IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF MICHIGAN
SOUTHERN DIVISION

MICHIGAN MOTOR TECHNOLOGIES LLC, Plaintiff, v. HYUNDAI MOTOR COMPANY, HYUNDAI AMERICA TECHNICAL CENTER, INC, Defendants.	Case No. 2:17-CV-12901-BAF-RSW Honorable Bernard A. Friedman Magistrate Judge R. Steven Whalen **JURY TRIAL DEMANDED**

AMENDED COMPLAINT FOR PATENT INFRINGEMENT

Michigan Motor Technologies LLC ("MMT" or "Plaintiff"), for its Amended Complaint against Defendants Hyundai Motor Company ("HMC") and Hyundai America Technical Center, Inc. ("HATCI"), (collectively "Hyundai" or "Defendants"), alleges the following:

NATURE OF THE ACTION

1. This is an action for patent infringement arising under the Patent Laws of the United States, 35 U.S.C. § 1 *et seq*.

THE PARTIES

2. Plaintiff is a Limited Liability Company organized under the laws of the State of Michigan with a place of business at 2360 Orchard Lake Road, Suite 100, Sylvan Lake, Michigan 48320.

3. Upon information and belief, Hyundai Motor Company is a corporation organized and existing under the laws of the Republic of Korea, with its principal place of business at 12, Heolleung-ro, Seochu-gu, Seoul, Korea, and has a regular and established place of business at

6800 Geddes Road, Ypsilanti, Michigan 48198. Upon information and belief, Hyundai Motor Company makes, sells, and offers to sell products and services throughout the United States, including in this judicial district, and introduces products and services into the stream of commerce and that incorporate infringing technology knowing that they would be sold in this judicial district and elsewhere in the United States.

4. Upon information and belief, Hyundai America Technical Center, Inc. is a corporation organized and existing under the laws of the Michigan, with its principal place of business at 6800 Geddes Road, Ypsilanti, Michigan 48198. Upon information and belief, Hyundai America Technical Center, Inc. makes products, which are sold and offered for sale throughout the United States, including in this judicial district, and introduces products and services into the stream of commerce and that incorporate infringing technology knowing that they would be sold in this judicial district and elsewhere in the United States.

JURISDICTION AND VENUE

5. This is an action for patent infringement arising under the Patent Laws of the United States, Title 35 of the United States Code.

6. This Court has subject matter jurisdiction under 28 U.S.C. §§ 1331 and 1338(a).

7. Venue is proper in this judicial district under 28 U.S.C. §1400(b). On information and belief, Defendants have committed acts of infringement in this District and have regular and established places of business within this District.

8. On information and belief, each Defendant is subject to this Court's general and specific personal jurisdiction because each Defendant has sufficient minimum contacts within the State of Michigan and this District, pursuant to due process and/or the Michigan Long Arm Statute because each Defendant purposefully availed itself of the privileges of conducting business in the State of Michigan and in this District, because each Defendant regularly conducts

and solicits business within the State of Michigan and within this District, and because Plaintiff's causes of action arise directly from Defendants' business contacts and other activities in the State of Michigan and this District.

COUNT I – INFRINGEMENT OF U.S. PATENT NO. 6,345,604

9. The allegations set forth in the foregoing paragraphs 1 through 8 are incorporated into this First Claim for Relief.

10. On February 12, 2002, U.S. Patent No. 6,345,604 ("the '604 patent"), entitled "*Electronically Controlled Throttle Valve With Commanded Default Position for the Throttle Valve of an Internal Combustion Engine*," was duly and legally issued by the United States Patent and Trademark Office. A true and correct copy of the '604 patent is attached as Exhibit 1.

11. Plaintiff is the assignee and owner of the right, title and interest in and to the '604 patent, including the right to assert all causes of action arising under said patents and the right to any remedies for infringement of them.

