RPM and Speed Sensors

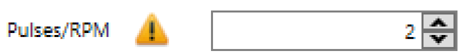
RPM and Speed sensors will indicate to the TCU Conditions of engine and road speed in order to determine the best conditions to shift gears. These sensor are very important and must be calibrated and stable. If it randomly fluctuates with interference the transmission will shift erratic.

These signals is a critical setting which means it is saved separate from the 4 maps. It can only be calibrated in MAP 1 and does not change when other maps are loaded in the TCU. The Clone function will alter this calibration to the Clone map.

Settings

RPM Sensor

This input is forced on and essential to the operation of the TCU. It can be any pulse configuration even uneven pulses. As long as you enter the number of pulses per one revolution of the engine. In some conversions you may add a sensor that scans a bolt on the crank or camshaft as the engine may be of a carburetor type. It is not possible to control the engine without this signal. This signal is normally connected on the ECU and may be tapped into. See the relevant product drawings.



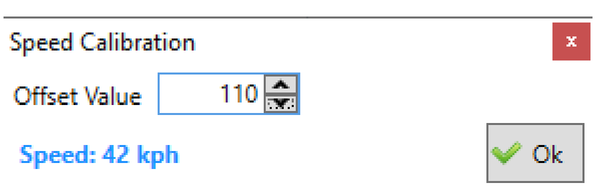
With this setting you can adjust how many pulses are in one engine revolution. If you tap into a 60-2 gear then you will enter 58 pulses per revolution as 2 teeth are missing.

Speed

This sensor indicates road speed to the TCU. It is also used for features such as kick down, gear down and smooth shifting. It is not possible to control the engine without this sensor. This signal is normally connected at the back of the transmission to measure prop shaft rotation. This sensor is set up in 2 parts.

First input the number of pulses per one prop shaft rotation in the block.

Click on the calibrate button left of the Speed check box.



Change the offset value till the speed value reads the same as the car, speedometer or as a GPS reading. Click the *OK* button. Then click on the *Save to TCU*  button to make the changes permanent. If you are not sure what the pulses value is then start with a 110 value here and adjust the speed sensor pulses/RPM till the speed is as close to real speed. Then do offset value again. If the offset value is very low or very high, then speed calculation becomes erratic.

Testing Magnetic Sensors

Work through each point below to find your problem.

1. First ensure that the setup in Hyperspace is done according to the startup procedure. This means you will only have a P1 and P4 connector on the Mercury2. The other connectors must be open, except for the Comms cable. Open the software and connect to the Mercury2.

2. Ensure that the correct firmware is loaded into the ECU or TCU for the specific trigger pattern of your engine. You can click on information button 

to verify.

3. Make sure the **Jumper settings** are set for magnetic sensors. On Mercury2 the 2-pin jumper must be open. You may now crank the engine without the other connectors.

4. Ensure that battery volts on the Real-time Volt Bar 

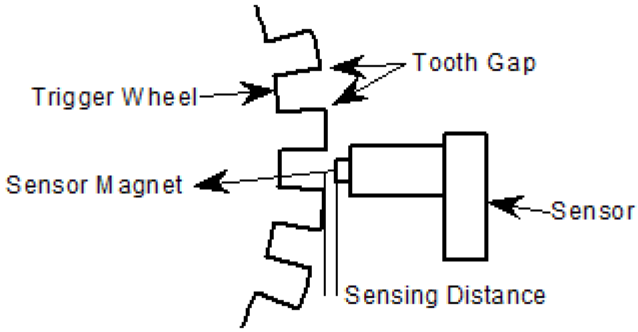
does not fall too low. A healthy battery will crank at 11 volts and higher. Under 9 volts, the sensor signal becomes weak and falls below the voltage threshold of Mercury2. Note: If it falls below 10 see chapter about ***'Power Connection'***.

5. Look if any error codes are displayed at the bottom. If there are errors remedy the fault. See **Error codes**.

6. Look at the RPM signal in the Real-time Display while cranking. It should show 200 to 300 rpm consistently. If it shows erratic readings and runs wild do not proceed to start! It must be constant. It means the edge setting is wrong or incorrect firmware or there is interference on the trigger signal and the ECU sees them as trigger pulses.

7. If it shows no error and no RPM it means that the ECU does not pick up the signal from the sensor. Proceed to testing the sensor itself.

8. Make sure you use the correct sensor size with your crank trigger wheel size. If the magnet of the sensor is larger than the gap in the teeth, then your signal will be very week. Rather use a gear with less teeth for the diameter or a sensor with a smaller sensing diameter. If you can't see the magnet protruding from the sensor, put a bit of iron filings on the tip. The magnetic field will show the diameter of the internal magnet immediately. In this case you may enlarge the sensing distance it the signal is strong enough. See the illustration below.

