WMS / SDS Programmable Engine Management System
for Ford 4.6 / 5.4 modular engines

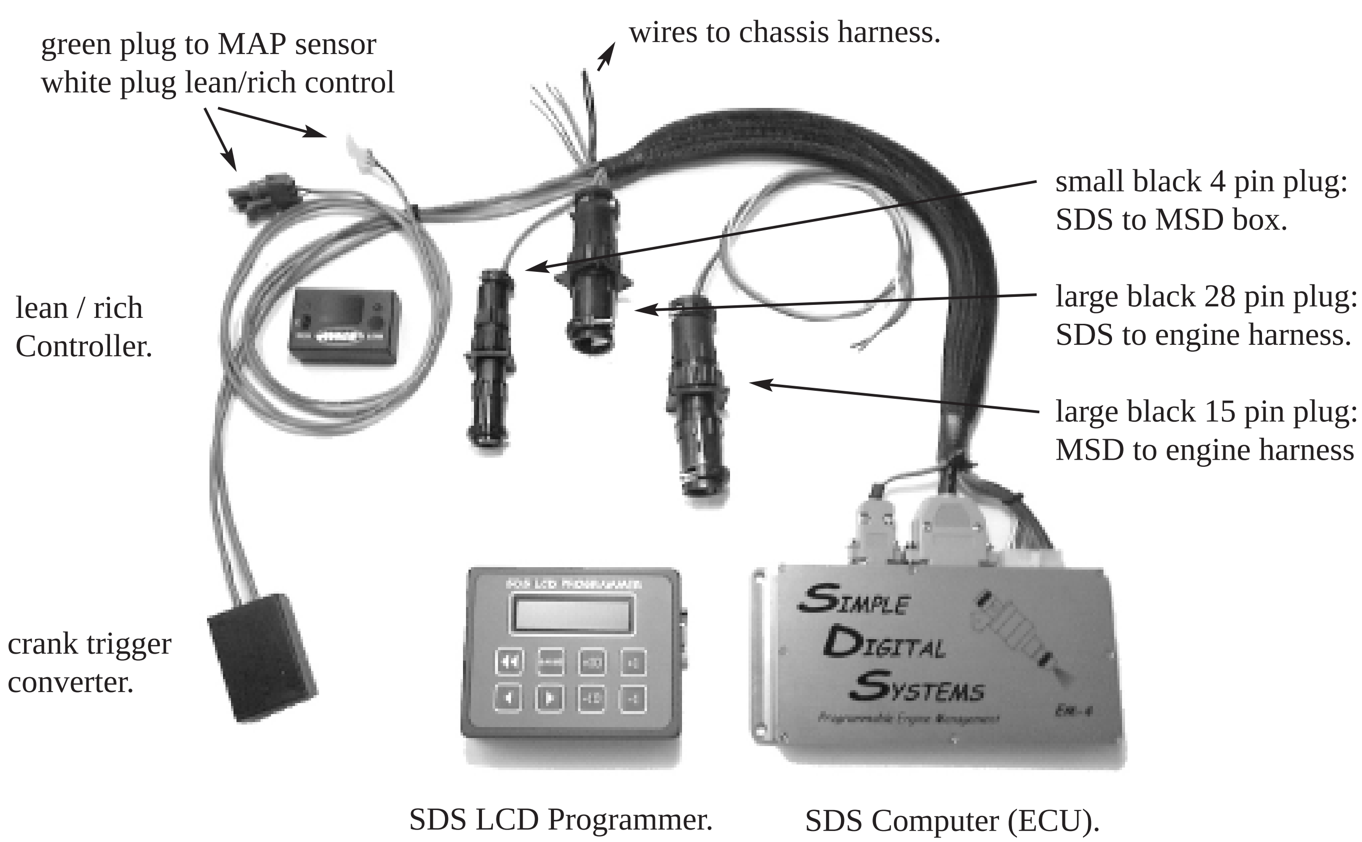
The WMS / SDS Engine Management System is a microprocessor based, digital, programmable EFI system that has been engineered to replace the Ford EEC computer, allowing the user to program all fuel and timing parameters for maximum performance for virtually any engine combination. All of the programming is done through the hand-held SDS LCD programmer, eliminating the need for a laptop computer and complicated software.

Theory of Operation

The injectors are controlled by the SDS which is fully programmable through the LCD programmer. Air temperature, water temperature, manifold pressure, and rpm are all measured and taken into account by the SDS which determines how often and how long the injectors remain open. The SDS then generates a precise triggering pulse which is fed to the injectors. Basically, the manifold pressure fuel value multiplied by the rpm fuel value determines the primary pulse width.

Engine spark is also controlled by the SDS and is fully programmable for both RPM and manifold pressure. Triggering is accomplished through the factory crank trigger. A signal from the crank trigger sends a pulse to the SDS, the SDS determines the exact rpm and manifold pressure, sums the programmed spark values then triggers the required MSD DIS4.

Components of the SDS Injection System



New Features of V14 Software - January 2005

•Datalogging of Air / Fuel Ratio using WMS Wideband or stock O2 sensors
•Improved closed loop operation
•A/C sense input - this function cannot be used on a Ford distributor engine.

O2 Logging
This is a great new 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.
This works with either a standard O2 sensor, or for best results, our WMS Wideband O2 sensor. A standard O2 sensor can only read 14.7:1 or leaner / richer than 14.7. A Wideband will give you an accurate air/ fuel ratio from 9.8:1 - 20:1.

O2 Type
This function is for selecting which type of O2 sensor. Proper selection is important in order for closed loop and O2 logging to operate properly. The two selections are standard or Wideband 0-5 volt. If you do not have the WMS wideband meter connected then leave this set to STANDARD. When set as STANDARD, Gauge3 mode will not display A/F ratio, but instead will display O2 voltage.

Hookup for Plug-in systems for EEC-4.
•Stock O2 Sensors : If you already have the stock O2 sensors installed these will work as is , the SDS uses the right side O2 sensor.

•WMS Wideband: The Wideband 0-5V output (purple wire) must be hooked up to the SDS. This is done through the stock O2 signal wire for the right side sensor. This can be done under the car but we prefer to hook it up at the computer - connect the purple wire from the Widband to the O2 signal at the stock Ford computer plug - pin number 29 (dark green / purple wire in many applications)

How this 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 sensor should be placed within 3 feet 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
• Throttle should be held stable to give repeatable accurate results, 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 and engine is fully loaded. O2 logging may not occur if engine rpm's increase too rapidly.
• 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.
• Erasing logged O2 data is done by turning off power to the SDS computer. 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.

• After reviewing logged data, it may be a good idea to power down the SDS momentarily to clear out all logged data before attempting the next run of the engine.

Correcting the mixture using the WMS wideband meter

If O2LOG readings are leaner than 14.0 at full throttle and or high RPM, then fuel numbers should be increased to richen the mixture. Once O2 data is logged you can use the Air / Fuel ratios at each RPM to change the RPM FUEL values and fine tune the fuel map. 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:

Most narrow band O2 sensors show maximum power with O2 voltages of approximately .75 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

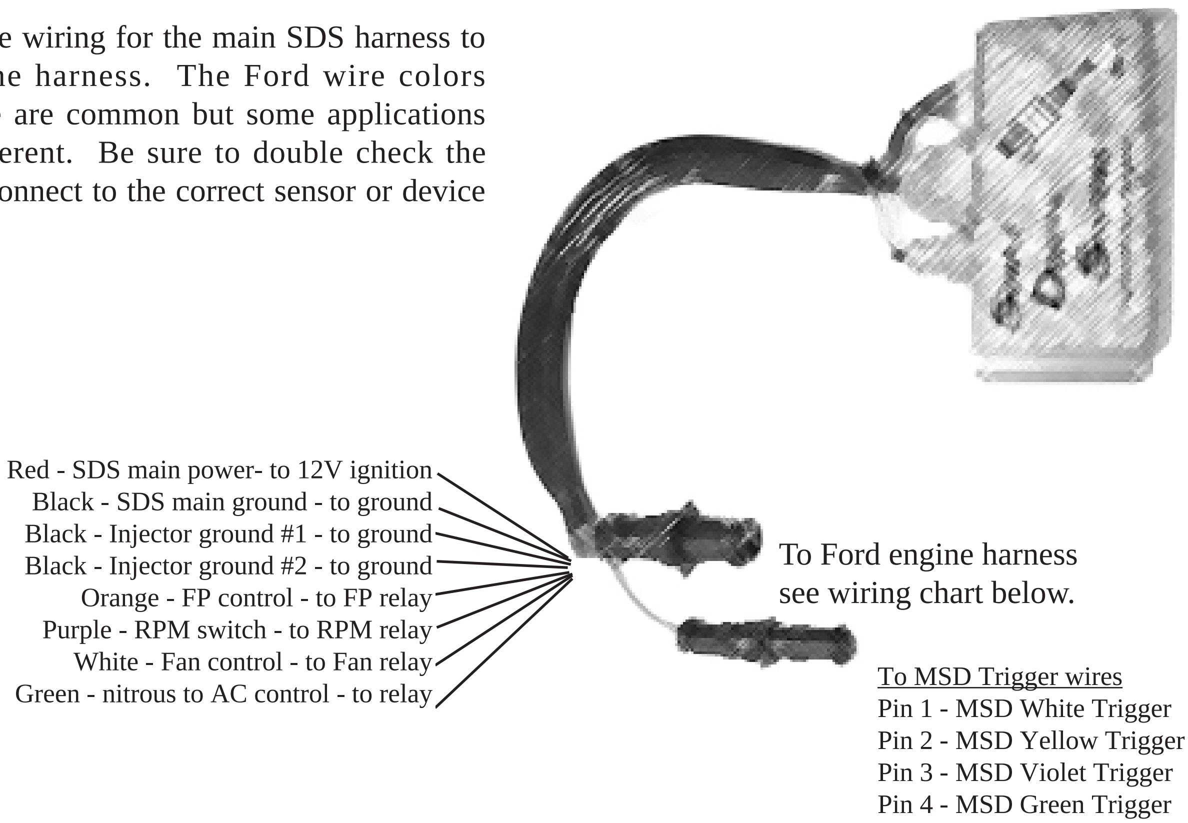
On Supercharged or Turbo engines

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.

Installation of the System

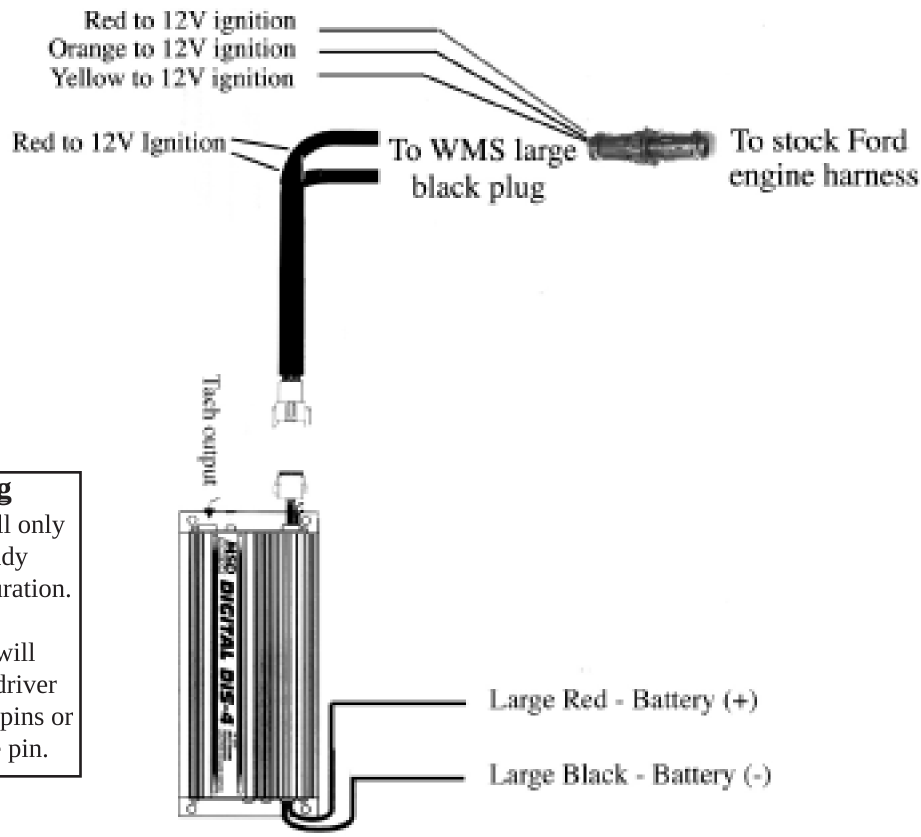
1. This SDS system is designed for the Ford modular 4.6 / 5.4 engines and is used with the stock engine wiring harness. The stock Ford harness firewall plug is replaced with the supplied plugs to connect the SDS to the stock engine harness.

