Twin Tec

User Instructions for Twin Tuner II

CAUTION: CAREFULLY READ INSTRUCTIONS BEFORE PROCEEDING.
NOT LEGAL FOR USE OR SALE ON POLLUTION CONTROLLED VEHICLES.

OVERVIEW

The Twin Tuner II is compatible with 2001-2010 H-D® Twin Cam and 2007-2010 Sportster® models with the 36 pin Delphi® module. The Twin Tuner II is not compatible with 2008 and later touring models with electronic throttle control. You can easily adjust your fuel injection and ignition timing to match the requirements of performance parts including high compression pistons/heads, camshafts, free flowing exhausts, and low restriction air filters. You can add or subtract fuel. You can retard ignition timing up to 10 degrees.

Installation takes only 10-15 minutes and is very easy, with no splicing, cutting, crimping, or bulky interconnections. All access is at the Delphi ECM. Just remove seven wires from the ECM connector, insert these wires into our small mating connector, insert seven new wires from the Twin Tuner II into the ECM connector, and connect one ground wire. The unit is completely encapsulated and impervious to moisture. With a very low profile of only ½" and occupying a fraction of the space required by competitive products, you won't have a problem finding a place to mount the unit.

Figure 1 – Twin Tuner II

You can use the up/down pushbutton switches to select the mode and change fuel trim and ignition retard values in the RPM and throttle position ranges required by most applications.

The Twin Tuner II also has an advanced mode, where you can use the optional USB interface and PC Link Tuner software to make precise fuel and ignition adjustments. The PC Link Tuner software uses the same RPM rows and throttle position columns as the Dynojet Power Commander. If you have created Dynojet Power Commander files for your applications, you can use the same values in our tables. You can make independent fuel trim adjustments to the front and rear cylinders.

The Twin Tuner II works great in combination with the Twin Scan II+ tuning aid sold by our sister company Daytona Sensors. You don't need a dyno for precise tuning. All you have to do is install the Twin Scan II+ and ride the bike around some. You can then copy the air/fuel ratio corrections calculated by the Twin Scan II+ into the PC Link Tuner software.

INSTALLATION

1. If the motorcycle is equipped with a security system (TSSM module), make sure the system is disarmed. Turn off the ignition switch and disconnect the battery ground cable before proceeding.
2. Find the Delphi® engine control module (ECM). The ECM is usually located under the seat or under a side cover.
3. Unplug the ECM connector. Cut the cable tie that secures the wire conduit. Use a small flat screwdriver to depress the tabs on the side of the connector and remove the clear plastic retainer as shown in Figure 2.
4. Use a small flat screwdriver to gently pry up the three locking tabs and separate the connector halves as shown in Figure 3.
5. Refer to Table 1 for connection details. Remove seven wires from the ECM connector (these will later be inserted into the Deutsch plug supplied with the Twin Tuner II).

