acc pump values are generally between 5 and 50 on most applications. The ACCPUMP LO RPM is usually a higher value than ACCPUMP HI RPM.

Engine Temperature (ENGINE TEMP, ET)

ET.JPG

There are 32 ranges under this parameter which determine the amount of extra fuel injected to compensate for a cold engine during warmup. Liquid cooled engines use a water temp sensor and air cooled engines use a cylinder head temp sensor to supply a signal to the EM-5. The function of this parameter is similar to a choke in a carburetor.

You should aim for a 0 value when the engine is at normal operating temperature. Most engines will not require extra fuel after 100-120 degrees F. The values should decrease in a fairly linear fashion from cold to operating temperature then have 0's entered above this threshold. Temperatures can be displayed in F or C.

Some engines like a little additional fuel when hot starting to compensate for hot fuel in the fuel rail due to heat soak back conditions. Extra fuel can be added until water circulation brings the engine temperature below this threshold. If you are doing this be sure to only enter numbers above the engine temps which are in the normal operating range.

As a reference, a value of 127 would add 50% to the pulse width and a 255 entered will double the pulse width.

By flicking back between gauge1 mode and ENGINE TEMPERATURE you can make adjustments while the engine is warming up. Each time the EM-5 updates to a new ET in gauge mode, you can go to that ENGINE TEMPERATURE range in the programmer. Now turn the knob richer and leaner and note where the engine starts to run rough on each side of 12 o'clock. If it runs rough say at 10 and 2 o'clock, you probably have the engine temp values about right. If not, adjust the ENGINE TEMP value at the engine temp displayed currently in gauge1 mode.

Start (START)

 START.JPG

Start enrichment is provided for under the START and START CYCLES parameters. The EM-5 reads the signal from the engine temperature sensor, looks up the START value at that temperature range, and injects extra fuel for a certain number of engine cycles after the EM-5 detects crank rotation. This function is activated every time that the engine is started, no matter what the engine temperature is. However, if there is a zero at the current temperature range, then no extra fuel will be added. START values are critical for proper starting, especially in cold climates.

Injector flow rates will have a large effect on these values. Large injectors will require smaller values on the same engine compared to smaller injectors.

At colder temperatures, the values are high, tapering off as the engine warms up. At temperatures over 100°F or 37°C, most engines do not require much extra fuel so the values should be low here although on some engines, hot starting may be improved with some extra fuel to aid flushing boiling fuel from the injectors. Experimentation is required for a satisfactory setup here.

It is best to not open the throttle during cranking, especially in cold temperatures. Opening the throttle will cause a leaner mixture during cranking. The engine needs a rich mixture to start.

Tuning all the START values will take many days and even months in very cold climates. You can usually only tune one value per day, and you will have to wait for colder weather to adjust the colder ranges.

If your system uses TP for load sensing(no MAP sensor), then Start values will need to relatively higher than systems that use a MAP sensor, so if you were to copy Start values from another engine that uses a MAP sensor, the values would likely be too low. This is because MAP systems get a higher Manifold Pressure value when cranking, than a TP system would.

Systems shipped after Oct 6, 2008 will do 1 injection of fuel at key-on, when the Start value is greater than 0 at any temperature. This will improve cold starting. Prior versions to this date, did 1 injection at key-on only when engine temperature was below approximately 15C or 60F.

Start Cycles
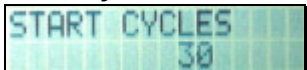
 STARTC.JPG

The value entered under START CYCLES determines how many engine cycles START enrichment lasts for. This is the number of crank revolutions times 2 on a 4 stroke engine and the number of crank revolutions on a 2 stroke engine.

Some engines require start enrichment lasting a long time, others only require a short start enrichment period. The larger the value under START CYCLES, the longer the enrichment period. This is adjustable between 0 and 255, but a value of 40 is probably as high as you would ever need, and do not set this below 10, because too low a value will make the START function expire too quickly.

Both START and START CYCLES must be set carefully. If the engine fires immediately at any temperature, the START values are good. If the engine takes a lot of cranking to get running, the START values may be too low. If the engines starts quickly but then stalls after a few seconds, there are two possibilities; either the START CYCLES value is too low or when the start cycles have expired, the ENGINE TEMPERATURE values are too low. Once the start injection cycles have occurred (usually 3-15 seconds), the EM-5 relies on ENGINE TEMPERATURE values for warmup enrichment. These two parameters should not be confused. The START function is automatically reset after the engine stops turning.
End of tuning section.

Closed Loop section

See also the O2 logging section for the O2 TYPE selection parameter.

Closed Loop (CLOSE LP or CL)

CL1.JPG

CLOSED LOOP, when turned ON using the programmer, will allow the SDS computer to read the O2 sensor and control the fuel mixture to around 14.7:1, to minimize harmful emissions and extend the life of the catalytic converter. Closed loop may also increase fuel economy. CLOSED LOOP is OFF when shipped from the factory. CLOSED LOOP should be OFF if you are trying to program the system. When CLOSED LOOP is OFF then the SDS system does not need an oxygen sensor connected to the gray wire, and the system runs from the values that are programmed.

To turn CLOSED LOOP ON push the +1 button. The gray wire must be connected to an oxygen sensor for proper closed loop operation. To turn CLOSED LOOP OFF push the +1 button.
Closed loop does not change any of the programmed values that you see in the programmer. Since there is a time delay time between sensing and correction, the air to fuel ratio will continuously fluctuate slightly to either side of stoichiometry (14.7 to 1 A/F ratio). This condition can be seen when using a mixture meter for setup. Holding the mixture close to the stoichiometric range is essential for the lowest possible emissions when the engine is fitted with a catalytic converter. Closed loop operation is not possible with leaded fuels, since leaded fuel will damage the O2 sensor.

Many engines will not tolerate being idled at the relatively lean mixtures associated with closed loop. Nor will they safely tolerate these lean mixtures at full throttle. For these reasons closed loop mode has rpm and manifold pressure limits. Outside of these limits the EM-5 will switch out of closed loop into open loop (programmed values) mode. Closed loop will not be engaged by the EM-5 until the engine temperature exceeds approximately 35C (95F).

Closed loop low RPM limit   **Closed loop high RPM limit**

CL2.JPG

CL3.JPG

Closed loop low manifold pressure limit   **Closed loop high manifold pressure limit**

CL4.JPG

CL5.JPG

The following limits are programmable: CL LO RPM LIMIT and CL HI RPM LIMIT, which determine where the EM-5 will discontinue closed loop control at. If you select 1500 and 4500 RPM respectively in these slots, closed loop operation will be discontinued whenever the rpm goes above or below these limits. The same thing applies for the manifold pressure limits, CL MAP LO and CL MAP HI. The engine must operate within these 4 limits or the EM-5 will revert back to open loop.

The O2 sensor will not supply reliable information to the EM-5 when cold (below 600 degrees F). A 3 wire heated sensor will give better results over an unheated one. Software limits prevent the EM-5 from adding or subtracting more than 25% to the primary pulse width in closed loop so it is important that the open loop fuel values are reasonably close to correct for proper functioning of the closed loop control.

Closed loop operation in most OE applications is generally limited to cruising conditions. **Never program in limits corresponding to high power, high rpm conditions, since this will cause a loss in power and possible engine damage due to lean mixtures**. A lean stumble is often apparent when the engine is unhappy about running in closed loop. Limits should be set to avoid these conditions. A mixture meter is highly recommended for system setup.

As stated before, many engines will not idle smoothly in closed loop mode. We recommend as a rough guideline, setting the CL LO RPM LIMIT no lower than 1500 rpm and the CL HI RPM LIMIT no higher than 70% of the redline rpm limit. Likewise, closed loop manifold pressure limits should preclude the low vacuum idle conditions as well as the high throttle ones. Set the CL MAP LO limit 3 to 5 inches above the normal idle MAP value and the HI limit around -5 inches for naturally aspirated engines and from -5 to 2 psi boost on turbo/super charged engines.

In CLOSED LOOP ON/OFF mode, ON/OFF is selected with the +1 and -1 buttons. In the other 4 CL modes, the +1,-1 buttons are used to select the HI/LO points which will be in the same graduations as your RPM and MAP ranges. **Always leave the closed loop off if no O2 sensor is connected and always leave closed loop off until all normal programming is completed.**

End of closed loop section.

Fuel cutoff, Rev and boost limiting

RPM and boost limiting in SDS are very harsh and sudden compared to "soft" rev limiters in other systems, so it is not recommended that you constantly hit the rev and boost limits with SDS. These limits are intended for the odd occasion where you miss a shift, or a malfunction on the engine or drivetrain occurs.

FUELCUT/RPM

 FCUTRPM.JPG

This will limit the RPM's of the engine by cutting off fuel if the engine attempts to rev 125 rpm's higher than the setting. For example if the FUELCUT/RPM was set to 8000, then fuel would cut off at exactly 8125 RPM's. Adjustments are in 250 RPM increments.