Below is the wiring for the main SDS harness to Ford engine harness. The Ford wire colors shown here are common but some applications can be different. Be sure to double check the wire does connect to the correct sensor or device as listed.



WMS 28pin plug to Ford Engine Harness Wiring

Pin #	Function	Wire To - typical Ford wire color
1	TPS power from SDS	TPS Power - Ford Bown / White
2	Intake Air Temp signal	IAT sensor - Ford Grey
3	Intake Air Temp return	IAT sensor - Ford Grey / Red
4	Engine Coolant temp return	ECT sensor - Ford Grey / Red
5	Engine Coolant temp signal	ECT sensor - Ford Green / Red
6	TPS signal	TPS signal - Ford Grey / White
7	O2 Sensor signal	O2 sensor - Ford Grey / Lt Blue
8	TPS return	TPS return - Ford Grey / Red
11	Idle air control	IAC solenoid - Ford White / Lt Blue
12	Injector #6	Ford Lt Green / Orange
13	Injector #1	Ford Tan
14	Injector #5	Ford Tan / Black
15	Injector #3	Ford Brown / Yellow
16	Knock Sensor signal	Knock Sensor
17	Injector #4	Ford Brown / Lt Blue
18	Injector #7	Ford Tan / Red
19	Injector #8	Ford Lt Blue
20	Injector #2	Ford White
26	Crank trigger (+)	Crank trigger - Ford Dark Blue
27	Crank trigger (-)	Crank trigger - Ford Grey



Coil pack vs. coil on plug

Engines equipped with coil packs will only use pins 1,3,5,7 as the coil pack already fires two coils in waste spark configuration.

Engines equipped with coil-on-plug will use all pins 1 thru 8. The MSD coil driver wires can be twinned to plug into all pins or crimp two Ford wires together in one pin.

WMS 15pin plug to Ford Engine Harness Wiring

Pin #	MSD wire	Function	Wire To - typical Ford wire color
1	Brown / white	coil driver #1	Ford Lt Green / White
2	Brown / white	coil driver #6, waste spark with #1	Ford Orange / Yellow
3	Brown / green	coil driver #3	Ford White / Pink
4	Brown / green	coil driver #5, waste spark with #3	Ford Lt Green / Yellow
5	Brown / yellow	coil driver #7	Ford Pink / Lt Blue
6	Brown / yellow	coil driver #4, waste spark with #7	Ford Dk Green / Violet
7	Brown / violet	coil driver #2	Ford Pink / White
8	Brown / violet	coil driver #8, waste spark with #2	Ford White / Red
9	Brown / orange	power to coils from MSD	Red, red / green (common to all coils)
10	Brown / orange	power to coils from MSD	Red, red / green (common to all coils)

Other wires shown in diagram above

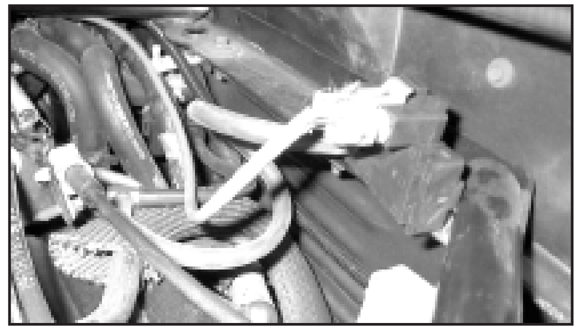
14		injector power	Ford red (common to all injs)
15		O2 sensor power	Ford red (common to all O2s)
16		IAC power	Ford red
			*use an ohmeter to trace these powers

NOTE: NEVER PLUG IN THE MSD BYPASS PLUG AS IT WILL SHORT OUT THE IGNITION DRIVERS IN THE SDS COMPUTER!

2. The SDS is design to work with an MSD DIS4 ignition box. The SDS controls all ignition functions but the DIS4 box is used as an amplifier to provide powerful spark for high compression, boost or nitrous applications. The MSD DIS4 must be wired as shown in the diagram below. If it is already installed in the car it will need to re-wired.
We recommend mounting the MSD box under the passengers seat or somewhere inside the car for all weather protection but many people mount them in the engine compartment as well. Be careful not to mount the box or route power wires too close to the SDS computer as RFI interference may result.

3. The Lean / Rich Controller can now be plugged into the white plug off our main harness.

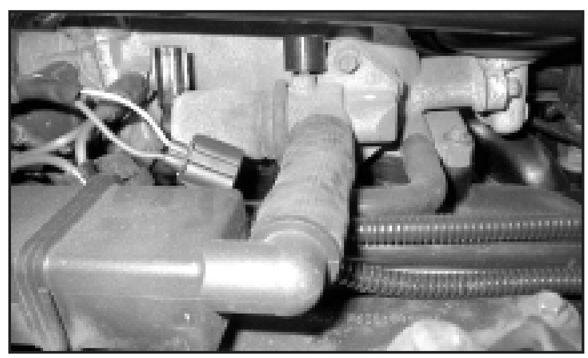
4. Mount the supplied MAP sensor inside the car or in the engine compartment. A vacuum line must be run from the new MAP sensor to a good vacuum source on your engine after the throttle body. Teeing into a vacuum line as show here is a good way to do it. Always try to mount the MAP sensor with the vacuum port facing down or horizontal so that moisture cannot enter the sensor.



The map sensor plugs into the harness / plug off our main harness.

5. The SDS computer must be mounted in a moisture free location inside the vehicle. The SDS computer should be mounted at least 3 feet away from the ignition coil,wires and ignition box if possible, preferably behind a metal firewall. We usually mount it behind the passengers kick panel where the Ford EEC computer used to be located. Use the mounting tabs to secure it to the chassis.

On systems using low impedance injectors, a resistor pack is used between the SDS and WMS Black Box. This is an aluminum plate with gold colored resistors mounted to it. 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.

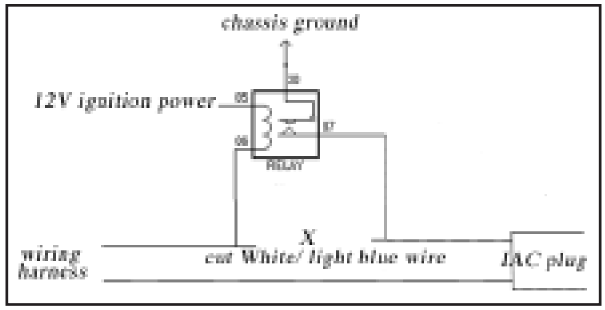


10. The SDS LCD Programmer and Lean / Rich knob can be mounted in a position so that easy tuning can be accomplished. Both units are not required for the system to operate and can be removed once tuning is complete although we find the gauge modes very handy to use on a regular basis.

11. **Disconnect the wiring harness from the Idle Air Control solenoid**, located on the throttle body, as it draws a very large current and will damage the SDS computer.   It is not necessary with most performance applications, instead we use a Ford Idle Air Control Kit that allows fine tuning of your idle, using air bleed screws. The Ford part number is F2PZ-9F939-A and is available from WMS or any Ford dealer.

12. Some later years did not have a Intake Air Temperature Sensor (it was built into the mass air meter). The sensor must be added and should be placed before the throttle body (and after intercooled if equipped). The standard Ford push in sensor part number DY-735 is best for most applications.

If you want fast idle capabilities for cold starts you must wire the supplied relay into the IAC harness at the engine. The wiring for the relay is as shown to the right.



You may find the fast idle to be too high without a restrictor for the air hole, a gasket or aluminum plate with a smaller hole works well. Adjust the hole size until you have the desired fast idle speed.

Initial Start up

Your SDS system comes with a base program that will in most cases, allow the engine to run in some reasonable fashion. These values will be based on the engine data and injector flow rates which you have provided us with.

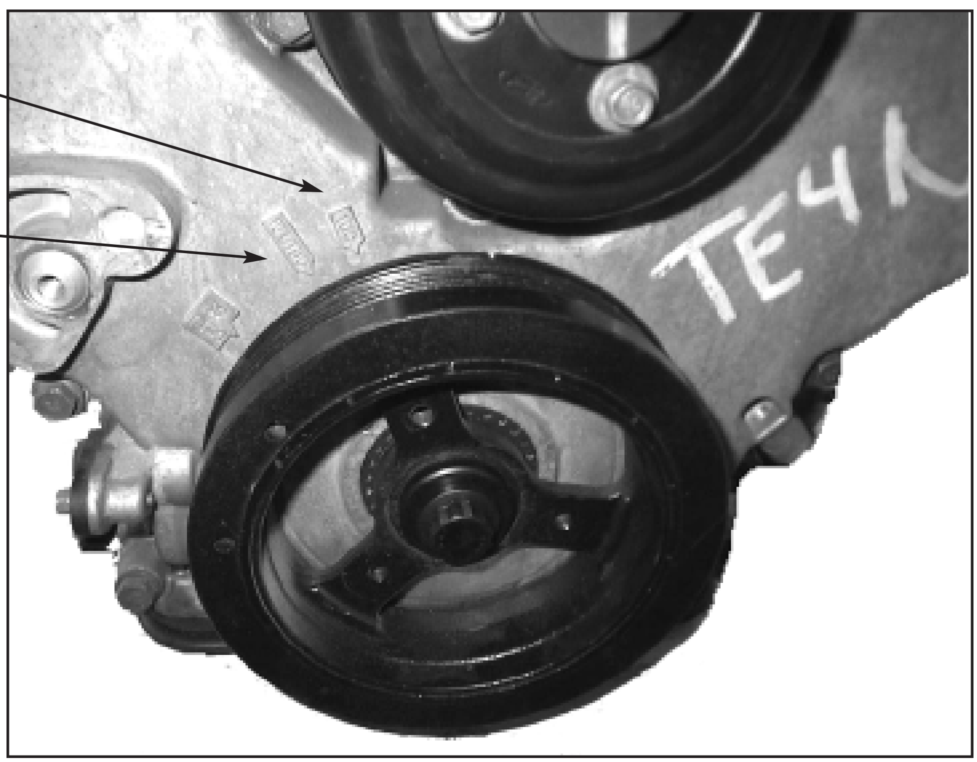
13. Make sure that fuel at the correct pressure is present at the injectors. Turn on ignition and computer power. The fuel pump should cycle and fuel pressure should rise to approx. 40lbs. Try starting the engine, if it does not fire right away try adjusting the mixture control while cranking. Once the engine is running, use the mixture knob to get a smooth idle and let the engine warm up to normal operating temperature.

14. Base timing at the balancer must now be checked. To keep the timing from moving around set the 500, 750, 1000 & 1250 RPM / IGN to 10° advance in the SDS programmer. Use a timing light to check the balancer matches the base timing of 10° BTDC. If the timing does not match go to the MAG POS function in the SDS Programmer and adjust this value until your base timing on the balancer is 10° BTDC. The MAG POS value usually runs around 80.

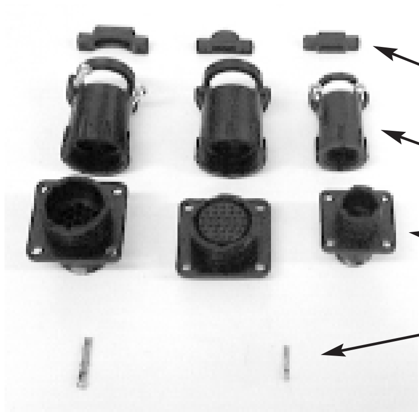
Once the timing is checked you can add some timing advance back in by increasing the RPM / IGN values at 750, 1000 & 1250. **The SDS RPM / IGN at 500rpm must match the balancer timing or all ignition curves will be incorrect.**

TDC mark - 0 degrees

10 BTDC mark - 10 degrees advance



Components of the plugs



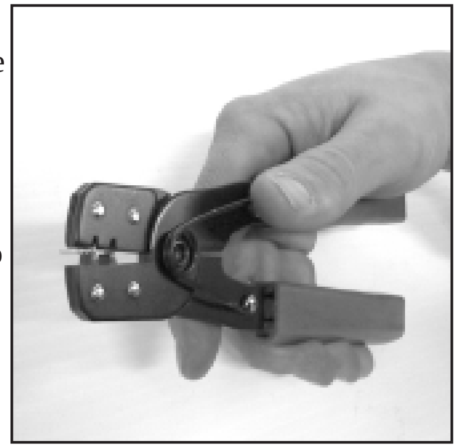
- clamps for wire strain relief, screw onto plug rear cap

- plug rear cap, screws onto main plug body

- main plug body, pins push in from the back

- crimp pins - large for large plugs, small for small plugs. Once crimped onto the wire they are inserted into the main plug body

Notes on assembling the circular plugs



• use supplied crimping tool as shown. Pins stick out right side of the tool, a pattern on the lower tooth shows postion of pin.
• for small pins, start with large crimp in took, then finish with small.
• for large pins, start crimp with small pliers, then use supplied crimp tool.
• some wires may be too large for small pins, strip a bit of the wire so they fit correctly
• some wires may be too small for large pins, double wire up so crimps are tight
• be sure to slide rear onto wires first before installing any pins into the plug
• a special tool is needed for removal of the pins once installed in the plug, be sure pins are inserted into correct position. The removal tool is avaiable at most industrial electronics stores that sell AMP products.