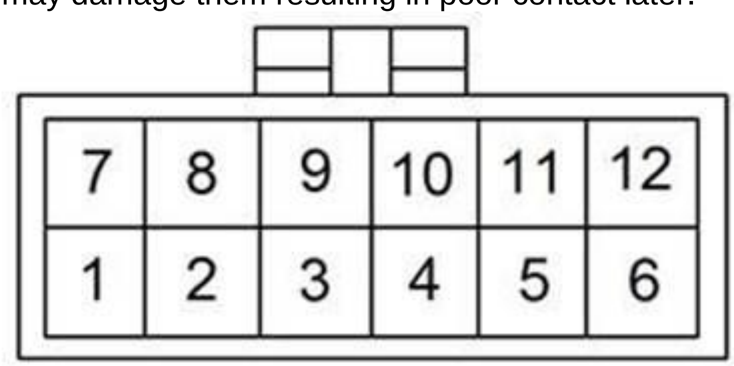


Testing the sensor.

1. Ensure that the thick black earth wire from the Mercury2 is earthed properly. Also make sure that the thin black wires coming from the harnesses are also tied to this point. We call this junction **Test Point A**

2. Disconnect P1 from the Mercury2. Now use a multi meter and set it on 2000-ohm scale.

3. Measure from Test Point A to pin 12 on the P1 harness connecter. You should get a resistance of 300 to 2000 ohm depending on the sensor. If you swop the meter wires you must read the same ohm measurement. If you don't get a reading it means your sensor is not connected correctly. Check your wiring connections. **NB**! Do not press too hard on the female pins as you may damage them resulting in poor contact later.



Harness Pin view

4. If you do get a reading put the meter on AC volts and measure on the same points. Use the lowest scale or 20 volts. Now crank the engine. The sensor will generate AC volts. Mercury2 requires a voltage above 0.5-volt peak to peak and above. If this voltage is lower, it means the signal is too weak and the ECU will not sense it properly. This could be due to a dirty sensor or the gap is too wide between the sensor and the gear. The gap is normally below 1 mm. It could also be that the sensor magnet inside the sensor is wider than the width in the teeth if it's a custom installation.

Errors and misfire during running or starting.

If the startup procedure tested correctly but you get errors during starting the engine, read through the following points.

1. The ignitions' coils may generate interference spikes on the crank sensor wires. Ensure that the sensor wire is screened as close to the sensor as possible. If you connect to a distant connector there is usually a screen pin that has to be connected to the ECU harness screen.

2. The coils may spike the Mercury2 and it may want to restart. This may be due to incorrect supply currents or relay wiring. An indication of this error is that the software will lose connection momentarily to the Mercury2. A restart error will come up.

3. Errors that comes at higher RPM's may be due to a trigger wheel that is not balanced or is buckled. Sensing distance may be too large. It could also be due to a small gear teeth pitch, or a sensor with a large sensing magnet. The 2-pin jumper is on and it should be off.

4. Ensure that the test signal next to the crank sensor in the ECU software is off.

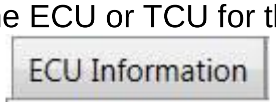
5. The RPM on the sensor signal could fade, this could be due to the gap between it and the trigger wheel been too close or too far apart.

6. Incorrect sparkplugs may generate feedback which leave spikes in the trigger signal. Normally resistor plugs are used for COP engines and non-resistor plugs for HT leads. Note: Ensure that you use carbon HT leads and not copper leads. Cracked lead also play havoc. A trick is to look at them in the dark while it idles. It will show flashes in the dark.

Testing Hall or Optic Sensors

Work through each point below to find your problem.

1. First ensure that the setup in Hyperspace is done according to the startup procedure. This means you will only have a P1 and P4connector on the Mercury2. The other connectors must be open, except for the Comms cable. Open the software and connect to the Mercury2.

2. Ensure that the correct firmware is loaded into the ECU or TCU for the specific trigger pattern of your engine. You can click on information button 

to verify.

3. Make sure the **Jumper settings** are set for Hall sensors. On Mercury2 the 2-pin jumper must be closed. You may now crank the engine without the other connectors.

4. Ensure that battery volts on the Real-time Volt Bar 

does not fall too low. A healthy battery will crank at 11 volts and higher. Under 9 volts, the sensor signal becomes weak and falls below the voltage threshold of Mercury2. Note: If it falls below 10 see chapter about ***'Power Connection'***.

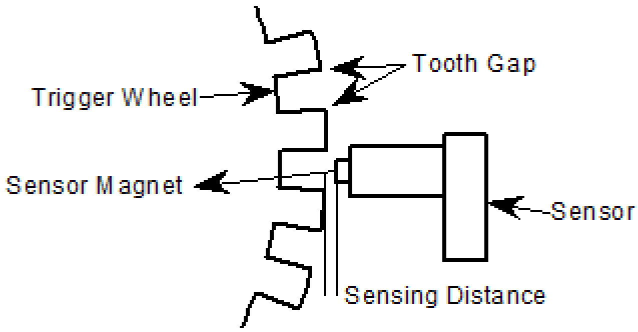
5. Look if any error codes are displayed at the bottom. If there are errors remedy the fault. See **Error codes**.