FUELCUT/MANPRESS

 FUELCMP.JPG

This will limit the amount of boost to protect the engine from over-boosting resulting from a malfunctioning wastegate etc. For example, if you are running around 10 PSI boost you should set this parameter to around 12 or 13 PSI, so the engine will not hit the limit under normal conditions.
Factory setting is NO CUT which disables this feature, so it will not affect the system. If this parameter is adjusted to high vacuum range it can cut off all fuel causing a no start condition.

FUELCUT BELOW TP
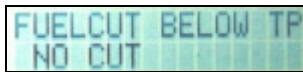
 FCUT.JPG

This parameter is used to cut off fuel when coasting with the throttle closed. It is in operation only when the engine is above 2000 rpm and a TP value is entered in the window. When it is set to NO CUT the function is disabled. A value of between 2 and 20 can be entered. The + and - buttons are used to select the desired value. If you plan to use this function, we recommend that you verify your closed throttle TP by selecting Gauge 3 mode. With the throttle closed, it will display your closed throttle TP setting here. If this is 5 for instance, you would probably want to enter 5 or 6 in your FUELCUT BELOW TP window. The advantage of using this parameter to shut off fuel when coasting over a MAP fuel cut is that there is no hunting and surging as the MAP fluctuates near its cutoff limit. Shutting off fuel during deceleration saves fuel and reduces emissions.

Launch Rev Limit
This is only available on "E" and "F" models. See the "E" and "F" supplement manuals.

Values Lock

VALUES LOCK
OFF   VALL.JPG

This feature allows you to lock out the programmer function to prevent accidental changes to your values. To lock your values, select VALUES LOCK window in the LCD programmer. The +1 and -1 buttons are used to select it to the ON or OFF position. When you are done programming for a while or plan to disconnect the programmer always engage VALUES LOCK ON. **You cannot program the system with VALUES LOCK ON selected.**

End of limits section.

RPM, MAP, Fuel Flow, Duty Cycle, Injector concerns

If your mixture still leans out under high power conditions no matter how large your MAP and RPM values are, the system is not at fault. Check for fuel delivery problems. Check the duty cycle first in gauge 2 mode at full power. If it's over 100%, you have a problem with the injectors, pump or regulator. If your fuel pressure does not keep up with demand, the engine will not run correctly no matter how you program the system. If your injectors are too small, the same thing applies. At full throttle and high rpm, the mixture should be fairly rich with one of the green LEDs lit: If your values go all over the place with huge steps or deviations, you are probably doing something wrong. Most well mapped engines have smooth transitions from one step to the next. Look at the sample maps in your manual. If you are really stuck, fax us your values, and we can usually suggest some constructive changes.

Changing injector flow rate

If you have your system fully programmed, and then change to injectors with a different flow rate, then some values will need to be changed using the programmer. For example if you had 24 lb/hr injectors and changed to 50 lb/hr injectors, the RPM FUEL, START and ACCPUMP LO RPM AND ACCPUMP HI RPM values would all need to be about half as much. ENGINE TEMP may need only very slight adjustments, since ENGINE TEMP values basically just add a percentage amount to the main injector pulse width. You should try to leave the MANIFOLD PRESSURE values unchanged.

Try to stay with the same injector impedance. If injector impedance is different, you will need to make changes to the wiring, and will need to add a resistor pack if changing to low impedance injectors from high impedance injectors.

End of concerns section.

Troubleshooting

Check Engine Light
Software in the EM-5 can detect some but not all problems with the following sensors:
MAP sensor: Power or ground connections, broken or intermittent.
Engine and air temperature sensors: Open or short circuit.
Hall sensor/RPM error problem: Caused by missed magnet or vibrating hall sensor mount.
Low battery voltage: If below 12.5 volts, will turn on the LED.
Lean warning: If lean mixture occurs at high throttle for 2 seconds.

Check Gauge modes for "ERR" readings to see which sensor has a problem.

RPM, temperature, map sensor errors, even if occuring for a very short period of time, will leave the check engine light turned on so the user can see there was a problem. You can attempt to clear the error and light by pressing the +10 button in Gauge1 mode, and if the light stays lit, then the problem still exists. If the light turns off, then the problem may be intermittent and you should check electrical connections at the faulty sensor, or check hall sensor alignment if gauge mode shows an RPM ERR message.

Low battery voltage will not lock the light turned on, instead the light will turn off when the battery voltage goes above 12.5 volts. It will be normal to have the light turned on while the ignition is turned on but the engine is not running, since battery voltage is around 12.3 volts.

Some problems cannot be detected such as MAP sensor broken signal wire, however this may be added in the future. Just because the LED is turned off doesn't mean everything is good with the system. SDS cannot detect faulty O2 sensors. SDS cannot detect all sensor problems.

Symptoms
Water entering the computer seems to be a very common problem. Remove the lid of the EM-5 and inspect the inside for water, or corrosion. Water, which has dried, leaves a white residue on the circuit board. Water may still be present under or inside connectors, which will cause random symptoms and running problems. The EM-5 may operate fine once dried out or may need to be sent for repair.

The three gauge modes permit monitoring of the primary sensor inputs to the EM-5 in real-time. Rpm should be stable, agreeing with the factory tach. Spurious rpm readings usually indicate ignition or triggering interference, or a hall sensor problem on E&F models.

Manifold pressure should increase as the throttle is opened at a given rpm. On TPS(no MAP sensor) systems, opening the throttle should increase the TP number. The TP number should not change if the throttle is not moving.

Engine and air temps should roughly agree with the ambient temperature if the engine has been shut down overnight.

Switching to gauge 2 mode allows you to monitor the mixture knob position. It should read 0 at the straight up position. You should be able to get the reading to change from -49% to +49% by turning fully to both stops.

In Gauge2 mode, acceleration pump operation is verified by snapping the throttle open. The AP number should rapidly increase until movement is stopped then the number should rapidly decrease to 0 again. The AP number should always be 0 unless the throttle is being moved. Rough running and a fluctuating TP or AP reading without throttle movement indicates a TPS problem usually.

When encountering problems which can be identified to be linked with a specific area or function, always go to that section in the manual first and re-read it.

Engine will not start:
1. Check FUELCUT/MANPRESS parameter. Should read NO LIMIT.
2. Try turning mixture knob richer while cranking. START values might have to be increased.
3. Check all connections on EM-5 main harness, ignition.
4. Check both ground wires from EM-5, one from main harness and one from injector drive harness.
5. Check MP reading in gauge1 mode. If between -26 to -29 then check MAP sensor connector for broken

wires, or bad contact in the terminals. Try new MAP sensor

6. Check for +12V to injectors while engine is cranking.
7. Check if the programmer goes blank during cranking. If so, then move EM-5 red wire to a different source for +12V.
8. Check battery voltage. Should be at least 10 volts while cranking, and 11 volts when not cranking.
9. Check for spark.
10. Check ignition timing while engine is cranking.
11. Check if the fuel pump is running.
12. If fuel pump relay is used, check connections.
13. Check for fuel flow out of regulator drain to return of fuel tank.
14. Check for injectors clicking.
15. Check FUELCUT/RPM parameter. Should read NO LIMIT, or a high RPM.
16. Check camshaft timing.
17. Distributor out of position.
18. D systems, green wire not connected or may not be getting a proper tach signal.
19. D systems, if Multi-spark ignition is used then SDS green tach wire must connect to the multi-spark unit's TACH terminal or wire, not to the coil negative terminal.
20. E & F systems check hall sensor gap and alignment with magnets.
21. If using a noid light, make sure all of the injector plugs are unplugged from every injector. Better to check +12v supply to injectors and check grounds on ECU. Use noid lights as a last resort. LED noid lights are much better than incandescent.
22. It is highly unlikely that there is a problem with the EM-5, since many ECU's in the past have been returned with "no fuel" symptoms, but they work just fine, so check all of the above carefully.

23. Engines originally equipped with Bosch type mechanical airflow meters as shown here, typically control the stock fuel pump relay. **When you remove these airflow meters, your fuel pump will no longer operate.** Two of the wires going to the meter are connected to a switch in the meter that completes the relay circuit when there is air flow. You can identify the two wires using an ohmeter by probing two terminals on the meter and opening and closing the flap in the meter. Once the two terminals are identified then you can cut and connect the two corresponding wires on the harness. Toyota, Mazda, Ford, BMW, Nissan, Datsun and others use these type.

Will not rev up or has Miss:
1. Check ACCPUMP values. May be too high.
2. Check AP number in gauge2 mode. Should be zero when throttle is stable. Check this with engine running. May only show up at certain RPM's.
3. Check for leaking fuel pressure regulator diaphragm. If fuel in vacuum reference hose then replace the regulator.
4. EGR valve may cause problems.
5. Check for bad values in RPM or MAP parameters. Could be crossing a bad value anywhere.
6. "E" and "F" models. Hall sensor mount is vibrating. Stronger bracket required. Watch RPM reading in gauge1 for ERR message.
7. Check FUELCUT/MANPRESS and FUELCUT/RPM parameters.
8. Check resistance of all spark plug wires. Possible poor crimp at the end of a wire causing arcing.
9. Try a different brand of spark plug wires.
10. If Knock sensor is being used, Knock Sense value may be too high. If there is no knock sensor on the SDS system set Knock Sense to 1, and Knock Retard to zero.

