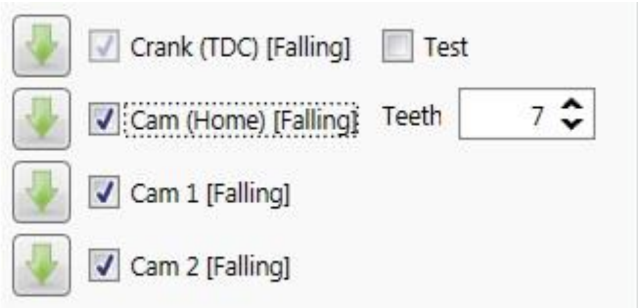
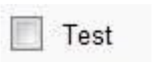
Crank and Cam angle Sensors

Settings



These inputs are required by the ECU to determine exact crank and cams angles so that spark and injection timing can be calculated. VVTI cams can be positioned by the ECU. Their cam signals will be compared to the crank signal to determine the right position for loop control. Version 3.6 firmware can only do open loop cam control. The firmware may blank out or force the signals in a state depending on the specific engine.

Crank (TDC)
The crank angle sensor is used by the ECU to determine exact crank degrees as it rotates. This sensor could be situated on the crank or in a distributor or encoder called a CAS. If it is situated on the cam gear like a distributor, then it will have enough pulses for 2 revolutions to represent the crank signal. For example, Toyota uses what we called a 24+TDC pattern. If the sensor is on the crank there will be 12 teeth. If it is on the cam there will be 24 teeth. If a pulse is generated on a 36-1 gear on a crank for example, then the missing tooth is used as a TDC pulse. A TDC pulse represent a signal that comes once every revolution. It is not necessary at TDC of the engine. In a distributor it may have a TDC pulse or Home pulse. If a pulse come once in two revolutions it is called a home pulse.



With Firmware Ver 3.5E onwards, the test function is used during crank and cam sensor tests. When this bit is set there will be no fuel injected. With the new Cam Home teeth sink this helps to set up cams with different teeth for different engines. If the sensors are read incorrectly, or the ECU has the wrong firmware, the software will show errors in the bottom status bar. These **Errors** have numbers indicating a fault code and description. This is a very useful feature for first time startup after the installation is done. See ***Setting Crank Sensor Timing*** below. See the next section.

On older firmware, the engine will start after the second revolution if there are no errors. **Note**. After setup put the test faction off. It may bother at high RPM's due to the calculations to determine correct patterns.

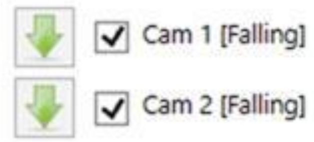
Cam (Home)
The cam angle sensor will always be situated on a cam shaft. It could be a lone sensor in the valve cover or in a distributor. This signal only came with later models when full sequential injection was introduced. Some distributors like Nissan and Toyota had both sensors in the distributor. The cam signal will give a unique pattern over two revolutions, allowing the ECU to detect which revolution is the firing stroke. This signal could be one pulse or a number of pulses. The ECU can compare it with the crank signal pattern and determine firing stroke.

This feature is incorporated in the new version 3.5E firmware to determine a home pulse position from different cam signals. Each manufacture uses a different cam pattern. One of the cam sensors must be connected to the ECU and selected. During setup, start with teeth 1 and crank the engine. It should show missing home pulses on the error codes. Increase the value and press C for clear after each adjustment. If the error stops appearing, at for example 4, then continue increasing till you see the error again. If the value is 10, for example, then set the teeth setting in the average of 7 teeth. Now the ECU knows the difference in stroke 1 and stroke 3 of the engine. One will have a pulse within 7 teeth after the slot and 3 will have no pulses. Note that Full Sequential Injection or Full Sequential Spark must be on to produce errors. Also not that Full Sequential Injection is still possible without a Cam (Home) pulse but not Spark. You need to have the Cam sensor setup correctly for spark.

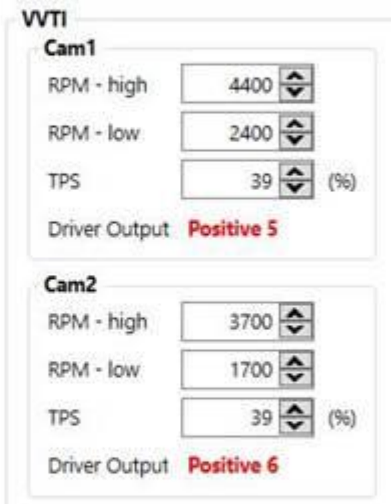
VVT Cam Control

This feature will reduce the number of firmware files required for different engines. Previous version was split in a normal engine or specific VVTI engines. VVTI consists of 2 cam control settings for inlet or exhaust cams. Control is still open loop so for V engines the 2 Cam solenoids are connected on the same driver. It requires only 1 x 3Amp diode to be installed. No input Cam sensors are required in open loop control. Also note that cam control will be 25% duty cycle when ***Off*** and 75% duty cycle when ***On***. If your engine requires different control parameters, then you need to load the engine specific firmware.

First you need to select 1 or 2 cam outputs. Note that the software will refresh the setup data as these drivers are shared with GP output drivers. If you don’t use cam outputs, then un select them to free up the GP drivers.



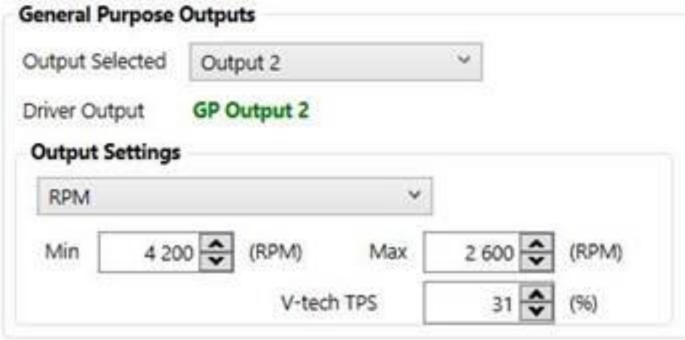
Then the cam control block will become visible also indicating which drivers are used for which coil. If no drivers are visible, then the cam selections are not selected.



