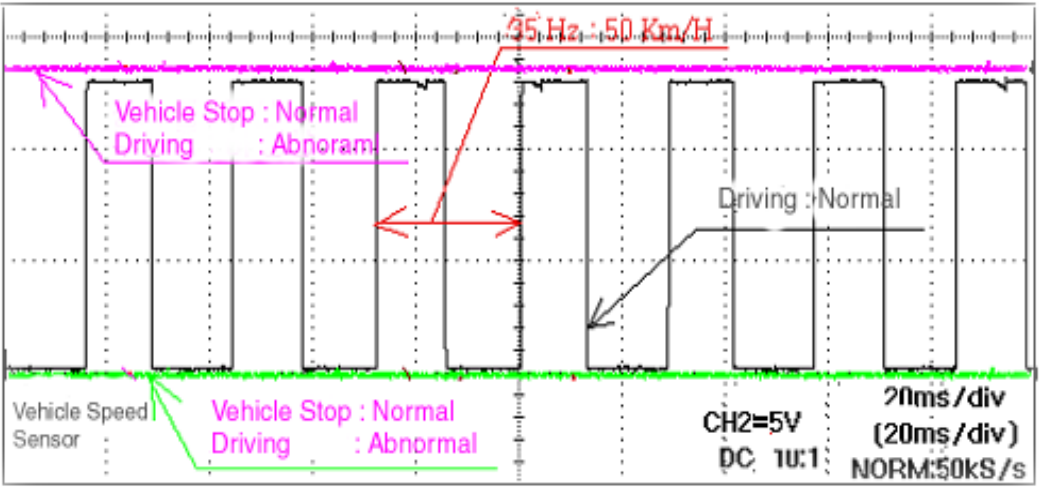
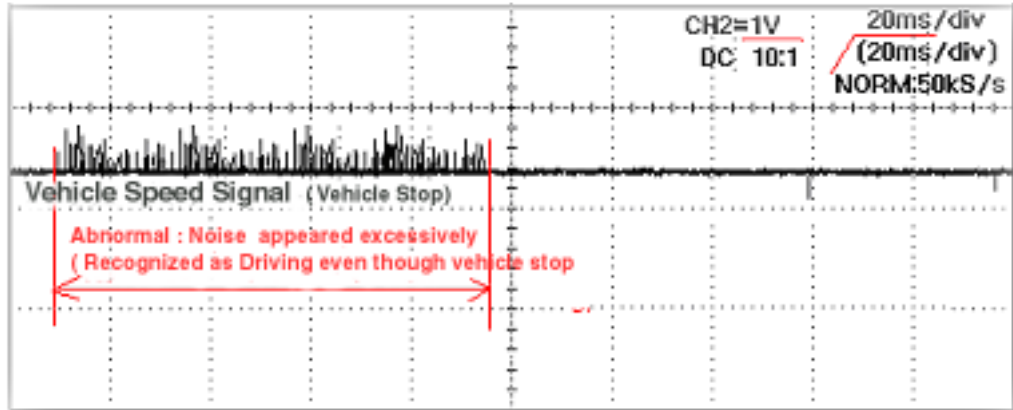


## 13. The signal check of Vehicle Speed Sensor

### 1. Troubles

1. Malfunction of vehicle speed sensor	
Cause of trouble	1.1 Malfunction of vehicle speed sensor or wiring circuit failure(Signal, Ground line)
Cause of trouble	1.1 Replace vehicle speed sensor 1.2 Bad connecting of vehicle speed sensor signal line or short to battery or ground
Engine state	RPM floating and cycling is occurred in idle sate.
Signal measurement	

2. Occurrence of over speed	
Cause of trouble	2.1 Noise occurrence in vehicle speed signal a. Noise detection from TCU connecting line b. Noise detection from ignition system
Cause of trouble	2.1 Shield wiring of vehicle speed sensor and connect directly with single line.
Engine state	RPM floating and cycling is occurred in idle sate. In case of manual transmission, surging may be detected with fast acceleration and in case of auto, poor acceleration is occurred with low vehicle speed and high gear shift.
Signal measurement	

