Spitronics ECU - Fuel and Timing - Guide

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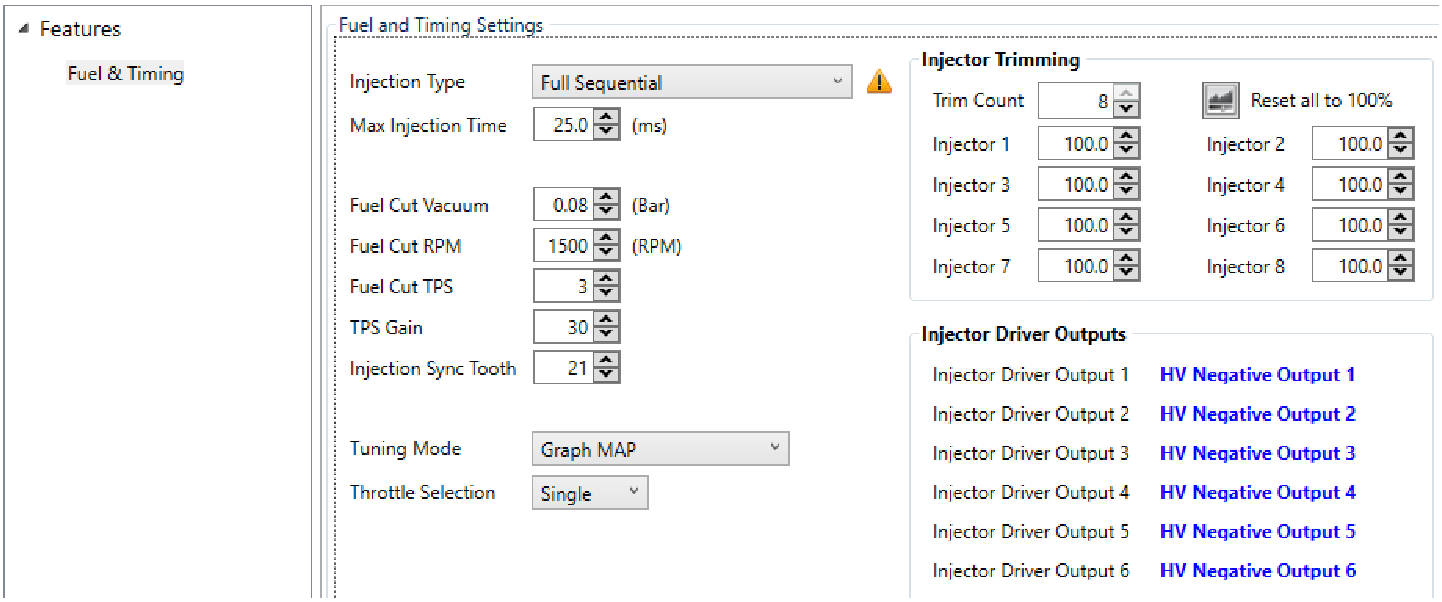
[Setup Check](#)

The **Fuel & Timing** page contains the main fuel-delivery configuration settings used by the ECU.

Open:

Features → Fuel & Timing



The available settings include:

- Injection Type.
- Max Injection Time.
- Fuel Cut Vacuum.
- Fuel Cut RPM.
- Fuel Cut TPS.
- TPS Gain.
- Injection Sync Tooth.
- Tuning Mode.
- Throttle Selection.
- Injector Driver Outputs.

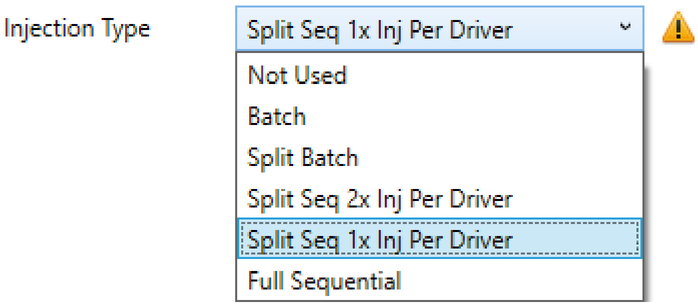
Some selections may be hidden or locked by the firmware where they are not valid for the application.

Injection Type

Injection Type determines how the ECU distributes fuel-injection events between the available injector drivers.