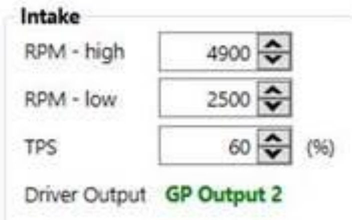
Take note that Cam1 is used Cyl1 in V engines or Intake Cam. Cam2 is used for the opposite cam than Cam1 or the Exhaust Cam.

Intake Flap Control

Should the engine have an intake Flap then use the V-Tech feature on GP2 for it as it has a TPS limit as well.



Dedicated firmware like the Lexus VVTI will use the Intake block in the VVTI settings block.

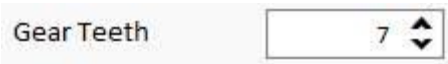


Setting Crank Sensor Timing

This block is used to indicate to the ECU where the exact TDC point is on the crank. It works differently for the different style of crank angle sensors. These settings will allow the ECU to synchronize software timing with the actual spark timing on the engine.

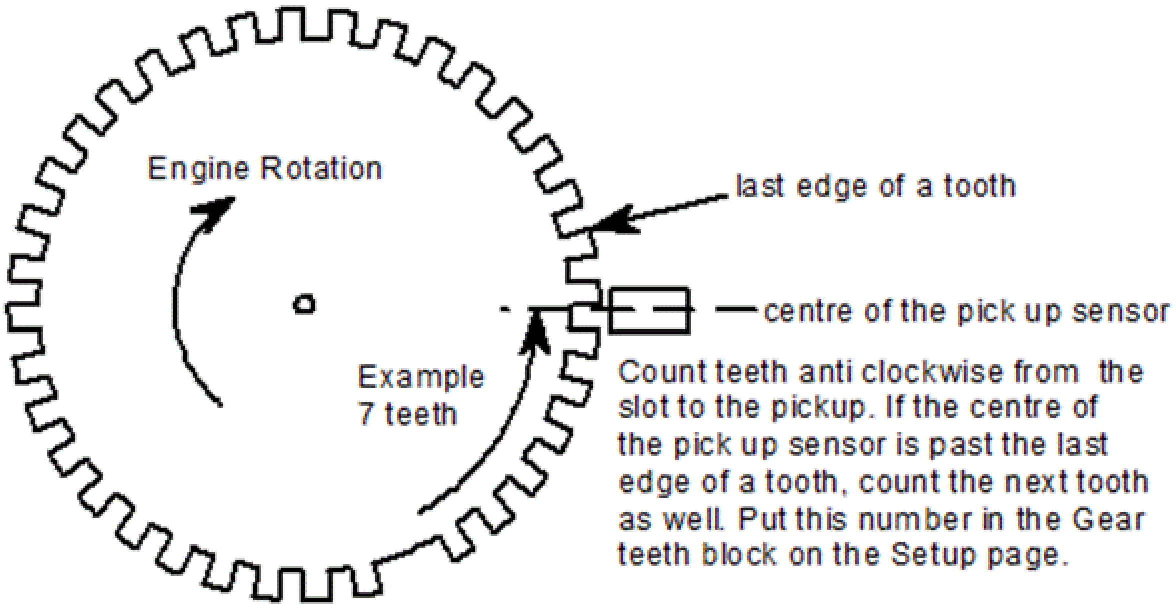
On gear type trigger wheels, the **Gear Teeth** will indicate to the ECU the amount of teeth between the slot and TDC. The **Timing Sensor** will do finer adjustments to precisely set the timing in-between the teeth.

The example below explains, if you put the engine of a 36-1 trigger wheel on TDC, count the number of teeth from the slot anti clockwise to the pickup sensor plus the one just past the sensor.

Put this value in 

. Then you may adjust the Timing Sensor 

from 0 to 9 degrees to precisely align the timing light to the tuning software. The example below should work out as Gear teeth 7 Timing Sensor 6 as the last edge of the teeth is in the center of the sensor.



With the engine running match the timing as close as possible by using the Gear teeth setting. For example; the ECU software indicates 10° advance on the real-time bar, but you see 12° advance on the engine. The Timing sensor °BTDC will now be adjusted to accommodate the difference which is 2. With the Timing sensor adjusted the Timing light and the ECU should now be matched.

Important!
When using an Advance / Retard timing light on a wasted spark system the timing light will read double the timing of the engine. So if the timing light reads 20° advance, the actual ignition timing is 10° advance. If you are not sure rather put the timing light on zero degrees and use the pulley marks. Remember that the COP systems are still fired in wasted spark sequence.

On single event triggers you will find that gear teeth are not adjustable only the degrees between the triggers. On a 4Cyl Nissan for example the timing sensor may be adjusted to 180 degrees.

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 ECU Information 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 

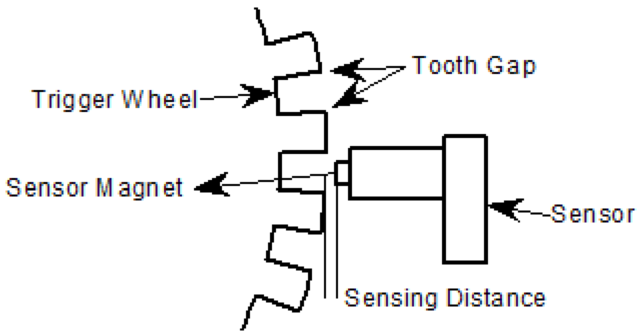
does not fall too low. A healthy battery will crank at 11 volts and higher. Under 9 volts, the sensor signal becomes weak and falls below the voltage threshold of Mercury2. Note: If it falls below 10 see chapter about ***'Power Connection'***.