Figure 2 – ECM Connector Retainer Removal

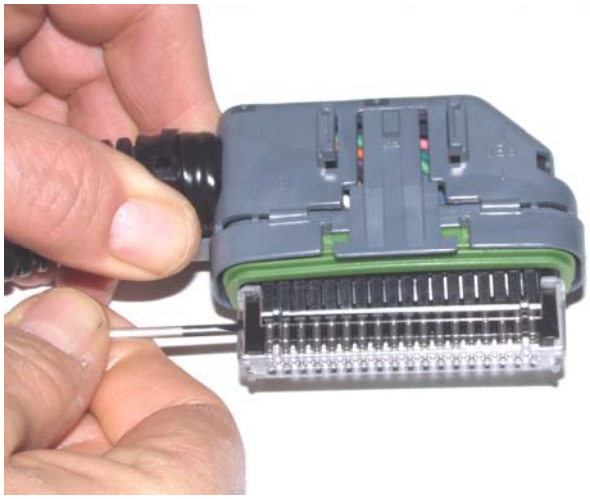


Figure 3 – ECM Connector Disassembly

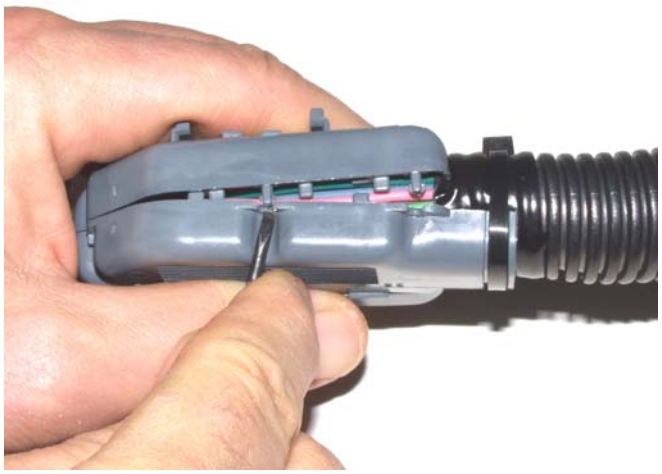


Figure 4 – ECM Connector Terminal Removal

Figure 5 – Completed Wiring at ECM

6. To release terminals from the ECM connector, use a small screwdriver to gently lift up the terminal and retaining tab while pulling on the wire as shown in Figure 4.
7. Terminal numbers are marked on the back side of the ECM connector. Original equipment wire color codes may vary. Note the color of each wire that you remove. We suggest that you mark up Table 1 with any corrections for future reference.
8. Refer to Table 1 and install the seven wires from the Twin Tuner II into the ECM connector.
9. Use a small side cutter to make a slit in the cable conduit so that the five wires you removed can exit as shown in Figure 5. Wrap electrical tape around the cable conduit. Reassemble the ECM connector. Secure the cable conduit with a supplied cable tie.
10. Refer to Table 1 and install the seven wires removed from the ECM connector into the supplied Deutsch plug (#1 In Figure 5). Terminal numbers are marked on the back side of the Deutsch plug. Install the orange secondary lock. Wrap the wires with electrical tape as shown in Figure 5.
11. Plug the ECM connector back onto the ECM. Connect the Deutsch plug from the ECM harness to the mating Deutsch receptacle on the Twin Tuner II harness as shown in Figure 5.
12. Connect the Twin Tuner II black ground wire to an appropriate ground. You can generally find one or more screws used for other ground connections under the seat or near the ECM.
13. The Twin Tuner II brown wire with Weather Pack connector is the data link used for PC communications. If not used, tape up this wire.

14. Find a location for the Twin Tuner II. You can use Velcro material to secure the unit.

15. Reconnect the battery ground cable. Do not attempt to start the engine until you have completed the initial setup.

Table 1 – Wiring Hookup

Twin Tuner II Wires		
Wire Color	**To ECM Connector**	**Signal**
Orange	4 (all Twin Cam) or 2 (Sportster only)	System Relay
Yellow	11	Rear Coil
White/Black	13	Ignition Switch
Green	19	Rear Injector
White	21	Front Injector
Violet	24	Throttle Position Sensor
Blue	29	Front Coil
ECM Wires (removed from ECM connector)		
Wire Color (ECM terminal)	**To Deutsch Plug #1**	**Signal**
White/Black (13)	1	Ignition Switch
Gray/Violet (24)	2	Throttle Position Sensor
White/Yellow (21)	3	Front Injector
Green/Gray (19)	4	Rear Injector
Blue/Orange (29)	5	Front Coil
Yellow/Blue (11)	6	Rear Coil
Green/Orange (4 or 2)	7	System Relay

INITIAL SETUP

The Twin Tuner II has two sets of up/down pushbuttons. The left set is used to select the mode (parameter to be displayed) and the right set is used to change the value. The parameter is displayed on the left two LED digits and the value is displayed on the right two LED digits. The display digits blink for negative values. Fuel trim parameters are listed on Table 2 and ignition retard parameters are on Table 3. **Values represent percent fuel trim or degrees ignition retard.** Note that the RPM and throttle position operating ranges for fuel trim parameters 1-9 are the same as for ignition retard parameters 11-19.

Before starting the engine for the first time, turn the ignition switch and run/stop switch on. The idle air control motor will move to the starting position and the fuel pump will be energized for several seconds, making an audible buzz. Scroll through parameters 0-19. The LED display should be off for parameter 0. The LED display should illuminate and read value (right two digits) 00 for parameters 1-19 (unless your Twin Tuner II has been preprogrammed for some specific application). If required, use the up/down pushbuttons to set the values for each parameter to zero. Start the engine and verify normal operation. If the engine will not start, or runs on one cylinder, recheck connections.

BASIC TUNING

Tables 2-3 show the engine operating ranges affected by fuel trim and ignition retard values in terms of RPM and throttle position sensor (TPS) values. To properly tune an engine, you need to know what fuel trim values are required. The only practical means of doing so is to use an air/fuel ratio (AFR) metering system based on a wide-band oxygen sensor, either directly mounted in the exhaust or as part of an exhaust sniffer. It is impossible to make accurate adjustments by seat-of-the-pants or reading spark plugs. For models with original equipment oxygen sensors, please read the section on page 10.

High compression engines may require some ignition retard. If spark knock is noted, try 3-4 degrees retard in the operating area where knock occurs (refer to Table 3).

