Fuel an Engine in Boost with a 2-bar Map Sensor in Place of a 1-bar

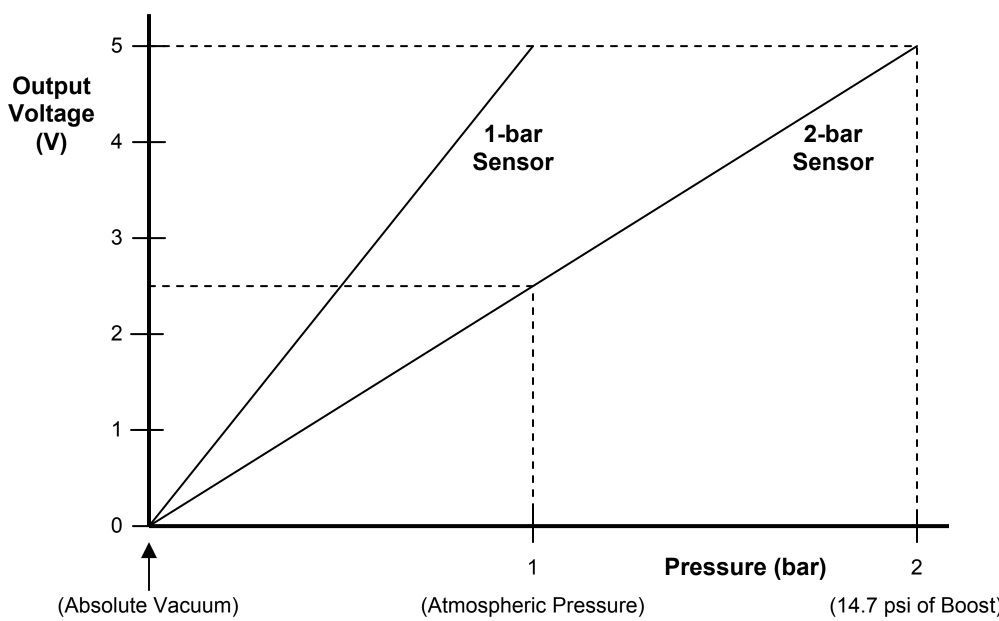
It is possible to replace an existing 1-bar map sensor with a 2-bar sensor and control an engine in boost. This approach is generally used with larger injectors and a means of calibrating the map sensor signal. There are a host of issues to be aware of when taking this approach. This application note covers the basics of applying piggyback calibration techniques and how to address the relevant issues.

Modern engine management systems generally measure load with either a flow sensor or pressure sensor. The pressure sensor based systems use a map sensor. Map stands for manifold absolute pressure. These sensors measure manifold pressure with respect to an absolute vacuum. This type of pressure measurement has advantages in engine management with regard to changes in ambient pressure. Most Chrysler and Honda models are map sensor based as well as specific vehicles from a wide range of other manufacturers.

Map based engine management systems are often referred to as speed density systems. This is because the load on the engine is calculated based on a combination of speed (RPM) and density (map). These parameters are combined with other factors to calculate the air entering the engine which directly corresponds to load. The calculated load is used to set the fuel and timing of the engine.

Map Sensor Comparison

The readings from a 1-bar and a 2-bar map sensor are compared in the following graph.



Pressure appears on the x-axis and output voltage is shown on the y-axis. Both sensors produce a 0-5 V output. The 1-bar sensor reaches its full scale reading of 5 V at 1 bar of pressure. At 1 bar, the 2-bar sensor is at 1/2 of full scale and produces a 2.5 V output. With the 2-bar map sensor, 1 bar of boost, or 14.7 psi is required to reach the full scale output of 5V.

