8. The signal check of ISC

1. Troubles

1. Malfunction of ISC valve	
Cause of trouble	Line break of ISC valve wiring Damage of ISC valve coil Damage of TR which operate ISC valve in ECU
Counter action	Inspect connector of ISC valve. If it is normal, connect new wiring. Replace ISC valve. Replace ECU. (In case of HMC MELCO system, it is sometimes happened)
Engine state	Engine is hard to start. Even if start is possible, it is stalled soon. RPM may stay 1200 ~ 1500[1/min] in case of BOSCH ISC equipped vehicle. The problem can be found out through scanner because ECU detect this error.
Signal measurement	

2. Malfunction of ISC opening valve (Not opened)

Cause of trouble	Line break of ISC valve wiring Damage of ISC valve coil Damage of TR which operate ISC valve in ECU
Counter action	Inspect connector of ISC valve. If it is normal, connect new wiring. Replace ISC valve Replace ECU. (In case of HMC MELCO system, it is sometimes happened)
Engine state	Engine is hard to start. Even if start is possible, it is stalled soon.
Signal measurement	

CH1=10V   CH2=10V   200ms/div
DC 10:1   DC 10:1   (200ms/div)
NORM 5kS/s

Measured at P range on A/T vehicle in the status
of no-load idle after warming up

10V

Normal case   Abnormal case(short to wire)

0.0

ISC valve: measuring between A terminal(ECU PIN 35)
and ground

Abnormal case
(short to ground)

10V

0.0

ISC valve: measuring between B terminal(ECU PIN 9)
and ground

Reference : Opening coil is open circuit or closing coil is short to ground

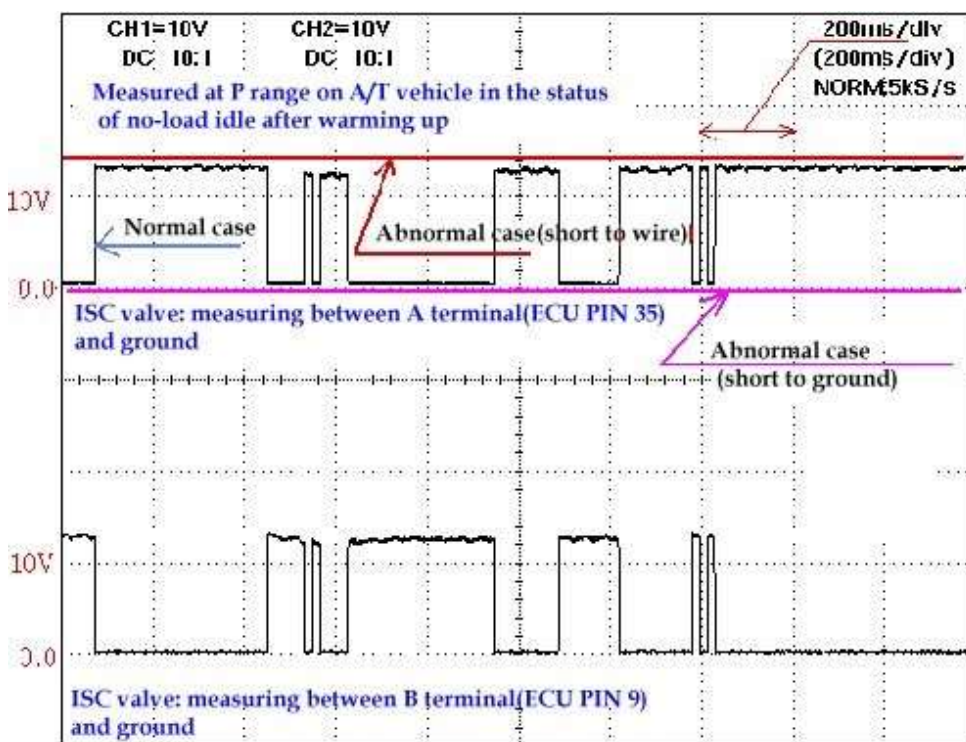| **3. Malfunction of ISC opening valve (Always opening)**	
Cause of trouble	Short to ground of ISC valve wiring Damage of ISC valve coil Damage of TR which operate ISC valve in ECU
Counter action	Inspect connector of ISC valve. If it is normal, connect new wiring. Replace ISC valve Replace ECU. (In case of HMC MELCO system, it is sometimes happened)
Engine state	It is not recovered to target idle RPM and stay around 2800 RPM.
Signal measurement	CH1=10V CH2=10V 200ms/div DC 10:1 DC 10:1 (200ms/div) NORM 5kS/s Measured at P range on A/T vehicle in the status of no-load idle after warming up 10V Normal case Abnormal case(short to wire) 0.0 ISC valve: measuring between A terminal(ECU PIN 35) and ground Abnormal case (short to ground) 10V 0.0 ISC valve: measuring between B terminal(ECU PIN 9) and ground Reference : Opening coil is open circuit or closing coil is short to ground

4. Stick of ISC valve

Cause of trouble	Carbon accumulation in air path of ISC valve Big resistance on moving of ISC valve pintle. (Head of air path line)
Counter action	Clean ISC valve line with compression air. < Reference > Even though ISC valve is stuck, it is difficult to find out stick by signal because ISC stuck signal don't have difference with normal. Therefore it should be inspected by the naked eye after disassembling. If ISC valve is contaminated by accumulation of carbon or other things, it must be cleaned. If it is not cleaned by compression air, it should be dried after cleaning with oil (light or volatile oil…). Grease on operating point. Nevertheless, if it is not run smoothly, replace ISC valve.
Engine state **Signal measure ment**	Engine stall is occurred or engine operating state don't recover idle as remaining with high engine speed. The phenomenon is repeated.
	<Difficulty to find with signal> In this case, ECU open and close ISC valve too much. Therefore check with scanner whether normal idle RPM(No load : 24~32%) is stayed or not.

5. Step loss of ISC valve

Cause of trouble	5.1 ISC valve step doesn't operate by ECU control.
Counter action	5.1 Restart after reset battery(Separate minus(-) terminal for 30 [sec]). And Maintain Idle engine state during 10 minutes. (1) In case of automatic transmission, shift with N ◉ D ◉ N—R sequence in idle state and shift again after 5 [sec]. (2) In case of manual transmission, work acceleration pedal. < Reference > This is to erase adaptation value in ECU and to newly adapt it step by step with automatic transmission.
Engine state	Engine stall is occurred or engine operating state don't recover idle as remaining with high engine speed. The phenomena is repeated.
Signal measure ment	<Difficulty to find with signal> In this case, ECU open and close ISC valve too much. Therefore check with scanner whether normal idle RPM(No load : 24~32%) is stayed or not.

2. Field example

< Example 1 > ISC valve stuck

Vehicle : Most of KIA vehicles(Duty control type, ISC valve quipped vehicle), Odometer : 20,000Km

Problem description : Engine operating state doesn't recover into idle with floating and RPM cycling is occurred. In some case, RPM is severely dropped or engine stall is happened with electric load.