Table 2 – Parameter Settings for Fuel Trim

Parameter	Fuel Trim Operating Range
0	Display off – used to prevent inadvertent changes during normal engine operation
1	Idle 750-1250 RPM 0% TPS
2	Low cruise 1250-2000 RPM 2.5-50% TPS
3	High cruise 2000-3750 RPM 2.5-50% TPS
4	Wide open throttle 1250-2000 RPM 50-100% TPS
5	Wide open throttle 2000-2750 RPM 50-100% TPS
6	Wide open throttle 2750-3750 RPM 50-100% TPS
7	Wide open throttle 3750-4750 RPM 50-100% TPS
8	Wide open throttle above 4750 RPM 50-100% TPS
9	Decel above 1250 RPM and less than 2.5% TPS
10	Acceleration enrichment (0 = none, 10 = maximum)

Table 3 – Parameter Settings for Ignition Retard

Parameter	Ignition Retard Operating Range
11	Idle 750-1250 RPM 0% TPS
12	Low cruise 1250-2000 RPM 2.5-50% TPS
13	High cruise 2000-3750 RPM 2.5-50% TPS
14	Wide open throttle 1250-2000 RPM 50-100% TPS
15	Wide open throttle 2000-2750 RPM 50-100% TPS
16	Wide open throttle 2750-3750 RPM 50-100% TPS
17	Wide open throttle 3750-4750 RPM 50-100% TPS
18	Wide open throttle above 4750 RPM 50-100% TPS
19	Decel above 1250 RPM and less than 2.5% TPS

If you do not have access to an AFR metering system, you can still make some adjustments based on the following guidelines.

1. Aftermarket camshafts will generally increase manifold pressure (reduce vacuum) near idle. The Delphi speed-density control will compensate with excessive fuel resulting in a very rich idle. Try reducing the idle fuel by -5% to -10% (parameter 1).
2. If the engine runs rough or coughs (backfire through the intake) under part throttle cruise conditions, try adding 10-15% fuel in the RPM ranges where problems are noted (parameters 2 and 3).
3. Performance modifications will generally increase the fuel requirement at wide open throttle. If the engine runs rough or hesitates at wide open throttle, try adding 10-15% fuel in the RPM ranges where problems are noted (parameters 4-8). If exhaust backfires occur on decel, try reducing fuel in the decel area by 10-15% (parameter 9).
4. If throttle roll-on response is poor, try adding some acceleration enrichment (parameter 10).

If you have access to an AFR metering system, either a standalone system such as the Daytona Sensors WEGO II or a load control dyno with an exhaust sniffer, you are in a much better position to make accurate adjustments.

1. Make sure the engine is fully warmed up and has reached normal operating temperature. Run the engine at idle. Trim the idle fuel (parameter 0), while observing the AFR. Idle AFR should be near 13.5. Very few applications will require adding fuel at idle. Aftermarket camshafts will generally increase manifold pressure (reduce vacuum) near idle. The Delphi speed-density control will

compensate with excessive fuel resulting in a very rich idle. You will have to subtract some fuel to compensate. **If you are using sniffer, obtaining an accurate idle AFR reading may be difficult due to reversion effects. Reversion will result in a false lean AFR reading. If the AFR reading is above 14.6 before fuel trim, but the engine is running reasonably well, you probably have a false lean reading.**

2. Run the engine at part throttle near the middle of the RPM and throttle position ranges given in Table 2 for low and high cruise (parameters 2 and 3). Trim the fuel so that average AFR readings are near 13.8. If you observe a lean spot where AFR exceeds 14.6, add more fuel. You are always better off with the engine running rich in some areas than coughing in one particular lean spot.
3. Performance modifications will generally increase the fuel requirement at wide open throttle. However, it is not unusual for some 2-into-1 exhaust systems to have a torque dip at some RPM point where the engine then runs very rich and fuel must be subtracted. Do wide open throttle runs and record AFR values. Target AFR values at wide open throttle are in the 12.8-13.0 range. Refer to Table 2 and make appropriate fuel trim adjustments in each RPM range (parameters 4-8). High compression engines may exhibit spark knock at wide open throttle. Spark knock can often be eliminated by adding more fuel (AFR in the 12.0-12.5 range) within the affected RPM range.
4. If throttle roll-on response is poor or a lean transient (high AFR values) is observed, try adding some acceleration enrichment (parameter 10).

ADVANCED TUNING

The Twin Tuner II also has an advanced mode, where you can use the optional USB interface and Windows software to check and observe system operation (Tuner Log) and make precise fuel and ignition adjustments (PC Link Tuner).

PC REQUIREMENTS

The Twin Tuner II connects to your PC by means of an optional USB interface (P/N USB-INTF) that is also used with our other engine controls. The PC must have a free USB port. If you have an older PC without USB capability, you cannot use the advanced tuning capability.

We recommend a laptop PC with Pentium processor and super VGA display (SVGA with 1024 x 768 pixel resolution) running Windows 98/ME/XP/Vista. Data display is graphics intensive and a high speed Pentium processor is recommended. Processors slower than 300 MHz will exhibit sluggish program loading and response. The PC must have a CDROM drive for program loading.

PC Link Tuner software includes print commands to print downloaded data. The program has been tested with Hewlett-Packard laser and inkjet printers and Epson inkjet printers. We recommend using a color inkjet printer.