Order of installation

• cut and strip wires
• crimp on all pins
• install rear cap over bundle of wires
• plug pins into correct pin numbers in main plug body
• screw rear cap to plug
• screw correct clamp into rear cap to hold wires.

Programming

Be sure to read the entire section on programming before proceeding any further. We recommend that you don't change any values that you don't understand. If the manual does not clarify things for you, please contact us. Trying to diagnose a problem when something has been improperly set can be very time consuming.

Important programming and tuning tips

1. CLOSED LOOP should be turned OFF, and it is normally off when shipped from the factory.
2. We highly recommend using a mixture meter or our Wideband O2 sensor to aid in tuning. See tuning with O2 sensor section on page 22 for further information.
3. 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 just getting off track.
4. You must vary only one parameter at a time and observe the change. If you change rpm and MAP, you don't know which parameter is affecting the air/fuel ratio. Hold MAP constant and vary rpm, never both.
5. 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 controller to see if the misfiring gets worse. We recommend to follow this sequence when tuning the fuel part of the system - RPM FUEL first, then MANIFOLD PRESS, ACC PUMP, ENGINE TEMP, START, CLOSED LOOP and FUEL CUT.

The amount of fuel injected by the EM-4 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 PRESS. Most of the MANIFOLD PRESS values can be left at their factory settings when the RPM FUEL values are set properly. RPM FUEL values are where programming should begin.

Ignition timing requirements differ widely between various types of engines, becareful with the timing values, SERIOUS ENGINE DAMAGE CAN OCCUR with improper values entered. Excessively advanced timing can cause pre-ignition and detonation, retarded timing can cause high exhaust gas temperatures. Start with safe timing values and concentrate on the getting the fuel side of the program tuned first.

LCD PROGRAMMER

The programmer allows you to access the SDS program and make changes to parameters. When powered, SDS EFI should appear in the LCD window. Following is an explanation of what each programmer button does.

Scroll Buttons - To navigate the program press the right '>' or left '<' scroll buttons, this will scroll your through the program one parameter at a time. Parameters will appear in the following order from left to right:

- GAUGE 1
- GAUGE 2
- GAUGE 3
- MAGNET SEEN/NOT SEEN
- IDLE FUEL AMOUNT
- IDLE FUEL LOCATION
- RADIATOR FAN ON
- RADIATOR FAN OFF
- FAST IDLE SWITCH
- RPM SWITCH
- FUELCUT BELOW TP
- FUELCUT/RPM
- FUELCUT/MANPRESS
- VALUES LOCK
- CLOSED LOOP ON/ OFF
- CL LO RPM LIMIT
- CL HI RPM LIMIT
- CL MAP LO
- CL MAP HI
- KNOCK MAX RPM
- KNOCK SENSE
- KNOCK RETARD
- MAGNET POSITION
- START CYCLES
- START - 32 points
- RPM IGN - 38 points
- IGN RET/MAN PRESS - 64 points
- ENGINE TEMP - 32 points
- MANIFOLD PRESS - 64 points
- RPM FUEL - 38 points
- ACC PUMP SENSE
- ACC PUMP LO
- ACC PUMP HI then, back to the beginning GAUGE.

Scroll buttons for left '<', right '>' and fast '<<'.
Gauge button to go to gauge mode.
Value change buttons for +10, -10, +1, and -1.

By holding down either the right or left scroll buttons for more than 2 seconds, ranges will advance quickly 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.

Value Change Buttons - To change values within the program press the '+1', '-1', '+10', or '-10' buttons. Each time the button is depressed the value will change by the corresponding amount. Again, by holding down these buttons for more than 2 seconds, values may be changed quickly to the desired figure. The VALUES LOCK feature must be selected off in order to make changes to the program.

Gauge Button - The 'GAUGE' Button allows you to jump between the GAUGE mode and the program and is useful when tuning. For instance if you were programming in the MANIFOLD PRESSURE parameters and wanted to see what manifold pressure the engine was idling at just press the GAUGE button once to go to GAUGE and again to return to MANIFOLD PRESSURE.

THE SDS PROGRAM

Following is an explanation of each part of the program starting with the GAUGE and moving to the right '>'.

GAUGE 1, GAUGE 2, GAUGE 3

Calling up the gauge modes allows you to see in real-time, the sensor inputs to the ECU. This is useful for diagnosing sensor problems as well as for programming. If you encounter a strange problem or stumble, 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 1 displays the following information:

- •MP - Manifold Pressure in the intake manifold in inches of vacuum or pounds of boost.
- •RPM - the current rpm of the engine.
- •ET - Engine Temperature, the current water temperature inside the engine.
- •AT - Air Temperature of incoming air into the engine.

GAUGE 2 displays the following information:

- •KNOB - the position of the mixture knob in a percentage change.
- •DUTY - injector duty cycle from 0% to 100% - **Note:** the display will read greater than 100% if injectors are too small and fuel values too big.
- •AP - accelerator pump action. The value will increase when the gas pedal is depressed then fall back to 0.
- •IGN - ignition timing in degrees BTDC. Note: The display should normally read '-' in front of the value (eg.-10), this indicates BTDC. A '+' would indicate ATDC and should not be seen.
- •IGN and Knock Sensor - A 'K' after the timing value indicates the knock sensor is activated and changing the timing

GAUGE 3 displays the following information:

- •BAT - battery voltage
- •TP - throttle position. The number should be 10-20 at idle and increase as the gas pedal is depressed..

MAGNET SEEN/NOT SEEN

This screen is simply a diagnostic tool. The screen should flash SEEN / NOT SEEN when the engine is turned over by the starter. If this does not flash the computer is not receiving the signal from the Ford crank trigger. Note that when the engine is running you may not be able to see the screen flashing.

IDLE TP LOCATION and IDLE FUEL AMOUNT

This function is only for radical engines with low vacuum at idle, most engines would not use these next two functions, leave them set to NOT IN USE. 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 SDS is shipped with these features showing NOT IN USE. To use these features you need to go to the IDLE TP LOCATION, this window is to tell the SDS throttle position 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 to 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 PRESS value, since TP is completely stable at idle the SDS can produce a very constant fuel pulse to keep the idle constant. You can adjust the IDLE FUEL AMOUNT to get the mixture correct, the RPM FUEL values also affect the mixture. 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, the system goes back to reading the MANIFOLD PRESS values again. To avoid an over-rich condition during deceleration or coasting downhill, you should make use of the FUELCUT BELOW TP settings.

RADIATOR FAN ON / RADIATOR FAN OFF

This function is used to control the electric cooling fan. The values to turn the fan on and off do 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. **Your RADIATOR FAN OFF value should be at least 2 higher than the RADIATOR FAN ON value**. On the 96+ Mustangs the low speed fan will run all the time and the SDS will control the high speed fan. You can unplug the low speed fan at the fan plug if you only want to use the high speed fan.

Good examples of programmed values: FAN ON 24, FAN OFF 26.
FAN ON 21, FAN OFF 25.
Bad examples of programmed values: FAN ON 21, FAN OFF 22.
FAN ON 21, FAN OFF 19.

If programmed incorrectly, software protection may turn the fan on but not allow the fan to turn off again. This is to prevent the relay from switching on and off rapidly, causing poor operation, electrical noise and damage to the relay.

To adjust, warm up the engine by driving the car around for at least 30 minutes, longer if in a cold climate. Stop driving 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 when it comes back down to normal, then change the RADIATOR FAN OFF value until the fan turns off. Typical number for Ford sensors are 27-35.

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 all the time.

Refer to page 28 for wiring instructions for electric fans other than stock.

FAST IDLE SWITCH

This is the ET (engine temperature) that the fast idle switch operates at. If you have wired the IAC for cold weather start up the ECU will open the IAC solenoid below this temperature and close it above. Usually the temperature should be set between 120 and 140 degrees F. The '+1' button will decrease the temperature and the '-1' temperature will raise it. See page 4, step 10 for proper wiring to use the fast idle function.

RPM SWITCH

The function allows the user to select an rpm to activate a switch. This may be used to switch anything rpm dependent on and off including shift lights and NOS systems. Simply set the desired rpm using the program change buttons. Below the rpm that you have selected the switch is off, when the rpm reaches the selected value the switch is turned on. See page 28 for wiring an rpm switch. On 96-98 Cobras this function controls the IMRCs.

FUELCUT BELOW TP

This function is used to cut off fuel when coasting with the throttle closed. It is in operation only above 2000 rpm and a TP value is entered in the window. When it is selected off, the function is disabled. A value of between 2 and 20 can be entered, use the + and - buttons to select the desired value.

To use this function, you must verify your closed throttle TP by selecting Gauge 3 mode. With the throttle closed, the display will show your closed throttle TP setting. For example, if this is 10 you would want to enter 10 or 11 in your FUELCUT BELOW TP window.

Using the TP to cut fuel when decelerating helps reduce surging, saves fuel and reduces emissions. If the system is programmed for anti-lag turbo operation, you would want to leave this function disabled in the NO CUT mode.

FUELCUT/RPM

This function is the rev limiter and cuts all fuel at a user specified rpm. Cutting all fuel is very safe as the engine will be pumping only air, although it is very harsh and not recommended that is hit on a regular basis.
Use the + and - buttons to select the desired rpm.

FUELCUT/MANPRESS

This function is used for boost limiting and cuts all fuel at a user specified boost level. Cutting all fuel is very safe as the engine will be pumping only air.
Use the + and - buttons to select the desired manifold pressure (boost).

VALUES LOCK

This function allows you to lock out programming to prevent inadvertent changes to your values. VALUES LOCK OFF allows you to make changes to the program. With the VALUES LOCK ON you cannot change any values. When you are done programming for a while or plan to disconnect the programmer, always turn the VALUES LOCK ON.

CLOSED LOOP ON/ OFF

This function allows the user to turn on and off closed loop operation. Use the +1 and -1 buttons to select the ON or OFF positions. Always leave the closed loop off if no O2 sensor is connected and always leave closed loop off until all normal programming is completed.

EM-4 systems are equipped with closed loop mixture control that takes cues from the factory oxygen sensor (right side sensor). In closed loop mode, the ECU attempts to hold the air/fuel ratio around stoichiometric (14.7 to 1 AFR for gasoline). The O2 sensor sends a DC voltage to the ECU in proportion to the free oxygen present in the exhaust stream. If the sensor detects a lean condition, the ECU increases the injector pulse width to compensate and vice versa. Since there is a delay time between sensing and correction, the air to fuel ratio will continuously fluctuate slightly to either side of stoichiometry. 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.

Many engines will not tolerate being idled at the relatively lean mixtures associated with closed loop operation nor will they safely tolerate these lean mixtures at full throttle, therefore the closed loop mode has rpm and manifold pressure limits, outside of which the ECU will switch out of closed loop into open loop (programmed values) mode. The ECU will also switch out of closed loop when the throttle is opened quickly. Closed loop will not be engaged by the ECU until the engine temperature exceeds 35C (95F) and the sensor voltage first exceeds .625 volts. The RPM and MAP must also fall within the following programmed limits.

CL RPM LO & CL RPM HI

These two functions determine where the ECU will discontinue closed loop control at. If you select 2000 and 4500 RPM respectively in these slots, closed loop operation will be discontinued whenever the rpm goes below or above these limits. We recommend as a rough guideline, setting the CL LO RPM LIMIT no lower than 1750 rpm and the CL HI RPM LIMIT no higher than 70% of the redline rpm limit.

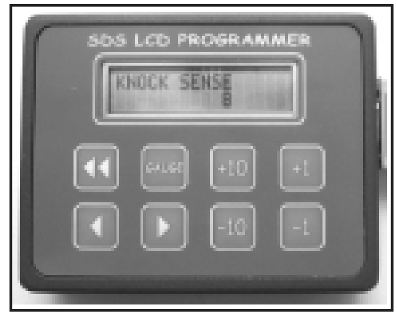
CL MAP LO & CL MAP HI

These two functions again determine where the ECU will discontinue closed loop control at. If you select -15 and -5 respectively in these slots, closed loop operation will be discontinued whenever the MAP goes below or above these limits. CL MAP limits should preclude the low vacuum idle conditions as well as the high throttle ones. Set the CL MAP LO limit 3 to5 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.

The engine must operate within these 4 limits of CL LO RPM, CL HI RPM, CL MAP LO AND CL MAP HI or the ECU will revert back to open loop. Software limits prevent the ECU 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 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. Severe engine damage due to lean mixtures can result. A mixture meter is highly recommended for system setup.

