Twin Tec TCFI IID Fuel Injection System Tuning Manual

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OVERVIEW

The Twin Tec TCFI IID fuel injection controller replaces the original equipment (OE) 36 pin Delphi® controller on 2001-2008 Harley-Davidson® motorcycles with fuel injected Twin-Cam series engines. **The terms TCFI and PC Link TCFI are used throughout this document as generic terms and refer to the new TCFI IID controller and PC Link TCFI IID software unless otherwise noted.**

The TCFI is intended for 95 CID and larger high performance race engines that are expected to produce over 100 HP. The TCFI solves tuning problems with highly modified engines with long duration/high overlap camshafts

The only practical means of tuning any fuel injection system is with an exhaust gas analyzer. Tuning the TCFI requires the WEGO IID or IIID dual channel wide-band exhaust gas oxygen sensor interface.

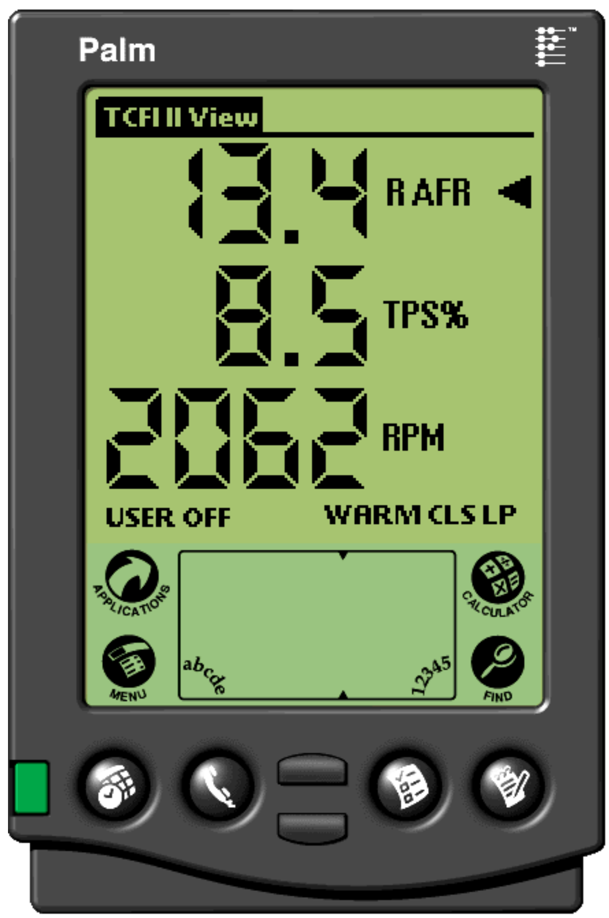
CAUTION: Tuning the TCFI requires competency in PC operation, using Microsoft Windows based programs, and basic engine tuning and fuel injection mapping concepts including the use of an exhaust gas analyzer to monitor air/fuel ratio (AFR). The TCFI installer is assumed to be familiar with the Delphi® fuel injection system and to have access to basic test equipment and factory service manuals.

WARNING: If you do not carefully read and follow all the instructions, you will probably damage your engine.

TUNING REQUIREMENTS

You must be able to monitor engine parameters including AFR and RPM during the tuning process. While you can use TCFI Log software and a laptop PC for this purpose, situations may arise where a mobile display system is required.

TCFI II View software allows using a Palm OS based handheld organizer (PDA) to view engine parameters on motorcycles equipped with the Twin Tec TCFI fuel injection controller. This facilitates tuning and diagnostics. You can view any three of the engine parameters that are logged by the TCFI system. Check our website at www.daytona-twintec.com for more information about TCFI II View, including PDA and cable requirements.



SYSTEM INSTALLATION

1. **Check for updates.** This tuning manual is for TCFI IID units with revision 7.0 firmware. Before proceeding, check our website at www.daytona-twintec.com for available updates for the TCFI firmware, accompanying PC based software, and documentation. Carefully read the instructions and familiarize yourself with operation of both the PC Link TCFI software used for tuning and the TCFI Log software used for data logging and analysis.

WARNING: You must use the new version 10.0 or higher PC Link TCFI IID software for setup and tuning. You cannot use the original PC Link TCFI software. To access all data, you must also use the new version 10.0 or higher TCFI Log software.

2. **TCFI Controller**. Carefully read the TCFI instructions and install the TCFI unit
3. **WEGO wide-band exhaust gas oxygen sensor interface.** Carefully read the WEGO instructions and install the WEGO unit.
4. **Initial setup and tuning.** Follow the instructions in this tuning guide. Do not start the engine until initial setup has been completed.

EDITING AND FILE OPERATIONS

After initial setup, the TCFI tuning process requires multiple edits of the engine tables and parameters using PC Link TCFI software. Unless otherwise noted, editing involves downloading the current setup data in the TCFI, performing the required edits, saving table edits to buffer memory, saving the revised setup file to disk, and then uploading it to the TCFI. You should always print out any affected tables and parameters and save each revised file with a unique filename. Use a filename that incorporates the customer name and a date code, such as Chris_20060410a.dat. We suggest that you create a separate folder for all tuning files. Keep detailed written notes on the changes you make and the associated filenames. Make frequent backup copies onto removable media such as floppy disk or CD.

New customers with limited PC experience often become confused and have problems with simple Windows file management functions including the use of the Windows Explorer. We regret that we cannot provide tech support for Windows related issues. We suggest that you spend some time practicing with the PC Link TCFI and TCFI Log software, including the Copy, Paste, and Modify commands on the right mouse button pop up menu.

CAUTION: If you fail to backup your tuning files, and you have a system crash, there is nothing we can do to help you recover.