6. Look at the RPM signal in the Real-time Display while cranking. It should show 200 to 300 rpm consistently. If it shows erratic readings and runs wild do not proceed to start! It must be constant.

It means the edge setting is wrong or incorrect firmware or there is interference on the trigger signal and the Mercury2 sees them as trigger pulses.

7. If it shows no error and no RPM it means that the Mercury2 does not pick up the signal from the crank sensor. Proceed to testing the crank sensor itself.

8. Make sure you use the correct sensor size with your crank trigger wheel size. If the magnet of the sensor is larger than the gap in the teeth, then your signal will be very week. Rather use a gear with less teeth for the diameter or a sensor with a smaller sensing diameter. If you can't see the magnet protruding from the sensor, put a bit of iron filings on the tip. The magnetic field will show the diameter of the internal magnet immediately. In this case you may enlarge the sensing distance it the signal is strong enough. See the illustration below.



Testing the sensor.

1. The hall or optic sensor requires power to operate. So it cannot be dry tested like a magnetic sensor.
2. First measure continuity from the ECU ground to the sensor ground. There should be 0 ohms as the earth comes from the thin black wire coming from the harness to the thick black earth of the Mercury2.
3. Measure continuity from the sensor power to the Mercury2 ignition power that comes from the key. There should be 0 ohms.
4. Now measure continuity from the sensor signal to the ECU input for that sensor, see the drawing. You can disconnect P1 and measure on the pin.
5. The fastest way to test it is while it is powered in the circuit. While P1 is connected switch the ignition on.
6. Measure at the power at the sensor between negative and positive. You should measure around 12V DC.
7. Now unbolt the sensor from the engine. Measure DC volts between sensor negative and signal. It should be 12 volts and if you bring a metal object to the sensor it should go to 0 volt. The logic may be reversed for some sensors. As long as you see the step change. On optic or some hall sensors you may need to move a plate between the sensor and transmitter part. If the voltage doesn't go to less than 1 volt, then it means the ECU will not detect the change.
8. If you don't measure the 12 volt on any condition on the sensor signal, it may be the pull-up jumper is not in closed position. If it is then disconnecting the sensor signal wire and measure at the ECU side for the 12 volt. If you measure 12 volts, it means the sensor output is damaged and short the signal wire to ground. If you don't measure 12 volts then the ECU does not provide power through the pull-up resistor.
9. Now bolt the sensor in place and measure on the signal negative and positive with AC volts. Crank the engine and you should see 12 volts AC.

Errors and misfire during running or starting.

If the startup procedure tested correctly but you get errors during starting the engine, read through the following points.

1. The ignitions' coils may generate interference spikes on the crank sensor wires. Ensure that the sensor wire is screened as close to the sensor as possible. If you connect to a distant connector there is usually a screen pin that has to be connected to the Mercury2 harness screen.

2. The coils may spike the Mercury2 and it may want to restart. This may be to incorrect supply currents or relay wiring. An indication of this error is that the software will lose connection momentarily to the ECU. A restart error will come up.

3. Errors that comes at higher RPM's may be due to a trigger wheel that is not balanced or is buckled. Sensing distance may be too large. It could also be due to a small gear teeth pitch, or a sensor with a large sensing magnet. The sensor may require an extra pull-up resistor.

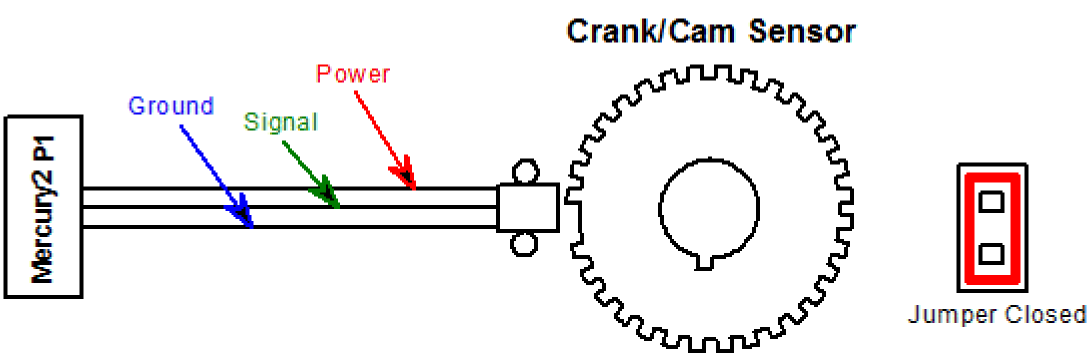
4. Ensure that the test signal next to the crank sensor is off.