KNOCK SENSE



Knock Sensor operation is an option available on EM-4 systems. If so equipped, the Knock Sense function allows sensitivity adjustment between 1 and 16 with 1 being least sensitive. It is important to adjust the sensitivity to ensure that the ECU is hearing only knock and not mechanical engine noise. Many engines go through various harmonics and the sensor is so sensitive that it can pick up noises which are not detonation and falsely trigger the sensing circuitry. This may severely retard the timing when in fact no detonation is present. The sensitivity adjustment allows you to tune out low amplitude noise, allowing only true knock pulses through to the ECU.

This condition is best diagnosed and remedied by first entering a 5 in KNOCK RET and 0's in all the IGN RET/MAN PRESS values. Enter 8 in the KNOCK SENSE window. Go to gauge 2 mode. Look at the IGN parameter then rev the engine up to redline in neutral with reasonably small throttle movements if possible. The ignition timing in the window should follow exactly what you have programmed in the RPM IGN program. If you see the timing suddenly retard as you are revving the engine, it means that the knock sensor is picking up mechanical engine noise and the ECU is retarding the timing because it thinks it is knocking. Decrease the KNOCK SENSE value to filter out this noise.

You should be able to rev the engine up in neutral without the knock sensor retarding the timing unless the engine actually knocks. If this happens, there may be too much timing for the fuel octane that you are using. The sensitivity must be set so that the ECU only hears true knocking and no engine "noise". If you can't get satisfactory operation, you may have to try other knock sensor locations on your engine.

KNOCK RETARD

This function adjusts the amount of knock spark retard, a value of 3 will retard the timing 3 degrees for every knock that the ECU hears. Timing returns to the previous value at a predetermined rate if no more knocks are heard. This rate of return increases with increasing rpm. Since every engine is different, try experimenting with different KNOCK RET values. 1 to 5 would be the normal range. The maximum retard that the system can deliver is 20 degrees.

If you wish to turn off the knock sensing option, you can enter a 0 in the KNOCK RETARD parameter. The knock sensing option can take the place of large amounts of MAP retard in some cases, however, total reliance on the sensor while running unrealistically high amounts of spark timing may lead to running problems. We recommend using the knock sensor as a safety device rather than a primary timing control.

Proper location of the sensor and tuning of the KNOCK SENSE along with a proper KNOCK RETARD value are essential for satisfactory operation of this option. Knock control is not a magic bullet. If the compression ratio or boost pressure is too high for the fuel octane you are using, either knock will occur or you will lose power by having to retard timing to prevent it. Constant hard knocking (detonation) will eventually destroy any engine, sometimes within seconds.

MAGNET POSITION

This function is used to set base timing of the engine at the balancer. Refer to page 5, step 14 for complete instruction on how to properly adjust your magnet position. **MAGNET POSITION can make a substantial difference in horsepower and driveability, be sure it is adjusted correctly!**

START CYCLES

This function allows the user to adjust how long the start enrichment lasts for. This is adjustable between 0 and 255. Start Cycles are 2x crank revolutions on a 4 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.

START - 32 points of programming

Start enrichment is provided for under the START program. The ECU takes its cues from the water temperature sensor and injects extra fuel for a certain number of engine cycles after the ECU detects crank rotation. This function is activated every time that the engine is started no matter what the water temperature is. It is critical for proper starting, especially in cold climates.

The value entered at a particular START water temperature determines how much will be added to the primary pulse width to aid starting. 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 temps over 100 degrees F, most engines do not require any extra fuel so the values should be low. For some engines hot starting may be improved with some extra fuel to flush boiling fuel from the injectors. Experimentation is required for a satisfactory setup here.

The combination of START, START CYCLES and ENGINE TEMP 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 off. 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 TEMP values are too low.

Once the start injection cycles have occurred (usually 3-15 seconds), the ECU reverts to engine temperature for warmup enrichment. START and ENGINE TEMP should not be confused.. The START function is automatically reset after the engine stops turning.

PROGRAMMING FOR TIMING

The SDS system calculates total timing by taking the **RPM IGN** value and subtracting the **IGN RET/MAN PRESS** value. Ignition timing requirements differ widely between various types of engines so we can only offer general guidelines for ignition values. Optimal timing is best found on a dyno or by driving the car. For most engines running adequate octane fuel, a simple timing curve using only RPM values often gives excellent results. For high compression, naturally aspirated engines and turbocharged / supercharged street engines running relatively low octane fuels and where fuel economy is important, a more complex curve taking MAP into account may be required. Timing may have to be retarded at higher manifold pressures to avoid detonation.

If you have no idea what your ignition curve should look like, programming should be done by somebody who does, SERIOUS ENGINE DAMAGE CAN OCCUR with improper values entered. Excessively retarded timing can cause high exhaust gas temperatures while advanced timing can lead to pre-ignition and detonation.

RPM IGN - 32 points of programming

The RPM IGN program allows control of timing from 500 rpm to 9750 rpm at 250 rpm increments. A typical timing curve should look something like the table below. For most engines at idle the timing should be between 10 and 15 degrees BTDC. As RPM increases total timing is gradually increased to 3000 RPM where full advance is usually in. Most engines like 30 or more degrees of full advance and often this timing figure is maintained right up to the redline.

RPM	IGN
500	10
750	10
1000	14
1250	16
1500	19
1750	22
2000	24
2250	26
2500	28
2750	30
3000	32
3250	32
3500	32
3750	32
4000	32
4250	32
4500	32
4750	32
5000	32
5250	32
5500	32
5750	32
6000	32
ETC.	

It is critical that the RPM / IGN value at 500 rpm matches base timing set on your balancer. In the table above that would mean base timing at the balancer must be 10 degrees BTDC.

IGN RET-ADV / LOAD - 64 points of programming

The IGN RET-ADV / LOAD program allows for timing retard under boost conditions as well as advance under cruise conditions. The program varies whether your system is naturally aspirated (-28.8" vacuum to .8 boost), 2 bar (-26.7" vacuum to 15lbs boost) or 3 bar (-25.7" vacuum to 30lbs boost). A retard or advance value can be entered for each point by using the program change buttons and the display will show if you are retarding or advancing.

For RPM only ignition mapping (used mostly with naturally aspirated or race only engines), enter 0's for all the IGN RET/MAN PRESS values. This will subtract nothing from the RPM / IGN values.

For street turbo / supercharged engines, the IGN RET-ADV / LOAD program can be utilized. To obtain optimum power and fuel economy under cruise conditions high total timing may be required, say 32 degrees above 3000 rpm. Under acceleration and boost conditions the engine will not tolerate this much timing with pump gas so the timing must be retarded, say above 3 lbs of boost. The following table shows how RPM / IGN

RPM	IGN	MP	IGN RET	TOTAL TIMING
2000	22	-10	0	22
2500	28	-5.75	0	28
3000	32	-2.91	0	32
3000	32	3.46	3 RETARD	29
4000	32	10.4	6 RETARD	26
5000	32	12.5	7 RETARD	25

and IGN RET-ADV / LOAD interact to control this.
It is important to remember that total timing is the result of the RPM IGNITION value minus the IGN RETARD (or plus IGN ADV) value at that given instant of engine operation. There are hundreds of possible timing curves available with the SDS to suit any engine, the previous examples are only hypothetical. As previously mentioned, efficient timing curves are best developed on the dyno.

The IGN RET-ADV / LOAD program can also be used to maximize fuel economy under cruise conditions. To utilize this you will need to add timing with the IGN ADV function. Compare the following table to the previous to see how timing increases in the 2000-2500 rpm range and under cruise conditions (higher MP vacuum numbers).

RPM	IGN	MP	IGN RET	TOTAL TIMING
2000	22	-10	8 ADV	30
2500	28	-5.75	4 ADV	32
3000	32	-2.91	0	32
3000	32	3.46	3	29
4000	32	10.4	6	26
5000	32	12.5	7	25

ENGINE TEMP (ET) - 32 points of programming

The ENGINE TEMP program determines the amount of extra fuel injected to compensate for a cold engine during warmup. A water temperature sensor supplies this info to the ECU. You should aim for a 0 value when the engine is at normal operating temperature as most engines will not require extra fuel after 100+ degrees F. The values should decrease in a fairly linear fashion from cold to operating temperature then have 0's entered above this threshold. Some engines like a little additional fuel when hot starting to flush the injectors, this extra fuel will be added until water circulation brings the water temperature below this threshold. If you are doing this be sure to only enter numbers above the water 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. Use the GAUGE button to toggle between gauge mode and water temp so you can make adjustments while the engine is warming up. Each time the ECU updates to a new ET in gauge mode, go to that ENGINE TEMP in the program. 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 at 10 and 2 o'clock, you probably have the water temp values about right. If not, adjust the ENGINE TEMP value at the current water temp parameter.

MANIFOLD PRESS (MP) - 64 points of programming

The MAN PRESS program controls the amount of fuel injected for a given manifold pressure, either vacuum or boost. The manifold pressure sensor is measuring the load on the engine. Standard EM-4 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. Three different MAP sensors are used, 1 bar (naturally aspirated), 2 bar (up to 15lbs boost) and 3 bar (up to 30lbs boost).

All units are pre-programmed with a standard MAP program, depending if the system is 1, 2 or 3 bar. These values should be close, so most **initial programming should be done on the RPM FUEL values.** If the engine appears to be too rich everywhere, lower the RPM FUEL values across the board. Do not start re-programming the MAP values as this often leads to people getting way off track.

MAP values should increase in a reasonably linear fashion. They should not go up by one or two per parameter then suddenly increase by 5 or 8. Three example MAP programs on shown on the opposite page, the first a basic program that will work with most engines, the second a program that was fine tuned for a particular engine combination and the third an example of how to program incorrectly.

The MAN PRESS curve may need to be modified to achieve a smooth idle, but only modify the MAN PRESS curve after working with the RPM FUEL curve. Select the gauge mode to determine what manifold pressure your engine is idling at. Now turn the KNOB richer and leaner and note where the engine starts to run smoother. Say the engine runs smoothest at -10% on the KNOB and the manifold pressure when idling is -15" vacuum. You would now go into the MAN PRESS curve and subtract roughly 10% from the values around -15". Be sure when modifying the MAN PRESS values you keep a smooth incremental curve as shown in the examples.

A basic Manifold Pressure program, note how the fuel value increases by 3 every point from vacuum through to boost.

MP	FUEL
15	193
14.6	190
14.1	187
13.7	184
13.2	181
12.8	178
12.4	175
11.9	172
11.5	169
11	166
10.6	163
10.2	160
9.73	157
9.29	154
8.86	151
8.42	148
7.98	145
7.54	142
7.1	139
6.66	136
6.22	133
5.78	130
5.34	127
4.91	124
4.48	121
4.05	118
3.62	115
3.19	112
2.76	109
2.33	106
1.9	103
1.47	100
1.04	97
0.61	94
-0.6	91
-1.5	88
-2.4	85
-3.3	82
-4.2	79
-5.1	76
-6	73
-6.9	70
-7.8	67
-8.7	64
-9.6	61
-10.5	58
-11.4	55
-12.3	52
-13.2	49
-14.1	46
-15	43
-15.9	40
-16.8	37
-17.7	35
-18.6	32
-19.5	30
-20.4	28
-21.3	26
-22.2	24
-23.1	22
-24	20
-24.9	15
-25.8	10
-26.7	1

MP	FUEL
15	202
14.6	199
14.1	196
13.7	193
13.2	190
12.8	187
12.4	184
11.9	181
11.5	178
11	175
10.6	172
10.2	169
9.73	166
9.29	163
8.86	160
8.42	157
7.98	153
7.54	150
7.1	147
6.66	143
6.22	140
5.78	137
5.34	134
4.91	131
4.48	128
4.05	124
3.62	120
3.19	115
2.76	110
2.33	105
1.9	100
1.47	95
1.04	90
0.61	85
-0.6	80
-1.5	76
-2.4	72
-3.3	68
-4.2	64
-5.1	60
-6	57
-6.9	54
-7.8	51
-8.7	48
-9.6	45
-10.5	42
-11.4	40
-12.3	38
-13.2	37
-14.1	36
-15	35
-15.9	34
-16.8	33
-17.7	32
-18.6	31
-19.5	30
-20.4	28
-21.3	26
-22.2	24
-23.1	22
-24	20
-24.9	15
-25.8	10
-26.7	1

A more complex Manifold Pressure program to compare to the basic program left.

This particular engine liked more fuel under boost, note how the fuel values are larger from 2.33 lbs of boost and up.

It also wanted less fuel under cruise conditions, note how the fuel values are smaller from 1.9 lbs of boost to -18.6" vacuum.