OVERVIEW OF TCFI OPERATION

The TCFI controls air/fuel ratio (AFR) and idle RPM using individual control loops. Each control loop can operate open loop (without feedback correction) or closed loop (with feedback correction) depending on conditions.

If you are not familiar with control systems concepts such as open and closed loop operation, we suggest that you order Understanding Automotive Electronics (Sixth Edition) by William B. Ribbens from www.amazon.com. Chapter 2 includes an excellent introduction to control system theory.

The output of the AFR control loop is injector pulse width. A higher pulse width causes more fuel to be injected and decreases the AFR towards a rich condition. An initial estimate of engine horsepower and injector size (flow rate) is used to calculate a base injector pulse width. Base injector pulse width corresponds to the amount of fuel required to generate a stoichiometric mixture (14.7 AFR) at wide open throttle (WOT), 6,000 RPM and standard atmospheric conditions. Base injector pulse width then corrected for intake air temperature (IAT) and barometric pressure.

At any given RPM and throttle position (TPS), the corrected base injector pulse width is multiplied by the values in the Alpha-N table (main fuel table), AFR table (the AFR command), front cylinder trim table (only for the front cylinder), and block learn multiplier (BLM) tables. The BLM tables store closed loop correction factors based on feedback from the WEGO system. Independent BLM tables are used for front and rear cylinders. The BLM tables are continually updated whenever the system is operating in closed loop (generally 30 seconds after engine start). The BLM tables are updated based on the AFR error (difference between AFR command and actual AFR read by the WEGO system).

Additional cold start enrichment fuel is applied based on engine temperature and elapsed time since engine start. Priming fuel is injected when the run/stop switch is cycled on. A fixed pulse width injection is also used during cranking (RPM < 400). Two tables set the priming and cranking pulse widths based on engine temperature.

The output of the idle RPM control loop is idle air control (IAC) stepper motor position ranging from 0-127. A higher IAC value allows more air flow and increases engine RPM. A table sets the idle RPM command as a function of engine temperature. This allows a higher idle RPM while the engine is cold. Closed loop idle RPM control is only enabled when vehicle speed is zero and TPS is less than the idle TPS value (usually 1%). Under open loop conditions (such as the motorcycle being driven while the engine is warming up), IAC position is continually adjusted based on engine temperature and elapsed time since engine start. When the engine is fully warmed up, the system assumes that the IAC position will be close to a nominal value (usually 30). Additional idle air (IAC > nominal IAC value) is considered the same as increasing TPS since the effect on airflow is identical. Under cold start conditions, when the IAC value is high, the system may be using the 2.5% or 5% TPS rows in the fuel tables even when the throttle is closed.

For more detailed explanations of the AFR and idle RPM control loops and various tables, please download the TCFI IID Idle Tuning Tech Note.

INITIAL SETUP

The TCFI requires setup, using PC Link TCFI software, before running the engine for the first time. Setup establishes module parameters such as engine horsepower, injector size, and appropriate ignition and fuel control tables. You should carefully read this entire instruction manual before proceeding.

Setup data files are provided in the program folder for typical engine applications. Refer to Table 3 on page 13 for details. Additional setup guidelines for aftermarket throttle bodies and larger displacement engines are given on page 8. Setup your TCFI unit as follows:

1. Connect the PC link cable between the TCFI unit and your PC.
2. Start the PC Link TCFI software, use the Open File command, and open the appropriate setup file.
3. Use the Edit Basic Parameters command. Make any required changes such as estimated horsepower, injector flow rating (refer to Table 1 on page 8), and RPM limit. Multiply rear wheel dyno horsepower by 1.1 to arrive at an estimated engine horsepower figure. **You must set the VSS frequency for your model.** This affects speedometer/odometer scaling, idle RPM control, and turn signal cancellation. Refer to page 12 of the PC Link TCFI instructions. 2007-2008 models will also require setting the 6th gear ratio. This will be done later as part of the tuning process. Do not change any other parameters or options unless there is a specific reason to do so. Click OK when done.
4. Use the Save File command to save your initial setup file with an easily identifiable name (refer to suggestions on page 2).
5. Turn the ignition key and run/stop switch on.
6. Upload the setup data to the TCFI unit.
7. Cycle the run/stop switch. This initializes the IAC motor.
8. Follow the instructions for tuning the system, from the throttle body setup described below through the final checks listed on page 7.
9. If you have questions or encounter problems, please contact our tech support.

WARNING: Files created with earlier versions of PC Link TCFI IID are automatically converted to the new file format used by version 10.0. However, several tables and parameters must be edited. If you plan to use one of your old files, please contact our tech support for assistance.

THROTTLE BODY SETUP

An alpha-N (throttle position and RPM based) fuel control system such as the TCFI requires that certain condition be met by the throttle body. All aftermarket throttle bodies and even some stock Delphi® units will require adjustment for proper operation.

Idle control is by means of the IAC system. The throttle blade(s) must remain at a fixed position against the idle stop screw when the throttle is closed. The throttle body is affected by thermal expansion. If the idle stop setting allows the throttle blade(s) to completely close and contact the throttle bore, the blade(s) may bind while cold. If the idle stop setting forces the throttle blade(s) to stay open too far, the IAC system can lose control and set a diagnostic code.

Either case can result in starting and idle stability problems.

Issues with throttle blade, linkage or cable binding are often encountered with installation of an aftermarket throttle body. Verify that the throttle system operates smoothly, that the take up cable has some slack, and that the return cable forces the throttle blade(s) against the idle stop. Verify that the throttle blade(s) do not bind when cold or hot.

If an initial adjustment is required for a new aftermarket throttle body and the manufacturer does not make a specific recommendation, set the idle stop screw so that the throttle blade(s) just barely open and do not bind when the engine is cold.

