



# Twin Tec

## User Instructions for Twin Tuner II P/N 16202

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

### OVERVIEW

Twin Tuner II P/N 16202 is for 2008-2013 H-D® touring models with the 73 pin Delphi® module and 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 connectors, 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. You can make independent fuel trim adjustments to the front and rear cylinders.

The Twin Tuner II works great in combination with our Twin Scan II Plus tuning aid. You can directly export calculated fuel correction data to Twin Tuner II data files. The system can be used for tuning on a dyno or under actual riding conditions on a closed course or race track.

### 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.
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 cable cover.
4. Use a small flat screwdriver to gently slide out the green terminal retainer as shown in Figure 2.
5. Refer to Table 1 for connection details. Remove seven wires from the ECM connector. 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.
6. To release terminals, use the supplied plastic push pin as a terminal removal tool. Insert the push pin into the round hole between terminal cavities as shown in Figure 3. This will release the two adjacent terminals. Remove the appropriate terminal. Make sure that the adjacent terminal is not dislodged.



Figure 6 – Twin Tuner II Wiring

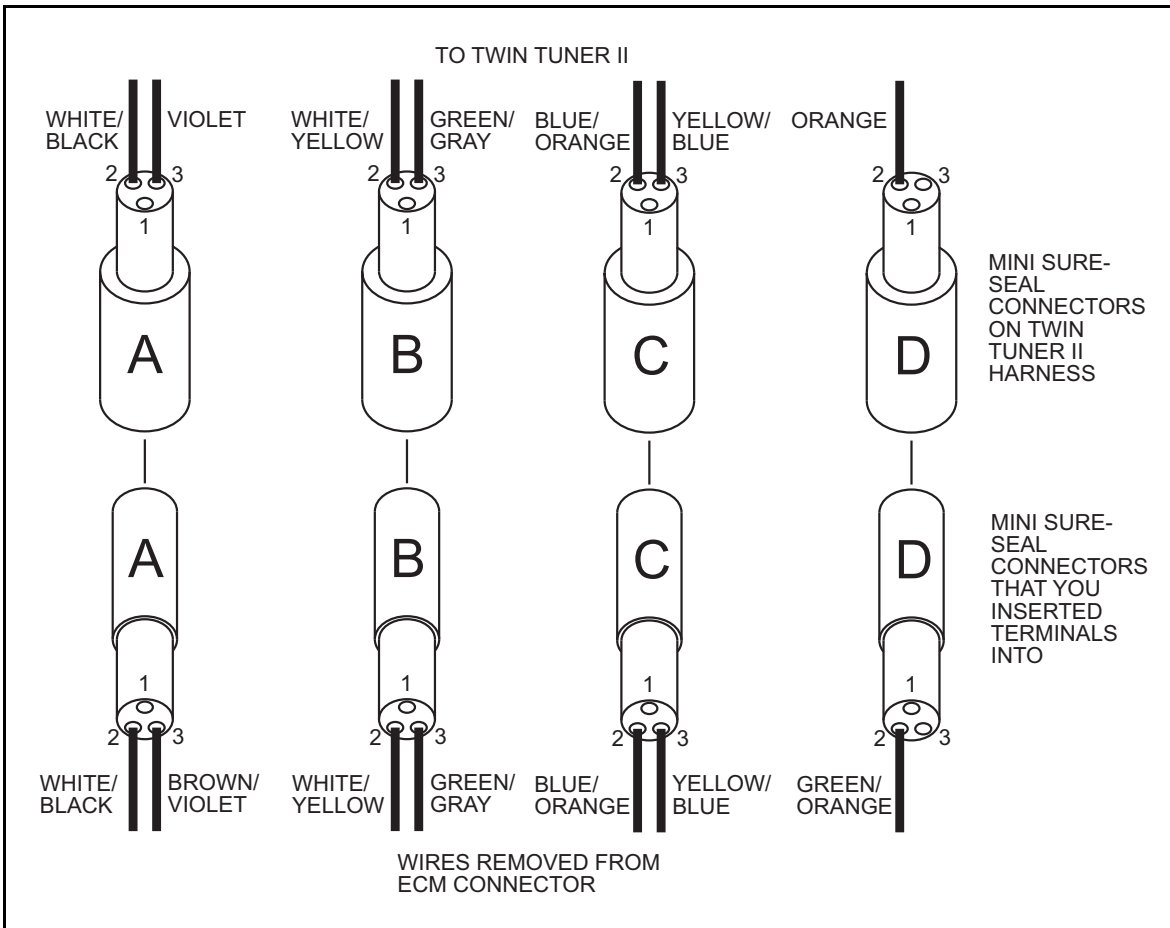


Figure 7 – Completed Twin Tuner II Installation



10. Mate the mini Sure-Seal connectors together and verify that the wire colors are correctly oriented as shown in Figure 6.
11. 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.
12. 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.
13. Refer to Figure 7 for suggested Twin Tuner II mounting location. You can use Velcro material to secure the unit.