Cause : ISC valve is stuck because pintle is not moved by carbon accumulation. It led to impossible ISC correction.

Signal measurement : Basically it is not different with normal signal. Even if it has difference, that is rare and it is not helpful to analyze.

Explanation : In this case, ECU adapt too much(100±40%). Thus, first you should check adaptation value of ISC. For more detail, refer to 7.1 Duty ISC valve.

Enlargement of application : With duty control ISC valve, if the severe engine vibration is occurred (Big RPM variation) and RPM floating or engine stall is intermittently happened in idle, you should check ISC valve stuck. Notice to customer that this problem is reoccurred after healing.

< Example 2 > ISC valve step loss

Vehicle : Most of DAEWOO vehicles(Step type ISC valve equipped vehicle), Odometer : Don't care

Problem description : Engine operating state doesn't recover into idle with floating and RPM cycling is occurred. In some case, RPM is severely dropped or engine stall is happened with electric load.

Cause : ISC valve step is not synchronized with ECU control. It led to impossible ISC correction.

Explanation : In this case, ECU adapt too much(100±40%). Thus, first you should check adaptation value of ISC. For more detail, refer to 7.1 Duty ISC valve.

Enlargement of application : With step type ISC valve equipped vehicle, if the severe engine vibration is occurred (Big RPM variation) and RPM floating or engine stall is intermittently happened in idle, you should check ISC valve stuck. Notice to customer that this problem is reoccurred after healing.

< Example 3 > The problem by too much adaptation

Vehicle : MAP sensor equipped vehicle(Most vehicle of SIEMENS EMS system), Odometer: 6,000Km

Problem description : Engine operating state doesn't recover into idle with floating and RPM cycling is occurred. In some case, RPM is severely dropped or engine stall is happened with electric load.

Cause : ISC basic opening duty is too big or small by abnormal adaptation value. It results in abnormal total ISC correction. It makes above described problem.

Signal measurement : The signal is normal.

Explanation : In this case, ECU adapt too much(100±40%). Thus, first you should check adaptation value of ISC. For more detail, refer to 7.1 Duty ISC valve.
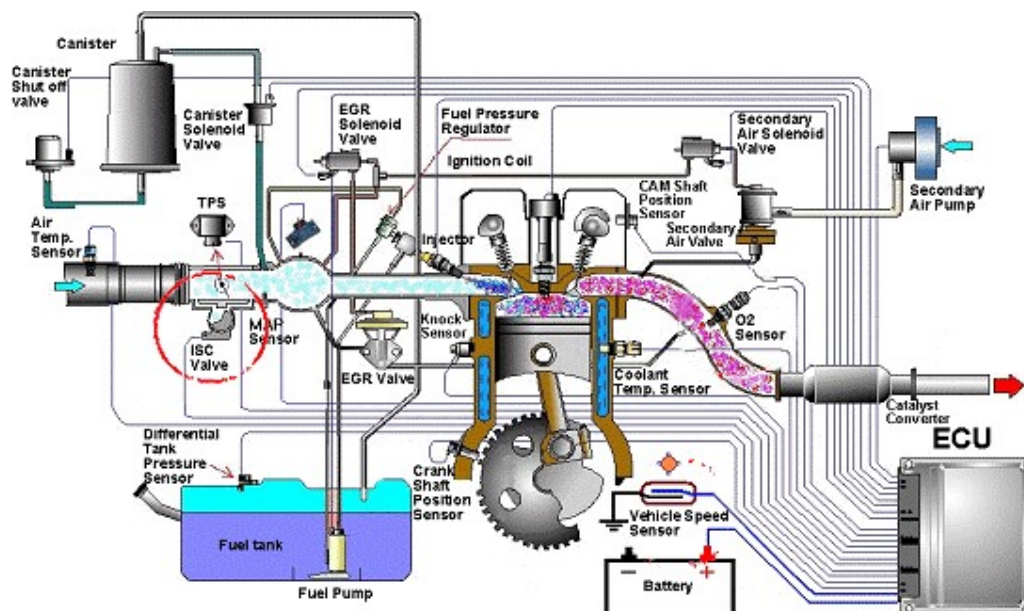
< Reference >

The MAP sensor system operates engine without problem even though mass air flow is come from besides ISC valve. Therefore ISC valve decreased in proportion to additional air flow and ECU adapt as reduced ISC quantity.
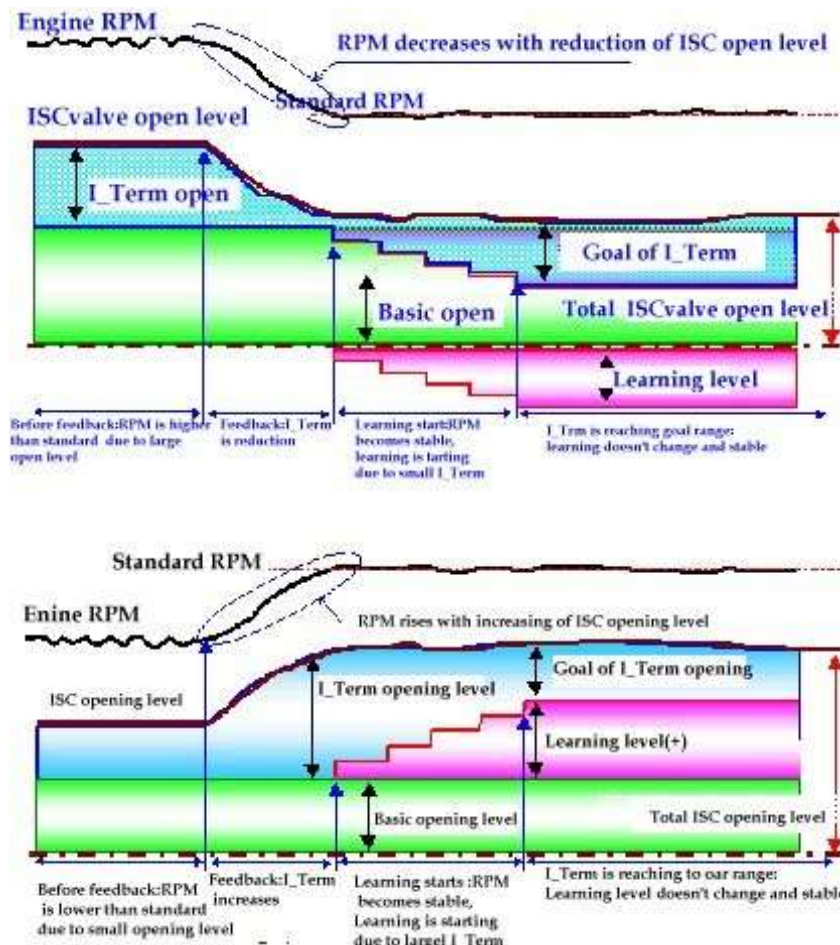
Enlargement of application : With duty control ISC valve, if the severe engine vibration is occurred (Big RPM variation) and RPM floating or engine stall is intermittently happened in idle, you should check ISC valve stuck. Notice to customer that this problem is reoccurred after healing.