This software version may include:

- Not Used.
- Batch.
- Split Batch.
- Split Seq 2x Inj Per Driver.
- Split Seq 1x Inj Per Driver.
- Full Sequential.



The firmware may hide selections that are not supported by the ECU hardware or application.

Changing Injection Type may also change the physical injector-driver allocation and is therefore a **Critical Setting**.

Do not change this setting on a running engine.

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Not Used

Select **Not Used** where the ECU does not control the fuel injectors.

This may be used in specialised applications where another system provides fuel control.

Batch Injection is generally a specialised strategy rather than the preferred choice where more structured injection methods are supported.
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Batch Injection

With **Batch Injection**, multiple injectors are pulsed together.

This is the simplest injection method but gives less control over the individual injection event because different cylinders may receive fuel at different positions in their intake cycle.

Spitronics generally uses more structured injection strategies where the trigger pattern and available hardware allow it.

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Split Batch Injection

Split Batch divides the injectors into two groups.

The two groups are normally fired approximately 180° apart in the injection sequence.

This means the two injector groups are pulsed out of phase from each other.

This gives better distribution of fuel events than firing all injectors together and can be useful where:

- No Cam Home signal is available.
- Available injector drivers are limited.
- The trigger pattern supports grouped injection.

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Split Sequential Injection

Split Sequential follows the engine firing sequence but injects fuel once per crankshaft revolution.

The calculated fuel for the complete four-stroke engine cycle is divided between the two revolutions.

This method does not normally require a Cam Home signal.

It is one of the most useful general-purpose injection strategies because it provides good fuel distribution while requiring fewer injector drivers than Full Sequential.

Fuel is injected once per crankshaft revolution, with the calculated fuel quantity divided between the two injection events.
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Split Seq 2x Inj Per Driver

With:

Split Seq 2x Inj Per Driver

one injector driver controls two injectors together.

This allows a larger-cylinder-count engine to operate with fewer physical injector drivers.

The paired injectors must be connected according to the applicable injector wiring drawing and engine firing sequence.

The driver current rating must also be sufficient for the combined injector load.

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Split Seq 1x Inj Per Driver

With:

Split Seq 1x Inj Per Driver

each injector driver controls one injector.

The injectors are sequenced according to the firmware firing order, but each injector is still pulsed once per crankshaft revolution.

This provides individual injector-driver control without requiring full 720° Cam synchronisation.

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Full Sequential Injection

Full Sequential uses one injector driver per injector and fires each injector once during the complete 720° four-stroke cycle.

A valid Cam Home or equivalent synchronisation signal is normally used so that the ECU knows which engine stroke is active.

However, Full Sequential injection can also be used **without a Cam Sensor** where the purpose is mainly to obtain a longer single injection pulse rather than precise stroke synchronisation.

This can be useful with larger injectors because the full calculated fuel amount is delivered in one injection event instead of being divided between two events.

Without Cam Synchronisation

When no valid Cam Home signal is available:

- The ECU cannot guarantee which engine stroke the injection event is synchronised to.
- Stroke position may differ from one engine start to the next.
- Precise injection phasing to a specific intake stroke is therefore not possible.

The injector still operates once per 720° cycle, but the ECU does not know which of the two crank revolutions corresponds to the intended intake stroke.

Injection Timing

Where stroke synchronisation is available, aim to position the injection event so that fuel is delivered **just after the intake valve closes**.

This allows fuel to collect on the warm intake valve and promotes good atomisation before the next intake event.

It also reduces the sensitivity of the Tune to whether the injector happens to spray onto an open or closed valve.

Where Full Sequential is used without Cam synchronisation, this exact valve relationship cannot be guaranteed, so the Tune should be checked for stable operation regardless of which stroke synchronisation occurs after startup.

Advantages include:

- Individual cylinder injection control.
- One fuel event per full engine cycle.
- More precise injection phasing.
- Individual injector trimming where supported.

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Injection Type and Driver Count

The selected Injection Type must match:

- Number of cylinders.
- Number of injectors.
- Available injector drivers.
- Injector current.
- Trigger configuration.
- Required engine synchronisation.

The firmware may hide or reject combinations that cannot be supported by the available hardware.