Unstable RPM reading in Gauge1 mode.
1. On SDS "D" systems, avoid using Bosch blue coils as they may cause double triggering in the tach circuit of the SDS ecu.
2. On SDS "E" or "F" systems, check hall sensor alignments and magnets. Bracket must not vibrate or flex.

Idle speed too high:

1. May have idle air bypass motor in open position. Close off or block bypass.
2. Find bypass adjustment screw and try adjusting.
3. Throttle stop may be set to hold open throttle plate. Make adjustment.
4. Vacuum leak.

Idle speed too slow:

1. May have idle air bypass motor in closed position. Adjust throttle stop or open bypass screw.
2. If engine is cold and idle too slow install fast idle option to speed up idle.
3. Mixture could be too rich or too lean. Adjust fuel values for fastest idle speed, then if idle speed is still too slow, adjust throttle stop or air bypass screw for faster idle speed.

Rough idle:

1. Bad ignition wire arcing to ground. Common on DOHC engines.
2. Mixture needs to be rich for best idle. Try adjusting fuel values until too rich then lower the values until engine is smooth.
3. Bad injector or bad cylinder. Unplug each injector to isolate.
4. Do engine compression check. Look for engine mechanical problem.
5. Bad connection at MAP sensor. Unplug and plug in the connector a few times.
6. MAP sensor vacuum line not connected or connected to the wrong area on the intake manifold or throttle body.
7. Closed loop low RPM limit may be too low. Raise limit to at least 250 above idle RPM.

Cuts Out at High Power:

1. Fuel pump not adequate.
2. Injector flow rate too low.
3. Check FUELCUT/MANPRESS parameter. Adjust and try again or set to NO LIMIT.
4. Fuel lines or filter plugged or too small.
5. Check for fuel flow out of regulator drain to return of fuel tank.
6. Engine is crossing an improper value.
7. Fuel pressure too high, injectors won't open.
8. Fuel tank not vented. Remove filler cap check for suction.
9. Bad injector ground connection. Do Ohms check from chassis to pin 8 of white connector.
10. Install a fuel pressure gauge.
11. Reduce spark plug gap. Ignition voltage may not be high enough for stock plug gap specification.
12. If system is using a knock sensor then Knock sensor may be activating and reducing the ignition timing too much. Try higher octane fuel or try lower Knock Sense value.

Not Running on all Cylinders:

1. Check each injector for clicking sound.
2. Not a computer problem if only one cylinder is dead, so likely mechanical, injector, or wiring problem.
3. Bad ignition wire arcing to ground. More common on DOHC engines.

Cuts out Under Lateral G Forces:

1. Fuel pickup problem in tank.
2. Air is entering the EFI fuel pump resulting in low fuel pressure.

Runs but lacks power:

1. Check distributor cap and rotor for proper alignment.
2. Check camshaft timing.
3. TPS vibrating and is activating the ACC PUMP function. Watch AP in Gauge2 mode. Should read zero when throttle is steady. Set both ACC PUMP values to zero and see if problem goes away.
4. Check TPS hookup and ACC PUMP values for too high a value.
5. Mixture far too rich or lean. Increase or decrease all RPM FUEL values to correct or adjust knob.
6. Fuel tank not vented. Remove filler cap, check for suction.

7. (E&F only). Check timing with a timing light, magnets could be mounted incorrectly.
8. (E&F only). RPM IGN (ignition timing) values too low.
9. O2 TYPE setting may be wrong, so closed loop may be wrongly adjusting mixture.
10. If system is using a knock sensor then Knock sensor may be activating and reducing the ignition timing too much. Try higher octane fuel or try lower Knock Sense value.

Programmer display is blank:
1. Check power and ground connections on black and red wires of main harness.
2. TPS connections are wrong. Try unplugging the TPS cable.
3. Programmer cable is damaged.
4. If +12V has been accidentally shorted to the EM-5 case, the circuit board may need repair, due to a broken ground circuit.

SDS EFI in Window:
1. TPS connections are wrong. Try unplugging the TPS cable.
2. Power has been interrupted or EM-5 has reset.
3. Do resistance check of ignition wires. Possible bad crimp at end of wire.
4. Spark plug wires causing EMI(interference). Try different brand of wires.
5. Check for loose spark plug wires.
6. Move sensor wires away from ignition.
7. Don't ground solenoids or other devices at the same place as the EM-5 ground.
8. Move EM-5 further away from engine.
9. Solenoid switching may cause this. Disable any solenoids, relays, motors etc. Diodes can be connected across solenoids to absorb electrical spikes. Call us for help.

Strange characters or black bar across the top of the LCD window:
1. Programmer cable damaged, common problem. New cable can be found at most computer stores.
2. Measure the resistance of all spark plug wires. Possible poor crimp at the end of a wire causing arcing, or bad insulation causing arcing to ground. Replace or repair any wire that has a much higher resistance than the others.
3. Interference from spark plug wires. Try different brand of plug wires.
4. Programmer data being interfered with. Don't run cable with other wiring.
5. Loose programmer cable connection.
6. Change spark plugs to resistor type. Non-resistor type cause electrical noise.
7. Programmer was plugged into EM-5 after the EM-5 was powered up.
8. Move ground connection to EM-5 to a different location.
9. Check main harness connection to EM-5.
10. Check ignition rotor phasing and plugs for excessive gap.

Engine fills up with fuel:
1. Bad EM-5 ground wire connection.
2. Check for leaking fuel pressure regulator diaphragm.

Won't run over 2000 rpm:
1. Check FUELCUT BELOW TP limit. Set to a lower value, or set to NO CUT.

Further troubleshooting

If problems persist, and you are calling for help, we may be able to help you better if you write down your values and fax them to us. This may help narrow down the problem much faster. The last page in this manual is for writing down your values. Our Fax number is 403-453-7687.

If you have "E" or "F" systems see the troubleshooting in that supplement manual. Don't ground the SDS EM-5 to the engine. Engine ground may be noisy and cause the EM-5 to malfunction. Ground it to the chassis of the vehicle. Be sure to sand off any paint where the connection is.

Make sure the EM-5 is permanently grounded to the chassis and never put a switch in any ground circuit of any SDS component. If a component needs a switch it should always be on the positive(+) wire.

Spark plug wires, **and Interference Problems**
Always use radio suppression type spark plug wires. NEVER use solid core wires.
Recommended wires:
Magnecor.
MSD superconductor.
NGK.
OEM or factory carbon string.
Accel 8.8 yellow.

For engines with coil-on-plug ignition coils be sure to use resistor type spark plugs. Resistor plugs have 5Kohms resistance. NGK resistor plugs will have the letter R in the part number.
Non resistor plugs can create electrical noise and cause interference problems.

Important! Wires which have caused interference problems in the past are Nology, Mallory and Taylor, so we do not recommend these. If you have these wires and are having problems try a different brand of wires. Ignition interference problems usually show up as strange characters in the programmer screen, rough running, misfiring or an RPM ERR code in gauge1 mode.

Factory default programmed values
If you have running problems or have trouble programming the system, then you may want to restore all the factory values. You will have to scroll through all the ranges in the programmer and check or reenter the factory values. Factory values are shown in the following pages. Be sure to select the proper page. There is a page for each of the three different MAP sensors, and another page for TPS load sensing(no MAP sensor), so you must know which MAP sensor you have.
If we knew your engine size and injector flow rate at the time the system was ordered, then we may have reprogrammed the RPM FUEL values specifically for your system. If this is the case, then see the RPM FUEL chart to look up the proper RPM FUEL numbers to enter, and you can enter all the default values for all other parameters.