12. Upon information and belief, Defendants have directly infringed at least claim 1 of the '604 patent by making, using, selling, importing and/or providing and causing to be used the 2011-2017 Hyundai Sonata (2.0L), 2010-2017 Hyundai Genesis Coupe (2.0L), 2013-2017 Hyundai Santa Fe (2.0L), 2011-2017 Hyundai Sonata (2.4L), 2010-2017 Hyundai Tucson (2.4L), 2010-2017 Hyundai Santa Fe (the "Accused Instrumentalities").

13. Upon information and belief, the Accused Instrumentalities incorporate the Theta II Engine which comprises a throttle controller for an internal combustion engine having a throttle body including an adjustable throttle valve in an intake air passage. Exemplary images representative of the Accused Instrumentalities is set forth below:

Figure 1- Theta II Internal Combustion Engine

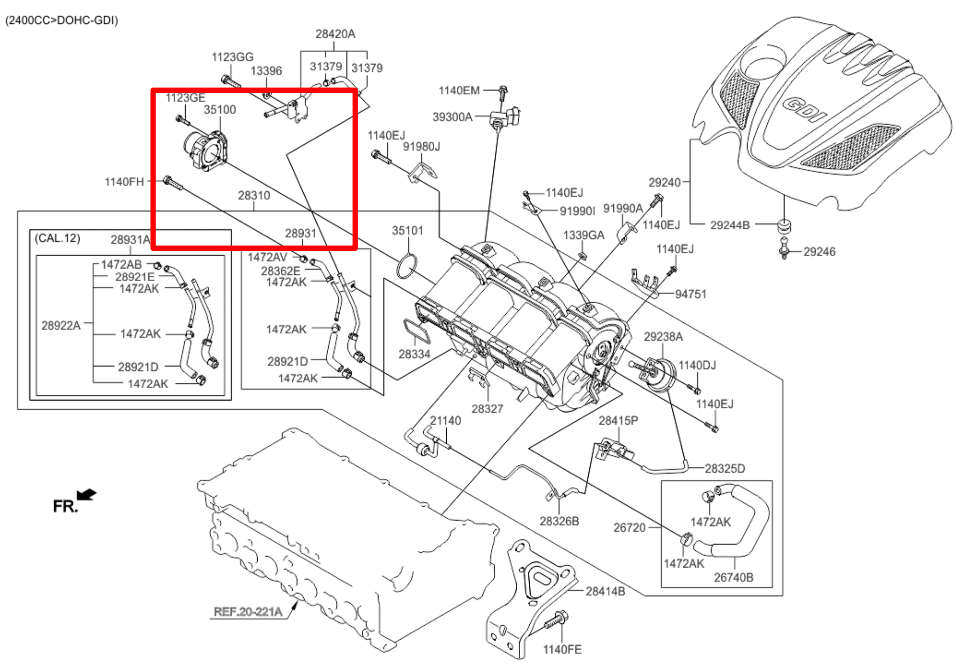


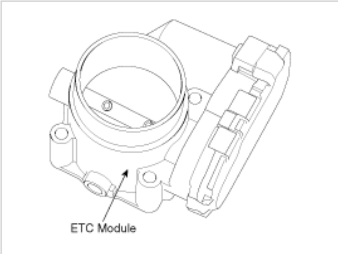
Figure 2- Throttle Body Assembly

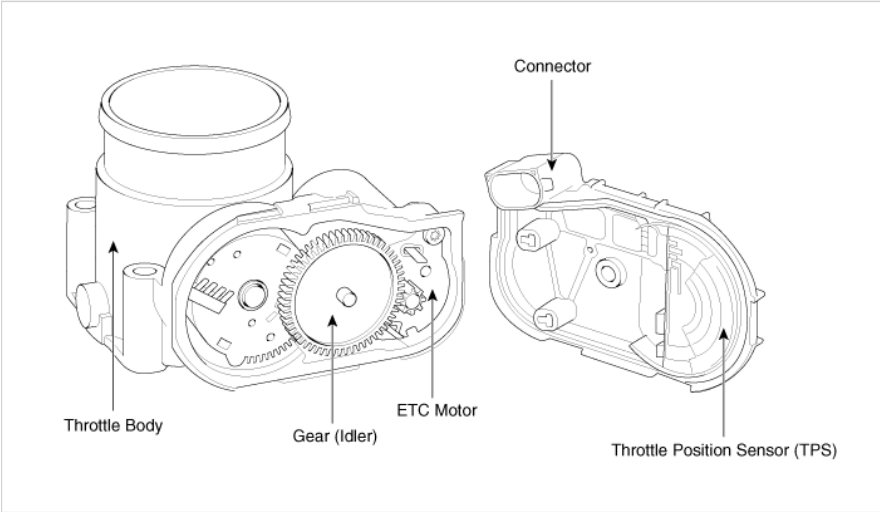
SONATA(YFA) > 2012 > Engine > Engine Control > Description