Always use the Injector Driver Outputs indication shown in the software after changing Injection Type.

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Max Injection Time

Max Injection Time limits the maximum injector pulse width that the ECU is allowed to command.

Example:

25.0 ms

This provides protection against excessive fuelling caused by the combined result of:

- Base Tune.

- Compensation.
- Acceleration enrichment.
- Other fuel additions.

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Injector Duty Cycle

The available injection time becomes shorter as RPM increases.

For a four-stroke engine, one complete engine cycle takes two crankshaft revolutions.

The injector should normally not be operated continuously at its absolute maximum available time.

A practical guideline is to keep injector duty below approximately:

85%

under sustained full-load operation.

If Injector Duty approaches its limit:

- Fit larger injectors.
- Increase fuel-system capacity where appropriate.
- Correct fuel pressure if it is below specification.

Do not simply increase Max Injection Time beyond the physical time available.

A practical guideline is to keep Injector Duty below approximately 85% during sustained full-load operation.
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Fuel Cut

Fuel Cut removes injection during suitable overrun or deceleration conditions.

The Fuel Cut function uses:

- Fuel Cut Vacuum.
- Fuel Cut RPM.
- Fuel Cut TPS.

All required conditions must be satisfied before Fuel Cut becomes active.

This allows the ECU to distinguish genuine closed-throttle deceleration from normal low-load driving.

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Fuel Cut Vacuum

Fuel Cut Vacuum sets the manifold-pressure condition required before the injectors may be switched off.

Example:

0.08 Bar

During deceleration with a closed throttle, manifold pressure normally drops significantly.

The Fuel Cut Vacuum value should therefore be selected so the feature operates during genuine overrun without activating during normal cruise.

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Fuel Cut RPM

Fuel Cut RPM sets the minimum engine speed above which Fuel Cut may operate.

Example:

1500 RPM

Below this point, fuel is restored so that the engine can return smoothly toward idle.

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Fuel Cut TPS

Fuel Cut TPS adds a throttle-position condition to the Fuel Cut strategy.

Example:

3%

The throttle must be below this value before Fuel Cut is permitted.

This helps prevent the injectors from being cut while the driver is still requesting engine torque.

Fuel Cut should transition close to the point where driveline torque changes between driving and overrun, without creating a noticeable jerk.
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Fuel Cut Operation

A typical Fuel Cut condition therefore becomes:

Low MAP / high vacuum

AND

RPM above Fuel Cut RPM

AND

TPS below Fuel Cut TPS

→ Injectors OFF

When one of the conditions is no longer satisfied, fuel delivery resumes.

The ECU includes transition behaviour to reduce jerking when entering and leaving Fuel Cut.

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Fuel Cut Setup

Set Fuel Cut so that it activates during genuine deceleration but not during normal light-load driving.

If the vehicle jerks when Fuel Cut activates or releases:

- Adjust Fuel Cut Vacuum.
- Adjust Fuel Cut RPM.
- Check Fuel Cut TPS.
- Verify TPS calibration.
- Verify MAP signal stability.

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TPS Gain

TPS Gain is used with:

Graph MAP & TPS

Tuning Mode.

It determines how strongly TPS contributes to the calculated load signal where the actual MAP signal is weak or unsuitable at low RPM.

This is particularly useful on engines with:

TPS Gain determines how strongly TPS is used to create the projected load value when the actual MAP signal is weak or unstable.

- Large camshafts.
- Individual throttle bodies.
- Poor manifold vacuum at low RPM.

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TPS Gain Operation

A larger TPS Gain causes throttle movement to have a greater influence on the calculated load.

A smaller TPS Gain reduces the TPS contribution.

Adjust TPS Gain so that the calculated load follows engine demand smoothly during:

- Pull-off.
- Low-RPM acceleration.
- Throttle transitions.

Detailed tuning belongs in the Tuning documentation.

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Injection Sync Tooth

Injection Sync Tooth sets the crank-angle relationship used for injection timing.

This allows the start of the injection event to be moved relative to engine position.

Older systems called this:

Injection Teeth

The current documentation term is:

Injection Sync Tooth

Use Injection Sync Tooth in current documentation; older software may still show Injection Teeth.