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DEFAULT VALUES FOR SDS EM-5 WITH 1 BAR SENSOR

RPM FUEL		MAP 1 BAR	FUEL	ENGINE GM F	TEMP	RET-ADV/ LOAD	VAL	RPM	IGN	START GM F			
500	80	-28.8	1	302	0	-28.8	0	500	10	302	9	START CYCLES	32
750	80	-28.3	1	230	0	-28.3	0	750	10	230	7	MAGNET POSITION	80
1000	80	-27.9	1	194	0	-27.9	0	1000	10	194	5	KNOCK RETARD	2
1250	80	-27.4	1	176	0	-27.4	0	1250	10	176	0	KNOCK SENSE	8
1500	80	-27	1	158	0	-27	0	1500	13	158	0	KNOCK MAX RPM	8000
1750	80	-26.5	1	142	0	-26.5	0	1750	17	142	0	CL MAP HI	-6.72
2000	80	-26	1	136	0	-26	0	2000	21	136	0	CL MAP LO	-15.2
2250	80	-25.5	1	129	0	-25.5	0	2250	24	129	0	CL HIRPM LIMIT	3250
2500	80	-25	18	126	0	-25	0	2500	27	126	0	CL LORPM LIMIT	1500
2750	80	-24.6	18	122	1	-24.6	0	2750	30	122	1	CLOSED LOOP	OFF
3000	80	-24.1	18	118	2	-24.1	0	3000	32	118	2	VALUES LOCK	OFF
3250	80	-23.6	24	113	3	-23.6	0	3250	32	113	3	FUELCUT/MAP	NO LIMIT
3500	80	-23.2	26	106	4	-23.2	0	3500	32	106	4	FUELCUT/RPM	8500
3750	80	-22.7	27	99	7	-22.7	0	3750	32	99	5	FUELCUT/TP	NO CUT
4000	80	-22.2	28	93	10	-22.2	0	4000	32	93	6	RPM SWITCH	1500
4250	80	-21.8	28	86	17	-21.8	0	4250	32	86	7	FAST IDLE	129
4500	80	-21.3	29	81	19	-21.3	0	4500	32	81	8	RADIATOR FAN OFF	28
4750	80	-20.8	30	77	21	-20.8	0	4750	32	77	9	RADIATOR FAN ON	23
5000	80	-20.3	30	73	24	-20.3	0	5000	32	73	10	IDLE TP	NOT IN USE
5250	80	-19.9	32	68	27	-19.9	0	5250	32	68	11	IDLE FUEL	NOT IN USE
5500	80	-19.4	34	64	30	-19.4	0	5500	32	64	12	ACCPUMPLORPM	30
5750	80	-18.9	36	61	33	-18.9	0	5750	32	61	13	ACCPUMPHIRPM	20
6000	80	-18.5	38	55	35	-18.5	0	6000	32	55	15	ACC PUMP SENSE	5
6250	80	-18	40	46	40	-18	0	6250	32	46	18		
6500	80	-17.5	42	45	45	-17.5	0	6500	32	45	20		
6750	80	-17.1	44	41	50	-17.1	0	6750	32	41	25		
7000	80	-16.6	46	36	55	-16.6	0	7000	32	36	30		
7250	80	-16.1	48	28	60	-16.1	0	7250	32	28	40		
7500	80	-15.6	50	18	65	-15.6	0	7500	32	18	50		
7750	80	-15.2	52	5	70	-15.2	0	7750	32	5	60		
8000	80	-14.7	54	-13	85	-14.7	0	8000	32	-13	70		
8250	80	-14.2	56	-40	100	-14.2	0	8250	32	-40	80		
8500	80	-13.8	58			-13.8	0	8500	32				
8750	80	-13.3	60			-13.3	0	8750	32				
9000	80	-12.8	62			-12.8	0	9000	32				
9250	80	-12.4	64			-12.4	0	9250	32				
9500	80	-11.9	66			-11.9	0	9500	32				
9750	80	-11.4	68			-11.4	0	9750	32				
		-10.9	70			-10.9	0						
		-10.5	72			-10.5	0						
		-10	74			-10	0						
		-9.54	76			-9.54	0						
		-9.07	78			-9.07	0						
		-8.6	80			-8.6	0						
		-8.13	82			-8.13	0						
		-7.66	84			-7.66	0						
		-7.19	86			-7.19	0						
		-6.72	88			-6.72	0						
		-6.25	90			-6.25	0						
		-5.78	92			-5.78	0						
		-5.31	94			-5.31	0						
		-4.83	96			-4.83	0						
		-4.37	98			-4.37	0						
		-3.9	100			-3.9	0						
		-3.42	102			-3.42	0						
		-2.95	104			-2.95	0						
		-2.49	106			-2.49	0						
		-2.02	108			-2.02	0						
		-1.55	110			-1.55	0						
		-1.08	112			-1.08	0						
		-0.61	114			-0.61	0						
		-0.14	116			-0.14	0						
		0.33	118			0.33	0						
		0.8	120			0.8	0						

DEFAULT VALUES FOR SDS EM-5 WITH 1 BAR SENSOR

RPM FUEL		MAP 1 BAR	FUEL	ENGINE GM F	TEMP	RET-ADV/ LOAD	VAL	RPM	IGN	START GM F			

DEFAULT VALUES FOR SDS EM-5 WITH 2 BAR SENSOR													
		MAP	FUEL	ENGINE	TEMP	RET-ADV/				START			
RPM	FUEL	2 BAR		GM F		LOAD	VAL	RPM	IGN	GM F			
500	80	-26.7	1	302	0	-26.7	0	500	10	302	9	START CYCLES	32
750	80	-25.8	1	230	0	-25.8	0	750	10	230	7	MAGNET POSITION	80
1000	80	-24.9	1	194	0	-24.9	0	1000	10	194	5	KNOCK RETARD	2
1250	80	-24	20	176	0	-24	0	1250	10	176	0	KNOCK SENSE	8
1500	80	-23.1	26	158	0	-23.1	0	1500	13	158	0	KNOCK MAX RPM	8000
1750	80	-22.2	28	142	0	-22.2	0	1750	17	142	0	CL MAP HI	-7.8
2000	80	-21.3	30	136	0	-21.3	0	2000	21	136	0	CL MAP LO	-15.9
2250	80	-20.4	30	129	0	-20.4	0	2250	24	129	0	CL HIRPM LIMIT	3500
2500	80	-19.5	30	126	0	-19.5	0	2500	27	126	0	CL LORPM LIMIT	1500
2750	80	-18.6	32	122	1	-18.6	0	2750	30	122	1	CLOSED LOOP	OFF
3000	80	-17.7	35	118	2	-17.7	0	3000	32	118	2	VALUES LOCK	OFF
3250	80	-16.8	37	113	3	-16.8	0	3250	32	113	3	FUELCUT/MAP	NO LIMIT
3500	80	-15.9	40	106	4	-15.9	0	3500	32	106	4	FUELCUT/RPM	9250
3750	80	-15	43	99	7	-15	0	3750	32	99	5	FUELCUT/TP	NO CUT
4000	80	-14.1	46	93	10	-14.1	0	4000	32	93	6	RPM SWITCH	1500
4250	80	-13.2	49	86	17	-13.2	0	4250	32	86	7	FAST IDLE	129
4500	80	-12.3	52	81	19	-12.3	0	4500	32	81	8	RADIATOR FAN OFF	28
4750	80	-11.4	55	77	21	-11.4	0	4750	32	77	9	RADIATOR FAN ON	23
5000	80	-10.5	58	73	24	-10.5	0	5000	32	73	10	IDLE TP	NOT IN USE
5250	80	-9.6	61	68	27	-9.6	0	5250	32	68	11	IDLE FUEL	NOT IN USE
5500	80	-8.7	64	64	30	-8.7	0	5500	32	64	12	ACCPUMPLORPM	30
5750	80	-7.8	67	61	33	-7.8	0	5750	32	61	13	ACCPUMPHIRPM	20
6000	80	-6.9	70	55	35	-6.9	0	6000	32	55	15	ACC PUMP SENSE	5
6250	80	-6	73	46	40	-6	0	6250	32	46	18		
6500	80	-5.1	76	45	45	-5.1	0	6500	32	45	20		
6750	80	-4.2	79	41	50	-4.2	0	6750	32	41	25		
7000	80	-3.3	82	36	55	-3.3	0	7000	32	36	30		
7250	80	-2.4	85	28	60	-2.4	0	7250	32	28	40		
7500	80	-1.5	88	18	65	-1.5	0	7500	32	18	50		
7750	80	-0.6	91	5	70	-0.6	0	7750	32	5	60		
8000	80	0.61	94	-13	85	0.61	0	8000	32	-13	70		
8250	80	1.04	97	-40	100	1.04	0	8250	32	-40	80		
8500	80	1.47	100			1.47	0	8500	32				
8750	80	1.9	103			1.9	0	8750	32				
9000	80	2.33	106			2.33	0	9000	32				
9250	80	2.76	109			2.76	0	9250	32				
9500	80	3.19	112			3.19	0	9500	32				
9750	80	3.62	115			3.62	0	9750	32				
		4.05	118			4.05	0						
		4.48	121			4.48	0						
		4.91	124			4.91	0						
		5.34	127			5.34	0						
		5.78	130			5.78	0						
		6.22	133			6.22	0						
		6.66	136			6.66	1						
		7.1	139			7.1	2						
		7.54	142			7.54	3						
		7.98	145			7.98	4						
		8.42	148			8.42	5						
		8.86	151			8.86	6						
		9.29	154			9.29	7						
		9.73	157			9.73	8						
		10.2	160			10.2	9						
		10.6	163			10.6	10						
		11	166			11	10						
		11.5	169			11.5	10						
		11.9	172			11.9	10						
		12.4	175			12.4	10						
		12.8	178			12.8	10						
		13.2	181			13.2	10						
		13.7	184			13.7	10						
		14.1	187			14.1	10						
		14.6	190			14.6	10						
		15	193			15	10						