The IAC actuator and wire harness connections changed on 2006 and later models. If you install an aftermarket throttle body on 2006 and later models and reuse the original equipment IAC actuator, you will not encounter any problems. If the aftermarket throttle body requires the earlier style actuator, you must swap the wires going to pins A and C. If you install the new 50mm Screamin' Eagle® throttle body (P/N 27623-05) on a 2001-2005 model, you must swap the wires going to pins A and C on the IAC actuator. Incorrect IAC connections will cause idle speed control to fail. This will result in erratic engine operation and the ECM setting IAC related diagnostic codes.

IDLE TPS CHECK & ADJUSTMENT

Proper operation of the TCFI system depends on an accurate throttle position sensor (TPS) signal. You can use TCFI Log or TCFI View software to check the TPS sensor. Carefully read the software instructions before proceeding.

Connect the PC Link cable and start TCFI Log or TCFI View software. Turn the run/stop switch on but do not start the engine. For TCFI Log, use the View Idle TPS command on the View menu. Idle TPS volts are displayed on the TPS bar graph gauge. For TCFI View, select TPS volts display. With the throttle closed, the TPS value must be within the range of .30-.80 volts.

Some aftermarket throttle bodies are supplied with undercut screws that facilitate TPS sensor adjustment. If you need to make an adjustment and you do not have the undercut screws, you will have to enlarge the holes and then use #8 flat washers with the original screws. For 2001-2005 TPS sensors, carefully drill out or press out the brass bushings. For 2006 TPS sensors, cut the plastic alignment tab off the back of the sensor to allow adjustment.

Do not attempt to substitute the older style Marelli TPS sensor. While the older style TPS sensor has screw slots that provide easy adjustment, it has a different output characteristic.

IDLE TUNING

Once the initial setup has been completed, the TCFI unit is ready for operation. Some applications will require adjustment of the idle stop screw. This should be completed before the motorcycle is driven.

Please note that during the initial period after engine start, fuel control is open loop (no feedback from the WEGO sensors) and relies entirely on correct values in the Alpha-N table. The TCFI will enter closed loop AFR control mode after the WEGO warm up time (nominal value of 30 seconds) has elapsed.

To allow viewing and logging AFR data immediately after engine start, turn the ignition switch on but leave the run/stop switch in the stop position. Wait 30 seconds for the WEGO sensors to warm up and then start the engine. Monitor engine data and status with TCFI Log or TCFI View software.

Allow the engine to idle until it reaches normal operating temperature (110-130° C). A fan should be used to direct cooling air on the engine to more realistically simulate actual warm up conditions and prevent the engine from overheating. If the engine does not start or stalls, please refer to the diagnostic tips at the end of this section on page 5.

Monitor front and rear cylinder AFR and BLM, engine temperature, and IAC values. Keep notes on your observations of these values. After 30 seconds, the system should be operating in closed loop and maintaining the desired idle AFR (nominal value of 13.5). The BLM values should remain within the range of 90-110%. The IAC value should slowly go down as the engine reaches operating temperature and requires less idle air.

BLM values below 100% indicate that the TCFI is removing fuel in closed loop to correct a rich condition. BLM values above 100% indicate that the TCFI is adding fuel in closed loop to correct a lean condition.

If the BLM values go below 80% or above 120% anytime during the warm up period, the system is running out of adjustment range and the idle cells in the Alpha-N fuel table should be edited before proceeding with further tuning.

Download the current setup with PC Link TCFI software and use the Edit 3D Table – Alpha-N Table command to edit the idle cells in the Alpha-N fuel table.

Depending on engine temperature, IAC value and idle RPM, the TCFI will be using the cells in the 750, 1,000, 1,250, and 1,500 RPM columns and the 0%, 2.5% (IAC between 50-80), and 5% TPS (IAC above 80) rows. You can select all these cells, right click the mouse, and then use the Modify command on the pop-up menu. Add a percentage corresponding to the BLM error. For example, if the worst case BLM value noted was 120%, add 20% fuel by entering +20% (not +20). Likewise, if the worst case BLM value was 80%, subtract 20% fuel by entering -20%. Remember to use the Save Table Edits to Buffer command after editing the table. Then use the Edit 3D Table – BLM Tables – Reset BLM Tables command to reset all BLM values to 100%. Save the edited setup file to disk and upload it to the TCFI.

As mentioned above, the IAC value should slowly go down as the engine reaches operating temperature. The IAC value should drop to near the nominal value of 30 (as set under basic module parameters). If the IAC value stays above 40 or drops below 25, the idle stop screw will require adjustment before proceeding with further tuning. Stock Delphi® and Screamin Eagle® throttle bodies may require drilling out and retapping the idle stop screw.

Some “trial and error” adjustments to the idle stop may be required to obtain the nominal IAC value. Turn the engine off and let it cool down between adjustments. If the IAC position is too high, turn the idle stop screw clockwise in ½ turn increments between trials to allow more air to flow through the throttle blade(s). **Please note that if you make any adjustment to the idle stop screw, you must also recheck (and possibly re-adjust) the idle TPS setting as explained in the previous section.**

CAUTION: Failure to perform required TPS and idle stop adjustments is the leading cause of installation problems requiring tech support.

After making any required edits and idle adjustments, repeat the start test and allow the engine to reach normal operating temperature. Make sure the engine runs for at least 4 minutes and the status display shows warm closed loop operation – otherwise BLM values will not be saved.

The idle tuning step is complete when BLM values stay within the range of 85-115% during the warm up phase and the IAC value is within the range of 25-40 once the engine reaches normal operating temperature. If these criteria cannot be met, please contact our tech support before proceeding.