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

**CAUTION: Professional installation is recommended. The female Delphi Micro64 terminals are delicate and easily damaged. Replacement terminals are available as P/N 829-15356827 from Mouser Electronics. The required Delphi crimping tool is P/N 15397700 available from Power & Signal Group. A professional insertion tool for the mini Sure-Seal connectors is also available as P/N MSS-T-Tool from PEI Genesis.**

Table 1 – Wiring Hookup

<b>Twin Tuner II Wires</b>		
<b>Wire Color</b>	<b>To ECM Connector</b>	<b>Signal</b>
Green	23	Rear Injector
Orange	27	System Relay
White	28	Front Injector
Violet	37	Throttle Position Sensor
Yellow	53	Rear Coil
Blue	54	Front Coil
White/Black	72	Ignition Switch
<b>ECM Wires (removed from ECM connector)</b>		
<b>Wire Color (ECM terminal)</b>	<b>To Mini Sure-Seal Plug</b>	<b>Signal</b>
White/Black (72)	2A	Ignition Switch
Brown/Violet (37)	3A	Throttle Position Sensor
White/Yellow (28)	2B	Front Injector
Green/Gray (23)	3B	Rear Injector
Blue/Orange (54)	2C	Front Coil
Yellow/Blue (53)	3C	Rear Coil
Green/Orange (27)	2D	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. For tuning recommendations and initial setup tables for common applications refer to the Appendix starting on page 12.

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

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## **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 18014) 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 XP/Vista/7. 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.

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 8 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%)

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

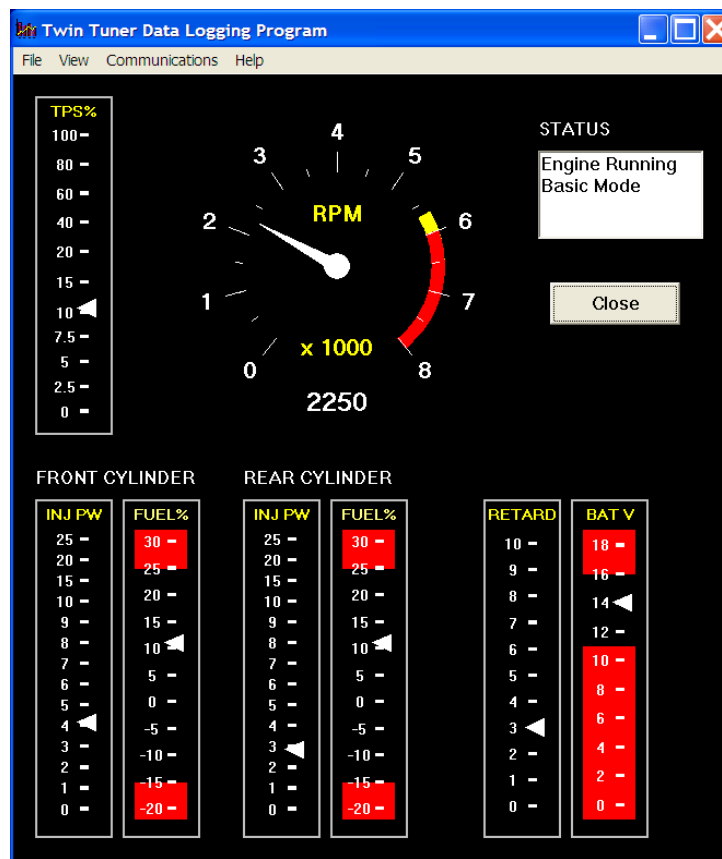
**FRONT FUEL%, REAR FUEL%** – fuel trim in percent (0% means no change)

**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)

Figure 8 – Real Time Engine Data Display



## 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 9 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 9 – Twin Tuner II Parameters

The screenshot shows a software dialog box titled "Edit Twin Tuner Parameters". It is divided into several sections:

- Twin Tuner Version:** Two radio buttons, "EX Version" and "Race Version". "Race Version" is selected.
- Twin Tuner Parameters:**
  - Two radio buttons: "Basic Mode" (selected) and "Advanced Mode".
  - Two checkboxes: "Injector Swap on Enrichment Mode" (unchecked) and "Enable Manual Trim in Advanced Mode" (unchecked).
- Fuel Parameters:** A list of nine parameters with input fields:
 

Parameter 1	-5
Parameter 2	7
Parameter 3	12
Parameter 4	10
Parameter 5	10
Parameter 6	9
Parameter 7	15
Parameter 8	19
Parameter 9	-10
Parameter 10 (Accel Enrichment)	2
- Retard Parameters:** A list of nine parameters with input fields:
 

Parameter 11	0
Parameter 12	2
Parameter 13	2
Parameter 14	2
Parameter 15	2
Parameter 16	4
Parameter 17	4
Parameter 18	4
Parameter 19	0
- User Data:** A text input field containing "Sample data".
- Buttons:** "OK", "Cancel", and "Restore Defaults" are located at the bottom of the dialog.



## 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.

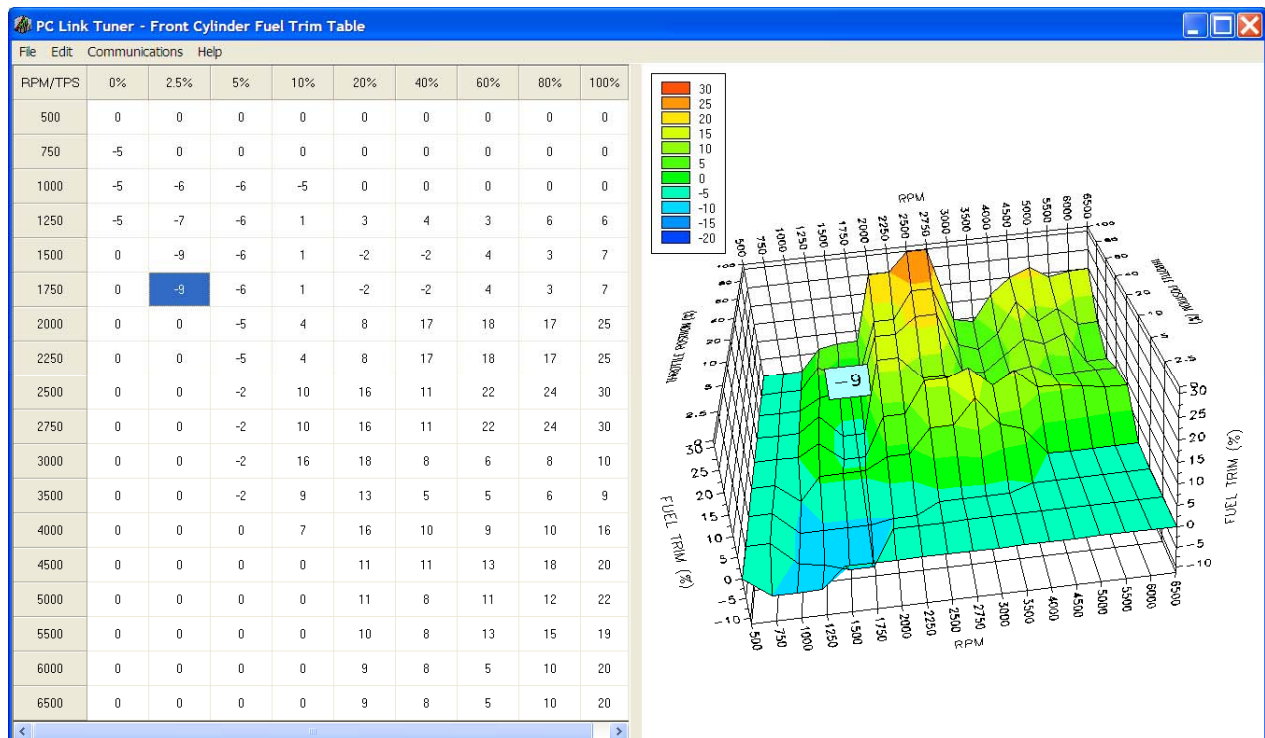
After you have edited a table, you must use the Save Table Edits To Buffer command from the Edit

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 10 – 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



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## ***ELECTRONIC THROTTLE CONTROL ISSUES***

All 2008 and later touring models have a throttle control actuator (TCA) that also controls idle air. Throttle position (TPS) refers to the position of the throttle plate in the TCA, not the twist grip sensor. Under warm idle conditions, scan tools will show TPS at about 5% (the value will be higher when the engine is cold). The Twin Tuner II subtracts 5% from the actual TPS value. Under warm idle conditions, the Tuner Log software will show zero TPS and the Twin Tuner II will operate in the zero TPS and 1000 RPM cell. A similar convention (to subtract 5% from the actual TPS value and report warm idle as zero TPS) is also used by other systems.