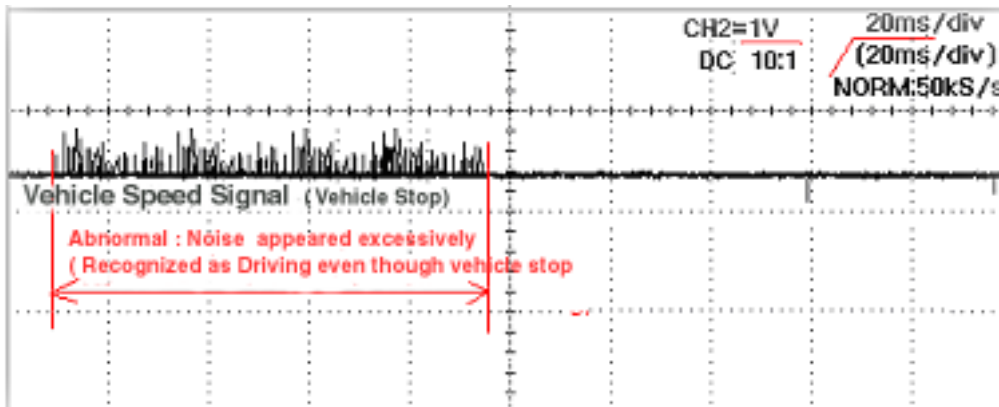
## 2. Field example

**Vehicle** : Credos 2.0L DOHC A/T, Odometer : 28,000Km

**Problem description** : Vehicle should be started with 2 or 3-gearshift and acceleration performance is lack.

**Cause** : ECU recognize 40~70Km/H driving with engine stop because noise is detected with vehicle speed signal . Thus gear was shifted to 2 Or 3.

**Signal measurement** :



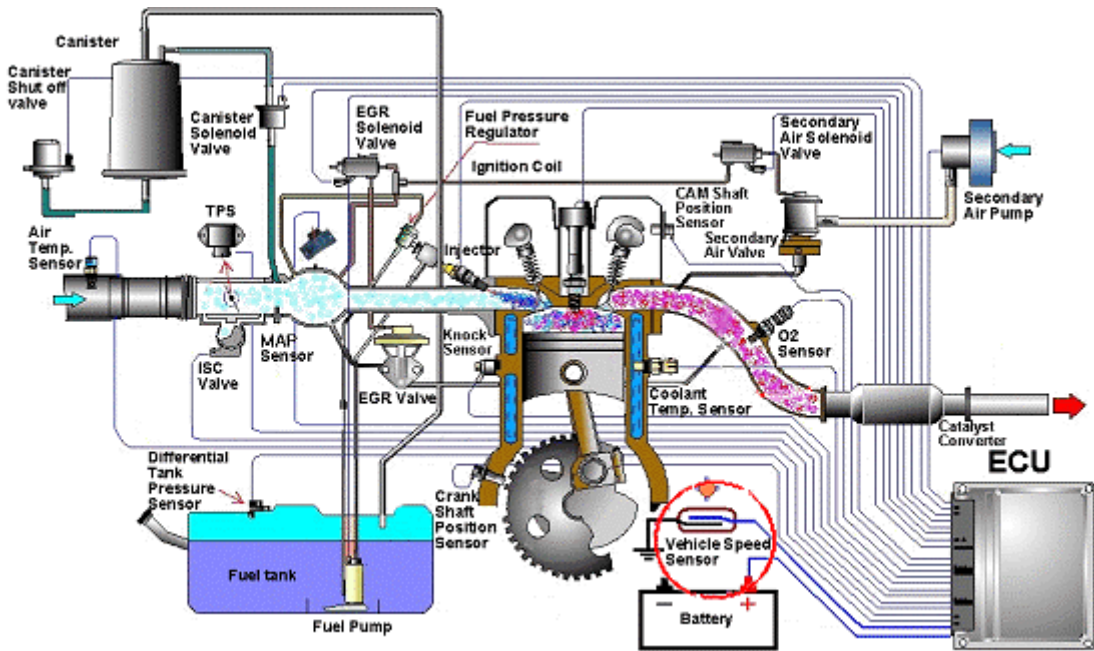
**Explanation** : ECU calculate vehicle speed with only frequency(ON/OFF pulse per second). It is not related to height and width of pulse signal. Therefore up and down signal is recognized as pulse for vehicle speed calculation.

**Enlargement of application** : In case of using pulse for vehicle speed calculation, ECU calculate vehicle speed with only frequency(ON/OFF pulse per second). Therefore pulse has noise, it should be counter action.

< The signal using as input pulse signal >

- A. Crank angle signal
- B. Camshaft angle signal
- C. Vehicle speed signal
- D. Knock signal
- E. Communication signal between ECU and TCU : TPS, Coolant temperature, Engine torque, RPM, Engine torque reduction request etc..

### 3. Location of vehicle speed sensor



## 4. Check method

Explain the checking Method and Diagnosis of trouble..

### Preparation

1. 1. Oscilloscope (It prefers not to use Multimeter )
2. 2. Wiring diagram of vehicle speed sensor.
3. 3. Scanner

1. 1. Find and connect the Signal and Ground line referencing the wiring diagram.
2. 2. Check How the Signal voltage is with connecting the Oscilloscope.
3. 3. Because it is difficult to measure the vehicle speed on driving, make the vehicle lock the rear wheels and lift the front wheels. And then engage the gear and declutch. At this time, let's reference that the vehicle speed displayed on Meter set is half of real speed due to mechanism of differential gear.

