

**EZECU® - Sport Fi ECU
Piggyback 3D Programmable
Fuel Injection Computer
for
BOSCH Compliant EFI
Systems**

User's Manual

January, 2012

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Revision History

Date	Revision	Description
25, May 2009	0.10	Initial draft
05, June 2009	0.11	Replace application software snapshot by English version and add wiring harness descriptions
14, December 2009	0.20	Update software function descriptions
29, December 2009	0.21	Update software function descriptions
05, February 2010	0.22	Support for Windows Vista and Windows 7
29, April 2010	0.30	Updated software logo with EZECU®
29, April 2011	1.00	Updated for Sport Fi ECU Rev.B
03, July 2011	1.10	Updated for Sport Fi v1.6.0 software
15, July 2011	1.11	Corrected some typo errors
02, January 2012	2.00	Updated for Sport Fi ECU Rev.C

1 Introduction

With the gradually increasing trend of electronic fuel injection engines, the EZECU® series – Sport Fi ECU (Engine Control Unit) developed by IC Leader Technology Corporation is announced for cooperating with the factory ECU to tune fuel injection amounts from -100% to +100%. Unlike other piggyback products that generate a faked signal (MAP, TPS, or MAF sensor) to cheat the factory ECU, Sport Fi ECU drives the fuel injector directly according to a base fuel injection width by the factory ECU. In other words, this product can control the fuel injector directly even when the factory ECU stops fuel injecting operations.

1.1 Product Package List of Sport Fi ECU

Thank you for purchasing the Sport Fi ECU originally designed and manufactured by our company in Taiwan. When you open the product package, all contained accessories are listed below.

- 1 × Sport Fi ECU
- 1 × wiring harness
- 1 × USB A-type male to B-type male cable
- 1 × CD-ROM containing the USB driver and the application software

1. Introduction

1.2 Product Features

Sport Fi ECU is a high-technology after-market product for electronic fuel injection engines with features as listed below:

- Piggyback fuel injection ECU dedicated for BOSCH compliant fuel injection systems
- Remove fuel-cut revolution limit of factory ECUs and support up to 15,000 RPM
- Programmable -100% ~ +100% fuel tuning percentages with 1% resolution
- Fuel tuning 3D table with 59×10 cells and 250/500/1,000 RPM resolutions
- Supports 12-1/18-1/24-1/12-2/18-2/24-2/12-3/18-3/24-3/1/12/18/24 teeth crankshaft flywheel types
- Programmable 0.0ms through 3.0ms fuel compensation when closing throttle
- Up to 10 customizable throttle position voltage levels
- Semi-auto detection for both fully-closed and fully-opened TPS calibration voltages
- Table uploading while engine is running
- Dynamic tracking of referenced cell within fuel tuning 3D table
- Graphical 2D curve for displaying fuel tuning percentages
- Graphical gauges for real-time engine status monitoring via standard USB interface
- Fast table uploading within 1 second
- Adopt water-proof metal case sealed by epoxy/silicon or equivalent
- Support languages: Traditional Chinese and English
- Support Microsoft Windows 2000/XP/Server 2003/Vista/7 32-/64-bit Operating Systems

1.3 Product Specifications

- Power supply input
 - 8 ~ 20VDC
 - 40VDC Max. reverse protection

- Sensor inputs
 - TPS (Throttle Position Sensor) signal with an analog voltage ranging from 0 to 5VDC
 - CPS (Crankshaft Position Sensor) signal with an analog voltage ranging from ± 3 to ± 120 VAC with 12-1/18-1/24-1/12-2/18-2/24-2/12-3/18-3/24-3/1/18/24 teeth per revolution

- Fuel injection signal input
 - Connects to the fuel driver output of the factory ECU
 - Supports either single-injection or double-injection per 4-stroke cycle
 - Pulse width modulation voltage ranging from 0 to 12VDC

- Fuel injection signal output
 - Direct drive of the BOSCH compliant fuel injector with resistance greater than 10Ω
 - Pulse width modulation voltage ranging from 0 to 12VDC
 - Supports up to 90% duty cycle of the fuel injector
 - Supports high flow-rate fuel injectors
 - Supports either single injection or double injections per 4-stroke cycle

- Indication LED
 - 1 × blue LED for power good indication

- USB interface
 - Standard USB B type male connector

- Form factor of Sport Fi ECU
 - Length: 79 mm (without including the connectors)
 - Width: 69 mm
 - Height: 22 mm
 - Net weight (without including wiring harness): 225 ± 10 gram

2 Wiring Diagrams

2.1 Connectors and LED

There are two connectors on Sport Fi ECU. One is a 6-pin main connector and another one is a B-type USB connector. Sport Fi ECU also provides one power good indication LED.

2.2 Wiring Harness and Wiring Diagram for YAMAHA

For YAMAHA scooters, the wiring harness is shown in [Figure 2-1](#) and the wiring diagram is shown in [Figure 2-2](#). Most signals are connected directly by the wiring harness. The only signal to be connected via the mid-way wire connector is the TPS (Throttle Position Sensor) signal. It is strongly recommended that using soldering and covered with the heat-shrink pipe can extend the life for the wiring of TPS. Please connect the wire with CARE AND PATIENCE. Any fault can cause either the product or any parts of the bike/scooter to be damaged permanently. If you are not familiar with this procedure, you should ask expert EFI engine technicians for wiring these signals.

