SECTION BOOKLET

3 Tuning Overview

33 guides · compiled Oct 17, 2026 · https://help.impactwiringsolutions.com/section/tuning-overview
Each guide keeps its own page numbers and version stamp. The newest versions are always online.

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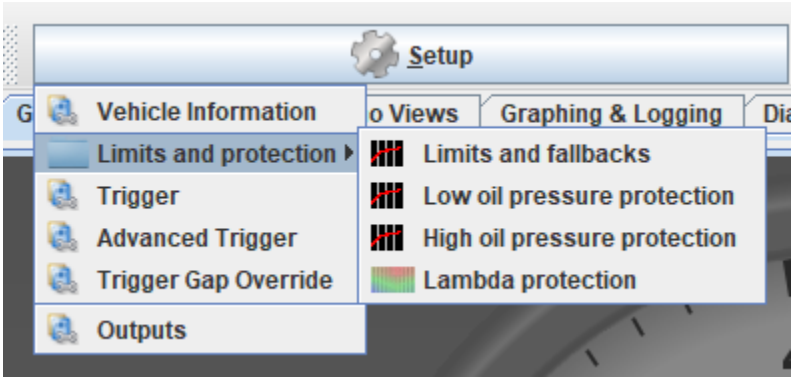
Setup Button in TS



1. Vehicle Information:

- This section contains essential settings related to the engine's fundamental configurations, such as **Displacement, VIN**, and other parameters crucial for proper ECU operation.

2. Limits and Protection:

- Allows you to set safety limits for engine parameters, such as RPM, coolant temperature, and oil pressure. This ensures the ECU can take protective actions if these values exceed safe thresholds, helping prevent engine damage.

3. Trigger:

- Contains settings for configuring the engine's crankshaft or camshaft position sensor (also known as the trigger). These settings are essential for synchronizing the ECU with the engine's rotation.

4. Advanced Trigger:

- This provides more detailed configurations for the trigger system, including settings for advanced triggering modes. This is usually required for engines with more complex timing needs or custom setups.

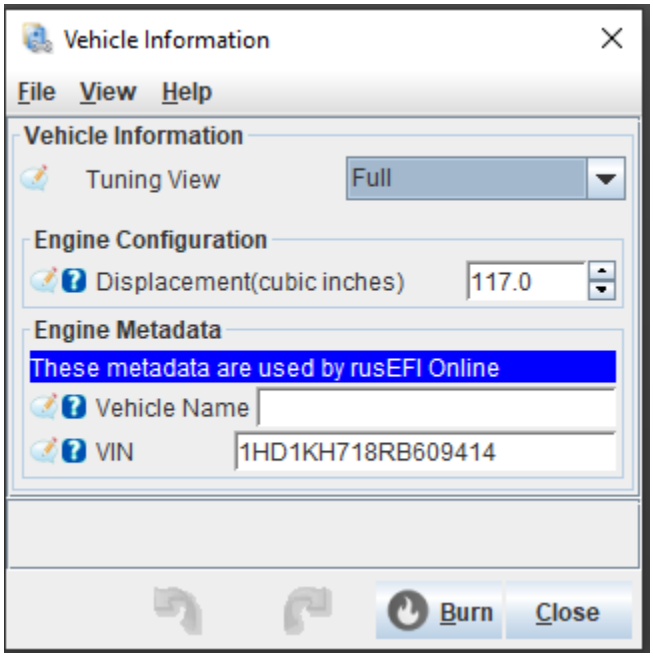
5. Trigger Gap Override:

- Allows you to manually set a gap override for the trigger signal. This option is useful if the standard trigger setup does not accurately detect gaps, which could affect engine timing.

6. Outputs:

- Configures various ECU outputs that control engine components, such as fans. These settings allow customization of how the ECU controls each output signal.

Vehicle Information Settings Window



1. Tuning View:

- **This dropdown lets you choose the complexity of the settings display**. For most users, the Tuning layout is recommended as it hides some less commonly used buttons, creating a cleaner interface. However, we will explain everything using the Full layout in this manual to ensure clarity.

2. Engine Configuration

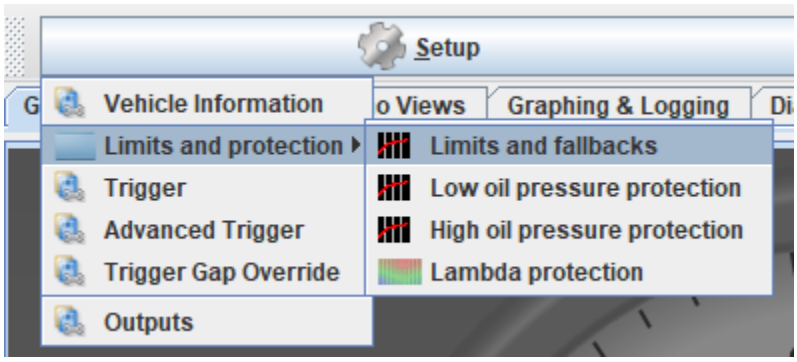
- Displacement (Cubic Inches): Enter the engine displacement in Cubic Inches, an essential input for calculating air-fuel ratios and other tuning parameters.

****NOTE: Some older versions of firmware still have displacement in liters, please make note of this and use the correct value**

3. Engine Metadata:

- These fields are primarily used to provide additional context, though they aren't necessary for basic Impact ECU functionality.
- Vehicle Name: A custom name for the vehicle (e.g., "Chris's Harley"), useful if managing multiple vehicles.
- VIN: in newer firmware versions the VIN input box is located here, input your VIN in all caps to get rid of any "VIN ERR" on your bike's dash

Limits and Protections (Setup Menu)



Limits and Protection (Base Engine Menu)

The **“Limits and Protection”** submenu under **“Setup”** includes essential settings for protecting the engine by setting operational limits. This section is crucial for safeguarding the engine against conditions that could lead to damage. The available options are:

1. Limits and Fallbacks

- This setting allows users to define **maximum operational limits** for various engine parameters, such as **RPM, boost pressure, and temperature.**
- When limits are reached, fallback strategies (like reducing power or triggering a safe mode) are activated to prevent damage.

  Example: Setting an RPM limit to ensure the engine doesn’t exceed a specified threshold, which can prevent mechanical failure.

2. Oil Pressure Protection

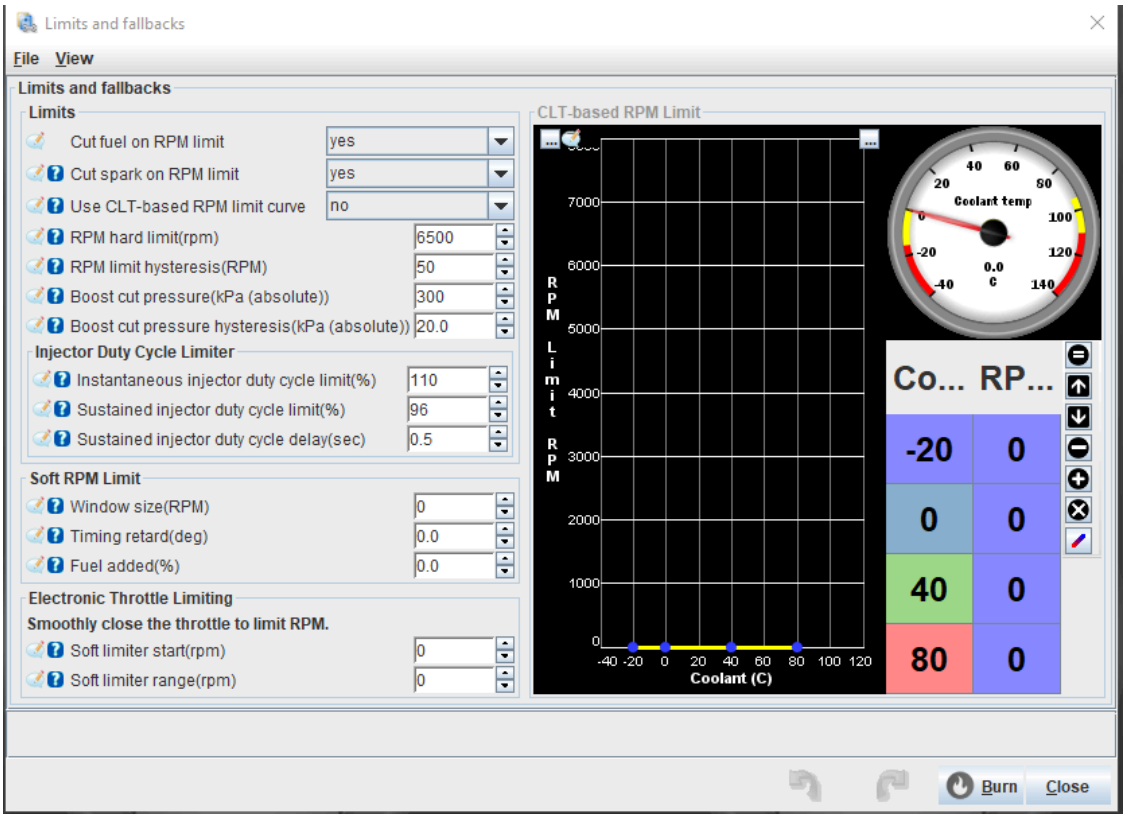
- Monitors oil pressure levels to protect the engine from insufficient lubrication, which can cause severe damage. This is typically not used on Harleys as they operate with an Oil Pressure Switch as opposed to an oil pressure sensor.

3. Lambda Protection

- This feature monitors air-fuel ratios (AFR) to ensure the engine operates within safe combustion parameters.
- If AFR deviates from the safe range (either too lean or too rich), it can trigger corrective actions.
- **Tip:** Lambda protection is essential for turbocharged or high-performance engines that require precise fuel control to avoid detonation or poor performance.

Limits and Fallbacks

Main Options



1. Cut fuel on RPM limit:

When enabled, this option cuts the fuel supply when the RPM limit is reached. Cutting fuel provides a smoother limiting action; however, it may lead to slightly higher combustion chamber temperatures since unburned fuel is not present to cool the combustion process.

2. Cut spark on RPM limit:

When selected, this option cuts the spark to limit RPM. Cutting spark can produce flames from the exhaust due to unburned fuel igniting in the exhaust system. Additionally, this unburned fuel can help cool the combustion chamber, which may be beneficial in high-performance applications.

3. Use CLT-based RPM limit curve:

Setting this to "yes" enables the RPM limit to vary with coolant temperature (CLT), utilizing the control panel on the right. This feature allows you to set different RPM limits based on the engine's coolant temperature, providing a temperature-dependent RPM control.

RPM Limits

- **RPM hard limit (RPM)**: The maximum RPM before cut actions (fuel or spark) are triggered.

- **RPM limit hysteresis (RPM):** Sets a buffer below the RPM hard limit, helping avoid rapid cycling of cut actions by defining a range within which RPM must drop before cut actions are re-enabled.

Boost Cut Limits:

- **Boost cut pressure (kPa absolute):**
  Specifies the absolute maximum boost pressure allowed before triggering a cut.
- **Boost cut pressure hysteresis (kPa absolute):**
  Defines a pressure range below the cut limit at which boost can resume, providing smoother control over boost cut actions.

Injector Duty Cycle Limiter

- **Instantaneous injector duty cycle limit (%):**
  This sets an immediate limit on injector duty cycle. If this threshold is reached, the system will immediately cut the injectors to prevent excessive fuel delivery.
- **Sustained injector duty cycle limit (%) & Sustained injector duty cycle delay(seconds):**
  This limit allows injectors to operate up to the specified duty cycle percentage for a short period (as defined by the delay). After this delay, if the duty cycle remains above the limit, it will trigger a cut. This setting helps balance performance by allowing temporary high fuel demands while protecting the injectors from prolonged stress.

Soft RPM Limit

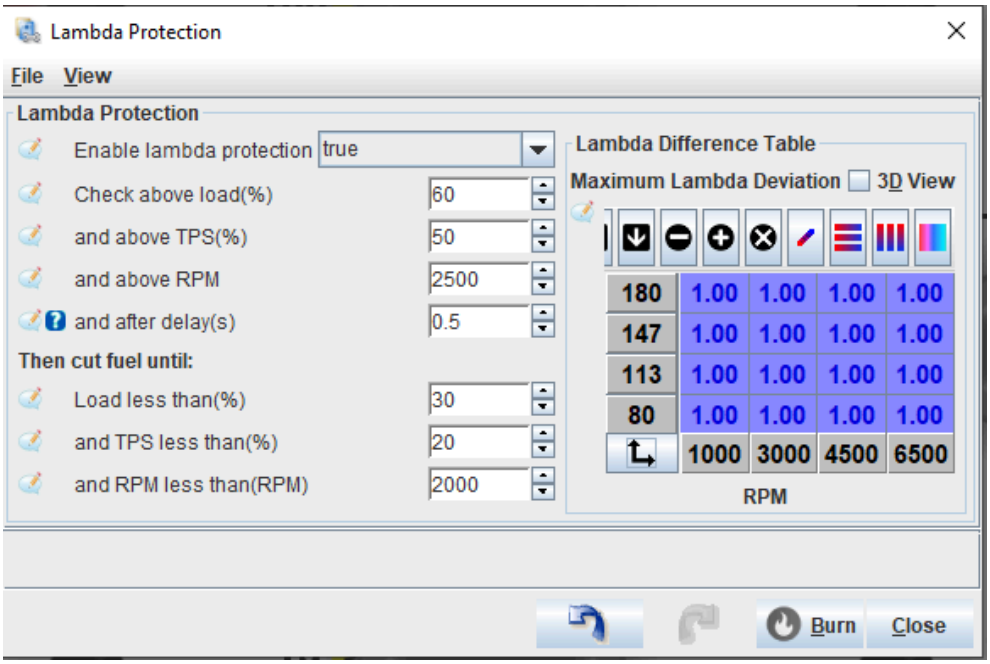
- **Window size (RPM), Timing retard (degrees), and Fuel added (%):** These options allow you to create a "soft" limiter that gradually engages, rather than abruptly cutting fuel or spark. This can help prevent sudden drops in power, making the limiter response smoother.

Electronic Throttle Limiting

- **Soft limiter start RPM and Soft limiter range (RPM):**
  Gradually closes the throttle as the RPM approaches the limit, helping to provide a smooth limiter response for electronically controlled throttles.

This section provides fine-tuned control over RPM, pressure, and throttle limits, with options for different limiter styles that balance performance and protection. For instance, using spark cut can add a visual effect with exhaust flames, while fuel cut keeps the action smooth and consistent.

Lambda Protection



The **Lambda Protection** window enables protection based on the Lambda values, which help in monitoring air-fuel ratio (AFR) deviations and ensuring safe engine operation under specific conditions. Here's a breakdown of the options:

Settings:

- **Enable lambda protection:** Allows you to toggle Lambda Protection on or off.
- **Check above load (%):** The system will check Lambda values only when the engine load exceeds this percentage threshold.
- **and above TPS (%):** Lambda values will only be monitored if the throttle position sensor (TPS) exceeds this percentage.
- **and above RPM:** Lambda protection activates only when the RPM is above this specified threshold.
- **and after delay (s)**: Sets a delay time (in seconds) before Lambda Protection engages after the above conditions are met.

Cut Fuel Until:

This section determines the conditions under which fuel will be cut when Lambda Protection is active.

- **Load less than (%):** Fuel will be cut until engine load drops below this percentage.
- **and TPS less than (%):** Fuel cut will continue until the TPS is below this percentage.

- **and RPM less than (RPM):** Fuel cut remains active until the RPM falls below this threshold.

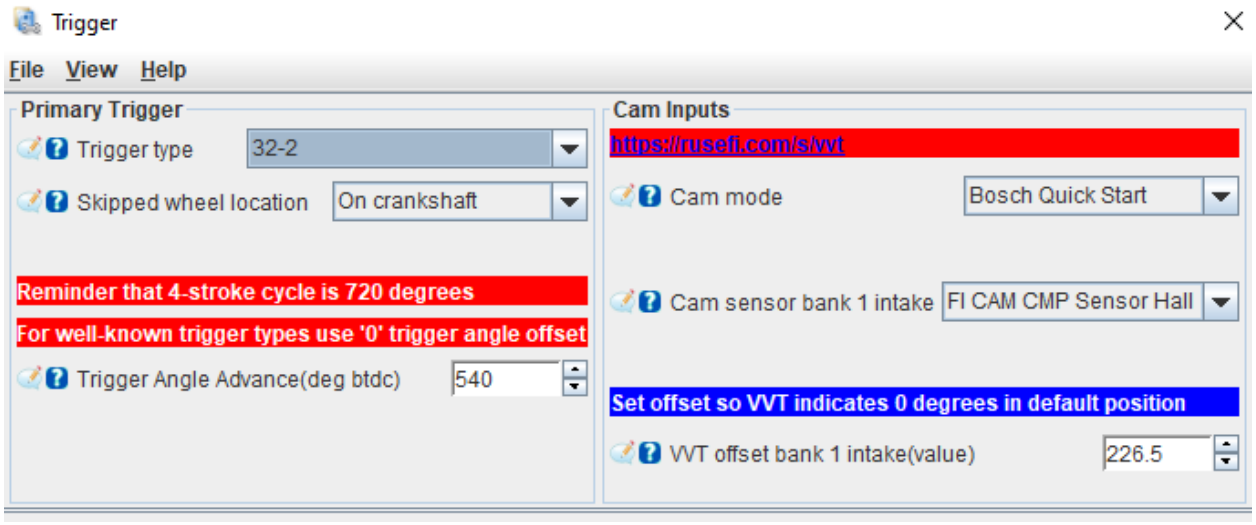
Lambda Difference Table:

The Lambda Difference Table (right side of the window) allows you to set a maximum allowable deviation in Lambda values.

- **Y-axis represents Load.**
- **X-axis represents RPM.**
- **Z-axis values represent Lambda values (not AFR)**.

This table helps define the Lambda deviation limits under various engine loads and RPMs, enabling finer control over protection levels based on actual engine performance conditions.

Trigger



Here's an explanation of the Trigger configuration based on the provided example. This setup uses a 32-2 trigger wheel, the trigger pattern for an HD M8. ***THESE SETTINGS WILL COME PRE-LOADED, AND IN MOST CASES WILL NEVER HAVE TO BE CHANGED!***

Primary Trigger Section

- **Trigger Type:** The example uses 32-2, meaning a 32-tooth wheel with 2 missing teeth, which is often mounted on the crankshaft.
- **Skipped Wheel Location:** Set to On Crankshaft to indicate that this trigger wheel is located on the crankshaft.
- **Trigger Angle Advance (deg BTDC):** Configured to 540 degrees in this setup. This setting depends on the engine's requirements.

Cam Inputs Section

Cam Mode: Set to **"Bosch Quick Start"** to indicate a Bosch Quick Start Cam Sensor Pickup Pattern is used. Can Also be set to **"Sync By Map"** to sync using a map dip threshold or **"Inactive"** to allow the bike to run in wasted spark.

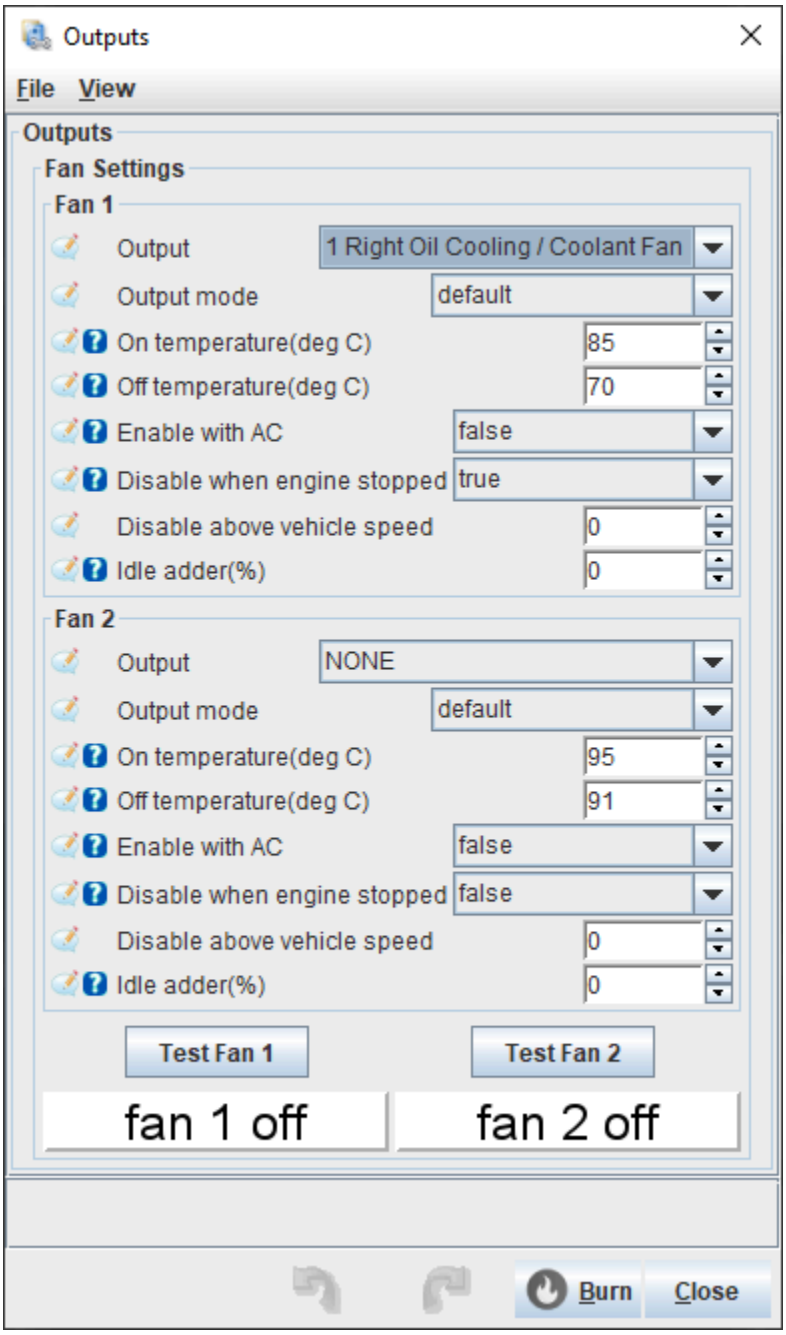
Cam Sensor Bank 1 Intake: Defines which input is being Cam Sensor input. When running wasted spark or sync by map this is typically set to "NONE" otherwise the above setting is correct.

VVT Offset Bank 1 Intake: This ensure proper timing alignment when VVT is active and is set so that VVT Cam Timing Value reads "0" When we are commanding "0" cam timing.

Outputs

Fan Settings:

- **Fan 1 and Fan 2:** Configure the control of two separate fans, including:
- **On/Off Temperature (°C):** Sets the activation and deactivation temperatures for each fan.
- **Disable When Engine Stopped:** Prevents fan operation when the engine is off.
- **Disable Above Vehicle Speed:** Prevents fan operation when the vehicle exceeds a specified speed.
- **Idle Adder (%):** Adds a specified duty cycle at idle to assist with cooling at low RPMs.
- **Test Fan 1 and Fan 2 Button:** Allows you to test functionality of the fans with just the ignition on.



IMPACT ECU · FUEL BUTTON GUIDE

Fuel Button Overview

The **Fuel** button in TunerStudio holds the settings that decide how much fuel your engine gets once it's running, and when. (Starting fuel is in the Cranking menu.) This guide is the map: what each item in the Fuel menu is for, and which guide explains it in detail.

Your tune came set up for your bike, so most of these never need changing.