< Reference >

In case of connecting the Multimeter, It prefers not to use multimeter because it is difficult to measure the vehicle speed signal, which continue ON/OFF fast.

< Reference >

In case of connecting the Auto-Scanner, Let's reference the results because Auto-scanner diagnoses some vehicle speed signal's troubles automatically.

Comparing Method: After measuring the signal, compare the measured signal with **Normal signal**.

- (1) Compare the current measured vehicle speed signal and frequency with that of normal condition.
- (2) It would like to check the Battery voltage with connecting the scanner if possible.

< Checking items >

- (1) Whether the scanner recognizes the vehicle speed though vehicle stop.
- (2) Whether the noise is occurring in the vehicle speed signal.
- (3) Whether the ON/OFF level of vehicle speed signal is not changed on driving.

### Check method

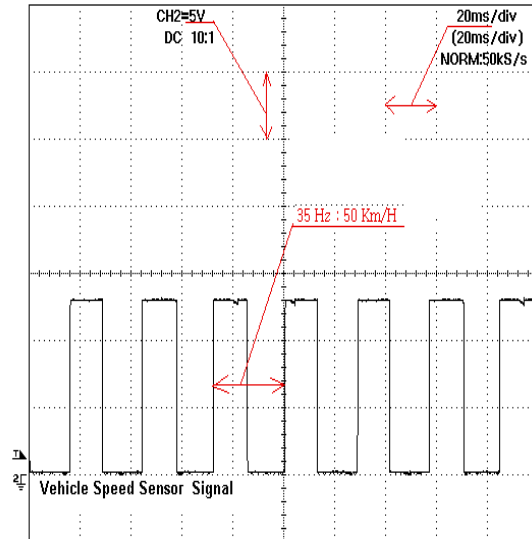
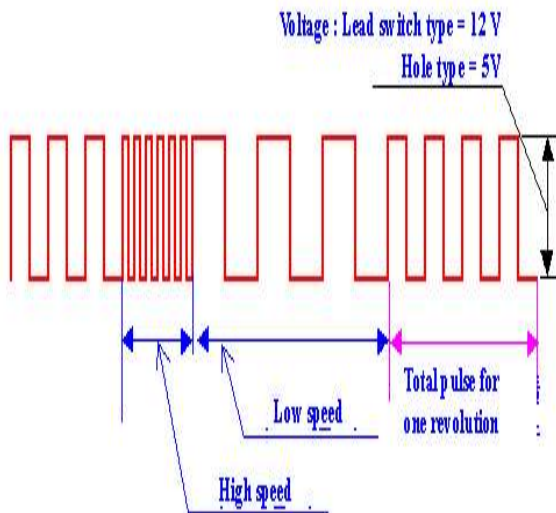
< After inserting the Picture which measuring the signal of Vehicle speed sensor, Write the Explanation about wiring. >

## 5. Wave analysis

Signal characteristic of vehicle speed sensor is as followings :

Voltage characteristic of vehicle speed sensor

1. Reed switch type : 0 – 12 / 0 – 5 volt
2. Hall type : 0 - 5 / 0 – 12 volt
3. Magnetic type : 0 – 40 volt (Change by speed)

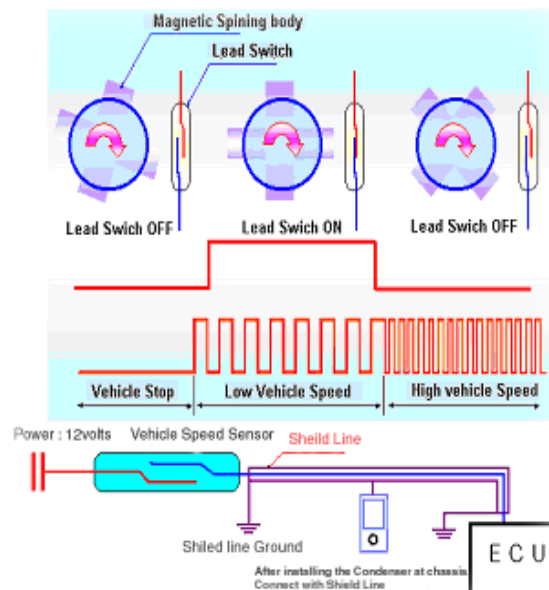
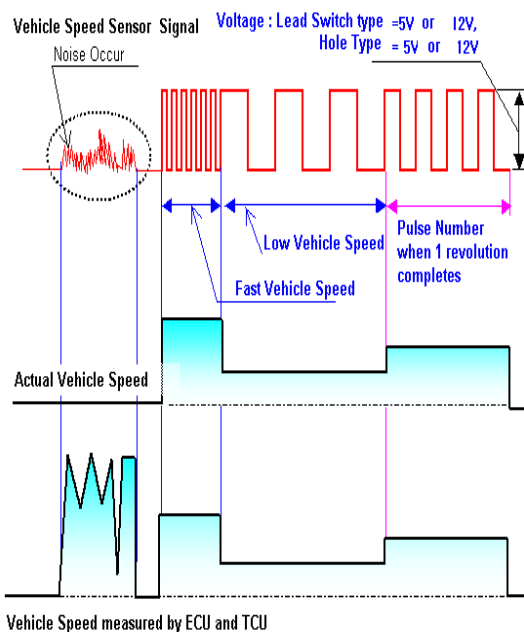


