



Twin Tec

VRFI D Version Fuel Injection System Tuning Manual

NOT LEGAL FOR USE OR SALE ON POLLUTION CONTROLLED VEHICLES

OVERVIEW

The Twin Tec VRFI D version fuel injection controller replaces the original equipment (OE) 36 pin Delphi® controller on 2002-2008 Harley-Davidson® V-Rod motorcycles with fuel injected VRSC engines. **The term VRFI is used throughout this document as a generic term and refers to the new VRFI D version controller unless otherwise noted.**

The VRFI is intended for high performance race engines. The VRFI 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 VRFI requires the new WEGO IIID dual channel wide-band exhaust gas oxygen sensor interface.

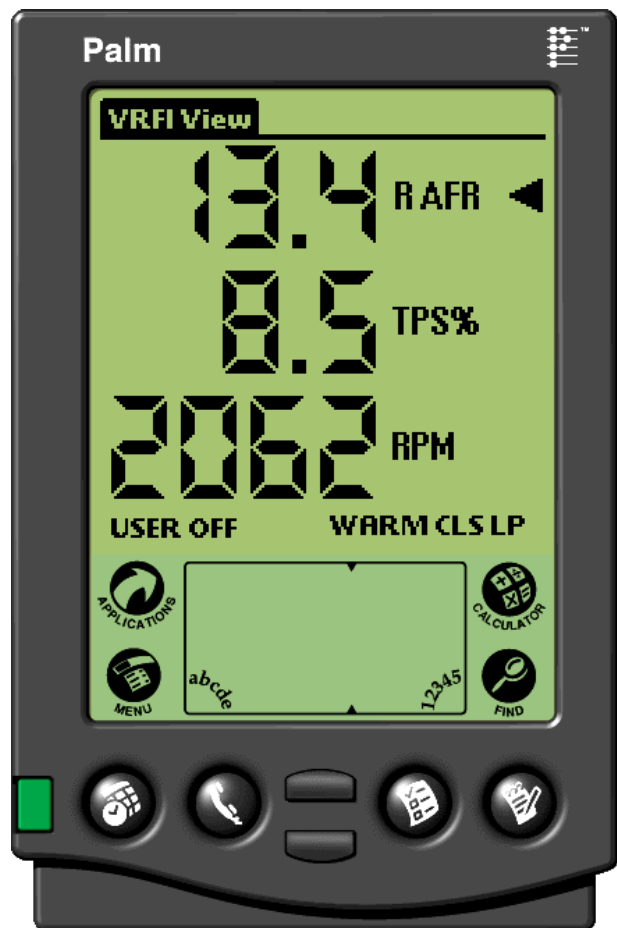
CAUTION: *Tuning the VRFI requires competency in PC operation, using Microsoft Windows based programs, and basic engine tuning and fuel injection mapping concepts including the use of an exhaust gas analyzer to monitor air/fuel ratio (AFR). The VRFI installer is assumed to be familiar with the Delphi® 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 VRFI Log software and a laptop PC for this purpose, situations may arise where a mobile display system is required.

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



SYSTEM INSTALLATION

1. **Check for updates.** Before proceeding, check our website at www.daytona-twintec.com for available upgrades for the VRFI firmware and accompanying PC based software. Carefully read the instructions and familiarize yourself with operation of both the PC Link VRFID software used for tuning and the VRFI Log software used for data logging and analysis.

WARNING: You must use the new version 4.0 or higher PC Link VRFID software for setup and tuning. You cannot use the original PC Link VRFI software. To access all data, you must also use the new version 3.0 or higher VRFI Log software.

2. **VRFI Controller.** Carefully read the VRFI instructions and install the VRFI 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 OPERATIONS

After initial setup, the VRFI tuning process requires multiple edits of the engine tables and parameters using PC Link VRFID software. Unless otherwise noted, editing involves downloading the current setup data in the VRFI, performing the required edits, saving table edits to buffer memory, saving the revised setup file to disk, and then uploading it to the VRFI. 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.