3. Location of ISC valve

< ISC Valve : Duty type(left, right) and Step type(center) >

4. Check method

| Explain the checking Method and Diagnosis of trouble.. |
|---|

Preparation

1. Oscilloscope.
2. Wiring diagram of ISC valve.

< Reference>
It prefers not to use Multimeter because it is difficult for the Multimeter to display the fast signal changing.

1. Find and connect the signal and ground line with referencing the wiring diagram.
2. After measuring the signal, compare the measured signal with Normal signal.
   (1) As there is several power lines according to ISC valve type, Measure the signal at the same time.
   (2) Let's reference that ISC valve power line is shorted by ECU though source of electricity is from Battery.
   (3) ISC Valve operation reiterates ON/OFF. If there is one power line, valve Opening (%) is the value when the source of electricity is '0' voltage. If in case of Open /close type, valve opening is the value when the source of electricity of open side is '0'voltage.
   (4) In case of step motor type, Check with normal operation value because there is difference of ON from OFF in opening value.
  3. It prefers to check the following signals at the same time to check the normal operating state of ISC valve exactly.
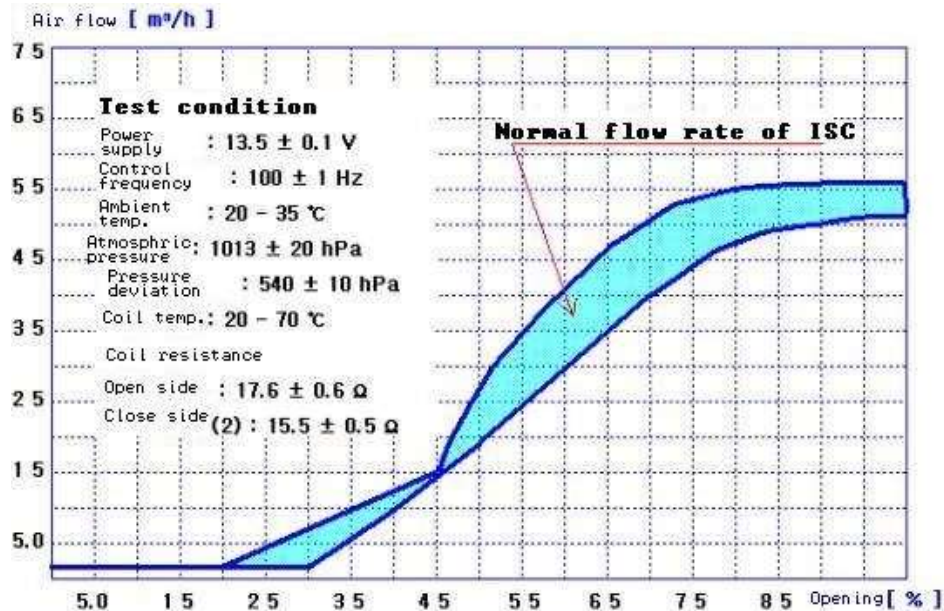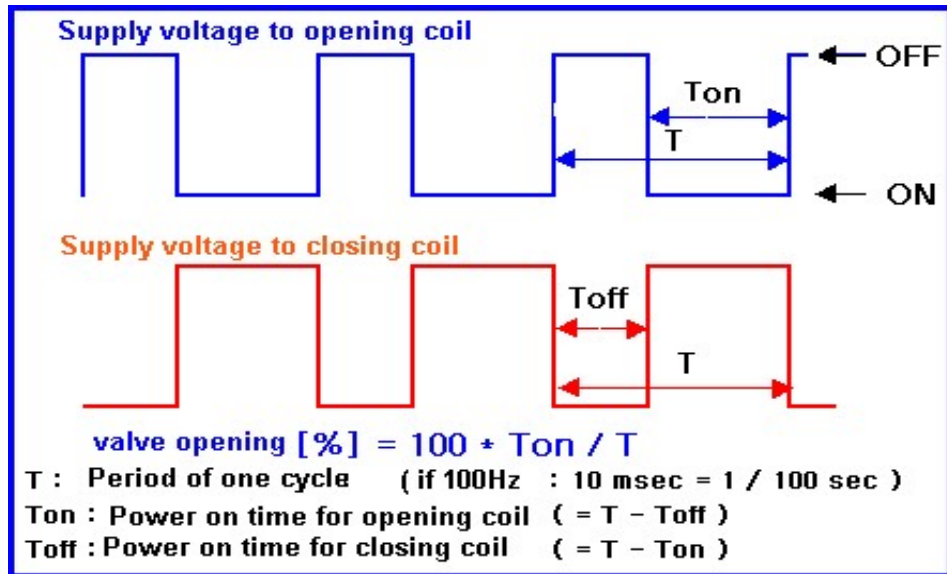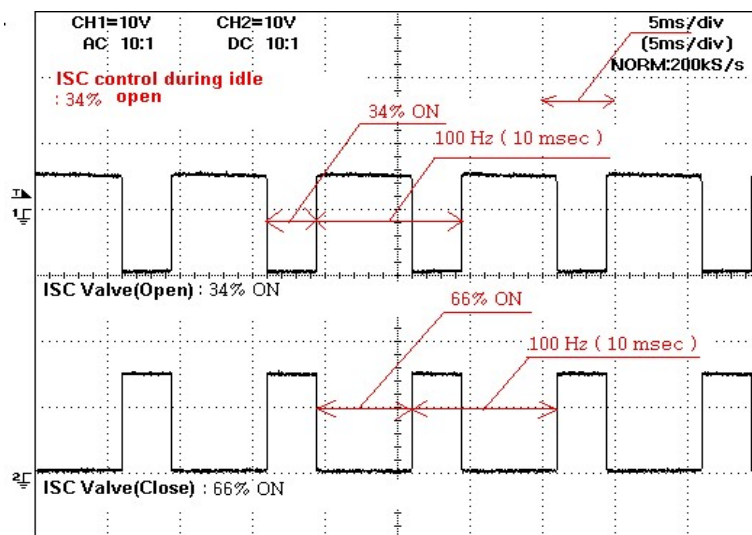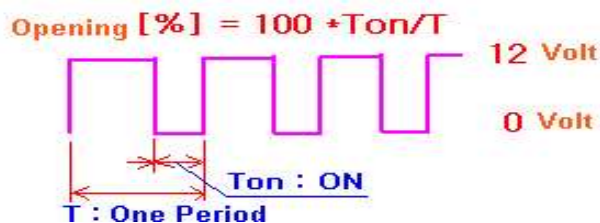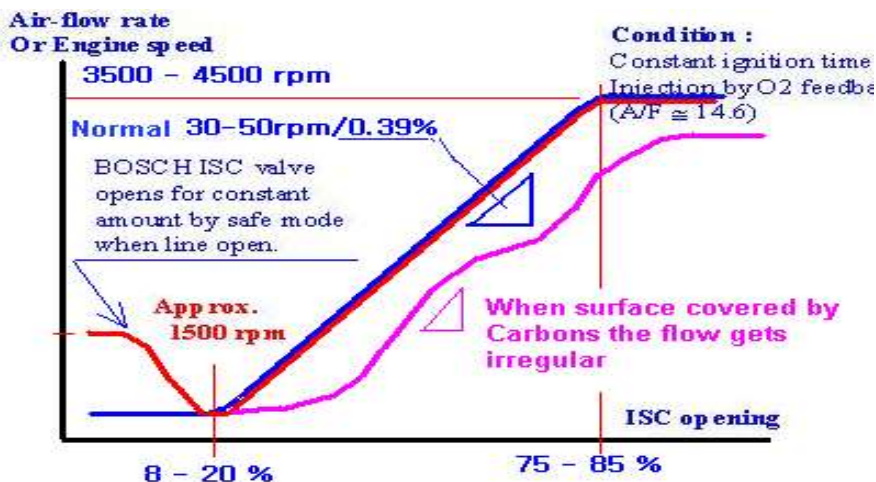
Check method
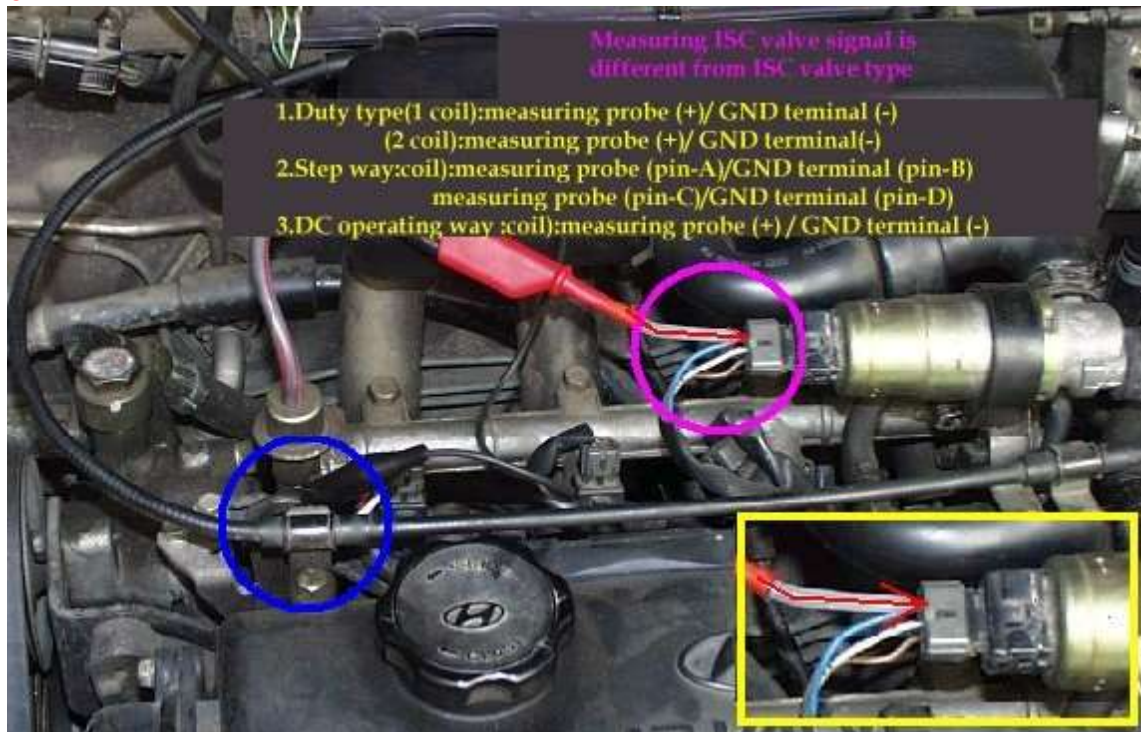
5. Wave analysis

