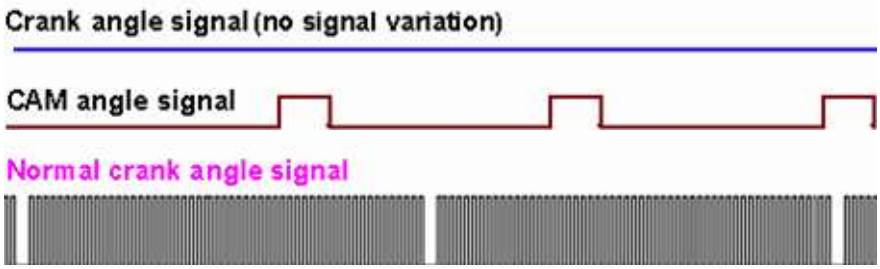
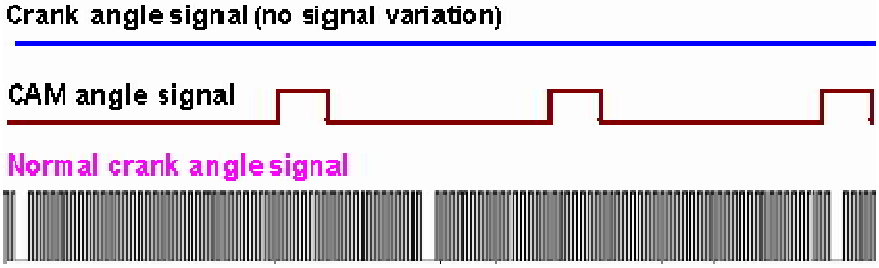
1. The signal analysis of Crank Angle Sensor

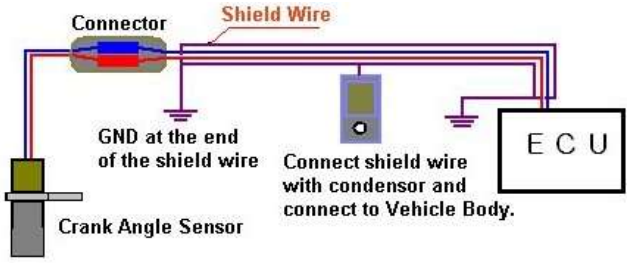
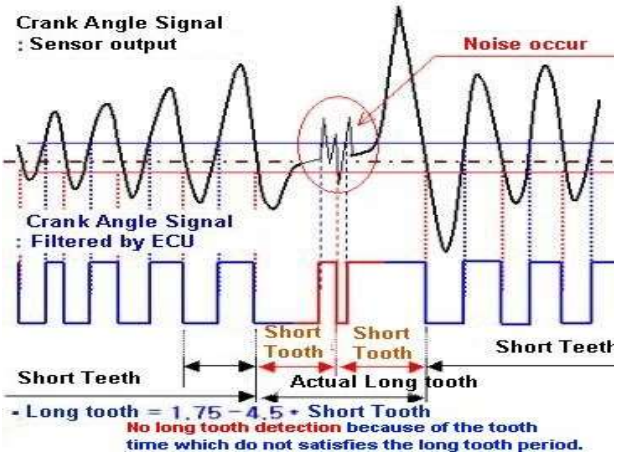
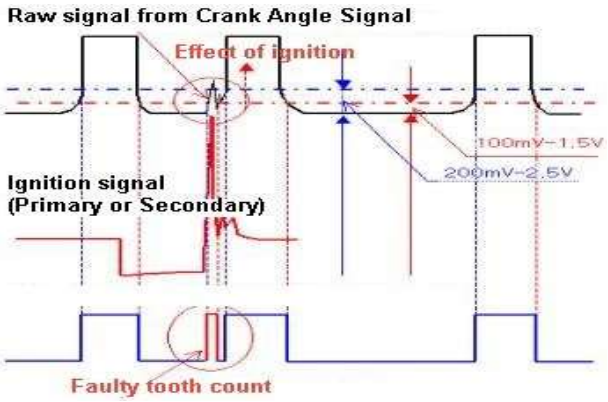
We will explain about malfunction type of Crank Angle Sensor. Crank angle sensor is one of main factors that cause engine vibration or stall. Therefore we will explain what is the reasons and algorithm to understand crank angle sensor as many as possible.

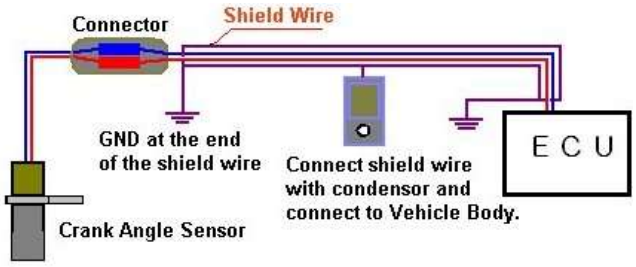
1. Troubles

1. Malfunction of Crank Angle Sensor	
Cause of trouble	Malfunction of CAPS or wiring circuit failure (Signal, Ground, Reference line)
Counter action	Healing by cause of trouble CAPS replace Wiring circuit repair
Engine state	Engine is not started due to non-ignition with fuel. In case of half moon type CAM sensor, engine is started and maintained idle state. But engine vibration and surging are occurred and performance is decreased.
Signal view	 In case of non-start, crank angle signal should be measured with cranking

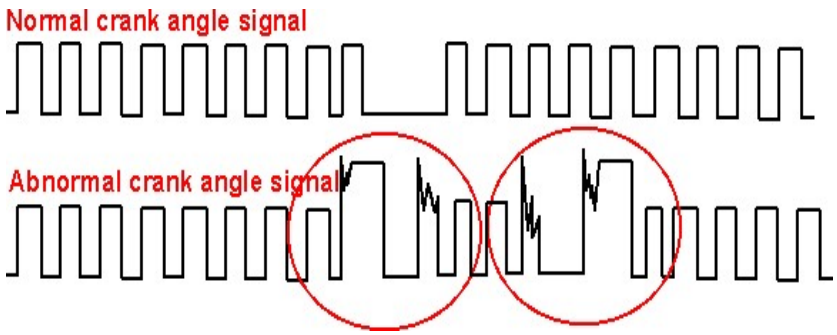
2. Crank angle signal is always constant	
Cause of trouble	Trouble detection more than one of the followings Abnormal CAPS Bad connecting of CAPS CAPS signal, ground and power supply line bad connecting or signal line short to ground or battery
Counter action	Healing by cause of trouble CAPS replace CAPS wiring circuit repair
Engine state	Engine is not started due to non-ignition with fuel. In case of half moon type CAM sensor, engine is started and maintained idle state. But engine vibration and surging are occurred and performance is decreased.
Signal view	

3. Too narrow gap between crank teeth

Cause of trouble	Crank angle recognition by electrical noise
Counter action	Healing by cause of trouble 3.1 Separate wiring of ignition system, CAPS ground and signal line from other wiring(TCU system etc.). After that make a shield the separated wirings(3[cm] front of ECU) and then keep away CAPS from wiring of ignition system. < Reference > It is so difficult to prevent noise actually but if it must be repaired, make ground as connecting condenser in shield line as below picture 
Engine state	Engine stall is intermittently occurred and sometimes engine vibration is happened in idle state. At the moment, fuel injection or ignition may be missed and out of normal control range. Especially, LPG vehicle make backfire in this situation.
Signal view	 < Magnetic type Crank Angle Sensor >  < Hall or Optical type Crank Angle Sensor >

4. Missing of tooth signal	
Cause of trouble	Crank angle recognition by electrical noise Move toward reverse direction with short engine revolution(1-5msec) Make a crank angle signal by flywheel vibration when engine is started with self-motor operation
Counter action	Healing by cause of trouble Separate wiring of ignition system, CAPS ground and signal line from other wiring(TCU system etc.). After that make a shield the separated wirings (3[cm] front of ECU) and then keep away CAPS from ignition system wiring. Adjustment engine mounting and chassis in order to avoid jerking when heavy acceleration (Correct ignition timing in Electronic Control Unit(ECU) to reduce shock when acceleration Make a smooth contact surface of flywheel pinion or if it is possible to change calibration data and program in ECU, it can be programmed in order to ignore crank angle signal during 50[msec] after first crank angle recognition. < Reference > It is so difficult to prevent noise actually but if it must be repaired, make ground as connecting condenser in shield line as below picture. 
Engine state	Engine stall is intermittently occurred and sometimes engine vibration is happened in idle state. At the moment, fuel injection or ignition may be missed and out of normal control range. Especially, LPG vehicle make backfire in this situation.
Signal view	The problem is happened due to wrong crank angle signal detection during very short time.

5. Position of long tooth or camshaft signal is not synchronized	
Cause of trouble	Move toward reverse direction with short engine revolution (1-5msec) Make a crank angle signal by flywheel vibration when engine is started with self-motor operation
Counter action	Healing by cause of trouble Adjustment engine mounting and chassis in order to avoid jerking when heavy acceleration (Correct ignition timing in Electronic Control Unit(ECU) to reduce shock when acceleration Make a smooth contact surface of flywheel pinion or if it is possible to change calibration data and program in ECU, it can be programmed to ignore crank angle signal during 50[msec] after first crank angle recognition.
Engine state	CAM sensor error is sometimes detected(Display of CAM diagnostic trouble code) and surging is occurred when acceleration. Engine is started with hesitating during ≈0.5[sec]. In case of LPG vehicle, severe backfire is happened..
Signal view	< Insert signal > Measure crank angle and ignition signal from start of Credos, Accent, Sephia2 vehicle and save it as BMP file. And explain that ignition timing has big deviation from TDC.

6. Too wide gap between crank teeth	
Cause of trouble	CAPS malfunction Move toward reverse direction with short engine revolution (1-5msec)
Counter action	Healing by cause of trouble CAPS replace Adjustment engine mounting and chassis in order to avoid jerking when heavy acceleration (Correct ignition timing in Electronic Control Unit(ECU) to reduce shock when acceleration).
Engine state	CAM sensor error is sometimes detected (Display of CAM diagnostic trouble code) and surging is occurred when acceleration. Engine is started with hesitating during ≈0.5[sec]. In case of LPG vehicle, severe backfire is happened.
Signal view	< Insert Signal >  Measure crank angle and ignition signal from start of Credos, Accent, Sephia2 vehicle and save it as picture file. And explain that ignition timing has big deviation from TDC.