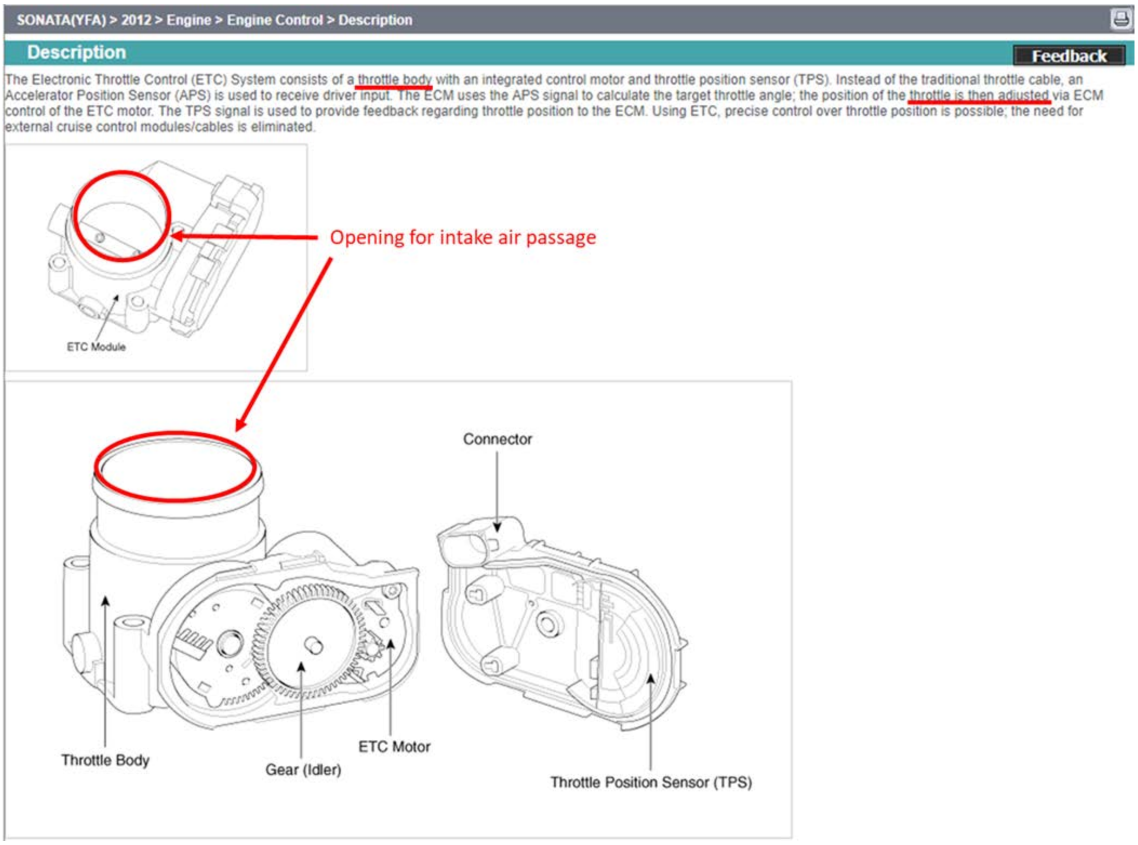
Description

Feedback

The Electronic Throttle Control (ETC) System consists of a throttle body with an integrated control motor and throttle position sensor (TPS). Instead of the traditional throttle cable, an Accelerator Position Sensor (APS) is used to receive driver input. The ECM uses the APS signal to calculate the target throttle angle; the position of the throttle is then adjusted via ECM control of the ETC motor. The TPS signal is used to provide feedback regarding throttle position to the ECM. Using ETC, precise control over throttle position is possible; the need for external cruise control modules/cables is eliminated.






SONATA(YFA) > 2012 > Engine > Engine Control > Description

Description

Feedback

The Electronic Throttle Control (ETC) System consists of a throttle body with an integrated control motor and throttle position sensor (TPS). Instead of the traditional throttle cable, an Accelerator Position Sensor (APS) is used to receive driver input. The ECM uses the APS signal to calculate the target throttle angle; the position of the throttle is then adjusted via ECM control of the ETC motor. The TPS signal is used to provide feedback regarding throttle position to the ECM. Using ETC, precise control over throttle position is possible; the need for external cruise control modules/cables is eliminated.

Figure 3- Electronic Throttle Control System

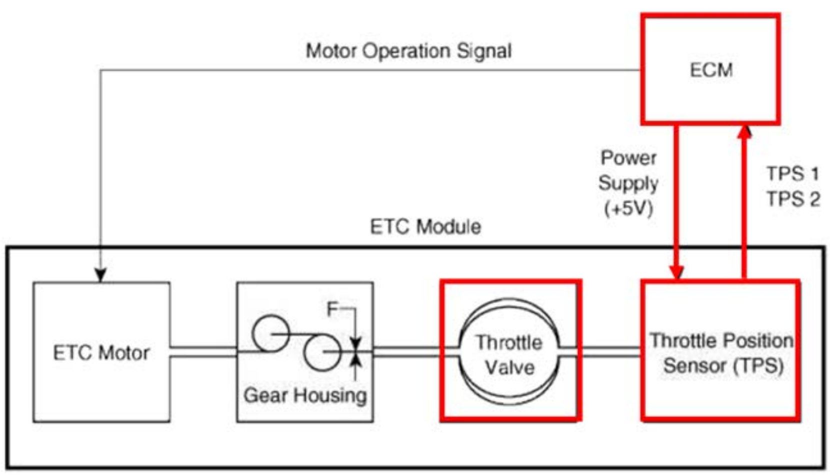


Figure 4 - Electronic Throttle Control Schematic Diagram

Component Parts And Function Outline

Component part		Function
Vehicle speed sensor		Converts vehicle speed to pulse.
ECM		Receives signals from sensor and control switches.
Cruise control indicator		Illuminate when CRUISE main switch is ON (Built into cluster)