< Reference >

ECU and TCU recognize wrong vehicle speed by noise from vehicle speed sensor.

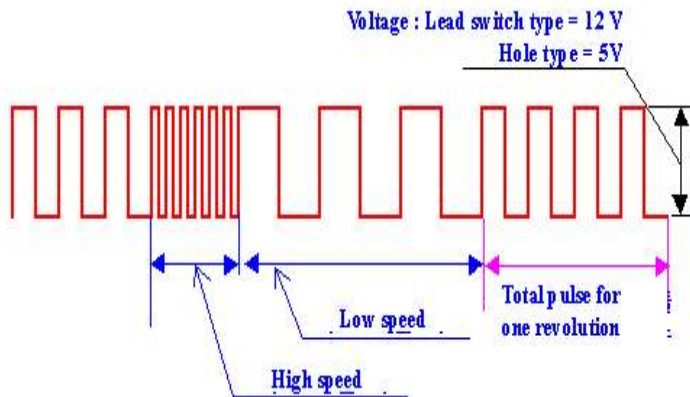
If noise is occurred, check whether ECU recognize vehicle speed with vehicle stop and if it is true, remove noise.

<The cut off of vehicle speed sensor noise>



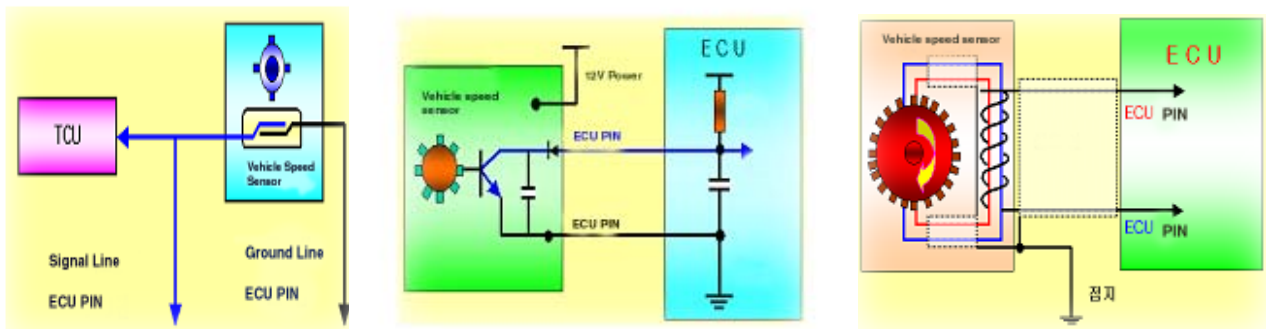
## 6. General

ECU can recognize the vehicle speed in driving by means of vehicle speed sensor and measure vehicle speed as using pulse(ON/OFF repeat signal)during vehicle rolling.



Voltage characteristic of vehicle speed sensor : Hall type

1. Reed switch type : 0 – 12volt
2. Hall type : 0 - 5 / 0 – 12 volt
3. Magnetic type : 0 – 20 volt (Change by speed)



< Vehicle speed sensor wiring : lead type(left)/Hall type(Middle)/Magnetic type (Right) >

Vehicle speed sensor make that ECU know whether vehicle is rolling or stop. ECU calculates the vehicle speed only referencing how much signal is occurring. At that time it is used for recognizing the Gear state on the Manual vehicle and for informing the vehicle speed needed for shifting the gear in Automatic vehicle. The troubles that are occurred in case of vehicle speed sensor error can be estimated by means of following sensor application.

1. There is a big difference in shock and acceleration feeling at manual vehicle according to fast acceleration with different gear ratio. Thus to improve this shock and acceleration feeling, ECU determines the gear ratio with reference to the engine speed and vehicle speed.

2. In automatic vehicle, gear ratio is determined with reference to the position of acceleration pedal and the vehicle speed at that time.

< Reference > In case of above sensor application

1. If there is a misdetection of driving though vehicle is stop, engine irregularity (bad condition) is occurred in idle state. On the contrary, if there is misdetection of vehicle stop though driving, severe irregularity and engine stall is occurred.