2. Field example

< Example 1 >

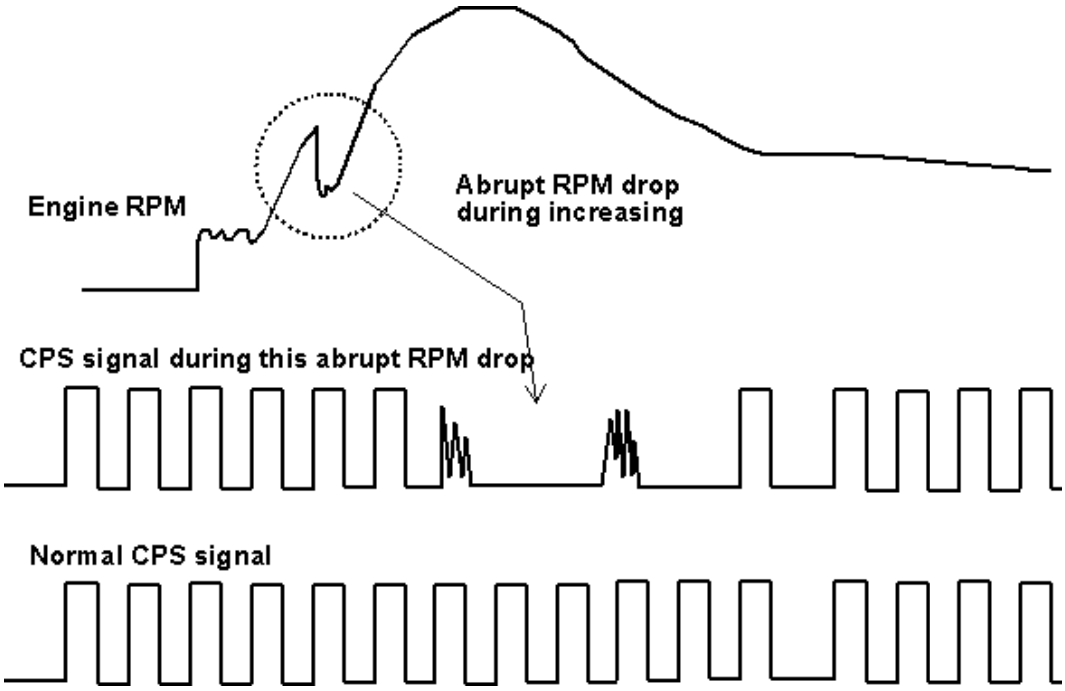
Vehicle : New Sephia 1.5L SOHC, Odometer : 7,200Km

Problem description : Engine is started with hesitating. Engine is stopped soon after starting in cold ambient condition and restart is hard.

Cause : Power, which is supplied, to distributor is cut during very short time when key is released after engine start. This phenomenon cause abnormal crank angle signal and it result in engine problem.

Signal measurement:

:



Explanation : When key is released after engine start, ECU doesn't inject fuel due to missing crank angle signal by the bouncing phenomenon(Repeat contact and non-contact)

Enlargement of application: The change of sudden engine speed is due to injection fuel cut or abnormal ignition timing control. Most of this phenomenon is case that ECU doesn't acquire normal crank angle signal, so crank angle sensor signal should be checked whether it is normal or not. And ignition timing and fuel injection control should be checked at the same time.

A. In case of back-fire occurrence of LPG vehicle

B. In case that engine stall is suddenly occurred in idle sate

C. In case that engine vibration is intermittently occurred

D. In case that engine is started with hesitating as jamming flywheel in self motor

< Example 2 >

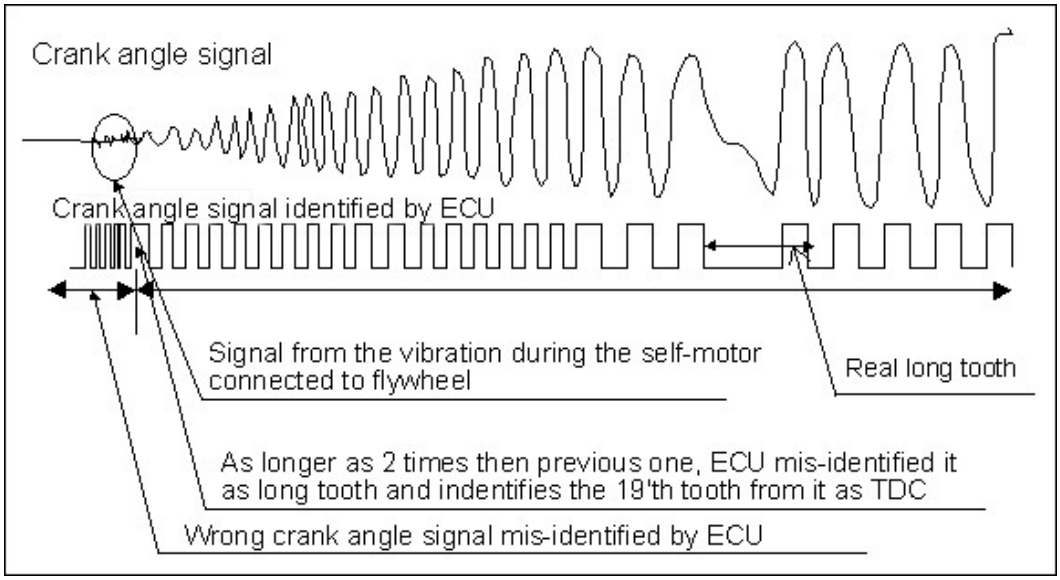
Vehicle : Sephia 2 1.5L SOHC, Odometer : 24,000Km / Credos 2.0L DOHC LPG

Problem description :

- Gasoline vehicle : Engine is started after hesitating during ≈0.5[sec] as jamming flywheel in self-motor or engine is not started with the phenomenon.
- LPG vehicle : Backfire is happened when engine start.

Cause : Injector opening phase is abnormal and ignition timing is controlled with intake stroke.

Signal measurement :



Explanation : When flywheel is jammed in self-motor with initial engine cranking, vibration is occurred. ECU regard it as tooth signal and then first normal crank signal is acquired as long tooth. It results in wrong TDC calculation in ECU and abnormal fuel injection time and ignition timing control.

Enlargement of application : It is example that is occurred by wrong acquisition of ECU. Even though signal is normal, in case that ECU acquires it as abnormal signal, trouble may be detected. Therefore if injection time and ignition timing control is out of normal range, crank angle signal should be.

A. In case of back-fire occurrence of LPG vehicle

B. In case that engine stall is suddenly occurred in idle sate

C. In case that engine vibration is intermittently occurred

D. In case that engine is started with hesitating as jamming flywheel in self motor

< Example 3 >

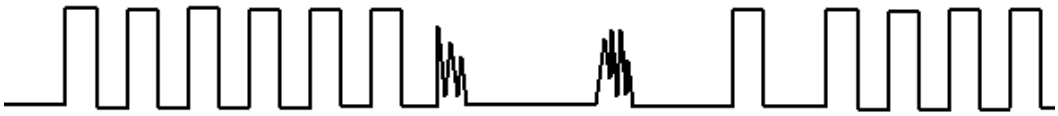
Vehicle : Avella / Sephia 1.5L SOHC/DOHC , Odometer : 24,000Km / Credos 1.8L/2.0L DOHC LPG Taxi (Optical distributor equipped)

Problem description : Engine stall is occurred at times and once the problem is happened it is repeated many times. And after maintaining normal state for long time, engine stall is suddenly occurred. And then engine is not started.

Cause : Crank angle signal is sometimes missed or noise is occurred.

Signal measurement :

CPS signal : Signal is missing once in a while.



CPS signal : Signal has much noise.

Explanation : In case of missing crank angle signal and noise occurrence, ECU recognize wrong tooth number. At this time injection and ignition is cut until tooth number is identified. If tooth number is corrected during injection and ignition cut, it is started again but engine stall may be occurred before ECU recognize it.

Enlargement of application : In case of sudden engine stall without abnormal engine operation, it is due to mainly abnormal crank angle signal. In this case, crank angle signal, injection time and ignition timing should be checked together and if missing injection or ignition is found out, check noise occurrence after amplifying crank angle signal.

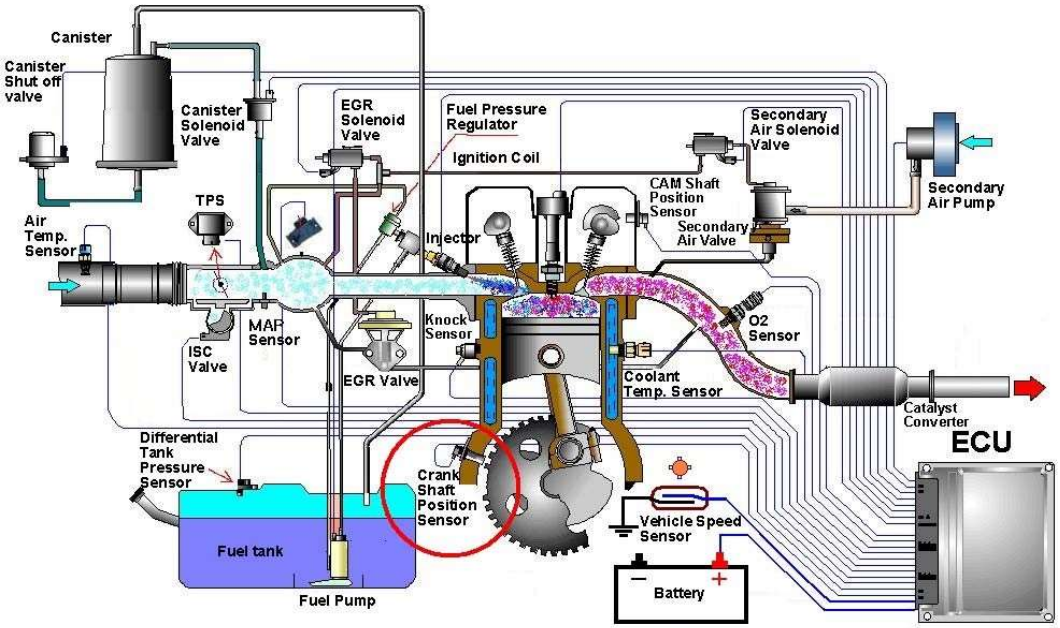
A. In case of back-fire of LPG vehicle

B. In case that engine stall is suddenly occurred in idle sate

C. In case that engine vibration is intermittently occurred

D. In case that engine is started with hesitating as jamming flywheel in self motor

3. Location of Crank Angle Sensor



< Crank angle sensor : Hall / Magnetic type(left) / Optical type(right) >

4. Check method

Check trouble – Crank Angle Sensor

Explain the Checking Method and Diagnosis of trouble.

Preparation

With connecting the Oscilloscope, Set the Sampling rate to over 250KHz and Compare the Counts and width of tooth between Long tooth after measuring the Crank Angle signal when Engine trouble is appearing.