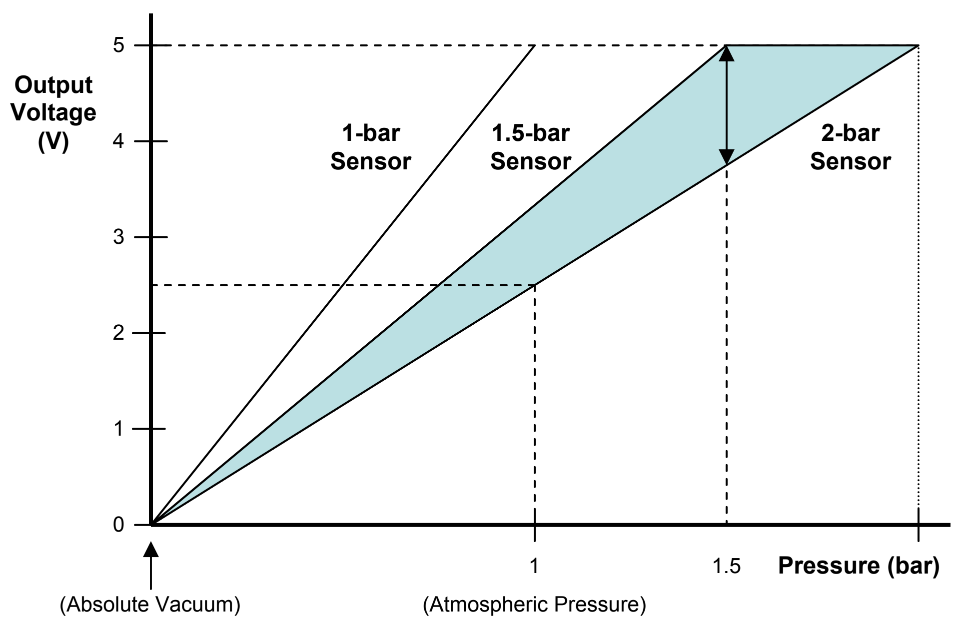
A naturally aspirated engine uses the vacuum generated by the intake cycle to draw in the intake charge. The manifold pressure depends on the throttle position. When the throttle is closed the engine pulls a strong vacuum against the throttle resulting in a low manifold pressure. At idle this pressure is around 1/3 of atmospheric pressure. Since the output voltage of the map sensor is linear with pressure, with a nominal full scale output of 5 V, the output voltage at idle will be approximately 5/3 = 1.67 V.

In practice, the full scale output of a map sensor is usually a bit less than 5 V. There is a variation among sensor manufacturers and part numbers, but a typical full scale voltage is around 4.6 V. During normal operation the map sensor reading will vary between about 1.5 V and 4.5 V. High vacuum can be generated on deceleration resulting in output voltages less than 1 V.

Match the Pressure Range of the Engine

When a naturally aspirated engine is converted to forced induction through the addition of a turbo or supercharger, the manifold pressure range is expanded to include the boost region as well as the vacuum region. In order to cover the higher pressure range, a map sensor must be used that covers that range. In the example below, the engine is capable of running 1.5 bar of pressure which corresponds to just over 7 psi of boost.

In this example we are going to use a 2-bar map sensor in place of the original stock 1-bar sensor. The 2-bar map sensor easily covers the new pressure range of the engine, but is not precisely matched to the pressure range of the engine. Ideally what we would like would be a 1.5-bar map sensor. With an appropriate calibrator, we can shift the reading of the 2-bar map sensor to precisely match the response of a 1.5-bar sensor.



Note the shaded area between the 2-bar sensor line and the 1.5-bar line. This represents the amount that the 2-bar line must be shifted to generate a 1.5-bar signal. Going from zero pressure to 1.5 bar, a steadily increasing value must be added to 2-bar sensor reading. The vertical line with two arrow heads shows the amount that is added at 1.5 bar of pressure. This represents the maximum amount we need to add. Since pressure and the output voltage of these sensors is linearly related, we can calculate the exact amount we need to add to the signal. To simplify the calculation we will assume a full scale voltage of 5V. At 1.5 bar the 2-bar sensor outputs (1.5/2)*5 V = 3.75 V. Since we want a full scale output of 5 V, the amount we need to add is 5 – 3.75 = 1.25 V.

