Spitronics - Lambda Sensor - Guide

1. Overview

All Spitronics ECUs support AFR (Air-Fuel Ratio) closed-loop control using a lambda sensor.

The tuner can configure lambda control parameters, and the ECU will then adjust the air-fuel ratio in real time based on the sensor input.

This helps maintain the optimum mixture, even when:

- Maps are not perfectly tuned
- Environmental conditions change (e.g. air density, humidity)

👉 The engine must be tuned correctly in open loop before enabling lambda control
👉 This is not a tuning tool but merely setup for active fuel control

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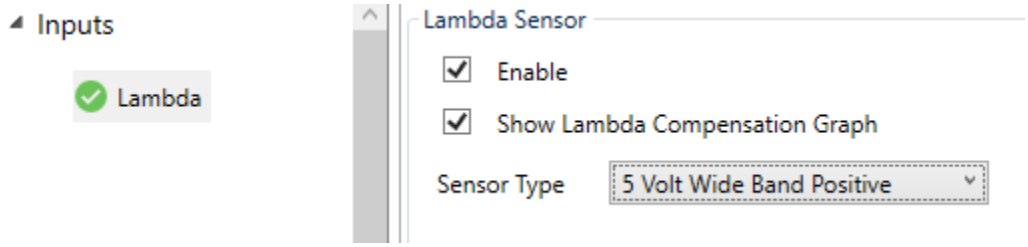
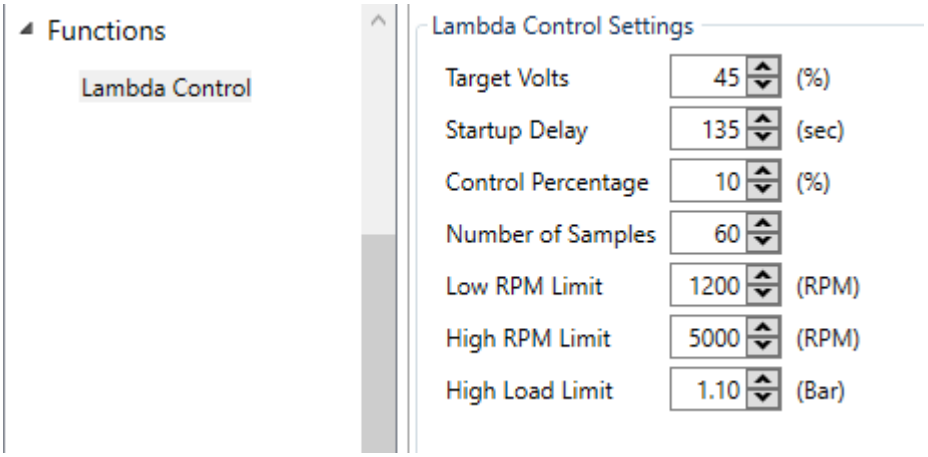
2. Lambda Configuration

To enable this feature:

- Select **Lambda** and **Show Graph**
- **Lambda only selected** → Displays values (no control)
- **Lambda + Show Graph** → Enables AFR control





👉 Use display-only mode during base tuning

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3. Target Volts

Narrowband Sensors

This represents the stoichiometric target.

- 14.7 AFR = 0.45 V (narrowband sensor) = 45%
- Narrowband sensors output: **0.1 V to 0.9 V**

Spitronics uses percentage values for simplicity.

Wideband Sensors
- Output: **0–5 V (linear)**
- Require external controller (not built into ECU)
- ECU uses voltage only for control (does not convert to AFR)
- 0 V = 0% and 5 V = 100%

👉 Voltage-to-AFR varies between wideband systems

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4. Startup Delay

Allows time for the sensor to heat up.
- Typical setting: **30–45 seconds**
- Disabled if engine temperature < 30°C

👉 Measure actual sensor warm-up time with a stopwatch

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5. Control Percentage

Defines injector correction range:
- Range: **0–20%**
- Example:
    - 10% → ECU adjusts fuel ±10%