For additional idle tuning information, please download the TCFI IID Idle Tuning Tech Note.

Diagnostic tips if the engine does not start:

1. Verify that the TCFI is properly installed and set up, that the battery is fully charged, that the IAC system is initialized (cycle run/stop switch), and that the engine is not flooded from excessive priming caused by repeatedly cycling the run/stop switch during setup. Disconnect the fuel pump relay and crank the engine to clear flooding.
2. Try the following starting procedure: set the run/stop switch to run, wait until the fuel pump stops running, slightly open the throttle, and then press the starter switch. If the engine starts, the problem is insufficient air caused by an incorrect idle stop setting. Try turning the idle stop screw clockwise in ½ turn increments between trials.
3. Ether starting spray can be used as a diagnostic aid. Try starting the engine after an application of ether spray. If the engine starts and momentarily runs at an abnormally high idle RPM, the problem is excessive air caused by an incorrect idle stop setting. Try turning the idle stop screw counterclockwise in ½ turn increments between trials. Otherwise, if the engine starts and runs at a normal idle RPM, the problem is insufficient fuel. Try increasing the priming and cranking fuel values by 10-20%. Download the current setup with PC Link TCFI software and use the Edit 2D Table – ET Based Priming Fuel Table and ET Based Cranking Fuel Table commands. Select all cells, right click the mouse, use the Modify command on the pop-up menu, and enter +10% (not +10). Remember to use the Save Table Edits to Buffer command after editing each table. Save the edited setup file to disk and upload it to the TCFI. Retest and repeat if additional fuel seems to be required.
4. If larger fuel injectors were installed, cranking and priming fuel values may need to be decreased. Try decreasing the priming and cranking fuel values by 20%. Download the current setup with PC Link TCFI software and use the Edit 2D Table – ET Based Priming Fuel Table and ET Based Cranking Fuel Table commands. Select all cells, right click the mouse, use the Modify command on the pop-up menu, and enter -20% (not -20). Remember to use the Save Table Edits to Buffer command after editing each table. Save the edited setup file to disk and upload it to the TCFI.

5. Try re-installing the stock ECM. Cycle the run stop switch to re-initialize the IAC system. If the engine does not start with the stock ECM, there may be an underlying problem that requires correction. If the engine starts with the stock ECM but not the TCFI, please contact our tech support for assistance.

Diagnostic tips if the engine stalls:

1. If the engine momentarily starts, runs for several revolutions (less than 2 seconds), and then stalls, priming and cranking fuel values may be insufficient to build up the required fuel film in the intake manifold. Try cycling the run/stop switch several times to add additional priming fuel before starting the engine. If the engine starts normally, you have confirmed that more fuel is required. Try adding 10-20% more priming and cranking fuel as explained in Paragraph 2 in the preceding section.
2. If the engine stalls after running for several seconds, observe AFR values. To do this you must allow the WEGO sensors to warm up 30 seconds before starting the engine. You can observe data in real time or download data logged using TCFI Log. For best results, use PC Link TCFI to set the data logging interval to 0.1 seconds. In most cases, the problem is caused by excessively lean AFR. Based on observed AFR values, make appropriate corrections to the idle cells in Alpha-N table. If the AFR is lean, try adding 10-20% fuel (use the procedure explained on page 4). If this does not solve the problem, please contact our tech support for assistance.
3. In some cases, changes to the cold start enrichment tables may be required. The new firmware and software support independent ET (engine temperature) based front and rear cylinder cold start enrichment tables. To allow viewing and logging AFR data immediately after engine start, turn the ignition switch on but leave the run/stop switch in the stop position. Wait 30 seconds for the WEGO sensors to warm up and then start the engine. Monitor engine data and status with TCFI Log. Download the logged data. Compare the front and rear AFR values after engine start to determine if adjustments are required. Refer to the TCFI IID Idle Tuning Tech Note for more details.

AUTO-TUNING

The closed loop auto-tuning process consists of operating the motorcycle through a wide range of loads and speeds while periodically monitoring progress using the PC Link TCFI software. Long rides at constant speed and load are of no value. The best technique is to very slowly accelerate through the useable RPM range in every gear, allowing several seconds of operation in each RPM and throttle position based cell. Also operate the motorcycle at various fixed speeds likely to be encountered during normal riding. For safety reasons, wide open throttle runs should be done on a closed course.

We recommend auto-tuning under actual riding conditions. If this is not possible, you can auto-tune on a load control dyno. Vehicle and engine manufacturers perform calibrations on dyno systems equipped with computer controlled variable speed fan drives that closely match the air velocity at the front of the engine to roll speed. Dynojet load control systems widely used for aftermarket tuning lack this level of sophistication and are incapable of simulating realistic operating conditions over an extended period of time. We have also observed considerable problems with maintaining steady RPM values during load control on Dynojet equipment. If you plan to auto-tune on a dyno, please contact our tech support for details.

Use TCFI View to monitor AFR. If AFR values appear very lean (above 14.5), we suggest that you edit the Alpha-N table to add 15-20% fuel to all cells except idle cells before proceeding. Auto-tuning works best if you start with a slightly rich Alpha-N table. Download the current setup with PC Link TCFI software and use the Edit 3D Table – Alpha-N Table command. You can select groups of cells, right click the mouse, use the Modify command on the pop-up menu, and enter +15% (not 15). Remember to use the Save Table Edits to Buffer command after editing each table. Save the edited setup file to disk and upload it to the TCFI

After 1-2 hours of engine operation, download the current setup with PC Link TCFI software and use the Edit 3D Table – BLM Tables – Edit Front and Edit Rear BLM Table commands to examine the BLM tables. Cells that are shaded red indicate that the system has run out of correction range. If you see red cells on a BLM table, you should use the corresponding Apply BLM Table command to automatically correct the Alpha-N fuel table and front cylinder trim table. This also resets all the BLM values back to 100% and allows auto-tuning to continue. Save the edited setup file to disk and upload it to the TCFI.