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.

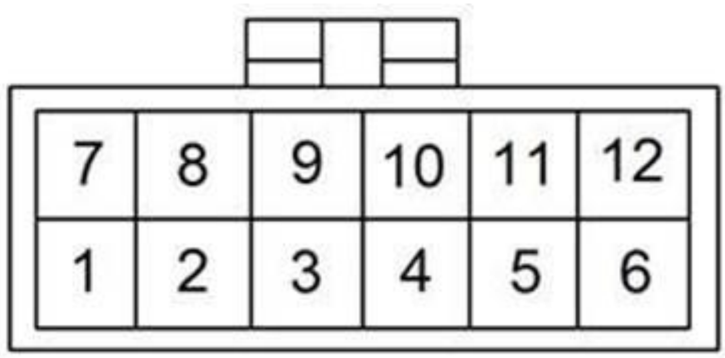


Testing the sensor.

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 

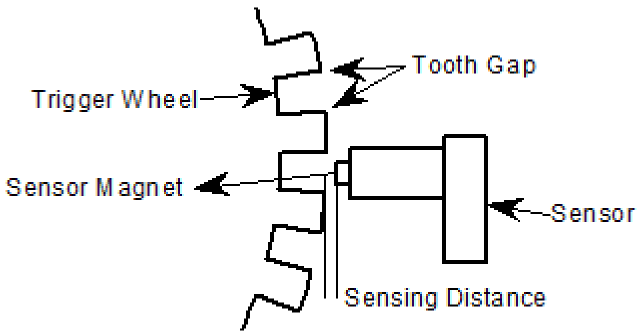
does not fall too low. A healthy battery will crank at 11 volts and higher. Under 9 volts, the sensor signal becomes weak and falls below the voltage threshold of Mercury2. Note: If it falls below 10 see chapter about ***'Power Connection'***.

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.

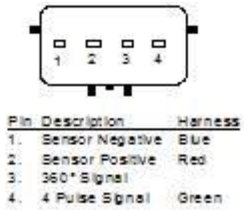
6. Incorrect sparkplugs may generate feedback which leave spikes in the trigger signal. Normally resistor plugs are used for COP engines and non-resistor plugs for HT leads. **Note**: Ensure that you use carbon HT leads and not copper leads. Cracked lead also generates interference. A trick is to look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

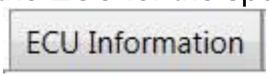
Optic CAS Cam Angle Sensor

This chapter discuss the connection and settings for the Optical CAS. For fault finding and testing see the ***Testing Magnetic Crank sensor*** chapter in this manual.

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 ECU.

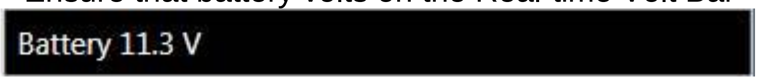
2. On the CAS there is a 360 slot output and a home or TDC slot output. The Spitronics ECU's only use the Home slots. Connect it to the crank sensor input. These sensors the Crank is forced to rising edge and the Cam is disabled. In older software use the same settings. Gear Teeth is locked on 1 and Timing Sensor is usually between 60 and 65 degrees BTDC. Make sure the CAS is in its original mounting position where the bolt slides in the slotted groove. See the illustrations below:

3. 

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

to verify.

5. Make sure the **Jumper settings** are set for Hall sensors. On Mercury2 the crank sensor jumper must be closed. The cam sensor input is not used. Leave the jumper open. You may now crank the engine without the other connectors.

6. 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 the specific ECU. Note: If it falls below 10 see chapter about ***'Power Connection'***.

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

8. 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.

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

Testing the sensor.

1. The 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 ECU.
3. Measure continuity from the sensor power to the ECU 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 CAS from the engine. Make a proper mark so you can install it in the exact position. Measure DC volts between sensor negative and signal. It should be 12 volts and if you turn the shaft slowly it should go to 0 volt. 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 the jumpers are correct, then disconnect 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.
10. 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 ECU harness screen.

2. The coils may spike the ECU 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 weak pull-up signal. The sensor may require an extra pull-up resistor between the sensor signal and the sensor positive. Use a 1K resistor.

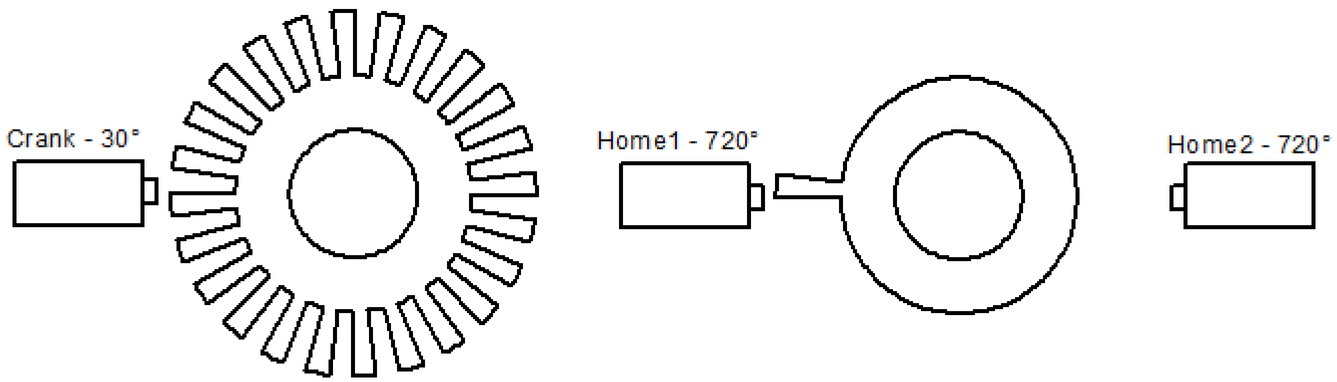
4. Ensure that the test signal next to the crank sensor is off.