MP	FUEL
15	193
14.6	190
14.1	187
13.7	184
13.2	181
12.8	178
12.4	175
11.9	172
11.5	169
11	166
10.6	163
10.2	160
9.73	157
9.29	154
8.86	160
8.42	170
7.98	160
7.54	150
7.1	139
6.66	136
6.22	133
5.78	130
5.34	127
4.91	124
4.48	135
4.05	130
3.62	125
3.19	120
2.76	109
2.33	106
1.9	103
1.47	100
1.04	97
0.61	94
-0.6	91
-1.5	88
-2.4	85
-3.3	82
-4.2	79
-5.1	76
-6	73
-6.9	60
-7.8	45
-8.7	40
-9.6	40
-10.5	50
-11.4	55
-12.3	52
-13.2	49
-14.1	46
-15	43
-15.9	40
-16.8	37
-17.7	35
-18.6	32
-19.5	30
-20.4	28
-21.3	26
-22.2	24
-23.1	22
-24	20
-24.9	15
-25.8	10
-26.7	1

The wrong way to set up a Manifold Pressure program.

Note how the fuel value jumps up quickly and drops again from 7 to 9 lbs of boost and from 3 to 5 lbs of boost.

It also drops from and rises from -10 to -6, maybe an attempt to lean out the idle. This would be better done in the RPM FUEL program.

If the idle speed is fluctuating up and down, move to the manifold pressure ranges just above and below where the engine is idling at. Make slight adjustments here until the idle is smooth. Idle MAP values often work best when the values are the same over the whole range of idle MAP ranges (2-3 ranges). If the MAP fluctuates over more than 3 ranges at idle and you cannot get a smooth idle, you may have to install a .025 to .035 inch orifice in the MAP sensor line.

Engines with large camshafts will have little vacuum at idle and may require a small RPM FUEL value to compensate for a higher MAN PRESS / FUEL value. If an engine idles at -5" vacuum you should not decrease the MAN PRESS / FUEL number in the -5" range, this would lead to poor running under part throttle conditions. The table to the right helps to clarify.

Correct Program		**Incorrect Program**	
MP	Fuel	MP	Fuel
-1.49	72	-1.49	72
-2.91	68	-2.91	68
-4.33	62	-4.33	**42**
-5.75	58	-5.75	**38**
-7.17	54	-7.17	**35**
-8.6	50	-8.6	50
-10	46	-10	46
-11.4	42	-11.4	42

For setting cruise and higher power MAP values, the same procedure as above applies. Use the programmer in GAUGE mode to monitor the MP and increase MP with the throttle until you identify a rich or lean spot. Use either the mixture knob or mixture meter to identify if the engine is running lean or rich.

For example, at -8.42" to -6.81" there is a slight stumble and the mixture meter reads very lean. Hold the throttle steady within this range while watching GAUGE mode. Now, turn the mixture knob richer until the stumble is no longer evident. If the knob is turned to +12% to make the engine run smooth go into the MAN PRESS values to the ranges spanning -8.42" to -6.81" and increase the values about 12%. Remember to turn the knob back to its 12 o'clock or 0% position to verify your change. You can repeat this procedure at all MAP points where the mixture is not right but be sure to keep a smooth incremental curve as shown in the examples.

Use caution at high throttle openings with severe stumbles. You can melt the pistons if the mixture is too lean. Always go richer first with the knob to see if the stumble gets worse. Return the knob to the 12 o'clock position before working on the next range. When programming, remember to change only one variable at a time. To hold MAP constant, use a high gear and the brake or a hill to keep rpm from changing as you open the throttle. Make the change then go back to gauge, reestablish the range that you were working on and check the mixture again.

When using the mixture meter, most engines have to idle rich to be smooth. Under light load cruising conditions, most engines can be run quite lean for good fuel economy. Under full throttle and boost conditions, the mixture needs to be quite rich to produce maximum power and suppress detonation. It is normal for the mixture meter to go full lean when the throttle is released while in gear if 1's are entered in the high vacuum areas of the MAP ranges.

RPM FUEL - 32 points of programming

The RPM FUEL curve program controls the amount of fuel injected at a given RPM and allows programming every 250 rpm. The fuel values should be fairly close to each other, increasing from idle and then varying only with the torque curve of the engine. It is important to note that the number of injections are doubled when the rpm is doubled if the values remain the same. RPM values therefore only compensate for the volumetric efficiency or breathing differences related to rpm.

A base RPM FUEL curve has been pre-programmed into the system to allow start up. **You will need to change the RPM FUEL curve to find best power and driveability from your engine combination**. Start by adjusting the RPM FUEL values at idle. Use the programmer in GAUGE mode to monitor your RPM and turn the KNOB richer and leaner and note where the engine starts to run smoother. Say the engine idles best at +15% on the KNOB. You would now go into the RPM FUEL curve and add roughly 15% to the values around idle, say 750-1250 rpm. Be sure when modifying the RPM FUEL values you keep a smooth incremental curve as shown in the examples below.

Use caution at high throttle openings with severe stumbles. You can melt the pistons if the mixture is too lean. Try turning the KNOB rich first to see if the engine runs better, if it is worse try turning it lean. This is the quickest way to get the setup close. Values in the RPM FUEL curve can be fine tuned later on.

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.

RPM	FUEL
500	140
750	144
1000	145
1250	147
1500	152
1750	157
2000	162
2250	165
2500	168
2750	170
3000	172
3250	176
3500	179
3750	179
4000	179
4250	179
4500	179
4750	179
5000	179
5250	177
5500	175
5750	173
6000	172
6250	172

An RPM FUEL curve for a supercharged 5.0 with a fairly healthy camshaft.

Note how the fuel increases from idle to 3250 rpm to compensate for low manifold pressure at idle.

The fuel values also drop off slightly above 5000 rpm as the engine does not breath as well up high.

RPM	FUEL
500	120
750	125
1000	125
1250	125
1500	129
1750	130
2000	133
2250	136
2500	140
2750	145
3000	150
3250	150
3500	150
3750	150
4000	150
4250	150
4500	150
4750	150
5000	150
5250	150
5500	150
5750	150
6000	150
6250	150
6500	150
6750	150
7000	150

An RPM FUEL curve for a 2.3 Turbo with a mild turbo camshaft.

The fuel does still increase from idle to 3000 rpm to but not as radically as the cammed 5.0.

The fuel values also remain the same all the way to redline, denoting the engine breathes better at high rpm.

ACC PUMP SENSE

The ACCPUMP SENSE function controls the sensitivity to slow throttle movements. This control is very important just out of the idle range. Set this control by opening the throttle slowly from the idle position. Use the +1 and -1 buttons to 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.

ACC PUMP LO & ACC PUMP HI

This function injects extra fuel when the throttle is rapidly opened. The ACCPUMP LO RPM value controls action from 0 to 1875 rpm. The ACCPUMP HI RPM setting controls action above 1875 rpm. Both parameters must have a proper value entered for proper engine response. To set this parameter properly, snap the throttle open quickly. If the engine hesitates, use the +1 and -1 buttons to change the value. If the hesitation is worse, you have changed the value the wrong way. Repeat this procedure on both HI and LO settings until engine response is acceptable. ACC PUMP values are generally between 10 and 40 on most applications with the high value less than lo value.

If changing the values will not make the engine respond properly, check to make sure that the TPS is hooked up correctly. You can check for proper operation by selecting GAUGE 2 mode. You should see the AP number increase from 0 to a higher number when the throttle is rapidly opened, then as the throttle movement stops, the number should quickly return to 0. The AP number should always be 0 when the throttle is not moving. If not, it indicates an intermittent connection or a damaged TPS.

AIR TEMP (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 the air temperature sensor. The current AT in real time is displayed in GAUGE mode. For special applications we can set up your system with the AIR TEMP user programmable, call us for details.

On turbocharged engines, the sensor should be located in a position where it will be wetted by high velocity air after the intercooler. The wide range of temperatures that these engines operate over dictate that the sensor detect changes as quickly as possible.

Heat soak-back after shut down or prolonged idling can cause starting and running problems. Fuel can boil in the injectors and fuel rails making it virtually impossible to meter fuel accurately. Don't blame these problems on the system. Changing the air temp sensor location may help this problem. Be aware that conduction from water or exhaust heated manifolds may give false air temperature readings.

Tuning with the WMS Wideband O2 Sensor

This section guides you through the process of tuning an SDS system, using the WMS Wideband O2 sensor. This sensor is extremely accurate and gives you real reading of Air/Fuel at any given point of operating conditions. This information can then be used to make changes to the SDS program in the corresponding areas. Other lower cost mixture meters that use narrow band, stock O2 sensors can also assist with tuning but will only give you an approximate Air / Fuel reading.

Background Information

The WMS Wideband O2 sensor uses Bosch's lastest motorsport technology to read an accurate Air / Fuel ratio across the spectrum from 10:1 (rich) to 18:1 (lean). This is very different than a stock narrow band O2 sensor that accurately reads 14.7:1 but can only approximate leaner and richer.

Spark ignited engines will produce the desired performance only within a relatively narrow range of AFRs. Best power is usually obtained with an AFR of between 11.8:1 and 13.0:1 on most engines. The lowest average emissions are obtained with the AFR around 14.7:1 (stoichiometric) and best fuel economy is at AFRs between 16:1 and 18:1. Most engines do not idle well unless they are setup to run richer than 14:1 AFR.

WMS Wideband O2 Sensor, showing close to optimum Air / Fuel ratio for naturally aspirated engine.

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 AFRs 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, this is can all be incorporated in the SDS program but takes more effort in tuning.

Tuning may be done on a dyno or by 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. It is important to understand that the engine should never be leaned out at high rpm or high throttle opening or boost conditions. This can lead to overheated and damaged parts or complete destruction if pre-ignition/detonation occurs.

Base tuning should always be accomplished with the Closed Loop function turned OFF. When the system is in closed loop, the ECU looks at oxygen sensor voltage to correct the air/fuel ratio automatically to around 14.7:1. This is mainly for emissions. It is dangerous to run most engines hard in closed loop mode because the air/fuel ratio is too lean at under power. For the purposes of simplification, we will assume that the closed loop function may be used for the part throttle conditions to satisfy emission requirements only. If emissions are not a concern, better driveability and fuel economy is often obtained by leaving the system in open loop or programmed mode under all conditions. Open loop mode is when the system is operating off the values programmed into the ECU's memory.

Several things are important to observe during the tuning process:

1. Let the engine reach operating temperature before changing any MAP, TP or RPM values. Trying to reprogram while the ECU is still adding extra fuel for warmup, you are wasting your time getting off track.

2.You must vary only one parameter at a time and observe the meter. If you change RPM and MAP values, you don't know which is affecting the air/fuel ratio. Keep MAP constant and vary rpm or vice versa, never both.

3. 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.

Tuning Idle Mixture and Initial Setup

Adjust the mixture controller after starting the engine to obtain a smooth idle. Let the water temperature reach at least 120F. If the knob is set leaner than 0% for a smooth idle, it means that the RPM FUEL value is too high at that idle rpm. Example - engine is idling at 750 rpm with the mixture knob at -10%. The RPM FUEL values at 500, 750 and 1000 rpm are 140. If you subtract 10% from 140 your have a new fuel value of 126. Use the -1 button on the programmer to change these values all to 126 and change the mixture controller back to 0%. Now use the mixture controller and try both to the rich side and to the lean side and see if the engine runs better either way, if you find it runs worse in either direction you are very close to the optimum mixture. On most engines the O2 sensor will read 13.50 to 14.00 air / fuel but let the best running of the engine be your guide here not necessarily the O2 sensor.

If you notice that the idle speed fluctuates up and down slightly, go to GAUGE 1 mode and look at the MAP window. You will likely see it moving between several ranges. Note the highest and lowest ranges then go to those ranges in the MANIFOLD PRESS program and make all values within those ranges the same, about 30 in most cases will work well. This should smooth out the idle. Once the O2 sensor is warmed up to over 600F, it should supply accurate voltage readings to the mixture meter. You will probably notice that your engine idles the smoothest when the mixture is fairly rich. This is normal.

Dyno Mapping

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 power curves to see where you picked up or lost power due to the richer mixture. If you gained power, keep richening the mixture in 10% increments until power drops off from the previous run. If you lost power go to 5% lean and see if power increases. 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 on engine dynos 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 upped. Any lean condition now at the higher boost as indicated by the Wideband O2 or a loss of power can likely be attributed to improper MAP values. By looking in GAUGE 1 mode at the MAP window, you can see where the ECU is currently operating and adjust that range if needed. These should be adjusted until the meter reads in the 11.8 to 13.0 range and for maximum power. Part throttle and accelerator pump settings can be done on a dyno but are probably better set on the road.

On the Road Mapping

You should select a stretch of smooth straight road with a few long hills if possible. The hills will allow you time to stabilize conditions at higher throttle openings without getting over the speed limit or roasting your brakes.