DEFAULT VALUES 3 BAR SENSOR													
RPM		MAP	FUEL	ENGINE	TEMP	RET-ADV/				START			
FUEL		3 BAR		GM F		LOAD	VAL	RPM	IGN	GM F			
500	80	-28.5	1	302	0	-28.5	0	500	10	302	9	START CYCLES	32
750	80	-27.1	1	230	0	-27.1	0	750	10	230	7	MAGNET POSITION	80
1000	80	-25.7	1	194	0	-25.7	0	1000	10	194	5	KNOCK RETARD	2
1250	80	-24.2	23	176	0	-24.2	0	1250	10	176	0	KNOCK SENSE	8
1500	80	-22.8	25	158	0	-22.8	0	1500	13	158	0	KNOCK MAX RPM	8000
1750	80	-21.4	27	142	0	-21.4	0	1750	17	142	0	CL MAP HI	-7.17
2000	80	-19.9	28	136	0	-19.9	0	2000	21	136	0	CL MAP LO	-14.8
2250	80	-18.6	29	129	0	-18.6	0	2250	24	129	0	CL HIRPM LIMIT	3500
2500	80	-17.1	30	126	0	-17.1	0	2500	27	126	0	CL LORPM LIMIT	1500
2750	80	-15.7	34	122	1	-15.7	0	2750	30	122	1	CLOSED LOOP	OFF
3000	80	-14.8	38	118	2	-14.8	0	3000	32	118	2	VALUES LOCK	OFF
3250	80	-12.9	42	113	3	-12.9	0	3250	32	113	3	FUELCUT/MAP	NO LIMIT
3500	80	-11.4	46	106	4	-11.4	0	3500	32	106	4	FUELCUT/RPM	8000
3750	80	-10	50	99	7	-10	0	3750	32	99	5	FUELCUT/TP	NO CUT
4000	80	-8.6	54	93	10	-8.6	0	4000	32	93	6	RPM SWITCH	1500
4250	80	-7.17	58	86	17	-7.17	0	4250	32	86	7	FAST IDLE	129
4500	80	-5.75	62	81	19	-5.75	0	4500	32	81	8	RADIATOR FAN OFF	28
4750	80	-4.33	66	77	21	-4.33	0	4750	32	77	9	RADIATOR FAN ON	23
5000	80	-2.91	70	73	24	-2.91	0	5000	32	73	10	IDLE TP	NOT IN USE
5250	80	-1.49	74	68	27	-1.49	0	5250	32	68	11	IDLE FUEL	NOT IN USE
5500	80	-0.06	78	64	30	-0.06	0	5500	32	64	12	ACCPUMPLORPM	20
5750	80	0.67	82	61	33	0.67	0	5750	32	61	13	ACCPUMPHIRPM	10
6000	80	1.37	86	55	35	1.37	0	6000	32	55	15	ACC PUMP SENSE	5
6250	80	2.06	90	46	40	2.06	0	6250	32	46	18		
6500	80	2.76	94	45	45	2.76	0	6500	32	45	20		
6750	80	3.46	98	41	50	3.46	0	6750	32	41	25		
7000	80	4.16	102	36	55	4.16	0	7000	32	36	30		
7250	80	4.86	106	28	60	4.86	0	7250	32	28	40		
7500	80	5.56	110	18	65	5.56	0	7500	32	18	50		
7750	80	6.25	114	5	70	6.25	0	7750	32	5	60		
8000	80	6.95	118	-13	85	6.95	0	8000	32	-13	70		
8250	80	7.65	122	-40	100	7.65	0	8250	32	-40	80		
8500	80	8.35	126			8.35	1	8500	32				
8750	80	9.05	130			9.05	2	8750	32				
9000	80	9.75	134			9.75	3	9000	32				
9250	80	10.4	138			10.4	4	9250	32				
9500	80	11.1	142			11.1	5	9500	32				
9750	80	11.8	146			11.8	6	9750	32				
		12.5	150			12.5	7						
		13.2	154			13.2	8						
		13.9	158			13.9	9						
		14.6	162			14.6	10						
		15.3	166			15.3	11						
		16	170			16	12						
		16.7	174			16.7	13						
		17.4	178			17.4	14						
		18.1	182			18.1	15						
		18.8	186			18.8	15						
		19.5	190			19.5	15						
		20.2	194			20.2	15						
		20.9	198			20.9	15						
		21.6	202			21.6	15						
		22.3	206			22.3	15						
		23	210			23	15						
		23.7	215			23.7	15						
		24.4	220			24.4	15						
		25.1	225			25.1	15						
		25.8	230			25.8	15						
		26.5	235			26.5	15						
		27.2	240			27.2	15						
		27.9	245			27.9	15						
		28.6	250			28.6	15						
		29	255			29	15						
		30	1			30	15						

DEFAULT VALUES FOR SDS EM-5 WITH TPS LOAD SENSING AND NO MAP SENSOR													
RPM			FUEL	ENGINE	TEMP	RET-ADV/				START			
FUEL	VALUE	TPS	VALUE	GM F	VALUE	LOAD	VALUE	RPM	IGN	GM F	VALUE		
500	80	1	25	302	0	1	0	500	10	302	9	START CYCLES	32
750	80	2	25	230	0	2	0	750	10	230	7	MAGNET POSITION	80
1000	80	3	25	194	0	3	0	1000	10	194	5	KNOCK RETARD	2
1250	80	4	25	176	0	4	0	1250	10	176	0	KNOCK SENSE	8
1500	80	5	27	158	0	5	0	1500	13	158	0	KNOCK MAX RPM	8000
1750	80	6	29	142	0	6	0	1750	17	142	0	CL MAP HI	23
2000	80	7	30	136	0	7	0	2000	21	136	0	CL MAP LO	15
2250	80	8	30	129	2	8	0	2250	24	129	0	CL HIRPM LIMIT	3000
2500	80	9	30	126	5	9	0	2500	27	126	0	CL LORPM LIMIT	1000
2750	80	10	30	122	9	10	0	2750	30	122	1	CLOSED LOOP	OFF
3000	80	11	30	118	13	11	0	3000	32	118	2	VALUES LOCK	OFF
3250	80	12	31	113	17	12	0	3250	32	113	3	FUELCUT/MAP	NO LIMIT
3500	80	13	32	106	22	13	0	3500	32	106	4	FUELCUT/RPM	8000
3750	80	14	34	99	27	14	0	3750	32	99	5	FUELCUT BELOW TP	NO CUT
4000	80	15	36	93	32	15	0	4000	32	93	6	RPM SWITCH	1500
4250	80	16	38	86	37	16	0	4250	32	86	7	FAST IDLE	129
4500	80	17	40	81	42	17	0	4500	32	81	8	RADIATOR FAN OFF	28
4750	80	18	42	77	45	18	0	4750	32	77	9	RADIATOR FAN ON	23
5000	80	19	44	73	48	19	0	5000	32	73	10	IDLE TP	NOT IN USE
5250	80	20	46	68	52	20	0	5250	32	68	11	IDLE FUEL	NOT IN USE
5500	80	21	48	64	57	21	0	5500	32	64	12	ACCPUMPLORPM	30
5750	80	22	51	61	61	22	0	5750	32	61	13	ACCPUMPHIRPM	20
6000	80	23	54	55	66	23	0	6000	32	55	15	ACC PUMP SENSE	5
6250	80	24	57	46	70	24	0	6250	32	46	18		
6500	80	25	60	45	74	25	0	6500	32	45	20		
6750	80	26	63	41	78	26	0	6750	32	41	25		
7000	80	27	66	36	84	27	0	7000	32	36	30		
7250	80	28	69	28	90	28	0	7250	32	28	40		
7500	80	29	73	18	96	29	0	7500	32	18	50		
7750	80	30	77	5	102	30	0	7750	32	5	60		
8000	80	31	81	-13	108	31	0	8000	32	-13	70		
8250	80	32	85	-40	118	32	0	8250	32	-40	80		
8500	80	33	89			33	0	8500	32				
8750	80	34	93			34	0	8750	32				
9000	80	35	97			35	0	9000	32				
9250	80	36	101			36	0	9250	32				
9500	80	37	104			37	0	9500	32				
9750	80	38	107			38	0	9750	32				
		39	110			39	0						
		40	113			40	0						
		41	116			41	0						
		42	119			42	0						
		43	122			43	0						
		44	125			44	0						
		45	128			45	0						
		46	130			46	0						
		47	132			47	0						
		48	134			48	0						
		49	136			49	0						
		50	137			50	0						
		51	138			51	0						
		52	139			52	0						
		53	140			53	0						
		54	141			54	0						
		55	142			55	0						
		56	143			56	0						
		57	143			57	0						
		58	143			58	0						
		59	143			59	0						
		60	143			60	0						
		61	143			61	0						
		62	143			62	0						
		63	143			63	0						
		64	143			64	0						

End of troubleshooting.