5. 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 leads also make interference. A trick is to look at them in the dark while it idles. It will show flashes in the dark.

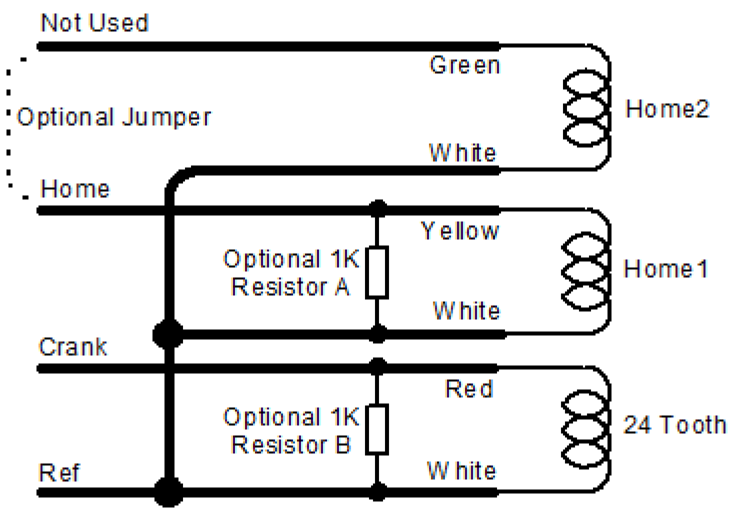
Cam Angle 24T + Home

The popular 24+TDC configuration from the Toyota, Mazda Rotary, Honda etc. engines can be used in many different ways. The 24 tooth gear gives a pulse every 30 degrees of crank rotation. Some distributor encoders use a combination of TDC and Home triggers with this gear. Below are explanations of the different types and also the modifications that could improve stability and simplicity in wiring when using the Spitronics ECU's.

Toyota usually have one tooth on a separate space in combination with two sensors. Each sensor provides a home pulse on a different revolution of the engine. This allows the ECU to sink injection and timing to a specific stroke of the engine every time it starts. This setup requires three inputs from the ECU. The ECU could sync in one revolution. Some ECU's have only one home input which means then engine may have to turn sometimes two revolutions before crank angle can be established.

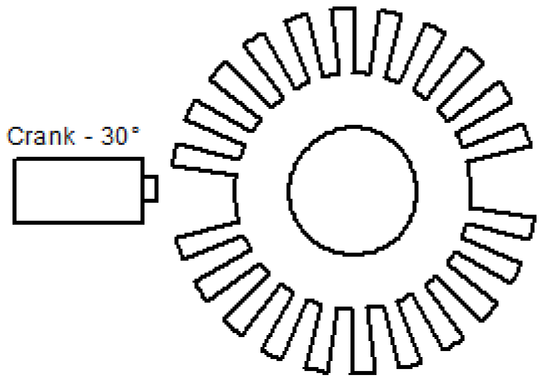


Using the sensors without modifications is possible but due to the differences in sensor that the Spitronics ECU's have to cater for, this one needs a bit of external filtering. See the drawing below.

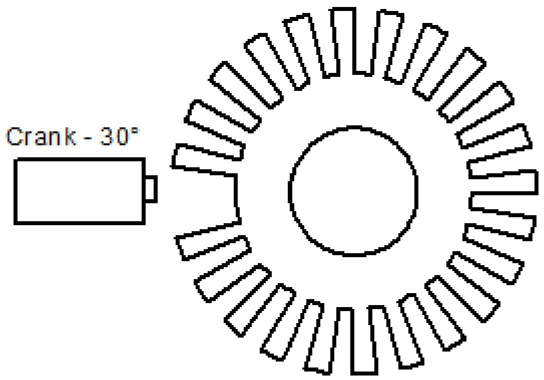


The Reference wire is usually common in these encoders. The older ones used these colours and white is common. Then Crank and Home are connected to P1 pin 12 and 11 respectively. Check the drawings for wire colours. Usually we use only Home1 sensor. You may add the Home2 sensor on the same connection as shown in optional jumper settings. If the sensor signal is strong this will work perfectly. If it is week then it cannot be used. This method is only for Split sequential injection. For full sequential only use Home1 sensor. If you find interference during cranking or at higher revs add the optional resistor A to the circuit. Resistor B is seldom required due to constant excitement of the crank sensor. If it is possible, move the sensors closer to the tooth gears but they must not touch. Ensure a paper can move between them easy. It they touch it will make more interference.

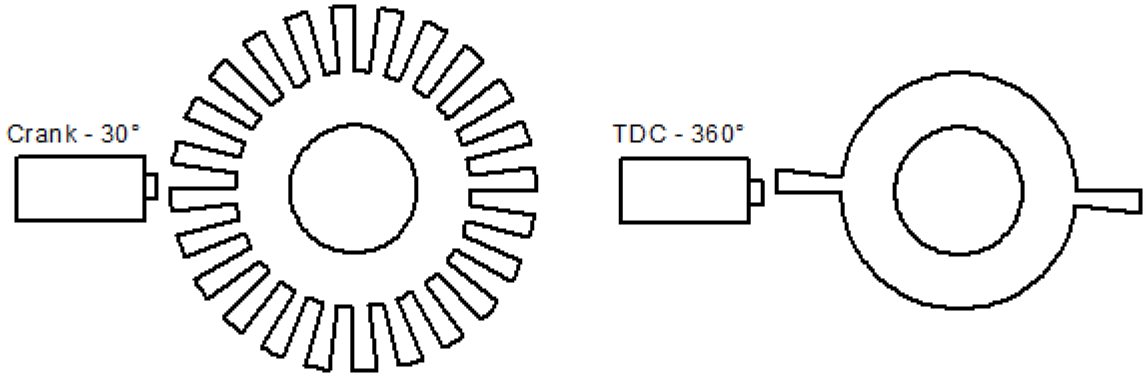
These 24 tooth trigger wheels can be modified and used with different firmware if it is available for that product. Make sure about this before you proceed. This means that the home sensors are not required. The interference with the 24 tooth gear is very little as the sensor is constantly exited by the many teeth. If you are going to fuel the engine with Split-sequential injection you may grind out two opposing teeth on TDC and BDC. This will then convert to the 12-1 programs which is available. **NB.** Engine must be on TDC in the drawing below. **Note** that the Home pulses on the Toyota CAS units have a gradual build-up of metal in front of the sensor as it turns. This is to prevent interference on the sensor due to no excitement. The Mercury2 style input cannot sense this configuration successfully so you may need to modify the sensor as described below.