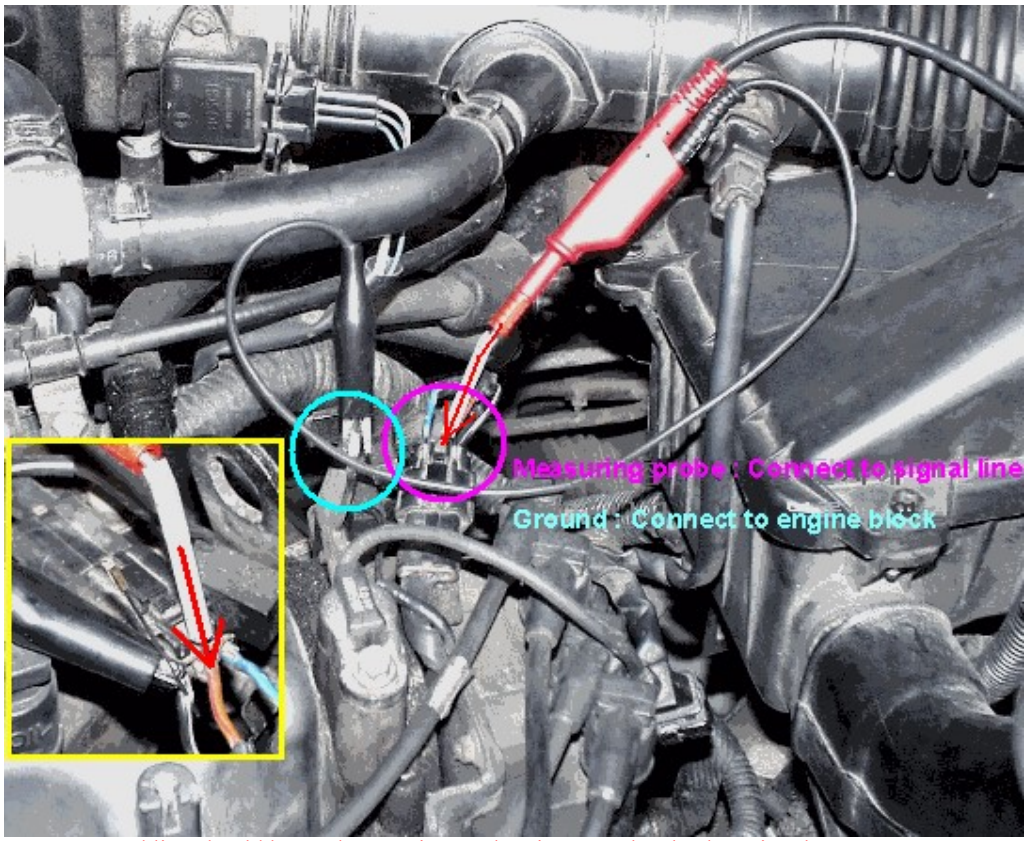
< Reference > This signal must be measured on over 250KHz sampling rate at least. In case of low memory capacity, Measuring time is very short. Thus It must be measured on time of appearing the Engine trouble as triggering the signal. But it is difficult to catch on time of Engine trouble. At this time, Connect the Auto-Scanner. In case of connecting the Auto Scanner, there is no need to additional check trouble because Auto-scanner analyzes and Diagnose the trouble automatically.

1. Find and connect the Signal and Ground line referencing the wiring diagram.
2. After measuring the Signal, Compare the measured signal with Normal Signal.
3. Check if Operating of Related components with this signal is Normal through checking the normal condition value of components

< Related components >

1. Injector Timing and working status.
2. Ignition timing and working status
3. Synchronization og CAM angle signal

Check method

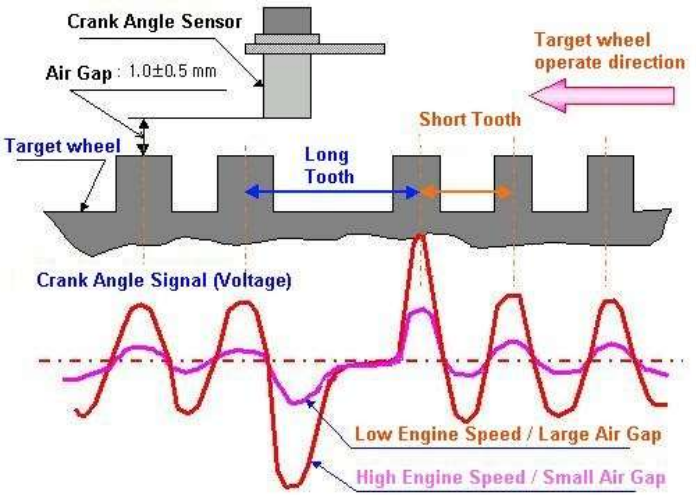


Reference : Ground line should be earth to engine or chassis to see the absolute signal.

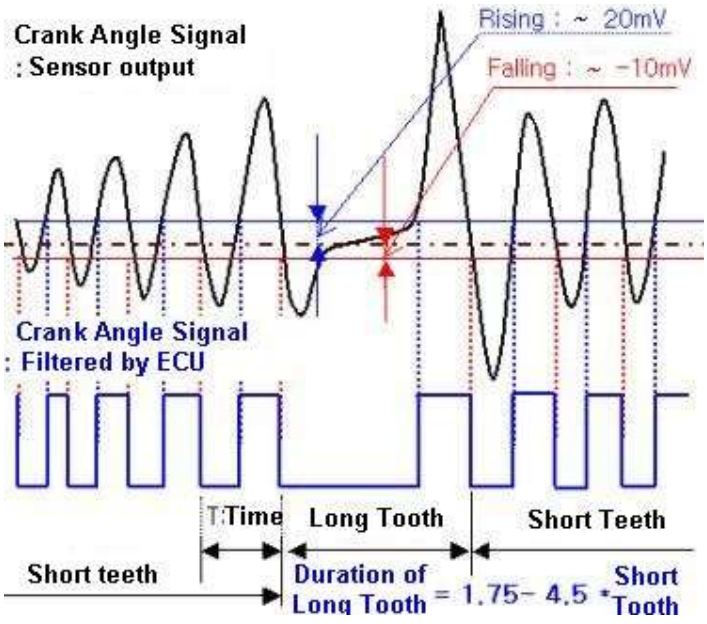
5. Wave analysis

Magnetic type

1) When the target wheel (The ring that has teeth) pass by the magnetic crankshaft sensor, electric pressure is generated during cutting the lines of magnetic force. The shorter the distance between crankshaft sensor and the target wheel (air gap) is and the higher the engine revolution is high electric pressure is generated. The longer and the slower, low electric pressure is generated.



2) ECU can recognize tooth signal not by means of peak signal but by means of rising edge and falling edge. That is, if the output voltage of the magnetic sensor is **over about 20mV ECU determines ON**, if **about – 5 ~ – 10mV ECU determines OFF**, and finally ECU recognize one ON/OFF cycle as one tooth.



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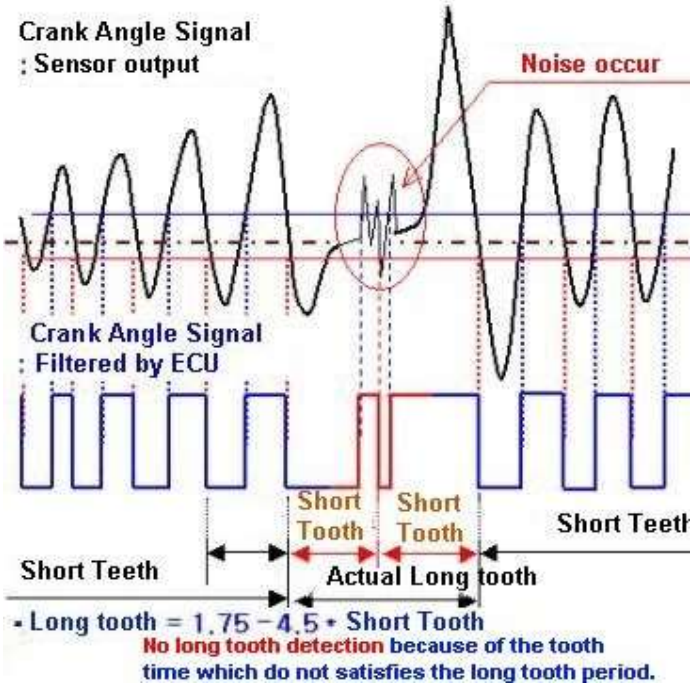
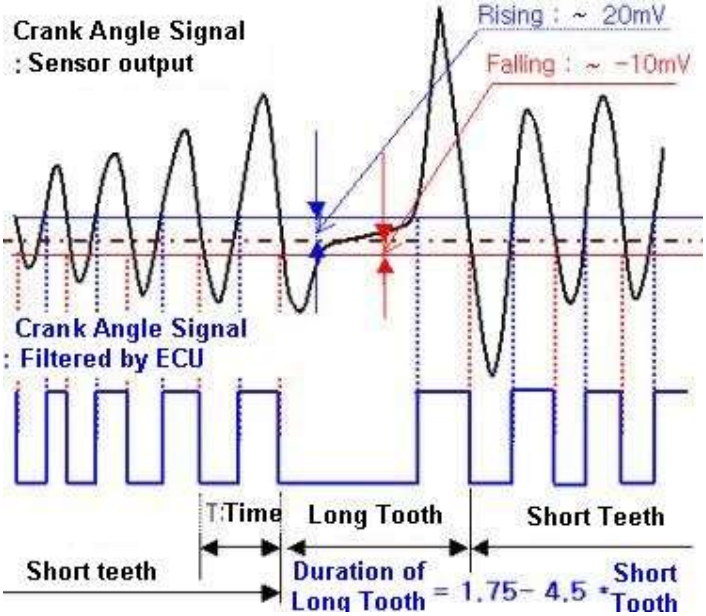
3) If noise is occurred and ECU recognizes this noise signal as real tooth signal, ECU cannot detect long tooth or detect more increased short tooth and it results in fuel cut and ignition cut. So when noise is exist, it must be checked abnormal injection.



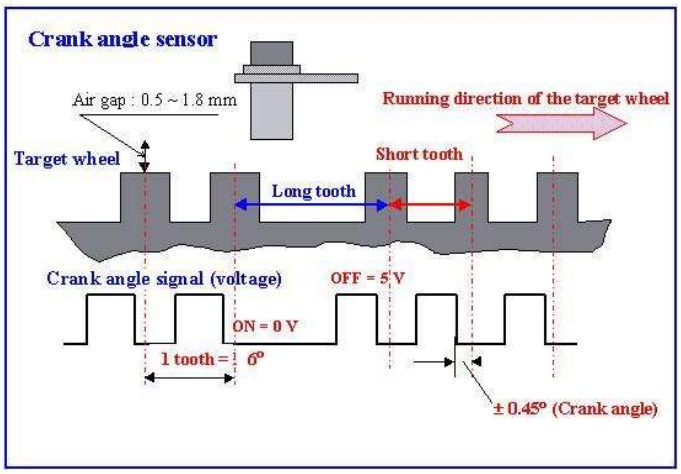
4) The level change (Edge: from high to low level/ from low to high level) of the camshaft signal must be occurred **at least two short teeth before from the long tooth**.

If the level change of the camshaft signal is occurred at long tooth or at short tooth before one tooth from the long tooth, We must check pulley (TDC) position and modify it.