Duty type

Output voltage when ISC(idle Speed Control) is moving is as shown below

Finally engine speed shows quantity of air flow through ISC valve. Usually, 30 ~ 50 rpm increase of engine speed by 0.39% ISC valve opening.

Air-flow rate Or Engine speed

3500 – 4500 rpm

Condition :
Constant ignition time
Injection by O2 feedba
(A/F ≅ 14.6)

Normal 30–50rpm/0.39%

BOSCH ISC valve
opens for constant
amount by safe mode
when line open.

Approx. 1500 rpm

When surface covered by
Carbons the flow gets
irregular

ISC opening

8 – 20 %

75 – 85 %

Opening [%] = 100 *Ton/T

12 Volt

0 Volt

Ton : ON

T : One Period

CH1=10V   CH2=10V   5ms/div
AC 10:1   DC 10:1   (5ms/div)
                                                NORM:200kS/s

ISC control during idle
: 34% open

34% ON

100 Hz (10 msec)

ISC Valve(Open) : 34% ON

66% ON

100 Hz (10 msec)

ISC Valve(Close) : 66% ON

< Reference>

It is very difficult to find out the malfunction of ISC valve by observing ISC valve signal.

Therefore check as followings :

 (1) Check deposit in the ISC valve inside such as carbon.

 (2) Too much adapted minus adaptation value of ISC valve.

Counter measure :

(1) Fixing of vavle: Check with naked eyes, if there is carbon, clean it.

   (2) Adaptation value: Check amount of minus value by scanner. If minus value is too big, delete

       adaptation value and do adaptation again in idle for 10 minutes until engine get warmed up

Step type

Finally engine speed shows quantity of air flow through ISC valve. Usually, 30 ~ 50 rpm increase of engine speed by 0.39% ISC valve opening..