How the ECU works out fuel

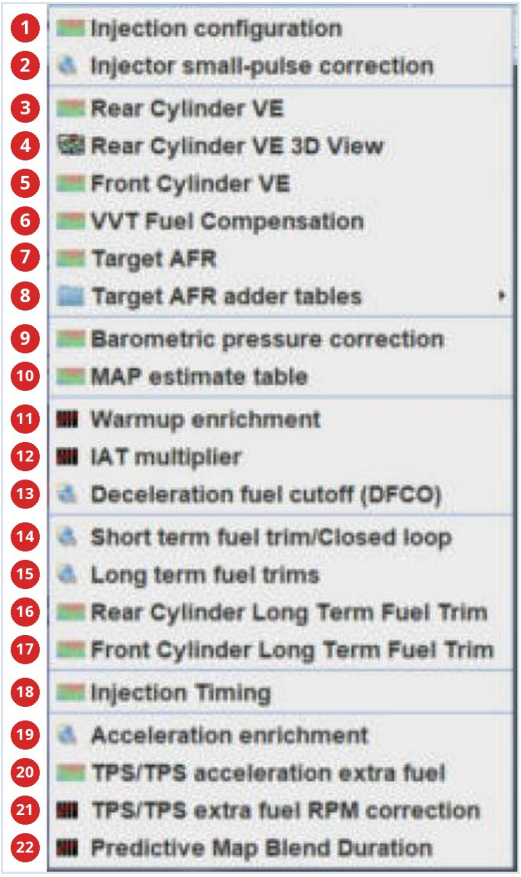
STEP 1 AIR	**How much air is in each cylinder.** Worked out from the VE tables, manifold pressure (MAP), air temperature and engine size.
STEP 2 TARGET	**How much fuel that air needs,** from the Target AFR table (and any adder tables).
STEP 3 ADJUST	**More or less fuel for conditions:** warmup, intake air temperature, altitude (baro), quick throttle changes (acceleration enrichment). While coasting, DFCO can cut fuel to zero.
STEP 4 TRIM	**Fine-tuning for each cylinder** from its own O2 sensor: short and long term fuel trim.
STEP 5 INJECT	**How long each injector opens, and when,** using the injector's flow and dead time and the Injection Timing table.

Every 5 milliseconds the ECU runs through these steps for each cylinder. The menu items below plug into one of them.

Before you change anything

- **Save a copy of your tune first**, so you can always go back.
- **Burn means save.** Changes go to the ECU as you make them, but are only kept after you click **Burn**.
- **Greyed-out items** are switched off by another setting. Each guide says which one.
- **Missing items?** Some only show when **Setup ▸ Vehicle Information ▸ Tuning View** is set to **Full**.
- **Change one thing at a time**, and take a datalog before and after. Not sure? Call us first.

The Fuel menu, item by item



▸ at the end of a name means it opens a smaller menu.

Items 2, 9 and 10 only show when **Tuning View** is **Full**. A greyed-out item is switched off by another setting.

1. **Injection configuration** Injector size and dead time, fuel type, front/rear tables.
2. **Injector small-pulse correction** For very short squirts. Normally off.
3. **Rear Cylinder VE** The rear cylinder's main fuel table.
4. **Rear Cylinder VE 3D View** The same table, drawn in 3D.
5. **Front Cylinder VE** The front cylinder's main fuel table.
6. **VVT Fuel Compensation** Adjusts fuel by cam position (VVT).
7. **Target AFR** The air-fuel ratio you want at each RPM and load.
8. **Target AFR adder tables ▸** Shift the target, for example richer when cold.
9. **Barometric pressure correction** Fuel change by outside air pressure (altitude).
10. **MAP estimate table** Backup MAP readings, and MAP Prediction.
11. **Warmup enrichment** Extra fuel while the engine is cold.
12. **IAT multiplier** Fuel change by intake air temperature.
13. **Deceleration fuel cutoff (DFCO)** Cuts fuel while you coast.
14. **Short term fuel trim/Closed loop** Fine-tunes fuel from the O2 sensors as you ride.
15. **Long term fuel trims** Learns those corrections and remembers them.
16. **Rear Cylinder Long Term Fuel Trim** What it learned for the rear cylinder.
17. **Front Cylinder Long Term Fuel Trim** What it learned for the front cylinder.
18. **Injection Timing** When each squirt happens.
19. **Acceleration enrichment** Extra fuel when you twist the throttle quickly.
20. **TPS/TPS acceleration extra fuel** How much extra fuel.
21. **TPS/TPS extra fuel RPM correction** Scales that extra fuel by RPM.
22. **Predictive Map Blend Duration** Only for MAP Prediction mode.

Which guide to read

GUIDE	MENU ITEMS	WHAT IT COVERS
Injector Setup	1, 2, 18	Injector size, pre-sets, dead time, fuel type, injection timing
Front & Rear VE Tables	3–6	The main fuel tables, VVT Fuel Compensation
Target AFR Table	7	The air-fuel ratio targets, AFR vs. lambda
Target AFR Adder Tables	8	Shifting the target, for example richer when cold
Barometric Correction	9	Altitude and air-pressure correction
Warmup Enrichment & IAT Multiplier	11, 12	Cold-engine fuel and intake-air temperature fuel
Deceleration Fuel Cutoff (DFCO)	13	Cutting fuel while coasting
Short Term Fuel Trim	14	Closed loop: fine-tuning from the O2 sensors
Long Term Fuel Trim	15–17	Learning and remembering corrections
Acceleration Enrichment	10, 19–22	Extra fuel for quick throttle changes, wall wetting, MAP estimate

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IMPACT ECU · FUEL BUTTON GUIDE

Injector Setup

These settings tell the ECU about your fuel injectors and your fuel: how much fuel the injectors flow, how long they take to open, and when they spray. The ECU needs them to turn “this much fuel” into “keep the injector open this long.”

Your tune came with these set for your injectors. **Most riders never change them.** The usual reason to come here is after changing injectors or fuel type, and that’s a good time to call us.

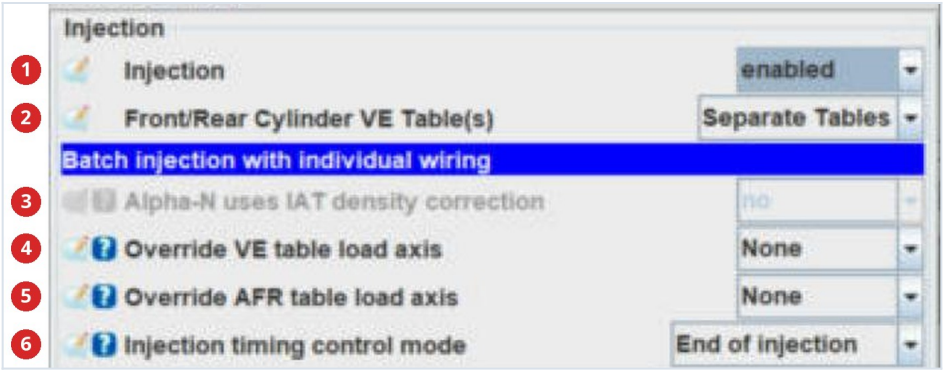
WHERE TO FIND IT

- A **Fuel ▸ Injection configuration**
- B **Fuel ▸ Injection Timing**
- C **Fuel ▸ Injector small-pulse correction**

The numbers in these pictures come from one example bike. Your tune’s numbers will be different, so don’t copy them. Units are Metric (°C, kPa, km/h). Red numbers in each picture match the table below it.

A Injection configuration

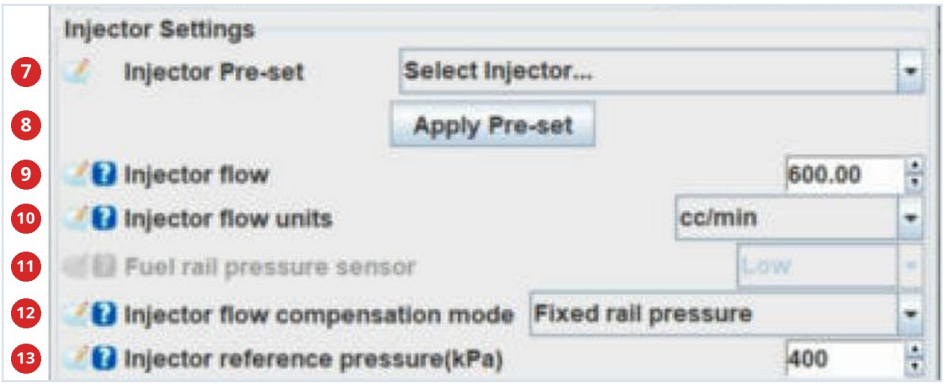
The main injector and fuel settings, all in one window. It has five parts.



#	SETTING	WHAT IT DOES
1	**Injection** LEAVE AS SET	Turns fuel injection on or off. Must be **enabled**. With it disabled the injectors never fire and the engine won’t run.
2	**Front/Rear Cylinder VE Table(s)** LEAVE AS SET	Must stay on **Separate Tables**: the front and rear cylinders each get their own VE (fuel) table. Single Table isn’t supported on the Impact ECU.

#	SETTING	WHAT IT DOES
3	**Alpha-N uses IAT density correction** NOT USED HERE	Only for the Alpha-N fueling method. The Impact ECU uses Speed Density, so this stays greyed out.
4	**Override VE table load axis** ADVANCED	Lets the VE tables use something other than manifold pressure (MAP) for their rows. Leave on **None**.
5	**Override AFR table load axis** ADVANCED	The same idea for the Target AFR table. Leave on **None**.
6	**Injection timing control mode** LEAVE AS SET	Which part of each squirt the Injection Timing table (section B) controls: **End of injection** (when the squirt finishes), Start, or Center.

The blue bar that reads "Batch injection with individual wiring" is only a label. There is nothing to set there.



#	SETTING	WHAT IT DOES
7	**Injector Pre-set**	A list of common injectors: Screamin' Eagle 5.5 and 6.8 g/s, Injector Dynamics ID1050x, Daytona Twin Tec, GMR and Deatschwerks. Picking one changes nothing until you click **Apply Pre-set**.
8	**Apply Pre-set**	Loads the flow and dead time for the injector you picked. **Click Burn right away**: unplugging before you Burn can lose the change. Then unplug the USB cable and plug it back in so TunerStudio shows the new values.

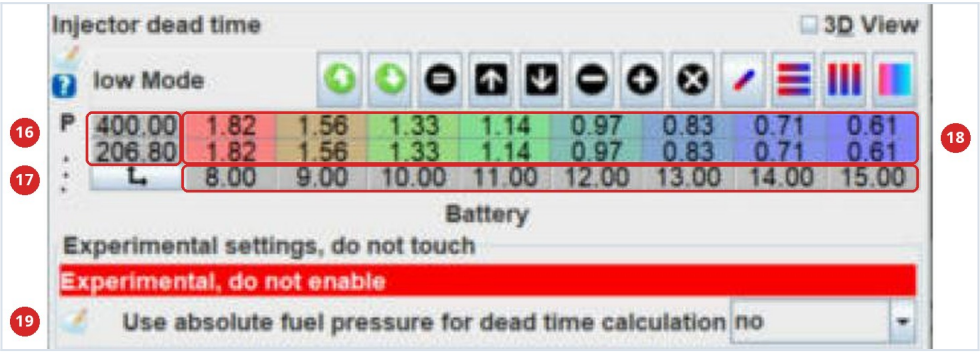
#	SETTING	WHAT IT DOES
9	**Injector flow** MAIN SETTING	How much fuel one injector flows at your fuel pressure, in the units set in 10. The injectors in this example flow **600 cc/min**. It must match the injectors on the bike, or all your fueling is off.
10	**Injector flow units** LEAVE AS SET	**cc/min** or **grams per second**. Our tunes use one or the other; keep what yours has. Changing the units does **not** convert the number. See the warning below.
11	**Fuel rail pressure sensor** NOT USED HERE	Only used if a fuel pressure sensor is fitted. Greyed out on stock bikes.
12	**Injector flow compensation mode** LEAVE AS SET	Corrects injector flow for the difference between fuel pressure and manifold pressure. **Fixed rail pressure** is right for the stock Harley fuel pump.
13	**Injector reference pressure (kPa)** LEAVE AS SET	The fuel pressure that Injector flow was measured at (400 kPa is about 58 psi). The ECU uses it to work out how much the injector really flows: a little more at idle, the rated amount at wide open throttle.



#	SETTING	WHAT IT DOES
14	**Stoichiometric ratio (:1)** LEAVE AS SET	The “chemically perfect” air-fuel ratio for your fuel. Gasoline is **14.7** (shown); E85 is much lower. Your tune was built around the number in this box, so call us before changing it. It changes fuel everywhere: 14.7 to 14.1 adds about 4% fuel.
15	**E100 stoichiometric ratio** NOT USED HERE	Only for flex-fuel setups with an ethanol sensor. Greyed out otherwise.

INJECTOR DEAD TIME

An injector takes a moment to open after the ECU switches it on. That delay is the **dead time**, and the ECU adds it to every squirt. Lower battery voltage means the injector opens more slowly, so it needs more dead time.



#	SETTING	WHAT IT DOES
16	**Pressure rows (kPa)**	Fuel pressure across the injector (fuel pressure minus manifold pressure). The ECU blends between the rows.
17	**Battery columns (volts)**	Battery voltage. The ECU follows it live.
18	**Dead time (ms)** LEAVE AS SET	Milliseconds added to every squirt. These come from the injector maker's data. Only change them when you change injectors.
19	**Use absolute fuel pressure for dead time calculation** LEAVE AS SET	Experimental. Leave on **no**.

Wrong dead time shows up mostly at idle, where the squirts are shortest, and while cranking, where battery voltage is lowest.

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

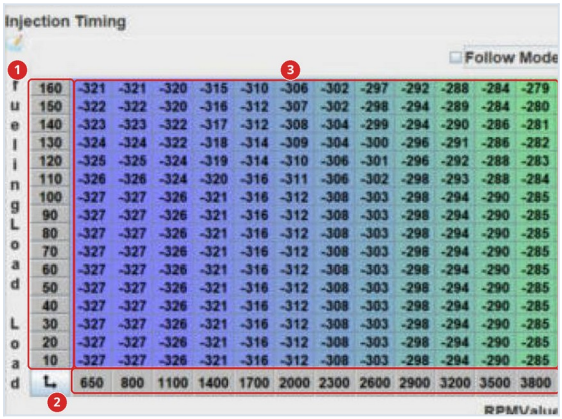
> **NEVER CHANGE THE UNITS ALONE** Switching **Injector flow units** without changing the number tells the ECU your injectors are a completely different size. 600 cc/min injectors read as 600 grams per second look about 83 times too big, and the engine won't run. If you ever need to convert: 1 gram per second is about 83 cc/min.

CHANGED INJECTORS? Use **Injector Pre-set** and **Apply Pre-set** (7 and 8): they set the flow and dead time for you. Afterward, check that Injector flow (9) and its units (10) match the new injectors. Or call us. Injector flow, reference pressure and dead time all have to match the new injectors.

If your acceleration enrichment uses MS Adder mode, its table is in milliseconds and needs scaling too. See the Acceleration Enrichment guide.

B Injection Timing

Sets **when** each squirt happens, not how much fuel. (Left part of the table shown.)



Load	650	800	1100	1400	1700	2000	2300	2600	2900	3200	3500	3800
160	-321	-321	-320	-315	-310	-306	-302	-297	-292	-288	-284	-279
150	-322	-322	-320	-316	-312	-307	-302	-298	-294	-289	-284	-280
140	-323	-323	-322	-317	-312	-308	-304	-299	-294	-290	-286	-281
130	-324	-324	-322	-318	-314	-309	-304	-300	-296	-291	-286	-282
120	-325	-325	-324	-319	-314	-310	-306	-301	-296	-292	-288	-283
110	-326	-326	-324	-320	-316	-311	-306	-302	-298	-293	-288	-284
100	-327	-327	-326	-321	-316	-312	-308	-303	-298	-294	-290	-285
90	-327	-327	-326	-321	-316	-312	-308	-303	-298	-294	-290	-285
80	-327	-327	-326	-321	-316	-312	-308	-303	-298	-294	-290	-285
70	-327	-327	-326	-321	-316	-312	-308	-303	-298	-294	-290	-285
60	-327	-327	-326	-321	-316	-312	-308	-303	-298	-294	-290	-285
50	-327	-327	-326	-321	-316	-312	-308	-303	-298	-294	-290	-285
40	-327	-327	-326	-321	-316	-312	-308	-303	-298	-294	-290	-285
30	-327	-327	-326	-321	-316	-312	-308	-303	-298	-294	-290	-285
20	-327	-327	-326	-321	-316	-312	-308	-303	-298	-294	-290	-285
10	-327	-327	-326	-321	-316	-312	-308	-303	-298	-294	-290	-285

1. **Load rows (kPa)**
   Engine load (manifold pressure).

2. **RPM columns**
   Engine speed.

3. **Timing (degrees)** LEAVE AS SET
   Crank degrees from the top of that cylinder's compression stroke (minus = before). With **End of injection** (A6), it's where the squirt finishes: here **−327** at low RPM, just after the intake stroke starts, getting later (closer to 0) as RPM rises.

C Injector small-pulse correction

Some injectors don't flow evenly on very short squirts, like at idle. This window can correct for that. It only shows in the menu when **Setup ▸ Vehicle Information ▸ Tuning View** is **Full**.



1. **Small pulse correction mode** LEAVE AS SET
   None means off. The other choices (Polynomial and Ford dual slope) need test data from the injector maker. Leave on **None** unless we tell you otherwise.

IMPACT ECU · FUEL BUTTON GUIDE

Front & Rear VE Tables

The VE tables are your main fuel tables. **VE** (volumetric efficiency) is how well a cylinder fills with air at each engine speed (RPM) and load. The ECU combines it with manifold pressure (MAP) and air temperature to work out how much air is in the cylinder, then adds the right amount of fuel for your Target AFR.

Higher VE number = more fuel. Lower VE number = less fuel. The Impact ECU gives the front and rear cylinders separate tables, because each cylinder has its own O2 sensor and fills a little differently.

WHERE TO FIND IT

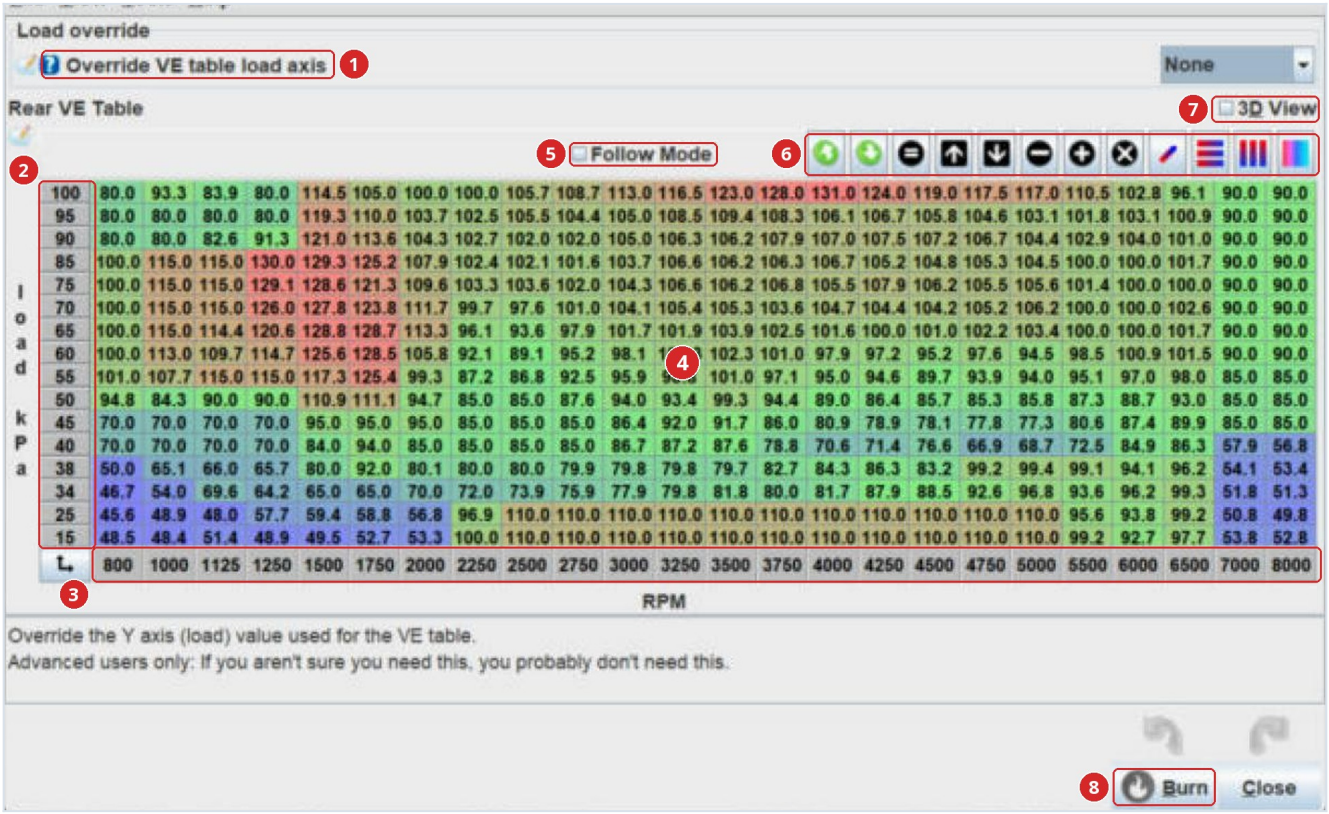
- A **Fuel ▸ Rear Cylinder VE**
- B **Fuel ▸ Front Cylinder VE**
- C **Fuel ▸ VVT Fuel Compensation**
- D **Fuel ▸ Rear Cylinder VE 3D View**

The numbers in these pictures come from one example bike. Your tune's numbers will be different, so don't copy them. Units are Metric (°C, kPa, km/h). Red numbers in each picture match the table below it.

Making changes

- Change a few cells at a time, in small steps (a few percent), then ride and check again.
- Compare each cylinder's air-fuel ratio with your Target AFR. **Leaner than target** (higher number) in an area: raise VE there. **Richer** (lower number): lower VE there. With closed loop on, watch the fuel trims too: a steady +5% trim means raise VE about 5% there. Running E85? Compare the Gas Scale readings (see the Target AFR guide).
- Work on the table for the cylinder whose O2 sensor shows the problem: rear sensor, Rear Cylinder VE; front sensor, Front Cylinder VE.
- Keep the table smooth. Sharp steps between neighboring cells make the bike surge.
- With **Detect Tuning and Suspend** on **no** (the usual setting, in the Acceleration enrichment window), closed loop, long term learning, decel fuel cut and throttle-based acceleration fuel pause for 20 seconds after each change to either VE table. This setting works backwards from its name: **yes** turns that pause off.

A Rear Cylinder VE



#	SETTING	WHAT IT DOES
1	**Override VE table load axis** ADVANCED	Lets the table use something other than manifold pressure for its rows. Leave on **None**. (The same setting is in Injection configuration.)
2	**Load (kPa) rows**	Engine load, measured as manifold pressure. Low numbers are closed throttle (coasting and idle); about 100 is wide open throttle at sea level.
3	**RPM columns**	Engine speed.
4	**VE cells** MAIN SETTING	The VE number for each RPM and load. The ECU blends between neighboring cells. Raise a cell to add fuel there; lower it to take fuel away.
5	**Follow Mode**	When the engine is running, follows and highlights the cells the engine is using right now.

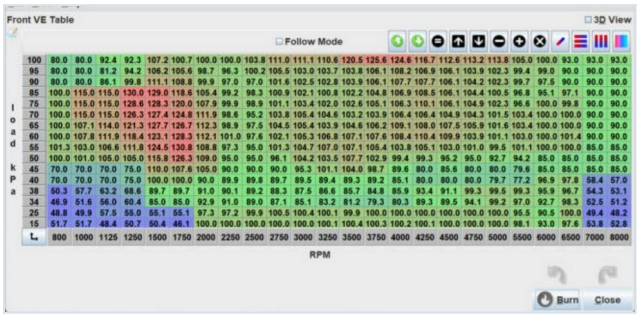
#	SETTING	WHAT IT DOES
6	**Toolbar**	Buttons for changing the cells you've selected, like raising or lowering them, setting a value or smoothing. Hover over a button to see its name. Our TunerStudio Hot Keys sheet lists the keyboard shortcuts.
7	**3D View**	Shows this table as a 3D picture next to the grid.
8	**Burn**	Saves your changes in the ECU.

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

B Front Cylinder VE

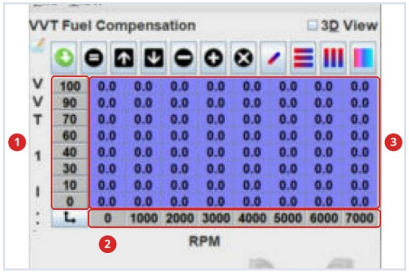
Works like the rear table, for the front cylinder (without the load-override box). It shares the rear table's RPM and load numbers, so changing an axis number in one changes both.