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 VRFID and VRFI Log software, including the Copy, Paste, and Modify commands on the right mouse button pop up menu.

OVERVIEW OF VRFI OPERATION

The VRFI 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), 8,000 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), rear cylinder trim table (only for the rear 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 VRFI Idle Tuning Tech Note.

INITIAL SETUP

The VRFI requires setup, using PC Link VRFID 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 69 CID engine applications (VRFI_Setup69.dat. The engine is assumed to have stock compression, mild performance camshafts, low restriction air cleaner and a low restriction 2-into-1 type exhaust. Setup guidelines for larger displacement engines are given on page 7. Setup your VRFI unit as follows:

1. Connect the PC link cable between the VRFI unit and your PC.
2. Start the PC Link VRFID 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 7), and RPM limit. Multiply rear wheel dyno horsepower by 1.1 to arrive at an estimated engine horsepower figure. You must also set the VSS frequency for your model. This affects speedometer/odometer scaling. Refer to page 11 of the PC Link VRFID instructions. 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 VRFI 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 pages 6-7.
9. If you have questions or encounter problems, please call our tech support.

THROTTLE BODY SETUP

An alpha-N (throttle position and RPM based) fuel control system such as the VRFI 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 blades 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 blades to completely close and contact the throttle bore, the blades may bind while cold. If the idle stop setting forces the throttle blades 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 blades against the idle stop. Verify that the throttle blades 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.

IDLE TPS CHECK & ADJUSTMENT

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

Connect the PC Link cable and start VRFI Log or VRFI View software. Turn the run/stop switch on but do not start the engine. For VRFI Log, use the View Idle TPS command on the View menu. Idle TPS volts are displayed on the TPS bar graph gauge. For VRFI 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 carefully drill oversize holes in the TPS sensor and then use #8 flat washers with the original screws.

IDLE TUNING

Once the initial setup has been completed, the VRFI 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 VRFI 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 VRFI Log or VRFI View software.

Allow the engine to idle until it reaches normal operating temperature (80-100° C). 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 VRFI is removing fuel in closed loop to correct a rich condition. BLM values above 100% indicate that the VRFI 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 VRFID 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 VRFI will be using the cells in the 1,000, 1,250, and 1,500 RPM columns and the 0%, 2.5% (IAC between 55-100), and 5% TPS (IAC above 100) 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 VRFI.

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.

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.**

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 VRFI Idle Tuning Tech Note.

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

Diagnostic tips if the engine does not start:

1. Verify that the VRFI 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 VRFID 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 VRFI. 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

VRFID 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 VRFI.

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 VRFI, 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 VRFI Log. For best results, use PC Link VRFID 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.

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 VRFID 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 VRFI 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 VRFID 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 VRFI

After 1-2 hours of engine operation, download the current setup with PC Link VRFID 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 VRFI.

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 rear 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 rear 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 rear 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 VRFI.

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 rear cylinder trim tables, saving, and uploading back to the VRFI 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 VRFID software to edit the ignition advance table and reduce the ignition advance 3-5 degrees under the conditions that cause spark knock. Using the VRFI Log software to examine engine data may be very helpful for determining exactly what manifold pressure and RPM values were encountered.

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.

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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.

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. With the dual independent runner intake on the VRSC engine, the fuel injectors can be run up to 80% duty cycle. Stock Delphi® injectors are rated at approximately 4.8 gm/sec flow and should be capable of delivering sufficient fuel for engines rated up to 150 HP.

LARGE DISPLACEMENT ENGINES

For large displacement engines and/or higher flow injectors, you can modify the 69 CID setup file (VRFI_Setup69.dat) by editing the module parameters and entering appropriate values for the estimated engine horsepower and injector flow rate.

Engines over 69 CID may require additional tuning procedures, such as increases to the priming and cranking fuel tables. Please contact our tech support for details.