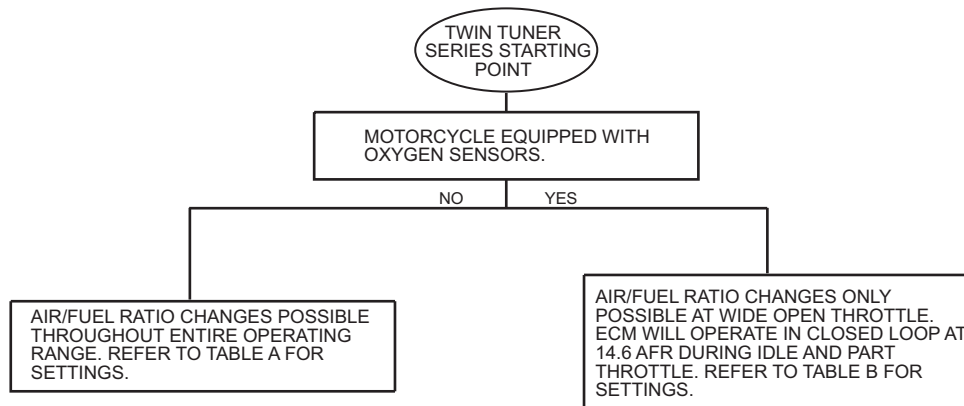
## APPENDIX – INITIAL SETTINGS

Use the flow chart to select the best initial settings for your application. The Twin Tuner series is appropriate for most Stage 1 (low restriction air filter and free flowing exhaust) and Stage 2 (performance camshafts) applications. For Stage 3 (increased displacement, high compression pistons, and ported heads), we recommend the Twin Tuner II series.

2006 fuel injected Dyna® and all 2007 and later Harley-Davidson® models are equipped with dual narrow-band oxygen sensors and a Delphi® ECM that supports closed loop air/fuel ratio (AFR) control based on feedback from the sensors. After the engine has warmed up, the ECM will maintain the AFR at 14.6

during idle and part throttle cruise. While the ECM is in closed loop operation, you cannot change the AFR at idle and part throttle cruise by adding fuel with the Twin Tuner. The ECM will correct for any attempt to add fuel in these operating ranges.

If the motorcycle has Stage 1 (low restriction air filter and free flowing exhaust) or Stage 2 (mild performance camshafts) modifications, the ECM can generally make the required fuel changes at idle and part throttle cruise based on closed loop feedback from the oxygen sensors. You can use the Twin Tuner to add fuel at wide open throttle.



**Table A - Twin Tuner II Settings****No Original Equipment Oxygen Sensors**

<b>Parameter</b>	<b>Fuel Trim Operating Range</b>	<b>Stage 1 Mods</b>	<b>Stage 2 Mods</b>	<b>Stage 3 Mods</b>
0	Display Off			
1	Idle 750-1250 RPM 0% TPS	0	-5	-5
2	Low cruise 1250-2000 RPM 2.5-50% TPS	5	10	12
3	High cruise 2000-3750 RPM 2.5-50% TPS	5	10	15
4	Wide open throttle 1250-2000 RPM 50-100% TPS	10	20	20
5	Wide open throttle 2000-2750 RPM 50-100% TPS	10	20	25
6	Wide open throttle 2750-3750 RPM 50-100% TPS	10	20	30
7	Wide open throttle 3750-4750 RPM 50-100% TPS	10	20	30
8	Wide open throttle above 4750 RPM 50-100% TPS	10	20	30
9	Decel above 1250 RPM and less than 2.5% TPS	0	0	0
10	Acceleration enrichment	4	5	7
<b>Parameter</b>	<b>Ignition Retard Operating Range</b>	<b>Stage 1 Mods</b>	<b>Stage 2 Mods</b>	<b>Stage 3 Mods</b>
11	Idle 750-1250 RPM 0% TPS	0	0	0
12	Low cruise 1250-2000 RPM 2.5-50% TPS	0	0	2
13	High cruise 2000-3750 RPM 2.5-50% TPS	0	0	3
14	Wide open throttle 1250-2000 RPM 50-100% TPS	0	0	5
15	Wide open throttle 2000-2750 RPM 50-100% TPS	0	0	5
16	Wide open throttle 2750-3750 RPM 50-100% TPS	0	0	4
17	Wide open throttle 3750-4750 RPM 50-100% TPS	0	0	4
18	Wide open throttle above 4750 RPM 50-100% TPS	0	0	4
19	Decel above 1250 RPM and less than 2.5% TPS	0	0	0

**Notes:**

1. These values will result in a slightly rich initial setup that should be safe for most applications.
2. If spark knock is noted, higher timing retard values may be required for some applications.
3. Refer to the Twin Tuner Tech FAQ for further tuning suggestions.

