Spitronics ECU - MAP and Barometric Pressure Sensors - Guide

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Overview

MAP and Barometric Pressure sensors measure absolute air pressure.

The ECU can use these pressure signals for:

- Engine load measurement.
- Fuel calculation.
- Ignition timing calculation.
- Boost measurement.
- Atmospheric pressure measurement.

- Barro Compensation.

A MAP sensor measures pressure in the intake manifold.

A Barometric Pressure sensor measures atmospheric pressure independently of the intake manifold.

Both normally operate using the same basic type of pressure sensor and calibration principle.

Most automotive pressure sensors use:

- A regulated sensor supply.
- Ground.
- An analogue signal that changes with pressure.

Correct calibration is important because an incorrect pressure reading can affect engine load, fuel and ignition calculations.

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Absolute Pressure

MAP means:

Manifold Absolute Pressure

Absolute pressure is measured relative to a complete vacuum.

This is different from boost gauges that may display pressure relative to atmospheric pressure.

Typical examples:

- Approximately 1.0 bar absolute = normal atmospheric pressure near sea level.
- Approximately 0.3 bar absolute = strong intake manifold vacuum.
- 2.0 bar absolute = approximately 1.0 bar boost above normal atmospheric pressure.

Atmospheric pressure changes with altitude and weather conditions.

The ECU uses absolute pressure because it provides a consistent reference for engine-load calculations.

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MAP Sensor

The MAP Sensor measures the pressure inside the intake manifold.

This signal represents engine load for MAP-based tuning methods.

Typical conditions are approximately:

Engine Condition	Typical MAP
Engine off near sea level	~100 kPa
Naturally aspirated idle	30-50 kPa
Light cruise	40-70 kPa
Naturally aspirated full throttle	95-100 kPa
Turbocharged operation	Above 100 kPa

These values are general references only. Engine design, camshaft, altitude and operating conditions can change the actual readings.

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Barometric Pressure Sensor

The Barometric Pressure sensor measures atmospheric pressure rather than intake manifold pressure.

The ECU can use this signal to compensate for changes in atmospheric conditions.

Atmospheric pressure decreases as altitude increases.

This affects:

- Available air density.
- Engine load.
- Fuel requirement.
- Naturally aspirated engine performance.
- Turbocharger operating conditions.

Where enabled, the ECU can use the Barometric Pressure signal for altitude compensation.

The Barometric Pressure sensor and MAP sensor are calibrated separately where separate sensors are used.

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Software Setup

Select the applicable MAP or Barometric Pressure Sensor under the ECU Inputs section.

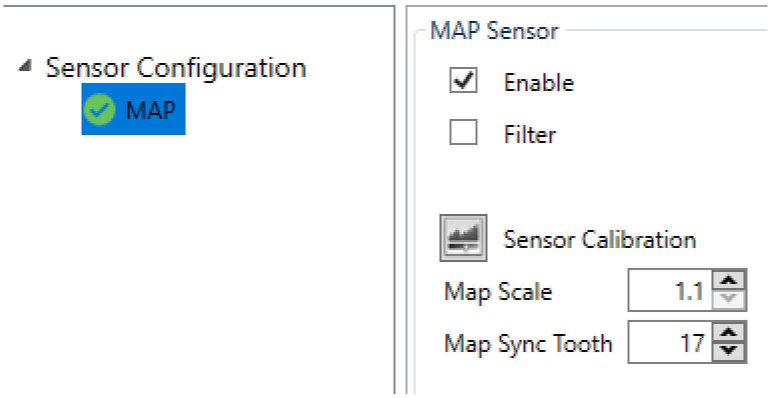
The available settings depend on the firmware generation and selected tuning method.