Tech help

For technical assistance contact your dealer or:
Racetech Inc.
#5, 304 Noorduyn Park (Springbank Airport)
Calgary, Alberta, Canada T3Z 3S8
Phone 403-671-4015, Fax 403-453-7687
E-mail   racetech1@telus.net   Website: www.sdsefi.com
When calling for help you should know which system you have. We offer 3 different systems,
"D" is fuel only, "E" fuel & ignition, "F" fuel & multi coil ignition.

Warranty

EM-5 is sold for off road use only. New car warranties and emission standards are voided by installation of this system. Since SDS cannot control the installation or use of its products, we accept no responsibility for damage, loss or personal injury while using our products. By using SDS products the user understands and accepts this. All SDS electronic components are guaranteed to be free from defects in workmanship and material for a period of 1 year from the date of sale to original purchaser if installed according to this manual. SDS shall make the sole determination with regards to all warranty claims.
Components are not covered if they have been altered in any way, physically damaged, subjected to moisture or incorrectly connected.

Repairs

1. **Please call or email Racetech before returning any SDS components for checking or repair.**
2. **Please ship parts to us via FEDEX AIR.**
3. **DO NOT ship parts to us via UPS. UPS shipments will be refused due to high fees.**
4. **Please write on the box and waybill "FOR WARRANTY REPAIR, MADE IN CANADA".**
5. **Items shipped to us for warranty checks or testing which are working properly will be subject to a $40.00US charge plus shipping.**

Prior authorization is required before any warranty or returned item is accepted. Defective components will be repaired or replaced as soon as possible at the discretion of Racetech.

Returns

No returns are accepted after 30 days and all returned goods are subject to a 15% restocking fee as well as a charge for any damaged components, cut wires or missing items.

Items for warranty or repair should be shipped to:
Racetech Inc.
#5, 304 Noorduyn Park (Springbank Airport)
Calgary, Alberta, Canada T3Z 3S8
Phone 403-671-4015, Fax 403-453-7687
E-mail: racetech1@telus.net   Website: www.sdsefi.com
Please call or email us before sending parts for checking or repair.
Please write on the box and waybill "FOR WARRANTY REPAIR, MADE IN CANADA"

For Magnecor spark plug wires contact:
Magnecor
24581 Crestview Court
Farmington Hills, Michigan 48335
USA   Phone 248-471-9505
Fax (USA): 248-471-9506
Website: www.magnecor.com E-mail: Magnecor sales and all other inquiries (mag@magnecor.com)

Example engine map

3.2L Porsche 911 normally aspirated with 30lb injectors, porsche fuel pressure regulator.

MAN PRES	VAL	RPM FUEL	VAL	ENG TEMP	VAL	START	VAL	RPM IGN	VAL	IGN RET/LOAD	VAL
-28.8	1	500	88	260	0	260	9	500	5	-28.8	0
-28.3	1	750	97	182	0	182	7	750	5	-28.3	0
-27.9	1	1000	105	146	0	146	5	1000	5	-27.9	0
-27.4	14	1250	107	128	5	128	0	1250	5	-27.4	0
-27	17	1500	110	115	10	115	0	1500	5	-27	0
-26.5	17	1750	113	102	23	102	0	1750	14	-26.5	0
-26	17	2000	115	93	24	93	0	2000	16	-26	0
-25.5	18	2250	120	86	29	86	0	2250	22	-25.5	0
-25	18	2500	128	81	34	81	0	2500	22	-25	0
-24.6	18	2750	133	75	36	75	1	2750	24	-24.6	0
-24.1	21	3000	138	69	33	69	2	3000	24	-24.1	0
-23.6	22	3250	140	67	43	67	3	3250	24	-23.6	0
-23.2	23	3500	140	63	47	63	4	3500	25	-23.2	0
-22.7	24	3750	140	60	53	60	5	3750	25	-22.7	0
-22.2	25	4000	140	56	53	56	6	4000	25	-22.2	0
-21.8	26	4250	140	52	56	52	7	4250	25	-21.8	0
-21.3	27	4500	140	48	56	48	8	4500	26	-21.3	0
-20.8	28	4750	140	43	65	43	10	4750	26	-20.8	0
-20.3	29	5000	140	37	70	37	10	5000	26	-20.3	0
-19.9	30	5250	140	35	73	35	13	5250	27	-19.9	0
-19.4	31	5500	140	32	75	32	17	5500	27	-19.4	0
-18.9	33	5750	140	29	75	29	35	5750	28	-18.9	0
-18.5	34	6000	140	26	75	26	40	6000	28	-18.5	0
-18	35	6250	140	22	70	22	60	6250	28	-18	0
-17.5	36	6500	140	19	70	19	80	6500	28	-17.5	0
-17.1	36	6750	140	16	70	16	80	6750	28	-17.1	0
-16.6	37	7000	140	13	75	13	80	7000	28	-16.6	0
-16.1	40	7250	140	10	75	10	80	7250	28	-16.1	0
-15.6	46	7500	140	-1	75	-1	80	7500	28	-15.6	0
-15.2	52	7750	140	-11	70	-11	80	7750	29	-15.2	0
-14.7	54	8000	140	-22	85	-22	80	8000	29	-14.7	0
-14.2	56	8250	140	-43	100	-43	80	8250	29	-14.2	0
-13.8	58	8500	140					8500	32	-13.8	0
-13.3	60			ACCPUMPLORPM			12			-13.3	0
-12.8	62			ACCPUMPHIRPM			8			-12.8	0
-12.4	64			ACCPUMPSENSE			2			-12.4	0
-11.9	66			START CYCLES			32			-11.9	0
-11.4	68			MAGNET POSITION			83			-11.4	0
-10.9	70			KNOCK RETARD			0			-10.9	0
-10.5	72			KNOCK SENSE			1			-10.5	0
-10	74			CL MAP HI			-6.25			-10	0
-9.54	76			CL MAP LO			-15.6			-9.54	0
-9.07	78			CL RPM HI			3500			-9.07	0
-8.6	80			CL RPM LO			1250			-8.6	0
-8.13	82			CLOSED LOOP	OFF					-8.13	0
-7.66	84			FUELCUT/MANPRESS	NO LIMIT					-7.66	0
-7.19	86			FUELCUT/RPM			6750			-7.19	0
-6.72	88			FUELCUT BELOW TP			12			-6.72	0
-6.25	90			FAST IDLE SWITCH	115 C					-6.25	0
-5.78	92			IDLE TP LOCATION			10			-5.78	0
-5.31	94			IDLE FUEL AMOUNT			35			-5.31	0
-4.83	96									-4.83	0
-4.37	98									-4.37	0
-3.9	100			TEMPS ARE IN CELCIUS						-3.9	0
-3.42	102									-3.42	0
-2.95	104									-2.95	0
-2.49	106									-2.49	0
-2.02	108									-2.02	0
-1.55	110									-1.55	0
-1.08	112									-1.08	0
-0.61	114									-0.61	0
-0.14	116									-0.14	0
0.33	118									0.33	0
0.8	120									0.8	0

Porsche 3.2L notes: Idle was unstable due to manifold pressure fluctuations, so we used IDLE TP LOCATION and IDLE FUEL AMOUNT to get a consistent idle. Cold start tuning was not completed in the colder ranges since the car is not driven in winter. Engine output was approximately 234 HP.