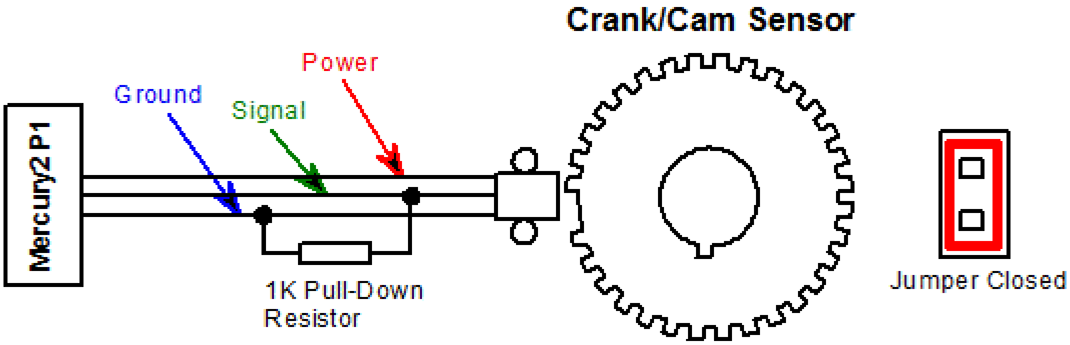
5. The RPM on the sensor signal could fade, this could be due to the gap between it and the trigger wheel been too close or too far apart.

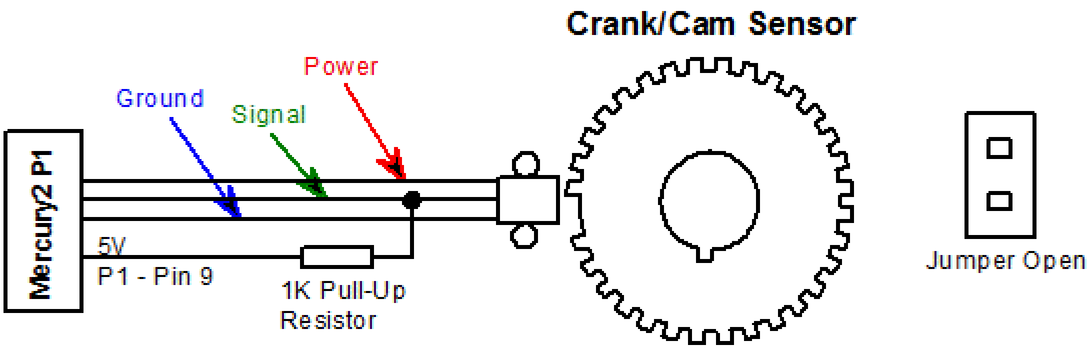
6. Incorrect sparkplugs may generate feedback which leave spikes in the trigger signal. Normally resistor plugs are used for COP engines and non-resistor plugs for HT leads. **Note**: Ensure that you use carbon HT leads and not copper leads. Cracked lead also generates interference. A trick is to look at them in the dark while it idles. It will show flashes in the dark.

Mercury2 pull-up

The Mercury2 use an isolated digital input to allow for magnetic sensor tap-in. For hall sensors an external jumper will connect a 1K pull-up resistor internally to the 12-volt power from the key. If this power is erratic due to other switching elements, then it may cause secondary triggering or interference of the input. To remedy this, you may add a 1K pull-down resistor to minimize the rippling effect on the power. If this does not help you may open the jumper and add a 1K pull-up resistor to 5-volt power from the ECU P1 pin 9. Alternatively use a relay to power the Mercury2 directly from the battery. Then the ignition power is only used to activate the relay. See the drawings below.







Mercury2 RPM and Speed Sensor Tap-In

The Mercury2 controllers can be tied into existing OEM sensor circuits. There are a few rules around this to ensure that both systems operate correctly and is not damaged. It varies for the different products and sensors.

Controllers that share a sensor, has to share a common earth connection. Differences in earth will have an effect on the sensors signal. So make sure you connect the Mercury2 earth to the OEM earth.

Never connect the reference voltage of the Mercury2 to any wire of the OEM sensor. Only the signal wire is connected. It may damage either controller. The sensor already has power or reference voltage from the OEM controller. See the drawings below.

Isolate the Mercury2 wires that are not used. They will have power on them and may short circuit damaging the harness.

If the OEM sensor is not screened it is best to tie in close to the sensor and use the Spitronics screened harness. It may reduce some interference from coils. Remember Mercury2 inputs need to cater for all kinds of sensors and cannot cater for week signals with interference. If you still have interference, then you may add a 100uF and 100nF cap as filtering on their reference line and the Mercury2 sensor earth. See drawings below. **NB**. Do make sure which line is signal and which is reference. Crank the engine and measure AC volts to ground of each point on the sensor. The one with the highest value will be the signal line. For speed sensor you may need to lift the wheels up to simulate pulses. It must detect speed at speeds from about 3 Km/H.