Note that above 1.5 bar, the height of the shaded region decreases. This indicates that in order to maintain a full scale reading, we add a decreasing offset to the 2-bar map sensor reading as pressure increases. This has practical importance because in map sensor based engine management systems, it is easy to hit fuel cut or generate a fault in the ECU if you exceed the nominal full scale reading. That is why we map a decreasing offset to the 2-bar sensor reading above the nominal full scale pressure.

Pick an Appropriate Injector Size

The whole idea of piggyback calibration is to make maximum use of the existing stock ECU. The range of sensor readings and the fuel injectors must be changed to match the new horsepower of the engine. We have seen how to adjust the map sensor reading. We also have to adjust the size (flow rate) of the injectors.

A simple way to estimate the correct injector size is to use the ratio of the new pressure range to the old one. In the example of an engine that runs to 1.5 bar (just over 7 psi of boost), the ratio is 1.5/1 = 1.5. That means we need injectors that are 1.5 times the size of the original. That would be a 50% increase over stock. For example you would want to replace stock 20 lb/hr injectors with 30 lb/hr injectors.

As a practical matter the limit of increase in injector size that you can get away with when doing piggyback calibration is around 100%. When you double the size of the injectors you get to the point where it is difficult to take away that much extra fuel at light load. If the injectors are too big it is difficult to correctly tune the engine at idle and cruise conditions. In extreme cases where injectors are too big, it is possible to flood the engine before it even starts.

Barometric Compensation

Because an absolute pressure sensor measures pressure with respect to an absolute vacuum, it is sensitive to changes in ambient pressure that result from barometric pressure variations and elevation change. The map sensor readings in response to these pressure changes are used by the stock ECU to correctly fuel the engine. For example, as you go up in elevation, the air becomes less dense and the ambient pressure reading goes down. Since the air is less dense, less fuel is required in order to maintain an optimum fuel mixture. The lower reading from the map sensor is interpreted as a lower load on the engine and as a result, the ECU injects less fuel to compensate.

Since barometric pressure is so essential to adjusting the fuel mixture with a map sensor based ECU, these computers measure barometric pressure just before the engine is started, just after it is turned off or both. These measurements are used to as a baseline to set the tune for current weather and elevation conditions. With the ignition-on and engine-off, the map sensor can be used to measure the baseline pressure. This way, the same sensor that controls the engine while it is running is used for the barometric measurement when the engine is off.

It is essential that the map sensor and calibrator be powered-up and running during the period of time that the ECU is measuring barometric pressure. Some ECUs do such housekeeping and self test routines for up to 15 minutes after the engine is shut off. You can monitor the 5 V supply to the stock map sensor to analyze when the calibrator must be powered up. A lack of power during these times will often lead to a check engine light with a fault for a low reading from the map sensor.

It is essential to insure that the ECU gets a valid barometric pressure reading. When replacing a 1-bar sensor with a 2-bar sensor we have already seen that at atmospheric pressure the 2-bar sensor outputs approximately 2.5 V while the 1-bar sensor output nearly 5 V. This makes it necessary to add a large offset to the map sensor voltage during the barometric reading. The exact amount can be determined by measuring the output of the stock sensor with ignition-on and engine-off. You must add an offset during the barometric reading that brings the reading of the new map sensor up to the same reading as the stock sensor.

Watch Out for Too Much Ignition Timing Advance

We have reviewed how you can fuel an engine in boost using larger injectors and a properly calibrated map sensor. This works because we can indicate to the ECU a lighter load on the engine than actual. This allows us to run larger injectors and still obtain the correct fuel mixture at light load. An unintended consequence of doing this is that the ECU will respond to the lower load signal by advancing the ignition timing. This can result in too much advance and potentially damaging pinging if the ignition timing is not retarded.

Most piggyback solutions for tuning engines with forced induction involve timing retard as well as fuel control. This is primarily done to reduce the timing advance in boost. It also comes in handy to lower the timing in the upper end of the vacuum region where even though the engine is not in boost there may be too much timing advance. If the compression of the engine has been lowered, it may not be necessary to retard the timing.