Cruise control switches	ON/OFF switch	Switch for automatic speed control power supply.
	Resume/Accel switch	Controls automatic speed control functions by Resume/Accel switch (Set/Coast switch)
	Set/Coast switch	
Cancel switches	Cancel switch	Sends cancel signals to ECM.
	Brake pedal switch	
	Transaxle range switch (A/T)	
ETS motor		Regulates the throttle valve to the set opening by ECM.

* ETS : Electronic Throttle System

Figure 5

14. In particular, claim 1 of the ’604 patent recites a throttle controller for an internal combustion engine having a throttle body including an adjustable throttle valve in an intake air passage; a throttle valve actuator motor connected to the throttle valve for activating the throttle valve between a closed position and a full-open position; a throttle position sensor connected to the throttle valve for developing a position signal indicating the actual throttle valve position; an ignition switch for initiating engine startup and engine shutdown and for developing an engine shutdown signal; an accelerator pedal and an accelerator position sensor for developing an actual accelerator pedal position signal; and an electronic microprocessor comprising an input signal conditioning circuit receiving the engine shutdown signal, the electronic microprocessor including means for developing a throttle valve actuator motor control signal responsive to the presence of an engine shutdown signal whereby the throttle valve actuator motor adjusts the throttle plate to a throttle plate position between the closed position and the fully open position to prevent throttle plate freezing when the engine is shut down. An exemplary schematic block

diagram of a throttle valve system for an internal combustion engine which is capable of embodying the improvements of the invention is included below:

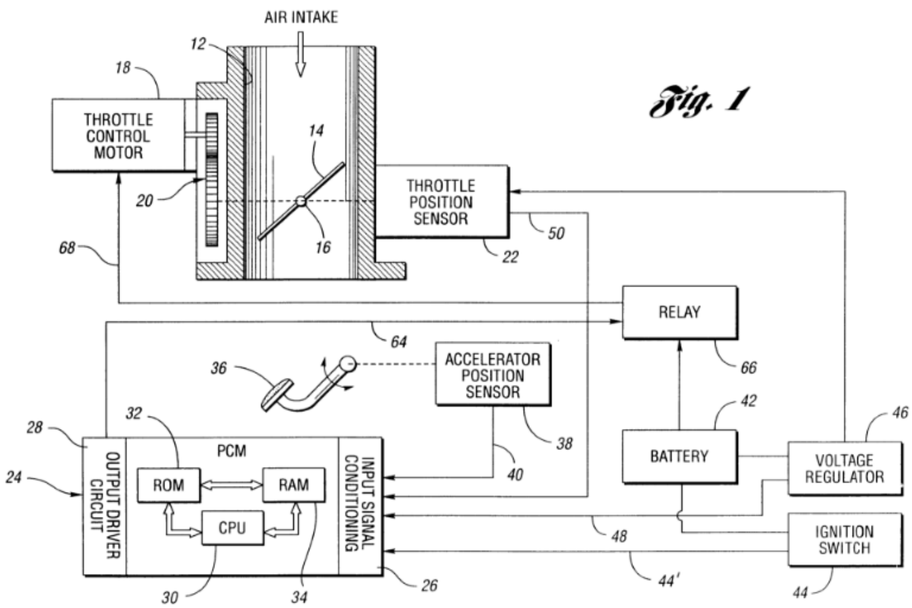


Figure 6

15. On information and belief, the Accused Instrumentalities infringe at least claim 1 of the ‘604 patent. The Accused Instrumentalities comprise a throttle controller (*Figure 3*) for an internal combustion engine (*Figure 1*) having a throttle body including an adjustable throttle valve in an intake air passage (*Figures 3-5*); a throttle valve actuator motor connected to the throttle valve for activating the throttle valve between a closed position and a full-open position (*Figures 3-5*); a throttle position sensor connected to the throttle valve for developing a position signal indicating the actual throttle valve position (*Figures 3-4, 7-8*); an ignition switch for initiating engine startup and engine shutdown and for developing an engine shutdown signal (*Figures 9-11*); an accelerator pedal and an accelerator position sensor for developing an actual accelerator pedal position signal (*Figures 3, 12-15*); and an electronic microprocessor (*Figure*

20) comprising an input signal conditioning circuit receiving the engine shutdown signal (*Figure 16*), the electronic microprocessor including means for developing a throttle valve actuator motor control signal responsive to the presence of an engine shutdown signal whereby the throttle valve actuator motor adjusts the throttle plate to a throttle plate position between the closed position and the fully open position to prevent throttle plate freezing when the engine is shut down (*Figures 3, 10, 14, 16-20*). In particular, Figure 10 indicates that the throttle plate is positioned between the closed position and the fully open position.