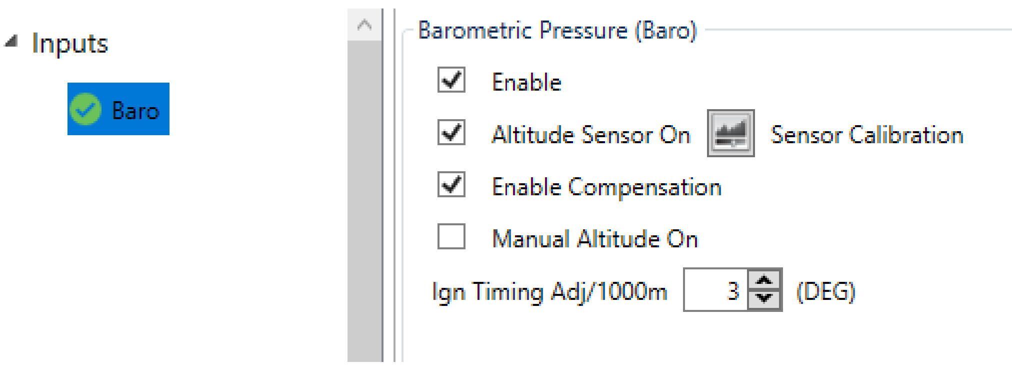
Typical MAP settings may include:

- Enable.
- Filter.
- Sensor Calibration.
- Pressure Scale.
- Other application-specific settings.

Typical Barometric Pressure settings may include:

- Enable.
- Sensor Calibration.
- Enable Compensation.
- Manual Compensation options.
- Ignition compensation where applicable.





Only settings available for the connected Device and firmware will be displayed.

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Pressure Scale

The Pressure Scale determines the pressure range used by the ECU tuning system.

The selected range should be large enough to cover the maximum expected manifold pressure while still providing useful tuning resolution.

This setting defines the pressure range across the applicable fuel and ignition tuning data.

Naturally Aspirated Engines

For a naturally aspirated engine, the pressure range only needs to cover manifold vacuum and atmospheric pressure.

A typical selection is approximately:

1.1 bar absolute

This allows good resolution through the normal naturally aspirated operating range.

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Turbocharged Engines

For a turbocharged engine, the selected pressure range must cover the maximum expected absolute manifold pressure.

Example:

Maximum boost pressure = 0.8 bar above atmosphere.

Approximate absolute pressure requirement:

1.0 bar atmospheric pressure
+ 0.8 bar boost
= 1.8 bar absolute

A pressure scale of approximately **1.9 bar or higher** would therefore provide suitable operating margin.

Allow additional margin where boost spikes or boost creep are possible.

Selecting the Range

Use the lowest pressure range that safely covers the required engine operating pressure.

An unnecessarily large pressure range reduces the amount of available measurement and tuning resolution used in the normal operating area.

This principle remains the same even where analogue input resolution differs between Devices and firmware generations.

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Sensor Calibration

Pressure sensors must be calibrated so that the ECU converts the sensor signal into the correct pressure value.

The calibration method depends on the firmware generation.

Some software generations use:

- Range Gain.

- Zero Offset.

Other firmware generations may present the calibration differently.

The important principle is always the same:

1. Establish the correct atmospheric-pressure reading.
2. Verify the sensor reading at another known pressure.
3. Adjust the calibration until the measured pressure follows the actual pressure correctly.

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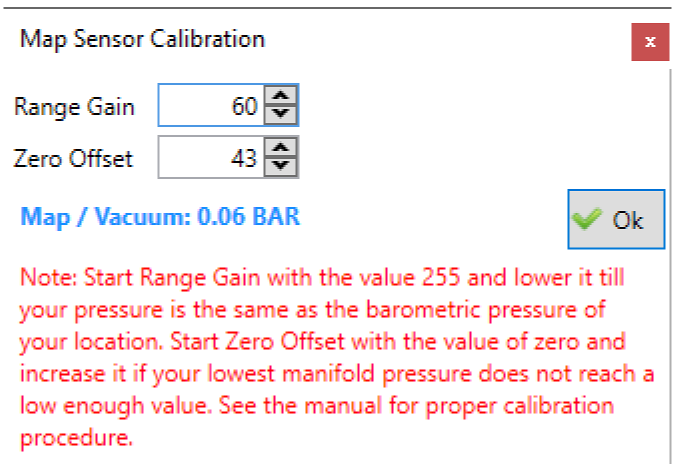
Range Gain and Zero Offset

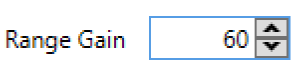
The following section applies to firmware generations that use the **Range Gain** and **Zero Offset** calibration method.