< Reference>

It is very difficult to find out the malfunction of ISC valve by observing ISC valve signal.
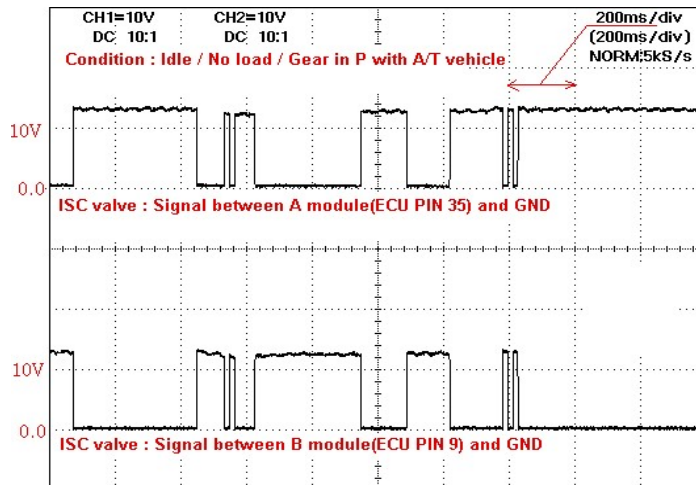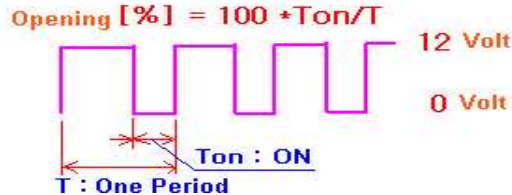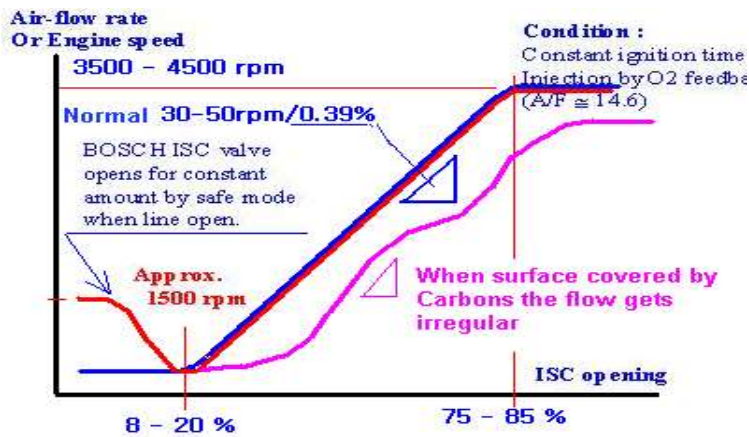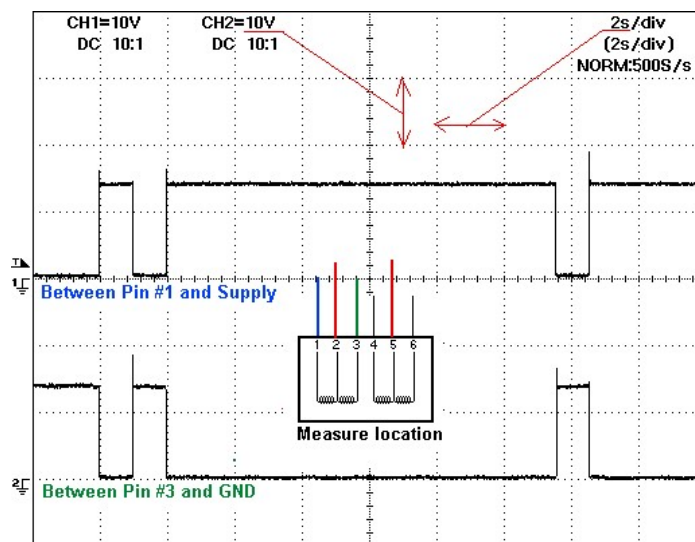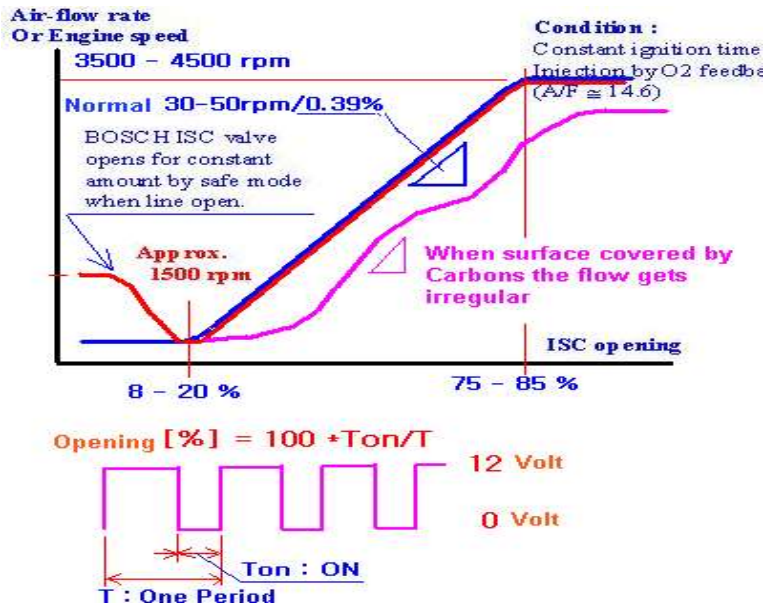
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(2) Adaptation value: Check amount of minus value by scanner. If minus value is too big, delete adaptation value and do adaptation again in idle for 10 minutes until engine get warmed up.

DC motor type

Finally engine speed shows quantity of air flow through ISC valve. Usually, 30 ~ 50 rpm increase of engine speed by 0.39% ISC valve opening.

$$Opening\ [\%] = 100 * Ton/T$$

< Reference>

It is very difficult to find out the malfunction of ISC valve by observing ISC valve signal.

Therefore check as followings :

(1) Check deposit in the ISC valve inside such as carbon.

(2) Too much adapted minus adaptation value of ISC valve.

Counter measure : (1) Fixing of vavle: Check with naked eyes, if there is carbon, clean it.

(2) Adaptation value: Check amount of minus value by scanner. If minus value is too big, delete
   adaptation value and do adaptation again in idle for 10 minutes until engine get warmed up.

6. General

DC motor type

ISC Valve opens and closes the valve through the DC motor. The pintle of ISC valve is connected with DC motor and moved up and down through the spiral. If positive current is engaged DC motor come to move positive direction (ISC opening), otherwise negative direction. Though the method of power supply is same as duty type, but the frequency (below 20Hz) is far less than that of duty type (about 100Hz) and pintle position distinguishing sensor is jointed.
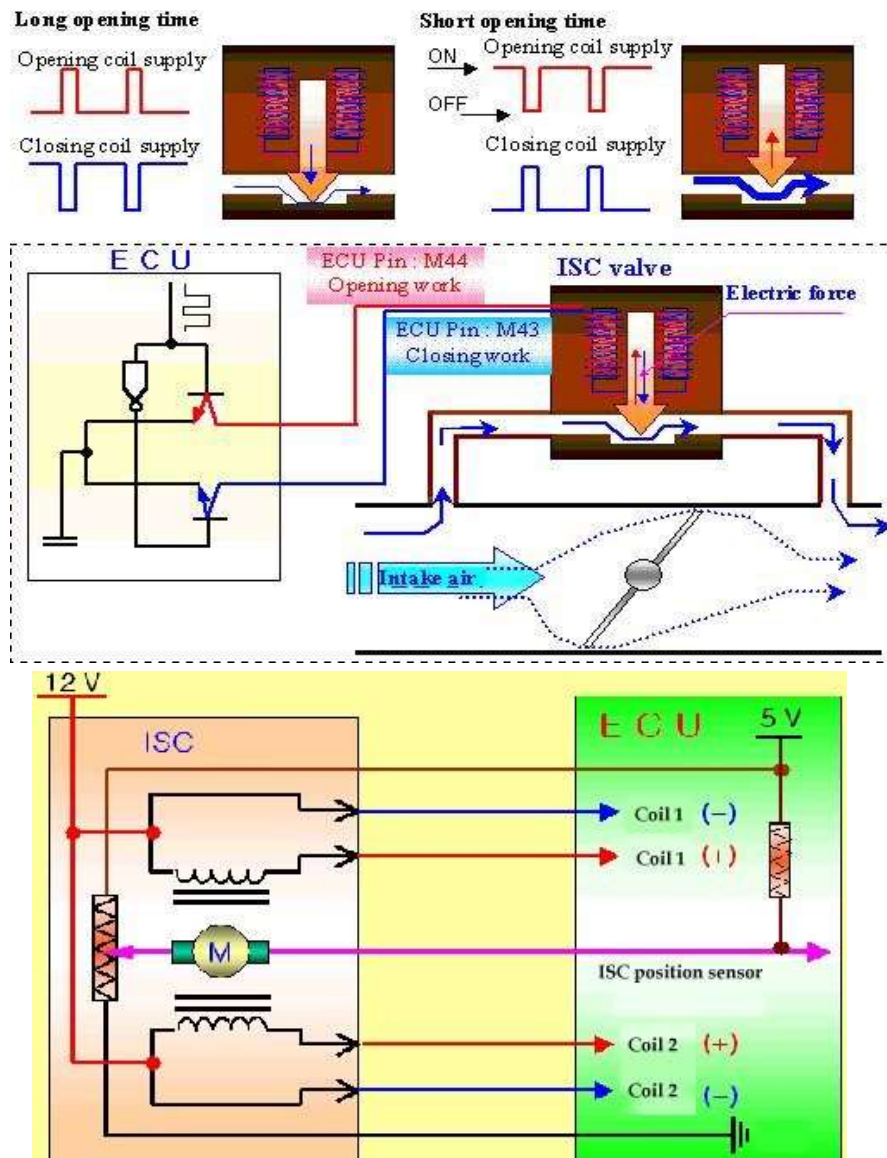
< Circuit of DC motor type ISC valve >