3.2 PORSCHE RPM FUEL VALUES

3.2 PORSCHE MANIFOLD PRESSURE VALUES
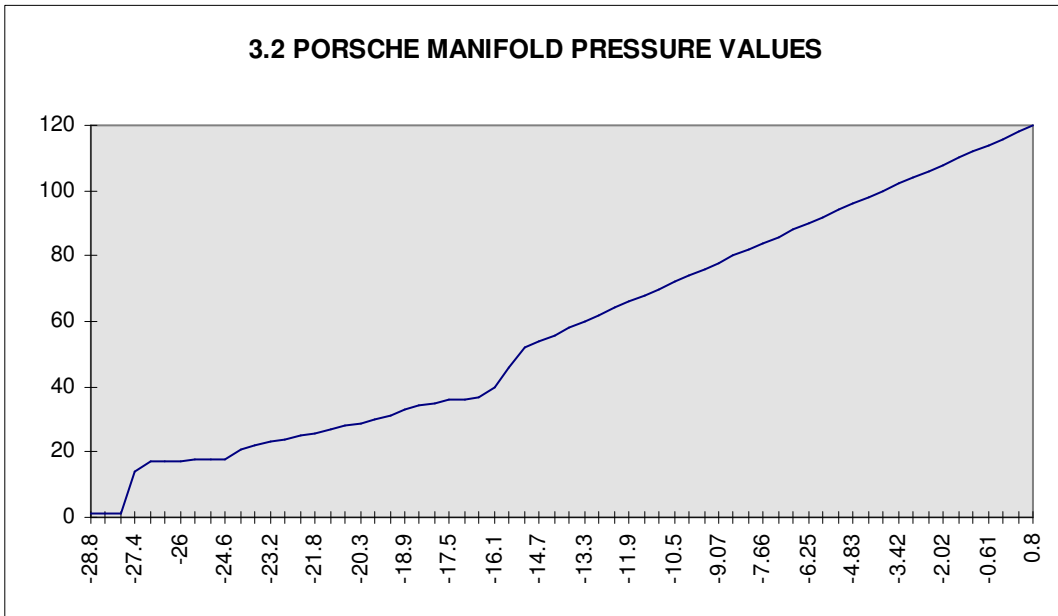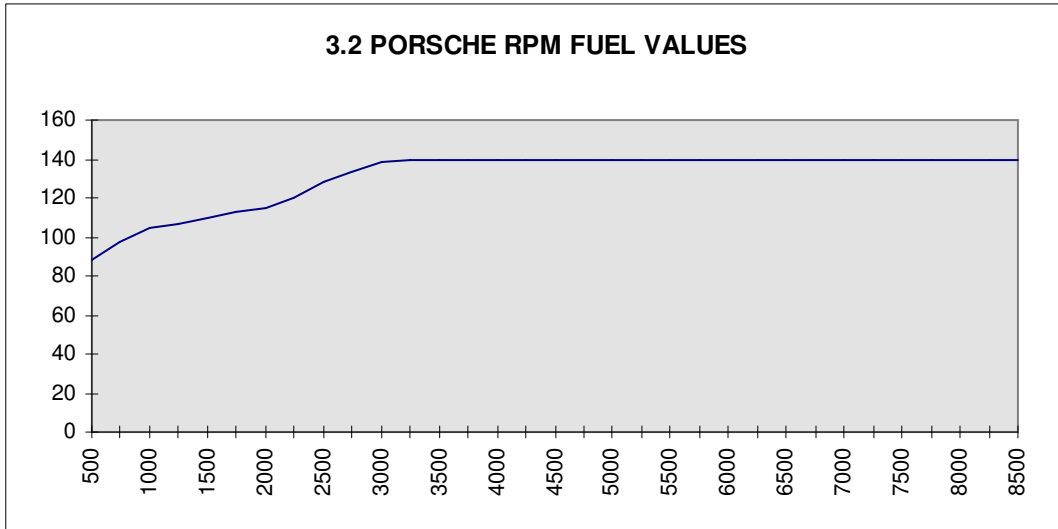
Example engine map

2.3L 20R CELICA TURBO 48LB/HR INJECTORS AT 38 PSI										IGN	
MAN PRES	VAL	RPM FUEL	VAL	ENG TEMP	VAL	START	VAL	RPM IGN	VAL	RET/LOAD	VAL
-26.70	1	500	71	-40	100	-40	80	500	7	-26.70	0
-25.80	1	750	71	-13	95	-13	75	750	10	-25.80	0
-24.90	1	1000	71	-4	90	-4	70	1000	12	-24.90	0
-24.00	20	1250	72	14	76	14	65	1250	14	-24.00	0
-23.10	25	1500	72	32	66	32	60	1500	17	-23.10	0
-22.20	29	1750	72	41	62	41	45	1750	21	-22.20	0
-21.30	30	2000	72	50	56	50	40	2000	25	-21.30	0
-20.40	30	2250	73	59	55	59	35	2250	30	-20.40	0
-19.50	31	2500	73	63	53	63	20	2500	30	-19.50	0
-18.60	34	2750	73	68	51	68	15	2750	30	-18.60	0
-17.70	37	3000	74	77	48	77	10	3000	30	-17.70	0
-16.80	39	3250	78	82	44	82	7	3250	30	-16.80	0
-15.90	40	3500	82	86	41	86	5	3500	30	-15.90	0
-15.00	39	3750	82	95	35	95	5	3750	30	-15.00	0
-14.10	42	4000	84	104	35	104	5	4000	30	-14.10	0
-13.20	45	4250	84	108	33	108	5	4250	30	-13.20	0
-12.30	48	4500	85	113	24	113	5	4500	30	-12.30	0
-11.40	52	4750	86	122	17	122	5	4750	30	-11.40	0
-10.50	55	5000	88	131	15	131	0	5000	30	-10.50	0
-9.60	58	5250	92	140	14	140	5	5250	30	-9.60	0
-8.70	61	5500	92	145	10	145	5	5500	30	-8.70	0
-7.80	64	5750	91	149	0	149	5	5750	30	-7.80	0
-6.90	67	6000	91	158	0	158	5	6000	30	-6.90	0
-6.00	69	6250	91	167	0	167	5	6250	30	-6.00	0
-5.10	74	6500	1	185	20	185	7	6500	30	-5.10	0
-4.20	78	6750	1	194	20	194	10	6750	30	-4.20	0
-3.30	81			203	20	203	10			-3.30	0
-2.40	84			221	20	221	10			-2.40	0
-1.50	88			239	20	239	10			-1.50	0
-0.60	91			257	20	257	10			-0.60	0
0.61	95			275	20	275	10			0.61	0
1.04	98			293	20	293	10			1.04	0
1.47	103									1.47	0
1.90	106					ACCPUMPLORPM	17			1.90	0
2.33	109					ACCPUMPHIRPM	9			2.33	0
2.76	117					ACCPUMPSENSE	5			2.76	0
3.19	122					START CYCLES	20			3.19	0
3.62	126					MAGNET POSITION	80			3.62	0
4.05	131					KNOCK RETARD	4			4.05	0
4.48	134					KNOCK SENSE	9			4.48	2
4.91	135					CL MAP HI	-6.9			4.91	3
5.34	138					CL MAP LO	-15.9			5.34	3
5.78	141					CL RPM HI	3500			5.78	5
6.22	144					CL RPM LO	1500			6.22	6
6.66	147					CLOSED LOOP	OFF			6.66	6
7.10	150					FUELCUT/MANPRESS	10.2			7.10	6
7.54	162					FUELCUT/RPM	6500			7.54	8
7.98	166					FUELCUT BELOW TP	NO CUT			7.98	8
8.42	169					FAST IDLE SWITCH	106 F			8.42	9
8.86	172					IDLE TP LOCATION	NOT IN USE		MAX	8.86	9
9.29	176					IDLE FUEL AMOUNT	NOT IN USE			9.29	10
9.73	181									9.73	11
10.20	187									10.20	13
10.60	191									10.60	14
11.00	196					1/8" NPT TEMP SENSORS				11.00	15
11.50	200					TEMPS IN F				11.50	16
11.90	203					MAX BOOST	9PSI			11.90	20
12.40	206									12.40	20
12.80	209									12.80	20
13.20	212									13.20	20
13.70	215									13.70	20
14.10	1									14.10	20
14.60	1									14.60	20
15.00	1									15.00	20

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20R Celica notes:Max boost is 9 PSI. Compression is about 7.5:1 using VW forged pistons. Spearco 12 x 8 inch intercooler. Can run 6 PSI with 89 octane fuel. Detonates at 12 PSI with 92 octane. Stock camshaft. TO4 turbo. Estimated at 200HP.