A Real World Example

In this example we will us an FTC1-019B to tune an 8-cylinder Dodge engine in boost. The FTC1-019B can be used to tune virtually any late model Chrysler engine for boost up to 16 psi. The FTC1-019B has an internal 2-bar map sensor that is used in place of the existing stock 1-bar sensor to calibrate the fuel. It intercepts the Hall Effect crank and cam sensors to adjust the timing. The rpm is measured by tapping onto one of the injector drive signals.

Installation involves identifying specific wires according to wire color and ECU pin location. In many cases step-by-step installation instructions are available. We recommend soldering the wire connections and covering with heat shrink. Soldering is good because you can inspect the quality of the connection before you cover it with heat shrink.

If vehicle specific instructions are not available we recommend that you obtain an ECU wiring diagram to find the correct wires to connect to. One thing to watch out for is the source of power for the unit. You should start by measuring the 5V wire going to the stock map sensor. See if it stays at 5V after the engine is shut off. If so, you will have to run the FTC1-019B directly from the battery, find a power source that is on when the 5 V is on, or make up a relay circuit that powers the unit whenever the 5V wire is active.

The accuracy of the map sensor reading is critical to maintaining the correct fuel mixture. That is why we recommend using the sensor ground as the ground point for the FTC1-019B. The sensor ground is the ground that is used on the stock map sensor. The sensor ground will provide a more stable voltage reference than a chassis ground connection. After the power, ground, and tach connections are made, complete the necessary connections to the map, crank and cam sensors. Be sure to locate the FTC1-019B in a cool, dry location. Pay special attention to the routing of the vacuum line. Use a semi-rigid nylon line so it can't be pinched or kinked.

Begin by installing the R4 software on your computer. Once the program is installed, launch the program and wait for the main screen to appear. Once the unit is installed we can set up a file in the R4 software with a base map that we can use to tune the engine. The base map is going to have the correct settings to match the hardware that we are using and initial maps for fuel and timing that work as a starting point.

From the main screen, click on File and New Customer. A dialog box will appear where you can type in the name of the file. You can use any name you want. We often use base map or tune 1 or something that indicates that this is a starting point. Type in the name of the file and click save. Click on File and Open Customer, select the file you just created and click Open.

The first time you open a file in the R4 program you have to set the System Settings. To access them, click on Options and System Settings. In the dialog box that appears select Vacuum/Pressure and Programmable Signal Calibrator. These are the correct settings for the FTC1-019B. Once those options are selected, you can close that window. Next, click on Options and Engine Settings. Select 1-cylinder and 4-stroke. These are the correct settings because we are getting the engine speed information from the coil drive for one cylinder. In a true sequential ignition there will be one pulse per engine cycle.

We are now ready to set up the map tables. In order to do that you need to start with the barometric reading from the stock map sensor. You can obtain that reading from a volt meter set to DC volts connected to the stock map sensor signal wire. The other way to do it is with an OBDII scan tool. If you do it the scan tool way, you will have to have the stock map sensor connected (and the FTC1 map sensor disconnected).

When you have a file open in the R4 program and you have established data communications with the FTC1 you will see a blue highlight box showing the active cell on the map table. If you are at sea level, the active cell will be at 0 Hg or 0.5 psi. If you are at higher elevation, the active cell may be at a lower pressure column to the left. You can successfully do the barometric compensation at an elevation above sea level and extrapolate to 0 psi. For simplicity we are going to assume that you are located at sea level in this example.

Let's say you get a voltage measurement of 4.6 V on the map sensor signal wire with ignition-on and engine-off. We can calculate the cell value for barometric compensation from that reading. The FTC1-019B 2-bar map sensor will output 2.5 V at atmospheric pressure. The amount we need to offset the reading is 4.6 – 2.5 = 2.1 V.