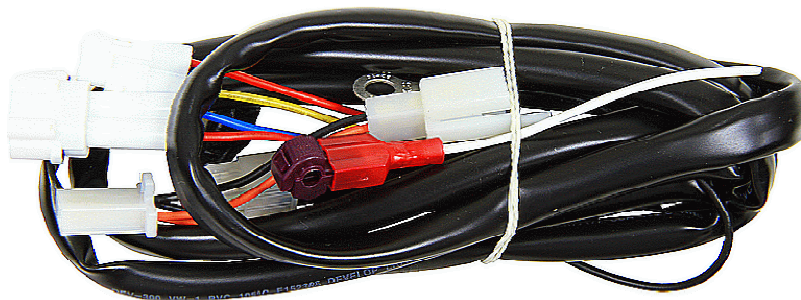


Figure 2-1 Wiring Harness of Sport Fi ECU for YAMAHA

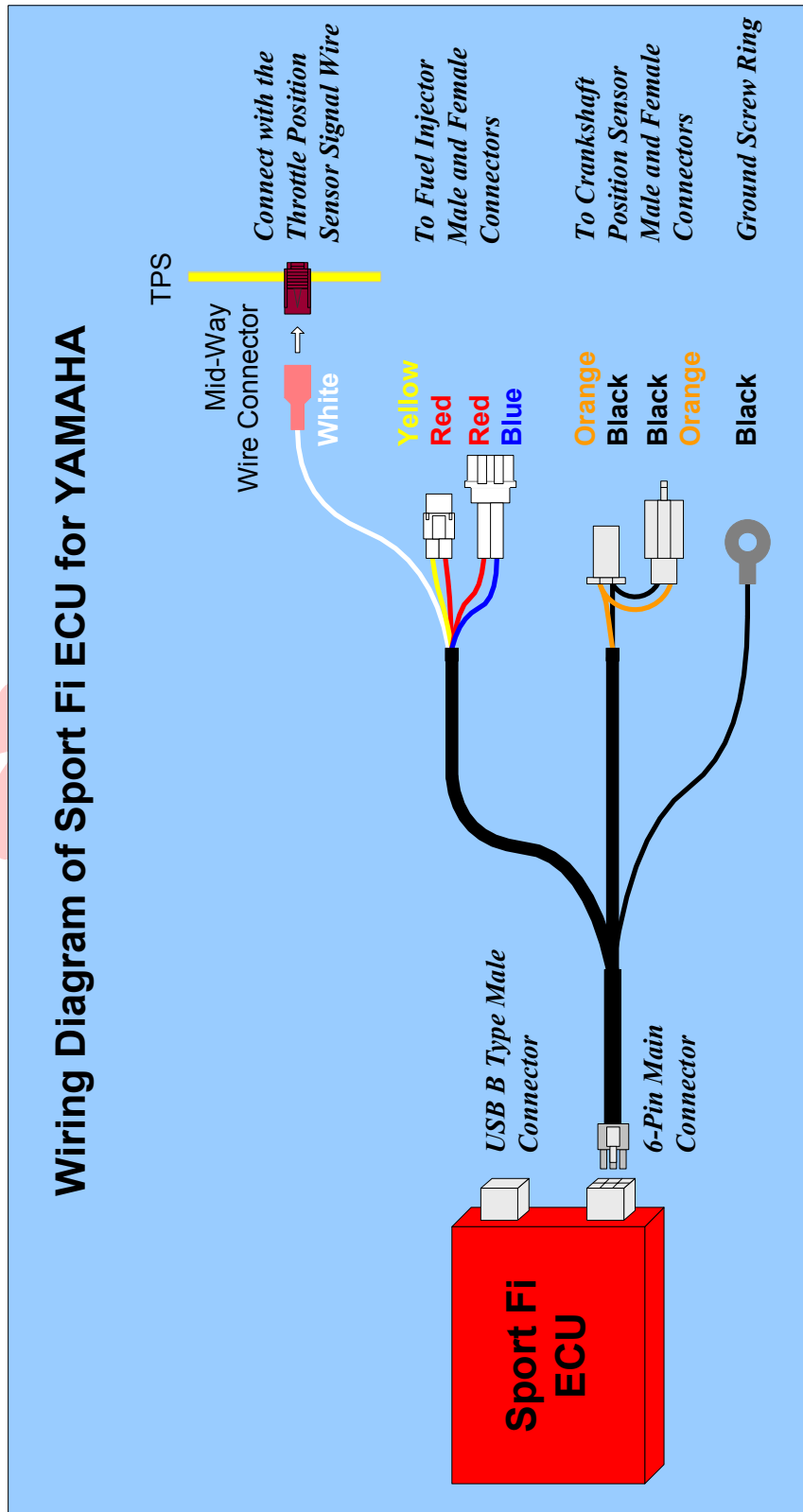


Figure 2-2 Wiring Diagram of Sport Fi ECU for YAMAHA

2. Wiring Diagrams

2.3 Wiring Harness and Wiring Diagram for KYMCO/SYM

For KYMCO/SYM scooters, the wiring harness is shown in [Figure 2-3](#) and the wiring diagram is shown in [Figure 2-4](#). Most signals are connected directly by the wiring harness. However, since the wiring definitions for the fuel injector are different for various scooter/bike models, users have to confirm the correct wiring definition by the following steps:

1. Disconnect the fuel injector connector from the fuel injector;
2. Turn on the power;
3. Switch the multi-meter to 20VDC and connect the black probe to battery ground;
4. Use the red probe of the multi-meter to test both terminals of the female fuel injector connector and find out the female terminal with +12V battery voltage;
5. Connect the male fuel injector connector provided by the Sport Fi ECU to the female fuel injector and insert the red wire male terminal to the corresponding position of the female terminal with +12V battery voltage; and
6. Insert the blue wire male terminal to the remaining position of the male fuel injector connector.

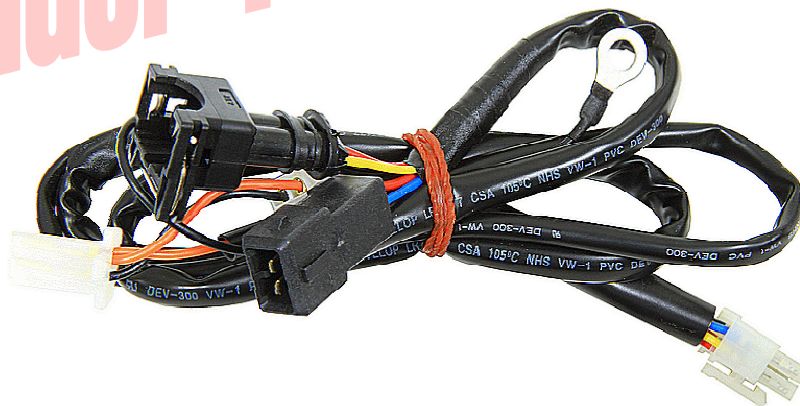


Figure 2-3 Wiring Harness of Sport Fi ECU for KYMCO/SYM

Furthermore, most KYMCO/SYM ECUs are integrated with the throttle body so that it is almost impossible to connect with the TPS signal inside. User may buy an additional TPS (contact with us if required) to be installed on the opposite axis of the throttle and take the white wire out from the PVC cable to solder with the added TPS signal. It is strongly recommended that using soldering and covered with the heat-shrink pipe can extend the life for the wiring of TPS. Please connect the wire with CARE AND PATIENCE. Any fault can cause either the product or any parts of the bike/scooter to be damaged permanently. If you are not familiar with this procedure, you should ask expert EFI engine technicians for wiring these signals.