Auto-tuning is a statistical process. The longer the operating time, the greater the probability that more cells will be covered. However, even a varied operating cycle can miss some cells. After you use the Apply BLM Table commands, take some time to examine the modified Alpha-N and front cylinder trim tables. Unless your engine has some unusual camshaft and exhaust interactions, the tables should appear smooth (with gently rising slopes). If you spot sharp spikes or dips, these cells have probably been missed during auto-tuning and will require some manual edits to smooth them into the surrounding terrain.

The Alpha-N table represents percent injector pulse width (fuel flow) before correction for BLM, front cylinder trim, barometric pressure, intake temperature, and cold start enrichment. You can use the following guidelines to smooth the Alpha-N table:

1. At part throttle (low TPS%), Alpha-N values in each row will tend to decrease as RPM increases (because the throttle is choking air flow).
2. At wide open throttle, Alpha-N values in each row will tend to follow the engine torque curve.
3. In any given RPM column, Alpha-N values must always increase with TPS.

The front cylinder trim table may appear more complex and irregular, with peaks and valleys corresponding to gas flow interactions within the intake and exhaust system. However, very sharp spikes and dips may require some smoothing.

If you edit the Alpha-N or front cylinder trim table to smooth out values, remember to use the Save Table Edits to Buffer command after editing each table. Save the edited setup file to disk and upload it to the TCFI.

Continue to operate the motorcycle under varying conditions for another 1-2 hours. Then repeat the process of downloading setup data, examining the BLM tables, using the Apply BLM Table commands, smoothing the Alpha-N and front cylinder trim tables, saving, and uploading back to the TCFI as previously described.

Repeat this process until most of the BLM cells remain in the 90-110% range.

If spark knock is noted under wide open throttle or throttle roll-on, use PC Link TCFI software to edit the ignition advance table and reduce the ignition advance 3-5 degrees under the conditions that cause spark knock. Using the TCFI Log software to examine engine data may be very helpful for determining exactly what manifold pressure and RPM values were encountered. A common error is to assume spark knock only occurs at high MAP (manifold absolute pressure) values. Large displacement engines are prone to spark knock at relatively low MAP values during throttle roll-on. You may need to reduce the ignition advance throughout the entire MAP range.

FINAL CHECKS

1. **Idle tuning.** Verify that the idle TPS is .30-.80 volts. On cold start, verify that the AFR values stay in the 11.5-14.5 range during the first 30 seconds before closed loop operation. After the engine has reached normal operating temperature and has been operated for at least 15 minutes, verify that the IAC position is in the range of 25-40 steps at idle. On hot restart after 5-10 minute hot soak, verify that the AFR values do not exceed 15.0 before closed loop operation.
2. **Auto-tuning.** The auto-tuning process is considered complete when most BLM table cells remain in the 90–110% range.
3. **Spark knock**. Verify absence of spark knock during throttle roll on and wide open throttle acceleration.
4. **System operation**. Verify that the speedometer reading is accurate and that the turn signals cancel properly.
5. **2007-2008 models only**. Verify proper operation of 6th gear indicator light. If required, operate the motorcycle at a steady speed around 50 MPH in 6th gear and then download data with TCFI Log. Use the gear ratio display function to determine the actual 6th gear ratio and enter this value into Module Parameters.

FUEL INJECTOR SIZING

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. 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 TCFI system cannot correct this problem.** Aftermarket throttle bodies with dual independent runners do not suffer from this problem and the fuel injectors can be run up to 80% duty cycle. At high duty cycles, fuel may puddle up in front of the intake valve but will ultimately be inducted into the correct cylinder. Stock Delphi® injectors are rated at 3.91 or 4.22 gm/sec flow depending on model year. We offer larger injectors rated at 6.0 gm/sec (fit 2001-2005 applications only). Table 1 lists conservative horsepower limits based on injector size and type of throttle body.

WARNING: H-D® has issued Service Bulletin M-1185. Most 2006 models have narrow 8° spray pattern injectors (P/N 27625-06) that cause poor cold start, idle, and cruise. The replacement injectors (P/N 27709-06A) have a 25° spray pattern. You must verify that the injectors have been replaced. The TCFI will not operate correctly with the original injectors.

Table 1 – Recommended Horsepower Limits

Injector Size	Siamesed Runners	Dual Runners
3.91 gm/sec (stock 2006-2008. Not recommended for performance applications)	80 HP	Not available
4.22 gm/sec (stock 2001-2005)	85 HP	135 HP
4.89 gm/sec (2006 Screamin Eagle® P/N 27654-06)	100 HP	Not available
6.0 gm/sec (Twin Tec)	120 HP	195 HP

WARNING: If you significantly exceed these horsepower limits, the result may be a lean cylinder and possible engine damage at high RPM wide open throttle.

LARGE DISPLACEMENT ENGINES

For large displacement engines and/or higher flow injectors, you can modify one of the 95 or 96 CID setup files by editing the module parameters and entering appropriate values for the estimated engine horsepower and injector flow rate.

The TCFI has been successfully applied to engines as large as the S&S Cycle 145 Tribute. Engines over 103 CID may require additional tuning procedures. Please contact our tech support for details.

The dimensions of the IAC pintle and idle air ports on currently available throttle bodies may not allow sufficient airflow for starting 120 CID and larger engines at low ambient temperatures. In this case, the customer must be instructed to use the following cold weather starting procedure: set the run/stop switch to run, wait until the fuel pump stops running, slightly open the throttle, and then press the starter switch.