The formula for output offset vs. cell value is:

$$Vos = (CV - 10)/4$$

This formula shows that 10 is the neutral cell value since if CV = 10, Vos = 0.
Solving for CV we get:

$$CV = 4Vos + 10$$

Plugging in the calculated offset of 2.1 V, we get a cell value of 18.4. Knowing that and the boost that the engine makes we can fill in the entire base map for the fuel table. For this example we will assume that the engine makes 5 psi of boost.

When the engine is off, the R4 system defaults to the 500 RPM row. Any RPM between zero and 600 will put the active cell in the 500 RPM row. Since the idle is greater than 600 RPM, once the engine is started, the active cell will jump to the 1000 RPM row. This allows us to use the 500 RPM row for our barometric values and the 1000 RPM rows and higher for our run map. We will create the base map with the same cell values in a given column from the 1000 to the 8000 RPM row.

To begin filling in the fuel map start by clicking on maps and fuel maps. Position the map so you see the cell at 500 RPM and 0 Hg. Click on that cell to select it. Type in 18.4 and hit enter. Select the cell at 500 RPM and 0.5 Psi and type 18.4 into that cell as well. This will insure that at sea level you will be reading the desired 18.4 value.

Fill in the rest of the 500 RPM row in a way that the cell values modify the 2-bar map sensor to read like the stock sensor. Begin by completely filling in the columns at each end of the table. The values we use for these end columns are always the same.

Use 10.4 as the starting cell values for all rows at the minimum pressure on the table which is -28.5 Hg. The value of 10.4 is used because the map table does not go all the way to -30 Hg which equates to zero absolute pressure. If it did, we would use the neutral cell value of 10. The cell value of 10.4 at -28.5 Hg is a good end point to use for auto-filling the map table.

At the far right hand side of the map table we reach the maximum pressure which is 16 psi. We fill in all the cells in the 16 psi column with a suitable value for auto-filling the table. At 16 psi, the 2-bar map sensor outputs approximately 5.25 V. We use a cell value of 8.0 which subtracts 0.5 V from the sensor reading. This gives us a net reading of 4.75 V which is a good estimate of the full scale reading of a 1-bar sensor.

Once the end columns are filled in, we can auto fill the 500 RPM row. Use click-and-drag to highlight the cells from -28.5 Hg to 0 Hg. With those cells highlighted, click the autofill icon. Next, use click-and-drag to highlight the cells from 0.5 psi to 16 psi and click the autofill icon. This completes the 500 RPM row with numbers that make the 2-bar map sensor read like the stock 1-bar map sensor when the ECU is taking a barometric pressure measurement. The decreasing sequence of numbers from 0.5 psi to 16 psi limits the map sensor reading to the full scale reading for the stock sensor. During tuning, these numbers can be used as a guide that shows the maximum cell value that can be used in a given column in boost.

Since we are assuming 5 psi of boost we can now go to the 5 psi column and fill that entire column with the value in the 500 RPM row. This will provide a full scale reading at 5 psi. Click on the column header where it says 5 psi. That will select that entire column. Click the fill selected icon and type in the number in the 500 RPM row and click OK. For our example the cell value throughout the 5 psi column is 15.4.