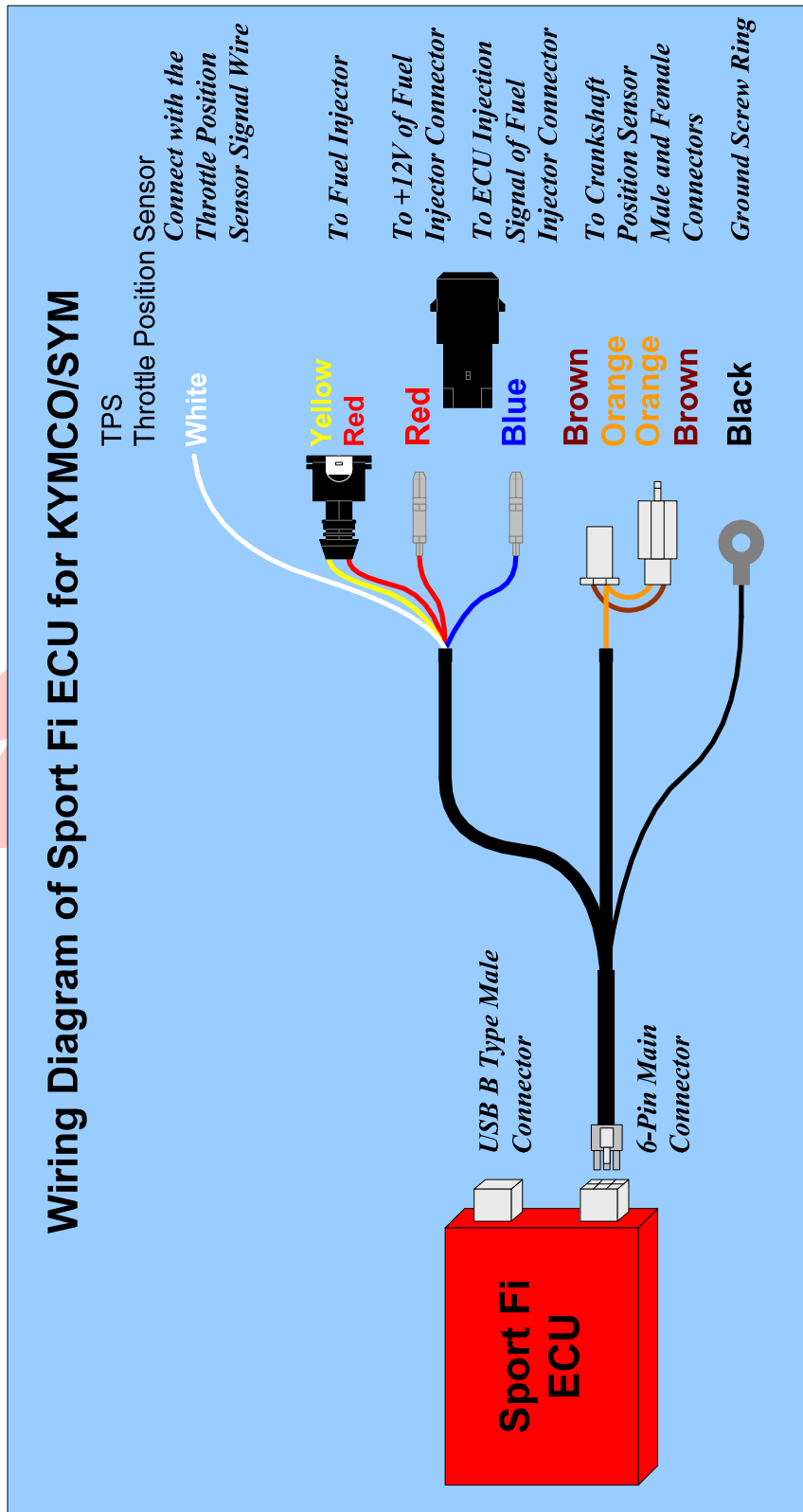


Figure 2-4 Wiring Diagram of Sport Fi ECU for KYMCO/SYM



3. Application Software

3 Application Software

The application software can be installed on Intel 80x86 compatible computers with Microsoft Windows 2000/XP/Server 2003/Vista/7 operating systems. At least one USB 1.1/2.0 compatible interface port is required to communicate with Sport Fi ECU. The screen resolution requirement is at least 1024 × 768 and the memory requirement is at least 1,024 MB.

3.1 Overview

The first screen of the application software is shown in Figure 3-1. Buttons on the left top corner are responsible of semi-detection of TPS (Throttle Position Sensor) voltages. Buttons on the middle-bottom are responsible for fuel map and firmware file open, save, save as, and upload operations. On the right top corner, three buttons are used for setting step-in RPM, maximum RPM and fuel compensations. The fuel tuning map and the graphical fuel tuning curve display are resided below.

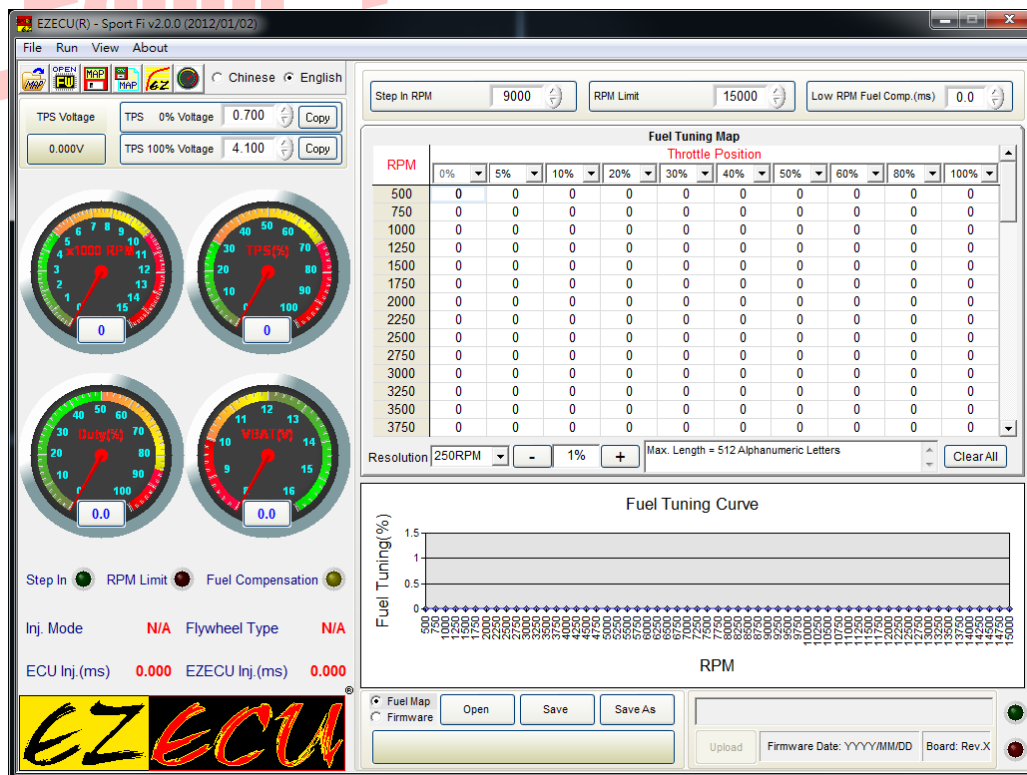


Figure 3-1 Overview of Sport Fi ECU Application Software (Unconnected)

If Sport Fi ECU is powered on and connected to PC, the green LED on the right bottom corner will be turned on as shown in Figure 3-2. Furthermore, the corresponding firmware date and board version of the Sport Fi ECU will be shown also.