The stock starting system is inadequate for high displacement, high compression engines. For these applications, you must install compression releases and upgrade the starter, ring gear/pinion, and battery. Based on customer feedback, the best available starting system is the combination of a Tech Cycle 2.0 KW Tornado starter, Rivera Engineering 84 tooth ring gear/pinion set, and Yuasa YuMicron CX battery.

THROTTLE BODY AND INTAKE RECOMMENDATIONS

95 CID or higher displacement engines will require an aftermarket throttle body and low restriction air cleaner for maximum performance. We recommend a throttle body with at least 50 mm ID. Smaller throttle bodies or modified stock throttle bodies will not allow sufficient air flow at high RPM. This can be verified by examining MAP (manifold pressure) during a dyno run with TCFI Log software.

Front cylinder fuel imbalance may become intolerable with large displacement engines unless a dual independent runner intake and throttle body system is used. We have tested BC Gerolamy Dual Flow and S&S Cycle VFI Induction systems. If you plan on using another dual runner type system, please contact our tech support before proceeding.

BC GEROLAMY DUAL FLOW THROTTLE BODY

Follow the installation instructions supplied with the throttle body. You can use the stock Delphi® injectors for applications up to 135 HP. Use the setup file TCFI_Setup_2001_Gerolamy.dat. This setup file is intended for a 95 CID engine. For large displacement engines, you can modify this setup file by editing the module parameters and entering an appropriate value for the estimated engine horsepower and injector flow rate.

S&S CYCLE VFI INDUCTION SYSTEM

The TCFI has been successfully retrofit on many problematic VFI systems. VFI systems are supplied with various fuel injectors. Contact S&S Cycle for information on the injector size supplied with your system. Follow the installation instructions supplied with the VFI system, with the following exceptions:

1. Some early production units have undersize idle air ports. All idle air ports leading to and from the IAC control must be at least 0.312" diameter. If required, mill ports to 0.312" diameter in a Bridgeport mill (do not attempt to use a drill). Tilt the milling machine head to match the angles of the idle ports. Remove the TPS sensor to facilitate clamping the throttle body in a vise.
2. When installing the VFI Induction, disregard the S&S Cycle instructions related to idle stop and TPS adjustment. Follow the procedures we give on pages 3-4.
3. Carefully check wiring connections. All OE H-D® signals (refer to H-D® Electrical Diagnostic Manual) must be connected. Common problem areas include failure to connect the vehicle speed sensor (VSS) signal. Some VFI applications did not use a manifold absolute pressure (MAP) sensor. The TCFI requires a MAP sensor ported to the front cylinder intake runner.
4. Use the setup file TCFI_Setup_2001_VFI.dat. This setup file is intended for a 95 CID engine and the S&S Cycle 4.6 gm/sec injectors commonly supplied with the VFI Induction System. You can modify this setup file by editing the module parameters and entering an appropriate value for the estimated engine horsepower and actual injector size.

IDLE TUNING CONSIDERATIONS

Some large displacement engines with high overlap/long duration camshafts may not idle properly at the nominal 1,000 RPM and 13.5 AFR settings used in the standard setup files. You may have to increase the idle RPM to a higher value such as 1,100 RPM and enrich the idle to 12.5-12.8 AFR.

Download the current setup with PC Link TCFI software and use the Edit 2D Table – ET Based Idle RPM command to increase the idle RPM. Do not decrease values at the left of the table (corresponding to a cold start condition) that are already higher than your desired idle RPM. If you significantly increase idle RPM, you may also have to make corresponding edits to the ET Based IAC Position table. Please contact our tech support for details.

Then use the Edit 3D Table – AFR Table command and change the applicable idle cells (750 - 1,500 RPM at 0-5% TPS) to the desired AFR value. Remember to use the Save Table Edits to Buffer command after editing each table. Save the edited setup file to disk and upload it to the TCFI.

For additional idle tuning information, please download the TCFI IID Idle Tuning Tech Note.

DYNO TUNING CONSIDERATIONS

Auto-tuning using the procedures listed on pages 6-7 will get you within a few horsepower of the maximum that the engine can deliver. If you decide to do dyno tuning for maximum power, you can experiment with wide open throttle (WOT) ignition timing and AFR. **Please pay careful attention to the following dyno tuning considerations:**

1. **Only edit the ignition advance and AFR tables.** Don't edit any other tables (never make any changes to the BLM or Alpha-N tables once auto-tuning is completed). The usual range for WOT ignition timing at 4,000-6,000 RPM is about 28-34 degrees BTDC. The usual range for WOT AFR is about 12.5-12.8. Some engines may require a richer mixture, possibly down to 11.5, to avoid detonation problems.
2. **The TCFI should be operated in closed loop.** Make sure that the engine is warmed up (oil temperature is in the 150-180° F range) before doing a run and that engine status in TCFI Log or TCFI View shows closed loop operation. If you have made any table edits, allow one run for auto-tuning before capturing data.
3. **Inadequate air flow for engine cooling is a major problem with many dyno systems.** Always let the engine cool off between dyno runs. The use of a separate heavy duty industrial grade fan capable of generating at least 50+ MPH air velocity at the front of the engine is recommended. You can measure the air velocity with a handheld anemometer such as Extech P/N 45118 available from Grainger.
4. **Use the TCFI data logging capability.** Set the data logging interval to 0.1 seconds. Always download data with TCFI Log software at the end of every run and study the results. Check engine and air temperatures, throttle position, manifold pressure, and AFR. TCFI Log is a very powerful tool that can help you identify potential problems

that may be affecting engine performance. Inconsistent dyno test results are often the result of thermal problems (engine temperature variations or hot soak effects).