< Reference >

Operation method is similar to that of step type valve but this one is operated without step and equipped
         with position sensor and pintle position can be detected.

Duty type

ISC Valve opens and closes the valve through the **electro-magnetic force of two coils**. One makes open and the other close at the same time when the current flows. Generally it makes connect and break the current flow in high frequency (about 100Hz: 100 times per 1sec).

It is the opening quantity for ISC valve that the ratio of time (=100 + time of current to open ISC valve / one cycle period [%]) for flowing the current on the coils making open during one cycle. ISC valve pintle is in appropriate location as repeating of open and close shortly with flowing the current.
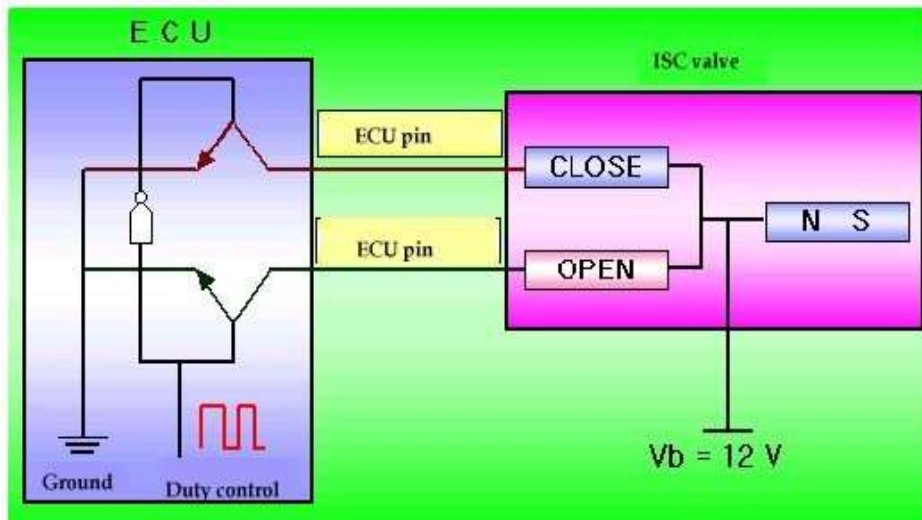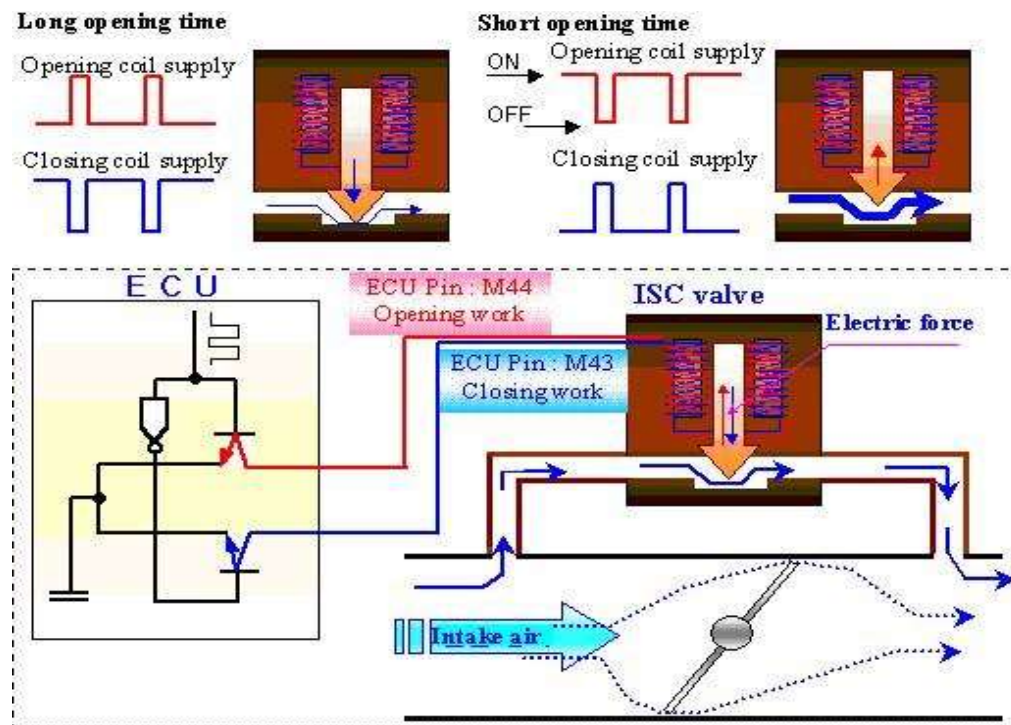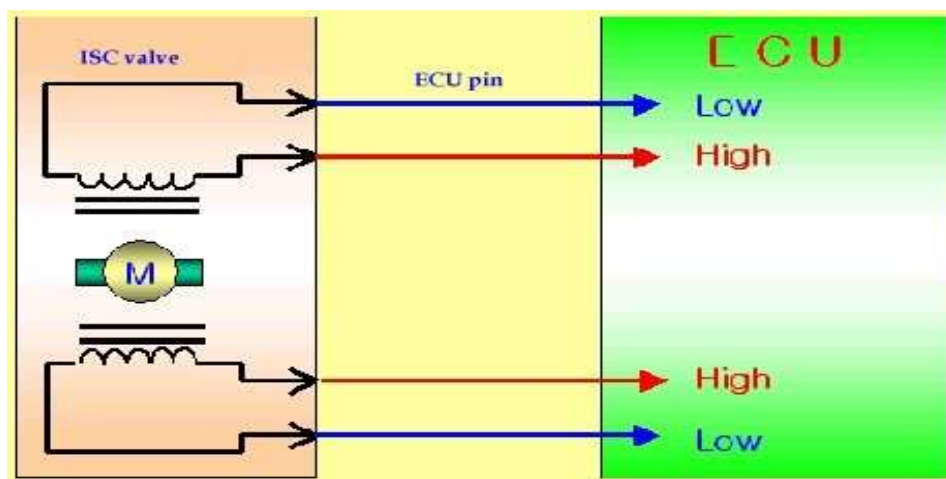

< Reference >

There is the ISC valve type that uses only one coil to open and close the valve (one is for plus(+) and the other is for ground(-).