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Injection Timing Principle

Injection timing influences when fuel is delivered relative to the intake-valve event.

Port-injected engines may respond differently depending on whether fuel is injected:

- Onto a closed intake valve.

- During valve opening.
- Earlier in the intake cycle.

The effect is generally more noticeable at:

- Idle.
- Low load.
- Short injector pulse widths.

At high load, injector duration becomes longer and the exact start position becomes less critical.

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Injection Sync Tooth Adjustment

Injection Sync Tooth should first be set to a sensible position for the trigger pattern and firmware.

Fine optimisation can then be performed after the basic fuel Tune is correct.

A practical optimisation method is to move the Injection Sync Tooth and observe mixture stability at idle or light load, then select the most favourable position.

Do not use Injection Sync Tooth to correct an incorrect fuel Tune.

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Injection Timing and Injector Dead Time

Injection Sync Tooth controls **when** injection starts.

Injector Dead Time controls the electrical delay between commanding the injector and actual fuel delivery.

These are different functions.

Incorrect Injector Dead Time can create significant fuelling errors, especially at short pulse widths.

Injector Dead Time includes the electrical delay while injector-coil current builds and the mechanical injector opening delay.

Refer to:

Spitronics - Injector Dead Time and Short Pulse Characterisation - Engineering Note

for advanced injector modelling.

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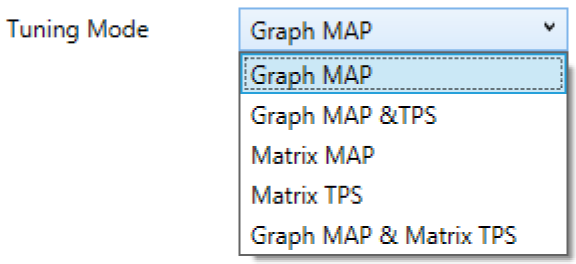
Tuning Mode

Tuning Mode selects the basic fuel tuning method.

This software version may include:

- Graph MAP.
- Graph MAP & TPS.
- Matrix MAP.
- Matrix TPS.
- Graph MAP & Matrix TPS.



Not all modes are available on every firmware.

This setting determines the tuning structure.

The actual tuning procedure belongs under the Tuning, Graph and Matrix documentation.

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Graph MAP

Graph MAP uses manifold pressure as the primary engine-load signal.

It is generally suitable for engines with a stable and useful MAP signal.

Graph MAP is particularly practical for road tuning on engines with a good manifold-pressure signal.

Typical applications include:

- Standard naturally aspirated engines.
- Turbo engines.
- Engines with a common intake plenum.

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Graph MAP & TPS

Graph MAP & TPS supplements the MAP load signal with TPS information.

This can improve low-RPM load calculation where manifold vacuum is poor or unstable.

This method is especially useful where MAP becomes unreliable at low RPM.

Possible applications include:

- Large camshafts.
- Individual throttle bodies.
- Engines with poor idle vacuum.

TPS Gain determines how strongly TPS influences the calculated load.

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Matrix MAP

Matrix MAP uses:

MAP × RPM

as the main fuel tuning table.

This is well suited to dyno tuning where RPM and load can be held accurately.

Matrix MAP uses direct table values for fuel tuning.
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Matrix TPS

Matrix TPS uses:

TPS × RPM

as the main fuel tuning table.

It can be useful on naturally aspirated engines where MAP is a poor load indicator.

Typical examples include:

- Individual throttle bodies.
- Aggressive camshafts.
- Race engines.

Because TPS alone does not compensate for changes in atmospheric pressure, Barometric Pressure compensation is recommended where the vehicle operates over significant altitude changes.

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Graph MAP & Matrix TPS

This hybrid method combines:

- TPS Matrix for the main naturally aspirated fuel Tune.
- MAP Graph for pressure-related or boost fuel correction.

It can be useful on turbocharged engines where TPS provides the more useful base load signal but MAP is still required to add fuel under boost.

This is a useful specialised strategy for turbo applications where TPS is the better primary load signal.
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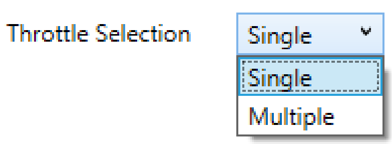
Throttle Selection

Throttle Selection determines how the MAP signal is sampled for the engine intake arrangement.