SOFTWARE INSTALLATION

The software is supplied on CDROM media or in the form of a compressed file downloaded from our website. The installation process uses InstallShield. This industry standard installer is based the new Microsoft Windows Installer service that greatly reduces potential problems such as version conflicts and allows for application self-repair. Since Windows 98 systems did not originally include the Windows Installer service, the required installer software is included in the distribution media.

There are two programs to install: Tuner Log and PC Link Tuner. Start by installing Tuner Log. If you are downloading software from the web, only download and install one program at a time. Before proceeding with installation, shutdown any other applications that may be running. For Windows Vista, you must disable the User Account Control (UAC) during installation. If you are not familiar with the UAC, please refer to the Vista UAC Tech Note on our website's Tech FAQ for details.

Use the Windows Explorer or the Run command from the Windows Start Menu to launch setup.exe in the Tuner_Log folder on the CDROM or the setup.exe file downloaded from our website. InstallShield will install the software in an appropriate folder under Program Files.

Repeat the installation process for PC Link Tuner. Use the Windows Explorer or the Run command from the Windows Start Menu to launch setup.exe in the PC_Link_Tuner folder on the CDROM or the setup.exe file downloaded from our website. InstallShield will install the software in an appropriate folder under Program Files.

Once InstallShield has completed the installation, Tuner Log and PC Link Tuner will appear on the Windows Start Menu. You can then launch them just as you would any other Windows program.

PC Link Tuner software requires the Monospace 821 BT fixed pitch printer font in order to properly align columns when printing. The Monospace 821 BT font is included in the distribution media and automatically copied to your Windows Fonts folder during

installation. A backup copy is also placed in the program folder. If you accidentally delete this font, use the Install New Font command from the Fonts folder File menu. The filename associated with Monospace 821 BT is monos.ttf.

TWIN TUNER II CONNECTION

Follow the instructions supplied with the optional USB interface to install the required USB drivers and configure the COM port. Once you have configured a COM port number for your new USB Interface, make sure that you use this same COM port selection in the Tuner Log and PC Link Tuner software. Use the "TC88A AND ALL OTHERS" switch setting.

An adapter harness is supplied with the USB Interface for use with the Twin Tuner II. Connect the alligator clip on the black wire to ground and the Packard Weather Pack connector to the mating connector on the brown wire from the Twin Tuner II.

Turn the ignition key and engine run/stop switch on to provide power to the system. Do not start the engine if you want to download or upload data with PC Link Tuner.

TUNER LOG SOFTWARE

When the engine is running, you can display real time engine data on an instrument panel type screen as shown in Figure 6 by using the View Real Time Data command on the View menu.

You can also check proper operation of the throttle position sensor (TPS) when the run/stop switch is on (engine not running). Rotate the throttle through the full range of motion. The TPS% value should go from zero to 100%.

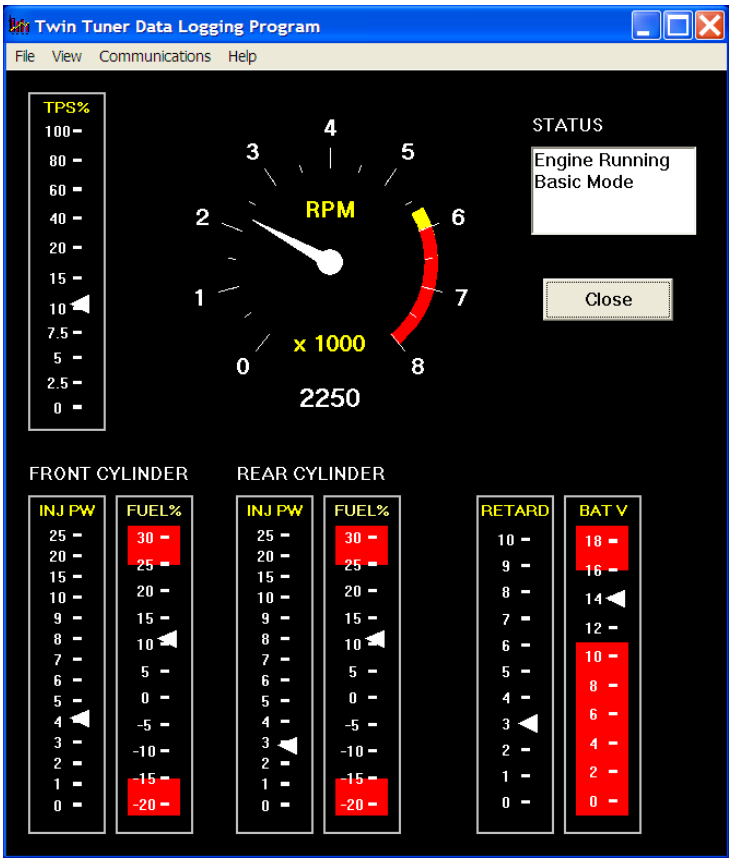
Real time engine data is displayed on an instrument panel type layout with a round tach gauge and bar graph type gauges for all other parameters. Status messages are displayed in a separate window. If the engine is not running, most values will appear as zero or off.