👉 Always tune the engine properly in open loop first

⚠ Excessive control range can cause incorrect AFR if the sensor fails

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6. Number of Samples

Used to stabilise control.
- Averages sensor readings
- Reduces oscillation due to sensor delay (~0.6 seconds)

👉 Higher values = more stable but slower response

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7. Control Limits

Defines where lambda control is active.
- Active within RPM limits
- Active below vacuum limit

⚠ Do NOT use lambda control:
- At high RPM

- Under high boost

👉 Sensor response is too slow for safe control

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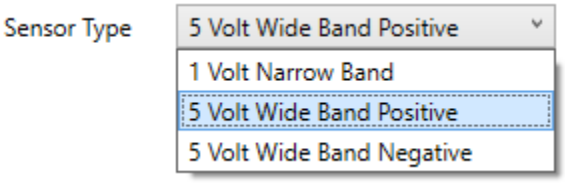
8. Sensor Input Selection



Select between:

- Narrowband (0–1 V, inverted response)
- Wideband (0–5 V, linear response – rising or falling slope)

👉 Rich/lean behaviour differs between sensor types

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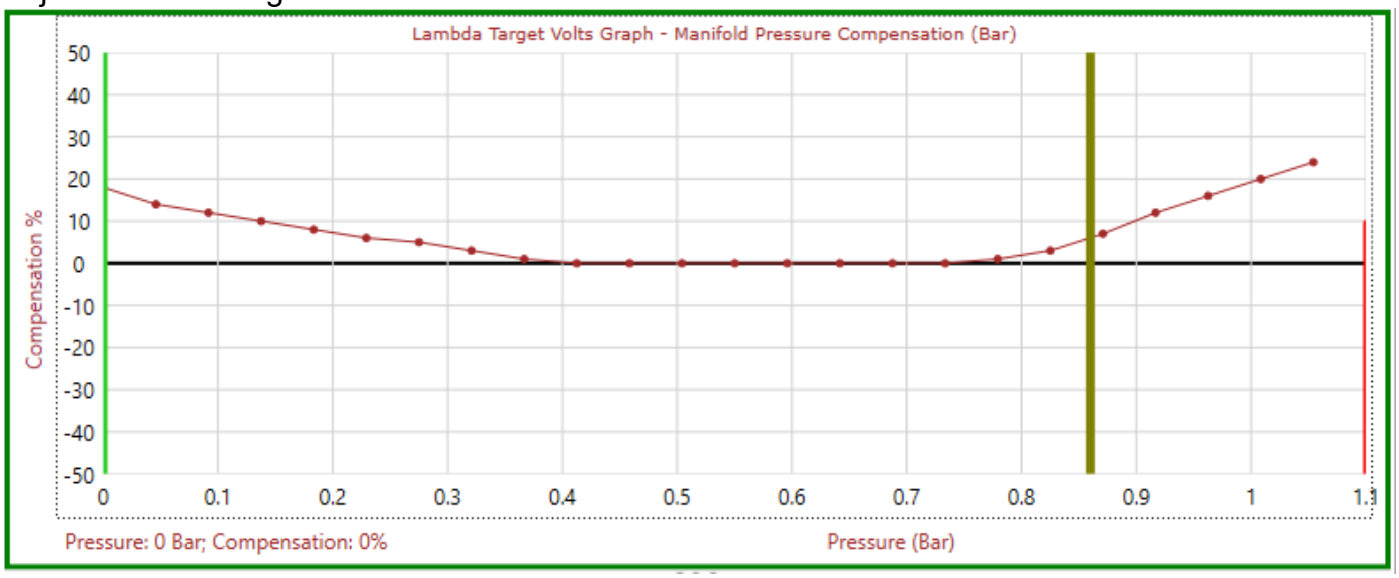
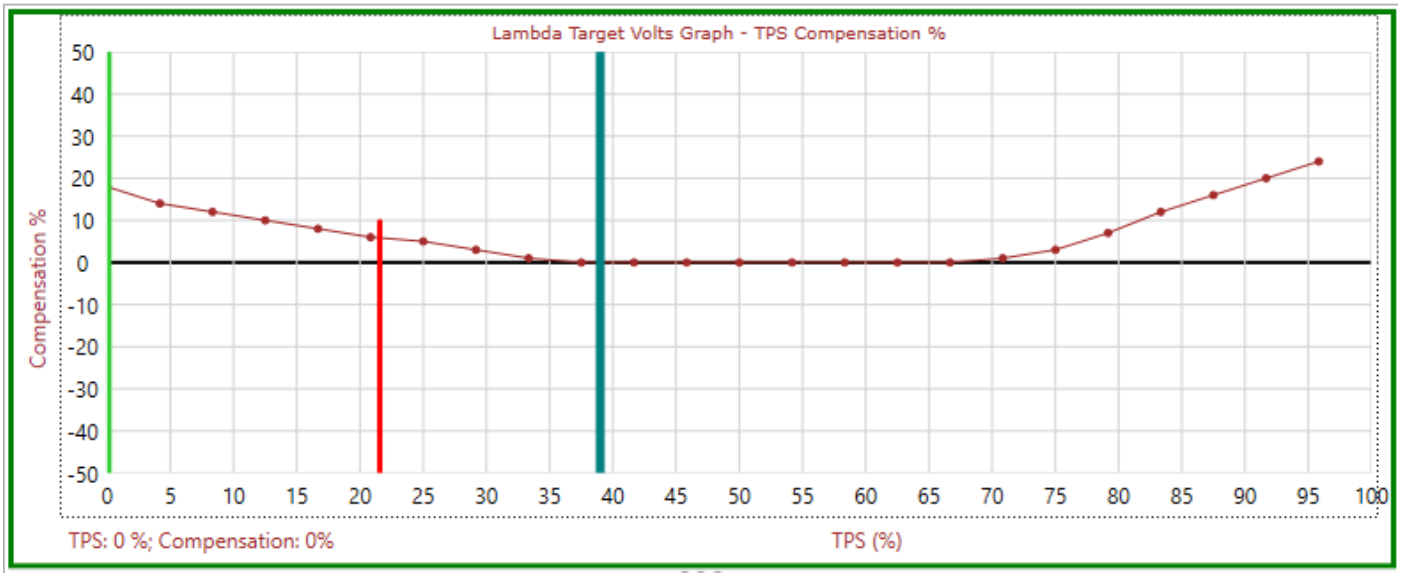
9. Lambda Graphs