It needs **Separate Tables** in Injection configuration. Keep it that way: Single Table isn't supported.



C VVT Fuel Compensation

Fine-tunes fuel by cam position on engines with variable valve timing (VVT): **+5 in the table means up to 5% more fuel, −5 up to 5% less**. It's greyed out unless it has been set up. Its setup isn't in the menus; we set it in your tune.



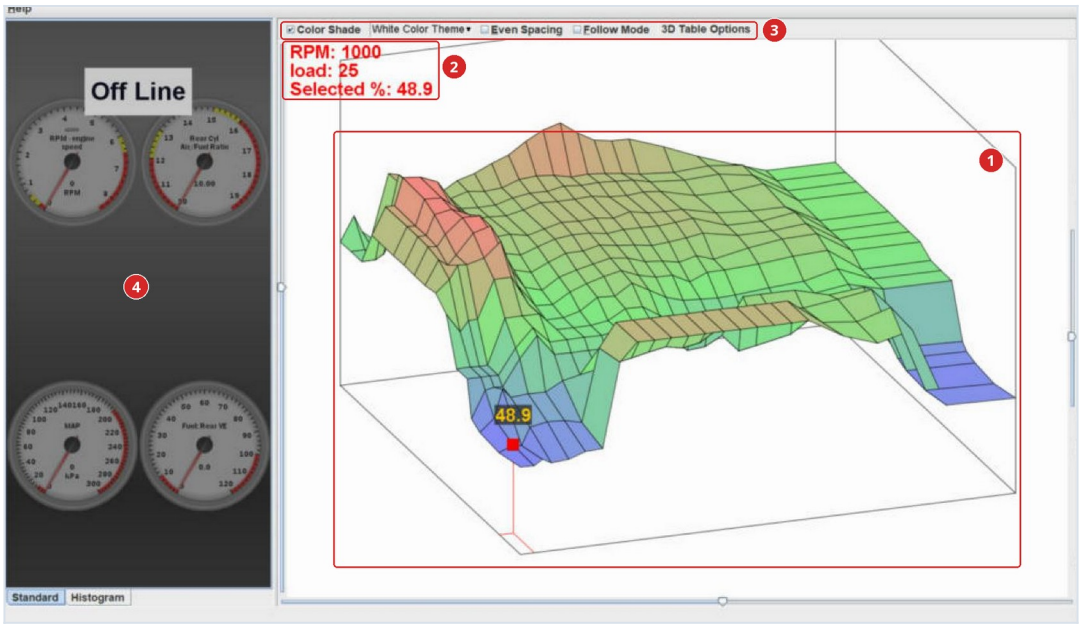
1. **VVT rows**
   Cam position, in degrees.

2. **RPM columns**
   Engine speed.

3. **Percent change** MAIN SETTING
   Percent added to (+) or taken from (−) the VE number. **0.0 = no change**, as here. Click **Burn** to save.

D Rear Cylinder VE 3D View

The rear VE table drawn as a landscape. It's the same table, not a copy: a change here changes the Rear Cylinder VE table. Bumps and dips that don't belong are easy to spot this way.



#	SETTING	WHAT IT DOES
1	**3D graph**	Higher = more fuel. Turn and tilt it with the M, K, N and J keys.
2	**Selected cell**	The RPM, load and VE value of the point you've picked (the red square).
3	**Display options**	Color shading, color theme, even spacing and Follow Mode.
4	**Gauges** DISPLAY ONLY	Live engine readings. They read "Off Line" when the ECU isn't connected.

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Target AFR Table

The Target AFR table is the air-fuel ratio (AFR) you want the engine to run at each engine speed and load. The ECU uses it directly when it works out fuel: **change a target and the fuel changes right away**, whether closed loop is on or not. With closed loop on, the O2 sensors then fine-tune the fuel to hit the target.

One table sets the target for both cylinders.

> **WHERE TO FIND IT**
> **Fuel ▸ Target AFR** called Target lambda if your project is set to lambda (see the last section)

AFR in 30 seconds

- **14.7 is "stoich"** for gasoline: exactly enough air to burn all the fuel.
- **Lower number = richer = more fuel.** Higher number = leaner = less fuel.
- Leaner targets save fuel; richer targets run cooler and are safer under heavy load. That's why targets usually get richer (lower) as load goes up.
- Small changes matter: moving a target from 13.2 to 12.5 adds about 5.6% fuel.

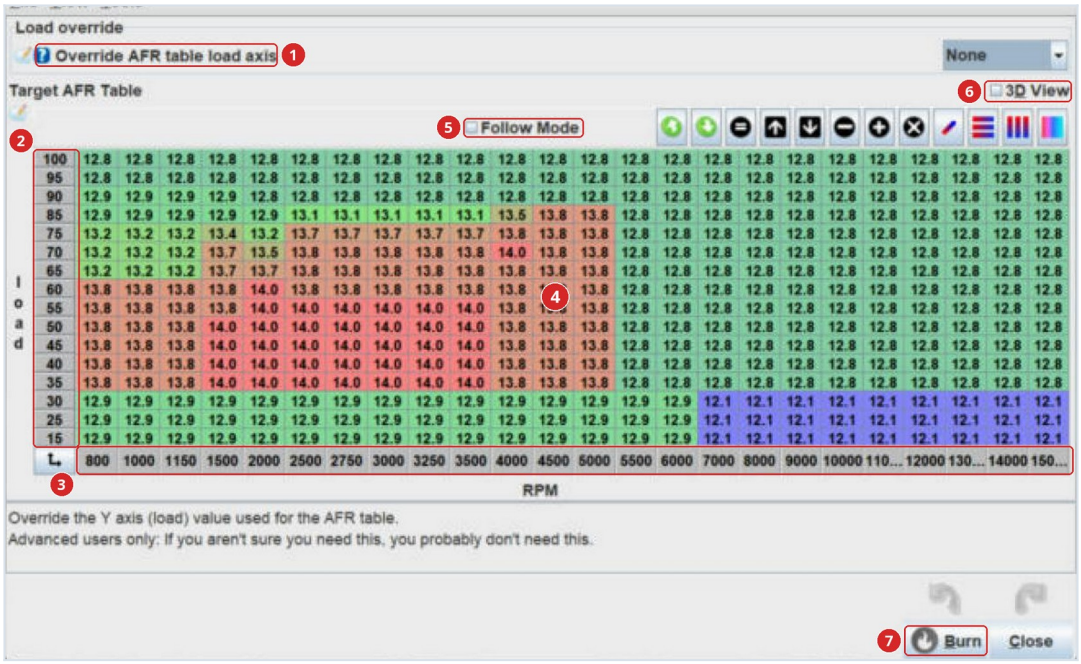
> **TARGET VS. VE** The target is what you **want**. The VE tables are what **make it happen**. If the O2 sensors show a different AFR than the target, fix the VE table there, not the target.

How it works with other settings

- **Short term fuel trim (closed loop)** compares each cylinder's O2 sensor with this target and trims that cylinder's fuel to match. When an O2 sensor reads outside the trim's learning limits, the trim pauses and holds its last correction.
- **Target AFR adder tables** can shift these targets, for example richer while the engine is cold.
- **Warmup enrichment** adds fuel on top of the target while the engine is cold, so a cold engine runs richer than the target on purpose, until closed loop takes over.

The numbers in these pictures come from one example bike. Your tune's numbers will be different, so don't copy them. Units are Metric (°C, kPa, km/h). Red numbers in each picture match the table below it.

The Target AFR window



#	SETTING	WHAT IT DOES
1	**Override AFR table load axis** ADVANCED	Lets the table use something other than manifold pressure for its rows. Leave on **None**. (The same setting is in Injection configuration.)
2	**Load (kPa) rows**	Engine load, measured as manifold pressure. About 100 kPa is wide open throttle at sea level.
3	**RPM columns**	Engine speed.
4	**Target AFR cells** MAIN SETTING	The air-fuel ratio you want at each RPM and load. The ECU blends between neighboring cells.
5	**Follow Mode**	When the engine is running, follows the cells the engine is using right now.
6	**3D View**	Shows the table as a 3D picture.
7	**Burn**	Saves your changes in the ECU.

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

HIGHER UP, WIDE OPEN THROTTLE USES LOWER ROWS The air is thinner at altitude, so manifold pressure is lower. Around 5,000 feet, wide open throttle reads about 84 kPa instead of 100, so it uses the rows below 100. If you ride at altitude a lot, see the Barometric Correction guide.

AFR or lambda?

TunerStudio can show this table as **AFR** or as **lambda**, where 1.00 lambda is stoich (0.88 lambda = 12.9 AFR). It's the same table either way, and switching doesn't change the fuel. This is a setting of your TunerStudio project, not of the ECU: **File ▸ Vehicle Projects ▸ Project Properties**, **Settings** tab, **Lambda Display**.



- Our tunes are set to **AFR**. Switching to lambda renames the menu item to **Target lambda**. Call us before you switch, and save a copy of your tune first.
- Units are always Metric: °C and kPa. The load rows are absolute pressure (about 100 kPa is the outside air at sea level), not boost.

RUNNING E85 OR ANOTHER ETHANOL BLEND? The table always uses the **gasoline scale** (14.7 = stoich). The Rear and Front Cyl Air/Fuel Ratio gauges use your fuel's own scale, so they won't match it. Compare the **Rear / Front Air/Fuel (Gas Scale)** datalog readings instead, or use the **Rear Lambda** and **Front Lambda** gauges.

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Short Term Fuel Trim

Short term fuel trim (STFT), also called **closed loop**, uses each cylinder's O2 sensor to fine-tune fuel while you ride. If a cylinder reads leaner than your Target AFR, the ECU adds a little fuel to it; if it reads richer, it takes some away. The rear and front cylinders are trimmed separately.

The trim is temporary. It starts from zero every time you turn the key on. To keep what it learns, use Long Term Fuel Trim (its own guide).

> **WHERE TO FIND IT**
> **Fuel ▸ Short term fuel trim/Closed loop**

How it works

- The window has three columns: **Bank 1** on the left is the **rear cylinder**, the settings are in the middle, and **Bank 2** on the right is the **front cylinder**.
- The engine's operating range is split into four **regions**: Idle, Overrun (closed-throttle coasting), Power (heavy throttle) and Main (everything else, mostly cruising). Each region has its own speed and limits, and keeps its own trim.
- The trim is a percentage: **+4% means 4% more fuel** for that cylinder. It is applied on top of the VE tables. It doesn't change them.

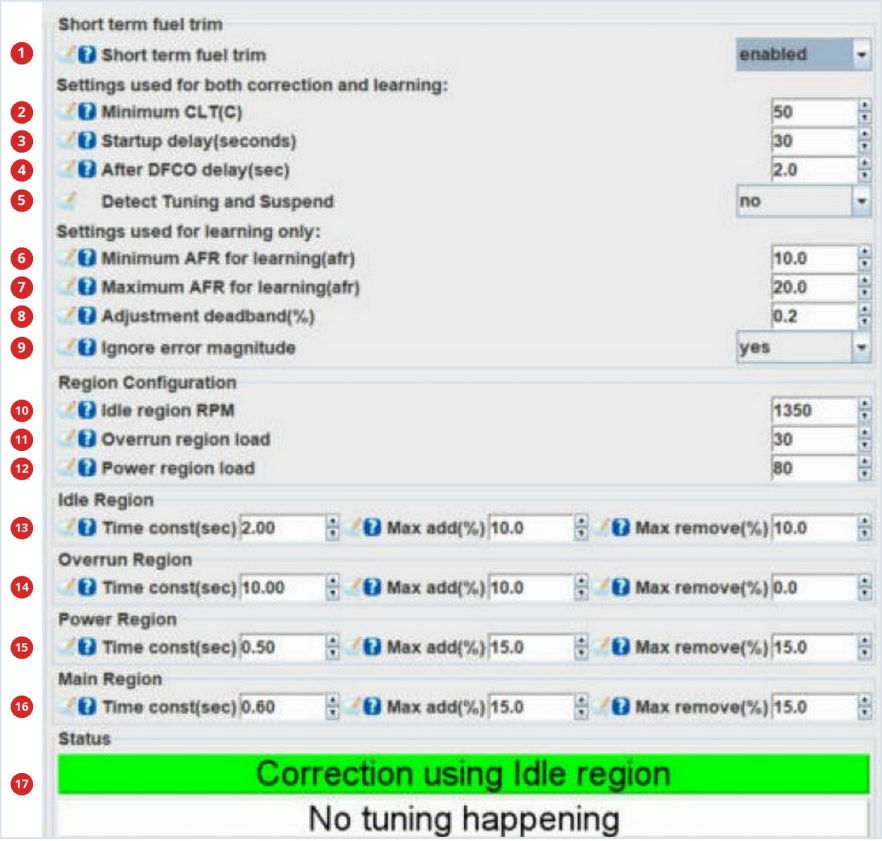
Off or just paused?

There are two kinds of "not working," and they act differently:

	CLOSED LOOP OFF	LEARNING PAUSED
What happens	No short term trim: the trim gauges read 0%. Fuel comes from the tables (plus Long Term Fuel Trim, if it's applied).	The trim stops changing, but its last value **keeps being applied**.
Which cylinders	Both at once	Each cylinder on its own
Why	Switched off · VE change (Tuning) · engine not running · Startup delay · engine colder than Minimum CLT, or a coolant sensor problem	O2 reading outside the learning AFR range, or not ready · right after decel fuel cut or acceleration fuel · rev limiter or another cut in the last 2 seconds

Pictures taken with no ECU connected, so the gauges read 0 and the status lights mean nothing there. Numbers from one example bike; don't copy them. Units are Metric. Red numbers match the tables.

The settings (middle column)



#	SETTING	WHAT IT DOES
1	**Short term fuel trim** MAIN SETTING	Turns closed loop on (**enabled**) or off (**disabled**). Everything below is greyed out while it's disabled.
2	**Minimum CLT (C)**	Closed loop stays off until the coolant is at least this warm, or if the coolant sensor fails.
3	**Startup delay (seconds)**	Closed loop waits this long after every start, so the O2 sensors can warm up.
4	**After DFCO delay (sec)**	After decel fuel cut, learning pauses this long while fueling settles. The trim is held, not reset. Same setting as "Inhibit closed loop fuel after cut" in the DFCO window.

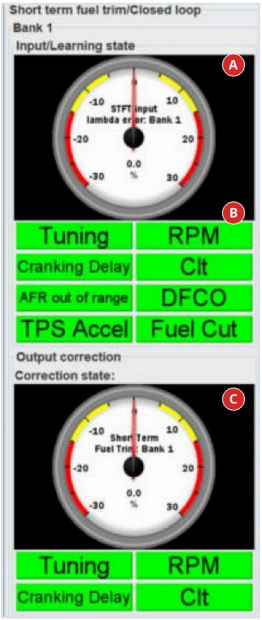
#	SETTING	WHAT IT DOES
5	**Detect Tuning and Suspend**	**Works backwards from its name. no** (the usual setting): for 20 seconds after you change either VE table, closed loop and long term learning switch off and decel fuel cut and throttle-based acceleration fuel stop, so they don't fight your change; the status (17) shows "Tuning Detected". **yes:** no pause.
6	**Minimum AFR for learning**	When an O2 sensor reads richer than this (a lower number), learning pauses for that cylinder. Uses the gasoline scale (14.7 = stoich).
7	**Maximum AFR for learning**	When it reads leaner than this, learning pauses. During decel fuel cut the sensor sees mostly air, so it pauses then.
8	**Adjustment deadband (%)**	A small zone around the target where the trim doesn't move, to keep it steady. 0.5% is about ±0.07 AFR.
9	**Ignore error magnitude**	**no:** the trim moves faster when the reading is far off. **yes:** it always moves at one fixed speed, as if the reading were well off. That's faster for small errors, so it suits longer Time const values. It can work better with a jumpy sensor.
10	**Idle region RPM**	Below this RPM, the **Idle** region is used. A good value is about 300 RPM above your warm idle.
11	**Overrun region load**	Below this load (manifold pressure, kPa), the **Overrun** region is used: closed throttle and coasting.
12	**Power region load**	Above this load (kPa), the **Power** region is used: heavy throttle.
13	**Idle Region**	Each region has three settings: **Time const (sec):** roughly how many seconds the trim takes to make most of a correction. Smaller = faster. **Max add / Max remove (%):** the most fuel the trim may add or take away in that region (25% at the most). Both at **0** means no trimming in that region.
14	**Overrun Region**	Same three settings, used while coasting with the throttle closed. (In this example it can only add fuel.)
15	**Power Region**	Same three settings, used under heavy throttle.
16	**Main Region**	Same three settings, used everywhere else (mostly cruising).

#	SETTING	WHAT IT DOES
17	**Status** DISPLAY ONLY	Engine running: “Correction using … region” on green means closed loop is working (Main shows as “Normal”). Otherwise it reads “Not active:” and the reason.

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

Region order: Idle first (by RPM only), then Overrun, then Power, otherwise Main. Below the Idle RPM it’s always Idle, even on heavy throttle.

The rear and front cylinder columns



A **STFT input lambda error** DISPLAY ONLY
How far that cylinder’s O2 reading is from the target, in %. **Plus = leaner** than target. It holds its last value while learning is paused.

B **Learning lights** DISPLAY ONLY
Tuning, RPM, Cranking Delay, Clt, AFR out of range, DFCO, TPS Accel, Fuel Cut. If one turns **red**, that’s what is pausing learning for that cylinder right now. The TPS Accel and Fuel Cut lights never turn red, even when they pause learning.

C **Short Term Fuel Trim** DISPLAY ONLY
The trim being applied to that cylinder right now. **+4 = adding 4% fuel**, −4 = taking away 4%. The lights under it (Tuning, RPM, Cranking Delay, Clt) turn red when closed loop is off for both cylinders.

Good to know

- If a cylinder’s trim stays well away from zero in an area, or sits at its Max add or Max remove limit, its VE table is off there. Fix the VE table (or let Long Term Fuel Trim learn it); don’t raise the limits.
- Where the O2 sensors read richer than Minimum AFR for learning, nothing new is learned; the cylinder keeps whatever trim that region already had. Get the VE table right there.

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Long Term Fuel Trim

Long term fuel trim (LTFT) is the ECU's memory for fuel corrections. Short term fuel trim fixes the fuel moment to moment, but forgets everything when you turn the key off. Long term fuel trim watches those corrections over many rides and **learns** them into two tables, one for the rear cylinder and one for the front. With Apply Correction on, every ride starts with part of the correction already in place.

You can use what it learns two ways: let the ECU apply it on top of your VE tables, or move it into the VE tables for good.

WHERE TO FIND IT

Fuel ▸ Long term fuel trims

Fuel ▸ Rear Cylinder Long Term Fuel Trim and Front Cylinder Long Term Fuel Trim (the learned tables)

How it works

- **It learns from short term fuel trim**, not from the O2 sensors directly. If the short term trim keeps adding 4% at some RPM and load, LTFT slowly learns +4% there. These settings stay greyed out until **Short term fuel trim** is enabled, and LTFT stops learning whenever closed loop is off (see "Off or just paused?" in that guide).
- Each cell learns only while you ride near that cell's RPM and load. A full table takes many rides.
- Two separate switches: **Gathering Data** (learn) and **Apply Correction** (use what was learned).
- What it learns is kept in the Impact ECU's own internal memory, so it's still there after you turn the key off. Your tune file (.msq) is not a reliable record of it.

The pictures were taken with no ECU connected, so the gauges and trim tables read 0 and the status lights are red. The numbers come from one example bike; don't copy them. Units are Metric (°C, kPa, km/h). Red numbers in each picture match the table below it.

The Long term fuel trims window

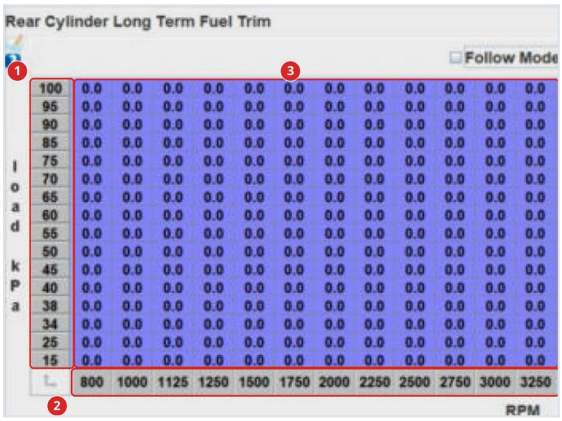


#	SETTING	WHAT IT DOES
1	**Gathering Data** MAIN SETTING	**yes:** learn. **no:** stop learning (what's already learned is kept). The trim tables in the Fuel menu are greyed out while this is **no**.
2	**Time const for Idle region (sec)**	How fast each region learns: roughly the seconds to learn most of a correction while riding on a cell. **Bigger = slower and steadier.** The regions are set in the Short term fuel trim window ("Cruise" here is "Main" there).
3	**Time const for Overrun region (sec)**	The same, for closed-throttle coasting.
4	**Time const for Power region (sec)**	The same, for heavy throttle.
5	**Time const for Cruise region (sec)**	The same, for everything else (mostly cruising).
6	**Max add (%)**	The most fuel any cell may add (up to 25%).

#	SETTING	WHAT IT DOES
7	**Max remove (%)**	The most fuel any cell may take away (up to 25%).
8	**Learning deadband (%)**	Short term corrections smaller than this are ignored, so LTFT doesn't chase tiny numbers.
9	**Apply Correction** MAIN SETTING	**yes:** the learned trims are added to the fuel **all the time**: cold starts, wide open throttle, everywhere, even when closed loop isn't active. **no:** the ECU still learns (if Gathering Data is yes) but doesn't use what it learned.
10	**Reset LTFT trims**	Sets every cell in both trim tables back to 0.
11	**Apply LTFT to VE and reset**	Adds the rear cylinder's learning into the Rear Cylinder VE table and the front's into the Front Cylinder VE table, then sets the trims back to 0. Use the steps in "Moving the learning into the VE tables" below.
12	**Status** DISPLAY ONLY	Green **Gathering data** and **Correcting** mean it's learning and applying. When it isn't, they read "No gather data" and "Not correcting" in red. The counters show how often it learned (hits), was outside the table (miss), or had nothing to learn (deadband).
13	**Trim bank 1 (rear cylinder)** DISPLAY ONLY	Top: the trim being applied to the rear cylinder right now (0 while Apply Correction is no). Bottom: a running total of all learning since power-up or the last Reset, a progress counter, not a fuel amount.
14	**Trim bank 2 (front cylinder)** DISPLAY ONLY	The same two gauges for the front cylinder.

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

The learned tables



1. **MAP (kPa) rows**
   The same load rows as the Rear Cylinder VE table.

2. **RPM columns**
   The same RPM columns as the Rear Cylinder VE table.

3. **Learned trim (%)** DISPLAY ONLY
   +3.0 = this cylinder wanted about 3% more fuel here (VE too low there); −3.0 = 3% less; 0.0 = nothing learned there yet. With Apply Correction on, the real need is about twice the number shown (see Good to know).

The ECU fills these tables in; you only need to look at them. **Fuel ▸ Front Cylinder Long Term Fuel Trim** is the same table for the front cylinder.

Using it step by step

1. Set up **Short term fuel trim** and make sure it's working (its own guide).
2. In **Long term fuel trims**, set **Gathering Data** to **yes**. Leave **Apply Correction** on **no** for now if you just want to see what it learns. Click **Burn**.
3. Ride normally, at different speeds and loads, over several rides.
4. Open the **Rear** and **Front Cylinder Long Term Fuel Trim** tables. Steady numbers well away from 0 show where each cylinder's VE table is off.
5. Then either set **Apply Correction** to **yes** and Burn, or move the learning into the VE tables with the steps below.

MOVING THE LEARNING INTO THE VE TABLES 1. Turn the ignition on and connect TunerStudio to the ECU.

2. Open **Fuel ▸ Rear Cylinder Long Term Fuel Trim**, then **Fuel ▸ Front Cylinder Long Term Fuel Trim**. Let each table fill in with the learned numbers from the ECU.

3. Open **Fuel ▸ Long term fuel trims** and click **Apply LTFT to VE and reset**. The ECU adds the learning into both VE tables and sets the trims back to 0.