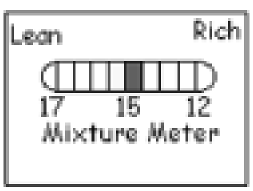
It is usually best to begin with full throttle, low rpm conditions first. On turbo cars, turn the boost pressure down to the minimum possible. RPM values should be adjusted first. By doing these at wide open throttle, you are only changing one thing at a time which allows you to adjust the correct parameter (rpm in this case). Put the car in 4th or 5th gear at 2000 rpm and floor it. Watch your mixture meter and tach or rpm in GAUGE 1 mode. You want the mixture to be rich at full throttle, 11.8 to 12.5 to be safe.

If the meter reads fine until 4000 rpm and then leans out there, you can increase the RPM FUEL value by 10 at the 4000 rpm and up and try it again. Note that you can flick quickly between GAUGE 1 and the range that you are programming by just hitting the GAUGE button again. This saves a lot of scrolling.

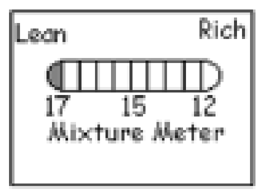
Once you get the mixture correct at full throttle throughout the whole rpm range, you can turn up the boost and start on the MAP values. If the engine ran fine to 6000rpm and 4 psi before but now leans out at 10 psi and 6000 rpm, you must increase the MAP values around the10 psi range. Again, you should be in GAUGE 1 mode watching the MAP and your mixture meter for any signs of lean out and at what MAP it occurs at. Use a hill and brakes to stabilize conditions for a few seconds to verify the bad range.

Part Throttle and Cruising

The part throttle conditions are probably the hardest to set up. Under light load conditions, you want the mixture to be substantially leaner than it is at full throttle. Depending on the engine, you want the mixture to be at 14.7 or leaner, some engines are quite happy cruising at 15.0 to 16.0.



Some engines are quite happy running full lean on the meter as shown right:



If the engine starts to miss or the car hitches as you lean out at part throttle, the mixture is too lean to be tolerated. Most adjustments are done to the MAP values for cruising conditions. Hold rpm constant with the brakes and slowly open the throttle while watching the MAP readout in GAUGE 1 mode. Try to stabilize the MAP reading at each step. If the mixture meter is not reading correctly at a certain MAP, go in with the programmer to that range and adjust the values in that range. Be sure to keep the MAP values in a smooth curve.

Fuel Cutoff, Closed Loop, Acceleration

To save fuel on street applications, 1s are often entered in the MAP ranges a few steps below the normal idle range. This cuts off fuel flow when closing the throttle and coasting and often prevents popping out of the exhaust on deceleration.

Once basic tuning is completed, the closed loop function can be programmed and switched on if lower emissions are desired or if a catalyst is fitted. It is important to set the MAP and RPM limits for closed loop properly. Limits should never be set so that it is engaged under boost or full throttle conditions nor at idle rpm or high rpm. We recommend using closed loop only under cruising conditions at light to medium load conditions. Whenever MAP or RPM falls outside of the 4 programmable limits the ECU will jump back into open loop, working off of the values that you have programmed. You can watch your mixture meter to tell if the ECU has switched into closed loop. When in closed loop, the meter will jump around 14.7. This is normal as the O2 sensor directs the ECU to richen or lean slightly on a continuous basis as it tries to hold mixture at the stoichiometric range.

You will notice that the mixture meter goes quite rich momentarily as you open the throttle suddenly. This is due to the accelerator pump circuit supplying increased fuel to prevent a lean out condition and is normal. The mixture should stabilize within a second or so.

Problems to Watch out for

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 system problems. Check the duty cycle first in GAUGE 2 mode at full power., if it's over 100% your injectors are too small. You should try and keep duty cycle under 85% for reliable operation. If your fuel pressure drops off under full power then there is a problem with your pump, filter, regulator etc, the engine will not run correctly no matter how you program the system.

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 value to the next. Look at our sample programs in the manual for some ideas. If you are really stuck, fax us your values, and we can usually suggest some constructive changes.

Additional Information

Digital Mixture Controller (KNOB)

The mixture controller controls the overall mixture across all ranges. In effect, it adds or subtracts a percentage to the injector pulse width. From 0%, the mixture can be leaned roughly 50% with the lean button or richened 50% with the rich button.

The mixture controller is very useful in determining a rich or lean condition. It is important to return the controller to 0% once programming is complete. Gauge 2 mode shows the position of the controller in % either - (lean) or + (rich). The controller may be disconnected if desired, this will leave the setting at 0% so it is important to complete proper programming with the controller at 0% if it is to be disconnected.

Disconnecting the LCD Programmer

Be sure you 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.

ECU Reset

Any time that the power is shut off or interrupted to the ECU or if interference prevents the software from running properly, the ECU 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.

Shutting off Power and Memory

Switching off power the ECU causes no ill effect for the system or ECU memory. As soon as you change a value with the programmer, it is permanently changed and stored in memory even with power off.

MAP Sensors and Vacuum Sources

The solid state MAP sensor requires a smooth vacuum/pressure signal to relay a proper signal to the ECU. High amplitude pressure pulsations as you would have when connecting the sensor to a single runner behind a throttle plate on an independent runner manifold would be unacceptable. The MAP sensor may function properly on an IR manifold only if all runners are tapped for a vacuum signal and run into a small common plenum leading to the sensor. In gauge mode, if the MAP reading fluctuates a lot at idle, the hose to the sensor may have to be orifice . A .025 to .035 inch MIG welder tip can be used.

Duty Cycle

Duty cycle 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. This is usually expressed in percent and can be verified in gauge 2 mode under DUTY.

RPM, MAP, Fuel Flow, Duty Cycle Concerns

Having both MAP and RPM values over 200 probably indicates that your injectors are too small or perhaps that fuel delivery to the injectors are insufficient. You can check the duty cycle in gauge 2 mode. At full throttle, the duty cycle should not exceed 85%. When duty cycle exceeds 100%, the engine will start to run lean. The injectors are too small in this case. Make certain that the fuel delivery is adequate at full throttle. The engine will not run properly if fuel flow is insufficient in any part of the system.

Injectors

There are basically 3 types of injectors with regards to the flow orifices. One is the pintle style, which most older Bosch and Siemens are, these have a small tapered spike or pintle which is pulled back when the magnet windings are energized, letting the fuel spray out. These are very reliable and quite resistant to plugging.

The second type is the GM/Rochester/MSD ball type. These have slightly better atomization but are more affected by dirt and varnish and do not have the long term reliability of the pintle style. The third type is the disc, made by various companies including Bosch and Lucas. These are popular in late model applications but also are not as reliable in the long term as the pintle style.

The second important injector characteristic is the resistance or impedance of the magnet windings. **Low impedance** injectors are characterized as peak and hold types. They will have a winding resistance from 1.7 to 3 ohms. They are opened with a current spike of 2.5 to 4 amps then held opened with a current of .75 to 2 amps. Low impedance injectors open more quickly at short pulse widths so the idle quality with large injectors may be somewhat better. **High impedance** injectors are referred to as a saturated type. Impedance is usually 10 to 16 ohms and they are opened with a sustained current of about 1 amp. Most Ford Motorsport injectors are high impedance. Low impedance injectors require our external resistor pack, high impedance injectors do not.

We specifically do not recommend MSD injectors 2011 or 2012. These injectors are electrically incompatible with our drivers. Also, injectors with a 2 amp open and .5 amp hold current cannot be used with our drivers.

All Bosch injectors are built to very high standards and are very robust. In the injector world, you get what you pay for, cheap injectors are usually poorly made, are non-linear with pulse width, won't last or have poor spray patterns. Buy Ford Racing, Bosch or Siemens and you can't go wrong.

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.

BSFC .55 lb/hr/hp — HORSEPOWER AT 100% DUTY CYCLE

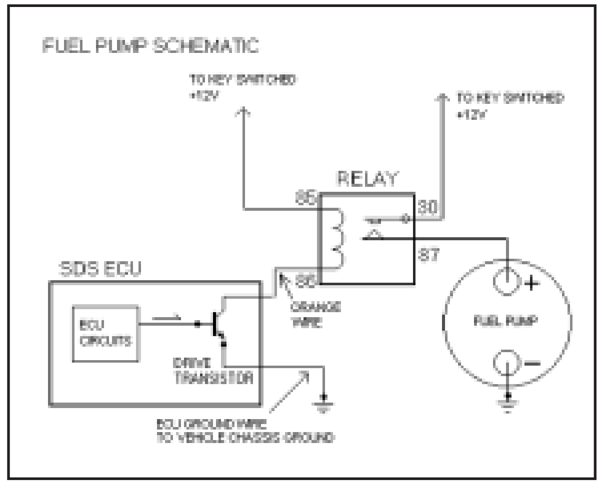
LB/HR	cc/MIN	4CYL	6CYL	8CYL	LB/HR	cc/MIN	4CYL	6CYL	8CYL
20	210	145	218	291	62	650	451	676	902
24	252	175	262	349	66	692	480	720	960
30	314	218	327	436	72	755	524	785	1047
36	377	262	393	524	78	818	567	851	1135
38	398	276	415	553	80	839	582	873	1164
42	440	305	458	611	84	881	611	916	1222
44	461	320	480	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
54	566	393	589	785	94	985	684	1025	1367
56	587	407	611	815	96	1006	698	1047	1396
58	608	422	633	844	98	1027	713	1069	1425
60	629	436	655	873	100	1048	727	1091	1455

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

Use of a fuel pressure gauge is recommended and should be monitored under full throttle acceleration. If the fuel pressure drops off the fuel pump, lines or some part of the fuel system is too small to support the horsepower level.

Fuel Pump Relay



The SDS ECU is equipped with an 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 ECU detects crank rotation. If the engine stalls the ECU will shut off the relay in 2.8 seconds.

The WMS / SDS plug in system for Mustangs uses the factory fuel pump relay and all necessary wiring is completed when the system is plugged in. If you are using an SDS system complete with harness or wiring your own relay the wiring is as follows:

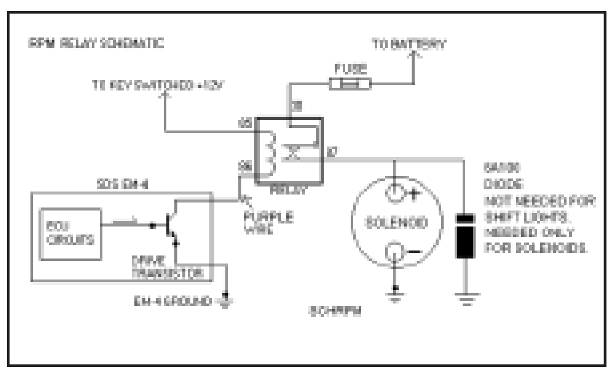
pin 30 to ignition switched 12 volts, be sure wire and power source will support the pump.
pin 85 to ignition switched 12 volts,
pin 87 to the fuel pump positive terminal,
pin 86 to orange wire on the main SDS harness.

The orange wire to the SDS computer **grounds** the fuel pump wire to energize the pump.

RPM Switch Wiring

The RPM Switch can be used to turn on an electrical device at a programmed rpm. The SDS computer does this by **grounding** the purple wire, similar to most OEM devices. A relay must be used on most devices as the current draw would damage the SDS computer, wire the relay as follows.

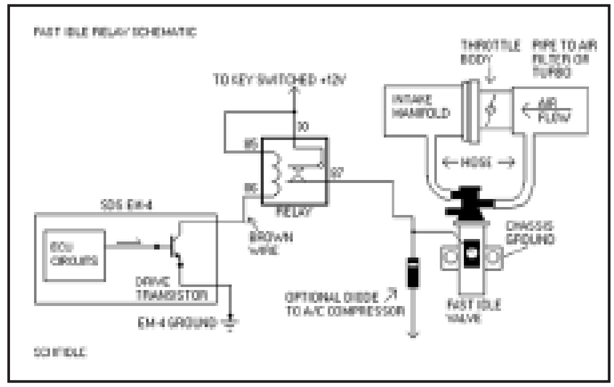
pin 30 to ignition switched 12 volts,
pin 85 to ignition switched 12 volts,
pin 87 to the device positive terminal,
pin 86 to purple wire on the main SDS harness



Autometer Quick Lite shift lites can be used by simply providing +12V to one side of the light and wiring the purple trigger wire to the other side. The LED light has a very low draw and is on of the few devices that can be wired without a relay.

Fast Idle Option

We offer a fast idle option for custom intakes that consists of a solenoid valve which connects to the intake manifold via 5/16 vacuum hose and a relay controlled by the SDS via the engine temperature sensor. The solenoid can be remotely mounted and is much easier than the Ford IAC to install on custom intakes.



Relay connections are as follows:

> pin 30 to ignition switched 12 volts,
> pin 85 to ignition switched 12 volts,
> pin 87 to the IAC solenoid terminal,
> pin 86 to brown wire on the main SDS harness.

The solenoid mounting flange must be grounded.