Displayed parameters include:

RPM – engine crankshaft RPM (numeric value displayed beneath gauge)

TPS – throttle position (0 to 100%)

Figure 6 – Real Time Engine Data Display



FRONT INJ PW, REAR INJ PW – injector pulse width in milliseconds (pulse width commanded by ECM before fuel trim by Twin Tuner II)

FRONT FUEL%, REAR FUEL% – fuel trim in percent (0% means no change)

RETARD – ignition retard in degrees

BAT – battery voltage

STATUS – engine running status and basic mode (switch settings used to trim fuel) or advanced mode (PC Link Tuner tables used to trim fuel)

PC LINK TUNER SOFTWARE

Before the engine is started, you can download or upload data with PC Link Tuner.

After PC Link Tuner is launched, the main screen appears blank. You have two options for obtaining data for editing. You can open a previously saved data file by using the Open File command on the File menu or you can download data from an attached Twin Tuner II unit by using the Download Data From Twin Tuner II command on the Communications menu. Note that Twin Tuner II data files use a .dat extension. You should create a separate folder to store these files.

Once you have Twin Tuner II data, you can edit various 3D tables and parameters. 3D fuel trim and ignition retard tables are accompanied by chart displays that help visualize the data. You can also rotate the 3D chart display for a better view of a particular region. You can print the data associated with an active table or Twin Tuner II parameters by using the appropriate Print command from the File menu. When you open a file or download data from a Twin Tuner II, the data is stored in a buffer memory. After editing a table, you can save the edits to this buffer memory. Once you have completed all your edits, you can save the data in buffer memory to a file or upload it back to the Twin Tuner II by using the appropriate command from the File or Communications menu.

Please note that communication is only possible if the ignition key and run/stop switch are turned on and the engine has not yet been started.

TWIN TUNER II PARAMETERS

Twin Tuner II parameters shown in Figure 7 control the overall operating mode of the unit and allow you to preset parameters without using the switches on the unit. Options and parameters that you can set include:

Twin Tuner II Version – when a file is opened or data is downloaded, the software automatically determines the Twin Tuner II version. Do not use EX version files or click on the EX option with the standard (race) Twin Tuner II.

Basic Mode – fuel trim and ignition retard values are based on parameter settings. This is the default operating mode.

Advanced Mode – fuel trim and ignition retard values are based on the 3D tables.

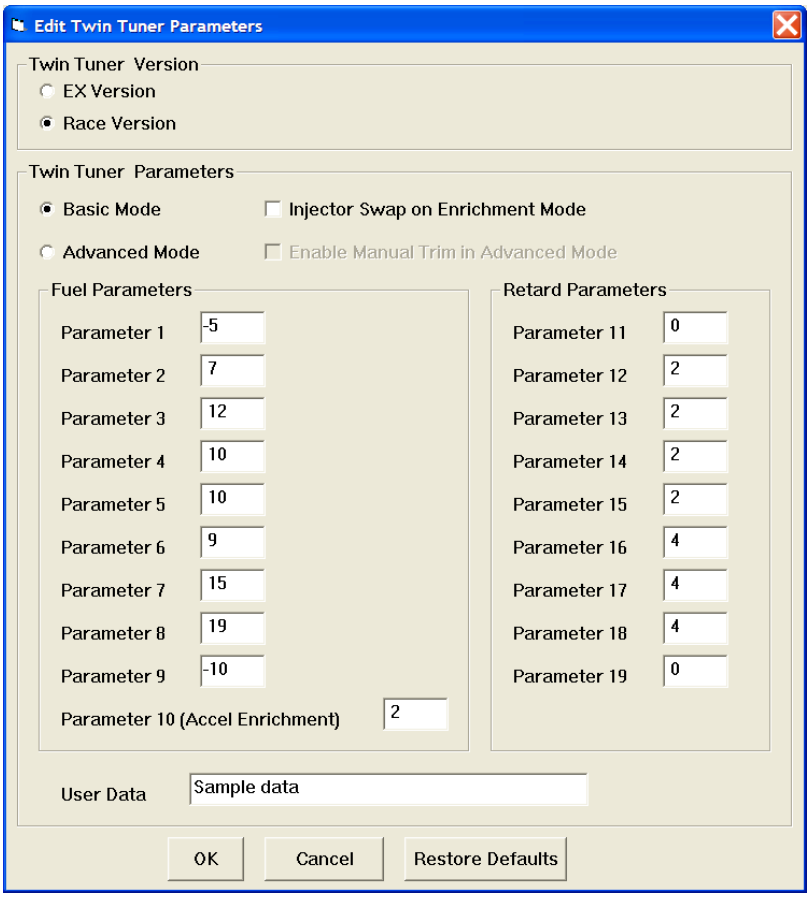
Injector Swap on Enrichment Mode – positive fuel trim is applied to the opposite injector to compensate for fuel distribution problems in some applications. This mode is not normally selected. Refer to tech support for additional details.