This software version provides:

- Single.
- Multiple.



This setting is especially important on individual-throttle-body engines where there is no common intake plenum.

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Single Throttle

Select:

Single

for engines with a conventional intake manifold and common plenum.

The MAP Sensor sees the combined manifold pressure from all cylinders.

This provides a relatively smooth and continuous load signal.

Most conventional engines use this setting.

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Multiple Throttles

Select:

Multiple

for suitable individual-throttle-body applications where a common manifold-pressure signal is not available.

The MAP Sensor may then be connected to one cylinder or a selected vacuum source.

Because that cylinder produces a strong vacuum pulse only during a specific part of the engine cycle, the ECU samples MAP at a particular crank position.

This is synchronised MAP sampling, allowing the ECU to use the strongest useful part of the pressure pulse.
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Multiple Throttle Setup

For Multiple Throttle operation:

- Throttles must be correctly balanced.
- MAP sampling position must be correctly synchronised.
- Trigger resolution must be adequate.
- Accelerator enrichment may require additional attention because the MAP response can be slower.

Detailed trigger-specific adjustment should remain application-specific.

Where adjustment is available, the sampling position can be moved to find the strongest and most stable useful vacuum signal.
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Injector Driver Outputs

Injector Driver Outputs indicates which physical ECU drivers have been allocated to the injector channels.

Example:

- Injector Driver Output 1 → HV Negative Output 1.
- Injector Driver Output 2 → HV Negative Output 2.
- Injector Driver Output 3 → HV Negative Output 3.

Injector Driver Outputs

Injector Driver Output 1	HV Negative Output 1
Injector Driver Output 2	HV Negative Output 2
Injector Driver Output 3	HV Negative Output 3
Injector Driver Output 4	HV Negative Output 4
Injector Driver Output 5	HV Negative Output 5
Injector Driver Output 6	HV Negative Output 6

This is an indication block.

The displayed outputs show the injector-driver sequence. The actual cylinder connection must still follow the applicable injector wiring drawing.

It does not by itself define engine firing order.

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Injector Driver Colour

The Driver Output colour follows the Cosmos driver convention.

For example:

Blue → Coil / HV Negative type driver allocation

Red → Coil / MV Positive type driver allocation

The colour assists with hardware identification but does not replace the Product wiring information.

Always verify:

- Driver name.
- Physical pin.
- Driver current capability.
- Injector impedance.
- Number of injectors connected to each driver.

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Injector Electrical Connection

Conventional fuel injectors are normally connected:

Ignition-switched Positive → Injector → ECU Negative Driver

The ECU controls injection by switching the injector toward Ground.

Conventional injector outputs therefore use negative switching with a common ignition-switched positive supply.

Do not exceed the current capability of the allocated driver.

Injector Dead Time

Injector Dead Time is not currently shown on this Fuel & Timing page.

It should therefore remain in the dedicated advanced reference rather than being forced into the normal software-page manual.

Dead Time becomes particularly important at short injector pulse widths because a small timing error becomes a large percentage of the delivered fuel.

The final injector command includes the calculated fuel time plus the injector offset / dead-time allowance.
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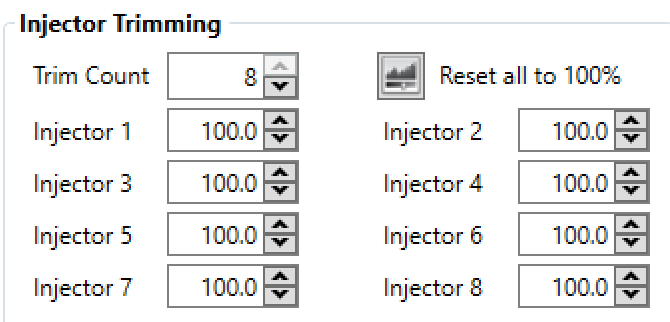
Injector Trimming

Injector Trimming becomes available when **Full Sequential Injection** is selected.

It allows the fuel delivery of each injector/cylinder to be adjusted individually.



The section contains:

- Trim Count.
- Individual Injector Trim values.
- Reset all to 100%.

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Trim Count

Trim Count determines how many individual injector trim channels are active.