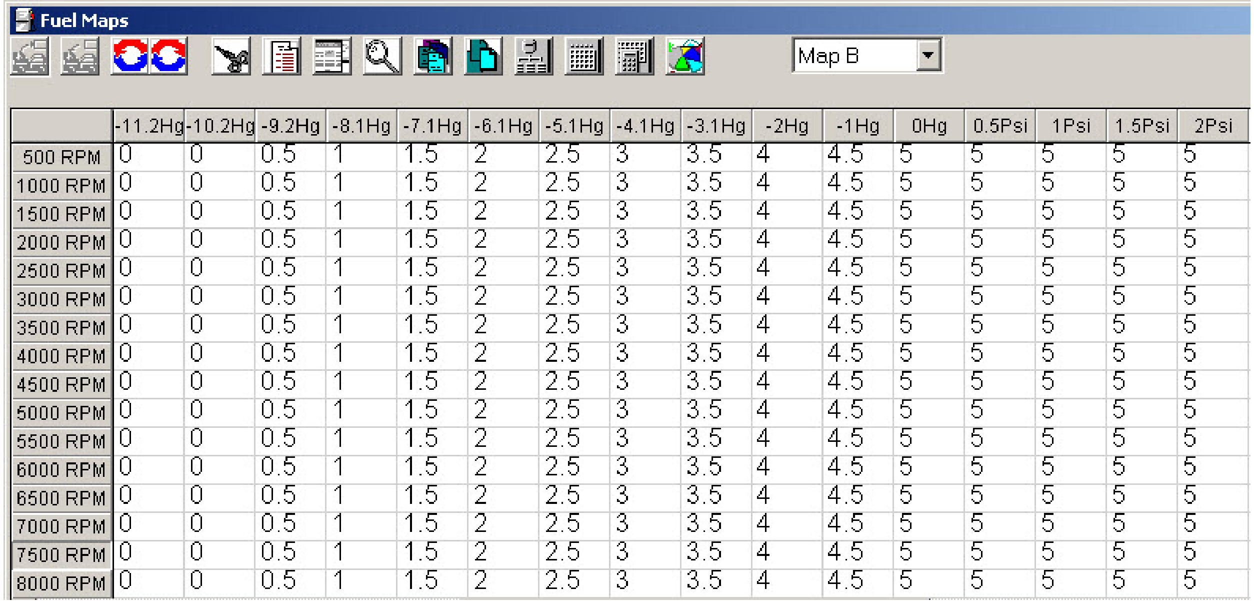
Complete the table above 5 psi by doing a click-and-drag from the 5 psi column header to the 16 psi column header. With all those columns selected, click the autofill icon. Complete the table below 5 psi by doing a click-and-drag operation starting from the cell at 1000 RPM and 5 psi and finishing at the cell at 8000 RPM and -28.5 Hg. With those cells selected, click the autofill icon.

The table should now look like the screen shot below. The complete table is 60 columns wide. The screen shot just shows the middle portion of the table. The barometric values of 18.4 are visible in the 500 RPM row at 0 Hg and 0.5 psi. The cell values in the 500 RPM row below 0 Hg steadily decrease to 10.4 at -28 inHg. That sequence of numbers makes the 2-bar map sensor read like a 1-bar and will provide valid barometric pressure readings as elevation changes. Above 0.5 psi, the cell values in the 500 RPM row steadily decrease to 8.0. This limits the 2-bar map sensor to a full scale reading that matches the barometric pressure reading for the stock map sensor at sea level.