Enable Manual Trim in Advanced Mode – this option is only available in advanced mode and is grayed out in basic mode. If this option is selected, parameter settings 1-9 and 11-19 can be used to manually trim the 3D fuel and ignition retard tables. If this option is not selected, parameter settings 1-9 and 11-19 are ignored (parameter setting 10 for acceleration enrichment is still active).

Parameters 1-19 – display fuel trim and ignition retard parameter values. Can be used to edit or preset values without using the switches on the unit. Parameters are listed in Tables 2-3.

User Data – you can enter up to 32 characters of user data that will be saved in EEPROM memory. User data can contain comments or serial numbers.

Figure 7 – Twin Tuner II Parameters



EDITING 3D TABLE DATA

You can edit front and rear cylinder fuel trim and ignition retard tables. Before you can edit one of these tables you must either open a data file or download data from a Twin Tuner II unit. Numeric data is always edited on the spreadsheet grid. The tables are accompanied by 3D graphs that help visualize the data.

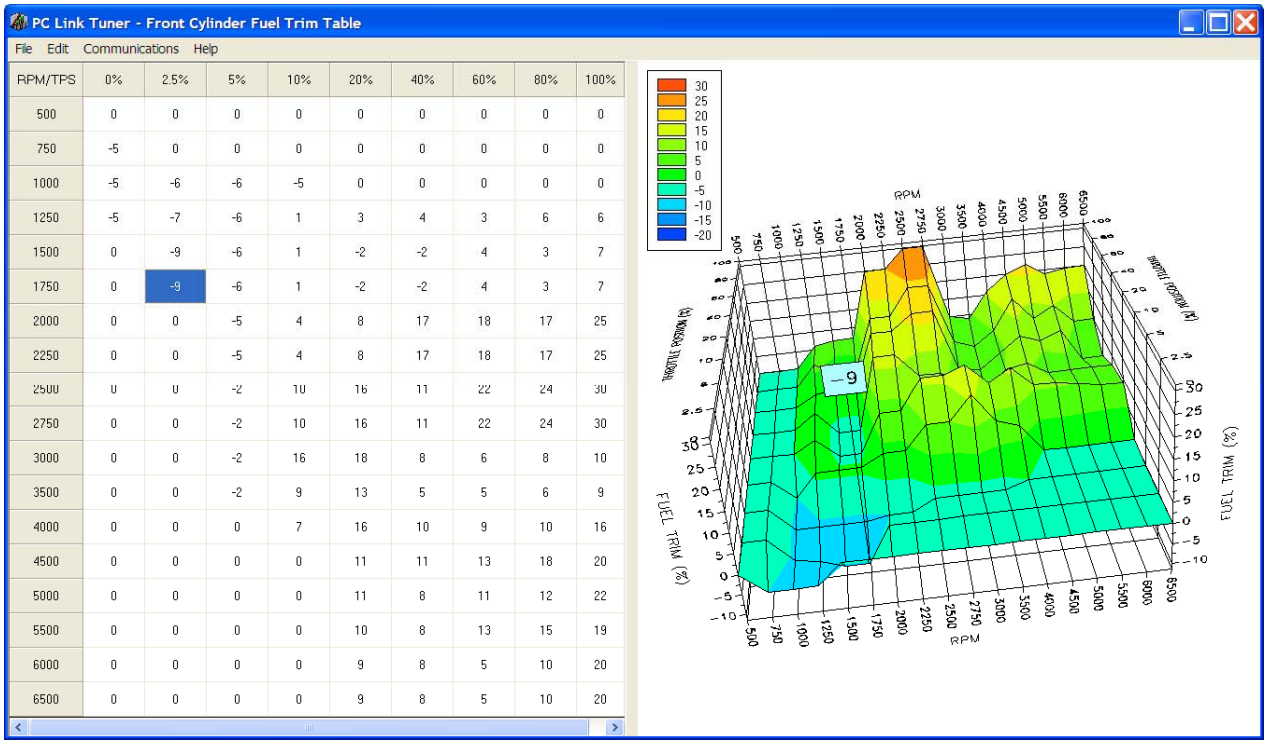
Each table consists of 18 rows from 500 to 6,500 RPM and 9 throttle position columns from 0% to 100%. The 6,500 RPM value is used at all higher RPM levels.

After you have edited a table, you must use the Save Table Edits To Buffer command from the Edit menu to save your edits to buffer memory. If you use the Close Table command from the Edit menu, all your edits are lost.