There can be bad acceleration feeling and shock from misdetection of gear ratio caused by the misdetection of vehicle speed. If vehicle speed is not determined exactly, gearshift come to be fast or slow

## 7. Principle (Algorithm) introduction

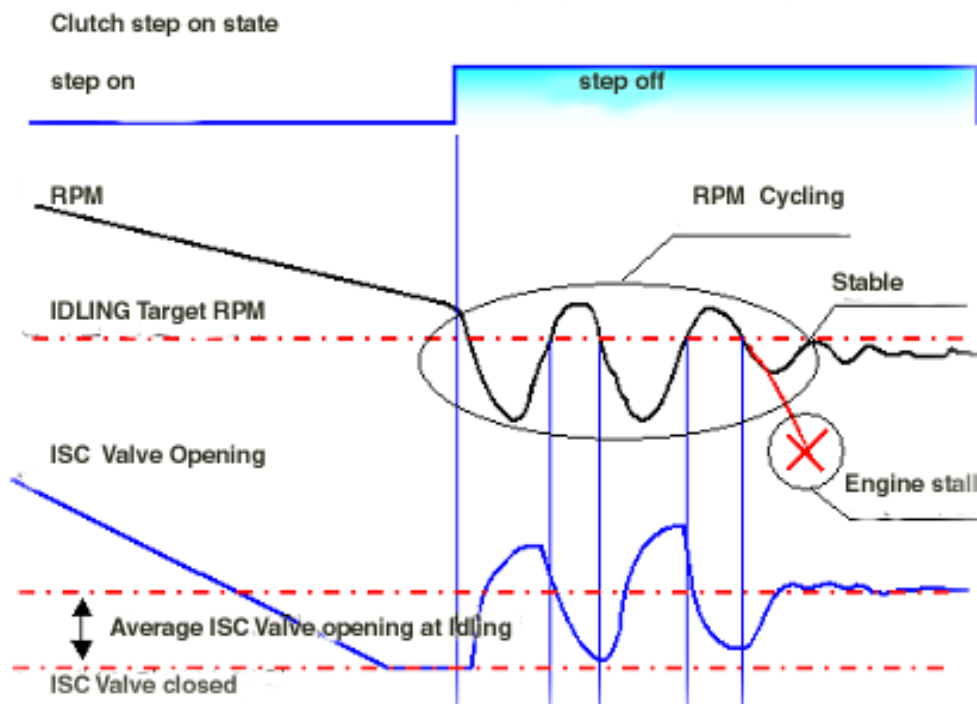
### 7.1 Function of vehicle speed sensor

#### 1) Distinguish vehicle running or not.

Vehicle running(ROLL = OFF) or stop(ROLL=OFF) is determined by vehicle speed signal. Vehicle is running with signal and stop with no signal.

First it is important to determine if vehicle is running or not. Because the main target during vehicle stop is kept target idle rpm by using ignition timing and ISC valve opening but ignition and spark time is limited during vehicle running.

**In case of unlimiting the ISC valve opening on Driving.**



For example, if we are driving down the hill with gear engaged and without clutch pedal pushing, engine speed will increase as slope is increase. In that case ECU will close the ISC valve because engine speed is higher than target with closed throttle which can be detected as idle state by ECU. ECU will close totally ISC valve until target engine speed. Then what will be happened if we push clutch in that time?

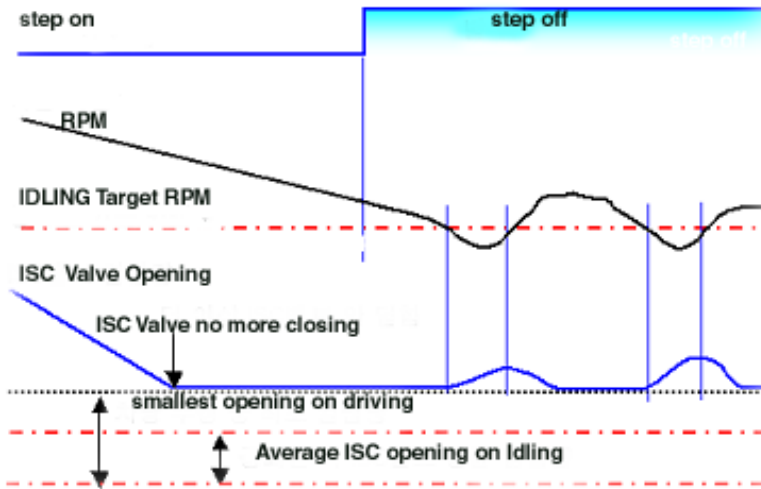
As ISC valve is totally closed, there will be a big engine speed drop as soon as pushing the clutch. Then ECU will open ISC valve again rapidly. Engine speed will increase again and then ECU will close ISC valve again. Finally engine speed will rising and falling for a while (cycling) and then it will be stabilized. So, when vehicle is running, there is a limit for ISC valve closing.