The blue Reference volts comes from the OEM controller and it differs between car manufacturers. Some use earth as a reference, other 2.4 volt, 5 volts and even 12 volts. The Mercury2 has isolating capacitors built in to connect to these signals without having a problem with different voltage levels. Mercury2 use a reference voltage for its sensors as ground. Note that Mercury2 requires a minimum 0.5-volt peak to peak signal to function correctly.

Below are the basic connections. Some cars may have a magnetic RPM sensor in combination with a Hall Speed sensor. Connect them accordingly. All the Mercury P1 connectors has the same pattern for RPM and Speed signals. Note that harness colours differ and should be verified on drawings or GP Priority charts.

For sensor Tap-In connections look at the following drawings.

Speed Sensor Wiring

RPM Sensor Wiring MTWX02-2

RPM Sensor Wiring MTSX02-2 Stand Alone

Orion2 RPM and Speed Sensor Tap-in

The Orion2 controllers can be tied into existing OEM circuits. There are a few rules around this to ensure that both systems operate correctly and is not damaged. It varies for the different products and sensors.

Controllers that share a sensor has to share a common earth connection. Differences in earth will have an effect on the sensors signal. So make sure you connect the Orion2 earth to the OEM earth.

Never connect the reference voltage of the Orion2 controller to any wire of the OEM sensor. Only the signal wire is connected. It may damage either controller. The sensor already has power or reference voltage from its own OEM controller. See the drawings below.

Isolate the Orion2 wires that are not used. They will have power on them and may short circuit damaging the Orion2 or harness.

If the OEM sensor is not screened it is best to tie in close to the sensor and use the Spitronics screened harness. It may reduce some interference from coils. Remember Orion2 inputs need to cater for all kinds of sensors and cannot cater for week signals with interference. If you still have interference, then you may add a 100uF and 100nF cap as filtering on their reference line. See drawings below. **NB**. Do make sure which line is signal and which is reference. Crank the engine and measure AC volts to ground of each point on the sensor. The one with the highest value will be the signal line. For speed sensor you may need to lift the wheels up to simulate pulses. It must detect speed at speeds from about 3 Km/H.

The blue Reference volts comes from the OEM controller and differs between car manufacturers. Some use earth as a reference, other 2.4 volt, 5 volts and even 12 volts. The isolating capacitor will block the DC volts from flowing and only let AC signal volts through. Orion2 reference its sensor to 5V. Note that Orion2 requires a minimum 1-volt peak to peak signal.

Below are the basic connections. Some cars may have a magnetic crank sensor in combination with a Hall speed sensor. Connect them accordingly. All the Orion2 P1 connectors has the same pattern for crank (Pin 12) and Speed (Pin 11) input signal. Note that harness colours differ and should be verified on drawings or GP Priority charts.

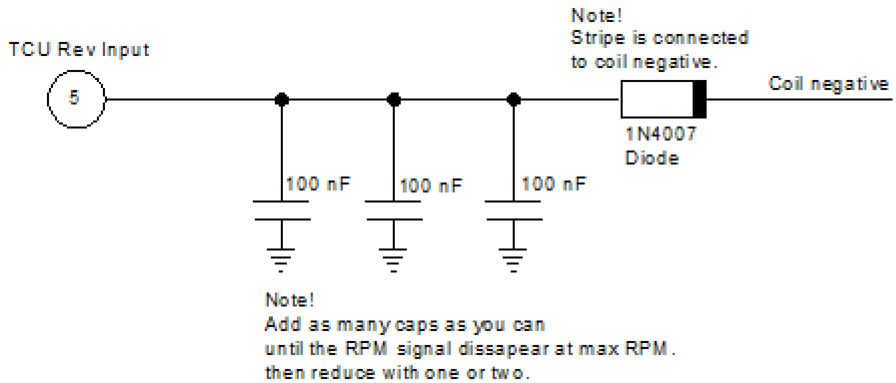
Speed Sensor Wiring

RPM Sensor Wiring OT01-P1

RPM Sensor Wiring OT02-P1 Stand Alone

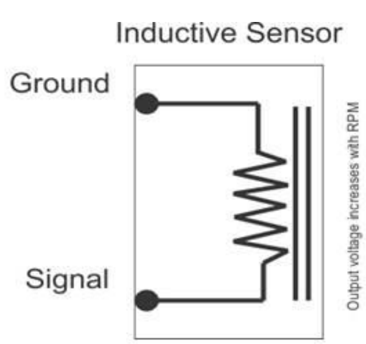
Hardware

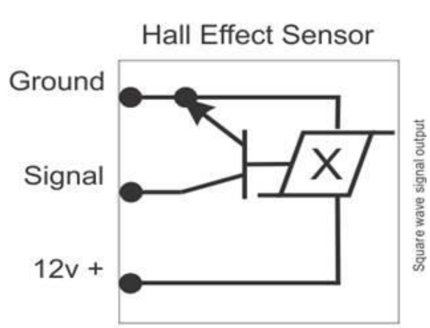
Do not connect the RPM signal to coil negative. It requires a signal converter board to filter out the high voltage. If it is the only option, you can use the circuit below. The caps are non-polarized. If you have a MSD device this will not work.