Front and Rear Cylinder Fuel Trim Tables

The fuel trim values in these tables are only active if advanced mode is selected. You can enter fuel trim values from -20% to +30% in every cell. Unless you have specific experience in trimming individual cylinders and the associated fuel distribution problems, we suggest that you use the same values for both front and rear cylinders. You can edit a table for the front cylinder. After saving the table edits to buffer memory, you can use the Copy Front Cylinder Trim to Rear command from the Edit menu to quickly copy the entire table.

Figure 8 – Typical Front Cylinder Fuel Trim Table



Ignition Retard Table

The retard values in these tables are only active if advanced mode is selected. On the table, retard values are shown as negative numbers (i.e. -5 is 5 degrees retard). You can enter retard values from zero to -10 degrees. Ignition retard is the same for both front and rear cylinders. On the chart, retard is shown as positive numbers to allow a better graphical representation.

Editing Table Data

You can edit table data using standard Windows copy and paste operations by selecting cells and then clicking the right mouse button to pop-up the edit menu. You can select cells by dragging the mouse with left button down. You can also use the Modify command on the pop-up menu. When you enter a value, the presence of optional sign (+ or -) or percent (%) characters affects the outcome of the Modify command as shown in Figure 9.

Data Export and Import by Means of Copy and Paste

You might want to export or import 3D table data to or from another application such as Microsoft Excel and other programs with tables that support copy and paste operations. You can directly copy and paste data to and from the PC Link Tuner program. In the PC Link Tuner program, you can select a range of cells with the mouse and right click to bring up a copy and paste menu. When you paste data into the PC Link Tuner program, the data is automatically checked and any out-of-range data corrected.

Figure 9 – Modify Command

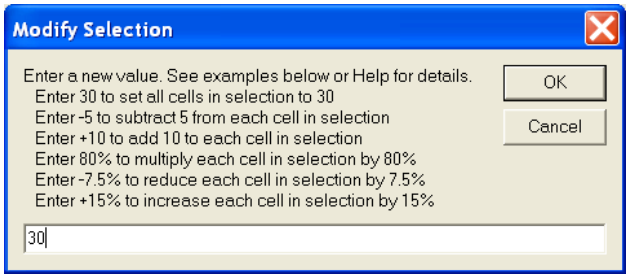
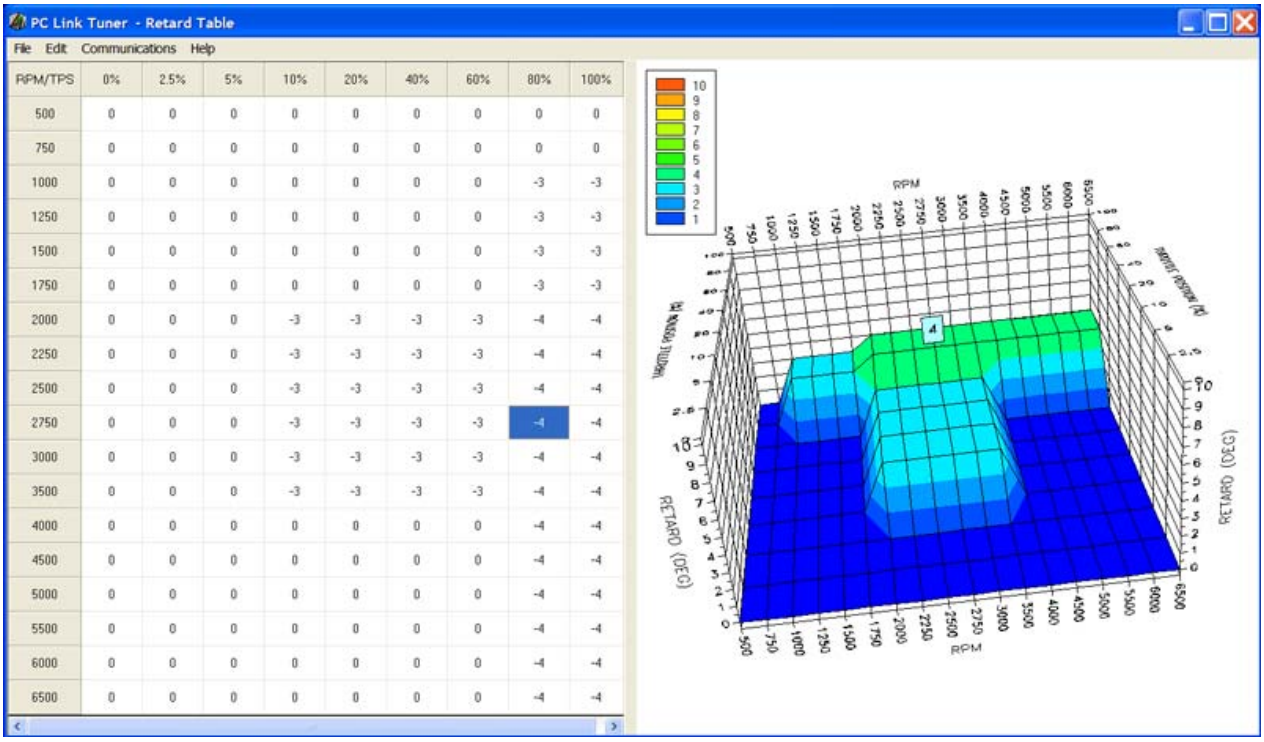


Chart Operations

You can rotate the 3D chart display for a better view of a particular region by dragging the mouse while holding both mouse buttons down.