Therefore if vehicle is moving then high idle engine speed can not be reduced to its target or can be reduced after some delay time..



**In case of limiting the ISC valve opening on Driving.**

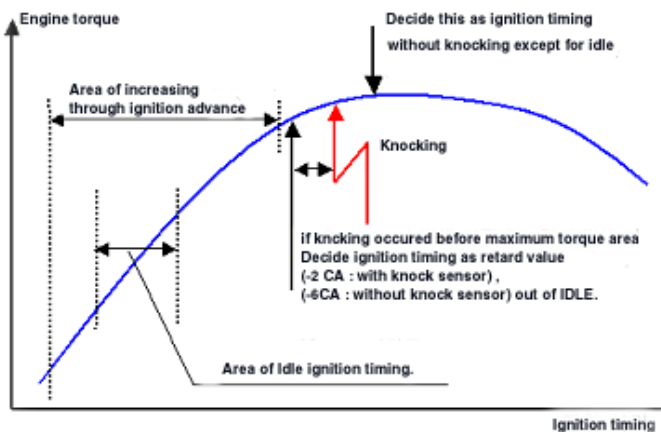
Clutch step on state



Spark time has also limit like ISC valve during vehicle moving. Generally spark is advanced with idle rpm is decreasing and retarded when idle rpm is increasing to prevent idle rpm variation. But, if spark variation during vehicle moving is too big then there will be a shock and jerk due to variation of torque.

As an remark, spark time at idle is established by considering of (1) variation of engine speed (2) intake air variation (3) vibration (4) noise (5) emission (6) exhaust gas temperature under stoichiometric air fuel ratio. Some of carmaker considers vibration more. But in order to control idle speed variation by spark time, basic ignition angle setting is done in the area of that torque increasing and decreasing is possible.

**Decision of Ignition timing**



As mentioned above, ECU considers vehicle moving or not is more important than to know vehicle speed itself.

**2) Define gear ratio by vehicle speed.**

Vehicle speed can be easily calculated ON/OFF signal per every 1sec. First, it is need to know why gear ratio is need in order to understand purpose of gear ratio calculation. We can feel big

shocks when we suddenly accelerate or decelerate with low gear ratio (1<sup>st</sup>, 2<sup>nd</sup>). Generally, biggest acceleration shock with 1500cc vehicle is coming from 2<sup>nd</sup> gear with 20Km/h of acceleration. And the biggest deceleration shock is coming from 1<sup>st</sup> and 2<sup>nd</sup> gear with deceleration from 30 – 40Km/h. Therefore ECU determine the current gear ratio using engine speed and vehicle speed ratio to compensate spark time and injection time during acceleration. Normally, compensation value for each gear ratio is decided by test and as it is important for carmaker, they continued the test until they produce the car.

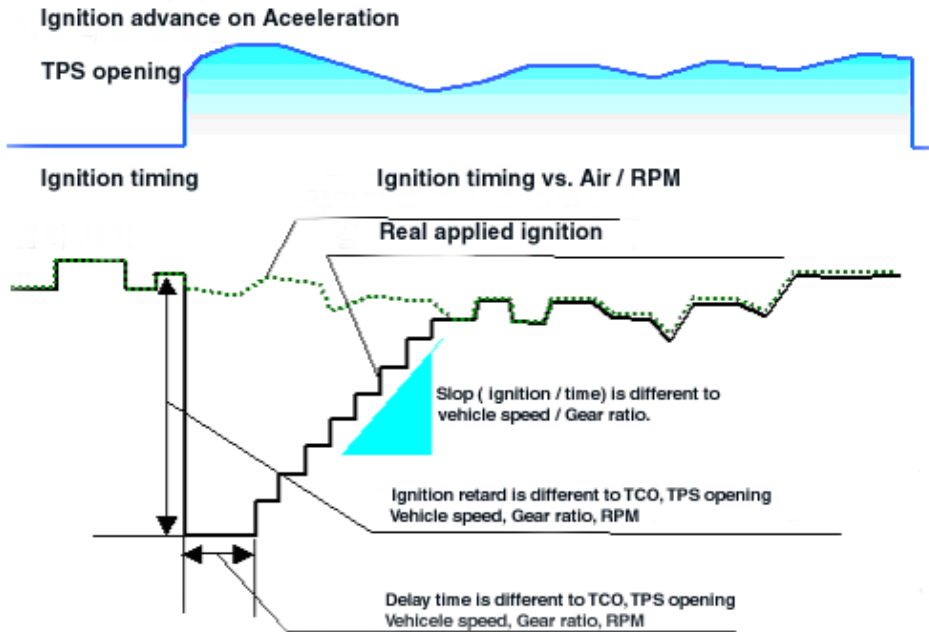
< Remark >

HMC : Accept reduction of accel response but do not accept accel shock. They prefer soft take off.