	-4.1Hg	-3.1Hg	-2Hg	-1Hg	0Hg	0.5Psi	1Psi	1.5Psi	2Psi	2.5Psi	3Psi	3.5Psi	4Psi	4.5Psi	5Psi	5.5Psi	6Psi
500 RPM	17.3	17.5	17.8	18.1	18.4	18.4	18.1	17.7	17.4	17.1	16.7	16.4	16.1	15.7	15.4	15.1	14.7
1000 RPM	13.6	13.7	13.8	14	14.1	14.2	14.3	14.5	14.6	14.7	14.9	15	15.1	15.3	15.4	15.1	14.7
1500 RPM	13.6	13.7	13.8	14	14.1	14.2	14.3	14.5	14.6	14.7	14.9	15	15.1	15.3	15.4	15.1	14.7
2000 RPM	13.6	13.7	13.8	14	14.1	14.2	14.3	14.5	14.6	14.7	14.9	15	15.1	15.3	15.4	15.1	14.7
2500 RPM	13.6	13.7	13.8	14	14.1	14.2	14.3	14.5	14.6	14.7	14.9	15	15.1	15.3	15.4	15.1	14.7
3000 RPM	13.6	13.7	13.8	14	14.1	14.2	14.3	14.5	14.6	14.7	14.9	15	15.1	15.3	15.4	15.1	14.7
3500 RPM	13.6	13.7	13.8	14	14.1	14.2	14.3	14.5	14.6	14.7	14.9	15	15.1	15.3	15.4	15.1	14.7
4000 RPM	13.6	13.7	13.8	14	14.1	14.2	14.3	14.5	14.6	14.7	14.9	15	15.1	15.3	15.4	15.1	14.7
4500 RPM	13.6	13.7	13.8	14	14.1	14.2	14.3	14.5	14.6	14.7	14.9	15	15.1	15.3	15.4	15.1	14.7
5000 RPM	13.6	13.7	13.8	14	14.1	14.2	14.3	14.5	14.6	14.7	14.9	15	15.1	15.3	15.4	15.1	14.7
5500 RPM	13.6	13.7	13.8	14	14.1	14.2	14.3	14.5	14.6	14.7	14.9	15	15.1	15.3	15.4	15.1	14.7
6000 RPM	13.6	13.7	13.8	14	14.1	14.2	14.3	14.5	14.6	14.7	14.9	15	15.1	15.3	15.4	15.1	14.7
6500 RPM	13.6	13.7	13.8	14	14.1	14.2	14.3	14.5	14.6	14.7	14.9	15	15.1	15.3	15.4	15.1	14.7
7000 RPM	13.6	13.7	13.8	14	14.1	14.2	14.3	14.5	14.6	14.7	14.9	15	15.1	15.3	15.4	15.1	14.7
7500 RPM	13.6	13.7	13.8	14	14.1	14.2	14.3	14.5	14.6	14.7	14.9	15	15.1	15.3	15.4	15.1	14.7
8000 RPM	13.6	13.7	13.8	14	14.1	14.2	14.3	14.5	14.6	14.7	14.9	15	15.1	15.3	15.4	15.1	14.7

Before we are ready to start tuning the engine, we also need to fill in the timing retard map in table B. We will assume a one degree per pound of timing retard as a conservative starting point. That gives us 5 degrees of retard at 5 psi. We will actually run the entire boost range at 5 degrees of retard and blend up to 5 degrees starting at -10 Hg. This is quite a bit of retard, but the idea is to start off at a safe point for running the engine. We can give back advance during tuning to set the optimum timing.

To fill in the timing map, click on map B to select that table. Select the entire boost region by doing a click-and-drag from the 0 psi column header to the 16 psi column header. Click the fill selected icon, type in 5 and click OK. Use click-and-drag across column headers to select the vacuum region from -10.2 Hg to 0 psi. Click the autofill icon. That will provide a smooth transition in 0.5 degree increments to the 5 degrees of retard in the boost region. The table will now look like the screen shot below.



	-11.2Hg	-10.2Hg	-9.2Hg	-8.1Hg	-7.1Hg	-6.1Hg	-5.1Hg	-4.1Hg	-3.1Hg	-2Hg	-1Hg	0Hg	0.5Psi	1Psi	1.5Psi	2Psi
500 RPM	0	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5	5	5	5
1000 RPM	0	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5	5	5	5
1500 RPM	0	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5	5	5	5
2000 RPM	0	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5	5	5	5
2500 RPM	0	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5	5	5	5
3000 RPM	0	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5	5	5	5
3500 RPM	0	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5	5	5	5
4000 RPM	0	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5	5	5	5
4500 RPM	0	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5	5	5	5
5000 RPM	0	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5	5	5	5
5500 RPM	0	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5	5	5	5
6000 RPM	0	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5	5	5	5
6500 RPM	0	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5	5	5	5
7000 RPM	0	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5	5	5	5
7500 RPM	0	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5	5	5	5
8000 RPM	0	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5	5	5	5

Minimize the map table screen and go back to the R4 main screen. Turn on the ignition on the vehicle, plug in the data cable and click the Connect to ECU icon. Restore the Map Table screen and click the Write Data to ECU icon. This will write the base map to the FTC1-019B. With this map loaded, you should be able to start the engine and begin tuning.