Throttle Position Sensor (TPS) [integrated into ETC Module]

Type: Variable resistor type

Specification

Throttle Angle(°)	Output Voltage (V)	
	TPS1	TPS2
0	0	5.0
10	0.48	4.52
20	0.95	4.05
30	1.43	3.57
40	1.90	3.10
50	2.38	2.62
60	2.86	2.14
70	3.33	1.67
80	3.81	1.19
90	4.29	0.71
100	4.76	0.24
105	5.0	0

Figure 7- Throttle Position Sensor Angles

1. Engine Control Module (ECM)	16. A/C Pressure Transducer (APT)
2. Manifold Absolute Pressure Sensor (MAPS)	17. ETC Motor [integrated into ETC Module]
3. Intake Air Temperature Sensor (IATS)	18. Injector
4. Engine Coolant Temperature Sensor (ECTS)	19. Purge Control Solenoid Valve (PCSV)
5. Throttle Position Sensor (TPS) [integrated into ETC Module]	20. CVVT Oil Control Valve (OCV) [Bank 1 / Intake]
6. Crankshaft Position Sensor (CKPS)	21. CVVT Oil Control Valve (OCV) [Bank 1 / Exhaust]
7. Camshaft Position Sensor (CMPS) [Bank 1 / Intake]	22. Variable Intake Solenoid (VIS) Valve
8. Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]	23. Fuel Pressure Regulator Valve
9. Knock Sensor (KS)	24. Canister Close Valve (CCV)
10. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 1]	25. Ignition Coil
11. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2]	26. Main Relay
12. Rail Pressure Sensor (RPS)	27. Fuel Pump Relay
13. Accelerator Position Sensor (APS)	28. Data Link Connector (DLC) [16-Pin]
14. Fuel Tank Pressure Sensor (FTPS)	29. Multi-Purpose Check Connector [20-Pin]
15. Fuel Level Sensor (FLS)	

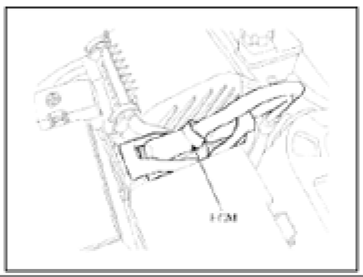
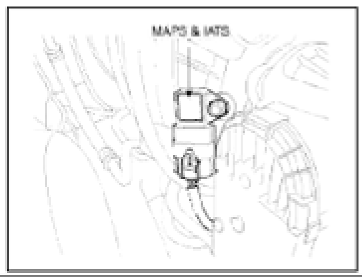
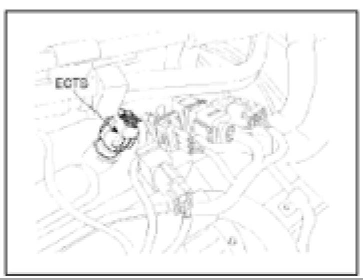
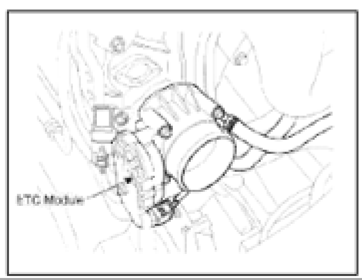
1. Engine Control Module (ECM)	2. Manifold Absolute Pressure Sensor (MAPS) 3. Intake Air Temperature Sensor (IATS)
	