**Table B - Twin Tuner II Settings****Original Equipment Oxygen Sensors Installed**

<b>Parameter</b>	<b>Fuel Trim Operating Range</b>	<b>Stage 1 Mods</b>	<b>Stage 2 Mods</b>	<b>Stage 3 Mods</b>
0	Display Off			
1	Idle 750-1250 RPM 0% TPS	0	-5	-5
2	Low cruise 1250-2000 RPM 2.5-50% TPS	0	5	10
3	High cruise 2000-3750 RPM 2.5-50% TPS	0	5	10
4	Wide open throttle 1250-2000 RPM 50-100% TPS	10	20	20
5	Wide open throttle 2000-2750 RPM 50-100% TPS	10	20	25
6	Wide open throttle 2750-3750 RPM 50-100% TPS	10	20	30
7	Wide open throttle 3750-4750 RPM 50-100% TPS	10	20	30
8	Wide open throttle above 4750 RPM 50-100% TPS	10	20	30
9	Decel above 1250 RPM and less than 2.5% TPS	0	0	0
10	Acceleration enrichment	4	5	7
<b>Parameter</b>	<b>Ignition Retard Operating Range</b>	<b>Stage 1 Mods</b>	<b>Stage 2 Mods</b>	<b>Stage 3 Mods</b>
11	Idle 750-1250 RPM 0% TPS	0	0	0
12	Low cruise 1250-2000 RPM 2.5-50% TPS	0	0	2
13	High cruise 2000-3750 RPM 2.5-50% TPS	0	0	3
14	Wide open throttle 1250-2000 RPM 50-100% TPS	0	0	5
15	Wide open throttle 2000-2750 RPM 50-100% TPS	0	0	5
16	Wide open throttle 2750-3750 RPM 50-100% TPS	0	0	4
17	Wide open throttle 3750-4750 RPM 50-100% TPS	0	0	4
18	Wide open throttle above 4750 RPM 50-100% TPS	0	0	4
19	Decel above 1250 RPM and less than 2.5% TPS	0	0	0
<b>Notes:</b>				
1. These values will result in a slightly rich initial setup that should be safe for most applications.				
2. If spark knock is noted, higher timing retard values may be required for some applications.				
3. Refer to the Twin Tuner Tech FAQ for further tuning suggestions.				



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Use the recommended setup table as a starting point for further tuning. If you have access to a dyno with an exhaust sniffer, refer to the following section for more guidelines. If you do not have access to a dyno, 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. If the idle still seems rich after using the recommended settings, try further reducing the idle fuel in -5% steps.
2. If the engine still runs rough or coughs (backfire through the intake) under part throttle cruise conditions, try adding an additional 5-10% fuel in the RPM ranges where problems are noted.
3. Performance modifications will generally increase the fuel requirement at wide open throttle. If the engine still runs rough or hesitates at wide open throttle, try adding 5-10% fuel in the RPM ranges where problems are noted.
4. If throttle roll-on response is poor, try using a higher value for acceleration enrichment.

If you have access to a load control dyno with an exhaust sniffer, you are in a much better position to make accurate adjustments. Skip steps 1-2 for models with oxygen sensors since the ECM can generally make the required fuel changes at idle and part throttle cruise based on closed loop feedback from the oxygen sensors (refer to following sections for more details about oxygen sensor equipped models).

1. Make sure the engine is fully warmed up and has reached normal operating temperature. Run the engine at idle. Trim the idle fuel, while observing the air/fuel ratio (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. If the idle AFR is still rich after using the recommended settings, try further reducing the idle fuel in -5% steps. 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 for low and high cruise. 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. Make appropriate fuel trim adjustments in each RPM range. 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 using a higher value for acceleration enrichment.

### ***Decel Popping***

Decel popping is sometimes encountered with open type exhaust systems without restrictive baffling. The solution involves modifying fuel values at closed throttle above the idle RPM range. Try removing fuel by using a negative value of 10-20% for fuel parameter 9 (decel range).