Double Check the Barometric Pressure Reading

Before you start tuning the engine, verify the barometric pressure reading. With ignition-on and engine-off, check the map sensor reading either as the map sensor voltage going into the ECU or the map sensor reading on an OBDII scan tool. If the reading does not match the stock map sensor reading, adjust the cell value in the active sell and rewrite the file until the reading matches.

If you are not at sea level, the active cell may be to the left of the 0 Hg cell. Use the active cell to make your changes. Once the barometric reading is correct, autofill the 500 RPM row from -28.5 Hg to the active cell. If the active cell is to the left of the 0 Hg column, you can complete the values to 0Hg by extrapolating the slope of the cell values to the left of the active cell up to the 0 Hg cell. Be sure to have the same cell value in the 0 Hg and 0.5 psi cells. Use autofill to complete the 500 RPM row from 0.5 psi to the 16 psi column. Once you have completed that row, leave it alone during the tuning process.

Fine Tune for Peak Performance

This application note is not intended to be a complete tuning guide. Here are a few tuning tips on what you need to do to complete the tune. The stock ECU operates in two distinct modes, closed-loop and open-loop. At operating temperature, the ECU operates in closed-loop most of the time. The ECU goes into open loop at wide open throttle at high RPM, and under deceleration. The closed-loop region is tuned according to short-term and long-term trims as viewed on the OBDII scan tool. The open-loop region is tuned according to air/fuel ratio as measured on a wideband air/fuel meter.

Begin by tuning the fuel map for the idle region. Allow the engine to reach operating temperature. Observe the short-term and long-term fuel trim numbers on the scan tool. Adjust the cell values in the idle region until the short-term and long-term trims cancel each other out. They cancel out when they are equal in amplitude and opposite in sign. In other words they should add up to zero. After you make a change, write the file to the ECU and evaluate the change on the scan tool. The easiest way to change the cell values is to use click-and-drag to highlight a region on cells and use the change-by icon to change the numbers by a percent. If the trim numbers add up to a negative number, decrease the cell values. If they add up to a positive number, increase the cell values. As you tune, make sure that you leave the 500 RPM row unchanged.

Because the cell values have a certain slope to simulate the precise map sensor calibration, there is a possibility of creating a surge condition at idle. This is because the idle speed control of the stock ECU can enter a self oscillating mode where as the idle speed goes up and down, the manifold pressure crosses columns and reads higher and lower cell values. To counter this, you can fill adjacent cells in the idle region with the same cell value.

After tuning the idle region, tune the light load region by driving the car. Start with a slow constant speed and fine tune that area. Then progress up in the map table through the entire vacuum region. Position yourself on the map table by holding progressively higher throttle inputs. Move over a few columns at a time. You can use autofill to fill in areas of the table between the columns that you tune.

The open-loop region can be tuned to your target fuel mixture with a wideband air/fuel ratio meter. Most tuners target an air/fuel ratio in boost that is somewhere between 11.0:1 and 12.0:1. You need to watch the scan tool to insure that you are in open-loop. As long as the ECU is operating in open loop you can adjust cell values to achieve your target air/fuel ratio. Make sure to not exceed the cell value in the 500 RPM row of a given column in boost. That will insure that you do not activate fuel cut due to a map sensor reading that is too high.

Many engines are capable of making boost at part throttle when the ECU is in closed loop. It is desirable to operate at a richer mixture than 14.7:1 during these conditions. Many late model vehicles have very aggressive fuel trim that can completely remove the extra fuel that is programmed through the map table. If you see that the ECU is operating in closed loop and applying a large negative fuel trim while you are in boost, you will need an enrichment solution. The Split Second Enricher is specifically designed to achieve enrichment under these conditions. It intercepts the O2 sensor signals and adjusts the readings in a way that allows you to add fuel with it being taken away by the stock ECU.

After you get your fuel trim dialed-in, adjust the timing in map table B. Set the timing at the minimum advance that gives you best torque throughout the load and RPM of the engine. With the fuel and timing set correctly your engine should have optimum horsepower and torque. It should have good throttle response and deliver smooth and progressive power as the throttle is increased.