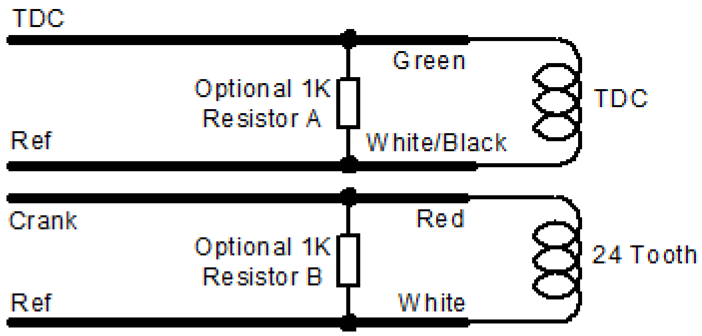
If you want to do full sequential then only take 1 tooth out under the sensor when the engine is on TDC. The firmware for this gear is Program 84 24-1 Dizzy 4Cyl Full/Seq. It is not popular and may be supplied on request. See the drawing below.



Mazda Rotary engines are 2 stroke and don't require a home pulse. They opted for the pattern below.

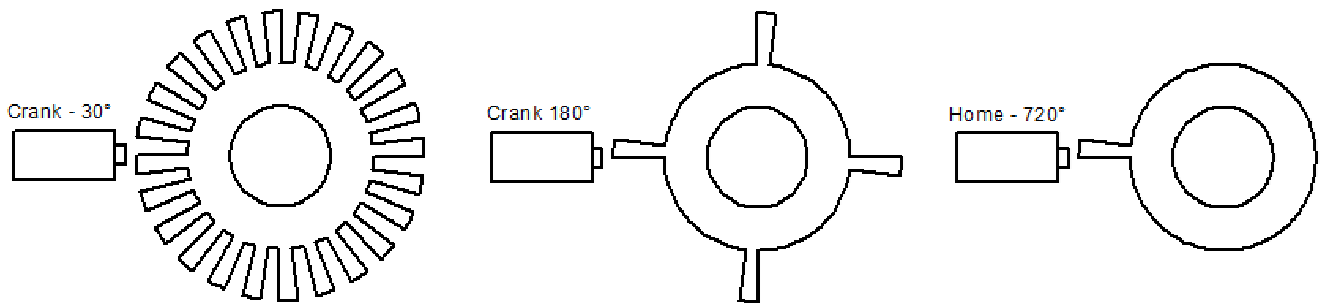


Using the sensors without modifications is possible but due to the differences in sensor that the Spitronics ECU's have to cater for, this one needs a bit of external filtering. See the drawing below.

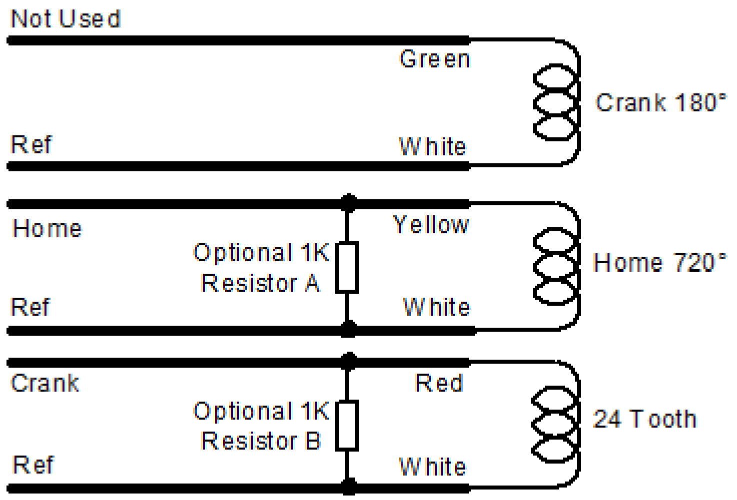


The older ones used these colours. Then Crank and Home are connected to P1 pin 12 and 11 respectively. Check the drawings for wire colours. If you find interference during cranking or at higher revs add the optional resistor A to the circuit. Resistor B is seldom required due to constant excitement of the crank sensor. If it is possible, move the sensors closer to the tooth gears but they must not touch. Ensure a paper can move between them easy. It they touch it will make more interference.

Honda use a 3 level crank angle sensor like below. The 4-point wheel is handy to start quickly because spark does not need to be synced to the stroke of the engine due to the distributor cap that does the syncing. Spitronics only use the crank 30° and the Home 720° sensors.

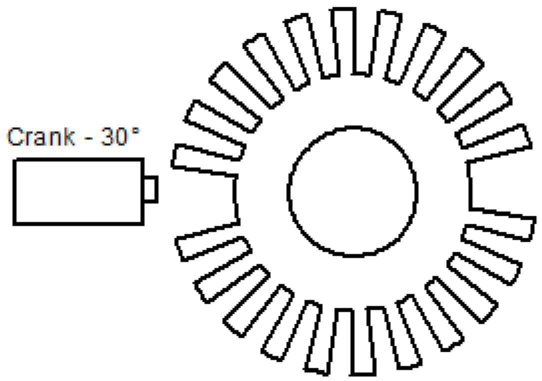


Using the sensors without modifications is possible but due to the differences in sensor that the Spitronics ECU's have to cater for, this one needs a bit of external filtering. See the drawing below.