4. Click **Burn** to save the VE tables.

Good to know

- LTFT can't learn more than the short term trim is allowed to correct (its Max add and Max remove).
- With Apply Correction on, the work is shared: LTFT learns about half of the correction, and the short term trim adds the rest again after each start. That's normal. Moving the learning into the VE tables may then take two or three rounds.
- After a big change (injectors, exhaust, cams, or big VE table changes), click **Reset LTFT trims** so old learning isn't applied to the new setup. The next time you connect, check that both trim tables read 0.
- After loading a different tune, check the two trim tables. If they don't suit the new tune, click **Reset LTFT trims**.
- If you send us your tune, send screenshots of the two Long Term Fuel Trim tables too.

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Deceleration Fuel Cutoff (DFCO)

When you roll off the throttle and coast, the engine doesn't need fuel. Deceleration fuel cutoff (DFCO) shuts off the injectors while you coast, and turns them back on the moment you twist the grip or the engine slows toward idle. It saves fuel and can reduce popping in the exhaust while coasting.

Spark keeps running during the cut. Only fuel is cut, to both cylinders at once.

> **WHERE TO FIND IT**
> **Fuel ▸ Deceleration fuel cutoff (DFCO)** the window is titled "Coasting Fuel Cutoff Settings"

When does fuel get cut?

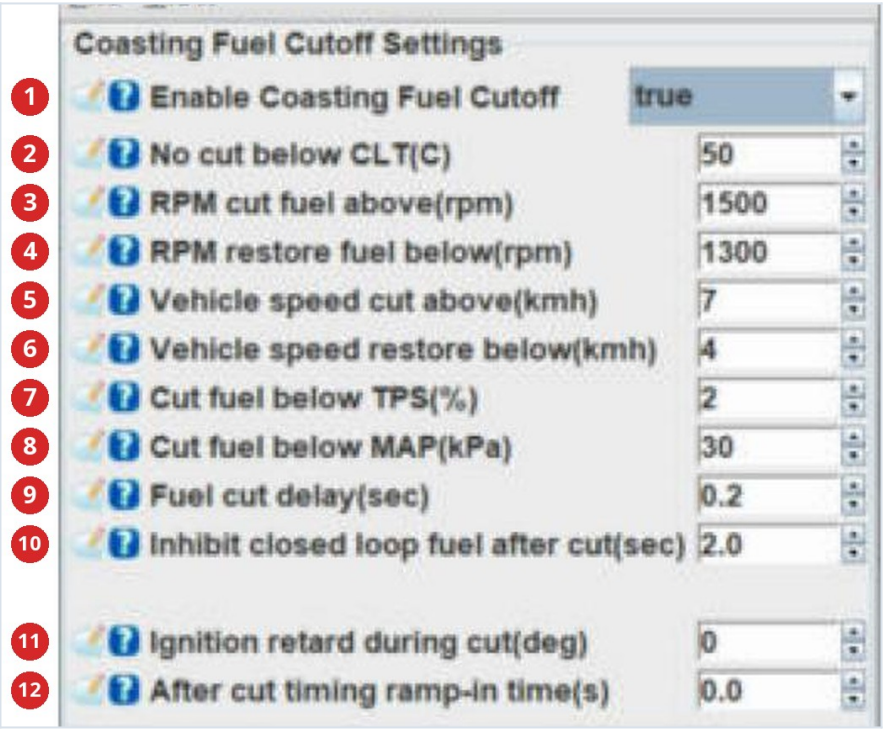
All of these have to be true at the same time:

- The **twist grip** is closed (below "Cut fuel below TPS"). It goes by the grip, not the throttle blade.
- The engine is **warm** (above "No cut below CLT").
- **Manifold pressure** is low, the way it is when coasting (below "Cut fuel below MAP").
- **RPM** is above "RPM cut fuel above".
- **Speed** is above "Vehicle speed cut above" (if that's set above 0).

After that the ECU waits for the **Fuel cut delay**, then cuts fuel. Fuel comes back right away when you twist the grip, when RPM drops below "RPM restore fuel below," or when speed drops below "Vehicle speed restore below."

The numbers in these pictures come from one example bike. Your tune's numbers will be different, so don't copy them. Units are Metric (°C, kPa, km/h). Red numbers in each picture match the table below it.

The settings



DFCO was turned on for this picture. The example tune has it off.

#	SETTING	WHAT IT DOES
1	**Enable Coasting Fuel Cutoff** MAIN SETTING	Turns DFCO on (**true**) or off (**false**). Everything below is greyed out while it's false.
2	**No cut below CLT (C)**	No fuel cut while the engine (coolant temperature) is colder than this.
3	**RPM cut fuel above (rpm)**	Fuel can only be cut above this RPM.
4	**RPM restore fuel below (rpm)**	Fuel comes back below this RPM. Keep it **lower** than the cut RPM (3), and above idle, so the engine is firing again before it reaches idle.
5	**Vehicle speed cut above (kmh)**	Fuel can only be cut above this road speed (the bike's speed signal). Set **both 5 and 6 to 0** to ignore speed.
6	**Vehicle speed restore below (kmh)**	Fuel comes back below this speed. Keep it lower than 5. Helps avoid jerkiness in low gears.

#	SETTING	WHAT IT DOES
7	**Cut fuel below TPS (%)**	The **twist grip** must be below this. It must be above what the grip reads when fully closed (Sensors ▸ Twist Grip Sensor). At 0, DFCO never turns on.
8	**Cut fuel below MAP (kPa)**	MAP must drop about 1 kPa below this to cut fuel; fuel comes back about 1 kPa above it. Set it at least 2 kPa above what your bike reads while coasting with the grip closed.
9	**Fuel cut delay (sec)**	How long everything must stay true before fuel is cut. **0 = cut right away.** A short delay smooths the cut.
10	**Inhibit closed loop fuel after cut (sec)**	After the cut, short term fuel trim waits this long before learning again, while fueling settles. Same setting as "After DFCO delay" in the Short term fuel trim window.
11	**Ignition retard during cut (deg)**	Takes this much timing out from the moment the cut conditions are met (including the Fuel cut delay) until fuel returns, to soften the bump when fuel comes back. **0 = off.**
12	**After cut timing ramp-in time (s)**	How the timing comes back after fuel returns. The ECU fades it back in over half a second, so if you use 11, set this to **0.5**. Shorter settings end the fade early and the rest comes back at once (all of it at 0).

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

Good to know

- To see it working, watch the **Decel fuel cut** light on TunerStudio's main screen (it reads "Not decel fuel cut" the rest of the time). It lights only while fuel is actually cut. The **Coasting** light is for idle control, not DFCO.
- DFCO is off for 20 seconds after each change to either VE table while **Detect Tuning and Suspend** is **no** (the usual setting; it works backwards from its name).
- Fuel turning on and off while coasting (surging)? Lower the restore RPM (4) to widen the gap from the cut RPM, or raise "Cut fuel below MAP" slightly.

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Acceleration Enrichment

When you twist the throttle open quickly, air rushes in faster than the normal fuel calculation can keep up with, and some of the fuel sticks to the cold intake walls instead of going into the cylinder. The result is a short lean moment: a stumble, hesitation or pop. Acceleration enrichment adds a quick shot of extra fuel to cover it, a lot like the accelerator pump on a carburetor.

Get the VE tables right first. Acceleration enrichment only fixes what happens during quick throttle changes.

WHERE TO FIND IT

- A **Fuel ▸ Acceleration enrichment**
- B **Fuel ▸ TPS/TPS acceleration extra fuel**
- C **Fuel ▸ TPS/TPS extra fuel RPM correction**
- D **Fuel ▸ MAP estimate table** higher up in the same menu
- E **Fuel ▸ Predictive Map Blend Duration**

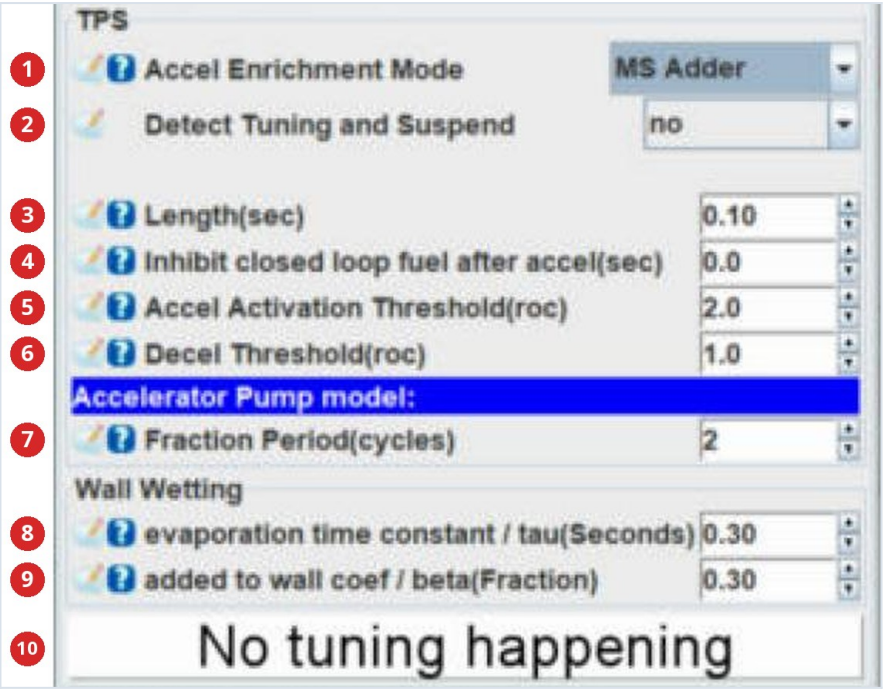
Two kinds of extra fuel

- **Throttle-based extra fuel** reacts to how fast the throttle opens. It works in one of three modes (setting A1). **MS Adder**, used in most tunes, and **Percent Adder** take the amount from table B, scaled by curve C. **MAP Prediction** works differently and uses D and E instead.
- **Wall wetting** keeps track of the fuel film on the intake walls. It adds fuel when you open the throttle and takes some away when you close it. It runs in every mode.

The numbers in these pictures come from one example bike. Your tune's numbers will be different, so don't copy them. Units are Metric (°C, kPa, km/h). Red numbers in each picture match the table below it.

A Acceleration enrichment

The main settings. The window is titled “Accel/Decel Enrichment.”



#	SETTING	WHAT IT DOES
1	**Accel Enrichment Mode** MAIN SETTING	**MS Adder:** table B is extra injector open time, in milliseconds, for each squirt. **Percent Adder:** table B is a share of the normal fuel: **0.10 = 10% more**, 1.00 = double. **MAP Prediction:** predicts the manifold pressure you’re heading to (D and E) instead of using table B. Advanced; ask us first. Settings 3 to 7 are greyed out in this mode, but 3, 4 and 5 still do their jobs: they decide when a prediction starts, and pause short term fuel trim after it.
2	**Detect Tuning and Suspend**	**This setting works backwards from its name.** **no** (the usual setting): throttle-based extra fuel (MS Adder or Percent Adder) pauses for 20 seconds after each change to either VE table, so it doesn’t confuse your VE tuning. Wall wetting and MAP Prediction keep working. **yes:** no pause. It’s the same setting as in the Short term fuel trim window.
3	**Length (sec)**	How long one quick twist keeps adding extra fuel. **0 = throttle-based extra fuel off.** The smallest value that works is 0.10.

#	SETTING	WHAT IT DOES
4	**Inhibit closed loop fuel after accel (sec)**	After acceleration fuel, short term fuel trim waits this long before learning again.
5	**Accel Activation Threshold (roc)**	How fast the throttle must open to count as a quick twist: the jump in throttle position (%) within 1/20 of a second (**2.0** = 2%). Set it above the small movements you see while cruising.
6	**Decel Threshold (roc)** NOT USED HERE	Shown, but it has no effect on fuel (the setting it works with is hidden and set to 0). A fast roll-off past it can still start the pause in 4. Leave it as set.
7	**Fraction Period (cycles)**	Spreads the extra fuel over this many engine cycles, like a carburetor's accelerator pump. **0 or 1 = off** (every squirt gets the full amount). Higher numbers mostly mean less extra fuel per squirt.
8	**evaporation time constant / tau (Seconds)**	Wall wetting: how long the fuel film on the intake walls takes to evaporate. Longer = the correction lasts longer.
9	**added to wall coef / beta (Fraction)**	Wall wetting: how much of each squirt sticks to the walls, from 0 to 1. Bigger = a bigger correction when the throttle changes. **0 turns wall wetting off** (so does a tau of 0).
10	**Tuning indicator** DISPLAY ONLY	Reads "Tuning Detected" while the 20-second pause from 2 is on, but only if Short term fuel trim or DFCO is turned on.

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

> **CHANGED INJECTORS? (MS ADDER)** In MS Adder mode, table B is injector time, so bigger injectors deliver more fuel for the same numbers. Scale the whole table by **old flow ÷ new flow**. Going from 600 to 700 cc/min injectors: multiply table B by 0.86 (in TunerStudio, select all the cells and press the * key).

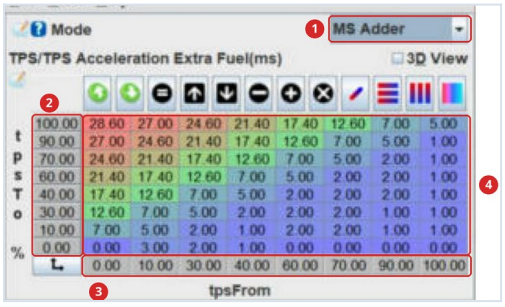
Tuning tips

- **Lean stumble or pop right after a quick twist:** not enough. Raise table B in that area, or wall wetting beta (A9) a little. **Bog or a rich spike:** too much. Lower table B or curve C.

- **Only a problem when cold?** In MS Adder mode the extra fuel doesn't change with temperature. Call us.
- Change one thing at a time and log a few twists before and after.

B TPS/TPS acceleration extra fuel

How much extra fuel each squirt gets, by where the throttle was (**from**) and where it went (**to**) during the quickest part of the twist. Bigger jumps usually get more fuel.



1 Mode
The same setting as Accel Enrichment Mode (A1).

2 tpsTo rows (%)
Where the throttle went.

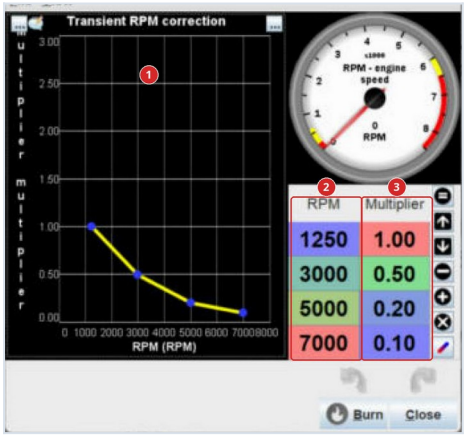
3 tpsFrom columns (%)
Where the throttle started.

4 Extra fuel MAIN SETTING
MS Adder: milliseconds per squirt. **Percent Adder:** share of normal fuel (0.10 = +10%). The table title says "ms" in every mode.

The extra fuel goes into **every squirt** for as long as the twist is within the Length (A3). At higher RPM there are more squirts in that time, so the total extra fuel grows with RPM. Curve C evens that out.

C TPS/TPS extra fuel RPM correction

Scales the extra fuel from table B by engine speed.



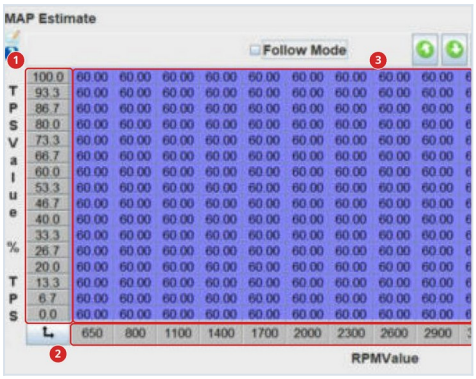
1 Graph
The multiplier at each RPM. Drag the points or type in the columns.

2 RPM
Engine speed points.

3 Multiplier MAIN SETTING
1.00 = full amount, 0.50 = half. Many tunes lower it as RPM rises, as in this example.

D MAP estimate table

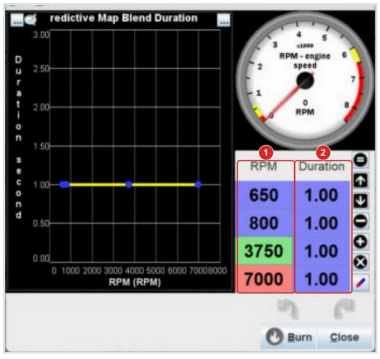
The manifold pressure (MAP) the engine normally reaches at each throttle position and RPM. The ECU uses it two ways: as a **backup if the MAP sensor fails**, and for **MAP Prediction** mode. This item only shows when **Setup ▸ Vehicle Information ▸ Tuning View** is **Full**.



1. **TPS (%) rows**
   Throttle position.
2. **RPM columns**
   Engine speed.
3. **Estimated MAP (kPa)**
   What MAP normally reads there. **60 in every cell, as in this example, means it hasn't been filled in.** Fill it in from a datalog of steady riding before using MAP Prediction.

E Predictive Map Blend Duration

Only used in **MAP Prediction** mode. When you twist quickly, the ECU fuels for the MAP it predicts from table D instead of the sensor reading (and briefly uses it for ignition timing too). The prediction fades out over this time, and ends early once the real MAP reading catches up.



1. **RPM**
   Engine speed points.
2. **Duration (seconds)**
   How long the prediction takes to fade out at that RPM, unless the real reading catches up first.

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Target AFR Adder Tables

Adder tables shift your Target AFR up or down based on a sensor you choose, like engine temperature. They don't replace the Target AFR table; they add to it. The most common use is a **richer target while the engine is cold**.

There are two, Target AFR 1 and Target AFR 2. They work the same way and both are **off** out of the box. This is an advanced feature, so call us before you rely on it.

WHERE TO FIND IT

Fuel ▸ Target AFR adder tables ▸ Target AFR 1 bias the settings

Fuel ▸ Target AFR adder tables ▸ Target AFR 1 adder the table; greyed out until a blend parameter is picked

How it works

- The **blend parameter** picks the sensor, for example CLT (engine coolant temperature).
- The **bias curve** says how much of the adder to use, from 0 to 100%, at each sensor reading.
- The **table** holds the amount, by RPM and engine load.
- The ECU multiplies the table value by the bias and adds the result to the target. Like the Target AFR table itself, this changes fuel right away, and closed loop then aims for the new target.

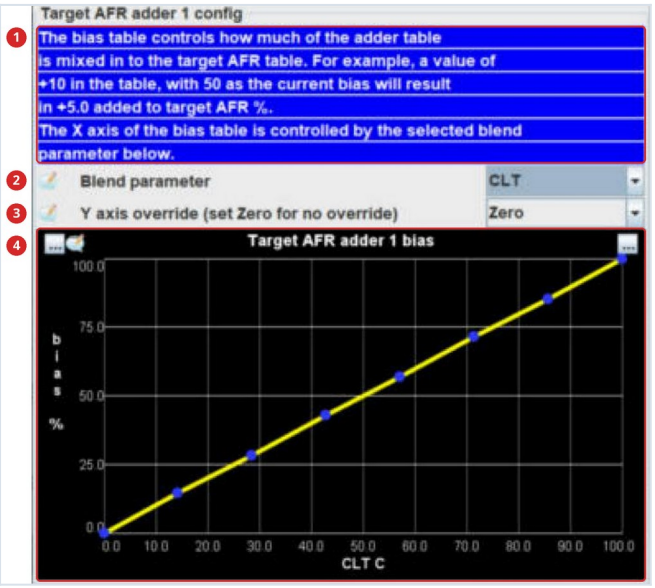
THE NUMBERS ARE LAMBDA, NOT AFR Adder values are in **lambda**. **Negative = richer.** −0.1 lambda is about 1.5 AFR on the gasoline scale (14.7 becomes 13.2). Keep values small: think −0.1 or −0.2, never −10.

The table only holds steps of 0.1. For smaller changes, use the bias curve: −0.1 at 50% bias is −0.05 lambda, about 0.7 AFR.

The help text at the top of the settings window is wrong for this table. Its example, "+10 with 50 as the bias," would add 5.0 lambda, an extremely lean target. The Help menu in the table window describes a different kind of table; ignore it too.

Target AFR 1 bias (the settings)

In this picture the blend parameter is set to CLT as an example; the bias curve is greyed out until a parameter is picked. The numbers are an example, not a recommendation.



1. **Help text** DISPLAY ONLY
   Describes the idea, but its example is wrong for this table (see the warning above).

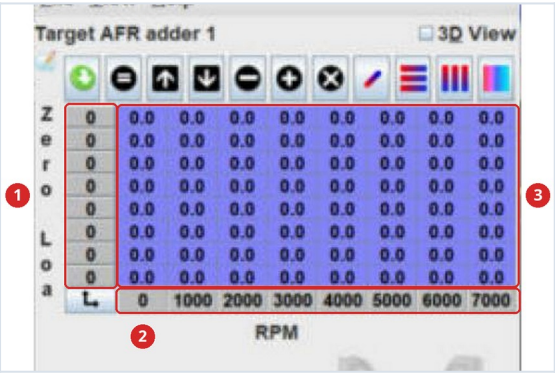
2. **Blend parameter** MAIN SETTING
   The sensor that controls this adder. **Zero = off.** CLT is the usual choice.

3. **Y axis override (set Zero for no override)**
   What the table's rows are. Leave on **Zero**: the rows are then engine load (kPa), like the Target AFR table.

4. **Target AFR adder 1 bias**
   How much of the table to use (0–100%) at each sensor reading.

   As it comes, it's a straight line: for CLT that means **more** adder when **hot**. Reshape it before use (see the example below).

Target AFR 1 adder (the table)



1. **Load rows (kPa)**
   Engine load. They're labeled "Zero Load" after the Y axis override, and they're all 0 out of the box. Fill them in from low to high (for example 20, 30, 40, 50, 60, 70, 85, 100), or put the same value in every cell so the rows don't matter.

2. **RPM columns**
   Engine speed.

3. **Adder (lambda)** MAIN SETTING
   Added to the target lambda, times the bias. **Negative = richer.** 0.0 = no change.

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

Example: a richer target while cold

1. Open **Target AFR 1 bias**. Set **Blend parameter** to **CLT**.
2. On the bias curve, drag the points so the line runs from **100%** at the coldest point down to **0%** at about **57 °C** (the fifth point), and stays at 0% above that. The points in between: 75, 50 and 25%. Click **Burn**.
3. Open **Target AFR 1 adder**. Drag across all the cells to select them, press **=**, type **-0.1** and press **Enter**. Click **Burn**.

Result: about 1.5 AFR richer at 0 °C (32 °F), about 0.7 richer at 29 °C (84 °F), and back to your normal target from 57 °C (135 °F) up. Check it in a datalog: **Fuel: target lambda** should read 0.1 lower at 0 °C, about 0.05 lower at 29 °C, and normal when warm.

IT ADDS TO WARMUP ENRICHMENT A richer cold target adds fuel on top of **Warmup enrichment**, which is also adding fuel while the engine is cold. If you add a cold adder, you may need less warmup enrichment. Check your AFR on a cold start before and after.

IMPACT ECU · FUEL BUTTON GUIDE

Warmup Enrichment & IAT Multiplier

Both of these are simple fuel **multipliers**. Warmup enrichment changes fuel by engine (coolant) temperature, so a cold engine gets the extra fuel it needs. The IAT multiplier changes fuel by intake air temperature.

1.00 = no change. 1.20 = 20% more fuel. 0.80 = 20% less fuel.

WHERE TO FIND IT

A **Fuel ▸ Warmup enrichment**

B **Fuel ▸ IAT multiplier**

What they do

- They work whenever the engine is **running**, at every RPM and load, for as long as that temperature lasts. They don't work while cranking; starting fuel is in the Cranking menu.
- Between two points the ECU blends smoothly. Below the first point or above the last, it uses the end value.
- If a temperature sensor fails, its multiplier goes to 1.00. A failed coolant sensor on a cold bike means no warmup fuel, and TunerStudio's "CLT OK" indicator changes to a red "CLT error".