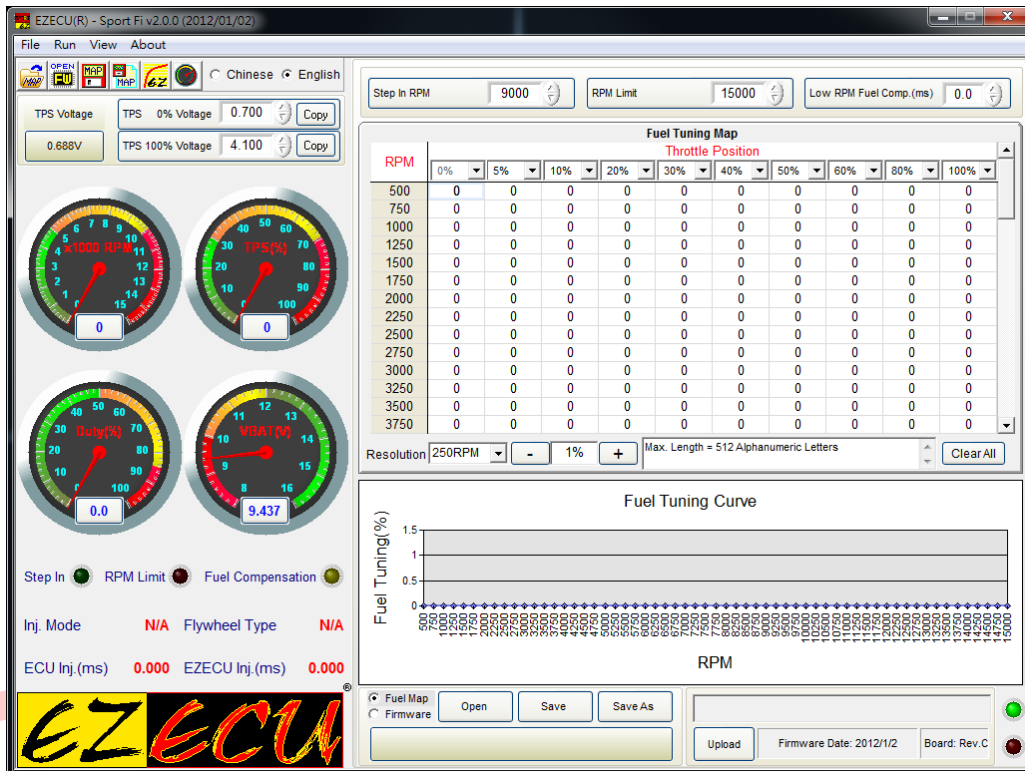


Figure 3-2 Overview of Sport Fi ECU Application Software (Connected)

3.2 Fuel Map and Firmware Operations

As shown in [Figure 3-3](#) and [Figure 3-4](#), file operations for the fuel map and the firmware are slightly different. The fuel map file can be opened, saved, and saved as another file name. However, the firmware file can be opened only.

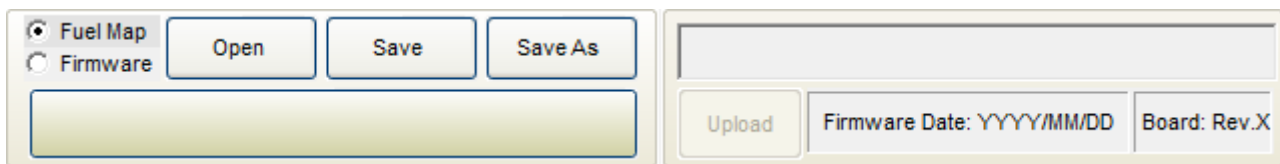


Figure 3-3 Fuel Map Operation Buttons

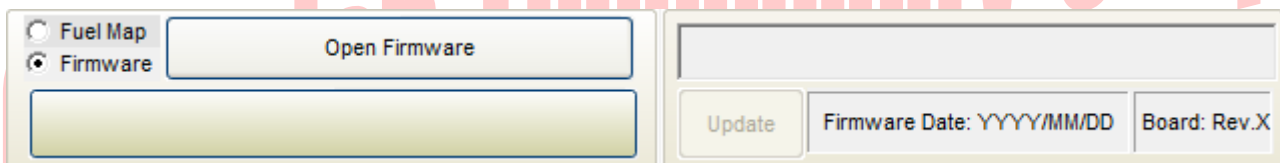


Figure 3-4 Firmware Operation Buttons

Before pressing the “Upload” button, please make sure that the USB cable is correctly connected between your computer and Sport Fi ECU. Finally, please confirm the power good LED is lighted on. You can press the “Upload” button even if the engine is running still. However, you must stop engine before pressing the “Update” button. When programming is in progress, the application software will show current programming progress. After uploading or updating, the application software will have a pop up window to indicate that the operation is completed.

3.3 TPS Voltage Calibration

The voltage values of TPS for each bike/scooter should be calibrated before operating correctly because the 0% and 100% throttle may be mapped to different voltages for different TPS models. For example, some TPS outputs 0V through 3.1V corresponding to 0% through 100%, while some TPS outputs 0.7V through 4.1V corresponding to 0% through 100%. Consequently, the application software provides semi-auto detection and manual input for the TPS calibration values.

As shown in [Figure 3-5](#), there are two “Copy” buttons and two fields for inputting the voltage values corresponding to 0% and 100% throttle, wherein two “Copy” buttons are responsible for the semi-auto input function and two fields are responsible for the manual input function.

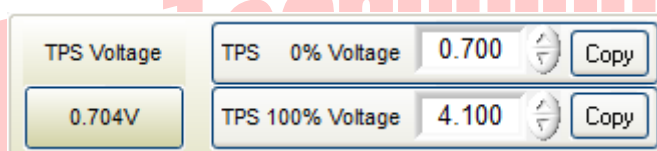


Figure 3-5 TPS Calibration Buttons

At first, the semi-auto input function is introduced as the following steps:

- Step 1 Connect Sport Fi ECU and your bike/scooter;
- Step 2 Connect the USB cable between Sport Fi ECU and your computer;
- Step 3 Execute the application software;
- Step 4 Turn on the bike/scooter power but do not start the engine and confirm the blue power LED on Sport Fi ECU is lighted;
- Step 5 Press the upper “Copy” button to copy TPS voltage of 0% throttle;
- Step 6 Rotate the bike/scooter’s throttle to 100% and hold, press the lower “Copy” button to copy TPS voltage of 100% throttle; and
- Step 7 Release the bike/scooter’s throttle.