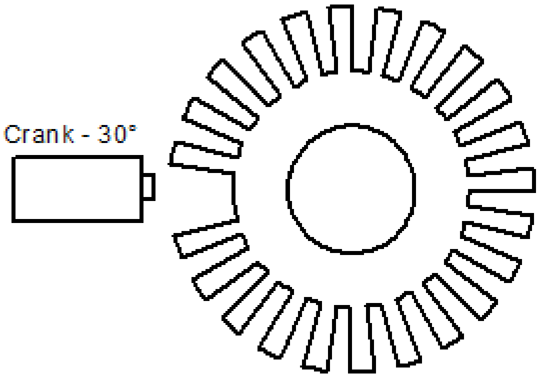


The older ones used these colours. Then Crank and Home are connected to P1 pin 12 and 11 respectively. Check the drawings for wire colours. If you find interference during cranking or at higher revs add the optional resistor A to the circuit. Resistor B is seldom required due to constant excitement of the crank sensor. If it is possible, move the sensors closer to the tooth gears but they must not touch. Ensure a paper can move between them easy. It they touch it will make more interference.

These 24 tooth trigger wheels can be modified and used with different firmware if it is available for that product. Make sure about this before you proceed. This means that the home sensors are not required. The interference with the 24 tooth gear is very little as the sensor is constantly exited by the many teeth. If you are going to fuel the engine with Split-sequential injection you may grind out two opposing teeth on TDC and BDC. This will then convert to the 12-1 programs which is available. **NB.** Engine must be on TDC in the drawing below.

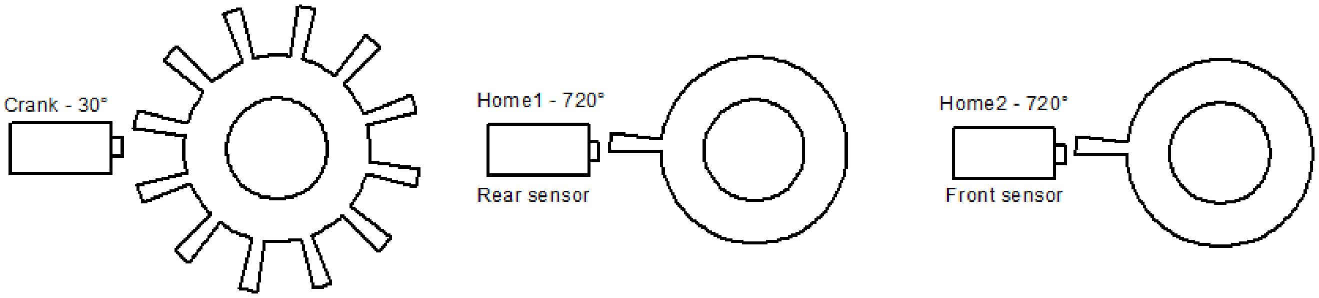


If you want to do full sequential then only take 1 tooth out under the sensor when the engine is on TDC. The firmware for this gear is Program 84 24-1 Dizzy 4Cyl Full/Seq. It is not popular and may be supplied on request. See the drawing below.

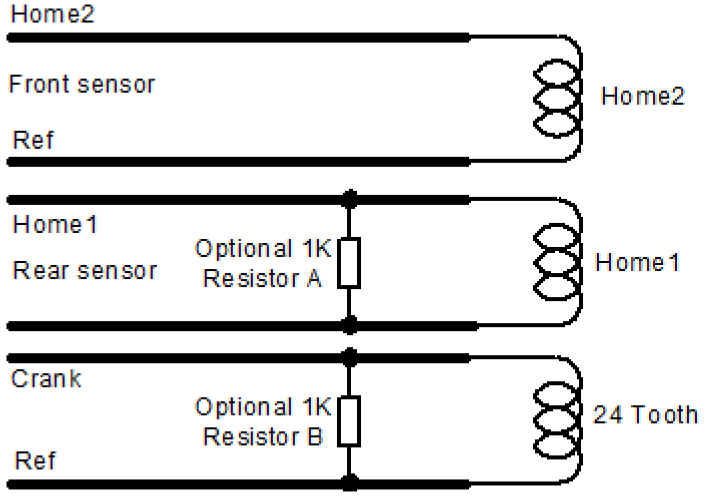


Crank Angle 12T + 2Home

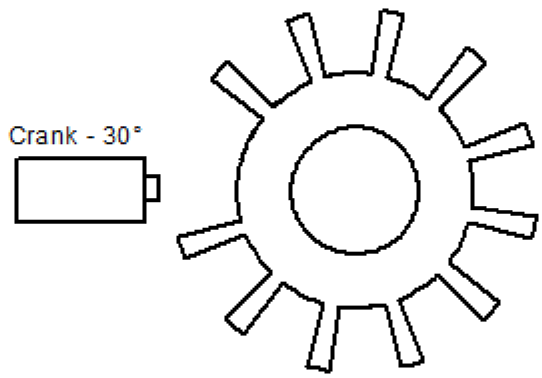
The 12+2home configuration has the same signal pattern as the old 24+TDC configuration from the Toyota. Here there is no CAS but only sensors on the crank and cam directly. The 12 tooth gear gives a pulse every 30 degrees of crank rotation. There are 2 separate Home sensors. Usually one on each cam and they are 360° out of phase. Sometimes they also act as VVTI movement detection sensor. This allows the ECU to sink injection and timing to a specific stroke of the engine every time it starts. This setup requires three inputs from the ECU. The ECU could sync in one revolution. Some ECU's have only one home input which means then engine may have to turn sometimes two revolutions before crank angle can be established. Below are explanations and also the modifications that could improve stability and simplicity in wiring when using the Spitronics ECU's.