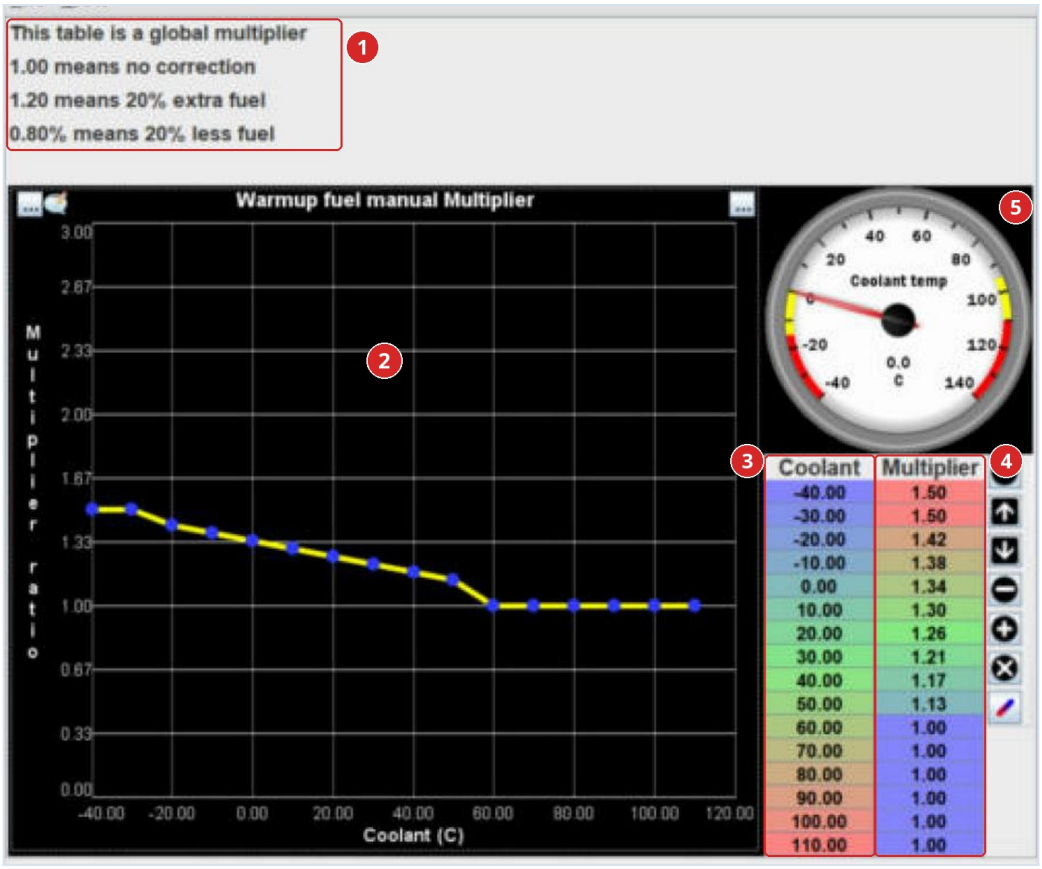
TWO RULES **Temperatures must go up, row by row.** Each one must be higher than the one above it. If two are the same or out of order, the ECU shows an error and won't run the engine until it's fixed and the ECU is restarted (key off and USB cable unplugged, then back on).

Never use 0.00. A multiplier of 0 means no fuel at that temperature.

The numbers in these pictures come from one example bike. Your tune's numbers will be different, so don't copy them. Units are Metric (°C, kPa, km/h). Red numbers in each picture match the table below it.

A Warmup enrichment

The curve is titled “Warmup fuel manual Multiplier.”

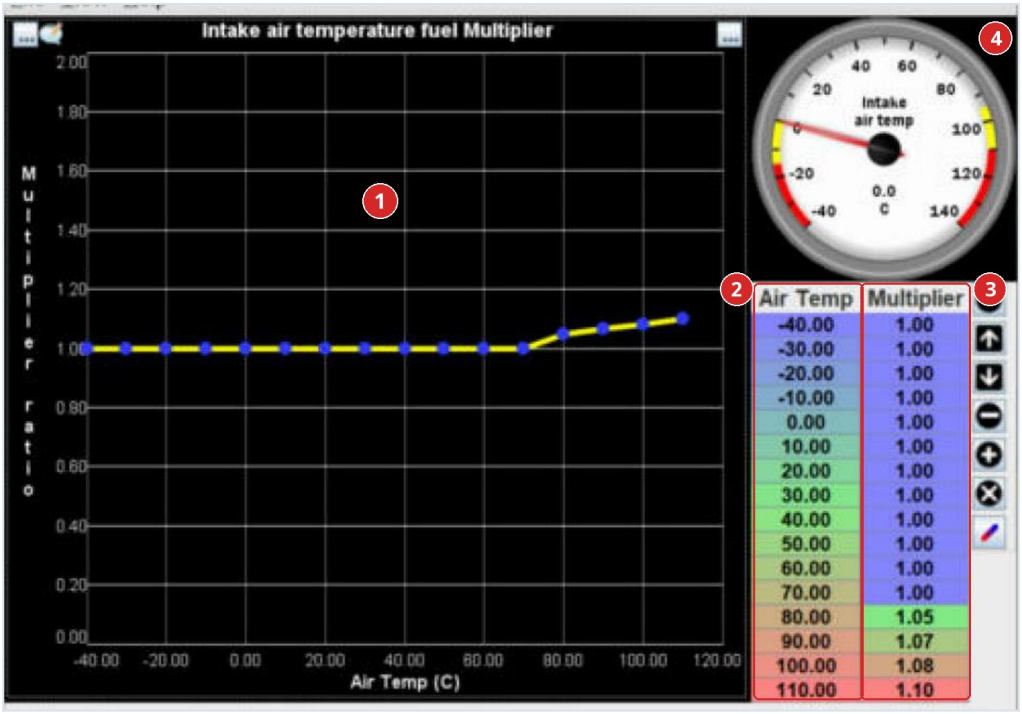


#	SETTING	WHAT IT DOES
1	**Help text** DISPLAY ONLY	Explains the multiplier. The last line has a typo: it should read “0.80 means 20% less fuel,” not “0.80%.”
2	**Graph**	The curve: coolant temperature across, multiplier up. You can drag the points.
3	**Coolant**	The temperature points, in °C.
4	**Multiplier** MAIN SETTING	The fuel multiplier at each temperature. In this example: **1.34 at 0 °C** (32 °F), coming down to 1.13 at 50 °C (122 °F), and **1.00 from 60 °C** (140 °F) up.
5	**Coolant temp gauge** DISPLAY ONLY	The live engine temperature. A marker on the graph shows where you are on the curve.

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

B IAT multiplier

Changes fuel by intake air temperature. **It's usually at or near 1.00**, because the ECU's fuel math already adjusts for air temperature: hotter air is thinner, and it gets less fuel automatically. A classic "air density" curve here would correct twice.



#	SETTING	WHAT IT DOES
1	**Graph**	The curve: air temperature across, multiplier up.
2	**Air Temp**	The temperature points, in °C.
3	**Multiplier** MAIN SETTING	The fuel multiplier at each air temperature. This example stays at 1.00 up to 70 °C (158 °F), then adds a little fuel when the intake air is very hot (1.10 at 110 °C, 230 °F).
4	**Intake air temp gauge** DISPLAY ONLY	The live intake air temperature.

The IAT window's Help text is incomplete (it stops mid-sentence). Leave this curve the way your tune came. Only change it if your logs show a fuel error that follows air temperature after the VE tables are tuned, and call us first.

Which setting fixes what?

SYMPTOM	WHERE TO LOOK
Cranks a long time or won't fire	**Cranking** menu (cranking fuel)
Starts, then dies within a few seconds	**Cranking ▸ After-start enrichment** (shows when Tuning View is Full)
Runs rough, lean or rich for the first few minutes while warming up	**Warmup enrichment** (this guide)
Idle speed too high or low while cold	**Idle** menu (that's air, not fuel)

Tuning warmup enrichment

1. Tune the VE tables with the engine fully warm first, where the warmup curve is 1.00.
2. Log a cold start all the way to fully warm: coolant temperature, **Rear Lambda**, **Front Lambda** and **Fuel: target lambda**. Lambda readings work the same on any fuel.
3. Where it's off: **new value = old value × measured lambda ÷ target lambda**. Example: 1.20 × 0.95 ÷ 0.88 = **1.30** (it read leaner than the target, so it gets more fuel). Use readings from before closed loop starts (below its Minimum CLT); after that, closed loop is already correcting.
4. Keep the curve smooth, and bring it to 1.00 by the time the engine is warm.

> **CLOSED LOOP AND WARMUP** Short term fuel trim stays off until the engine reaches its **Minimum CLT**, so warmup fuel isn't corrected until then. After that, closed loop steers toward the Target AFR and can take away some of the warmup richness. A Target AFR adder table set to CLT can make the target richer while cold.

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IMPACT ECU · IGNITION BUTTON GUIDE

Ignition Button Overview

The **Ignition** button in TunerStudio holds everything about the spark: the timing tables, timing corrections for heat, coil charge time (dwell) and knock control. This guide is the map to its menu: what each item is for, and which guide explains it.

Your tune came with these set for your bike. Change them only in small steps.

> **WHAT IS IGNITION TIMING?** The spark fires a little before the piston reaches the top (**top dead center**, TDC), so the fire has time to build. **30°** means 30 degrees of crankshaft turn before TDC. More degrees is more **advance**. Too little costs power and makes heat; too much causes **knock** (pinging), which can break pistons.

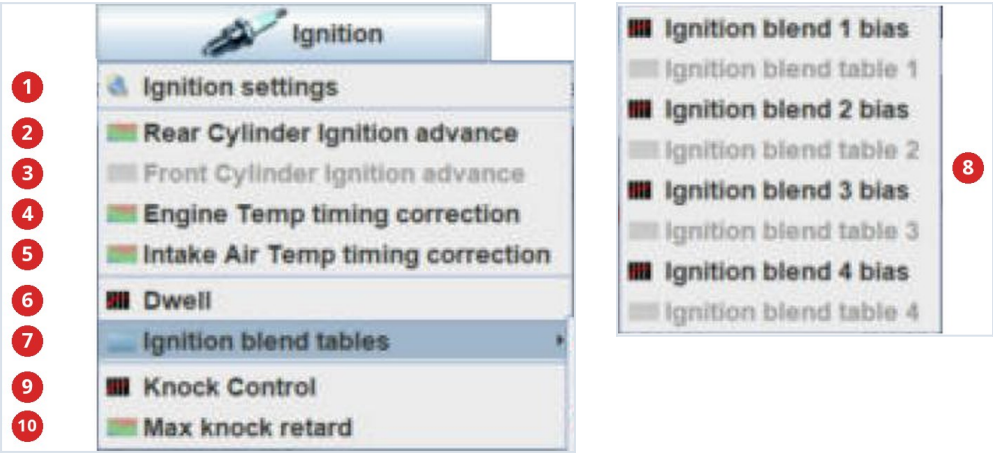
How the ECU works out the timing

STEP 1 **BASE TIMING**	**Ignition advance table:** the timing for every RPM and load. One table for both cylinders, or one for each.
STEP 2 **CORRECTIONS**	**Engine Temp** and **Intake Air Temp** corrections take a little timing out when it's hot. **Blend tables** can add or take away timing (off in our tunes).
STEP 3 **KNOCK CONTROL**	**Knock Control** takes timing out if the knock sensors hear knock, then puts it back slowly.
STEP 4 **SPARK**	**Dwell:** how long each coil charges before it fires the spark plug.

Before you change anything

- **Save a copy of your tune first**, so you can always go back.
- **Burn means save.** Changes go to the ECU as you make them, but are only kept after you click **Burn**.
- **Greyed-out items** are switched off by another setting. Each guide says which one.
- **Missing items?** Some only show when **Setup ▸ Vehicle Information ▸ Tuning View** is set to **Full**.
- **Add timing in small steps** (about 1 degree at a time). After each change, check a datalog (a recording of what the engine is doing) for knock.
- **Change one thing at a time.** Not sure? Call us first.

The Ignition menu, item by item



1. **Ignition settings** Spark on or off, one timing table or two, and fixed timing for a timing light.
2. **Rear Cylinder Ignition advance** The main timing table. With Single Table, both cylinders use it.
3. **Front Cylinder Ignition advance** The front cylinder's own table. Greyed out with Single Table.
4. **Engine Temp timing correction** Takes timing out when the engine is hot.
5. **Intake Air Temp timing correction** Takes timing out when the intake air is hot.
6. **Dwell** How long the coils charge, by RPM and battery voltage.
7. **Ignition blend tables ▸** The ▸ means it opens a smaller menu (8).
8. **Blend bias and blend table, 1 to 4** Four extra timing tables. Off in our tunes, so the tables are greyed out.
9. **Knock Control** The knock sensor settings, and how much timing to take out when knock is heard.
10. **Max knock retard** The most timing knock control may take out.

Which guide to read

GUIDE	MENU ITEMS	WHAT IT COVERS
Ignition Settings	1	Spark, one table or two, fixed timing
Front & Rear Ignition Advance	2–3	The main timing tables
Engine Temp & Air Temp Timing Corrections	4–5	Timing taken out when it's hot
Dwell	6	Coil charge time
Ignition Blend Tables	7–8	Extra tables that add or take away timing
Knock Control	9–10	Knock sensors, timing taken out for knock

Good to know

- **Other buttons change the timing too.** While the engine is cranking, the timing comes from **Cranking ▸ Cranking ignition advance** instead of the advance table. At idle, **Idle ▸ Closed-loop idle timing** can add or take away a few degrees to hold the idle speed steady.
- **Watching the timing:** TunerStudio's **Timing: ignition** gauge shows the timing in use. In a datalog, **Ign: Timing Cyl 1** (rear) and **Ign: Timing Cyl 2** (front) show each cylinder.

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IMPACT ECU · IGNITION BUTTON GUIDE

Ignition Settings

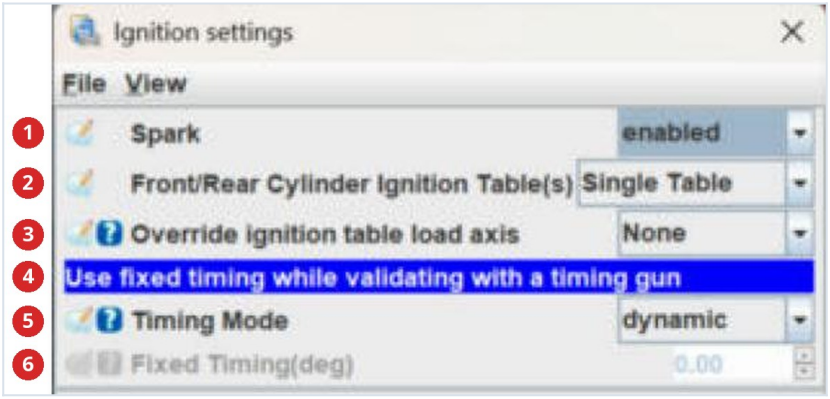
This small window switches the spark on, sets whether your bike uses one timing table for both cylinders or one for each, and has a fixed-timing mode for checking timing with a timing light.

Your tune came with these set for your bike. **You should never need to change them.**

WHERE TO FIND IT
Ignition ▸ Ignition settings

The numbers in these pictures come from one example bike. Your tune's numbers will be different, so don't copy them. Units are Metric (°C, kPa, km/h). Red numbers in each picture match the table below it.

The settings



#	SETTING	WHAT IT DOES
1	**Spark** LEAVE AS SET	**enabled:** the ECU fires the spark plugs. **disabled** turns all spark off: the engine won't run, and most of the Ignition menu is greyed out.
2	**Front/Rear Cylinder Ignition Table(s)** LEAVE AS SET	**Single Table:** both cylinders use the Rear Cylinder Ignition advance table. **Separate Tables:** the front cylinder uses the Front Cylinder Ignition advance table, and the rear keeps the Rear table. See "One table or two?" below.
3	**Override ignition table load axis** LEAVE AS SET	**None:** the rows of the timing tables are engine load, which on our tunes is manifold pressure (MAP, kPa). The other choices are for other setups.

#	SETTING	WHAT IT DOES
4	**Use fixed timing while validating with a timing gun** DISPLAY ONLY	The blue bar is only a label for 5 and 6. A timing gun is a timing light.
5	**Timing Mode** LEAVE AS SET	**dynamic:** timing comes from the tables, as normal. **fixed:** timing is locked at the number in 6, with no corrections and no knock control. Fixed is only for checking timing with a timing light. **Never ride the bike with Timing Mode on fixed.**
6	**Fixed Timing (deg)** LEAVE AS SET	The timing used when 5 is **fixed**: **0** here. Greyed out while 5 is **dynamic**.

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

One table or two?

Item 2 has two choices, **Single Table** and **Separate Tables**. Which one a bike usually uses depends on how its engine is cooled:

ENGINE	USUAL SETTING (2)	WHY
Gen 1 Milwaukee-Eight (2017–2023)	Separate Tables	Mostly air-cooled and run hotter. A table for each cylinder gives more control.
Gen 2 Touring	Single Table	Liquid-cooled heads keep the heat down, so one table does both cylinders.

Your tune may not use the usual setting. Either way, leave it as we set it. This setting is only for **timing**: the fuel (VE) tables have their own setting in Injection configuration, and that one always stays on **Separate Tables**.

> **DON'T SWITCH IT YOURSELF** Separate Tables only works if the Front table is filled in. This example bike uses Single Table, and its Front table is all **0** because it isn't used: switched over, the front cylinder would get no timing advance. Call us first.

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IMPACT ECU · IGNITION BUTTON GUIDE

Front & Rear Ignition Advance

The ignition advance tables are your main timing tables. For every engine speed (RPM) and load, they tell the ECU when to fire the spark plug, in **degrees before top dead center**: how far the crankshaft still has to turn before the piston reaches the top.

Higher number = earlier spark (more timing). Lower number = later spark (less timing). Your tune came with these set for your bike.

> **WHERE TO FIND IT**
>
> A **Ignition ▸ Rear Cylinder Ignition advance**
>
> B **Ignition ▸ Front Cylinder Ignition advance** greyed out with Single Table

The numbers in these pictures come from one example bike. Your tune's numbers will be different, so don't copy them. Units are Metric (°C, kPa, km/h). Red numbers in each picture match the table below it.

One table or two

Ignition ▸ Ignition settings ▸ Front/Rear Cylinder Ignition Table(s) sets how your tune uses the two tables. The bike in these pictures uses **Single Table**.

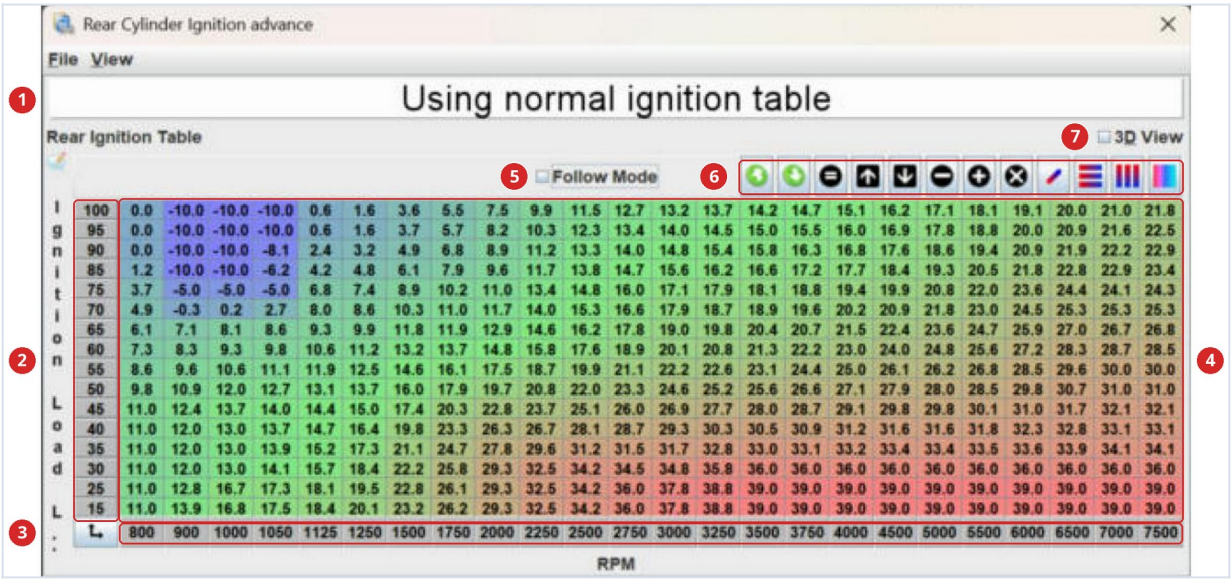
SETTING	REAR CYLINDER	FRONT CYLINDER	USUALLY ON
Single Table	Rear table	Rear table	Gen 2 Touring (liquid-cooled heads)
Separate Tables	Rear table	Front table	Gen 1 Milwaukee-Eight, 2017–2023 (mostly air-cooled)

This is for timing only. The fuel tables have their own setting, which always stays on Separate Tables.

Making changes

- Change a few cells at a time, about **1 degree** at a time. Then ride, take a datalog (a recording of what the engine is doing) and check it for knock.
- More timing isn't always more power. Past a point it only adds heat and knock.
- Keep the table smooth. Sharp steps between neighboring cells make the bike surge or jerk.

A Rear Cylinder Ignition advance



#	SETTING	WHAT IT DOES
1	**Table in use** DISPLAY ONLY	It only changes to **Using idle ignition table** when the separate idle timing table (**Idle ▸ Idle Ignition advance**) is on and the engine is idling. That's off in our tunes, so it always reads **Using normal ignition table**.
2	**Ignition Load (kPa) rows**	Engine load, measured as manifold pressure. Low numbers are closed throttle (coasting and idle); about 100 is wide open throttle at sea level. Up high it's lower: around 5,000 feet, wide open throttle reads about 84 kPa.
3	**RPM columns**	Engine speed.
4	**Timing cells** MAIN SETTING	Degrees of timing for each RPM and load. The ECU blends between neighboring cells. Raise a cell for more timing there; lower it for less.
5	**Follow Mode**	When the engine is running, follows and highlights the cells the engine is using right now.
6	**Toolbar**	Buttons for changing the cells you've selected: raise, lower, set a value, smooth and more. Hover over a button to see its name. Our TunerStudio Hot Keys sheet lists the keyboard shortcuts.
7	**3D View**	Shows this table as a 3D picture next to the grid.

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

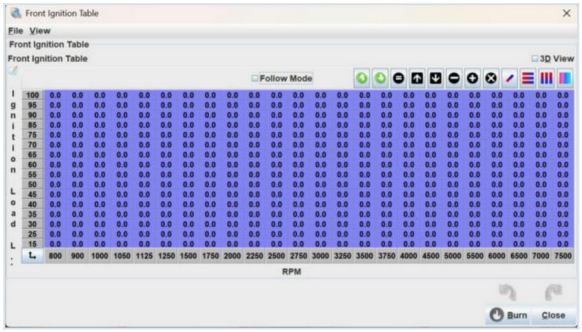
Reading this example

- **Light load, more timing.** At 40 kPa (light cruising) it runs 26.3° at 2000 RPM and 29.3° at 3000 RPM. A partly filled cylinder burns slowly, so the spark fires early.
- **Heavy load, less timing.** At 100 kPa (wide open throttle) it runs 7.5° at 2000 RPM, 13.2° at 3000 RPM and 20° at 6500 RPM (this tune's rev limit). A full cylinder burns fast and knocks more easily.
- **Negative numbers** mean the spark fires just after top dead center. This tune has some, down to −10: the blue cells at the top left (70 to 100 kPa, 900 to 1050 RPM). Leave cells like that as they are unless we tell you otherwise.

B Front Cylinder Ignition advance

Works like the rear table, for the front cylinder (without the bar at the top). The window is titled **Front Ignition Table**.

It's only used with **Separate Tables**, and it stays greyed out in the menu with Single Table. It shares the rear table's RPM and load numbers, so changing an axis number in one changes both.



ALL ZEROS IN THIS EXAMPLE This bike uses Single Table, and its Front table is all **0** because it isn't used. Switched to Separate Tables like this, the front cylinder would get no timing advance. Call us before switching.

Good to know

- This table isn't the only thing setting your timing. While cranking, it comes from **Cranking ▸ Cranking ignition advance**. At idle, **Idle ▸ Closed-loop idle timing** can add or take away up to 12° (in this tune) to hold the idle speed, so changing cells near idle won't change the idle much.
- The temperature corrections and knock control adjust it too. **Ign: Timing Cyl 1** (rear) and **Ign: Timing Cyl 2** (front) in a datalog show the final number.