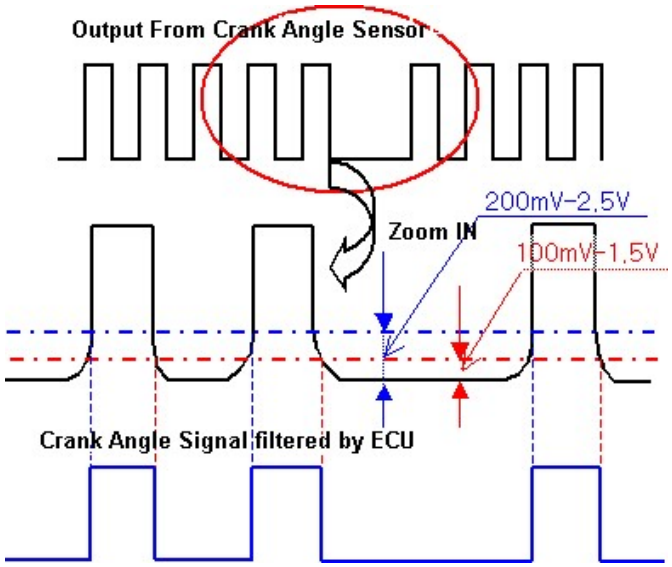


Hall type

1) This one is hall type sensor and circuit is included within sensor and 12V power is supplied. If metal is passed the sensing part within 1.0±0.5mm gap, 5V (or 12V with another sensor) output voltage is generated through sensor internal circuit.

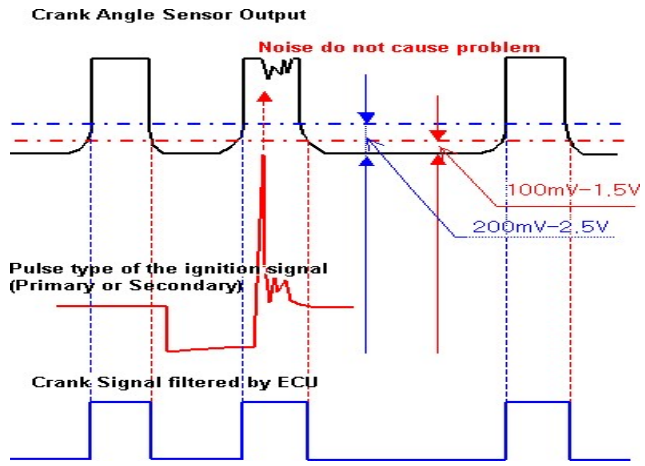


2) ECU can recognize tooth signal not by means of peak signal but by means of rising edge and falling edge. That is, if the output voltage of the magnetic sensor is **over about 200mV ~ 2.5V ECU determines ON**, if **about 100mV ~ 1.5V ECU determines OFF**, and finally ECU recognize one ON/OFF cycle as one tooth.

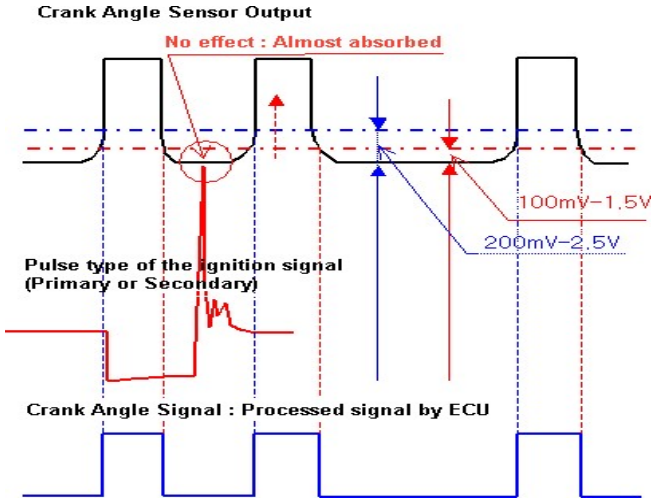


3) If noise is occurred and ECU recognizes this noise signal as real tooth signal, ECU cannot detect long tooth or detect more increased short tooth and it results in fuel cut and ignition cut. So when noise is exist, it must be checked abnormal injection.

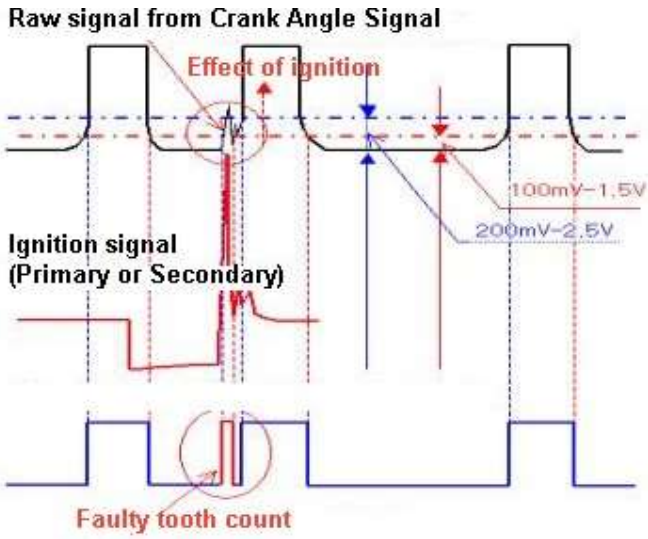
< When ignition wave is occurred during crank angle signal ON >



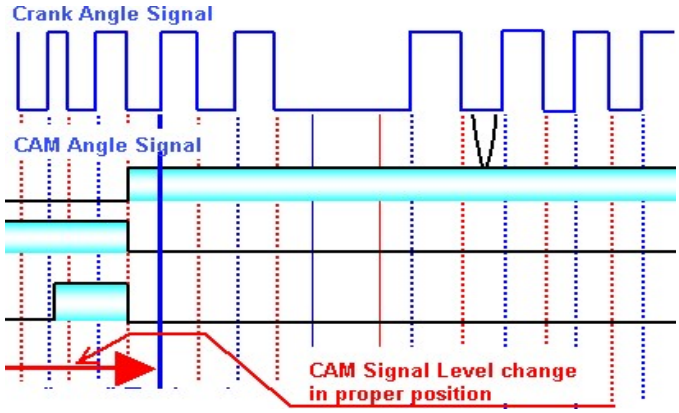
< When ignition wave is occurred during crank angle signal OFF >



< When ignition wave is occurred at the beginning of crank angle signal ON (or OFF) >



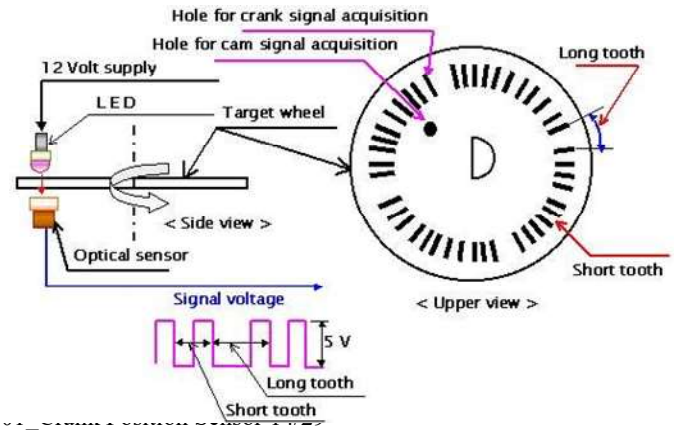
4) The level change (Edge: from high to low level/ from low to high level) of the camshaft signal must be occurred **at least two short teeth before from the long tooth**.



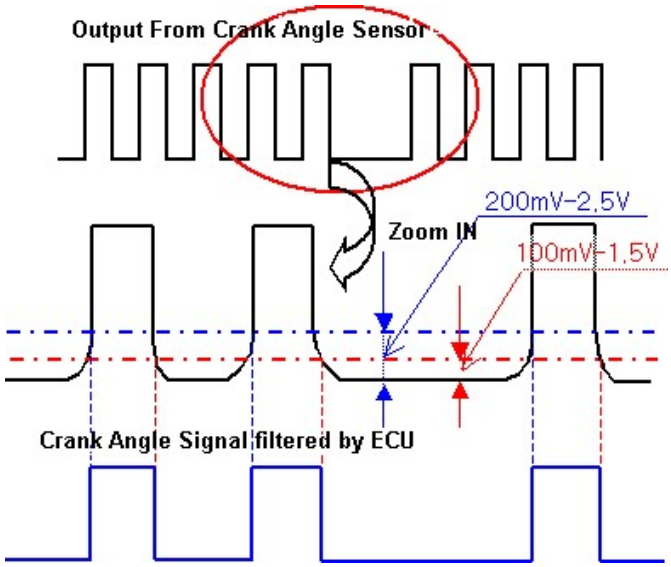
If the level change of the camshaft signal is occurred at long tooth or at short tooth before one tooth from the long tooth, We must check pulley (TDC) position and modify it.

Optical type

1) This is an optical sensor. During round plate (It is called target wheel) that has holes is revolved with camshaft, the light is shone. If the light passes through the hole, out put voltage is generated. This sensor uses this principle and need power to be operated.



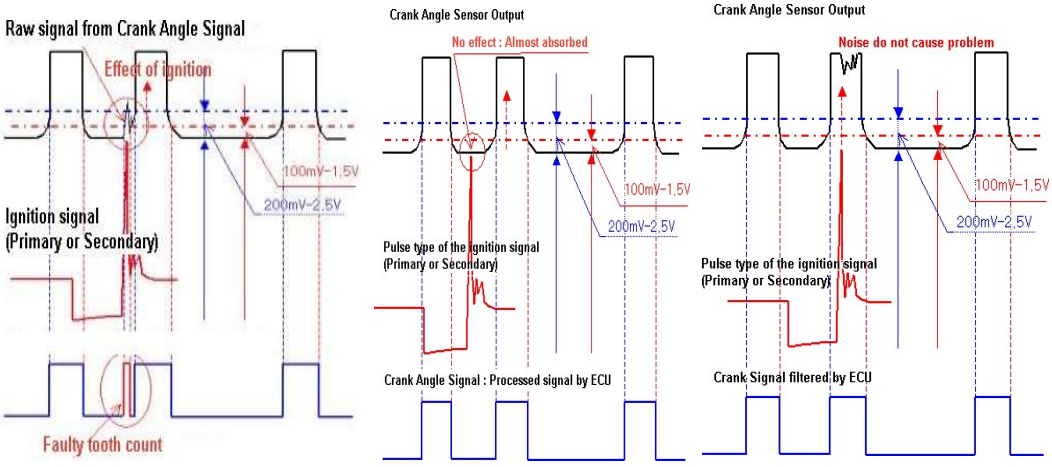
2) ECU can recognize tooth signal not by means of peak signal but by means of rising edge and falling edge.



That is, if the output voltage of the magnetic sensor is **over about 200mV ~ 2.5V ECU determines ON**, if **about 100mV ~ 1.5V ECU determines OFF**, and finally ECU recognize one ON/OFF cycle as one tooth.