Since the TPS is made of resistor, the voltage output may vary according to different working temperatures. Consequently, we suggest to increase the fully-closed TPS voltage by 0.1V and to decrease the fully-opened TPS voltage by 0.1V.

In this manner, the TPS mapping range for your bike/scooter can be detected. Both TPS setting

3. Application Software

values can be saved into the fuel map file. If user wants to update the fuel map again, the TPS calibration process can be skipped by reloading the saved TPS setting values.

Finally, user may use a precise voltage meter to measure TPS voltage values corresponding to 0% and 100% throttle and then fill the measured voltage values into the TPS calibration fields.

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3.4 Real-Time Engine Status

As shown in Figure 3-6, real-time engine status includes a RPM gauge, a TPS % gauge, a fuel injector duty % gauge, a battery voltage gauge, a Sport Fi step-in indication LED, a RPM limit indication LED, a fuel compensation indication LED, a fuel injection mode, a flywheel type, an ECU fuel injection time, and a Sport Fi ECU fuel injection time.

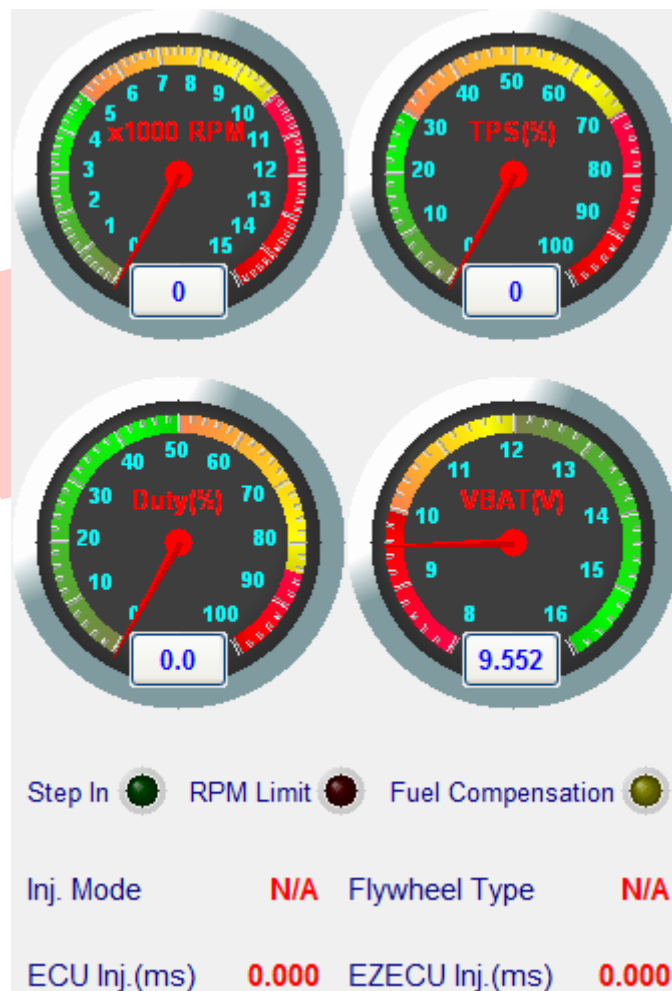


Figure 3-6 Real-Time Engine Status

The “Step In” indication LED will be lighted if the Sport Fi takes over the fuel injection operation without referring to the factory ECU. This is especially useful to achieve racing or heavy sport oriented purposes. The ECU injection time will show zero when the engine RPM value is too high for the factory ECU. For example, many ECUs will cut fuel injection operations when the engine RPM value is greater than 9,300 RPM. The Sport Fi can extend the fuel-cut restriction up to 15,000 RPM. The “RPM Limit”

3. Application Software

indication LED will be lighted when the engine RPM exceeds the maximum RPM setting inputted by the user. The injection mode shows the number of fuel injection times within the 4-stroke cycles. The crankshaft flywheel type shows one of 12-1/18-1/24-1/12-2/18-2/24-2/12-3/18-3/24-3/1/18/24 teeth.

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3.5 Fuel Tuning Map

The fuel tuning map with 250 RPM resolution is shown in Figure 3-7.

