Spitronics ECU - Hall vs Variable Reluctance (VR) Sensors - Guide

1. Overview

One of the most common questions when converting an older engine to electronic engine management is whether to use a **Hall sensor** or a **Variable Reluctance (VR) sensor** for crankshaft and camshaft position sensing.

Both technologies are capable of providing accurate engine position information and have been used successfully by vehicle manufacturers for many years. However, each has its own advantages and limitations.

For new installations where the trigger system can be designed from scratch, Spitronics generally recommends **Hall sensors**. Their clean digital signal, excellent noise immunity and tolerance to manufacturing variations make them easier to install and more reliable in most aftermarket applications.

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2. Hall Sensors

A Hall sensor is an active electronic device that requires a power supply. It produces a clean digital ON/OFF output regardless of engine speed.

Advantages

- Excellent immunity to electrical interference.
- Reliable signal during engine cranking.
- Produces a clean digital output independent of engine speed.
- Less sensitive to variations in trigger wheel air gap.
- More forgiving of manufacturing tolerances.
- Easier to diagnose using an oscilloscope.
- Ideal for aftermarket trigger wheels and custom engine conversions.

These are some of the reasons why most modern OEM engines use Hall sensors for camshaft position sensing.

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3. Variable Reluctance (VR) Sensors

A Variable Reluctance sensor is a passive magnetic sensor that generates an AC voltage as the teeth of the trigger wheel pass the sensor.

Unlike a Hall sensor, the signal amplitude depends on engine speed.

Advantages

- Very simple and robust construction.
- No external power supply required.
- Excellent high-temperature capability.
- Long service life.
- Proven technology used successfully by OEM manufacturers for decades.

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4. Comparison

Feature	Hall Sensor	VR Sensor
Signal Type	Digital	Analogue AC
External Power	Required	Not Required
Cranking Performance	Excellent	Good (lower signal voltage)
Noise Immunity	Excellent	Good if correctly installed
Air Gap Tolerance	Excellent	More Critical
Trigger Wheel Accuracy	More Forgiving	Requires better machining
Oscilloscope Diagnosis	Easy	More Complex
Complex Trigger Patterns	Excellent	Good, depending on decoder design
Typical OEM Cam Sensor	Very Common	Less Common
Typical OEM Crank Sensor	Common	Very Common

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5. Signal Characteristics

The biggest difference between the two technologies is the type of signal produced.

A VR sensor is an **analogue** sensor.

Its output voltage increases as engine speed increases.

At cranking speed the signal is relatively small and becomes larger as RPM increases. This means the ECU requires a good signal conditioning circuit to accurately detect the trigger points.

A Hall sensor is a **digital** sensor.

It switches cleanly between HIGH and LOW regardless of engine speed, provided the sensor receives the correct supply voltage and the trigger wheel passes within the specified air gap.

Because the ECU only detects the change between HIGH and LOW, Hall sensors are generally less susceptible to electrical interference.

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6. Trigger Wheel Design

Both Hall and VR sensors can successfully read common trigger wheels such as:

- Single Tooth
- Multi-tooth
- Missing Tooth (36-1, 60-2, etc.)
- Distributor triggers
- Cam synchronisation wheels

However, Hall sensors provide greater flexibility when using more advanced trigger wheel designs.

Because the signal remains digital, the ECU can more accurately determine the timing of individual edges. This makes Hall sensors better suited to trigger wheels using:

- Different tooth widths.
- Variable gap lengths.
- Special synchronisation teeth.

- Custom trigger patterns.

A conventional VR interface is generally optimised to detect the passing of a tooth rather than analyse the width of the tooth or pulse. Although advanced VR decoding techniques are possible, Hall sensors naturally preserve this timing information, making implementation simpler and more robust.

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7. Electrical Interference

Electrical interference is one of the most common causes of trigger problems.

VR sensors are particularly susceptible during engine cranking because the signal voltage is relatively low.

As engine speed increases, the signal becomes much stronger and the effect of electrical noise is greatly reduced.

Hall sensors produce a constant digital signal independent of engine speed and are therefore generally more tolerant of electrical interference.

Correct wiring practices remain important for both sensor types.

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8. Installation Recommendations

For the best results:

- Use screened cable where recommended.
- Keep trigger wiring away from ignition coils, injectors and alternator wiring.
- Maintain the correct sensor air gap.
- Ensure the trigger wheel runs true without excessive run-out.
- Use good engine grounding.

Following these basic installation practices is often more important than the choice of sensor.

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9. Which Sensor Should I Choose?

If the engine already has a well-designed factory VR trigger system, there is usually little benefit in changing it. OEM manufacturers have successfully used VR sensors for many years with excellent reliability.

However, when designing a new trigger system or converting an older engine to electronic fuel injection, Spitronics generally recommends using **12 V Hall sensors**. While **5 V Hall sensors** are compatible, they require minor harness modifications because the trigger inputs are optimised for a **12 V digital pulse**. Using a 12 V Hall sensor simplifies the installation and avoids the need for additional interface components.

The cleaner digital signal provides:

- Improved starting performance.
- Better resistance to electrical interference.
- Greater tolerance to trigger wheel manufacturing variations.
- Simpler installation.

- Easier fault finding.

For these reasons, Hall sensors are normally the preferred choice for custom engine management installations.

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10. Conclusion

Both Hall and Variable Reluctance sensors are capable of providing accurate crankshaft and camshaft position information when correctly installed.

VR sensors remain an excellent choice where an original factory trigger system already exists.

For new installations and custom engine conversions, Hall sensors generally offer the most robust, installer-friendly and reliable solution due to their clean digital signal, excellent noise immunity and flexibility with modern trigger wheel designs.

Spitronics Recommendation

Use the original sensor technology wherever possible. If a factory trigger system is already proven and reliable, there is usually no advantage in replacing it. However, for new trigger wheel designs and custom engine conversions, Hall sensors are generally the preferred choice due to their simpler installation, better noise immunity and greater flexibility.