For example:
Trim Count = 8
makes Injector 1 through Injector 8 available for adjustment.

The number used should correspond with the injector channels that require individual trimming.
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Injector Trim Value

Each Injector Trim value is a percentage multiplier applied to the calculated **Injector Time**.

The normal value is:
100% = No compensation

Examples:
Injector Time = 10.0 ms
- Trim = 100% → 10.0 ms
- Trim = 105% → 10.5 ms
- Trim = 95% → 9.5 ms

So:
Final Injector Time = Injector Time × Injector Trim %

This allows small cylinder-to-cylinder fuelling differences to be corrected without changing the main Tune.
Each trim is a percentage correction applied to the calculated Injector Time.

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Reset all to 100%

Select **Reset all to 100%** to remove all individual injector compensation.

All active injector trims are returned to:
100%
which means the calculated Injector Time is passed to each injector without individual percentage correction.

This is useful before:
- Initial tuning.
- Injector replacement.
- Flow matching.
- Rechecking cylinder balance.

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When to Use Injector Trimming

First tune the engine as accurately as possible with all trims set to:
100%

Injector Trimming should then be used only for small cylinder-to-cylinder corrections.

Useful measurement methods include:

- Individual-cylinder Lambda.
- Individual EGT.
- Injector flow-test results.
- Controlled cylinder-balance testing.

Do not use Injector Trimming to compensate for a badly tuned main fuel Tune.
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Injector Differences

Individual injectors are not always perfectly matched.

Injector Trimming provides a convenient way to correct these differences where accurate cylinder-specific information is available.

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Initial Fuel Setup Procedure

Before starting a newly installed engine:

1. Select the correct Injection Type.
2. Confirm the Injector Driver Outputs.
3. Verify injector wiring.
4. Confirm injector current is within driver capability.
5. Set a safe Max Injection Time.
6. Configure Fuel Cut settings.
7. Set TPS Gain where Graph MAP & TPS is used.
8. Set an initial Injection Sync Tooth.
9. Select the required Tuning Mode.
10. Select Single or Multiple Throttle operation.
11. Verify all sensors used for fuel calculation.
12. Save the Tune.
13. Only then begin fuel tuning.

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Common Problems

Symptom	Possible Cause	Check
No injection	Injection Type set to Not Used	Check configuration
Wrong injectors operate	Driver wiring incorrect	Check Injector Driver Outputs and firing order
Engine runs rich at high RPM	Max Injection Time or injector sizing incorrect	Check duty cycle
Engine jerks on deceleration	Fuel Cut transition incorrect	Adjust Vacuum, RPM and TPS thresholds
Fuel Cut never activates	One condition not satisfied	Check MAP, RPM and TPS
Fuel Cut activates during cruise	Thresholds too aggressive	Adjust settings
Flat spot at low RPM	TPS Gain too low/high	Check Graph MAP & TPS setup
Mixture changes with injection mode	Injector Dead Time incorrect	Check injector offset
Idle AFR changes with Sync Tooth	Injection phasing effect	Optimise after base Tune
MAP unstable on ITB engine	Wrong Throttle Selection	Check Multiple mode
Wrong output pin used	Firmware reallocated drivers	Use current Driver Output indication
Full Sequential inconsistent	Cam synchronisation problem	Check Home signal

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Setup Check

Before considering Fuel & Timing setup complete, verify:

[ ] Injection Type matches the engine and hardware.

[ ] Injector Driver Outputs match the actual wiring.

[ ] Driver current is suitable for the injectors.

[ ] Max Injection Time is safe.

[ ] Injector Duty remains within a safe range.

[ ] Fuel Cut Vacuum is suitable.

[ ] Fuel Cut RPM is suitable.

[ ] Fuel Cut TPS is suitable.

[ ] Fuel Cut transitions smoothly.

[ ] TPS Gain is configured where required.

[ ] Injection Sync Tooth has a sensible initial setting.

[ ] Tuning Mode suits the engine.

[ ] Throttle Selection matches the intake system.

[ ] Multiple-throttle MAP sampling is correctly configured where used.

[ ] Fuel sensors and inputs are calibrated.

[ ] Critical Settings have been transferred correctly.

[ ] Engine is ready for fuel tuning.

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