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Dwell

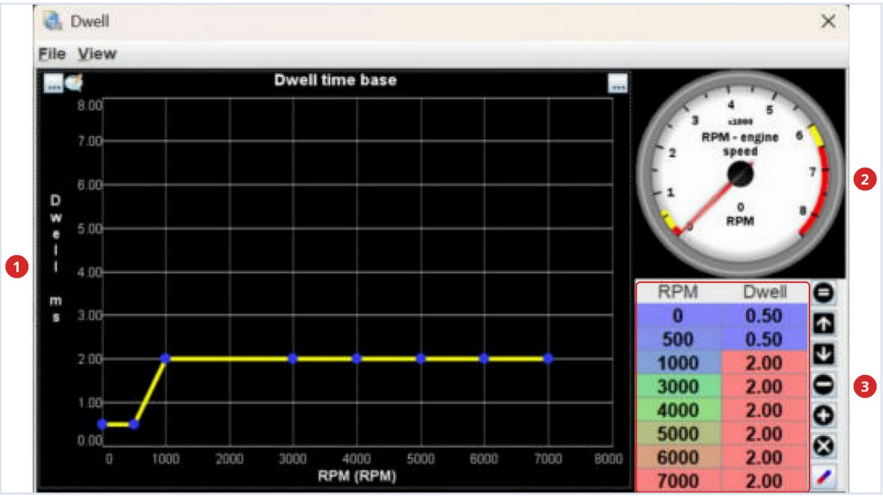
Dwell is how long each ignition coil charges before it fires the spark, in milliseconds (**ms**, thousandths of a second). Too little and the spark is weak, which can cause misfires. Too much and the coils run hot.

These are set for the coils on your bike. **You should never need to change them.** If you fit different coils, call us first.

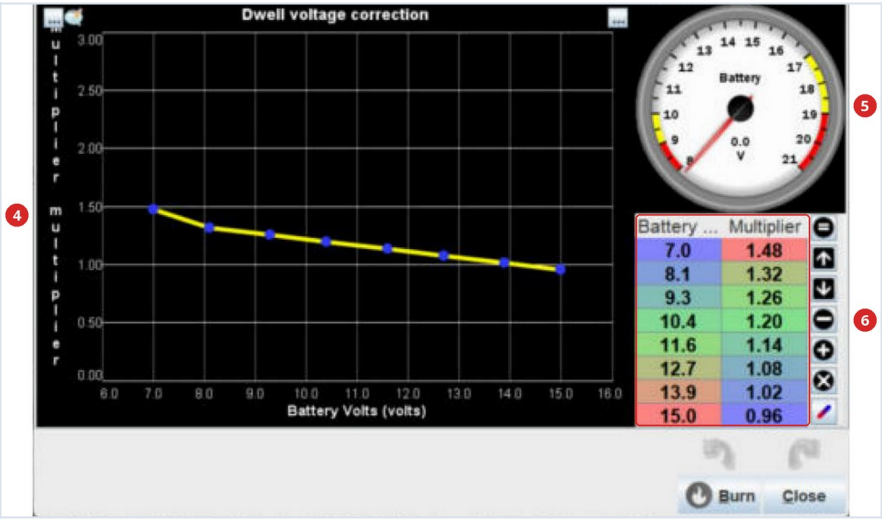
WHERE TO FIND IT
Ignition ▸ Dwell

The numbers in these pictures come from one example bike. Your tune's numbers will be different, so don't copy them. Units are Metric (°C, kPa, km/h). Red numbers in each picture match the table below it.

The settings



#	SETTING	WHAT IT DOES
1	**Dwell time base** LEAVE AS SET	A graph of the base dwell against RPM. Its numbers are in 3.
2	**RPM gauge** DISPLAY ONLY	Live engine speed. It reads 0 when TunerStudio isn't connected.
3	**RPM and Dwell columns** LEAVE AS SET	The base dwell (ms) at each RPM. In this example: **0.5 ms** at 0 and 500 RPM, rising to **2.0 ms** at 1000 RPM and staying there up to 7000 RPM.



#	SETTING	WHAT IT DOES
4	**Dwell voltage correction** LEAVE AS SET	A graph of a multiplier against battery voltage. A coil charges more slowly at low voltage, so the ECU stretches the dwell when the voltage is low. Its numbers are in 6.
5	**Battery gauge** DISPLAY ONLY	Live battery voltage. It reads 0.0 when TunerStudio isn't connected.
6	**Battery Volts and Multiplier columns** LEAVE AS SET	The multiplier at each voltage: **1.48** at 7.0 V, **1.02** at 13.9 V and **0.96** at 15.0 V in this example.

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

How the ECU uses them

- **Dwell = base dwell × multiplier.** At 3000 RPM and 13.9 V: 2.0 ms × 1.02 = about 2.04 ms. The ECU blends between points, and past the last point it uses the last value.
- While starting (from a stop until RPM first reaches the **Cranking RPM limit**, 600 here), the coils get the **Fixed Cranking Dwell** from **Cranking ▸ Cranking settings** instead: 5.0 ms here. After that the ECU uses these curves, even if RPM dips below 600.
- In a datalog (a recording of what the engine is doing), **Ignition: coil charge time** shows the dwell in use.

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IMPACT ECU · IGNITION BUTTON GUIDE

Engine Temp & Air Temp Timing Corrections

These two tables adjust the timing for temperature. A hot engine and hot intake air knock more easily, so the ECU takes a little timing out when it's hot.

A negative number takes timing out, a positive number adds it, and 0 means no change. Your tune came with these set for your bike. Leave them as they are: they protect the engine on hot days.

WHERE TO FIND IT

- **A** **Ignition ▸ Engine Temp timing correction**
- **B** **Ignition ▸ Intake Air Temp timing correction**

The numbers in these pictures come from one example bike. Your tune's numbers will be different, so don't copy them. Units are Metric (°C, kPa, km/h). Red numbers in each picture match the table below it.

How they work

- The number is added to the timing from the ignition advance table, for both cylinders. The two corrections add up.
- The ECU blends between neighboring cells. Past the edges it uses the edge: above 120 °C, for example, it keeps using the 120 °C numbers.
- They work whenever the engine is running, but not while it's cranking or when Timing Mode is on fixed.
- If a temperature sensor fails, its correction is 0, so the engine loses this heat protection. Have a failed sensor fixed before riding hard.

A Engine Temp timing correction

Window title: **Warmup timing correction**. In our tunes it works when the engine is hot.



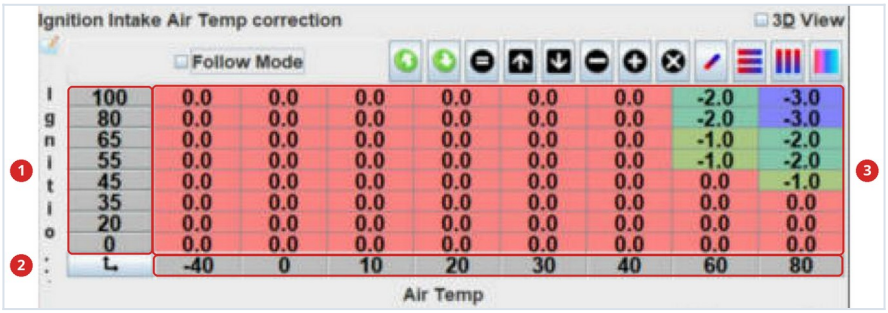
THE NUMBERS IN THE PICTURES (A AND B)

#	SETTING	WHAT IT DOES
1	**Ignition Load (kPa) rows**	Up the side: engine load, measured as manifold pressure.
2	**Temperature columns (°C)**	Along the bottom. **A:** engine temperature (**CLT Temp**; CLT is short for coolant temperature). **B:** intake air temperature (**Air Temp**).
3	**Correction cells (deg)** LEAVE AS SET	Degrees of timing added (+) or taken out (−) at each temperature and load.

In this example: no change up to 80 °C (176 °F). At 100 °C (212 °F) it takes out 1° at 35 kPa, 2° at 70 kPa and 3° at 105 kPa. At 120 °C (248 °F) it takes out up to 4°. The 105 and 140 kPa rows are above what an engine without a turbo or supercharger reaches (about 100 kPa at sea level): at full throttle it takes out about 3° at 100 °C and almost 4° at 120 °C.

B Intake Air Temp timing correction

Window title: **Ignition Intake Air Temp correction**.



In this example: no change up to 40 °C (104 °F). At 60 °C (140 °F) it takes out 1° to 2° from 55 kPa up. At 80 °C (176 °F) it takes out 1° to 3° from 45 kPa up.

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

Hot intake air usually comes from heat soak: sitting at a light or riding slowly on a hot day. In a datalog (a recording of what the engine is doing), **Ign: CLT correction** and **Ign: IAT correction** show what these tables are doing.

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IMPACT ECU · IGNITION BUTTON GUIDE

Ignition Blend Tables

Blend tables let a tuner add or take away timing based on something other than RPM and load, like ethanol content, throttle position or a sensor you've added. There are four of them, and they're **off** in our tunes.

Leave them off unless we set one up for you.

WHERE TO FIND IT

- (A) **Ignition ▸ Ignition blend tables ▸ Ignition blend 1 bias** (and 2, 3, 4)
- (B) **Ignition ▸ Ignition blend tables ▸ Ignition blend table 1** greyed out while off

The numbers in these pictures come from one example bike. Your tune's numbers will be different, so don't copy them. Units are Metric (°C, kPa, km/h). Red numbers in each picture match the table below it.

How a blend works

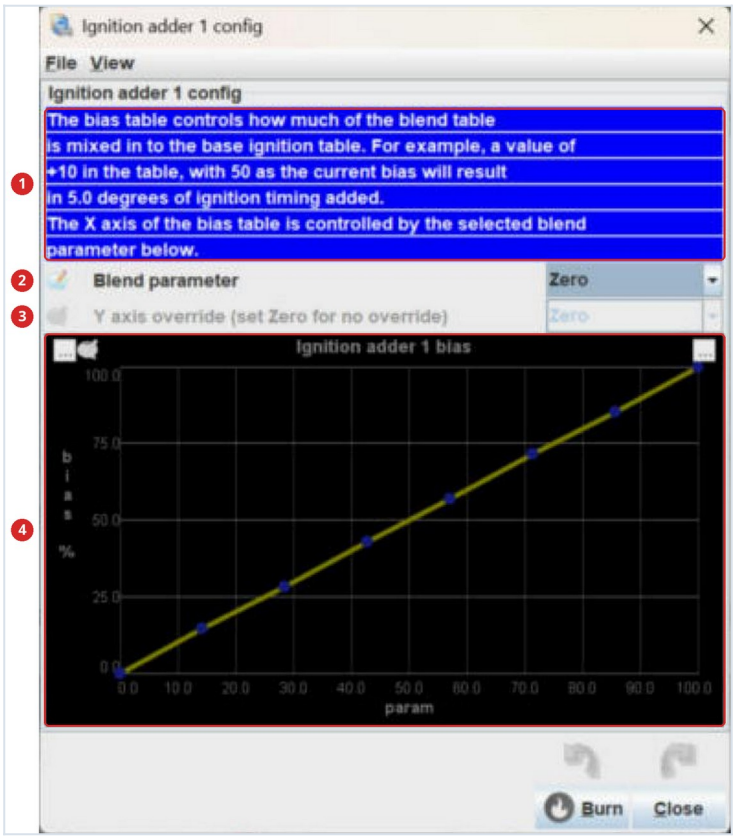
1. **Blend parameter:** the input the blend watches, like Ethanol (Flex) %. **Zero** means the blend is off.
2. **Bias curve:** for each value of that input, how much of the blend table to use, from 0 to 100%.
3. **Blend table:** degrees to add (+) or take away (−), by RPM and load.
4. The ECU adds **bias × table value** to the timing. The window's own example: **+10** in the table with a bias of **50%** adds **5 degrees**.

The four blends add up, and they work on both cylinders. Like the temperature corrections, they work while the engine runs, not while it's cranking. If the input's sensor fails, the blend adds nothing. In a datalog (a recording of what the engine is doing), **ignBlendOutput 1** to **4** show how many degrees each blend is adding: 0 while they're off.

ABOUT THESE PICTURES In our tunes the Blend parameter is **Zero**, so the bias curve is greyed out and the blend table can't be opened from the menu. For the table picture we set it to **TPS** for a moment with TunerStudio offline (not connected to a bike), then set it back to Zero without saving.

A Ignition blend bias

The window is titled **Ignition adder 1 config** (2, 3 or 4 for the other blends).

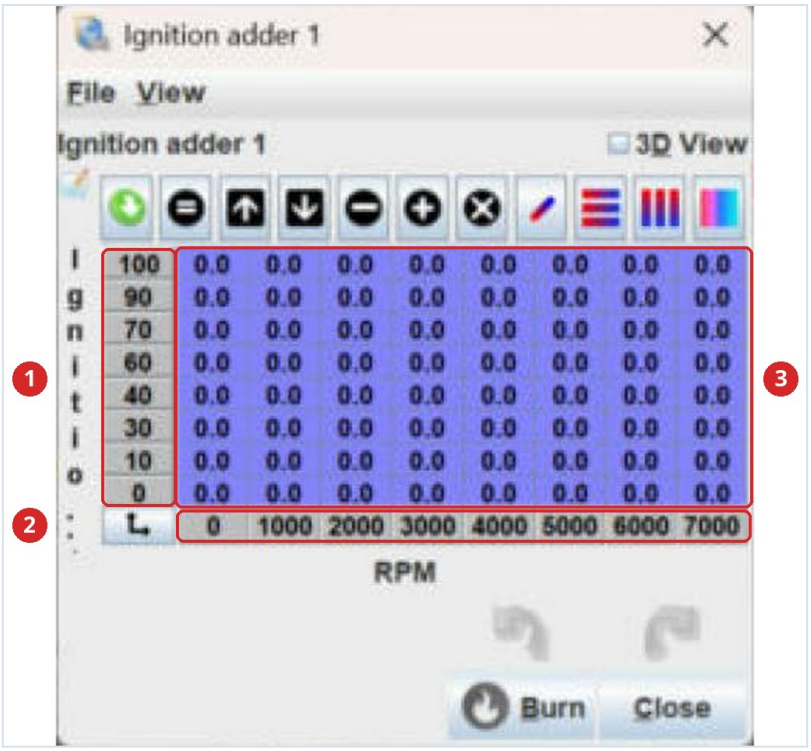


#	SETTING	WHAT IT DOES
1	**Help text** DISPLAY ONLY	Explains the bias, with the +10 and 50 example above.
2	**Blend parameter** ADVANCED	The input this blend watches. **Zero = off**, as in our tunes. Choices include TPS, MAP, engine and air temperature, Ethanol (Flex) %, battery voltage, RPM, gear, vehicle speed and spare sensor inputs.
3	**Y axis override (set Zero for no override)** ADVANCED	**Zero:** the blend table's rows are engine load (manifold pressure), like the main timing table. Another choice uses that input for the rows instead. Greyed out while 2 is Zero.
4	**Bias curve** ADVANCED	Across: the value of the input in 2 (**param**). Up: how much of the table to use (**bias**, %). Greyed out while 2 is Zero.

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

B Ignition blend table

The window is titled **Ignition adder 1** (or 2, 3, 4).



#	SETTING	WHAT IT DOES
1	**Ignition Load (kPa) rows**	Engine load (manifold pressure), like the main timing table, or the input picked in Y axis override.
2	**RPM columns**	Engine speed.
3	**Cells (deg)** ADVANCED	Degrees added (+) or taken away (−) at full bias. **0 everywhere** in our tunes.

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

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IMPACT ECU · IGNITION BUTTON GUIDE

Knock Control

Knock (also called pinging or detonation) is the fuel exploding in the cylinder instead of burning smoothly. It can crack pistons. Your engine has a knock sensor on each cylinder. Knock control listens to them, takes timing out when it hears knock, then puts the timing back slowly.

Knock control is on in most of our tunes and set for your engine. If yours shows **enabled**, leave it on. If it shows **disabled**, leave it that way and call us before turning it on.

WHERE TO FIND IT

A **Ignition ▸ Knock Control**

B **Ignition ▸ Max knock retard**

The numbers in these pictures come from one example bike. Your tune's numbers will be different, so don't copy them. Units are Metric (°C, kPa, km/h). Red numbers in each picture match the table below it.

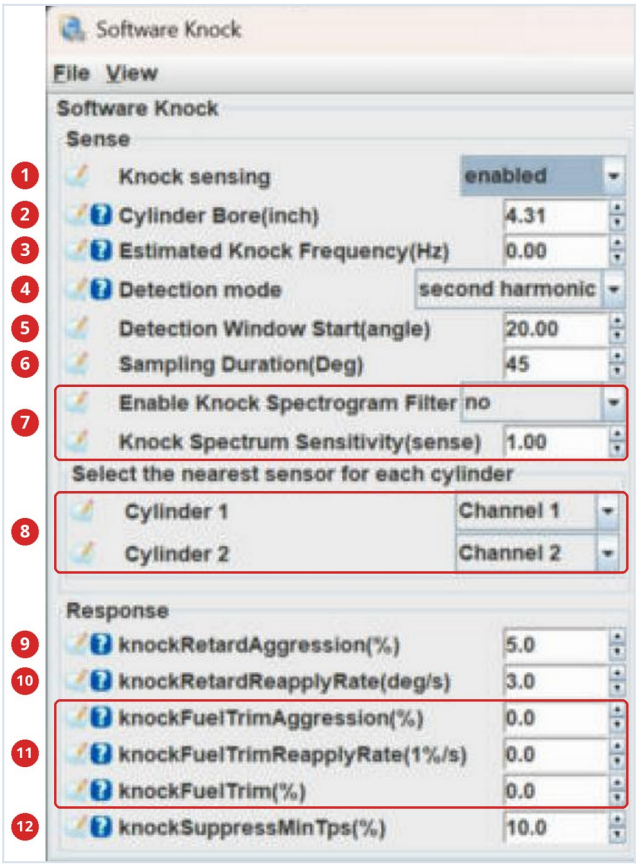
How knock control works

- Right after each spark, the ECU listens to that cylinder's knock sensor for a short moment.
- If the sound is louder than the knock line for that RPM (13), it counts a knock and takes timing out of **both cylinders**: 5% here (9) of the distance from the current timing down to −20°. At 30° of timing that's 2.5°.
- It never takes out more than the **Max knock retard** table allows (B).
- Then it puts the timing back at **3 degrees per second** here (10).
- Below **10% throttle** opening here (12), it doesn't take timing out, and any timing it took out goes straight back. Knocks it hears there still add to the knock count.

SOME CHANGES NEED A RESTART Changes to Knock sensing, Cylinder Bore, Estimated Knock Frequency and Detection mode (items 1 to 4) only take effect after the ECU restarts. Click **Burn**, turn the key off and unplug the USB cable for a few seconds, then plug it back in and turn the key on. The ECU stays on while the USB cable is plugged in, even with the key off.

A Knock Control

The window is titled **Software Knock**. Its left half holds the settings (1 to 12). Its right half holds the knock line (13).



#	SETTING	WHAT IT DOES
1	**Knock sensing** LEAVE AS SET	**enabled** turns knock control on. Leave it as your tune came.
2	**Cylinder Bore (inch)** LEAVE AS SET	Your engine's bore (cylinder width): **4.31** in this example. The ECU uses it to work out the pitch of the knock sound to listen for: a bigger bore knocks at a lower pitch. Fitted a big-bore kit? Call us.
3	**Estimated Knock Frequency (Hz)** LEAVE AS SET	Frequency is the pitch of the sound, in Hz. **0** means the ECU works it out from the bore (2), using Detection mode (4). Any other number is used exactly as typed, and Detection mode is then ignored.
4	**Detection mode** LEAVE AS SET	**second harmonic:** listens at twice the knock frequency, where there's usually less background noise.

#	SETTING	WHAT IT DOES
5	**Detection Window Start (angle)** LEAVE AS SET	Listening starts this many degrees of crankshaft turn after each spark: **20** here.
6	**Sampling Duration (Deg)** LEAVE AS SET	How long it listens, in degrees of crankshaft turn: **45** here.
7	**Knock spectrogram settings** LEAVE AS SET	For the knock spectrogram, a picture of the knock sensor's sound that a TunerStudio add-on can show. They don't change how knock is found.
8	**Cylinder 1 and Cylinder 2** LEAVE AS SET	Which knock sensor input each cylinder listens on. **Cylinder 1 is the rear cylinder** (Channel 1), Cylinder 2 the front (Channel 2).
9	**knockRetardAggression (%)** ADVANCED	How much timing to take out for each knock: **5%** of the distance from the current timing down to −20°.
10	**knockRetardReapplyRate (deg/s)** ADVANCED	How fast timing comes back after knock: **3.0** degrees per second.
11	**knockFuelTrim settings** LEAVE AS SET	Can add fuel when knock is heard. All **0** in our tunes: no fuel is added. Leave them at 0.
12	**knockSuppressMinTps (%)** ADVANCED	Below this throttle opening (**10%**), knock control doesn't take timing out, and any timing it took out goes back at once.

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

THE KNOCK LINE



13 **Knock Sensitivity By RPM** ADVANCED

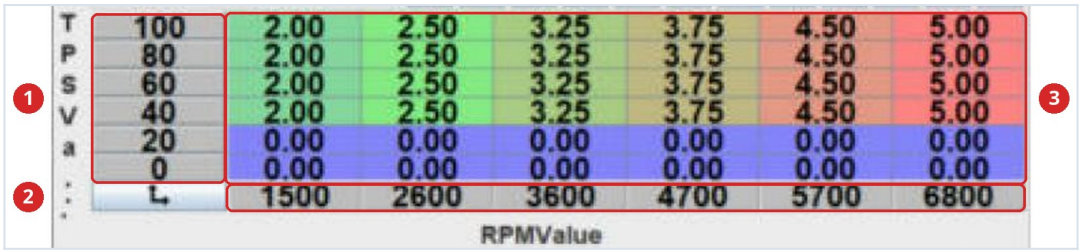
A knock is counted when a sensor's reading goes above this line. The columns are **RPM** and **Threshold** (loudness, in dB): **−20** up to 2300 RPM, rising to **−5** from about 6200 RPM. Engines get noisier as RPM rises, so the line rises too.

A lower number is more sensitive and counts more knocks.

The graph beside these columns stays empty (its scale only goes from 0 to 8). Go by the columns.

B Max knock retard

The most timing knock control may take out, by RPM and load.



#	SETTING	WHAT IT DOES
1	**Load rows**	Engine load: manifold pressure in kPa, like the timing table, even though TunerStudio labels them **TPSValue**: 60 means 60 kPa. For the same reason, don't go by Follow Mode's highlight in this table.
2	**RPM columns**	Engine speed.
3	**Cells (deg)** ADVANCED	The most timing that may be taken out. In this example: **none** at 0 and 20 kPa (closed throttle); **2°** at 1500 RPM up to **5°** at 6800 RPM from 40 kPa up.

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

Checking for knock

- Take a datalog (a recording of what the engine is doing). **Knock: Retard** shows how many degrees knock control is taking out of both cylinders right now, and **Knock: Count** how many knocks it has heard since the ECU last started.
- **Knock: Cyl 1** (rear) and **Knock: Cyl 2** (front) show how loud each cylinder's sensor is. **Knock: Threshold** shows the knock line at the current RPM: a reading above it is a knock.
- Seeing knock retard often? Call us: the tune may have too much timing for your fuel, or the engine may be running hot.

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IMPACT ECU · CRANKING BUTTON GUIDE

Cranking Button Overview

The **Cranking** button in TunerStudio holds the settings for starting the engine: the squirt of fuel when you turn the key on, the fuel and spark timing while the starter turns the engine, and the extra fuel for the first moments after it starts. This guide is the map to its menu: what each item is for, and which guide explains it.

Your tune came with these set for your bike. Most of them never need changing.