Step type

The upper part of pintle is composed of magnet, and ISC valve is opened and closed by this pintle. This part is surrounded by three magnets. So, if the direction of current is changed the positive pole or the negative pole is arisen, and in case of same pole between a magnet and the magnet part of pintle repulsive fore is arisen, otherwise attractive force is arisen, thus pintle is rotated 1/6 revolution. On the basis of this principle, this pintle moves up and down with rotating and ISC opening quantity is controlled.
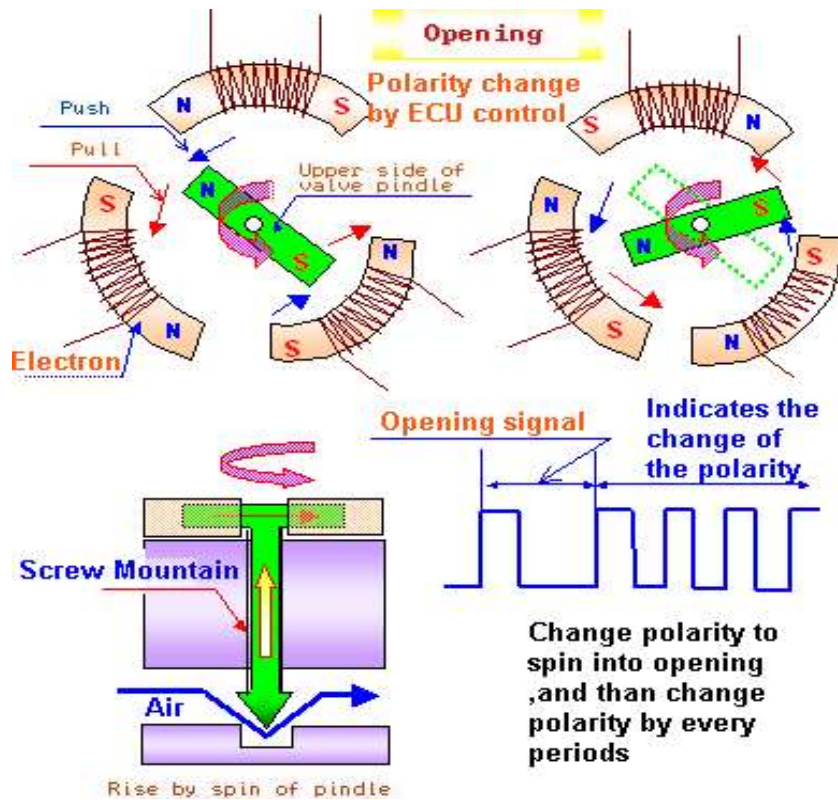
< Reference>

The control method is simular to that of DC motor, but the difference is that this pintle is rotated 1/6 revolution by step.

7. Principle (Algorithm) Introduction

I'd like to introduce three big trouble which are too difficult to fix it and understanding it.

At least it is need to know why it is difficult when you can not fix it completely. And if you find out similar problem in the filed, do not spend much money or time but let you customer know that the problem can be happened again..

Important problem : Abnormal operation of ISC valve

This is the phenomenon that occurred when ISC valve pintle is stuck.

Duty type ISC valve

This valve used by all three carmaker, yet KIA use it more.

The pintle is open with ISC valve ON and pintle is close with ISC valve OFF. If we continue this ON/OFF then pintle is located at certain position. If ON time is longer than OFF time then pintle is located in the more opening position or if OFF time is longer than ON time then pintle is located in the more closing position. Using this principle, ISC valve opening is controlled by ON time rate.

The ON/OFF time per 1sec of ISC valve is normally 100 Hz. And this frequency is decided to get smaller ISC noise.

There is a case that the pintle is not moving due to the carbon inside the ISC valve. We call it "stick" and following trouble is happened.

(1) Stick with high opening:
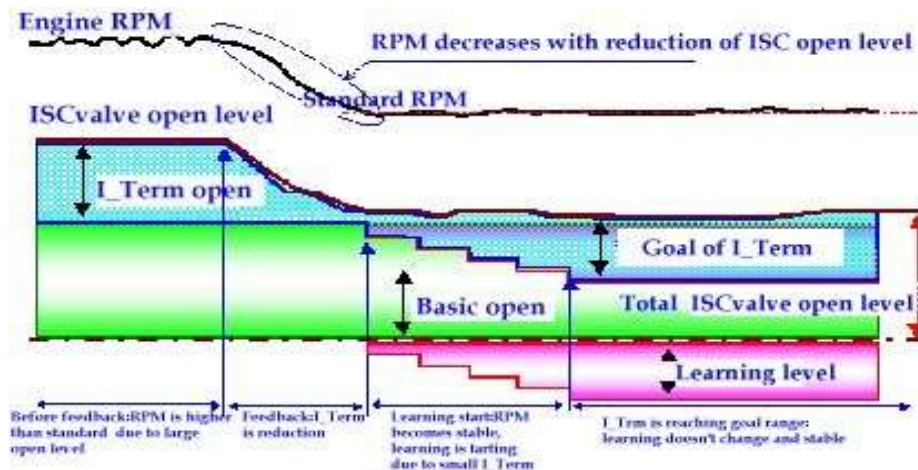
During this trouble, engine speed can not return to idle speed and oscillate with high speed (about 1000-1700rpm). In this time, if we push throttle pedal, it can return to normal, but it is very seldom. And if it return to idle speed before adaptation start then there is no problem but if adaptation is occurred during this trouble then it is the reason (minus adaptation) of engine stalling or unstable..