Range Gain

Range Gain adjusts the span or scaling of the sensor signal.

It determines how the sensor's electrical signal is converted into pressure through the usable range.



Zero Offset

Zero Offset shifts the pressure calibration.

It is used to correct the lower end or zero reference of the pressure range.

The two adjustments interact, so calibration should be checked again after either value is changed.

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Quick Calibration

For firmware using the 0-255 Range Gain calibration method, start with:

Range Gain = 255

Zero Offset = 0

Then:

1. Adjust Range Gain until the sensor reading agrees with the actual local atmospheric pressure.
2. Apply a known vacuum.
3. Adjust Zero Offset to obtain the correct low-pressure reading.
4. Return the sensor to atmospheric pressure.
5. Recheck Range Gain.
6. Repeat if necessary.

These numerical starting values apply only to firmware using this 0-255 calibration system.

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Recommended Calibration Method

A simple syringe can be used to produce a repeatable vacuum for sensor calibration.

Required Equipment

- Approximately 50 cc syringe.
- Short suitable vacuum hose.
- Sensor pressure specifications where available.
- Reliable local atmospheric pressure reference.

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Set Atmospheric Pressure

With the sensor exposed to atmospheric pressure:

1. Switch the ECU on.
2. Do not start the engine.
3. Observe the pressure reading.
4. Compare it with the actual local atmospheric pressure.
5. Adjust the applicable sensor scaling until the values agree.

For Range Gain / Zero Offset firmware, adjust Range Gain first.

Atmospheric Pressure Reference

Do not automatically assume atmospheric pressure is exactly 1.0 bar.

Atmospheric pressure depends on:

- Altitude.
- Weather.
- Local conditions.

A known Barometric Pressure sensor, weather reference or suitable pressure instrument can be used as the reference.

Apply Vacuum

Remove the sensor from the manifold if necessary.

1. Push the syringe fully closed.
2. Connect the syringe to the sensor with the vacuum hose.
3. Pull the syringe open to create vacuum.
4. Observe the pressure reading.

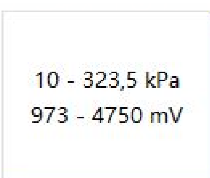
The syringe provides a convenient way to test the lower end of the sensor range without running the engine.

Adjust the Low-Pressure Reading

Where the actual sensor specification is known, the preferred method is to calibrate against the specified sensor range.

Example:

Sensor specification:



10-323.5 kPa

The lower calibration point would then be approximately:

0.10 bar absolute

Where reliable sensor specifications are available, calibrating to the actual sensor range provides the clearer physical reference.

Recheck Atmospheric Pressure

After adjusting the lower end of the calibration:

1. Disconnect the syringe.

2. Allow the sensor to return to atmospheric pressure.
3. Check the pressure reading again.
4. Correct the scaling if required.
5. Repeat the low-pressure test.

Continue until both ends of the calibration are acceptable.

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Engine Calibration Method

The sensor can also be checked while installed on the engine.

This is less controlled because the MAP signal is also being used by the ECU for engine calculations.

A practical check is:

1. With the engine off, verify atmospheric pressure.
2. Start the engine.
3. Allow it to idle normally.
4. Briefly increase RPM.
5. Release the throttle.
6. Observe the lowest MAP pressure during deceleration.

A naturally aspirated engine should normally produce a significant pressure drop when the throttle closes.

Engine design and camshaft specification must be considered before treating any particular vacuum value as a fault.

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MAP Filter

The MAP Filter can be used to smooth an unstable manifold-pressure signal.

Increasing filtering may help with:

- Intake pulsation.
- Large camshaft overlap.
- Individual throttle bodies.
- Unstable vacuum signals.

Filtering also slows signal response slightly.

Do not use excessive filtering to hide a poor mechanical pressure connection.

First check:

- Vacuum hose.

- Sensor location.
- Intake pulsation.
- Leaks.
- Mechanical installation.

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Engines with Poor MAP Signal

Some engines do not produce a stable MAP signal at low RPM.

Typical examples include engines with:

- Large camshaft overlap.
- Individual throttle bodies.
- Very low idle vacuum.

In these applications, MAP may not be the ideal sole load signal.