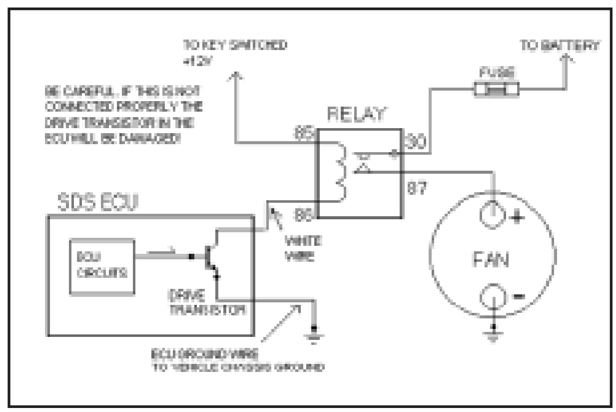
If the fast idle rpm is higher than desired, a restrictor can be placed in the port hose to cut down the air volume bypassed. The MAP sensor automatically compensates for the extra air being admitted by the solenoid valve.

Fast Idle with A/C

If you already have a fast idle solenoid installed (stock Ford or SDS) you can install a diode connected between the fast idle valve and the a/c clutch (+) connection. The diode allows current to flow from the a/c clutch over to the valve to open the valve when the a/c is running. If the fast idle circuit is turned on, the diode will block any current from the fast idle circuit from going to the a/c clutch. See the fast idle diagram above for wiring.

Electric Fan control

The SDS can control an electric fan through the water temperature sensor and is much more accurate than other add-on fan controllers. Wiring is show in the diagram to the right. Fuse rating will depend on the current draw of the fan(s). 15 - 20 Amp should work for most applications.



For 96+ Mustang applications the stock fan is controlled through the stock wiring.

Turbo Anti-lag Programming

For racing applications only, the SDS system may be programmed to reduce turbo lag by retarding the ignition timing and increasing the fuel supplied under high manifold vacuum conditions. The fuel is forced to burn in the exhaust system which keeps the turbine spooled up to some degree during closed throttle conditions. This function should be used only on race applications and only on cars equipped with very strong straight through, stainless steel mufflers or no mufflers as extreme temperatures and pressures may result. Turbocharger and exhaust system life may be seriously reduced as well.

Programming is accomplished by entering a MAP fuel value of 20-40 under the lowest MAP range available and entering an IGN RET/MANPRESS value of 20-30 in the lowest range available.

Diagnosing Sensor Problems

The three GAUGE modes permit monitoring of the primary sensor inputs to the ECU in real-time. Rpm should be stable, agreeing with the factory tach. Spurious rpm readings usually indicate ignition or triggering interference. Manifold pressure should increase as the throttle is opened at a given rpm.

Engine and air temps should roughly agree with the ambient temperature if the engine has been shut down overnight. The SDS will detect and display temperature sensor failures. If Gauge1 mode displays ET ERR or AT ERR, this indicates that the wiring or sensor has had an open circuit condition. Even if a sensor is momentarily disconnected from the SDS, the gauge display show ERR. The ERR message can be cleared by pressing the +10 button only when in Gauge1 mode or by turning off the power. GAUGE 2 mode allows you to monitor the mixture knob position. It should read 0 at the 12 o'clock position. You should be able to get the reading to change from -49% to +49% by turning fully to both stops.

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. The TP number, usually 10-20, should remain constant with the throttle closed and increase as the throttle is opened, then decrease as the throttle is closed.

Ignition Wires, and Interference Problems

Always use radio suppression type spark plug wires, NEVER use solid core wires. We recommend Ford Racing, MSD wires. Try to mount the ECU as far from the ignition system as possible. Ignition interference problems usually show up as gibberish or strange symbology in the programmer screen. It is also not a good idea to route any of the SDS wiring near the ignition system.

Trouble Shooting

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

Will not start

1. Check FUELCUT / RPM, should read NO LIMIT or RPM higher than normal operating range.
2. Check FUELCUT / MANPRESS, should read NO LIMIT
3. Check FUELCUT / TP, should read NO LIMIT
4. Try turning mixture knob while cranking. RPM fuel and START values might have to be changed.
5. Check all connections on ECU, driver box, coil, power and grounds.
6. Check fuel pump output, check that the pump cycles when ignition is turned on and fuel pressure is at rails.
7. Check for spark and be sure ignition box is wired correctly.
8. Check the MAGNET SEEN / NOT SEEN function in the programmer, this should flash SEEN / NOT SEEN intermittently when cranking the engine
9. Check injectors for clicking
10. Check +12v supply to all injectors when key is on.
11. Check configuration of MSD DIS4 box and see if indicator light is on.

Testing the Ignition Box and Coil

To check the ignition box (MSD, Crane) make sure that you have +12 volts on both red wires and a good ground. Disconnect a plug wire and place the end within 1/4 inch of ground, disconnect the trigger wire for that cylinder and momentarily touch the wire to ground. Spark should jump from the coil wire to ground.

Cuts Out at High Power
1. Check for timing advance at the balancer, if there is no advance the ignition box is wired incorrectly.
2. Fuel pump not adequate, check fuel pressure at fuel rail under load.
3. Injector flow rate too low, check duty cycle of injectors under Gauge 2.
4. Fuel lines or filter plugged or too small.
5. There is an improper value in the program, check against your base program provided.
6. Fuel pressure too high, injectors won't open.
7. RPM or MAP limiter is set too low.
8. Check spark plug gap on turbo / supercharged engines, should be .030 to .035.
9. Fuel tank is not vented, remove filler cap and check for suction.

Not Running on all Cylinders
1. Check each injector for clicking sound.
2. Check plug wires & plugs, could be one channel in the MSD box.
3. Cannot be a computer problem if only one cylinder is dead.

Runs but lacks power
1. Check for leaking fuel pressure regulator diaphragm.
2. Check ACCPUMP high value, should be 20-40, Check ACCPUMP low value, should be 20-40
3. Mixture is too rich or lean, use mixture controller to richen mixture until too rich and then lower the values until engine is smooth.
4. Check base timing and magnet position, may have not been set correctly.
5. Check for timing advance at the balancer, if there is no advance the ignition box is wired incorrectly.

Idle speed too high
1. Fast idle solenoid is stuck open, Ford IAC was not unplugged during install and no relay was installed.
2. Check adjustment of stop screw on stock throttle plate
3. Check for vacuum leak.

Idle speed too low
1. Check adjustment of stop screw on stock throttle plate, may need to open the throttle plate more.
2. Check base timing and magnet position, may have not been set correctly.
3. Mixture is too rich or lean, use mixture controller to richen mixture until too rich and then lower the values until engine is smooth.

Rough Idle
1. Bad ignition wire or spark plug.
2. Mixture is too rich or lean, use mixture controller to richen mixture until too rich and then lower the values until engine is smooth.
3. Bad connection or vacuum hose to the MAP sensor or connected to wrong port on the intake.

Will not rev up or has miss
1. Check ACCPUMP values, may be too high.
2. Check for bad values in program, check against your base program provided.
3. Check for timing advance at the balancer, if there is no advance the ignition box is wired incorrectly.
4. Check fuel cut limits.
5. Check Magnet Position and rotor alignment
6. Check resistance of sparkplug wires, try different brand of wires.

Engine fills up with fuel
1. Bad ECU ground wire connection
2. Check for leaking fuel pressure regulator diaphragm.

Won't run over 2000 rpm
1. Check fuel cut TP limit
2. Check ACCPUMP high value, should be 20-40

Cuts out Under Lateral G
1. Fuel pickup problem in tank.
2. Air is entering the EFI fuel pump resulting in low fuel pressure.

SDS EFI in Window
1. Power has been interrupted or ECU has reset.
2. ECU has reset due to ignition interference. Move sensor wires away from ignition components, change ignition wires, check for loose ignition leads. Move ECU further away from engine.
3. TPS connections are wrong, try unplugging the TPS
4. Check any solenoid grounds, disable any external solenoids, relays etc. Ground these at a different location than the SDS grounds

Strange Symbology or black bars in the LCD Programmer.
1. Programmer data being interfered with. Check connections and cord for damage. Could be caused by ignition interference from poor plug wires.
2. Check ignition rotor phasing and plugs for excessive gap.
3. Check for bad ignition wires, or wires that have bad RFI interference.
4. Programmer was plugged in after the computer was powered up.

Warranty and Returns

The WMS / SDS Engine Management System is sold for off road and racing use only. New car warranties and emission standards are voided by installation of this system. Since Western Motorsports Inc or 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 WMS / SDS products the user understands and accepts this.

All WMS / 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. WMS 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.

Defective components will be repaired or replaced as soon as possible at the discretion of WMS. Prior authorization from WMS is required before any warranty or returned item is accepted, please give us a call for a return autorization number. All returns shall be shipped ONLY by Air Mail, FEDEX AIR. No returns are accepted after 30 days and all returned goods are subject to a 20% restocking fee as well as a charge for any damaged components, cut wires or missing items.

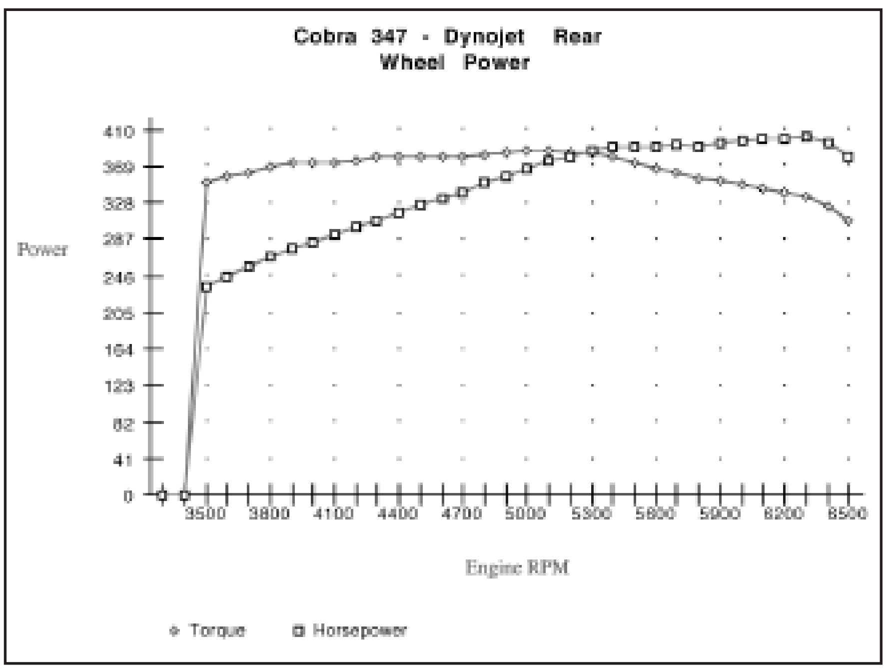
Items shipped to us for warranty checks or testing which are working properly will be subject to a $60 CDN charge plus shipping.

SDS Program - 347 Stroker in WMS Cobra replica

Srt °F	Fuel	Wtr°F	Fuel	MP	Fuel	MP	Fuel	RPM	Fuel	RPM	Ign
-31	150	-31	100	0.8	119	14.2	53	500	100	500	11
-9	140	-9	85	0.33	115	14.7	51	750	110	750	11
14	130	14	70	-0.14	113	15.2	49	1000	120	1000	13
19	120	19	65	-0.61	111	15.6	47	1250	135	1250	17
32	110	32	60	-1.08	109	16.1	45	1500	150	1500	21
43	100	43	55	-1.55	107	16.6	43	1750	160	1750	24
46	90	46	50	-2.02	105	17.1	41	2000	170	2000	26
50	80	50	45	-2.49	103	17.5	39	2250	180	2250	28
54	70	54	40	-2.95	101	18	37	2500	190	2500	30
55	60	55	35	-3.42	99	18.5	35	2750	195	2750	32
59	50	59	33	-3.9	97	18.9	33	3000	200	3000	33
63	40	63	30	-4.37	95	19.4	31	3250	205	3250	33
68	25	68	27	-4.83	93	19.9	30	3500	210	3500	33
75	15	75	24	-5.31	91	20.3	29	3750	210	3750	33
79	12	79	21	-5.78	89	20.8	28	4000	210	4000	33
84	10	84	19	-6.25	87	21.3	27	4250	210	4250	33
88	8	88	17	-6.72	85	21.8	26	4500	210	4500	33
91	6	91	10	-7.19	83	22.2	25	4750	210	4750	33
95	4	95	5	-7.66	81	22.7	23	5000	210	5000	33
99	2	99	0	-8.13	79	23.2	22	5250	210	5250	33
104	0	104	0	-8.6	77	23.6	20	5500	210	5500	33
113	0	113	0	-9.07	75	24.1	18	5750	210	5750	33
118	0	118	0	-9.54	73	24.6	16	6000	210	6000	33
129	0	129	0	-10	71	25	14	6250	210	6250	33
133	0	133	0	-10.5	69	25.5	12	6500	210	6500	33
138	0	138	0	-10.9	67	26	10	6750	210	6750	33
145	0	145	0	-11.4	65	26.5	8	7000	1	7000	33
153	0	153	0	-11.9	63	27	1	7250	1	7250	33
163	0	163	0	-12.4	61	27.4	1	7500	1	7500	33
176	5	176	0	-12.8	59	27.9	1	7750	1	7750	33
189	7	189	0	-13.3	57	28.3	1	8000	1	8000	33
212	9	212	0	-13.8	55	28.8	1	8250	1	8250	33