4. Engine Coolant Temperature Sensor (ECTS)	5. Throttle Position Sensor (TPS) 16. ETC Motor
	

Figure 8- Throttle Position Sensor Location on Theta II Engine

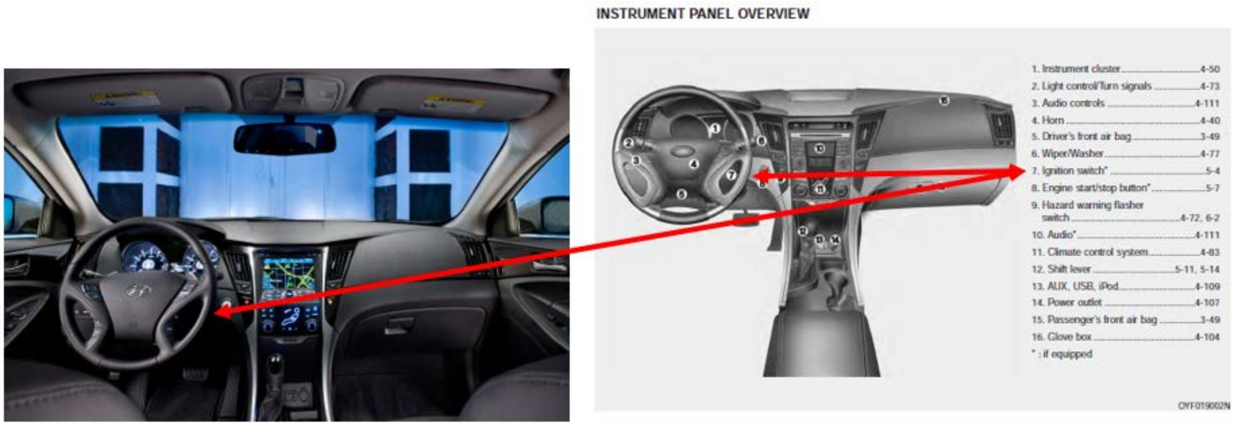


Figure 9- Ignition Switch for Initiating Engine Startup and Engine Shutdown, Sending Engine Shutdown Signal

The Infringing Instrumentalities comprise an electronic microprocessor including means for developing a throttle valve actuator motor control signal responsive to the presence of an engine shutdown signal whereby the throttle valve actuator motor adjusts the throttle plate to a throttle plate position between the closed position and the fully open position to prevent throttle plate freezing when the engine is shut down.

As shown below, the fail-safe mode where the throttle is stuck at 5 degrees (implying this is the default position). The 5 degree default position prevents the throttle from freezing closed. This position is between the closed and fully open position to prevent the throttle from freezing.

Fuel System > Engine Control System > ETC (Electronic Throttle Control) System > Troubleshooting