KIA : Accel response is important point. They do not accept accel hesitation at all and prefer light take off.

DMC : They prefer soft take off without any shock at acceleration.

It is depend on tester but generally they develop the car with above mentioned mood.



In case of deceleration, gear ratio is used to decide the fuel cut off duration and especially ISC dashpot amount. Additionally, spark time also can be influenced by gear ratio. So, vehicle speed and gear ratio is effective variable of ECU data setting.

### 3.) Transmit vehicle speed to TCU.

Vehicle speed is transmitted to the TCU (Transmission Control Unit) in the automatic transmission vehicle and it is used for gear shift pattern together with TPS in the TCU. Shift pattern also decided by test.

## 7.2 Error type of vehicle speed sensor

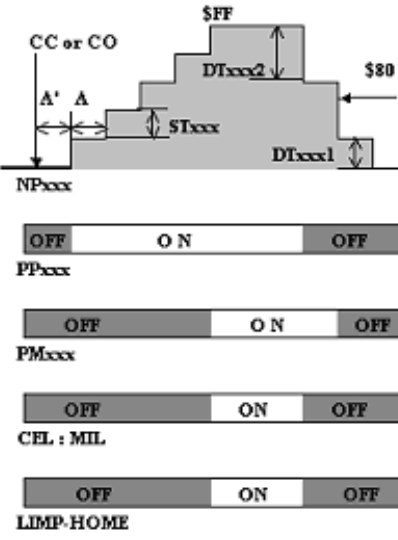
### 1) Error detection by ECU

Error detection of vehicle speed sensor is very simple. If no vehicle speed is detected under the condition that can not be occurred with vehicle stop, error is detected.

For example, 3000rpm and air quantity of 50% throttle opening for 6 – 8sec can not be happened during engine stop. If we open throttle more then engine speed increase and air flow is increasing too. But it is impossible to keep this state. As soon as we push throttle

pedal, engine speed rising up to red-zone and if engine speed is on the red zone, fuel cut off is occurred. In order to avoid this red-zone, throttle must be open small but in this case air quantity is too small to start the diagnosis.

**Vehicle speed sensor**

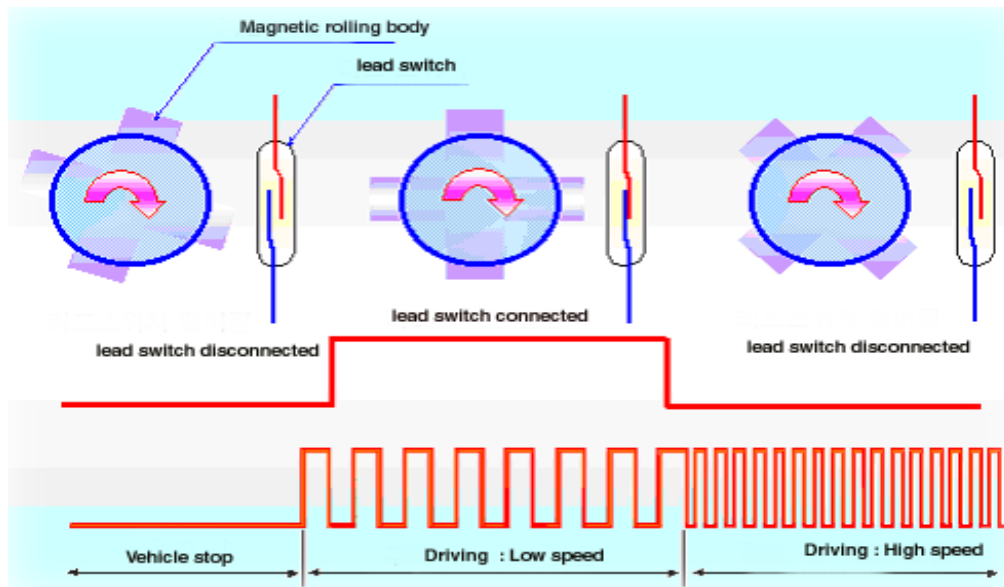
Condition of error recognition	Condition of error decision	Others
<p>Vehicle speed sensor</p> <ul style="list-style-type: none"> <li>- RPM &gt; REGVIT ( High rpm)</li> <li>- Intake manifold pressure &gt; LOADVIP( high load when accel )</li> <li>- Deviation of manifold pressure &lt; DPVIT ( Constant air)</li> </ul> <p>in above condition, error is recognized if vehicle speed signal is not changed lasting TMPVIT.</p> <p>Reference : condition of minifold pressure, decidethrough RPM</p>		<p>A', A = TPS sensor : DELPAP = Vehicle speed sensor : TMPVIT</p> <p>NPxxx : error count STxxx : error count increment step DTxxx : error count decrement step</p> <p>error recognition is made to reach count 255 debounce is made to under 127</p> <p>PPxxx : current failure PMxxx : error recognition CEL : MIL Lamp LIMP HOME : emergency function TPS : CTS, WOT is decided through Load others, TPS signal is not considered VS : Decided as driving Torque reduction request signal : HO</p>
<p><b>Torque reduction request ( AT vehicle torque reduction request) if frequency is over 5% at 10msec, error is recognized.</b></p>		