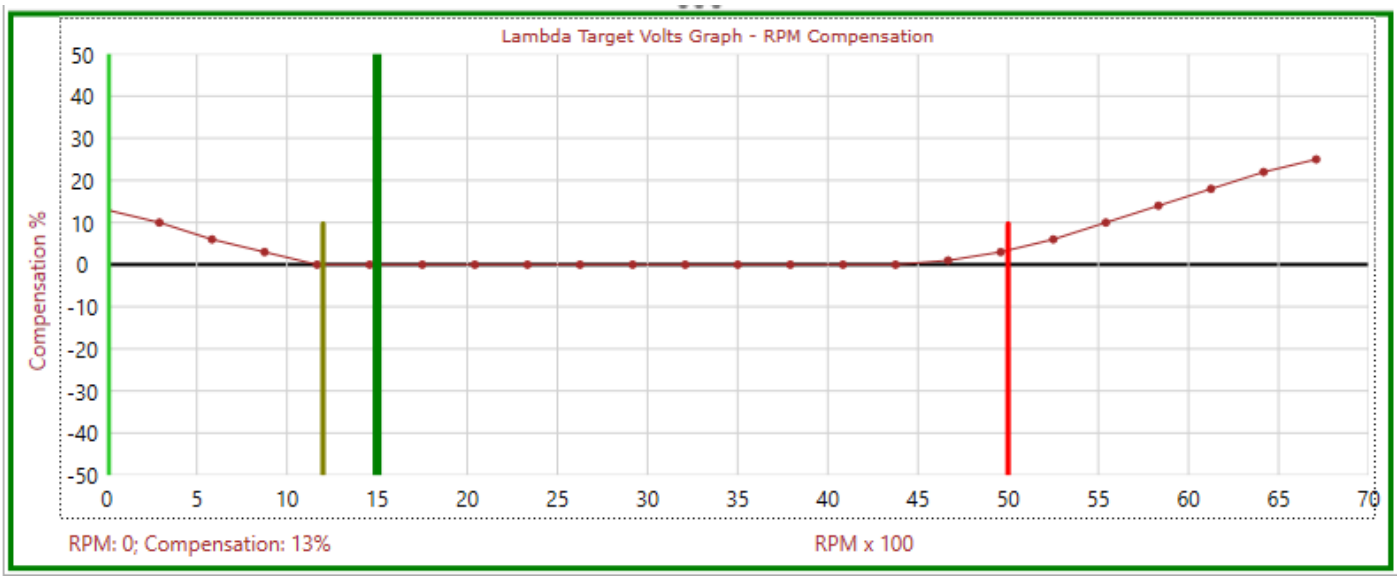
Manifold Pressure Compensation
Adjusts lambda target based on load.