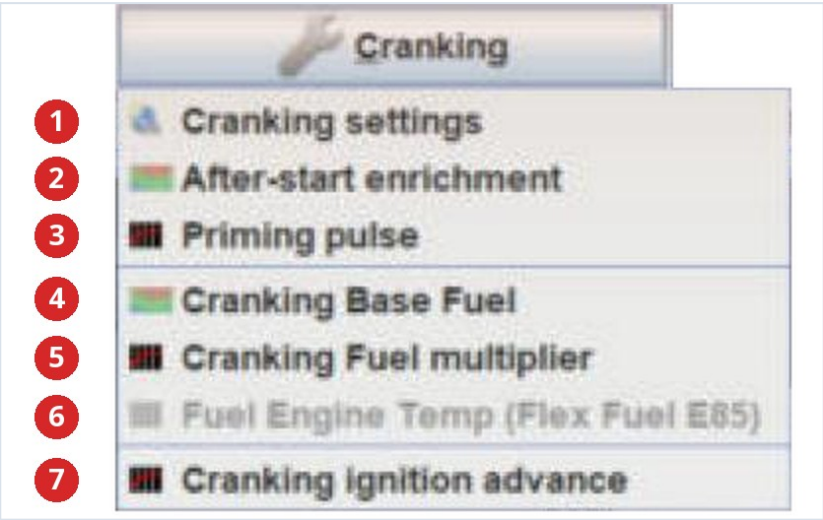
What happens when you start the bike

STEP 1 **KEY ON**	**Priming pulse:** a moment after the key goes on, the injectors open once to wet the intake with a little fuel.
STEP 2 **CRANKING**	While the starter turns the engine, the ECU uses the **cranking fuel**, spark timing and coil charge time (dwell) instead of the normal ones. Keep the twist grip closed: opening it gives less fuel, and wide open cuts the fuel completely (flood clear).
STEP 3 **RUNNING**	Once the engine reaches the **Cranking RPM limit** (the speed at which the ECU counts the engine as started), it switches to the normal Fuel and Ignition settings.
STEP 4 **JUST STARTED**	**After-start enrichment** adds extra fuel for about the first 15 seconds, more when the engine is cold.

Before you change anything

- **Save a copy of your tune first**, so you can always go back.
- **Burn means save.** Changes go to the ECU as you make them, but are only kept after you click **Burn**.
- **Greyed-out items** are switched off by another setting. Each guide says which one.
- **Missing items?** Some only show when **Setup ▸ Vehicle Information ▸ Tuning View** is set to **Full**.
- **Hard starting is often not the tune.** Check the battery first: a weak battery turns the engine slowly and makes a weak spark.
- **Change one thing at a time.** Not sure? Call us first.

The Cranking menu, item by item



*Items 2, 3, 6 and 7 only show when **Tuning View** is **Full** (Setup ▸ Vehicle Information). If your menu shows only three items, set it to Full.*

1. **Cranking settings** The Cranking RPM limit, how the injectors fire while cranking, cranking timing and dwell, and flood clear.
2. **After-start enrichment** Extra fuel for the first moments after the engine starts.
3. **Priming pulse** The squirt of fuel when the key goes on.
4. **Cranking Base Fuel** The starting amount of fuel for each injection while cranking, by engine temperature. The multipliers then add to it.
5. **Cranking Fuel multiplier** More cranking fuel when the engine is cold.
6. **Fuel Engine Temp (Flex Fuel E85)** The same, for E85 (fuel with 85% ethanol). Only with a flex fuel sensor; greyed out otherwise.
7. **Cranking ignition advance** The spark timing while cranking.

The idle valve opening while cranking is set in the **Idle** button (**Cranking Idle Valve Curve** and **Idle Valve Crank-to-Run Taper**). The Idle guides explain them.

Which guide to read

GUIDE	MENU ITEMS	WHAT IT COVERS
Cranking Settings	1	Cranking RPM limit, injection mode, cranking timing mode and dwell, flood clear
After-Start Enrichment	2	Extra fuel just after the engine starts
Cranking Fuel	3–6	Priming pulse, cranking base fuel and multipliers
Cranking Ignition Advance	7	Spark timing while cranking

Which setting fixes what?

IF THE BIKE…	LOOK AT
Turns over but never fires	Make sure the twist grip is closed and the battery is strong. Then call us
Cranks a long time before it fires	**Cranking Fuel** (base fuel and multiplier) and the priming pulse. Call us before changing them
Smells of fuel or floods when you try to start it	If you can see or smell leaking fuel, don't try to start it: call us. Otherwise the engine may be flooded (too much fuel): use flood clear (see Cranking Settings), then call us
Starts, then dies within a few seconds	**After-Start Enrichment**, and the Idle button's cranking idle valve settings
Kicks back or pops while cranking	Check the battery first, and make sure **Ignition ▸ Ignition settings ▸ Timing Mode** is **dynamic**. Then call us. Don't change Cranking Ignition Advance yourself

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IMPACT ECU · CRANKING BUTTON GUIDE

Cranking Settings

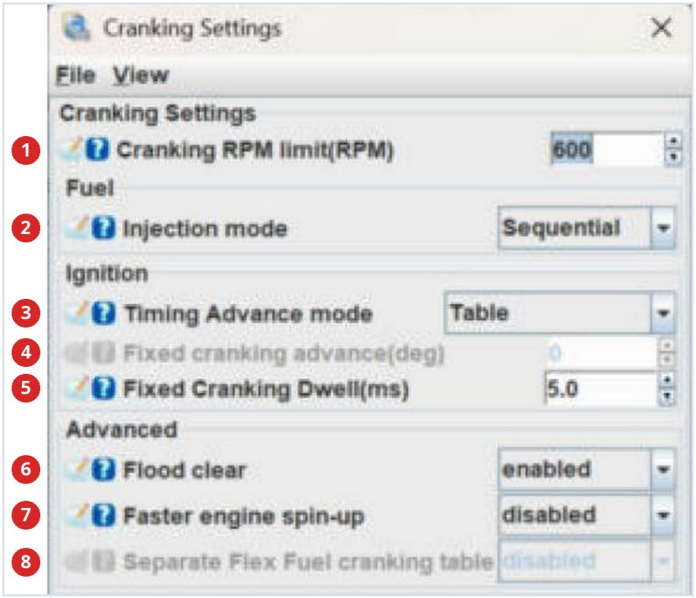
This window sets when the ECU counts the engine as **cranking** (being turned by the starter), how the injectors fire while cranking, the spark timing and coil charge time (dwell) while cranking, and flood clear.

Your tune came with these set for your bike. **You should never need to change them.**

WHERE TO FIND IT
Cranking ▸ Cranking settings

The numbers in these pictures come from one example bike. Your tune's numbers will be different, so don't copy them. Units are Metric (°C, kPa, km/h). Red numbers in each picture match the table below it.

The settings



#	SETTING	WHAT IT DOES
1	**Cranking RPM limit (RPM)** LEAVE AS SET	The engine counts as started when it first reaches this speed: **600** here. Until then, from a stop, the ECU is **cranking** and uses the cranking fuel, timing and dwell. Once started, it uses the normal Fuel and Ignition settings until the engine stops, even if the RPM dips below 600.

#	SETTING	WHAT IT DOES
2	**Injection mode** LEAVE AS SET	**Sequential:** each injector fires once per engine cycle (two crankshaft turns), timed for its own cylinder. **Batch:** both fire together twice per cycle, each with half the fuel.
3	**Timing Advance mode** LEAVE AS SET	**Table:** the timing while cranking comes from **Cranking ▸ Cranking ignition advance**. **Fixed (auto taper):** it starts at the number in 4 and blends toward the normal timing as RPM rises.
4	**Fixed cranking advance (deg)** LEAVE AS SET	The starting timing for Fixed (auto taper). Greyed out while 3 is **Table**.
5	**Fixed Cranking Dwell (ms)** LEAVE AS SET	Coil charge time while cranking: **5.0** ms here, with no battery voltage correction. It replaces the Ignition button's Dwell curves until the engine starts.
6	**Flood clear** LEAVE AS SET	**enabled:** while the engine isn't running, holding the twist grip wide open (more than 90%) stops all fuel, to clear a flooded engine. **enabled** here.
7	**Faster engine spin-up** LEAVE AS SET	**enabled** lets the ECU fire sooner, before it has timed a full engine cycle. **disabled** here: while it finds the engine's position, the first fire can take up to four crankshaft turns.
8	**Separate Flex Fuel cranking table** NOT USED HERE	Also uses the **Fuel Engine Temp (Flex Fuel E85)** curve, blended by ethanol content. Only with a flex fuel (ethanol) sensor; greyed out without one.

The grey help box at the bottom of the window has general notes for all engines. Where they differ from this guide (350–450 RPM, "Simultaneous", "Constant mode", 95%), go by this guide.

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

> **CLEARING A FLOODED ENGINE** In **neutral**, hold the twist grip **wide open** and crank for a few seconds: no fuel is injected. If it starts to fire, let go of the grip at once. Then start normally, grip closed. Still floods? Call us.

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IMPACT ECU · CRANKING BUTTON GUIDE

Cranking Fuel

Starting fuel comes in two parts: the **priming pulse**, a squirt of fuel when the key goes on, and **cranking fuel** for each injection while the starter turns the engine.

Your tune came with these set for your bike. A cold engine needs much more fuel to start than a warm one.

WHERE TO FIND IT

- (A) **Cranking ▸ Priming pulse** shows when Tuning View is Full
- (B) **Cranking ▸ Cranking Base Fuel**
- (C) **Cranking ▸ Cranking Fuel multiplier**
- (D) **Cranking ▸ Fuel Engine Temp (Flex Fuel E85)** flex fuel bikes only

The numbers in these pictures come from one example bike. Your tune's numbers will be different, so don't copy them. Units are Metric (°C, kPa, km/h). Red numbers in each picture match the table below it.

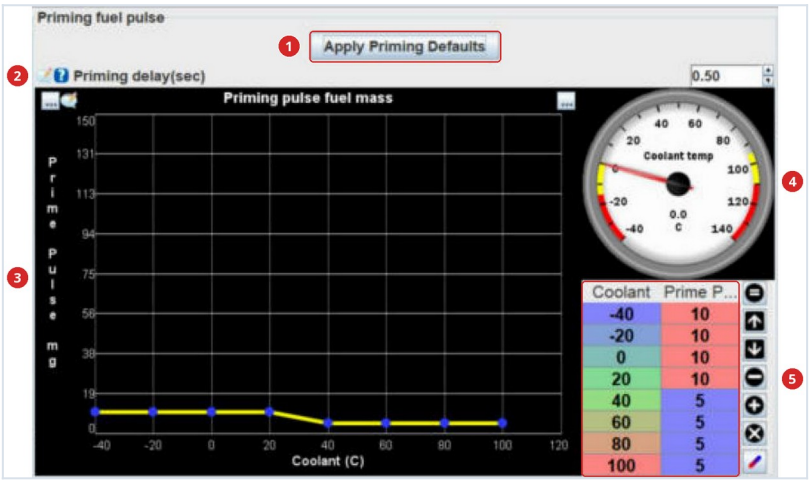
How cranking fuel is worked out

CRANKING FUEL = Base fuel (B) × Cranking Fuel multiplier (C) × throttle multiplier

- Fuel amounts are in **milligrams (mg)** per injection. The ECU turns that into injector open time.
- The **throttle multiplier** goes by the twist grip. In this tune it's **1.50** with the grip closed and drops to **1.00** wide open, so opening the grip while you start gives less fuel, not more. Past 90% open, **Flood clear** stops the fuel completely (see the Cranking Settings guide). It's set in your tune but isn't on any TunerStudio menu.
- **Example:** engine at 20 °C (68 °F), the 0 column, twist grip closed: 58.5 mg × 1.84 × 1.50 = about 161 mg.
- In a datalog (a recording of what the engine is doing), **Fuel: Cranking cycle mass** shows the cranking fuel while cranking, and **Fuel: Cranking cycle base mass**, **Fuel: cranking CLT mult** and **Fuel: cranking TPS mult** its three parts (the last one says TPS, but goes by the grip).
- Cranking fuel stops when the engine reaches the Cranking RPM limit. Then the normal fuel tables and After-start enrichment take over.

A Priming pulse

The window is titled **Priming fuel pulse**. The injectors open once, together, a moment after the key goes on with the engine stopped. After several key-ons without starting, the ECU may skip it, so the engine doesn't flood. With a failed engine temperature sensor (**CLT error**), there's no priming pulse, and cranking fuel is set for a cold engine even when it's hot.

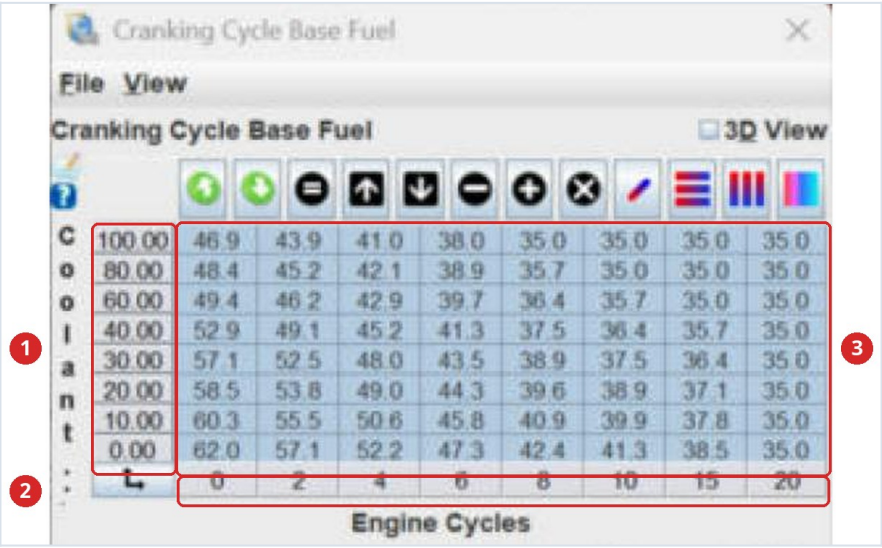


#	SETTING	WHAT IT DOES
1	**Apply Priming Defaults**	Replaces your tune's priming settings with the ECU's default ones. **Don't click it** unless we ask you to. Clicked it by mistake? Don't click Burn, and call us.
2	**Priming delay (sec)** LEAVE AS SET	How long the ECU waits after the key goes on before priming, so the fuel pump can build pressure: **0.50** seconds here. The ECU adds another 0.1 second.
3	**Priming pulse fuel mass** LEAVE AS SET	A graph of the priming fuel against engine temperature. Its numbers are in 5.
4	**Coolant temp gauge** DISPLAY ONLY	Live engine temperature. It reads 0.0 when TunerStudio isn't connected.
5	**Coolant and Prime Pulse columns** LEAVE AS SET	The priming fuel (mg) at each engine temperature: **10** mg at 20 °C (68 °F) and colder, **5** mg at 40 °C (104 °F) and warmer in this example.

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

B Cranking Base Fuel

The window is titled **Cranking Cycle Base Fuel**. In this picture all the cells happen to be selected, so they show light blue instead of colors.



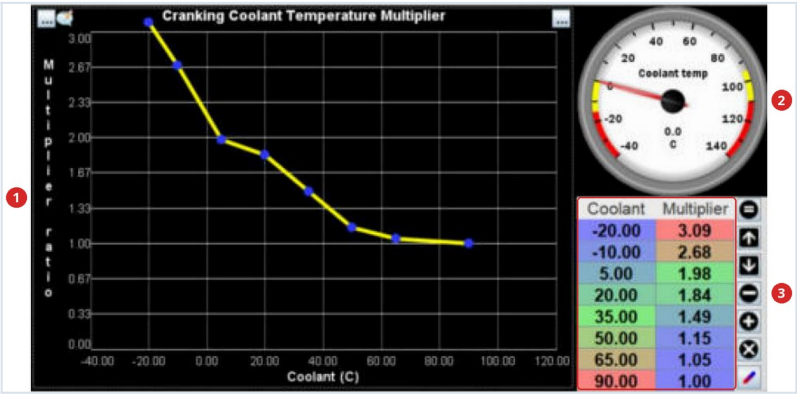
#	SETTING	WHAT IT DOES
1	**Coolant rows (°C)**	Engine temperature, from 0 °C (32 °F) to 100 °C (212 °F).
2	**Engine Cycles columns**	Engine cycles since the engine started turning: here 0 to 20. One engine cycle is two turns of the crankshaft, with each cylinder firing once.
3	**Base fuel cells (mg)** MAIN SETTING	The base fuel for each injection. In this example: **62** mg in the 0 column at 0 °C, down to **35** mg by 20 cycles; **46.9** mg at 100 °C, down to **35** by 8 cycles.

The first few cycles get the most fuel: the intake ports are dry and soak some of it up. Past the last column, the ECU keeps using the last column; outside the temperature rows, it uses the nearest row. The window's help (?) mentions IAT and a starting point of 60 mg per liter. Those are general notes: air temperature isn't used for cranking fuel, and your tune's numbers are set for your engine.

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

C Cranking Fuel multiplier

Window title: **Cranking Coolant Temperature Multiplier**. It multiplies the base fuel by engine temperature: **1.00 = no change, 2.00 = double**.



#	SETTING	WHAT IT DOES
1	**Multiplier graph**	A graph of the multiplier against engine temperature. Its numbers are in 3.
2	**Coolant temp gauge** DISPLAY ONLY	Live engine temperature. It reads 0.0 when TunerStudio isn't connected.
3	**Coolant and Multiplier columns** MAIN SETTING	In this example: **3.09** at −20 °C (−4 °F), **1.84** at 20 °C (68 °F), **1.15** at 50 °C (122 °F) and **1.00** at 90 °C (194 °F).

Cranks a long time before it fires? It may need more cranking fuel. Floods? Use **Flood clear** first (Cranking Settings); if it keeps flooding, it may need less. Call us before changing these tables.

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

D Fuel Engine Temp (Flex Fuel E85)

The same kind of curve, for E85 (85% ethanol). Used only with a flex fuel sensor and **Separate Flex Fuel cranking table** on: the ECU blends C and this curve by ethanol content. Otherwise greyed out; it only shows when Tuning View is Full.

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IMPACT ECU · CRANKING BUTTON GUIDE

After-Start Enrichment

Right after it starts, an engine needs a little extra fuel to run smoothly, most of all when cold. **After-start enrichment** adds that fuel for the first moments after a start, then fades away.

1.00 = no change. 1.30 = 30% more fuel. Your tune came with this set for your bike.

WHERE TO FIND IT
Cranking ▸ After-start enrichment shows when Tuning View is Full

The numbers in these pictures come from one example bike. Your tune's numbers will be different, so don't copy them. Units are Metric (°C, kPa, km/h). Red numbers in each picture match the table below it.

How it works

- It starts when the engine reaches the **Cranking RPM limit** (Cranking settings) and switches to its normal fuel.
- It multiplies the normal fuel, on top of **Warmup enrichment** (Fuel button). It can only add fuel: the smallest number it takes is 1.00 (no extra fuel).
- The columns count **engine cycles** since the engine started turning. One engine cycle is two turns of the crankshaft. The count starts with cranking, so a few cycles have passed by the time the engine runs. It starts again from 0 every time the engine stops, so a restart after a stall gets the full enrichment again.
- After the last column (150 cycles: about 15 seconds at a cold idle), it stops adding fuel.
- The ECU blends between neighboring cells. With a failed engine temperature sensor, it uses the 0 °C row.

Stalls or runs rich after starting?

- Starts, then stalls within a few seconds when cold? It may need more after-start enrichment, or it may be the idle air (**Idle ▸ Idle Valve Crank-to-Run Taper**). Runs rich (smells of fuel) just after a cold start? It may need less. Call us before changing it.
- In a datalog (a recording of what the engine is doing), **Fuel: Post cranking mult** shows the multiplier. It shows a number while cranking too, but it's only used once the engine is running.

The table

The window is titled **After start enrichment**.



#	SETTING	WHAT IT DOES
1	**Coolant Temp rows (°C)**	Engine temperature, from −20 °C (−4 °F) to 80 °C (176 °F).
2	**Engine Cycles columns**	Engine cycles since the engine started turning: 0 to 150.
3	**Multiplier cells** MAIN SETTING	The extra fuel at each temperature and time after the start. **1.00 = none**.

In this example: at 0 °C (32 °F) and −20 °C (−4 °F) it starts at **1.30** (30% more fuel), and fades to 1.05 at 0 °C and 1.10 at −20 °C. At 20 °C (68 °F): 1.10 fading to 1.00. At 40 °C (104 °F): 1.05 fading to 1.00. From 60 °C (140 °F) up: **1.00**, no extra fuel.

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

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IMPACT ECU · CRANKING BUTTON GUIDE

Cranking Ignition Advance

This curve sets the spark timing while the starter turns the engine, by engine speed (RPM). Starting timing is kept low, near **top dead center** (TDC: the piston at the very top, 0°), so the engine doesn't kick back against the starter.

Your tune came with this set for your bike. **You should never need to change it.**

> **WHERE TO FIND IT**
> **Cranking ▸ Cranking ignition advance** shows when Tuning View is Full

The numbers in these pictures come from one example bike. Your tune's numbers will be different, so don't copy them. Units are Metric (°C, kPa, km/h). Red numbers in each picture match the table below it.

When it's used

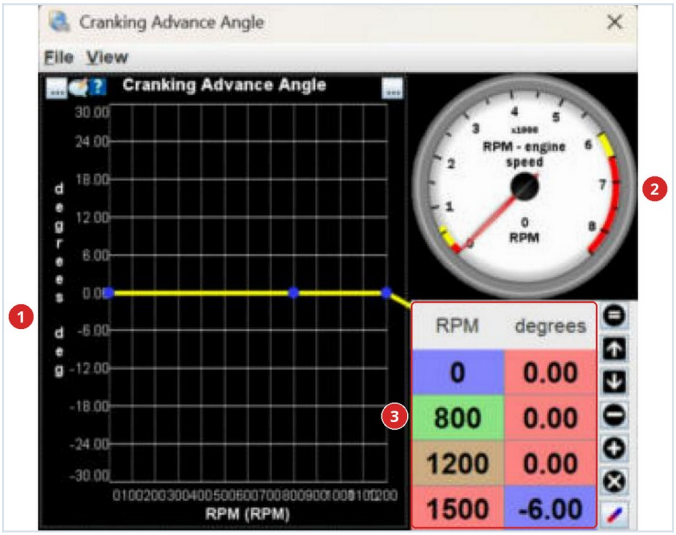
- Only while cranking: from a stop until the engine first reaches the **Cranking RPM limit** (600 here). After that, the normal timing tables in the Ignition button take over.
- Only when **Cranking ▸ Cranking settings ▸ Timing Advance mode** is **Table**, as in our tunes. With **Fixed (auto taper)**, the timing starts at the **Fixed cranking advance** instead and blends toward the normal timing as RPM rises, and this menu item is greyed out.
- No timing corrections are used while cranking: not the engine temperature or air temperature corrections, and not **Idle ▸ Closed-loop idle timing**.
- If **Ignition ▸ Ignition settings ▸ Timing Mode** is **fixed**, the Fixed Timing number is used instead, even while cranking.

Good to know

- Kicks back against the starter, or pops while cranking? Too much cranking advance can do that. Call us before changing this curve.
- The coil charge time while cranking is the **Fixed Cranking Dwell** in Cranking settings.
- In a datalog (a recording of what the engine is doing), **Ign: Timing Cyl 1** (rear) and **Ign: Timing Cyl 2** (front) show the timing in use, while cranking too.

The settings

The window is titled **Cranking Advance Angle**.



#	SETTING	WHAT IT DOES
1	**Cranking Advance Angle** LEAVE AS SET	A graph of the timing against RPM. Its numbers are in 3. The graph only goes up to 1200 RPM, so the 1500 RPM point is off its right edge.
2	**RPM gauge** DISPLAY ONLY	Live engine speed. It reads 0 when TunerStudio isn't connected.
3	**RPM and degrees columns** LEAVE AS SET	The timing at each RPM, in degrees before top dead center (a negative number fires after it). In this example: **0°** at 0, 800 and 1200 RPM, and **−6°** at 1500 RPM.

Cranking ends at the Cranking RPM limit (600 RPM here), so the ECU only uses the line between the 0 and 800 RPM points. Both are **0°** here, so this bike cranks at 0° every time. The 1200 and 1500 RPM points are never used. The grey help box at the bottom of the window (below the part in the picture) mentions "useSeparateAdvanceForCranking": that's **Timing Advance mode** in Cranking settings.

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

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IMPACT ECU · IDLE BUTTON GUIDE

Idle Button Overview

The **Idle** button in TunerStudio holds the settings that keep the engine running smoothly when your hand is off the twist grip: the idle speed, how far the throttle opens to get there, and how the ECU holds that speed steady. This guide is the map to its menu: what each item is for, and which guide explains it.