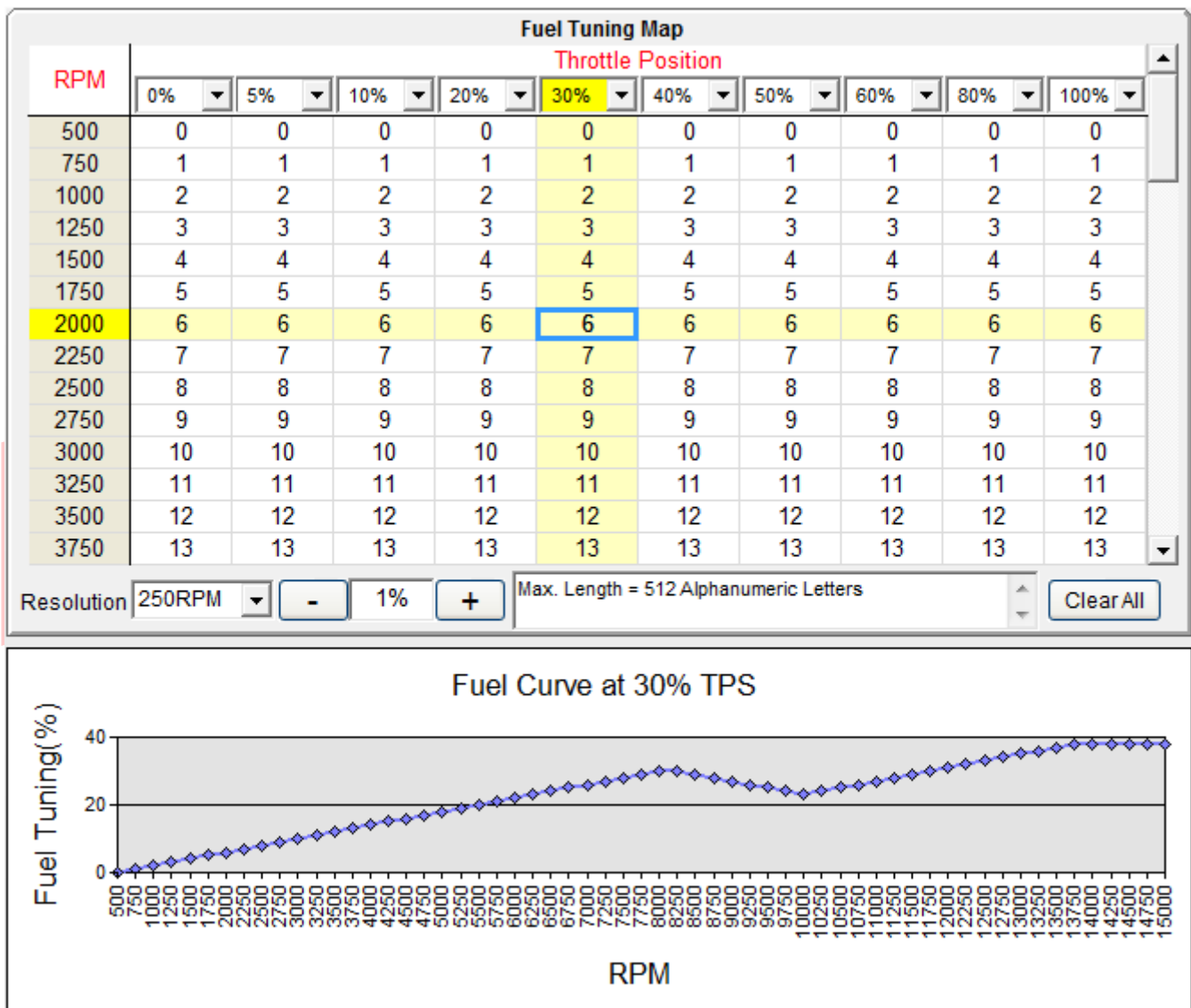


Figure 3-7 Fuel Tuning Map with 250 RPM Resolution

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Sport Fi ECU provides a fuel tuning map with 500 RPM through 15,000 RPM by programmable 10-level TPS resolutions with 1% step (the default TPS levels are 0%, 5%, 10%, 20%, 30%, 40%, 50%, 60%, 80%, and 100%). The 500 RPM through 15,000 RPM can be set by selecting the RPM resolution as one of 250 RPM, 500 RPM and 1,000 RPM. Fuel tuning maps with 500 RPM and 1,000 RPM resolutions are shown in [Figure 3-8](#) and [Figure 3-9](#), respectively.