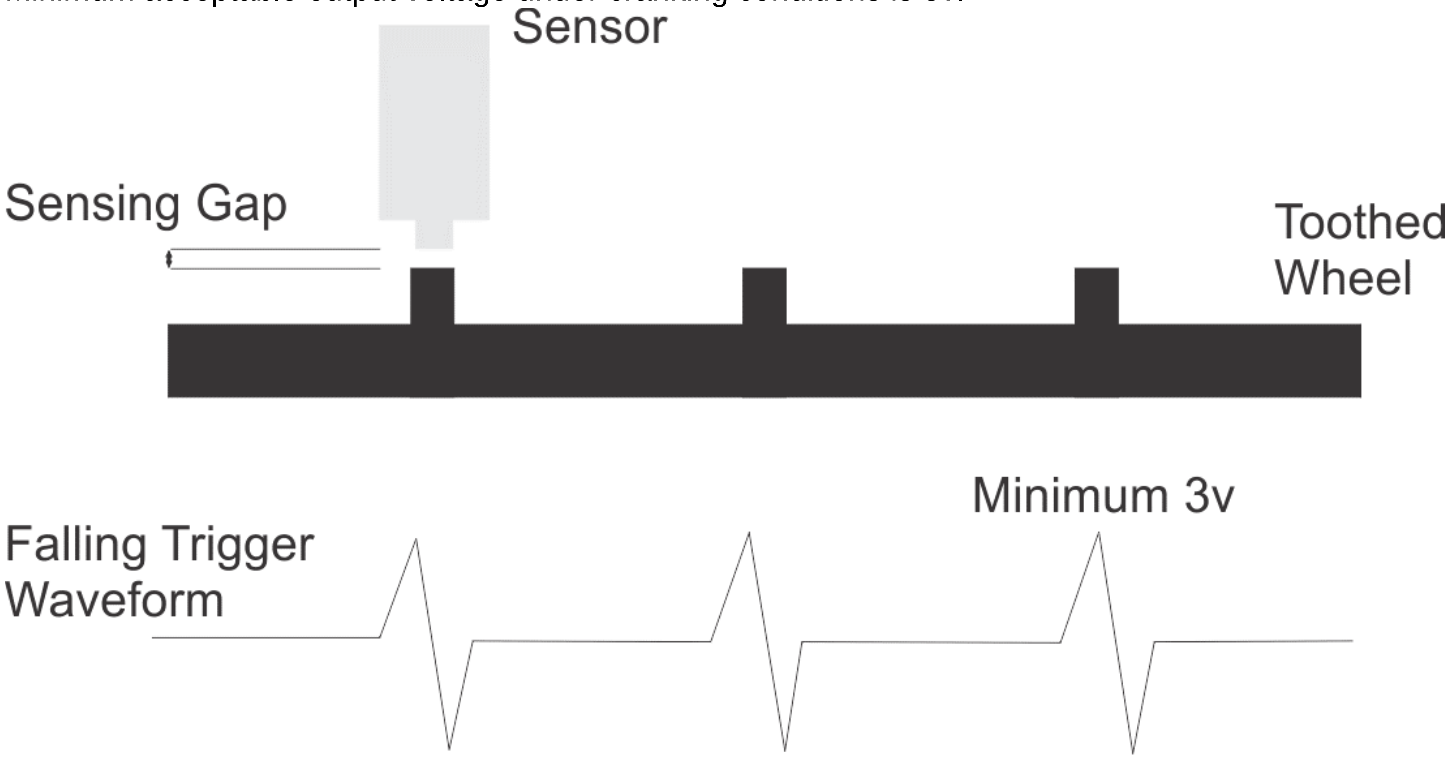
The RPM signal can be any pulse that is equivalent to engine RPM. It can be a bolt on the alternator etc. Some alternators have a 'W' point which can be used in the magnetic input. The pulses can be adjusted up to 60 pulses per engine revolution.

There are three types of sensors. The Inductive sensor, Optic sensor and Hall type sensor. The inductive sensor is a coil wound over a magnet. The teeth of a gear will disturb the magnetic field and that will generate a voltage spike over the 2 wires. Hall and optic sensors both give a square wave output and are treated exactly the same. They have electronic components in the sensor which convert the signals to square wave. The Hall sensor uses magnetic field where optic uses infrared light. In both cases a beam is broken and detected.