Depending on the firmware and tuning strategy, the ECU may use combinations of:

- MAP.
- TPS.
- RPM.

to determine engine load.

The appropriate load-calculation method is covered in the Fuel Tuning documentation.

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Sensor Selection

Use a pressure sensor with a range suitable for the application.

Naturally Aspirated

Use a sensor with a relatively low maximum pressure range where practical.

This provides better usable resolution through the normal manifold-pressure range.

Turbocharged

The sensor must safely measure the maximum expected absolute pressure.

Allow for:

- Normal boost.
- Boost spikes.
- Boost creep.

- Future boost increases where appropriate.

Do not select an excessively large pressure range without a reason.

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Sensor Installation

Install the MAP sensor so that it receives a clean and reliable manifold-pressure signal.

Recommended practice includes:

- Mount the sensor above the manifold pressure connection where practical.
- Position the pressure port to reduce moisture collection.
- Route the pressure hose so condensation can drain away from the sensor where possible.
- Keep the pressure hose reasonably short.
- Avoid leaks or soft hose that may collapse under vacuum.
- Avoid pressure connections that are heavily disturbed by another system.

Product-specific wiring, connector locations and hardware arrangements are covered under the applicable Product information.

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Testing the Sensor

A basic MAP sensor test should verify three things:

Sensor Supply

Confirm the sensor receives the correct regulated supply specified for that sensor.

Many automotive MAP sensors use approximately 5 V.

Ground

Confirm a reliable sensor Ground reference at the ECU electronic ground point.

Signal

The signal should change smoothly as pressure changes.

A typical analogue pressure sensor signal should:

- Change progressively with pressure.
- Not jump randomly.
- Not remain fixed.
- Stay within the expected electrical range.

Exact voltages depend on the sensor specification.

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Troubleshooting

Symptom	Possible Cause	Action
Incorrect MAP reading	Sensor not calibrated	Recalibrate sensor
Reading correct at atmosphere but wrong under vacuum	Calibration span or offset incorrect	Check both calibration points
Unstable MAP reading	Unstable pressure signal	Check hose and sensor installation
Unstable MAP reading	Intake pulsation	Use appropriate filtering
MAP reads too high or too low throughout range	Incorrect calibration	Recheck sensor calibration
Reading does not change	Wiring, sensor or pressure connection fault	Test supply, Ground, signal and hose
Reading changes suddenly or wraps around	Calibration outside usable range	Return calibration to a valid range
Turbo pressure reaches maximum reading	Sensor range too small	Fit suitable higher-range sensor

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Tested Sensor Calibration Values

The following values apply to firmware using the 0-255 Range Gain and Zero Offset calibration system.

They are provided as tested reference values for those systems.

Do not apply them directly to firmware using a different A/D resolution or calibration scale.

Spitronics and ecuDIY 1.15 Bar MAP Sensor

Sensor specification:

- 15-115 kPa.
- Approximately 180-4650 mV.

Tested calibration:

Pressure Scale	Range Gain
1.1 bar	199

Zero Offset:

0

Toyota-Style 3.23 Bar Replica Sensor

Sensor specification:

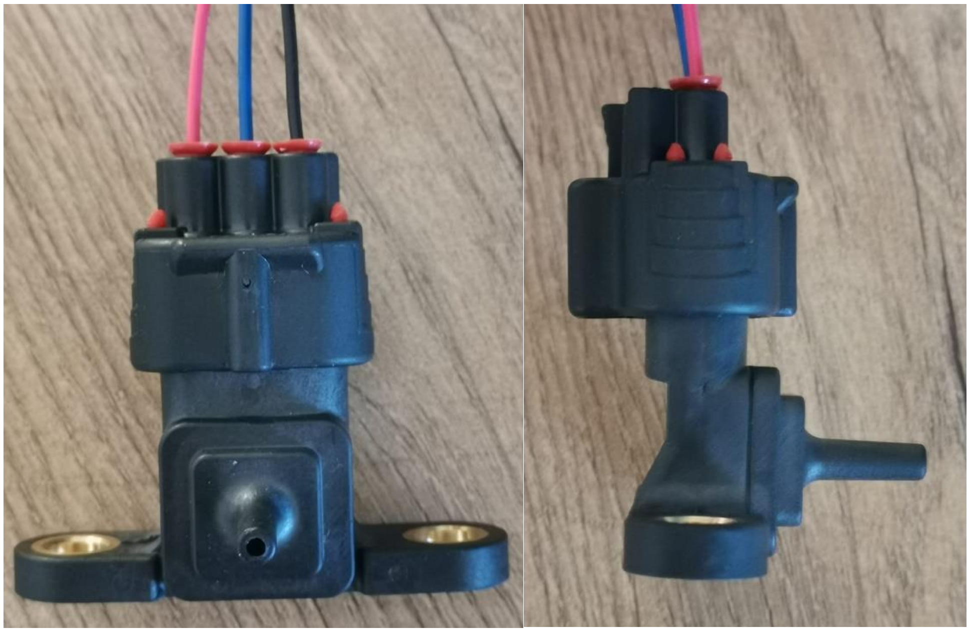
- 10-323.5 kPa.
- Approximately 973-4750 mV.