20R CELICA TURBO MANIFOLD PRESSURE VALUES

20R CELICA TURBO RPM FUEL VALUES
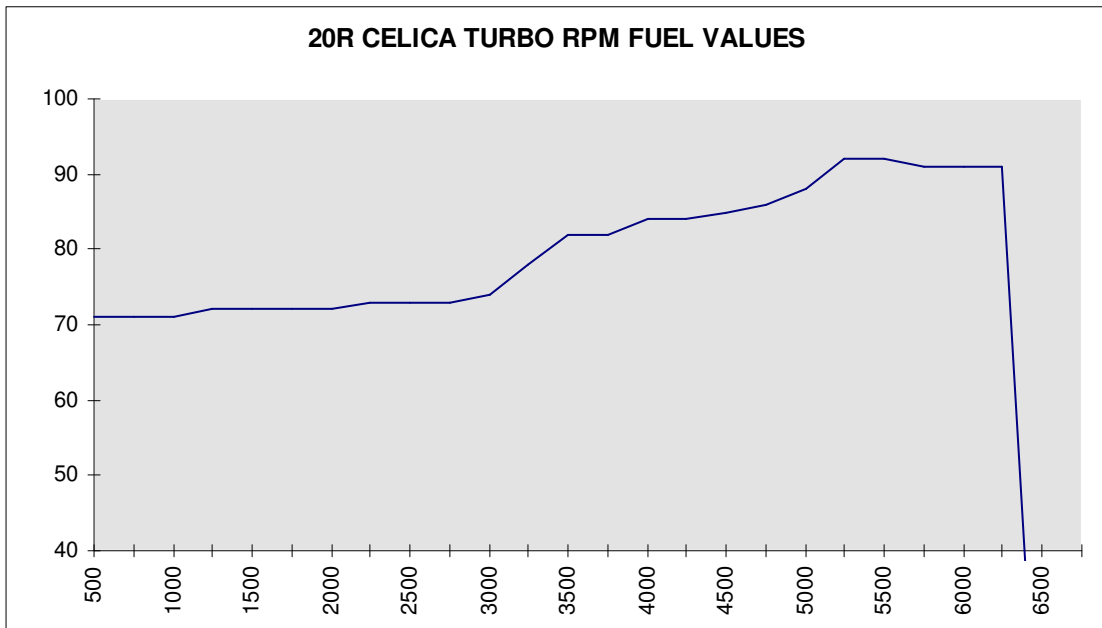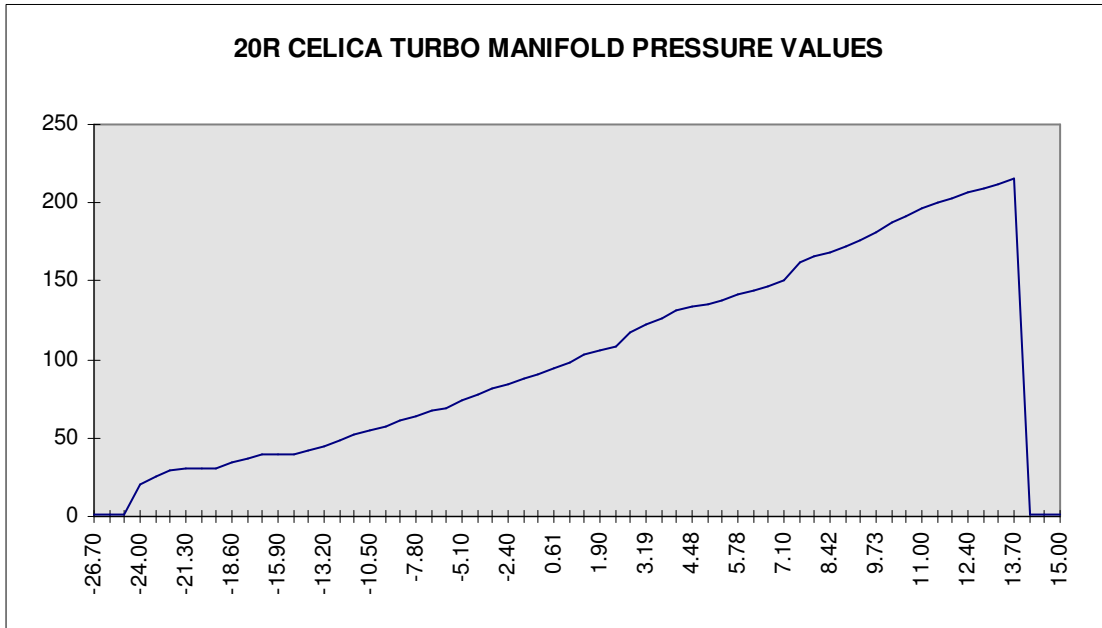
Example engine map
240SX TURBO 2.4L WITH 36 LB INJECTORS AT 38 PSI STOCK CAM & PISTONS

MAN PRES	VAL	RPM FUEL	VAL	ENG TEMP	VAL	START	VAL	RPM IGN	VAL	RET/LOAD	VAL	
-26.70	1	500	106	302	0	302	10	500	10	-26.70	0	RET
-25.80	1	750	99	230	0	230	10	750	10	-25.80	0	RET
-24.90	18	1000	98	194	0	194	10	1000	11	-24.90	0	RET
-24.00	20	1250	108	176	0	176	10	1250	14	-24.00	0	RET
-23.10	23	1500	107	158	0	158	10	1500	16	-23.10	0	RET
-22.20	30	1750	106	142	0	142	10	1750	20	-22.20	0	RET
-21.30	30	2000	106	136	0	136	10	2000	24	-21.30	0	RET
-20.40	30	2250	106	129	2	129	7	2250	29	-20.40	0	RET
-19.50	34	2500	106	126	4	126	5	2500	29	-19.50	0	RET
-18.60	35	2750	106	122	8	122	5	2750	29	-18.60	0	RET
-17.70	37	3000	106	118	10	118	5	3000	29	-17.70	3	ADV
-16.80	39	3250	106	113	16	113	5	3250	29	-16.80	3	ADV
-15.90	41	3500	108	106	20	106	5	3500	29	-15.90	3	ADV
-15.00	44	3750	111	99	28	99	0	3750	29	-15.00	3	ADV
-14.10	47	4000	113	93	36	93	5	4000	29	-14.10	3	ADV
-13.20	52	4250	118	86	43	86	5	4250	29	-13.20	3	ADV
-12.30	55	4500	121	81	48	81	5	4500	30	-12.30	3	ADV
-11.40	58	4750	123	77	52	77	5	4750	31	-11.40	3	ADV
-10.50	61	5000	125	73	56	73	5	5000	32	-10.50	3	ADV
-9.60	63	5250	129	68	58	68	5	5250	32	-9.60	2	ADV
-8.70	65	5500	135	64	62	64	7	5500	34	-8.70	2	ADV
-7.80	67	5750	138	61	66	61	10	5750	35	-7.80	1	ADV
-6.90	70	6000	140	55	70	55	15	6000	35	-6.90	0	RET
-6.00	72	6250	142	46	75	46	20	6250	36	-6.00	0	RET
-5.10	75	6500	1	45	78	45	35	6500	36	-5.10	0	RET
-4.20	77	6750	1	41	81	41	40	6750	36	-4.20	0	RET
-3.30	82			36	83	36	45			-3.30	2	RET
-2.40	87			28	86	28	60			-2.40	4	RET
-1.50	92			18	89	18	65			-1.50	6	RET
-0.60	96			5	91	5	70			-0.60	7	RET
0.61	100			-13	106	-13	75			0.61	7	RET
1.04	104			-40	110	-40	80			1.04	8	RET
1.47	112									1.47	9	RET
1.90	116					ACCPUMPLORPM	22			1.90	10	RET
2.33	118					ACCPUMPHIRPM	12			2.33	10	RET
2.76	122					ACCPUMPSENSE	6			2.76	10	RET
3.19	127					START CYCLES	20			3.19	11	RET
3.62	131					MAGNET POSITION	83			3.62	12	RET
4.05	135					KNOCK RETARD	0			4.05	12	RET
4.48	139					KNOCK SENSE	1			4.48	13	RET
4.91	143					CL MAP HI	-2.4			4.91	13	RET
5.34	147					CL MAP LO	-18.6			5.34	13	RET
5.78	156					CL RPM HI	4000			5.78	13	RET
6.22	158					CL RPM LO	1500			6.22	13	RET
6.66	164					CLOSED LOOP	ON			6.66	13	RET
7.10	173					FUELCUT/MANPRESS	9.29			7.10	13	RET
7.54	181					FUELCUT/RPM	6500			7.54	13	RET
7.98	186					FUELCUT BELOW TP	NO CUT			7.98	14	RET
8.42	191					FAST IDLE SWITCH	106 F			8.42	15	RET
8.86	194					IDLE TP LOCATION	NOT IN USE			8.86	15	RET
9.29	198					IDLE FUEL AMOUNT	NOT IN USE			9.29	15	RET
9.73	193									9.73	15	RET
10.20	198									10.20	15	RET
10.60	204									10.60	15	RET
11.00	1									11.00	15	RET
11.50	1									11.50	15	RET
11.90	1					MAX BOOST 7PSI				11.90	15	RET
12.40	1									12.40	15	RET
12.80	178									12.80	10	RET
13.20	181									13.20	10	RET
13.70	184									13.70	10	RET
14.10	187									14.10	10	RET
14.60	190									14.60	10	RET
15.00	193									15.00	10	RET

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Write down your values here

MAN PRES	VAL	RPM FUEL	VAL	ENG TEMP	VAL	START	VAL	RPM IGN	VAL	RET/LOAD	VAL
		500						500			
		750						750			
		1000						1000			
		1250						1250			
		1500						1500			
		1750						1750			
		2000						2000			
		2250						2250			
		2500						2500			
		2750						2750			
		3000						3000			
		3250						3250			
		3500						3500			
		3750						3750			
		4000						4000			
		4250						4250			
		4500						4500			
		4750						4750			
		5000						5000			
		5250						5250			
		5500						5500			
		5750						5750			
		6000						6000			
		6250						6250			
		6500						6500			
		6750						6750			
		7000						7000			
		7250						7250			
		7500						7500			
		7750						7750			
		8000						8000			
		8250						8250			
		8500						8500			
		8750		ACCPUMPLORPM				8750			
		9000		ACCPUMPHIRPM				9000			
		9250		ACCPUMPSENSE				9250			
		9500		START CYCLES				9500			
		9750		MAGNET POSITION				9750			
				KNOCK RETARD							
				KNOCK SENSE							
				CL MAP HI							
				CL MAP LO							
				CL RPM HI							
				CL RPM LO							
				CLOSED LOOP							
				FUELCUT/MANPRESS							
				FUELCUT/RPM							
				FUELCUT BELOW TP							
				FAST IDLE SWITCH							
				IDLE TP LOCATION							
				IDLE FUEL AMOUNT							