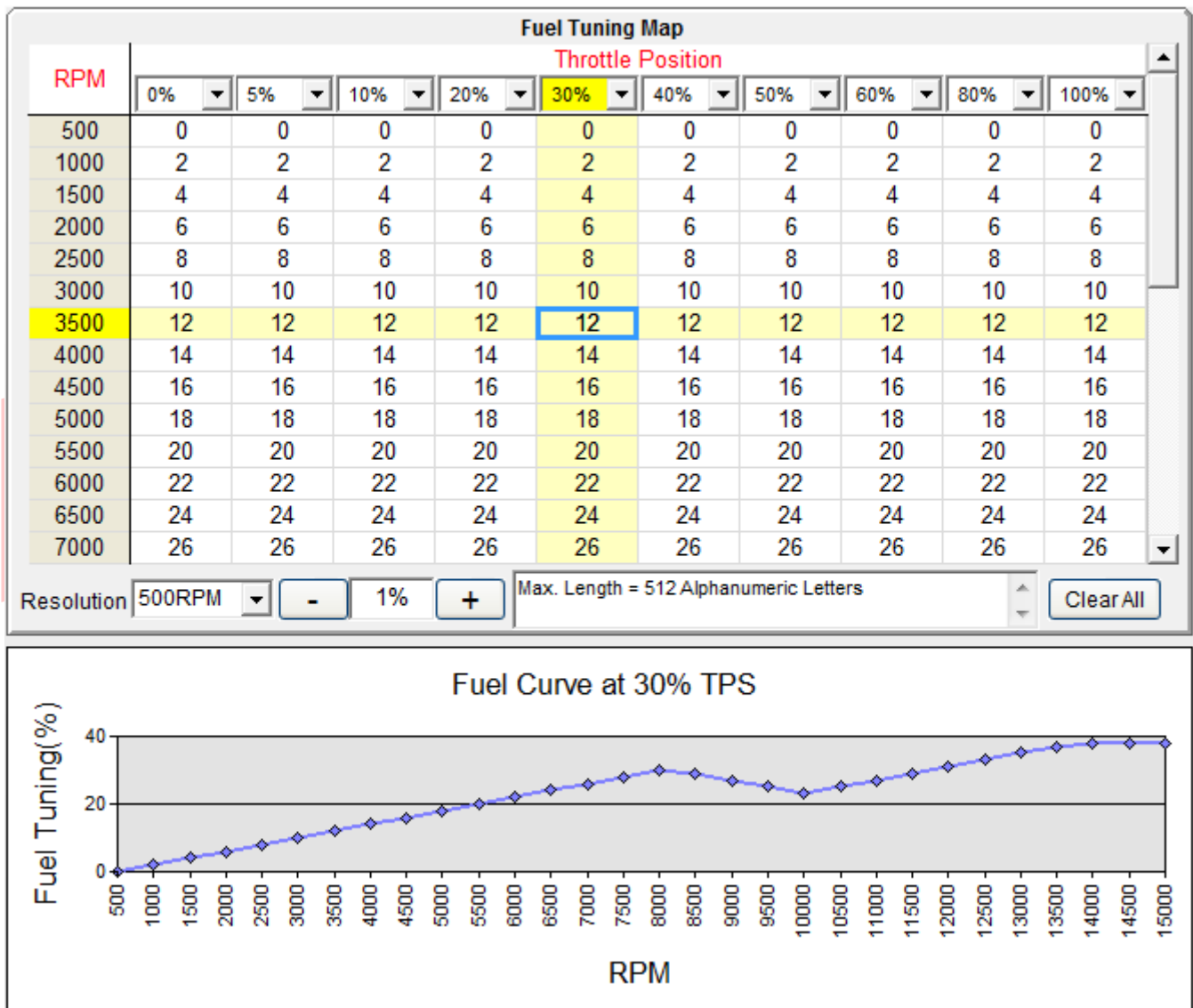


Figure 3-8 Fuel Tuning Map with 500 RPM Resolution

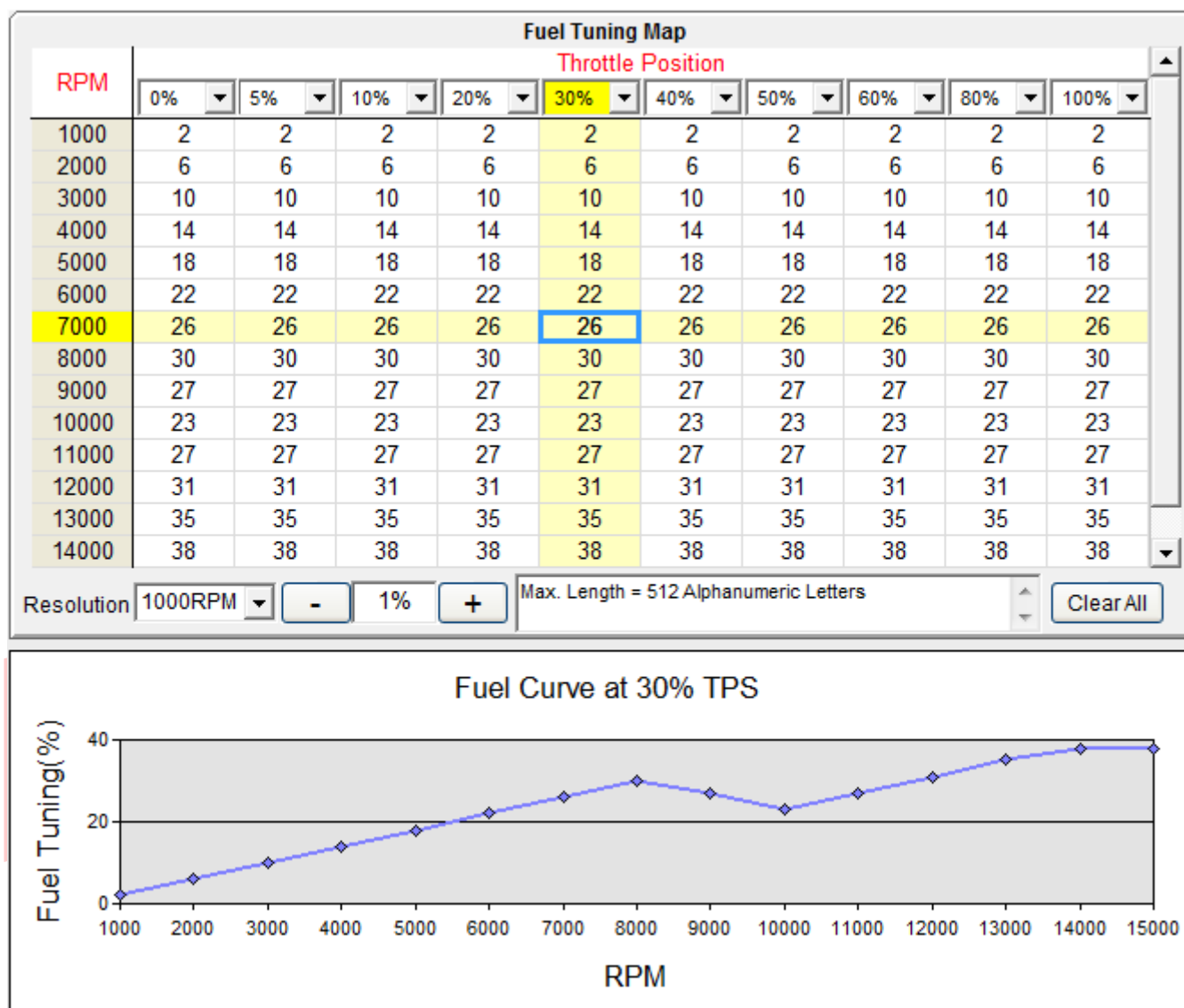


Figure 3-9 Fuel Tuning Map with 1,000 RPM Resolution

In general, the 1,000 RPM resolution is recommended as a startup basis. The fuel tuning map with 1,000 RPM resolution is formed as a 15 by 10 table. Since there are fewer cells, it is easier for roughly tuning the fuel map. The application software will average and interpolate the fuel tuning map values into each cell of the 250 RPM fuel tuning map. User does not need to worry about losing control precision due to selecting the 1,000 RPM resolution.

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If user wants to increase resolution for tuning the fuel map, the 500 RPM resolution can be selected. The fuel tuning map with 500 RPM resolution is formed as a 30 by 10 table. Since there are double cells as compared to the 1,000 RPM resolution, user may tune the fuel injection amount in a more detailed order. The application software will average and interpolate the fuel map values into each cell of the 250 RPM fuel tuning map. User does not need to worry about losing control precision due to selecting the 500 RPM resolution.

The maximum resolution is to set as the 250 RPM resolution. The fuel tuning map with 250 RPM resolution is formed as one 59 by 10 table. Since there are almost double cells as compared to the 500 RPM resolution, user may tune the fuel injection amount in a most detailed order.

When editing the fuel tuning map, user may mark an area to perform addition/subtraction/clear all by pressing corresponding buttons below the fuel tuning map. The addition/subtraction button will add/subtract each cell inside the marked area by the value of the addition/subtraction value field. The clear all button will reset each cell of the fuel tuning map to 0.

The fuel injection time is calculated as follows:

$$\text{Fuel Injection Time}_{\text{Sport Fi ECU}} = (\text{Fuel Injection Time}_{\text{Factory ECU}} - \text{Fuel Inejctor Turn On Time}) \times (100\% \pm X\%) + \text{Fuel Inejctor Turn On Time}$$

, wherein the $X\%$ is the 32-bit bilinear interpolated percentage value by the Sport Fi ECU with the range of $-100.00\% \leq X \leq +100.00\%$.

The initial values of the fuel tuning map are all 0s. That is, the fuel injection time of Sport Fi ECU is the same as the factory ECU. If user has an enlarged cylinder from 125CC to 164CC, the enlarge percentage is $((164-125) \div 125) \times 100\% \approx 30\%$. If the fuel injector remains the same, the fuel tuning map may be all filled by 30% as a tuning basis. Use the wideband oxygen sensor (contact us if required) and the optional dyno machine to fine-tune the engine and modify the cells in the fuel tuning map. Ride the bike/scooter as the final feedback for tuning. You may get your best performance for your engine.

3.6 Programmable Revolution Limit

The factory ECU may stop fuel injection when the engine RPM is greater than a threshold value (for example, 9,300 ~ 9,600 RPM). Sport Fi ECU can let user set a step-in RPM and a RPM limit to enable the fuel-cut relief function as shown in [Figure 3-10](#).



Figure 3-10 Programmable Revolution Limit Functions

The step-in RPM can be set from 7,000 RPM through 15,000 RPM with a 250 RPM step. The step-in RPM should be set to a nearest RPM less than and the revolution limit RPM of the factory ECU. For example, if the factory ECU cuts fuel at 9,300 RPM, the step-in RPM of 9,000 RPM will be a nice selection. The RPM limit function can be used for protecting the engine from over-RPM if it is well-used.

The RPM limit can be set from 9,000 RPM through 15,000 RPM with a 250 RPM step. Please ask professional technicians to confirm the maximum allowable working RPM for your engine! Our company is not responsible for any damage and losses.