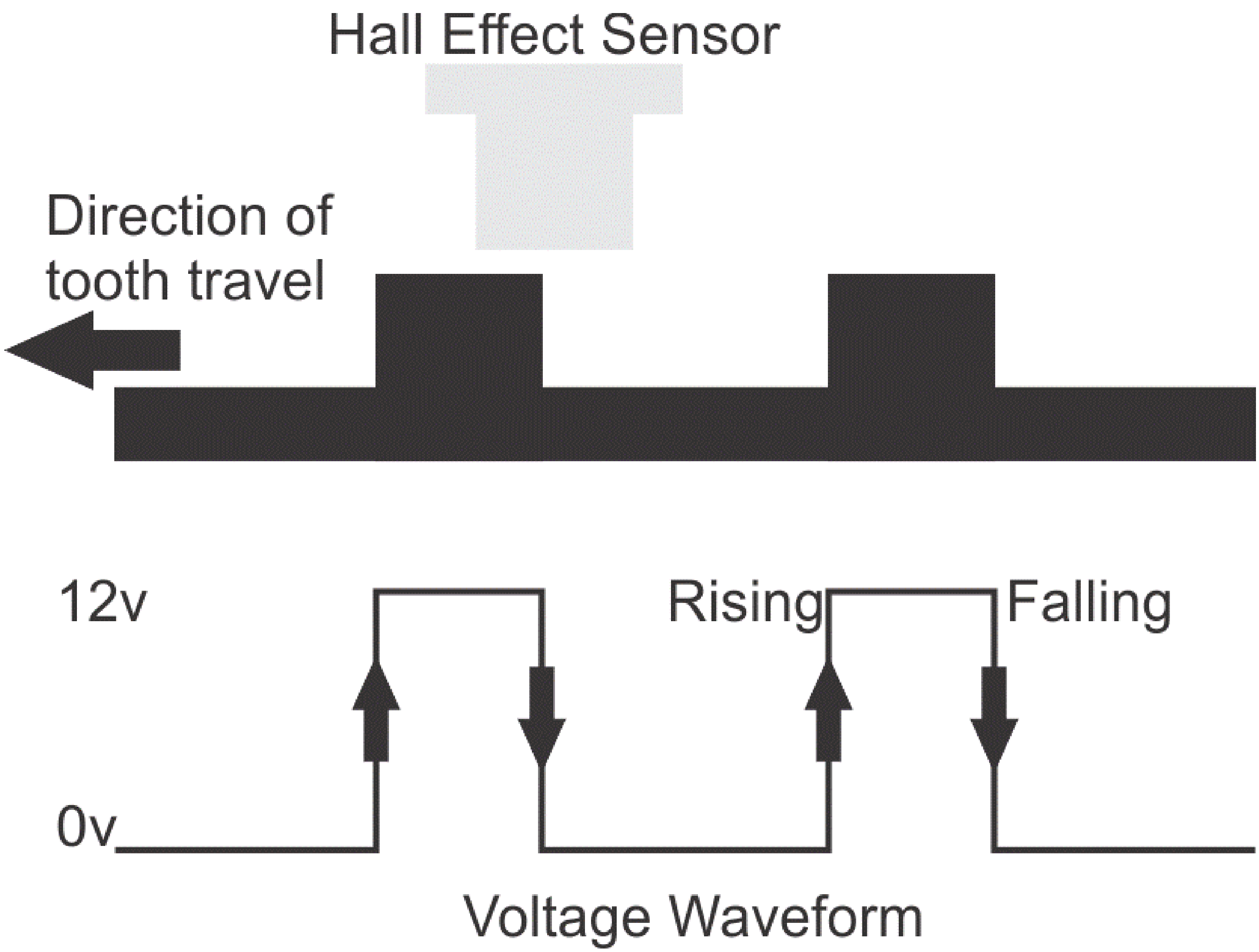


Operation of an inductive sensor:
The inductive sensor generates a voltage between the coil wires when the magnetic field strength is changed by a tooth passing the sensors. The sensor must be wired for a Falling waveform, this is best determined using an oscilloscope. The output voltage amplitude increases with increased RPM. The output voltage amplitude also depends on the gap between the sensor and the Tooth. The Minimum acceptable output voltage under cranking conditions is 3v.