From the above condition, there is something unclear. What if we push throttle pedal with driving position of automatic gear with braking? (Stall rpm condition). Engine speed can rise up to 2600rpm and air quantity is also high with small variation.

In order to avoid this condition, engine speed must be set over 3000rpm. Then it is difficult to detect an error in the downtown.

Once I asked to Japan engineer for this and he replied that he set engine speed condition to 4500rpm. So, I asked again about difficulty of error detection and his answer was " vehicle speed sensor is not so important that they do not turn on the check lamp". I was worried about vehicle running detection as I mention above but he told me that he did not care about that because his car had a clutch sensor

Current system detects an error using air mass flow depending on engine speed. If air quantity per each engine speed is bigger than threshold for certain duration (6-8sec) then vehicle speed signal error is detected.



## 2) Phenomenon and counteraction with error.

### (1) In case of ECU detects vehicle speed signal error with defective signal.

Most of case, if there exist vehicle speed sensor error then ECU recognize vehicle state as vehicle running. So, ISC valve opening and spark time control will be limited even vehicle is stop. Therefore there will be small rpm oscillation or engine speed can not return to idle rpm. And big shock will be happened at acceleration.

On contrary, some of case, ECU recognizes engine stop with vehicle speed sensor error. In this case, rpm oscillation can be happened after down hill driving with clutch engaged. If vehicle is running without throttle pedal, vehicle oscillation can be happened due to big spark correction.

Especially, vehicle oscillate in the downtown too much then it is better to suspect vehicle speed sensor error. Current vehicle do not turn on check lamp for the vehicle sensor error,

If the phenomenon that I mentioned above is occurred then connect the scanner and check error.

### (2) In case of ECU do not detect vehicle speed signal error with defective signal.

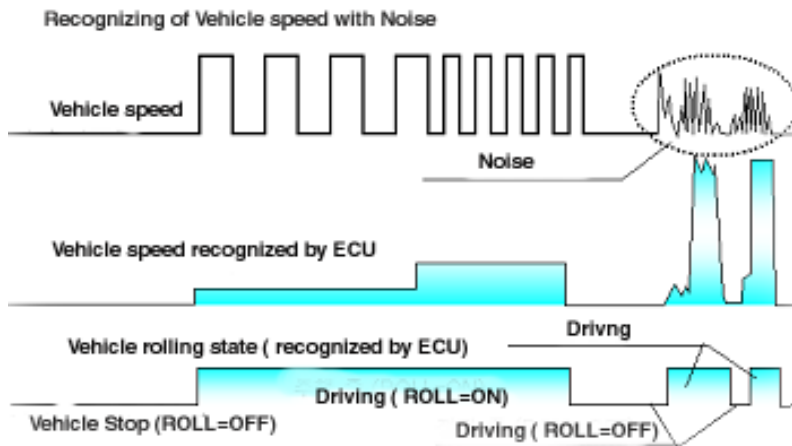
In case of vehicle speed sensor error, it is difficult for ECU to detect a sensor error with downtown driving due to difficult diagnosis activation condition. In this case, lift up front wheel ( rear wheel in case of rear wheel driving) and connect the scanner and then check if vehicle running(ROLL=ON) is detected with the running wheel. If vehicle stop is detected(ROLL=OFF) without vehicle speed signal while wheel is running then it is same case as mentioned above "(1)". The counteraction for this is to fix the sensor.

### (3) In case of noise on the vehicle speed signal.

This is the case that often happened in the filed. Especially in case of automatic transmission, many noises are occurred by TCU (TCU maker do not agree with this). Before everything,

basically vehicle stop is detected as running and it will produce same problem like “vehicle running recognition with sensor error mentioned above (1)”. Especially automatic vehicle can makes wrong gear shift at take off and vehicle will start to move not from 1<sup>st</sup> but from 2<sup>nd</sup> gear which leads very slow acceleration. In order to check this, connect scanner at vehicle stop and check if vehicle running(ROLL=ON) is detected. If yes, then it is due to noise.

Ways to remove noise is very headaches even for electric control unit developer. General



method is wrap signal line and ground line with shield wire and connect each end of shield wire to the ground. If there is still problem then connect condenser between shield wire and ground.

In case of TCU, change connection point until you

get reduced noise.