5. **Dyno exhaust sniffer limitations.** Some of the older sniffers monitored CO and CO_2. These systems are so slow and inaccurate that they should be totally disregarded. Modern sniffers from Dynojet and Horiba use a wideband sensor similar to the WEGO sensor. These sniffers are still subject to erroneous lean readings caused by reversion of atmospheric oxygen if the probe cannot be inserted past the baffles in the exhaust. Sensor degradation caused by leaded racing gas is a common occurrence. Another problem is sampling delay due to the long hose between the sniffer tip and actual sensor. The bottom line is to trust your WEGO sensors and disregard any errant readings from an exhaust sniffer.

ENGINE TUNING GUIDELINES

Higher AFR values correspond to a leaner (less fuel) condition. The practical operating range for most engines using gasoline fuel is from approximately 11.5 to 14.7 AFR. Combustion of a stoichiometric mixture (exactly enough air to burn all the fuel) results in 14.7 AFR indication. Automotive engines with catalytic converters operate near 14.7 AFR during cruise and idle. Air-cooled motorcycle race engines usually require a richer mixture to limit cylinder head temperature and prevent detonation. Table 2 lists recommended AFR values for race engines without emission controls.

Table 2 – Recommended AFR Values

Operating Mode	Recommended AFR
Cold Start (first 30 sec)	11.5-12.5
Idle	12.8-13.5
Part Throttle Cruise	13.0-14.0
Wide Open Throttle	12.5-12.8 (values down to 11.5 may be used to reduce detonation)

EXHAUST CONSIDERATIONS

The use of a WEGO system for closed loop fuel control places constraints on the choice of exhaust system. The WEGO system may give inaccurate results in certain situations:

Exhaust reversion. Reversion is the term for a negative pressure wave that can suck ambient air back into the exhaust and cause an erroneous lean AFR indication. Open drag pipes suffer from reversion effects. Please note that if you use drag pipes or other open pipes, auto-tuning may not be possible at idle or part throttle due to reversion effects. Fuel tables for idle and part throttle cells will have to be tuned manually. You can modify drag pipes by welding washers that block off at least 2/3 of the ID about 3-4 inches from the end of the pipes. This will increase mid-range torque and should reduce reversion effects enough to allow proper operation of the WEGO. Reversion effects will also occur with certain exhausts used on “bagger” style motorcycles, where two pipes split off near the rear cylinder. At part throttle, air is actually sucked into the left tailpipe. The only solution is to install a true dual type performance exhaust. Reversion effects will be most noticeable at idle, part throttle low RPM cruise, and decel.

Excessive scavenging. Tuned exhausts in combination with a high overlap camshaft profile can pull unburned air and fuel mixture through the cylinder into the exhaust and cause an erroneous rich AFR indication. Some aftermarket 2-into-1 systems, such as the Thunderheader appear to suffer from this problem, whereas others such as the Supertrapp, Vance & Hines Pro Pipe and White Brothers E-series seem less affected.

Misfiring. If the AFR is so rich that the engine misfires, high levels of oxygen will remain in the exhaust gas and result in an erroneous lean indication.

CAUTION: Insistence on using an inappropriate exhaust and consequent failure of auto-tuning is a major cause of installation problems requiring tech support.

HOT STARTING PROBLEMS

Some Twin-Cam engines are prone to hot starting problems. When cranked after a short hot soak, the engine may “kick back.” Over time, this will cause damage to the ring gear and starter pinion.

The TCFI module uses an improved starting algorithm that includes a programmable cranking delay. The TCFI module is shipped with a zero cranking delay: it fires on the first recognized compression stroke. This works best on stock and mildly modified engines.

High compression engines will generally require compression releases. When compression releases are installed, best starting results will be obtained by programming the TCFI module for a 1-2 revolution cranking delay. This can be done by means of the PC Link TCFI software.

SPARK KNOCK PROBLEMS WITH HIGH COMPRESSION ENGINES

Spark knock problems may be encountered with high compression engines. If engine parts were "mixed and matched" from different suppliers, the actual compression ratio may differ substantially from the expected value. You cannot estimate compression ratio with cranking compression tests, as camshaft timing usually causes an erroneous low reading.

To accurately calculate compression ratio, you must measure the combustion chamber volume and use the formula:

$$\text{Compression Ratio} = \frac{\text{Head cc} + \text{Deck cc} + \text{Cylinder Volume}}{\text{Head cc} + \text{Deck cc}}$$

The practical limit for compression ratio is about 10.5:1 to 11:1 when running 93 octane pump gas. Any higher compression ratio will require retarding the ignition timing to the point where more power is lost from the retarded timing than is gained from the higher compression.

If spark knock is encountered during operation, you can use the TCFI Log software to download data and examine the operating conditions (RPM and manifold pressure) where spark knock occurred. You can then make appropriate reductions to the ignition advance table. Large displacement, high compression engines are prone to spark knock at relatively low MAP values during throttle roll-on. You may need to reduce the ignition advance throughout the entire MAP range.

2007 H-D® MODELS WITH CVO 110 CID ENGINE

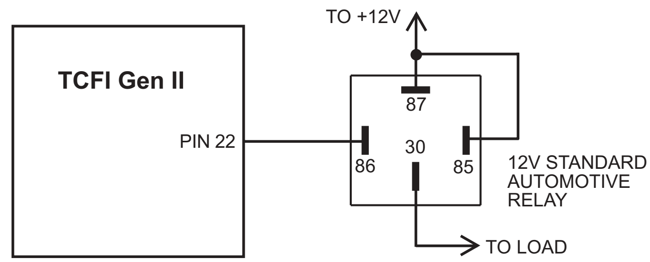
These models are equipped with an automatic compression release (ACR) system. When the TCFI is installed in these models, the ACR system must be modified. Please refer to the TCFI IID ACR System Tech Note on our website for details.