]

3) If noise is occurred and ECU recognizes this noise signal as real tooth signal, ECU cannot detect long tooth or detect more increased short tooth and it results in fuel cut and ignition cut. So when noise is exist, it must be checked abnormal injection.



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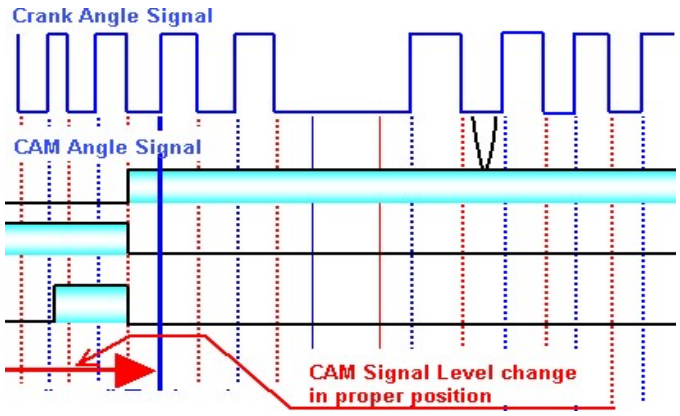
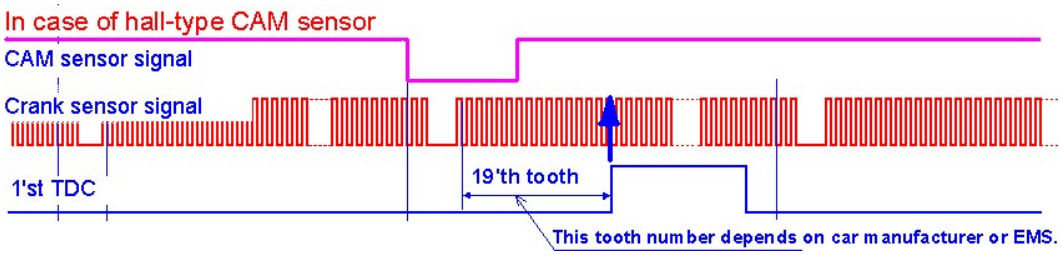
4) The level change (Edge: from high to low level/ from low to high level) of the camshaft signal must be occurred **at least two short teeth before from the long tooth**.



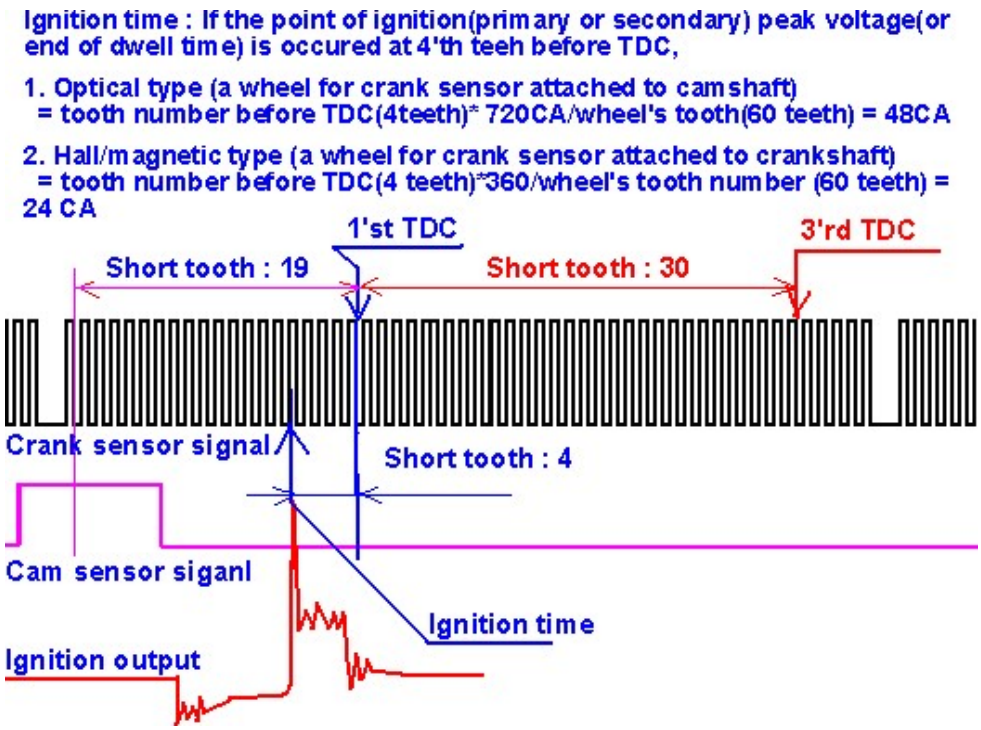
If the level change of the camshaft signal is occurred at long tooth or at short tooth before one tooth from the long tooth, We must check pulley (TDC) position and modify it.

6. General

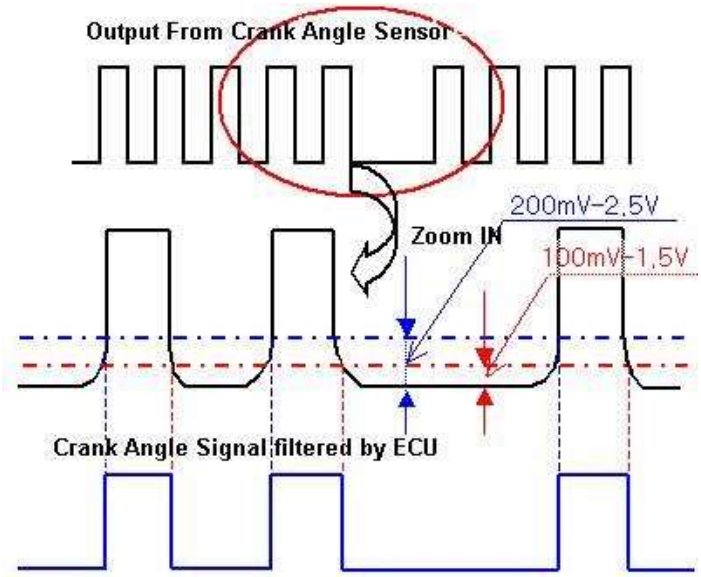
Crank angle sensor is used to know the piston position for injection and ignition. To know the 1 engine revolution, there is a long tooth(3 times long than other tooth) within flywheel. And ECU is memorized the TDC position from long tooth base. For example, "Long tooth after 19th tooth is #1 TDC.



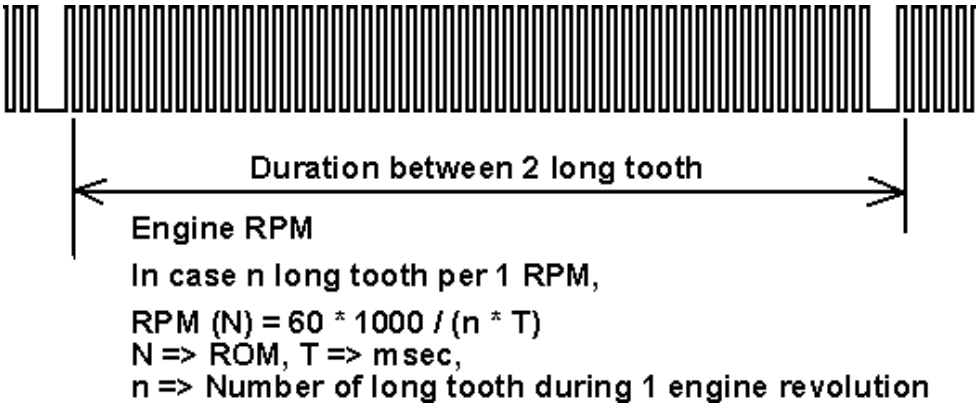
ECU calculate the injection & ignition time from crank angle sensor signal base.



ECU calculate the tooth number from rising/falling edge.



Engine speed is calculated from the period of long tooth – long tooth



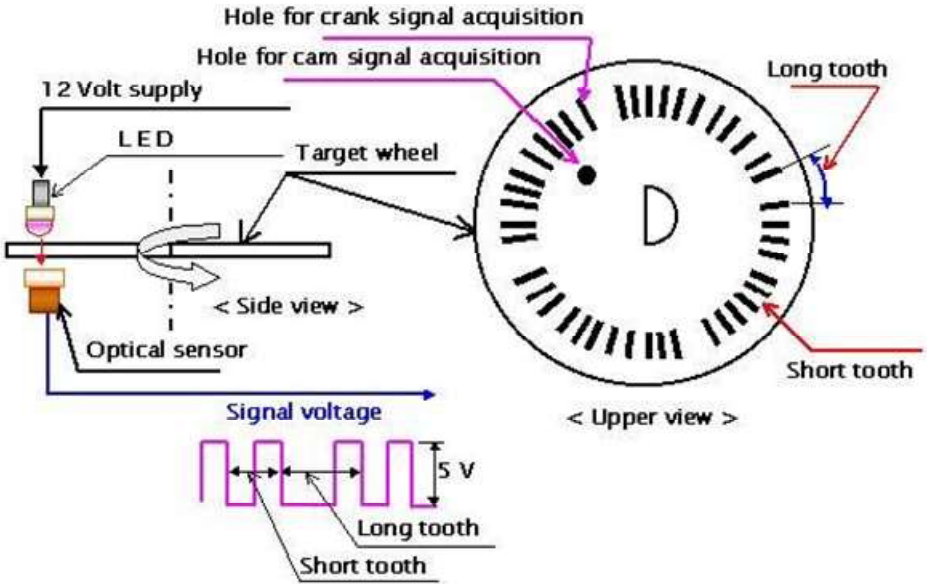
If scanner read the engine speed signal, it means ECU recognize the crank angle sensor signal normally.

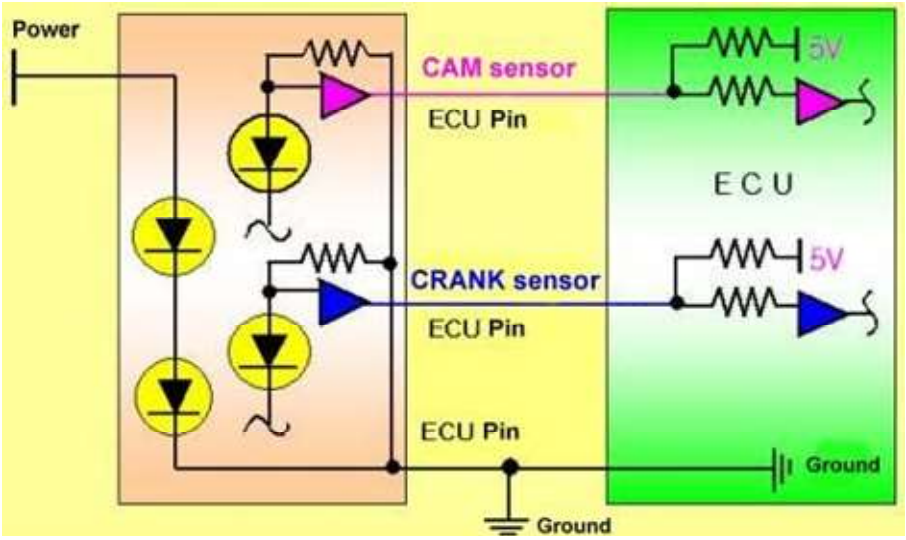
There are three types of crank angle sensor,

(1) Optical type : This is an optical sensor. During round plate (It is called target wheel) that has holes is revolved with camshaft, the light is shone. If the light passes through the hole, out put voltage is generated. This sensor uses this principle and need power to be operated. Generally this sensor is located within distributor and revolved with camshaft together. This optical sensor is weak at heat and moisture and then results in error. One hole of the target wheel makes one tooth signal, and this signal stands for the angle of engine revolution. If the short tooth (when hole interval is short) is N, long tooth means (when hole interval is long) three short tooth. As crankshaft revolves 2 cycles during one camshaft revolution, one crank angel is calculated as follows.

