Twin Tec — TCFI 100 kPa Speed-Density Firmware Tech Note

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

INTRODUCTION

Daytona Twin Tec can supply specially programmed TCFI units with firmware that implements speed-density control for normally aspirated applications (refer to Appendix A for details). There are no required electrical modifications to the motorcycle. The original equipment Delphi 1-bar (20-102 kPa) MAP sensor is retained. For engine setup and mapping, PC Link TCFI software version 15.7 or higher is required. For real time display and downloading logged data, TCFI Log software version 15.1 or higher is required. Software files are available for download from our website.

Installation requires an initial setup file. Daytona Twin Tec will assist customers in preparing an initial setup file. To determine required fuel injector flow ratings and setup parameters, a fuel calculator in the form of an Excel spreadsheet is also available for download from the same page on our website (refer to Appendix B for details). The calculator spreadsheet includes a table with typical brake specific fuel consumption (BSFC) and target Lambda values for various fuels.

INSTALLATION

1. Follow the basic instructions in the standard TCFI Installation & Tuning Manual.

2. Based on the results of the fuel calculator spreadsheet analysis, higher flow fuel injectors will be required. Sources for fuel injectors include Marren Fuel Injection (www.injector.com) and RC Engineering (www.rceng.com).

PC LINK TCFI SOFTWARE

Version 15.7 and higher PC Link software implements the special features required for 100 kPa speed-density control including a volumetric efficiency (VE) table in place of Alpha-N main fuel table, manual entry of injector base pulse width for very high output engines or alternate fuels (in place of automatic calculation based on engine horsepower), and use of Lambda fuel calibrations (in place of gasoline air/fuel ratio units).

Implementation of the special features described above is controlled by a configuration file that is loaded into the program folder during installation. You may have to edit some options in the configuration files for your application. You can use any text editor, such as Notepad or Wordpad. The PC Link TCFI configuration file name is PC_Link_TCFI.cfg. The configuration section is near the end of the file and starts with a comment line and then has four entries:

!configuration statements section

MAP3Bar_False (leave as-is; not used with 100 kPa firmware)

ManualBaseInjPW_True (allows manual entry of base injector pulse width; change to ManualBaseInjPW_False for automatic calculation)

SpeedDensity_True (selects speed-density mode)

LambdaCal_True (selects Lambda based fuel calibration; leave as-is or change to LambdaCal_False if you prefer gasoline AFR units)

For all 100 kPA applications, you should set the configuration file statements to include ManualBaseInjPW_True and SpeedDensity_True. Use the Excel fuel calculator spreadsheet mentioned in the introductory section for calculating the value for base injector pulse width. This value is entered under Module Parameters. Note that base injector pulse width controls overall fuel scaling within the system.

Note that H-D® has changed to Lambda based calibrations. There is no actual change to engine operation or values saved in the files, just the table display changes to Lambda values. For gasoline, Lambda = AFR/14.69.

We can help you prepare an appropriate setup file to upload into the TCFI system. Contact our tech support for details. The VE table is based on initial estimates or available logged data and will then automatically be corrected during the auto-tuning process. With the exceptions noted above, you can use the general installation and tuning steps outlined in

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the standard TCFI Installation & Tuning Manual. All references to the Alpha-N table should be replaced with the VE table.

TCFI LOG SOFTWARE

Version 15.1 and higher TCFI Log software implements the special features required for 100 kPa speed-density control including an option to display Lambda values in place of gasoline air/fuel ratio units.

Implementation of the special features described above is controlled by a configuration file that is loaded into the program folder during installation. You may have to edit some options in the configuration files for your application. You can use any text editor, such as Notepad or Wordpad. The TCFI Log configuration file name is TCFI_Log.cfg. The configuration section is near the end of the file and starts with a comment line and then has two entries:

!configuration statements section

MAP3Bar_False (leave as-is; not used with 100 kPa firmware)

LambdaCal_True (when set to false, air/fuel ratio units are gasoline AFR values. When set to true, you can select Lambda or gasoline AFR units on the main menu using the Edit Units Selection command)

All other aspects of TCFI Log software remain unchanged.