USER FUNCTIONS

Previous versions of the TCFI provided both a user input and output. On the TCFI IID, the pin formerly assigned as the user input is now assigned to the second WEGO sensor input. The user input function is no longer available.

The TCFI user output on pin 22 can drive a standard automotive relay connected as shown in Figure 1. When the user output is active, +12V power is applied to the load. Refer to the User Functions section of the PC Link TCFI instructions for details on programming the user output.

Figure 1 – User Output Relay Wiring Diagram



UPGRADES AND KNOWN ISSUES

The TCFI controller can be upgraded in the field by the user. Operating firmware is stored in FLASH memory and new firmware can easily be uploaded by means of the PC link cable. We suggest you periodically check our website at www.daytona-twintec.com for upgrades to the TCFI firmware and accompanying PC based software.

The TCFI system is new to the marketplace and as with all complex new computer systems, unforeseen issues may occur. As of the shipment date, there are no known issues other than those listed below.

Possible firmware corruption during dyno test. We suggest that you do not connect the PC link cable to any PC running Dynojet WinPEP software. Use a separate PC, such as a laptop with isolated ground. There appears to be a serial port conflict or noise issue from the Dynojet ignition pickup.

CUSTOM BIKE CONSIDERATIONS

The TCFI can be used for custom bike applications. The TCFI also has special features to accommodate aftermarket speedometers and tachometers, even on 2004-2006 H-D® models with the J1850 data bus. The TCFI does not require the presence of a turn signal/security module (TSM/TSSM). However, it does require all the engine sensors and actuators used with a standard H-D® application, including a vehicle speed sensor (VSS). Prior to installation on a custom bike, we suggest that you contact our tech support. Improper wiring connections, with missing or incorrect signals, are the most common problem encountered with custom bike applications.

The Delphi® ECM and TCFI both have a tach signal available on pin 3 of the 36 pin ECM connector. This is a one pulse per revolution (PPR) 12 volt square wave signal with 50% duty cycle that is compatible with all standard tachometers and other RPM activated accessories such as shift lights. 2004 and later models use the J1850 data bus for communication with original equipment tachometers, however the tach signal on pin 3 can still be used if you are installing an earlier style H-D® or aftermarket tach.

2001-2003 models have the vehicle speed sensor (VSS) connected to the speedometer. A VSS signal is routed from the speedometer to pin 33 on the 36 pin ECM connector. The J1850 data bus is used to send distance data to the turn signal/security module (TSM/TSSM) for turn signal cancellation. On 2004 and later models, the VSS is connected direct to pin 33 on the ECM. Speed and distance data is sent on the J1850 data bus to the speedometer and TSM/TSSM.

For all model years, the ECM requires a valid VSS signal for idle RPM control and turn signal cancellation. If you plan to install an aftermarket speedometer, you must maintain the VSS signal to the ECM. For 2004 and later models, you can try connecting the VSS input on the aftermarket speedometer to the existing VSS signal on pin 33 (leave the existing VSS ground and power connections undisturbed). After completing the hookup, you should test drive the motorcycle, download data with TCFI Log software, check VSS data, and verify that the ECM is still receiving a valid VSS signal. If the speedometer does not function with this hookup, it is not compatible with a fuel injected application.

TECH SUPPORT

If you require tech support for tuning issues, we will ask you to email us both the current setup file (downloaded by means of PC Link TCFI) and a data logging file (downloaded by means of TCFI Log) that shows the problem. The data logging files are large and tend to be corrupted when attached to an email. **You must use an archiving program such as PKZIP or WinZip to compress the files prior to attaching them to an email.** You can send email to techsupport@daytona-twintec.com. Please make sure that you include your full name, phone number, complete information about the engine setup, and a detailed description of the problem. We suggest that you call us first to discuss the situation.

Table 3 – Setup File Listing

Filename	**Description**
TCFI_Setup_2001_88CID.dat	2001-2005 88 CID engines with stock compression, mild performance camshafts, low restriction air cleaner, and low restriction exhaust. Also use this file for 2006 engines with aftermarket siamesed runner throttle body.
TCFI_Setup_2006_88CID.dat	2006 88 CID engines with stock compression, mild performance camshafts, new style H-D throttle body (inc. SE version), low restriction air cleaner, and low restriction exhaust.
TCFI_Setup_2001_95CID.dat	2001-2005 95 CID engines with 10:1 or higher compression, high flow heads, high performance camshafts, aftermarket type throttle body (50mm or greater), low restriction air cleaner, and low restriction exhaust. Also use this file for 2006 engines with aftermarket single plenum throttle body.
TCFI_Setup_2006_95CID.dat	2006 95 CID engines with 10:1 or higher compression, high flow heads, high performance camshafts, new style H-D throttle body (inc. SE version), low restriction air cleaner, and low restriction exhaust.
TCFI_Setup_2001_Gerolamy.dat	2001 and later 95 CID engines with 10:1 or higher compression, high flow heads, high performance camshafts, BC Gerolamy dual independent runner throttle body, low restriction air cleaner, and low restriction exhaust. **Call tech support for additional information before using on 2006-2008 applications.**
TCFI_Setup_2001_VFI.dat	2001 and later 95 CID engines with 10:1 or higher compression, high flow heads, high performance camshafts, S&S Cycle VFI induction system, and low restriction exhaust. **Call tech support for additional information before using on 2006-2008 applications.**
TCFI_Setup_2007_96CID.dat	2007-2008 96 CID engines with stock compression, mild performance camshafts, low restriction air cleaner, and low restriction exhaust.