Your bike's throttle body is electronic, so there's no separate idle valve: to idle, the ECU simply holds the throttle open a little. The menu still calls this the **idle valve**. Your tune came with these set for your bike, and most of them never need changing.

How the ECU handles idle

STEP 1 **CRANKING**	While the starter turns the engine, the ECU opens the throttle to the **Cranking Idle Valve Curve** position, so the engine gets enough air to start.
STEP 2 **JUST STARTED**	Over the first several seconds, the **Idle Valve Crank-to-Run Taper** moves the throttle from the cranking position to the normal idle position.
STEP 3 **IDLING**	With the twist grip closed, the throttle opens to the **Base Idle Valve Position**. The ECU then fine-tunes the opening and the spark timing to hold the **Target RPM**.
STEP 4 **RIDING**	Open the twist grip and your grip sets the throttle. Close it at higher RPM and the ECU waits until the engine slows close to the target before it idles again.

Before you change anything

- **Save a copy of your tune first**, so you can always go back.
- **Burn means save.** Changes go to the ECU as you make them, but are only kept after you click **Burn**.
- **Greyed-out items** are switched off by another setting. Each guide says which one.
- **Cranking Idle Valve Curve greyed out or missing?** Set **Setup ▸ Vehicle Information ▸ Tuning View** to **Full**.
- **Change one thing at a time.** Not sure? Call us first.

The Idle menu, item by item



Item 4 needs Tuning View set to Full. Items 7 to 10 are optional tables, off in our tunes.

1. **Idle settings** Idle control mode, idling limits, fan adders, closed-loop and extra settings.
2. **Target RPM** The idle speed the ECU aims for, by engine temperature.
3. **Base Idle Valve Position** How far the throttle opens at idle, by engine temperature.
4. **Cranking Idle Valve Curve** How far the throttle opens while cranking, and the ETB idle maximum angle.
5. **Idle Valve Crank-to-Run Taper** How long the move from cranking to idle position takes.
6. **Closed-loop idle timing** Small spark timing changes that help hold the idle speed.
7. **IAC PID multiplier** Optional. Scales the closed-loop idle correction.
8. **Coasting IAC position** Optional. A separate throttle opening for coasting.
9. **Idle VE** Optional. A separate fuel table for idle.
10. **Idle Ignition advance** Optional. A separate timing curve for idle.

Three more idle items, in other menus, are greyed out on your bike: leave them as set. They're **Sensors ▸ ETB-style Idle valve position sensor**, and **Controller ▸ Idle flow estimate** and **Idle airmass/timing equivalence**. The ETB idle maximum angle (item 4) also shows in **Advanced ▸ Electronic Throttle Body actuator**: it's the same setting.

Which guide to read

GUIDE	MENU ITEMS	WHAT IT COVERS
Idle Settings	1	Idle control mode, idling limits, fan adders, closed-loop and extra settings
Target Idle RPM	2	The idle speed by engine temperature
Idle Valve Position	3–5	Idle, cranking and crank-to-run throttle opening
Idle Timing	6, 10	Closed-loop idle timing and the optional idle timing curve
Optional Idle Tables	7–9	IAC PID multiplier, coasting position and Idle VE

Which setting fixes what?

IF THE BIKE…	LOOK AT
Idles high when cold	Normal. The target idle speed is higher on a cold engine (**Target RPM**) and comes down as it warms up
Won't come back down to idle when you close the twist grip while riding	**Base Idle Valve Position** (see the Idle Valve Position guide)
Idle hangs high for a while after you close the twist grip	Lower **Base Idle Valve Position** at the temperatures where it hangs, 1 at a time
Idle stays above the target as the engine warms up	Lower **Base Idle Valve Position** at that temperature, 1 at a time
Idles more than about 50 RPM below the target	Raise **Base Idle Valve Position** at that temperature, 1 at a time. Within 50 RPM is normal
Idles more than about 150 RPM above the target	Lower **Base Idle Valve Position** at that temperature, 1 at a time. Up to about 150 RPM above is normal
Idle swings up and down (hunts)	Check the fueling at idle. Also check that **Base Idle Valve Position** isn't set too high or too low, leaving the closed-loop correction to make up the difference
Dips low or stalls as you come to a stop	Raise **Base Idle Valve Position**, 1 at a time
Starts, then dies within a few seconds	**Base Idle Valve Position** too low, or the mixture too lean (Fuel button)

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IMPACT ECU · IDLE BUTTON GUIDE

Idle Button Overview

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How the ECU handles idle

STEP 1 **CRANKING**	While the starter turns the engine, the ECU opens the throttle to the **Cranking Idle Valve Curve** position, so the engine gets enough air to start.
STEP 2 **JUST STARTED**	Over the first several seconds, the **Idle Valve Crank-to-Run Taper** moves the throttle from the cranking position to the normal idle position.
STEP 3 **IDLING**	With the twist grip closed, the throttle opens to the **Base Idle Valve Position**. The ECU then fine-tunes the opening and the spark timing to hold the **Target RPM**.
STEP 4 **RIDING**	Open the twist grip and your grip sets the throttle. Close it at higher RPM and the ECU waits until the engine slows close to the target before it idles again.

Before you change anything

- **Save a copy of your tune first**, so you can always go back.
- **Burn means save.** Changes go to the ECU as you make them, but are only kept after you click **Burn**.
- **Greyed-out items** are switched off by another setting. Each guide says which one.
- **Cranking Idle Valve Curve greyed out or missing?** Set **Setup ▸ Vehicle Information ▸ Tuning View** to **Full**.
- **Change one thing at a time.** Not sure? Call us first.

The Idle menu, item by item



Item 4 needs Tuning View set to Full. Items 7 to 10 are optional tables, off in our tunes.

1. **Idle settings** Idle control mode, idling limits, fan adders, closed-loop and extra settings.
2. **Target RPM** The idle speed the ECU aims for, by engine temperature.
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9. **Idle VE** Optional. A separate fuel table for idle.
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Three more idle items, in other menus, are greyed out on your bike: leave them as set. They're **Sensors ▸ ETB-style Idle valve position sensor**, and **Controller ▸ Idle flow estimate** and **Idle airmass/timing equivalence**. The ETB idle maximum angle (item 4) also shows in **Advanced ▸ Electronic Throttle Body actuator**: it's the same setting.

Which guide to read

GUIDE	MENU ITEMS	WHAT IT COVERS
Idle Settings	1	Idle control mode, idling limits, fan adders, closed-loop and extra settings
Target Idle RPM	2	The idle speed by engine temperature
Idle Valve Position	3–5	Idle, cranking and crank-to-run throttle opening
Idle Timing	6, 10	Closed-loop idle timing and the optional idle timing curve
Optional Idle Tables	7–9	IAC PID multiplier, coasting position and Idle VE

Which setting fixes what?

IF THE BIKE…	LOOK AT
Idles high when cold	Normal. The target idle speed is higher on a cold engine (**Target RPM**) and comes down as it warms up
Won't come back down to idle when you close the twist grip while riding	**Base Idle Valve Position** (see the Idle Valve Position guide)
Idle hangs high for a while after you close the twist grip	Lower **Base Idle Valve Position** at the temperatures where it hangs, 1 at a time
Idle stays above the target as the engine warms up	Lower **Base Idle Valve Position** at that temperature, 1 at a time
Idles more than about 50 RPM below the target	Raise **Base Idle Valve Position** at that temperature, 1 at a time. Within 50 RPM is normal
Idles more than about 150 RPM above the target	Lower **Base Idle Valve Position** at that temperature, 1 at a time. Up to about 150 RPM above is normal
Idle swings up and down (hunts)	Check the fueling at idle. Also check that **Base Idle Valve Position** isn't set too high or too low, leaving the closed-loop correction to make up the difference
Dips low or stalls as you come to a stop	Raise **Base Idle Valve Position**, 1 at a time
Starts, then dies within a few seconds	**Base Idle Valve Position** too low, or the mixture too lean (Fuel button)

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IMPACT ECU · IDLE BUTTON GUIDE

Target Idle RPM

This curve sets the idle speed the ECU aims for, by engine temperature. A cold engine idles faster so it runs smoothly while it warms up; the target comes down as the engine gets warm.

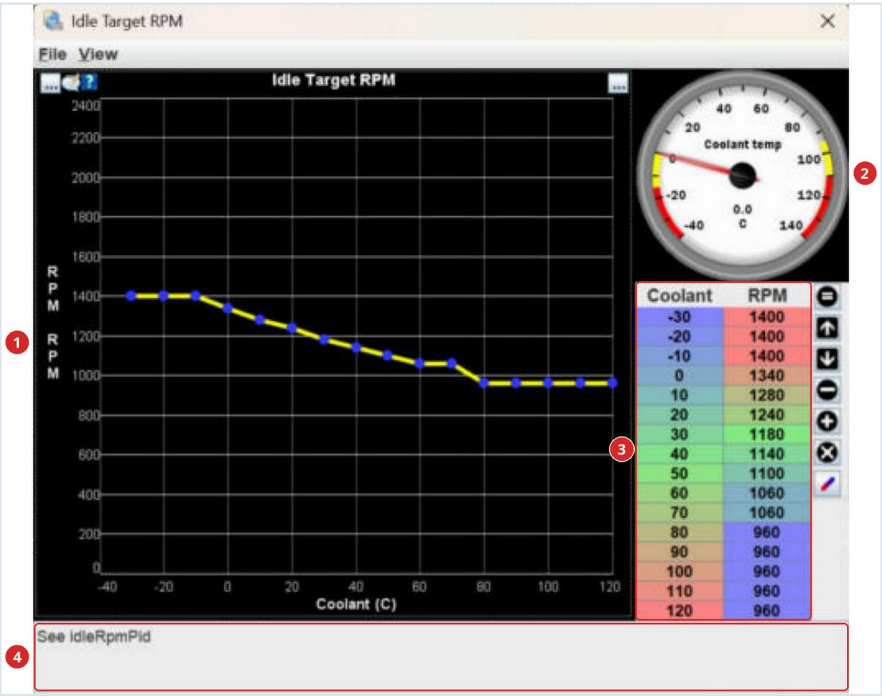
Your tune came with this set for your bike.

WHERE TO FIND IT
Idle ▸ Target RPM

The numbers in these pictures come from one example bike. Your tune's numbers will be different, so don't copy them. Units are Metric (°C, kPa, km/h). Red numbers in each picture match the table below it.

The settings

The window is titled **Idle Target RPM**.



#	SETTING	WHAT IT DOES
1	**Idle Target RPM** LEAVE AS SET	A graph of the target against engine temperature. Its numbers are in 3.
2	**Coolant temp gauge** DISPLAY ONLY	Live engine temperature. It reads 0.0 when TunerStudio isn't connected.

#	SETTING	WHAT IT DOES
3	**Coolant and RPM columns** MAIN SETTING	The target idle speed at each engine temperature. In this example: **1400** RPM at −10 °C (14 °F) and colder, **1240** at 20 °C (68 °F), **1100** at 50 °C (122 °F), **1060** at 60 and 70 °C (140 and 158 °F), and **960** RPM from 80 °C (176 °F) up.
4	**Help box** DISPLAY ONLY	It says “See idleRpmPid”, a note for programmers. You can ignore it.

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

If you change it, go one or two steps (20–40 RPM) at a time, then click **Burn**. Too low a target can make the idle rough or stall the engine. Not sure? Call us.

Good to know

- The ECU blends between points. Colder than the first point or hotter than the last, it uses the end values.
- Targets go in steps of 20 RPM. TunerStudio changes a number in between to a 20 RPM step.
- If the engine temperature sensor fails, the ECU uses the 0 °C (32 °F) target, **1340** RPM here, for a safe, higher idle.
- The target also decides when the engine counts as idling (see the Idle Settings guide) and which rows of the Base Idle Valve Position table are used (see the Idle Valve Position guide).
- In a datalog (a recording of what the engine is doing), **Idle: Target RPM** shows the target in use.

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Idle Valve Position

These settings decide how far the ECU opens the throttle body when your hand is off the twist grip: while cranking, right after the start, and at idle. Your bike has no separate idle valve: the electronic throttle body does the job.

Your tune came with these set for your bike.

WHERE TO FIND IT

- (A) **Idle ▸ Base Idle Valve Position**
- (B) **Idle ▸ Cranking Idle Valve Curve** needs Tuning View set to Full
- (C) **Idle ▸ Idle Valve Crank-to-Run Taper**

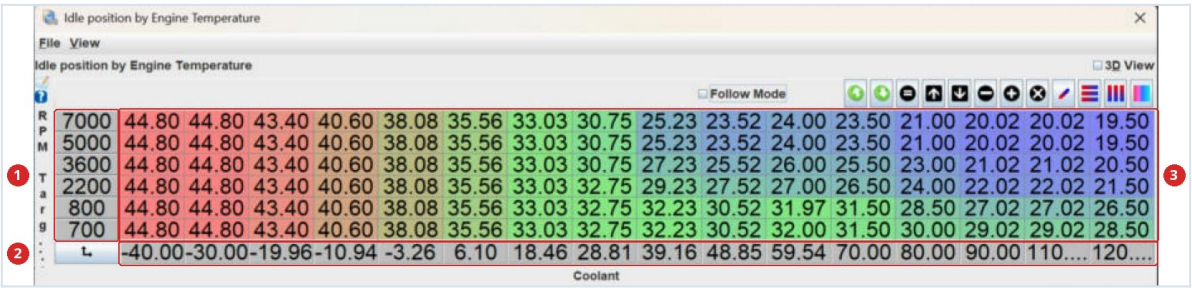
The numbers in these pictures come from one example bike. Your tune's numbers will be different, so don't copy them. Units are Metric (°C, kPa, km/h). Red numbers in each picture match the table below it.

How the idle opening works

- Idle positions are in **%** of the idle range, not of the whole throttle. 100% idle position is the **ETB idle maximum angle** (B1): a **15%** throttle opening here.
- **Example:** a warm engine (80 °C, 176 °F) with the 960 RPM target uses about **28%** idle position, so the throttle opens about **4%** (28% of 15%).
- While cranking, the opening comes from the Cranking Idle Valve Curve (B). After the start, it moves to the Base Idle Valve Position (A) over the Crank-to-Run Taper (C).
- At idle, the ECU adds its closed-loop correction to hold the target, and the **Fan #1 adder** while Fan 1 runs (see the Idle Settings guide).
- When you open the twist grip, the throttle opens further, starting from the idle opening.
- In a datalog (a recording of what the engine is doing), **Idle: Position** shows the idle position in use.

A Base Idle Valve Position

The window is titled **Idle position by Engine Temperature**. It was made wider for this picture.



#	SETTING	WHAT IT DOES
1	**Target RPM rows**	The idle target in use (see the Target Idle RPM guide). The ECU blends between rows. With this bike's targets (960 to 1400 RPM) it uses the **800** and **2200** rows; the others aren't used.
2	**Coolant columns**	Engine temperature, from −40 °C (−40 °F) to 120 °C (248 °F). The window cuts the last two labels short: they're 110 and 120.
3	**Cells (%)** MAIN SETTING	The idle position at each temperature and target. In this example: **44.8%** at −40 °C (−40 °F), about **37%** at 0 °C (32 °F), about **33%** at 20 °C (68 °F) and about **28%** at 80 °C (176 °F), for the targets in use.

With a failed engine temperature sensor, the ECU uses 0 °C (32 °F): about 37% here, plus the fan adder.

TUNING TIPS **Save a copy of your tune first.** Work in neutral, on the stand: changes act as you type them. Up to about 50 RPM below or 150 RPM above the target for that temperature is normal.

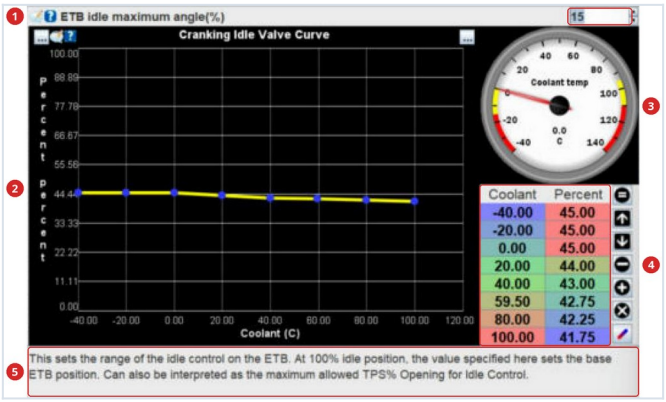
More than 150 RPM above the target, or hanging as it warms up? Lower the cells at that temperature by 1 (28.5 to 27.5, say). More than 50 RPM below it? Raise them by 1. Change the whole column, or both columns if you're between two.

Click **Burn**, let it idle for a minute, and check again (the cold temperatures on the next cold start). Stalls or nearly stalls at a stop? Put the old numbers back and call us.

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

B Cranking Idle Valve Curve

The window is titled **Cranking Idle Valve Curve**. It also holds the ETB idle maximum angle, which every idle position uses.



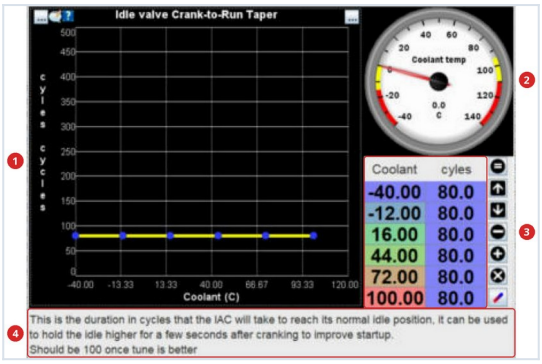
#	SETTING	WHAT IT DOES
1	**ETB idle maximum angle (%)** LEAVE AS SET	The throttle opening at 100% idle position: **15%** here (ETB = electronic throttle body). Every idle position (A, B, the fan adders and the closed-loop correction) is a % of this, so changing it changes them all. Also shown in Advanced ▸ Electronic Throttle Body actuator.
2	**Cranking Idle Valve Curve** LEAVE AS SET	A graph of the cranking idle position against engine temperature. Its numbers are in 4.
3	**Coolant temp gauge** DISPLAY ONLY	Live engine temperature. It reads 0.0 when TunerStudio isn't connected.
4	**Coolant and Percent columns** LEAVE AS SET	The idle position while cranking: **45%** at 0 °C (32 °F) and colder, down to **41.75%** at 100 °C (212 °F). With the 15% maximum angle, that's a throttle opening of about 6.3 to 6.8%.
5	**Help box** DISPLAY ONLY	The help for the setting you click; here, the ETB idle maximum angle.

It's used while cranking: from a stop until the Cranking RPM limit (600 RPM here). After the start, the Crank-to-Run Taper (C) fades from it to the Base Idle Valve Position, so it also sets the idle for the first few seconds.

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

C Idle Valve Crank-to-Run Taper

The window is titled **Idle Valve Crank-to-Run Taper**.



#	SETTING	WHAT IT DOES
1	**Idle valve Crank-to-Run Taper** LEAVE AS SET	A graph of the taper length against engine temperature. Its numbers are in 3.
2	**Coolant temp gauge** DISPLAY ONLY	Live engine temperature. It reads 0.0 when TunerStudio isn't connected.
3	**Coolant and cycles columns** LEAVE AS SET	Engine cycles for the move from the cranking position to the base idle position, counted from when cranking starts: **80** at every temperature here. One cycle is two crankshaft turns, so that's about 7 seconds at a cold idle and 10 at a warm idle. (The window spells it "cyles".)
4	**Help box** DISPLAY ONLY	General notes. "Should be 100 once tune is better" is a general starting point: your tune's number is set for your bike.

The count starts over every time the engine stops. During the taper, closed-loop idle and closed-loop idle timing wait.

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

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IMPACT ECU · IDLE BUTTON GUIDE

Idle Timing

At idle, a small change in spark timing changes the engine speed much faster than the throttle can. **Closed-loop idle timing** uses that to hold the idle steady: a little more advance when the RPM drops below the target, a little less when it rises above it.

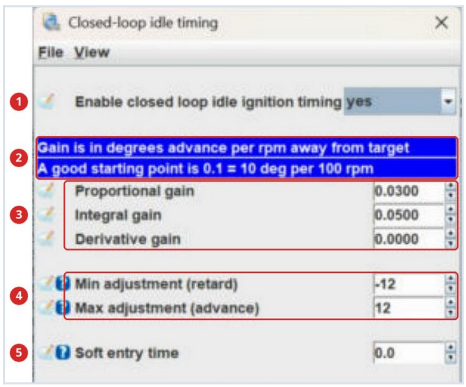
Your tune came with this set for your bike. **You should never need to change it.**

WHERE TO FIND IT

- **A** **Idle ▸ Closed-loop idle timing**
- **B** **Idle ▸ Idle Ignition advance** greyed out: off in our tunes

The numbers in these pictures come from one example bike. Your tune's numbers will be different, so don't copy them. Units are Metric (°C, kPa, km/h). Red numbers in each picture match the table below it.

A Closed-loop idle timing



1. **Enable closed loop idle ignition timing** LEAVE AS SET
   yes here. **no** turns it off.

2. **Blue notes** DISPLAY ONLY
   General notes on the gains. Your tune uses its own numbers.

3. **Proportional, Integral and Derivative gain** ADVANCED
   How strongly and quickly the timing reacts. Proportional gain is degrees per RPM off target: **0.03** here, about 3° per 100 RPM.

4. **Min adjustment (retard), Max adjustment (advance)** LEAVE AS SET
   The most timing it can take out or add: **−12°** and **+12°** here (degrees, though their help says "duty cycle").

5. **Soft entry time** LEAVE AS SET
   Eases the correction in over this many seconds when the engine first settles into idle. **0.0** = off, as here.

Burn means save. Changes go to the ECU as you make them, but they are only kept after you click **Burn**.

When it works

- Only while idling: twist grip closed (2% or less), RPM no more than 500 above the target, and after the Crank-to-Run Taper. Not while cranking, coasting or riding.
- It adds to the normal timing from the Ignition button: the timing table and the temperature corrections.
- In a datalog (a recording of what the engine is doing), **Idle: Timing adjustment** shows the degrees it's adding (+) or taking away (−).

B Idle Ignition advance

An optional timing curve just for idle, by RPM (window **Idle Advance Angle**). It's only used when **Idle ▸ Idle settings ▸ Separate idle ignition table** is **enabled**. Then, while idling and right after a start (during the Crank-to-Run Taper), the timing comes from this curve instead of the normal timing tables, and blends back to them as you open the twist grip from 1% to 2%. Closed-loop idle timing and the temperature corrections still add to it.

In our tunes it's **disabled**, so this menu item is greyed out and the normal tables are used at idle. Leave it off unless we set it up for you.

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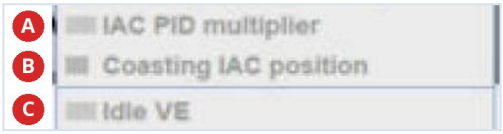
Optional Idle Tables

Three items in the Idle menu are extra tables a tuner can use for special cases. They're **off** in our tunes, so they're greyed out in the menu. IAC means idle air control: on your bike, that's the throttle body's idle opening.

Leave them off unless we set one up for you.

WHERE TO FIND IT

- (A) **Idle ▸ IAC PID multiplier** greyed out
- (B) **Idle ▸ Coasting IAC position** greyed out
- (C) **Idle ▸ Idle VE** greyed out



(A) IAC PID multiplier

An 8 × 8 table, by RPM and engine load, that scales the closed-loop idle correction: **1** = the full correction, **0** = none. It only opens when **Idle ▸ Idle settings ▸ Idle control mode** is **Open Loop + Closed Loop** and **Use IAC PID Multiplier Table** is **yes**.

In our tunes it's **no**, and the table is empty (all zeros). Turning it on with the table empty would switch the closed-loop idle correction off.

(B) Coasting IAC position

A curve, by RPM, of the idle position to use while coasting (twist grip closed, RPM well above the target). It only opens when **Idle ▸ Idle settings ▸ Separate coasting idle table** is **enabled**. Then, while coasting, it replaces the Base Idle Valve Position.

In our tunes it's **disabled**, and the curve is all zeros. Turning it on with the curve empty would close the throttle all the way while coasting.

C Idle VE

A separate 4 × 4 fuel table (VE) for idle, by RPM and engine load. There's no switch for it on any TunerStudio window, so it stays greyed out and off. Your idle fuel comes from the normal VE table in the Fuel button.

For the same reason, **Override Idle VE table load axis** in Idle ▸ Idle settings is greyed out too.

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