PC Link Tuner is intended to be an open system and uses the Component One Chart 7.0 3D charting control. The adventurous user can experiment with the chart property pages by right clicking on the chart. Almost any chart property can be changed. Click on the Help button for more information. If you corrupt the chart, exit and restart PC Link Tuner.

Figure 10 – Typical Ignition Retard Table



MODELS WITH ORIGINAL EQUIPMENT OXYGEN SENSORS

2006 fuel injected Dyna® and all 2007-2010 models are equipped with dual narrow-band oxygen sensors and a Delphi® ECM that supports closed loop AFR control based on feedback from the sensors. A similar system is used on Buell® models. After the engine has warmed up, the ECM attempts to maintain the AFR at 14.6 during idle and part throttle cruise. Several factors must be considered when modifying engines equipped with this system:

1. The engine components are designed to operate properly at idle and part throttle cruise with this relatively lean 14.6 AFR. Some camshaft profiles and aftermarket heads or head modifications may result in excessive lean surge or stalling at idle.
2. If installation of an aftermarket exhaust is planned, it must have provision for the oxygen sensors.
3. At idle and part throttle, the ECM can automatically correct for modifications by changing the baseline fuel up to ±25%. You can use a scan tool such as our Twin Scan II to check what correction the ECM is making under closed loop conditions (original equipment narrow-band sensors must be installed). The correction is referred to as the error integrator value and will range from 75-125%. If the ECM is running out of adjustment range, you may be able to use the Twin Tuner II to trim the baseline fuel delivery in order to bring the error integrator value back to near 100%. However, you will not be able to change the target AFR value. This will always remain at 14.6.
4. You can use the Twin Tuner II to make corrections at wide open throttle (parameters 4-8). If you have the Twin Scan II+, you can use it (with WEGO sensors temporarily installed) to calculate required corrections above 40% TPS on the fuel trim tables.
5. When using the Twin Scan II+, temporarily installing the WEGO sensors in place of the original equipment narrow-band sensors (disconnect sensors) will cause the Delphi® ECM to remain in open loop without any fuel corrections that would affect the tuning process. After tuning is completed, reinstall the original equipment sensors and clear any trouble codes.

CYLINDER TRIM ISSUES

Accepted engineering practice is to use the smallest possible injectors (in terms of flow) for best control at idle and part throttle. The Delphi® style single throttle body and similar aftermarket units with

siamesed runners are subject to fuel imbalance problems between the front and rear cylinders.

The Delphi® ECM synchronizes fuel injection events so that the end-of-injection for each cylinder occurs when the intake valve is starting to close. At idle and part throttle where the injector duty cycle is low, the air flow will carry the fuel into the correct cylinder. When the fuel injector duty cycle approaches 50%, fuel will start being inducted into the wrong cylinder (i.e. front injector spraying fuel while rear intake valve is still open).

The Twin Tuner II, and similar competitive systems such as the Dynojet Power Commander, increase fuel delivery by extending the injector pulse width. If the fuel trim is more than 5-10%, the fuel will continue being injected after the intake valve has already closed and this additional fuel will ultimately be carried into the opposite cylinder.

The combined effect of high injector duty cycle at wide open throttle and the extended injector pulse width make trimming fuel between cylinders difficult and somewhat unpredictable. Many customers are unfamiliar with this issue and other vendors have been reluctant to address it with any specific information or suggested techniques.

In most cases, it is best to use the same fuel trim value for both cylinders and tune based on the worst case cylinder.

If an extreme AFR imbalance exists between cylinders and a significant amount of fuel must be added to one cylinder, you can try using the injector swap on enrichment mode (refer to Twin Tuner II parameters on page 8).

USING DYNOJET POWER COMMANDER TUNING DATA

If you have created Dynojet Power Commander files for your applications, you can use the same values in our tables. A typical Power Commander fuel table is shown in Figure 11. The TPS columns are the same as used in our tables and the RPM rows are very similar. For intermediate RPM rows in our tables, such as 1,250 RPM, you can enter values approximately in between the values in the Power Commander 1,000 and 1,500 RPM rows. For Power Commander files that have a single fuel table, use the same values for both cylinders with the Twin Tuner II.

Figure 11 – Typical Dynojet Power Commander Fuel Table