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APPENDIX A – AFR CONTROL LOOP

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.

TCFI SPEED-DENSITY CLOSED LOOP FUEL CONTROL

Injector pulse widths are calculated based on the following equations:

Front Injector PW = Base PW x CF x Front CSE x (MAP/100) x VE x (14.7/AFR) x Front Cyl Trim x Front BLM

Rear Injector PW = Base PW x CF x Rear CSE x (MAP/100) x VE x (14.7/AFR) x Rear BLM

Where:

Front Injector PW **Rear Injector PW**	Injector pulse width (milliseconds)
Base PW	Base injector pulse width (milliseconds)
CF	Correction factor (air temperature and battery voltage)
Front CSE **Rear CSE**	Cold start fuel enrichment (percent). There are independent front and rear cold start enrichment tables
MAP	Manifold absolute pressure (kPa)
VE	Volumetric efficiency table (percent)
AFR	Air/fuel ratio (numeric AFR value)
Front BLM **Rear BLM**	Block learn multiplier tables (closed loop correction factor as percent)
Front Cyl Trim	Front cylinder trim table (percent)

The calculated base injector pulse width (refer to Appendix B) is corrected for cold start enrichment, intake air temperature (IAT), and battery voltage. The corrected value is then multiplied by the VE table value to determine the theoretical injector pulse width for a 14.7 air fuel ratio. This value is then multiplied by the AFR table to arrive at the desired air/fuel ratio. A feedback correction is applied based on the oxygen sensor signal and the stored closed loop correction values in the block learn multiplier (BLM) table.

APPENDIX B – FUEL CALCULATOR SPREADSHEET

The fuel calculator spreadsheet shown below is available for download from our website in the form of an Excel spreadsheet. The calculator spreadsheet is used to verify that the selected fuel system will be adequate for the intended engine power level. The spreadsheet also calculates the base injector pulse width that is required as an overall scale factor for program setup.

TCFI/VRFI Fuel Calculator for 100 kPa
Speed-Density Systems Version 2.0

Input Values

Engine Horsepower Note 1	100
RPM (at Maximum Horsepower) Note 1	6000
Target Lambda (at Wide Open Throttle) Note 2	0.87
BSFC (Brake Specific Fuel Consumption lbs/HP-hr) Note 2	0.45
Injector Flow Rating (lbs/hr)	31
Number of Injectors	2
Injector Rated Pressure (PSI) Note 3	58.0
Actual System Pressure (PSI) Note 3	58

Calculated Values

Maximum Fuel Requirement (lbs/hr)	48
Available Fuel at 80% Injector Duty Cycle (lbs/hr)	50
Base Injector Pulsewidth (msec) Note 4	13.3
Expected Duty Cycle at Maximum Condition (%) Note 5	77%

Notes:

1. Use the peak horsepower value and the corresponding RPM. Do not use the maximum RPM that the engine will run at.

2. Typical values for maximum power at wide open throttle (BSFC values are at approximately .92 Lambda)

Fuel Type	BSFC	Lambda
Gasoline	.45	.85-.87
E10	.47	.85-.87
E70	.62	.71-.75
E85	.67	.71-.75
E100	.73	.71-.75

3. Fuel injectors rated are at differential pressure across the injectors. Industry standard ratings are at 43.5 psi. Harley rates injectors at actual operating pressure of 58 psi. To convert from gm/sec to lbs/hour, multiply by 7.93.

4. Base injector pulsewidth is used by the PC Link program to establish overall fuel scaling and is entered under Module Parameters.

5. Expected duty cycle at maximum condition is the value at the horsepower, RPM and target lambda values above. This is the highest duty cycle that the system will run at and should be less than 80%.

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