TPS Compensation
Used when no MAP sensor is available.



RPM Compensation
Adjusts lambda target across RPM range.



👉 Graphs are interpolated

👉 Example:

- Target = 45%
- +10% graph = 49.5% new target

⚠ Narrowband sensors respond more aggressively to voltage changes

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10. Tuning Strategy

- Use wideband AFR gauge for accurate tuning
- Set base AFR in open loop
- Use lambda control for fine adjustment

👉 Adjust target values for different load conditions

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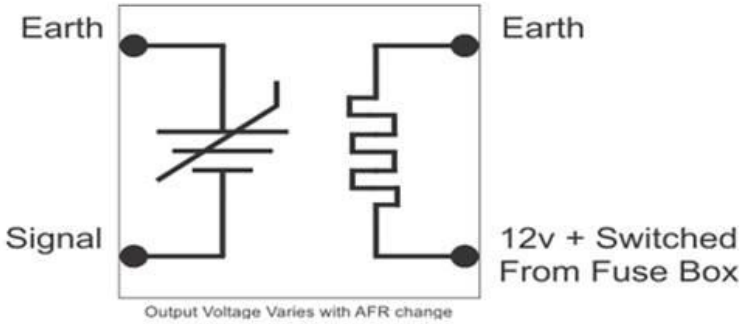
11. Sensor Description



The lambda (oxygen) sensor is used to:

- Monitor AFR
- Optimise fuel economy
- Maintain correct mixture

👉 ECU displays voltage, not AFR values

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12. Sensor Types

- 1–4 wire → Narrowband (0.1–0.9 V)
- 5–6 wire → Wideband (0–5 V, requires controller)

Bosch 4 Wire
White - Heater 12v +
White - Heater Earth
Grey - Sensor earth
Black - Signal to ecu

Denso 1 Wire
Black - Signal to ecu

Bosch 3 Wire
White - Heater 12v +
White - Heater Earth
Black - Signal to ecu

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13. Testing Sensor Pinouts

1. Measure resistance between pins
2. Heater wires:
    - Same colour
    - Resistance: **6–12 Ω**
    - Connect to 12 V and ground (no polarity)
3. Remaining wires:
    - Signal and ground

👉 Sensor output only active when engine is warm

If no signal:

- Swap signal and ground wires and retest

👉 No damage will occur if swapped

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14. Sensor Life Expectancy

- Approx. **500 hours (unleaded fuel)**

- Shortened by:
    - Rich mixtures
    - Fuel additives
    - Sealants / anti-seize

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15. Sensor Position

👉 Ideal location:

- At least **0.5 m from engine**
- After exhaust collector or turbo downpipe

👉 Mount:

- Top or side of pipe

⚠ Never mount at the bottom

💡 Notes

- Always tune open loop first
- Use lambda for fine correction only
- Incorrect setup can cause engine damage
- Wideband systems are recommended for performance tuning