Using the sensors without modifications is possible but due to the differences in sensors that the Spitronics ECU's have to cater for, this one needs a bit of external filtering. If your harness has all the wires in one cable, then you need to make an adapter cable from the crank or cam sensor to the other one. They may be far apart so the connecting lead must be screened and the screen wire must be connect to the screen wire of the original loom. Do not connect the screen to the engine. See the drawing below.



Then Crank and Home are connected to P1 pin 12 and 11 respectively. Check the drawings for wire colours. Usually we use only Home1 sensor. You may add the Home2 sensor in parallel to the Home1 sensor. Positives together and reference together. If the sensor signal is strong this will work perfectly. If it is week then it cannot be used. This method is only for Split sequential injection. For full sequential only use Home1 sensor. If you find interference during cranking or at higher revs add the optional resistor A to the circuit. Resistor B is seldom required due to constant excitement of the crank sensor. If it is possible you may grind the teeth under the sensor out when the engine is on TDC and use this with the 12-1 split sequential program. Then you don't need the cam sensors.



Crank and Cam Sensor Tap-In

The ECU 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. See the connection diagrams on how to connect each product. Some may require additional components.

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 ECU earth to the OEM earth.

Never connect the reference voltage of the ECU 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.

Isolate the ECU 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 ECU 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.

The 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. Orion2 and Venus3 do not have these capacitors and they must be added separately. Mercury2 use a reference voltage for its sensors as ground. Orion2 and Venus3 use 5 volt. Mercury2 requires a minimum 0.5-volt peak to peak signal to function correctly. Orion2 and Venus3 requires 1 volt peak to peak signal to function correctly.

Setting Distributor Rotor Fazing

This setup for distributors with rotors requires you to align the rotor with actual crank degrees. Rotor fazing is a mechanical adjustment to ensure that the Rotor is under the relevant high tension pole during the spark distribution. If not, the spark will have to jump the gap in the distributor which will cause less energy at the spark plug. It will also generate interference on the sensors causing erratic misfires. As most cars operate between 14 and 36 °BTDC you must ensure that the Rotor is under the pole during this span. Put the engine on 25°BTDC and place the rotor under the center of the pole. Then it can advance a total of 11 degrees, up to 36° or retard a total of 11 degrees, down to 14° and still have contact between rotor and pole. Lock the distributor nut properly and ensure that wiring is tied in the correct manner to prevent damage or strain due to engine movement.

NB! Do not adjust the distributor again. Rotor fazing is now complete.
(See Illustration below.)
sit drawing in

Setting Crank Gear Timing

This crank trigger is a single sensor and some form of crank gear like 60-2, 36-1, 12-1 etc. the more teeth on the gear, the more accurate timing is during blip conditions. This setup requires 2 settings which will indicate TDC accurately to the ECU. One is a course gear teeth number and the other is a degree setting between the teeth.

Gear not visible.

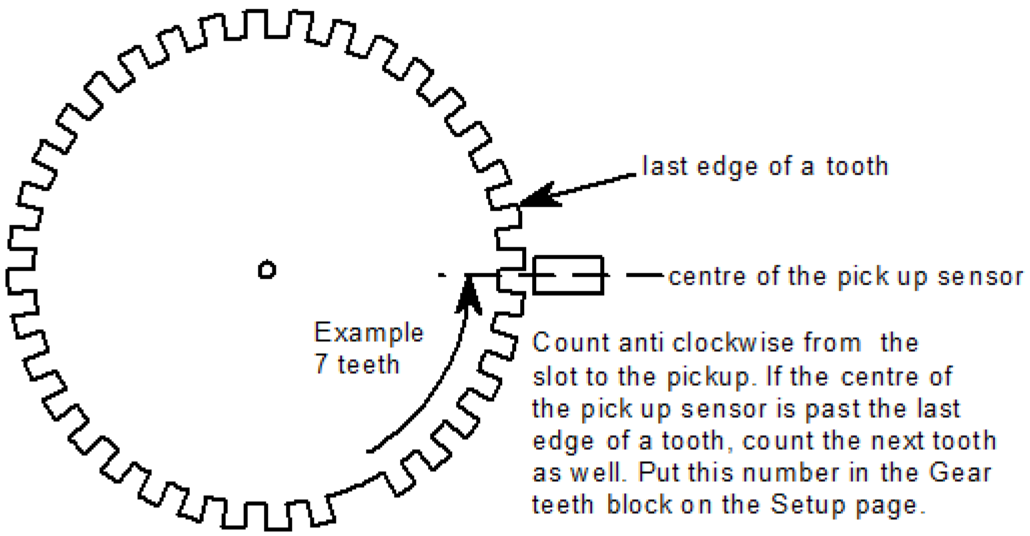
If you can't see the gear you can enter speculative values in Gear Teeth. Best is to disconnect the fuel pump and use a timing light. Start with a teeth value of 1 and timing sensor value of 0.

Set the Maximum Timing on zero.