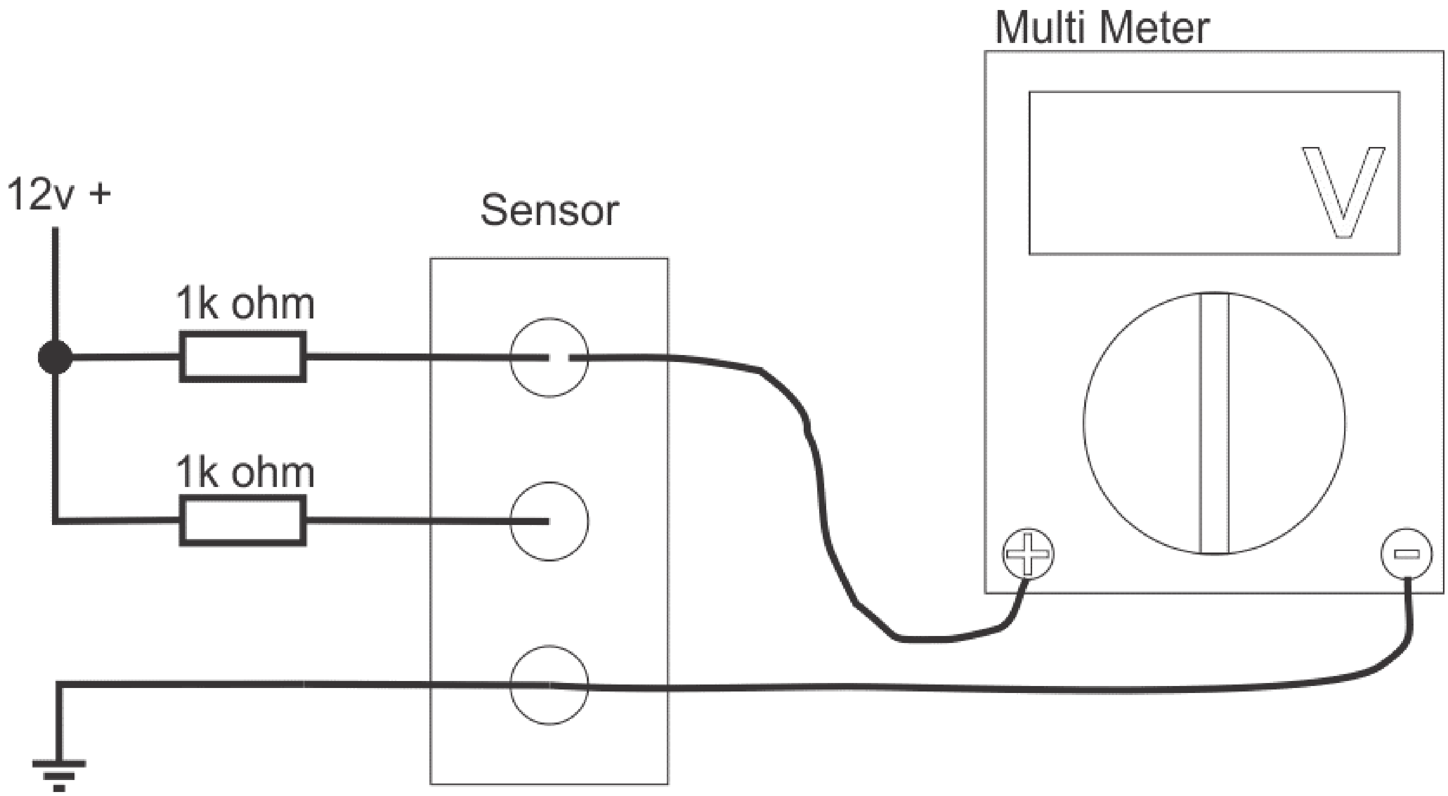


Testing an Inductive Sensor:
Inductive sensors has a wired coil with a magnet. The sensor either has two or three wires from which the third wire is not connected to the coil. The sensor coil resistance may vary from 150ohm to 1200ohm. Multi meter polarity will not change the coil resistance reading. A multi meter switched to AC voltage can be used to test the sensor polarity without an oscilloscope. Connect the wires from the coil to the multi meter and move a metal object to the sensor. Look closely at the polarity indicator, if it indicates positive when moving closer and negative when moving away from the sensor then the red wire of your meter is on the positive of the sensor and the black wire of your meter is on the ground of the sensor.

Operation of a Hall Effect Sensor:
Hall sensors use a magnetic field effect to switch between a low voltage (usually 0 V) and a high voltage (5 V or 12 V) to form a ‘square wave’. Both the rising and falling edges are valid reference points for the ECU input.



Testing a Hall Effect Sensor:



Hall Effect sensors normally have three wires. A supply wire (5v + or 12v +), an earth wire and a signal out. This sensor is equipped with electronic components that require power to operate. Incorrect connections will cause damage to the sensor. First test for resistance on all the pins and swop the test leads around to make sure it is not an inductive sensor. Put the multi meter on diode test and measure voltage drop over the pins. You should get a voltage drop between 0.5v and 1.9v. This is an indication that it is a Hall Effect sensor.

Now take two 1k ohm resistors and tie one end of each to 12v +. This will ensure that if you connect the supply wrong the sensor will not be damaged. Connect ground to the one sensor pin and the two resistors onto the remaining two pins. Connect the multi meter black wire for the remainder of this test. Connect the multi meter red wire onto any of the other pins. Now move a metal object to the sensor or in the gap and away. If the signal varies between 0v and 12v then this pin might be the sensor signal output. Now put the red wire on the other pin and repeat the metal process. The voltage should not change, but might be less than 12v due to the drop over the resistor. If so then this is the supply pin.

Now change the earth pin to the next and repeat the process. Note that you may get a similar reaction if you have the earth and signal pins swopped, the pin that reacts most to the iron pulse is the signal and the other the earth.

Remember this is a guideline to black box testing and not a failsafe operation.