3.7 Fuel Compensation When Closing Throttle

When a rider is closing throttle to de-accelerate the engine revolution, the factory ECU may stop the fuel injection operation for a while until the engine revolution drops to the idle RPM range. Without fuel supply during the de-acceleration period, the re-acceleration response time for the engine is not good enough. Besides, the engine may possibly stop for most enlarged cylinders since no fuel supply being injected.

Sport Fi ECU can overcome this by a programmable fuel compensation setting when closing throttle as shown in [Figure 3-11](#). The valid fuel injection time is from 0.0ms through 3.0ms with a 0.1ms step. It should be noted that this fuel injection time includes the injector turn-on time. For most fuel injectors, the required turn-on time is 0.8ms through 1.2ms. Consequently, if the filled fuel injection time is equal to or less than the fuel injector turn-on time, no fuel would be injected. Users may ask your injector provider for the turn-on time specification.

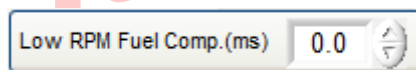


Figure 3-11 Fuel Compensation When Closing Throttle

The operations of the fuel compensation when closing throttle are described as follows. When the rider accelerates the engine RPM, the throttle is almost open. When de-accelerating, the throttle will be closed. Two necessary conditions to enable the fuel compensation when closing throttle are listed below:

1. TPS level is less than 5% and RPM is less than 8,000; and
2. The factory ECU fuel injection width is less than the programmed fuel compensation width;

When fuel compensation is enabled, Sport Fi ECU will activate one fuel injection for each engine revolution. The fuel injection time per engine revolution is according to the filled value in the fuel compensation field.

3.8 Mini Bar

On the left-top corner of the application software, there is a mini bar shown in [Figure 3-12](#) to provide quick accesses to functions.



Figure 3-12 Mini Bar of Sport Fi ECU Application Software

Functions for buttons on the mini-bar from left to right are listed below:

1. Open Fuel Map
2. Open Firmware
3. Save Fuel Map
4. Save As Fuel Map
5. Dynamic Track Mode
6. Full Screen Engine Status

The first four buttons have same functions as aforementioned in [Section 3.2](#). The dynamic track mode is described in [Section 3.9](#). The full screen engine status is described in [Section 3.10](#). The display language options are also shown on the mini bar.



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3.9 Dynamic Track Mode

When the “Dynamic Track Mode” button on the mini bar is pressed as shown in [Figure 3-13](#), Sport Fi ECU will report which cell inside the fuel tuning map has been referenced. This may be helpful for technicians who are tuning engines. Press the same button on the mini bar again will exit the track mode.



Figure 3-13 Dynamic Track Mode on the Mini Bar of Sport Fi ECU Application Software

3.10 Full-Screen Engine Status

When the “Full-Screen Engine Status” button on the mini bar is pressed, the application software of Sport Fi ECU will switch to a full-screen as shown in [Figure 3-14](#). This may be helpful for longer distance observing. Press the same button on the mini bar again will switch back to the original screen.

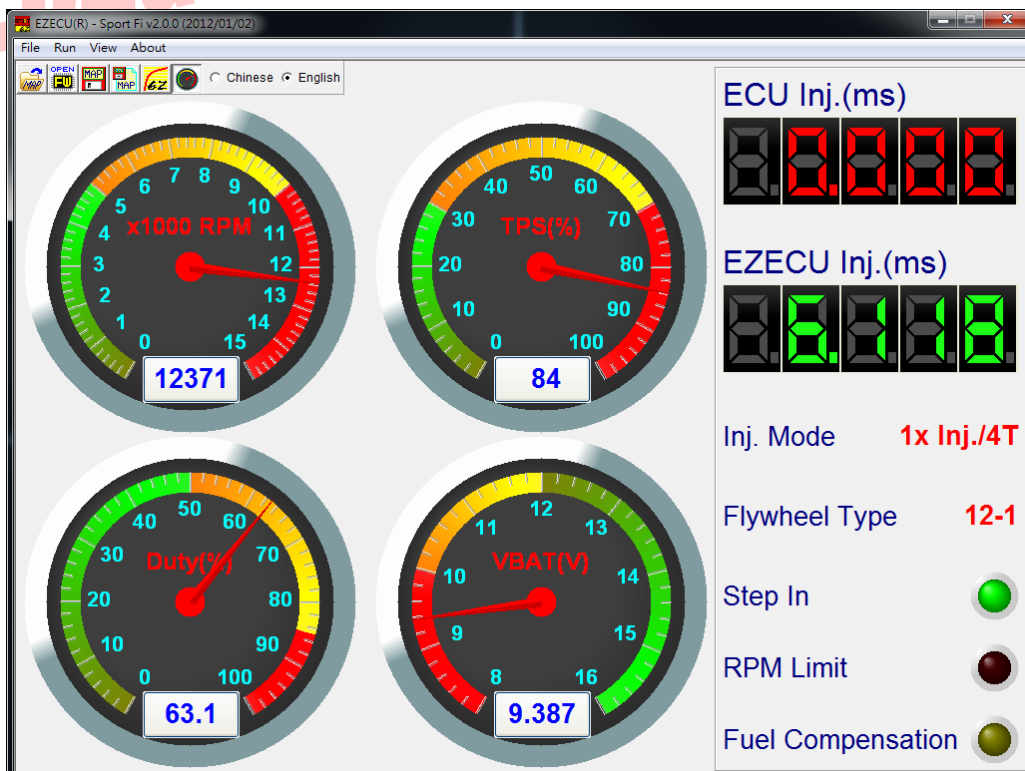


Figure 3-14 Full-Screen Engine Status of Sport Fi ECU Application Software

3.11 About EZECU®

The information about EZECU® series products and our company can be found by clicking the “About” menu. The following window with trademarks and URL will appear.



Figure 3-15 EZECU® Product Information Window

Appendix Main Connector Signals

Table A-1 Main Connector Pin Numbers

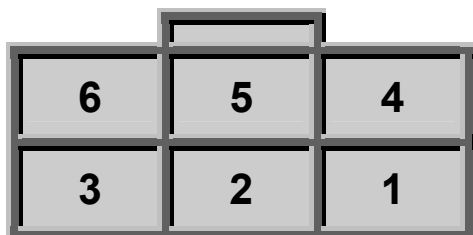


Table A-2 Main Connector Signals

Pin No.	Signal Description	Wire Color
1	TPS (Throttle Position Sensor) Input	White
2	Power Ground	Black
3	Fuel Injection Input (from Factory ECU)	Blue
4	CPS (Crankshaft Position Sensor) Input	Orange
5	+12V Power	Red
6	Fuel Injection Output (to Injector)	Yellow