Engine Combination

347 Stroker
11:1 Compression
Edelbrock Heads
Stage 3 Porting with High Port Exhaust
Ford Racing X303 Cam
WMS / Victor Jr EFI Intake
75mm Throttle body
30lb Ford Racing Injectors
45lbs Fuel pressure
Custom 1 5/8" to 1 3/4" Hedders to
2" 4 into 1 Sidepipes

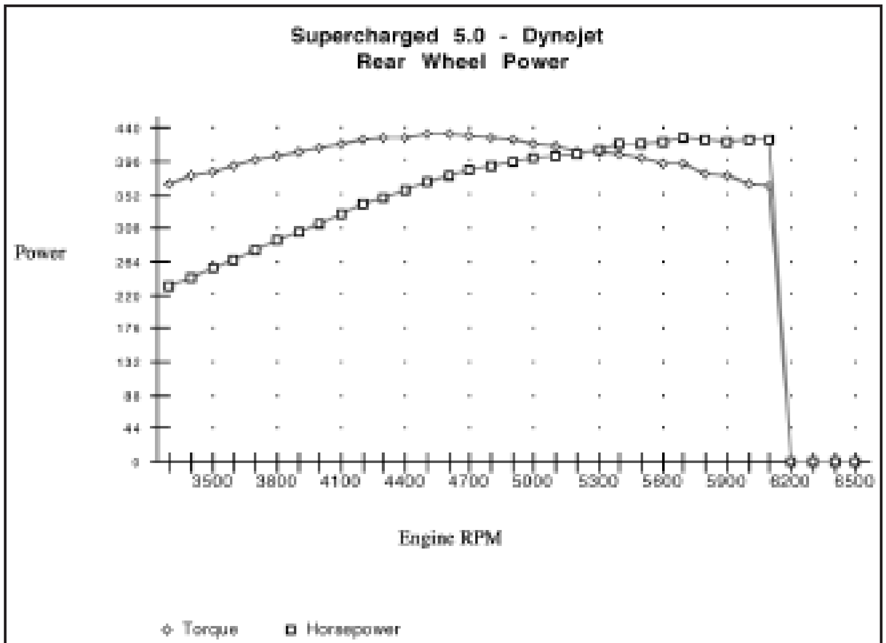


SDS Program - 5.0 Supercharged 92 Mustang

Srt °F	Fuel	Wtr°F	Fuel	MP	Fuel	MP	Fuel	RPM	Fuel	RPM	Ign	MP	Ret	MP	Ret
-31	130	-31	120	15	214	1.04	95	500	95	500	12	15	12	1.04	1
-9	120	-9	110	14.6	210	0.61	92	750	96	750	14	14.6	12	0.61	0
14	110	14	100	14.1	206	-0.6	88	1000	97	1000	16	14.1	12	-0.6	0
19	100	19	95	13.7	202	-1.5	84	1250	105	1250	19	13.7	12	-1.5	0
32	90	32	90	13.2	198	-2.4	80	1500	115	1500	23	13.2	12	-2.4	0
43	80	43	85	12.8	194	-3.3	76	1750	125	1750	27	12.8	12	-3.3	0
46	70	46	80	12.4	190	-4.2	73	2000	135	2000	31	12.4	12	-4.2	0
50	60	50	75	11.9	186	-5.1	69	2250	145	2250	32	11.9	12	-5.1	0
54	50	54	70	11.5	182	-6	65	2500	150	2500	33	11.5	12	-6	0
55	40	55	65	11	178	-6.9	61	2750	155	2750	34	11	12	-6.9	0
59	35	59	60	10.6	174	-7.8	59	3000	160	3000	33	10.6	11	-7.8	0
63	30	63	55	10.2	171	-8.7	56	3250	160	3250	32	10.2	11	-8.7	0
68	25	68	50	9.73	168	-9.6	52	3500	160	3500	31	9.73	10	-9.6	0
75	15	75	45	9.29	165	-10.5	48	3750	160	3750	31	9.29	10	-10.5	0
79	12	79	40	8.86	162	-11.4	45	4000	160	4000	31	8.86	10	-11.4	0
84	10	84	35	8.42	159	-12.3	42	4250	160	4250	31	8.42	10	-12.3	0
88	8	88	30	7.98	156	-13.2	39	4500	160	4500	31	7.98	10	-13.2	0
91	6	91	25	7.54	153	-14.1	36	4750	160	4750	31	7.54	10	-14.1	0
95	4	95	20	7.1	150	-15	33	5000	160	5000	31	7.1	10	-15	0
99	2	99	17	6.66	147	-15.9	29	5250	160	5250	31	6.66	10	-15.9	0
104	0	104	14	6.22	144	-16.8	27	5500	158	5500	31	6.22	9	-16.8	0
113	0	113	11	5.78	140	-17.7	25	5750	156	5750	31	5.78	9	-17.7	0
118	0	118	8	5.34	136	-18.6	23	6000	154	6000	31	5.34	8	-18.6	0
129	0	129	6	4.91	132	-19.5	20	6250	152	6250	31	4.91	8	-19.5	0
133	0	133	4	4.48	128	-20.4	17	6500	150	6500	31	4.48	7	-20.4	0
138	0	138	2	4.05	124	-21.3	15	6750	1	6750	31	4.05	7	-21.3	0
145	0	145	0	3.62	120	-22.2	13	7000	1	7000	31	3.62	6	-22.2	0
153	0	153	0	3.19	115	-23.1	11	7250	1	7250	31	3.19	6	-23.1	0
163	0	163	0	2.76	110	-24	10	7500	1	7500	31	2.76	5	-24	0
176	5	176	0	2.33	105	-24.9	7	7750	1	7750	31	2.33	4	-24.9	0
189	7	189	0	1.9	100	-25.8	4	8000	1	8000	31	1.9	3	-25.8	0
212	9	212	0	1.47	97	-26.7	1	8250	1	8250	31	1.47	2	-26.7	0

Engine Combination

Stock 92 5.0
Stock 8.8:1 Compression
Mild Street Porting
Stock Cam w/ 1.7 Rockers
Ford Racing Cobra Intake
65mm Throttle body
36lb Ford Racing Injectors
255lph intank pump
45lbs Fuel pressure
MAC Long Tube hedders and
MAC Prochamber
WMS / Procharger P1SC
Non-intercooled
11 lbs boost

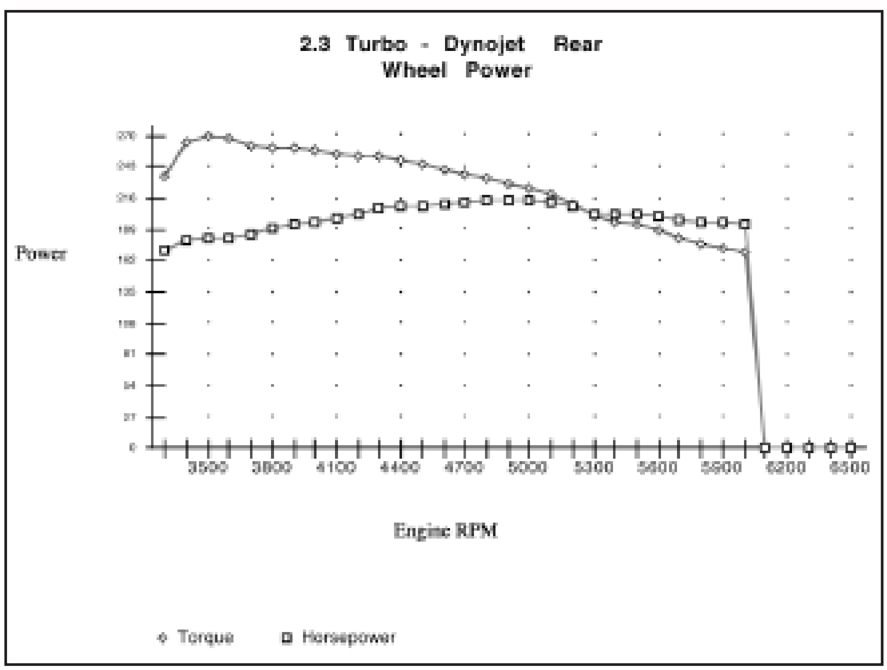


SDS Program - 2.3 Turbo 86 Mustang SVO

Srt °F	Fuel	Wtr°F	Fuel	MP	Fuel	MP	Fuel	RPM	Fuel	RPM	Ign	MP	Ret	MP	Ret
-31	80	-31	120	30	250	7.65	130	500	120	500	10	30	15	9.05	5
-9	70	-9	110	29	246	6.95	126	750	125	750	12	29	15	8.35	5
14	60	14	100	28.6	243	6.25	122	1000	125	1000	14	28.6	15	7.65	4
19	50	19	95	27.9	240	5.56	118	1250	125	1250	16	27.9	15	6.95	4
32	40	32	90	27.2	237	4.86	114	1500	129	1500	18	27.2	15	6.25	4
43	30	43	85	26.5	234	4.16	109	1750	130	1750	20	26.5	14	5.56	4
46	25	46	80	25.8	231	3.46	104	2000	133	2000	22	25.8	14	4.86	3
50	20	50	75	25.1	228	2.76	99	2250	136	2250	24	25.1	14	4.16	3
54	18	54	70	24.4	225	2.06	94	2500	140	2500	27	24.4	13	3.46	3
55	15	55	65	23.7	222	1.37	89	2750	145	2750	30	23.7	13	2.76	2
59	13	59	60	23	218	0.67	84	3000	150	3000	32	23	13	2.06	2
63	12	63	55	22.3	214	-0.06	79	3250	150	3250	32	22.3	13	1.37	1
68	11	68	50	21.6	210	-1.49	74	3500	150	3500	32	21.6	12	0.67	1
75	10	75	45	20.9	206	-2.91	69	3750	150	3750	32	20.9	12	-0.06	0
79	9	79	40	20.2	202	-4.33	64	4000	150	4000	32	20.2	12	-1.49	0
84	8	84	35	19.5	198	-5.75	59	4250	150	4250	32	19.5	11	-2.91	0
88	7	88	30	18.8	194	-7.17	54	4500	150	4500	32	18.8	11	-4.33	0
91	6	91	25	18.1	190	-8.6	50	4750	150	4750	32	18.1	11	-5.75	0
95	5	95	20	17.4	186	-10	46	5000	150	5000	32	17.4	10	-7.17	0
99	4	99	17	16.7	182	-11.4	42	5250	150	5250	32	16.7	10	-8.6	0
104	3	104	14	16	178	-12.9	37	5500	150	5500	32	16	10	-10	0
113	2	113	11	15.3	174	-14.8	34	5750	150	5750	32	15.3	9	-11.4	0
118	1	118	8	14.6	170	-15.7	31	6000	150	6000	32	14.6	9	-12.9	0
129	0	129	6	13.9	166	-17.1	28	6250	150	6250	32	13.9	2	-14.8	0
133	0	133	4	13.2	162	-18.6	25	6500	150	6500	32	13.2	2	-15.7	0
138	0	138	2	12.5	148	-19.9	21	6750	150	6750	32	12.5	7	-17.1	0
145	0	145	0	11.8	154	-21.4	1	7000	150	7000	32	11.8	7	-18.6	0
153	0	153	0	11.1	150	-22.8	1	7250	1	7250	32	11.1	6	-19.9	0
163	0	163	0	10.4	146	-24.2	1	7500	1	7500	32	10.4	6	-21.4	0
176	5	176	0	9.75	142	-25.7	1	7750	1	7750	32	11.1	6	-22.8	0
189	7	189	0	9.05	138			8000	1	8000	32	10.4	6	-24.2	0
212	9	212	0	8.35	134			8250	1	8250	32	9.75	5	-25.7	0

Engine Combination

Stock 86 SVO
8.0:1 Compression
Stock Heads
Stock Cam
Stock Intake
Stock Throttle body
Stock 36lb Injectors
255lph intank pump
40 to 60lbs Fuel pressure
Stock Exhaust
Stock Turbo
13lbs boost
Stock Intercooler
3.5" Inlet with K&N Filter



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Technical Assistance

When calling for technical assistance we need to know if your system is an EM-3 o rEM-4 as well as the application. You can call or e-mail us for technical assistance, tech is open Monday to Friday 9:00am to 5:00. All e-mail questions are answered within 24 hours.

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