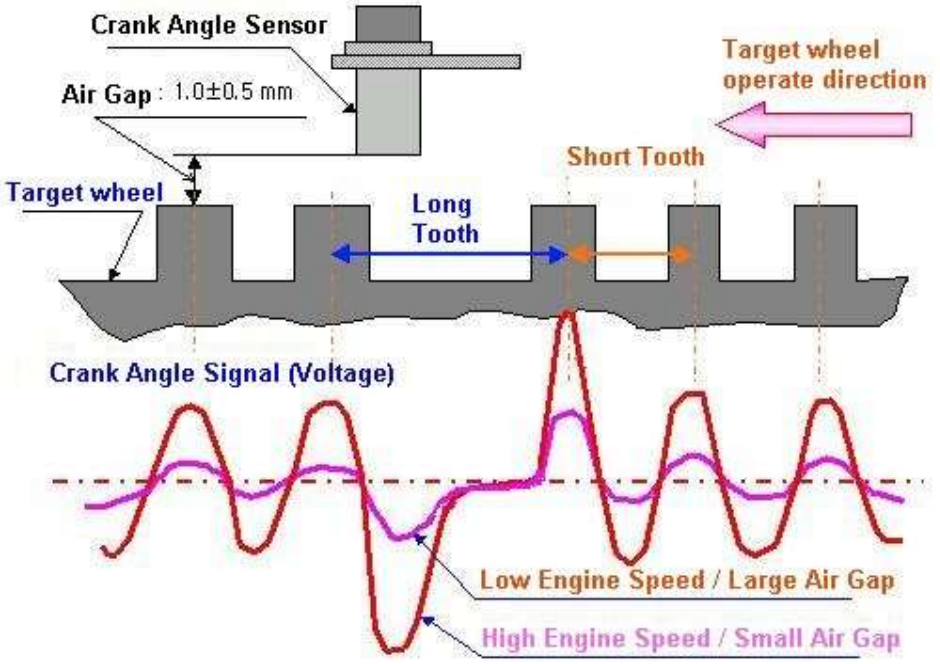
< Reference >

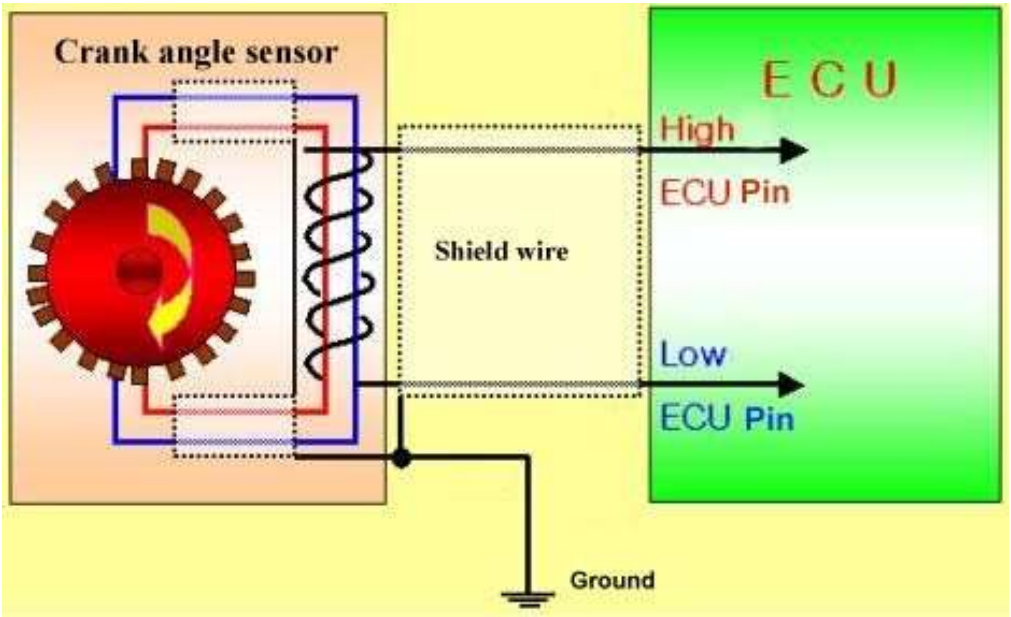
Crank angel pre one tooth at 4 cylinder engine = 720 / N [angel].



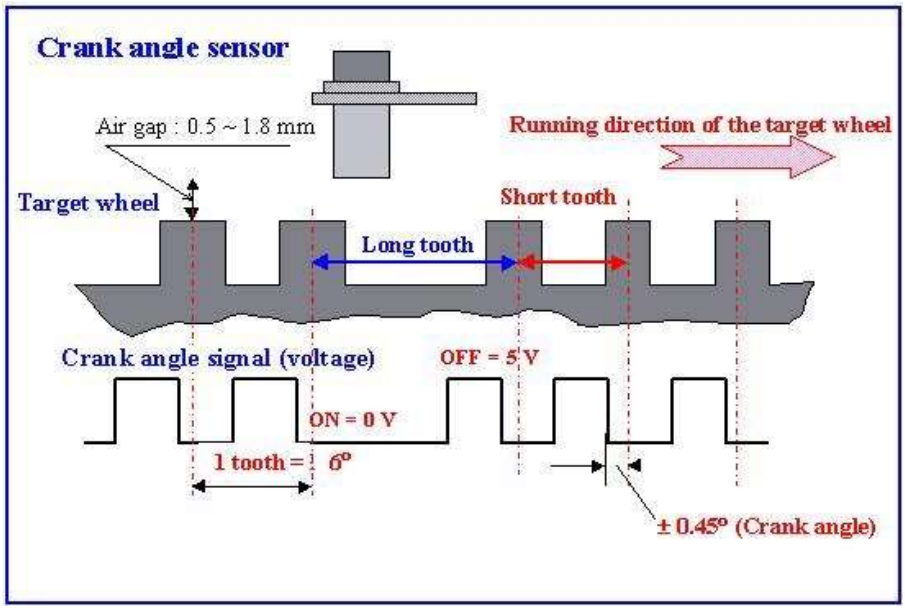


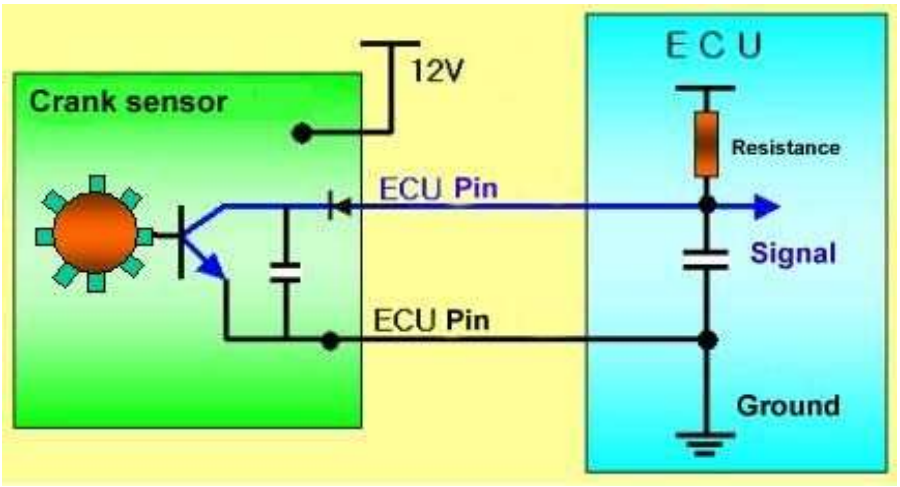
(2) Magnetic type : Magnetic hall sensor makes magnetic line of force, thus if flywheel cuts this line during revolution out put voltage signal is generated. The gap between sensor and flywheel must be within **1.0 ± 0.5mm**. One of the signal lines generates positive voltage and the other negative one. As a square type wheel (It is called target wheel) is assembled at flywheel that is connected to crankshaft, this sensor generates tooth signal during engine running. One tooth stands for crank angle of engine revolution that is called tooth signal. If the total tooth number is N during 1 engine revolution, the crank angel is calculated as follows.





(3) Hall type : This one is hall type sensor and circuit is included within sensor and 12V power is supplied. If metal is passed the sensing part within 1.0±0.5mm gap, 5V output voltage is generated through sensor internal circuit. As a square type wheel (It is named target wheel) is assembled at flywheel that is connected to crankshaft, the sensor can get the tooth signal if engine is running.

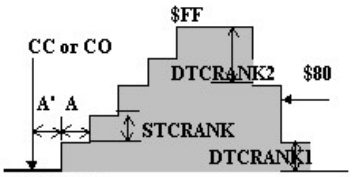




7. Principle (Algorithm) introduction

Malfunction of crank angle sensor makes critical problem on automotive engine electric control. Usually, ECU detects an error when no crank angle signal is detected during 2 engine revolutions but recent ECU has the logic that detect an error when number of teeth from crank angle sensor is incorrect.

Fault detection logic(algorithm)

Fault type	Detection of fault	Strategy	Code	Remark
C O C C GND CC BAT+	Crank angle sensor Fault detected when there are no crank angle signal during 4 CAM signals(4 engine revolutions)	 OFF ON OFF PPCRANK : Present fault detection	0 0 0 2	A' : delay for detection = 4 engine revolutions A : delay for detection = 2 engine revolutions
C O or C C GND C C BAT+	CAM shaft sensor Fault detected when there are no CAM signal during 4 TDCs (2 engine revolutions)	OFF ON OFF PMCRANK :Fault detection memorized OFF ON OFF CEL : MIL OFF ON OFF LIMP-HOME	0 0 0 3	A, A' : delay for detection = 2 engine revolutions

< Reference > As above mentioned error detection condition and logic can be changed by electric control unit developers, it must be understood as an example information otherwise you will see different cases.

For example, it is possible to make a algorithm to detect an error when Camshaft sensor signal is wrong for more than 2 times in stead of above algorithm.