Tested calibration for approximately 10 kPa minimum:

Zero Offset = 43

Pressure Scale	Range Gain
1.1 bar	60
1.5 bar	82
2.0 bar	109
2.5 bar	136
3.0 bar	162
3.3 bar	174

These are tested reference values for this calibration system.



<u>**Toyota-Style 1.38 Bar Replica Sensor**</u>

Sensor specification:

- 10-138 kPa.
- Approximately 894-4637 mV.

Tested calibration:

Zero Offset = 30

Pressure Scale	Range Gain
1.1 bar	145
1.4 bar	183
1.5 bar	197

These values apply to firmware using the same Range Gain scaling.

<u>**GM-Style 3 Bar Replica Sensor**</u>

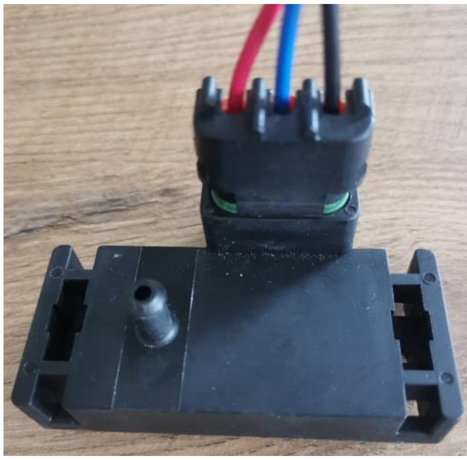
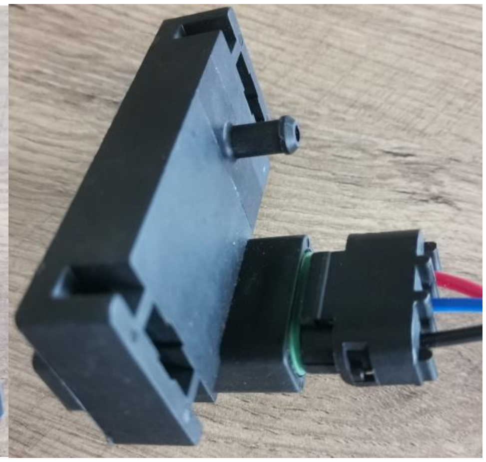
Tested calibration for the 0-255 Range Gain system:

Zero Offset = 13

Pressure Scale	Range Gain
1.1 bar	61
1.5 bar	92
2.0 bar	123
2.5 bar	154

Pressure Scale Range	Gain
3.0 bar	184

These are tested reference values for this calibration system.



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Setup Check

Before tuning with MAP or Barometric Pressure information, verify:

[ ] Correct sensor is selected.

[ ] Sensor pressure range is suitable for the application.

[ ] Sensor supply and Ground are correct.

[ ] Pressure signal changes smoothly.

[ ] Engine-off MAP agrees with atmospheric pressure.

[ ] Barometric Pressure sensor agrees with actual atmospheric pressure.

[ ] Low-pressure calibration is reasonable.

[ ] Pressure Scale covers the complete operating range.

[ ] MAP Filter is not excessive.

[ ] Turbocharged applications have sufficient pressure range.

[ ] Sensor calibration has been saved.

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