Necessary quantity Air to Idle of ngine

ISC opening level

Necessary quantiry of air to idle of engine

Necessary ISCV opening level to idle of engine

ISCV opening level by I_Term

ISCVbasic opening leve

Quanty of Air-supply by leakage :Air balance

Coolant Temp
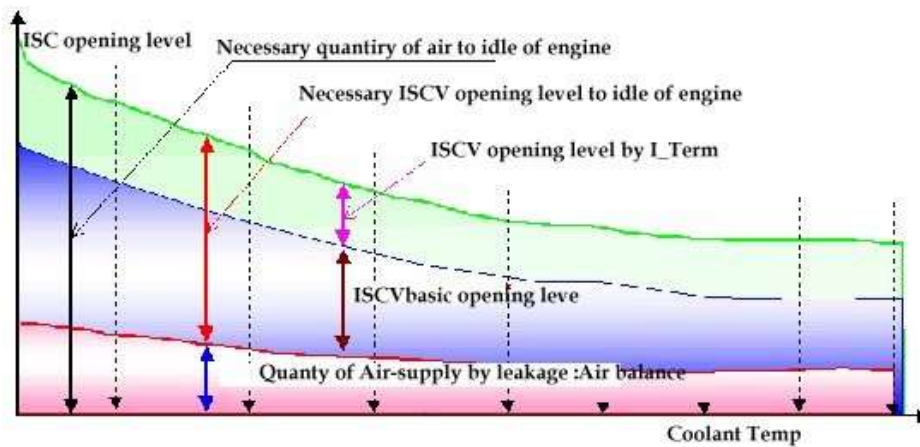
- ISC valve adaptation is learned by "I_Term" and I_Term is feedback control value that increase when engine speed is lower than target and decrease in reverse case. If this value is small then minus adaptation is occurred and plus adaptation with high I_Term.
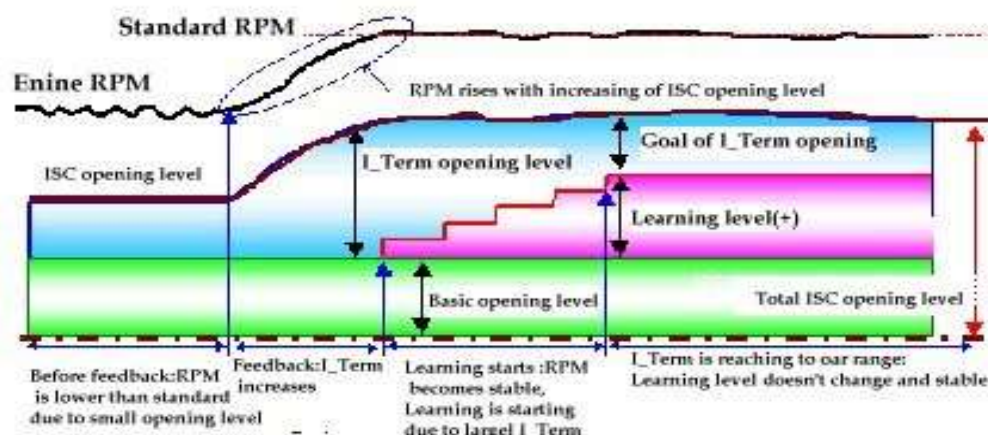
Therefore, if ISC valve is stuck with high opening then feedback control has not effect and engine speed can not return to target speed. Then ECU recognize too much basic opening is applied and learn minus adaptation.

Then finally ISC valve opening value by ECU is (basic opening + adaptation) +I_Term opening. In this time, adaptation is minus and I_Term is very small due to high engine speed. Then let's think about the case of when trouble is disappeared. In that case, ISC valve is opened only by ECU and calculation value (basic opening + adaptation) +I_Term opening is too mall to keep engine speed.

Engine stalling or oscillation will be happened until it learns normal one even with restart, because of remained adaptation value.

The only method for this is to delete adaptation value and learn normal adaptation. And remember it can occur again.

(2) ISC valve closing stick.

Standard RPM

Enine RPM

RPM rises with increasing of ISC opening level

ISC opening level

I_Term opening level

Goal of I_Term opening

Learning level(+)

Basic opening level

Total ISC opening level

Before feedback:RPM is lower than standard due to small opening level

Feedback:I_Term increases

Learning starts :RPM becomes stable, Learning is starting due to largel I_Term

I_Term is reaching to oar range: Learning level doesn't change and stable

In this case, ECU increase I_term to open more ISC valve. Yet engine can stall or oscillate due to close stuck valve. If stick problem disappeared like above "(1)", engine oscillation or stalling is disappeared. But if stick is continued for long time then ECU increase I_Term and then plus adaptation is occurred . Then ISC valve opening is (basic opening + adaptation) +I_Term opening and total opening is big due to big plus adaptation.

If stick trouble is disappeared then engine speed is high and not returns to idle due to too much opening of ISC valve. We call it RPM floating and it happen more with siemens system

(3) In case of that problem occur again

I've seen many case that above "(1), (2)" is solved by exchanging the ECU. But most of case is not the problem of ECU but adaptation is deleted while they change the ECU. And more problem is that this problem can be happened only with ECU change.

(4) Countermeasure from carmaker

In fact, fundamental countermeasure is impossible. However, they've changed ISC valve pintle type form one coil to two coils to get strong movement of pintle and make dull the tip of pintle. But best solution is to prevent incoming of oil or carbon into ISC valve and this needs engine design change.

Step type ISC valve.

This is the type that applied to most of DAEWOO car. There is a magnet at the same axis of pintle on the top of ISC.   And there are three electromagnets around the magnet that changes the N pole and the S pole by direction of current to push or pull the magnet on the top of pintle. While magnet on top of pintle is revolving, pintle is rising (open) and falling (close), so that air flow is controlled.

When magnet moves one step by the electromagnet, this step is same meaning of "ON rate of duty type" ECU to change the N pole and the S pole by changing the direction of power to electromagnet to open or close ISC valve until certain step that ECU want.

Then, what will be happened that if pintle is not moving when electromagnetic power is balanced between N pole and S pole?

Step type ISC valve use a word "step loss" instead of "stick" that used in duty type. Because difference between real step and memorized step of ECU exists.

(1) Step loss with high opening.

This case is happened frequently and it is happened when ISC valve is fixed against step value ordered by ECU. The troubles that occurred in this time are same as **"(1) Stick with high opening".** High engine speed is not return to idle during step loss and engine stalls by minus adaptation after step loss is disappeared.

(2) Step loss with almost closing.

This is also same as "**(2) ISC valve closing stick"**. Engine oscillation or stalling is happened during step loss and plus adaptation is performed when step loss is continued for long time. If step loss is disappeared then engine speed is high and not returns to idle due to too much opening of ISC valve.

(3) In case of that problem occur again

Many people asked me how to fix the step loss problem and what the reason is?   They changed ISC valve, ignition and spark plug to solve the problem, but the problem was happened again.

In fact no solution exist.   Because, nobody can say there is no more step loss problem after replacement of the ISC valve.

Even GM has suffered step loss problem. So, it is better to explain to you customer that frequency of this problem would be reduced by changing ISC valve but problem can be happened again anyway.

(4) Countermeasure form carmaker

It is same as duty type ISC valve that there is no fundamental solution. But they close ISC valve to set the step again at every engine stop. So, step loss problem is disappeared when engine stops but the problem is still remained until engine stop.

DC motor type ISC valve

Hyundai motors use this type more. The pintle is revolved by DC power like a motor and it is moving up and down to control airflow like step type ISC valve.

The difference from step type is to rotate the pintle without step until certain required value. So, ISC valve position sensor is used to detect pintle position for this type. But recently it is used without sensor due to cost reduction.

As DC motor type has enough power to rotate the pintle, pintle stick problem can be hardly happened.