If crank angle sensor signal is incorrect, the ECU will do extravagant operation. For example, it is similar to that nobody knows what a mental patient will do. Because the top dead center of every cycle is the reference point of ECU operation (read input signals and operate actuators). Therefore If ECU recognize wrong TDC by reason of incorrect crank angle signal input, wrong output will be calculated by ECU.

<Example> Normally ECU checks whether EGR is equipped and if it is recognized as “No EGR” then ECU will not operate EGR. However, if there is no EGR and ECU start to operate EGR without “EGR recognition phase”, ECU will detect an EGR error, because no EGR activate while ECU try to operate EGR… it is a kind of nonsense case for technician.

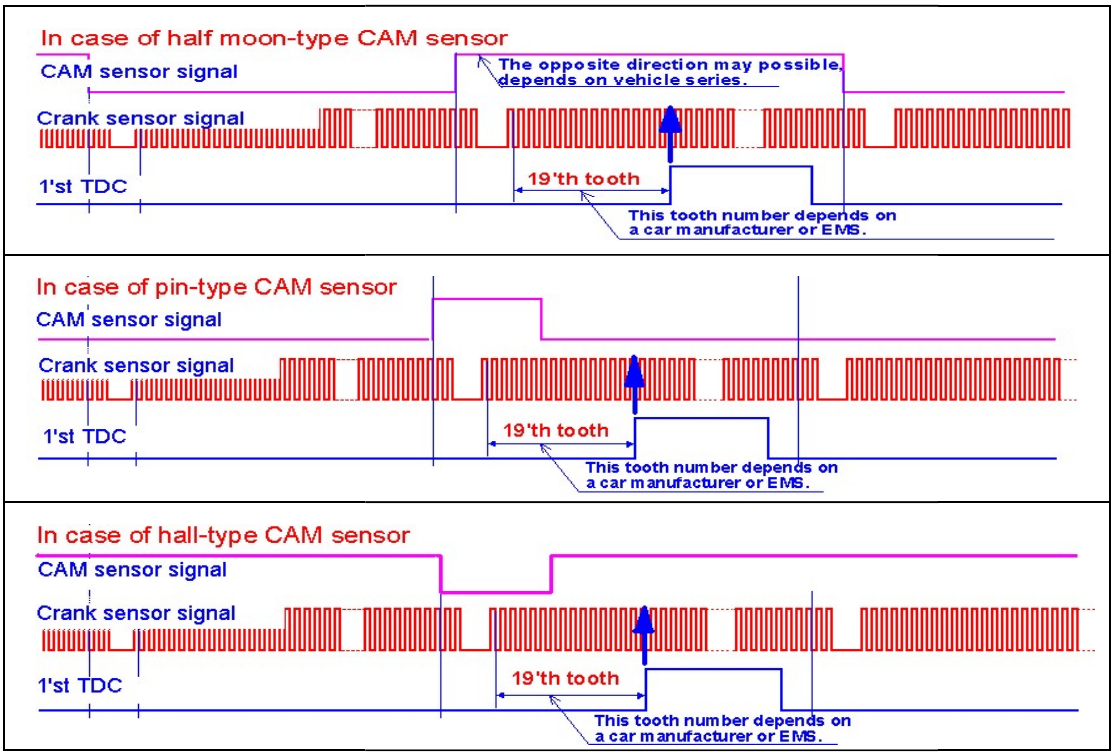
Now let me explain about how to check and how to deal with crank angle sensor error, which makes ECU crazy in case of sensor error.

Frankly speaking, complete healing of following cases are quite difficult except “1” and “2”.

It is important that existence of normality of cam angle sensor when we check angle sensor. So, following explanations are divided by crank angle sensor condition

1. In case of normal crank angle signal

If ECU detect a number of crank angle signal (4 –15) in the beginning of engine start, ECU recognize it as engine is running and calculate engine top dead center in accordance with crank angle signal which is detected up to now. According to this top dead center (TDC), ECU control ignition angle, injection phase and read other input signals and operate actuators and therefore the engine is running.



(1) How to find TDC

Crank angle signal has two different widths short and wide. We call crank angle signal with wide width as long tooth and the other as short tooth. However, TDC is located in the 19th short tooth after long tooth.

<Reference>

Vehicles made in Korea have different reference for TDC point depending on carmaker or electric control unit maker. So, 19th means mostly used TDC reference point in recent.

(2) How to find TDC of cylinder no.1

ECU cannot recognize TDC number from the above picture “(1)”. So, TDC after cam angle signal is recognized as 1st TDC.

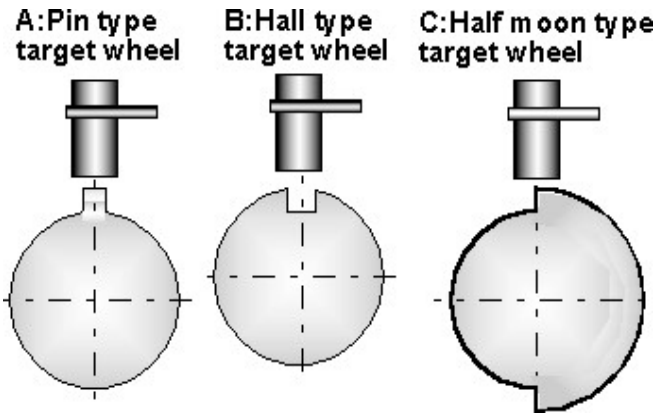
2. In case of no crank angle signal or fixed signal.

< Reference >

Some people call cam angle sensor as TDC or phase sensor. If we call it as TDC sensor, it can be misunderstood as TDC (top dead center) signal made from ECU by electric control unit developer.

In this case, it works in two different ways.

Basically, ECU switches on fuel pump relay or main relay when ECU is aware of engine running by crank angle signal. But ways to operate engine is different by CAM sensor type.



(1) In case of pin or hall type cam angle sensor.(A,B)

The injection and ignition is stop. So, engine start is impossible. A countermeasure of this problem is to check short circuit or line break of crank angle sensor signal line and correct it.

(2) In case of half moon type cam angle sensor (C)

ECU runs engine according to TDC calculated roughly by cam angle signal.

< Reference >

It is possible to run engine with cam sensor signal alone when electric control developer put good data in the ECU to operate engine with cam angle sensor only, otherwise engine may not run. For example, though a certain carmaker's cam angle sensor is half moon type, engine is not running with crank angle sensor.

In this case, ignition angle and injection phase is defined by not tooth number of crank angle sensor but cam angle sensor which is not precise to control engine. So, shock and jerk at acceleration phase or rpm hesitation in the beginning of acceleration take place or a lot of emission might be produced.

< Remark> Start of Injector opening (Injection Phase): Injection phase can be selected from

three ways -(1) Idle area (Idle stability), (2) General1 area (less emission), (3) Power area (more power) - key point to select the phase is to find position of intake valve for good fuel vaporization and burning by test.

< Cause of trouble >

The reason is that no signal voltage from crank angle sensor is due to line break or constantly low signal voltage is due to short circuit to ground or always high voltage is due to line is shorted to reference voltage(5V) or power supply(12V). ?

< Countermeasure > This problem is very simple to repair to general service man and as ECU recognize it as error, problem can be found out by scanner.

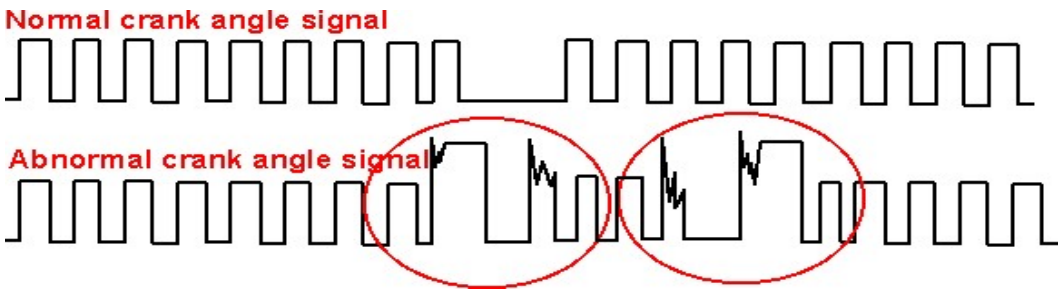
2. In case of no crank angle signal.

In this case, as ECU recognize engine stop due to no engine start with ignition key ON, ECU runs fuel pump for a while (about 1sec but different depend on coolant temperature)

At this time, the reason is same like above “1”. It takes place when line is breaked or connector is not connected well.

3. In case of occasionally abnormal crank angle signal (a part of signal is not appear)

This problem can be happened often during engine start, especially with optical sensor. With



this problem ECU can not recognize crank angle signal well and for that reason, ECU perform injection and ignition at the wrong phase or stop injection until ECU get normal crank angle sensor signal. (Same with case “4”)

In this case, you can feel either engine rpm hesitation or engine is not run well as if start motor gear sticks to gear on the flywheel at starting and in case of LPG, back fire with a bang will happen.

< Cause of trouble > It is due to very short disconnection of power supply to crank angle sensor. Especially micro cut off (about 6~40usec) of power supply to crank angle sensor is expected by unstable connection of complicate wiring in the key box on the steering column, but most of case, the reason is not disclosed.

One of reason found clearly is that as soon as key is released after engine start, micro cut off with vibration was happened, yet most of vehicle have this kind of problem..