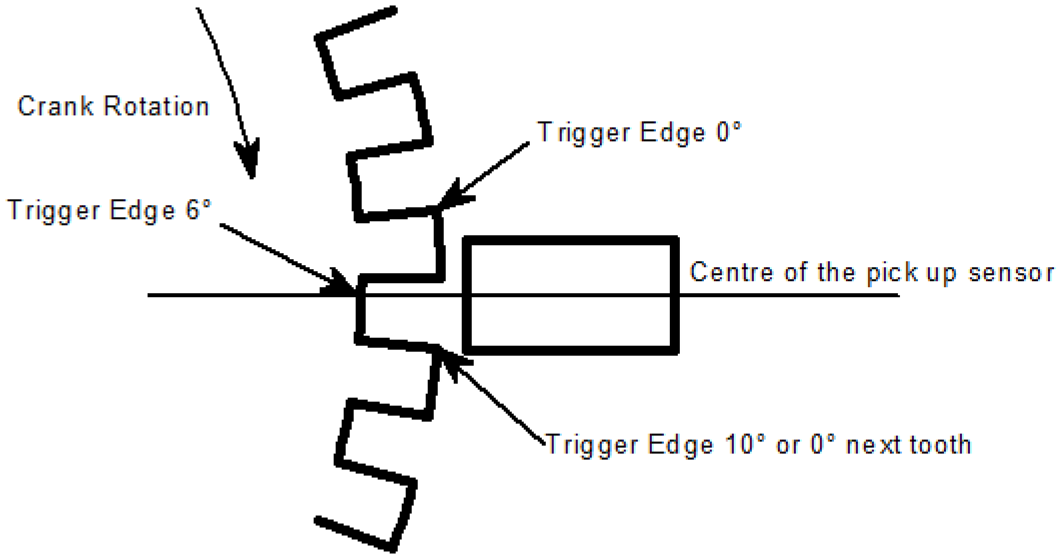
Put the timing light on zero degrees. Crank the engine and look at the timing. Adjust the Gear Teeth till the mark is just past TDC. Then adjust the Timing Sensor till it is on TDC. Put the Maximum Timing back to its value. Save the settings and connect the fuel pump. Start the engine. Once the engine is stabilized and idle fueling is adjusted, repeat the above process to fine tune timing.

Gear Visible.

If you can see the gear, put the engine on TDC. Count the number of teeth from the slot to the sensor in an anti-clockwise direction. Enter this number of teeth plus one in the software under Gear Teeth. Enter 0 in Timing Sensor °BTDC field. The car should start unless it is a low teeth count. If it is a 12 tooth gear then you could still be out 30 degrees. Rather make an estimate by following the visual sample below.



To determine what degrees is between the teeth compare the center of the pickup to the 2 teeth it falls between. Use the last edge of the tooth as the reference. The sample below is a 36-1 gear which means it has 10 degrees between the teeth. This one seems like it is close to 6 degrees from the last tooth that will pass the sensor. Enter 6 in Timing Sensor.



This engine should start and idle if the fuel is correctly set. Check with the timing light to see if the software timing correlates with the engine timing. If the difference is less than the tooth pitch degrees, adjustments can be made on the Timing Sensor °BTDC field. Otherwise add or subtract one tooth and try again.

If a magnetic pickup is used, ensure that the positive and negative of the magnetic sensor are correct. If they are connected wrong way round, the timing will retard instead of advance and the fazing will be wrong. Sometimes the engine will start but it may not rev up. Look for errors indicating pickup problems.

Jumper Settings

The Spitronics ECU's are universal products that cater for all kinds of sensors and features. Therefore, it has Jumpers that will expand the universality of these products. the drawings for the correct jumper positions of each product.

Sensors Hardware

The Mercury2 is a universal controller designed for most types of Optic, Hall or Magnetic reluctor sensors. It can read 4 sensors in total. Mostly Crank and Cam or Speed sensors. Below is a link to a drawing with the different connect options for the Orion triggers.




The crank and cam angle sensors on an engine is used to determine crank and cam angles. (See the sub folders for more information.)

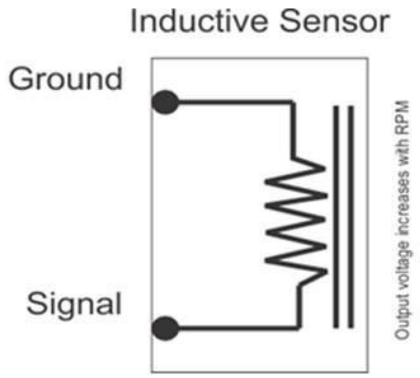
A **crank angle sensor** can be used alone for non VVTI engines, but this can only give information relative to 360 degrees. This engine will only run with split sequential injection and wasted spark coil firing. If full sequential injection is selected, injection is not in sink per engine stroke. It means you may sometime inject on the bottom deck of exhaust stroke and sometimes on bottom end of compression stroke. The aim is to always go for injection angle at bottom stroke just after the intake valve closes. Here atomization will be at its best and also consistent even if the stroke is not in sink. Full sequential spark is not possible in this scenario.

The **cam angle sensor** will give the ECU information over 720 degrees. This will indicate the 4 strokes for sequential injection or coil firing. Depending on the trigger wheel designs, some engines may need up to 2 revolutions cranking before the ECU can sink properly. Some programs may start in split sequential injection and fire the injectors in split sequential to enhance starting. Thereafter it will go to full sequential mode and stay there.

VVTI engines may have additional cam angle sensors that indicates the cam angle relative to the crank angle. This will let the ECU calculate and manipulate the cam angle for RPM and load variances. There may be intake cam control, exhaust cam control and also lift control. Then V type engines have all this in dual banks.

There are three types of sensors. The Magnetic reluctor sensor, Optic sensor and Hall type sensor.

The **Magnetic reluctor sensor** is a coil wound over a magnet. The teeth on the crank gear will disturb the magnetic field and that will generate a voltage spike over the 2 wires. The sensor is normally located on the engine block and picks up from a toothed wheel on the crankshaft. The physical position of the sensor may vary from front pulley, inside block and flywheel.



Hall and optic sensors both give a square wave outputs 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 sensor uses infrared light. In both cases a beam is broken and detected. The sensor output is usually an open collector transistor which means it will require a pull-up resistor normally situated in the ECU or TCU. This sensor is normally located on the valve cover and picks up protruded teeth from the camshaft. The physical position of the sensor may vary. The VVTI sensor will be positioned on the actual camshaft and not on the cam pulley to measure cam movement.