IDLE TUNING CONSIDERATIONS

Some large displacement engines with high overlap/long duration camshafts may not idle properly at the nominal 1,200 RPM and 13.5 AFR settings used in the standard setup file. You may have to increase the idle RPM to a higher value and enrich the idle to 12.5-12.8 AFR.

Download the current setup with PC Link VRFID 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 (1,000 - 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 VRFI.

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

DYNO TUNING CONSIDERATIONS

Auto-tuning using the procedures listed on pages 5-6 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 4,000-9,000 RPM is about 27-31 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 VRFI should be operated in closed loop.** Make sure that the engine is warmed up (coolant temperature is in the 80-100° C range) before doing a run and that engine status in VRFI Log or VRFI 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 VRFI data logging capability.** Set the data logging interval to 0.1 seconds. Always download data with VRFI Log software at the end of every run and study the results. Check engine and air temperatures, throttle position, manifold pressure, and AFR. VRFI 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 CO₂. 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 and doubt any disregard any errant readings from an exhaust sniffer.

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 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. This problem has been noted with some aftermarket 2-into-1 systems on Twin Cam 88[®] applications.

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.

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. 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)

HOT STARTING PROBLEMS

The VRFI module uses an improved starting algorithm that includes a programmable cranking delay. The VRFI module is shipped with a zero cranking delay: it fires on the first recognized compression stroke.

The OE VRSC camshafts include automatic compression releases. If you install, aftermarket camshafts without this feature, cylinder head compression releases may be required. In this case, best starting results will be obtained by programming the VRFI module for a 1-2 revolution cranking delay. This can be done by means of the PC Link VRFID 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.

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

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

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

With a stock compression ratio of 11.3:1, the V-Rod is at the practical limit for 92-93 octane pump gas. Any higher compression ratio will require high octane racing gas or retarding the ignition timing to the point where more power is lost from the retarded timing than is gained from the higher compression.

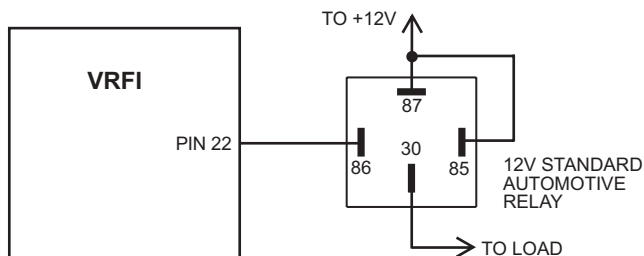
If spark knock is encountered during operation, you can use the VRFI Log software to download data and examine the operating conditions (RPM and manifold pressure) where spark knock occurred. You can then make appropriate reductions to the ignition advance table.

USER FUNCTIONS

Previous versions of the VRFI provided both a user input and output. On the VRFI D version, 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 VRFI user output on pin 22 can drive a standard automotive relay connected as shown in Figure 2. When the user output is active, +12V power is applied to the load. Refer to the User Functions section of the PC Link VRFID instructions for details on programming the user output.

Figure 2 – User Output Relay Wiring Diagram



UPGRADES AND KNOWN ISSUES

The VRFI 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 VRFI firmware and accompanying PC based software.

The VRFI 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.

Purge solenoid valve. The purge solenoid valve (output on pin 22) used on California models is not supported. With the current VRFI firmware, pin 22 is a user output as explained above. If you have a California model, please contact our tech support before proceeding with installation.

TSSM module trouble code. Installation of the VRFI may set a TSSM module trouble code. This may cause the turn signals to momentarily blink and the security LED to light up for several seconds when the engine is started. The turn signals and security system will continue to function normally.

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 VRFI can be used for custom bike applications. The VRFI also has special features to accommodate aftermarket speedometers and tachometers. The VRFI 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.

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 VRFID) and a data logging file (downloaded by means of VRFI 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.