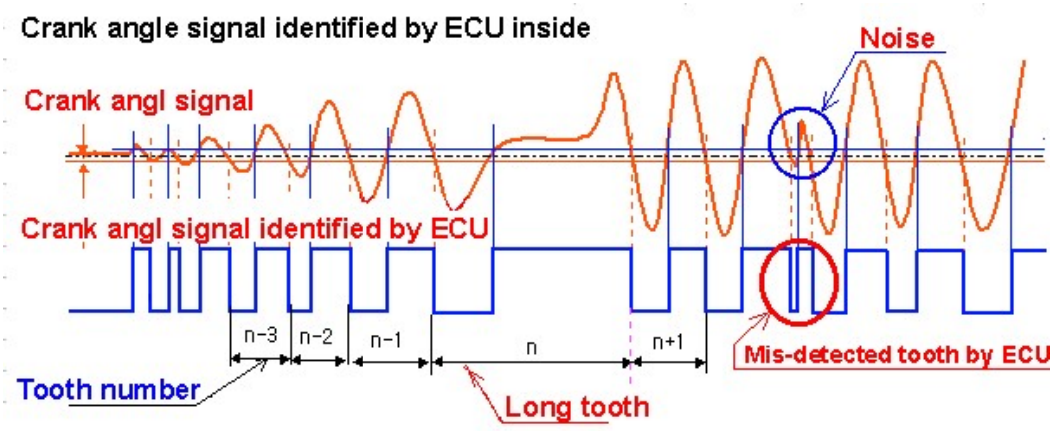
< Countermeasure > Carmakers tried to improve this problem so hard, but they didn’t solve it

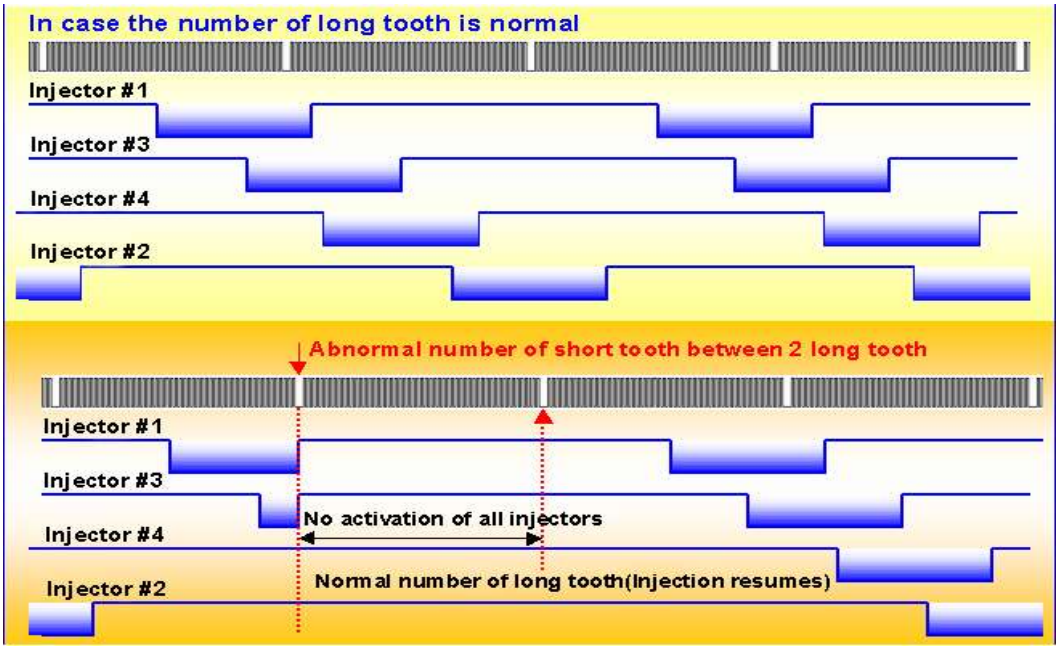
completely and sold it. So, we can meet this kind of problem in the field.

If you want to fix it as a normal technician in the field, one of ways is to connect line between ignition key and starter direct without any terminal.

4. There are noise in the crank angle sensor and ECU treat it as real crank angle signal and number of teeth are incorrect.

It is difficult for ECU to measure width of each crank angle signal due to low processing speed (Of cause possible to measure is by hardware but difficult to process it with one CPU.) But, ECU count the teeth by comparing signal level high or low, so if there is noise, ECU count it as real tooth regardless of its width.





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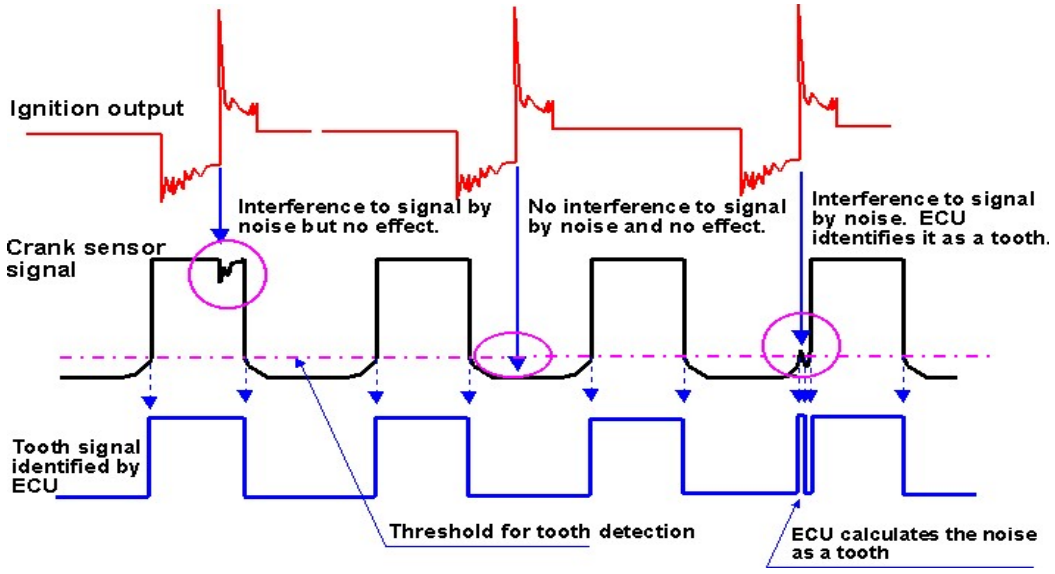
Then injection and ignition is stop until normal crank angle signal due to wrong teeth number of one cycle but it is different by electric control unit maker (ex, no stop in Japan).

< Cause of trouble > In case of optical type (signal produced when light passed), it is easy to be influenced by noise. If ignition noise occurred at the moment of signal falling or rising, this noise can be defined as real tooth and would cause engine trouble (instant fuel cut off).



< Countermeasure > As crank angle sensor signal noise can be expected during development of electric control unit, counteractions are considered to protect that problem. But, it is very hard to block the electric noise from ignition system thus these noise cannot be prevented completely. In addition to the shield on the crank angle sensor signal line to absorb the noise, shield on the ignition system to reduce noise can be used.

Possible method in the field is to shield ignition coil wire and crank angle sensor wire near ECU (About 3 Cm) and both wire must be apart.

< Remark >

Some vehicles that sometimes have engine stalling can be considered as same reason mentioned above. Because ignition and injection stop for one cycle at the moment of noise can be happened. But as we can not see how does ECU recognize crank angle signal, it is difficult to check this problem in the filed. And those vehicles that show above-mentioned problem have odd number of idle ignition angle in order to avoid ON and OFF point (rising and falling edge) of crank angle sensor.

5. Trouble with wrong detection of long tooth of crank angle signal.

This trouble can be happened intermittently depending on engine operation conditions and driving conditions and I'd like to introduce the facts that found out during electric control unit

development up to now.

(1) In case of hall type crank angle sensor, it is happened most of time when plus(+) and minus(-) terminal of the crank angle sensor is switched each other. In addition, if we drive under the condition that needs more power such as uphill driving with high gear level (4th or 5th gear) and with low speed, engine is oscillate. At this time irregular tooth interval can be happened when piston speed drop suddenly due to engine oscillation and the trouble can be happened when short tooth is detected as a long tooth. (short tooth with wider interval). In this case, ECU seemed to be stopped for a while and retarded ignition angle more than 20°.

But driver can feel less power or engine stall. Especially, LPG vehicle makes back fire with "Bang" sound.

< Countermeasure >

First of all, in case of hall type crank angle sensor, check if plus (+) and minus(-) terminal is switched. If you have enough time, switch terminals each other and test it.

But basic solution is to ask to the driver " Do not drive with high gear level". In my experience, this trouble seems to take place at the engine which have low torque or low compression rate in the low engine speed. If it is true then to improve ignition system to get normal torque may be effective.

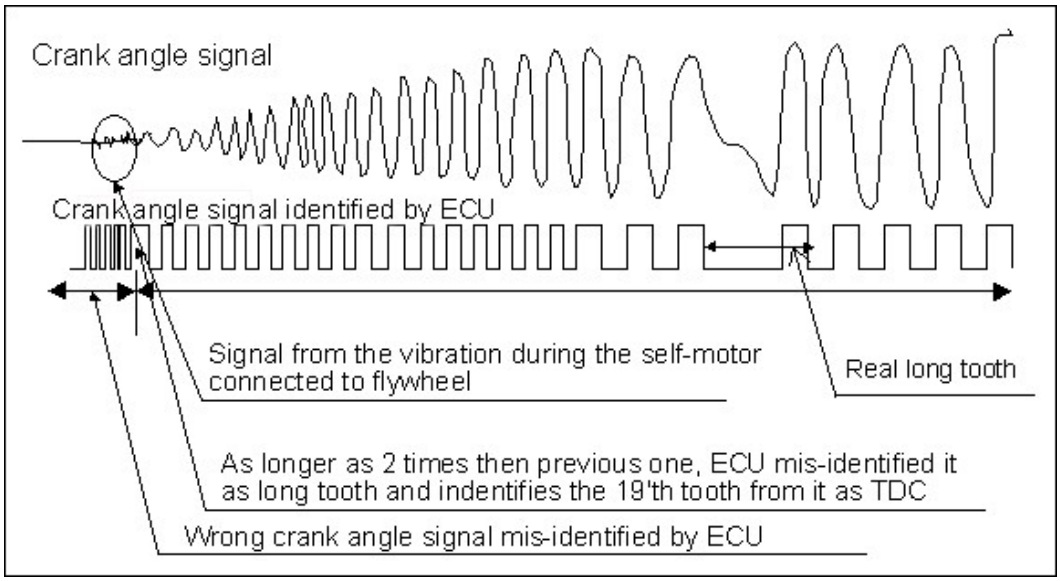
(2) During the engine starting with cold engine, if fuel is too rich or too lean or ignition time is advanced so that fire take place before piston reaches to top dead center (so called "bucking"), then piston speed drop rapidly and tooth gap is getting abnormally wider and it is recognized as long tooth like "(2)" and engine stall.

< Countermeasure>

Trouble can be happened more if winter fuel (high RVP: Relative Vapor Pressure) is used in the late fall or early spring. In addition, using bad spark plug or high heat range of spark plug (cold plug) can makes same trouble. Considering this, check and repair ignition system.

(3) If ignition key is released before engine gets enough speed, engine speed drop suddenly and wrong long tooth detection can be occurred due to increasing tooth gap or in worse case, engine rotates to the reverse direction and makes more teeth.

Generally driver can feel that starter is not engaged well or hesitation before engine start. Of cause engine can stall in worse case.



<Countermeasure >

The engines with low compression rate seems to have less frequency. And the bigger backlash of between starter gear and flywheel gear is the softer phenomenon. It is difficult to fix it in the field completely, but to makes good ignition system can little bit improve this trouble.

(4) In case of magnetic crank angle sensor, vibration in the beginning of engine start can be detected as a real signal by ECU and trouble occurs when ECU recognize real signal after noise as a long tooth. In this case, driver can feel engine speed hesitation during engine start as if start motor is stuck with flywheel. Especially LPG vehicle makes 100% back fire with 'bang' sound.

< Countermeasure > I experienced that a certain company's A/S have fixed this trouble by changing only start motor. They changed starter motor until trouble disappeared. Once customer complained about same trouble again after fixing. The root cause was that ECU recognize normal signal incorrect and later on carmaker changed ECU to ignore crank angle signal for 40 – 60msec after 1st crank angle signal detection. Counteraction on field is to prevent crank signal input at moment of start and it needs electronic engineer's help.