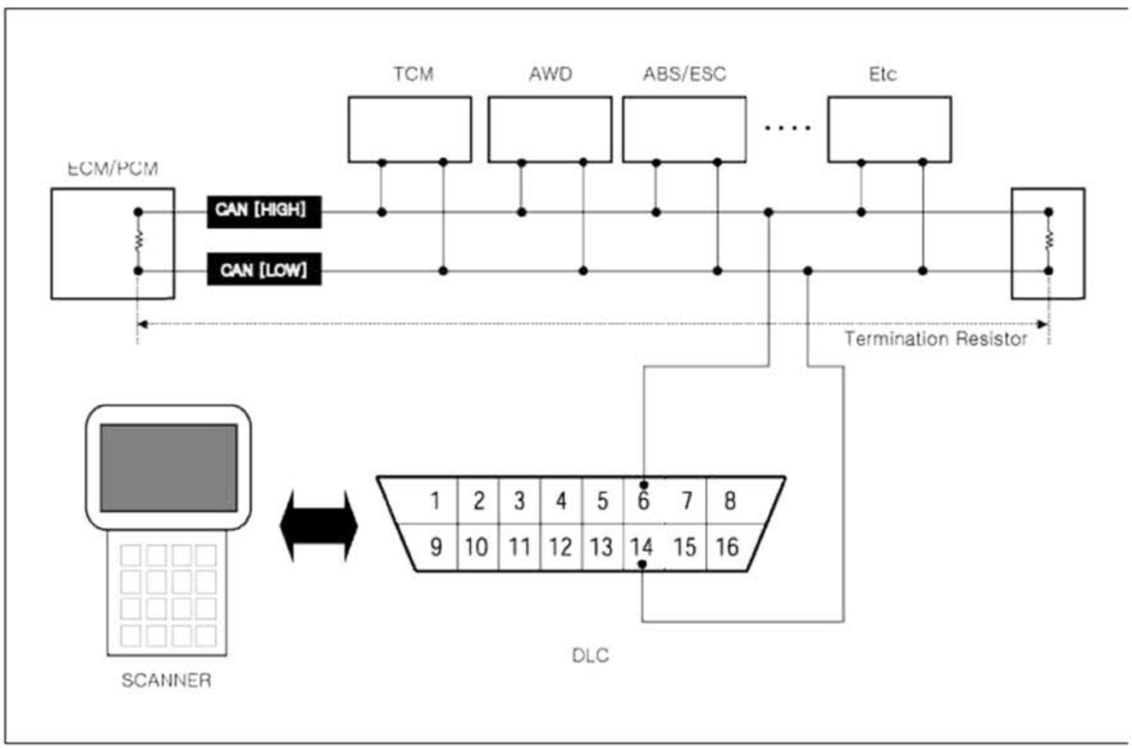
Fail-Safe Mode

Item	Fail-Safe	
ETC Motor	Throttle valve stuck at 5°	
TPS	TPS 1 fault	ECM looks at TPS2
	TPS 2 fault	ECM looks at TPS1
	TPS 1,2 fault	Throttle valve stuck at 5°
APS	APS 1 fault	ECM looks at APS 2
	APS 2 fault	ECM looks at APS 1
	APS 1,2 fault	Throttle valve stuck at 5°

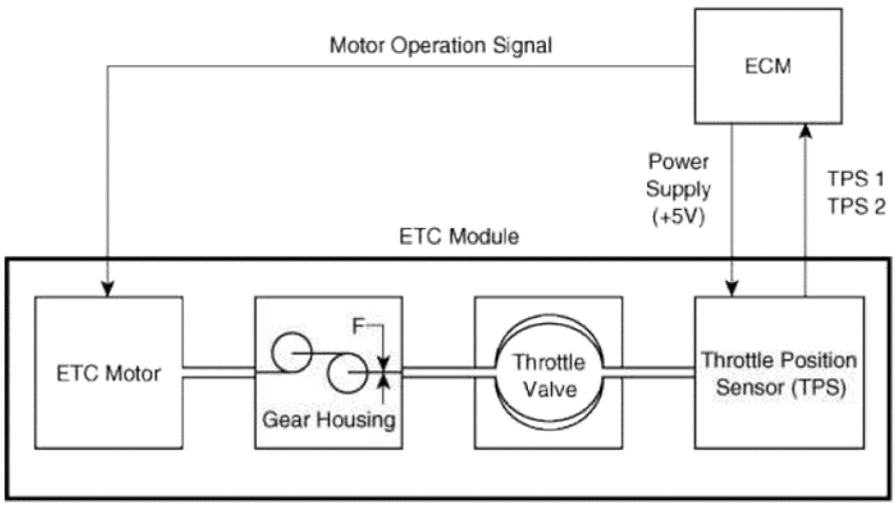
For example, as evidenced by the figures below, the Engine Control Module (ECM) is an electronic microprocessor.

The diagnostic executive is a computer program in the Engine Control Module (ECM) or PowertrainControl Module (PCM) that coordinates the OBD-II self-monitoring system. This program controls all the monitors and interactions, DTC and MIL operation, freeze frame data and scan tool interface.
Freeze frame data describes stored engine conditions, such as state of the engine, state of fuel control, spark, RPM,

load and warm status at the point the first fault is detected. Previously stored conditions will be replaced only if a fuel or misfire fault is detected. This data is accessible with the scan tool to assist in repairing the vehicle.
The center of the OBD-II system is a microprocessor called the Engine Control Module (ECM) or Powertrain Control Module(PCM).
The ECM or PCM receives input from sensors and other electronic components (switches, relays, and others) based on information received and programmed into its memory (keep alive random access memory, and others), the ECM or PCM generates output signals to control various relays, solenoids and actuators.
2. Configuration of hardware and related terms
1) GST (Generic scan tool)



The ECM includes a means for developing a throttle valve actuator motor control signal responsive to the presence of an engine shutdown.



Hyundai Service Website - Google Chrome

Hyundai Motor America [US] | https://www.hyundaitechinfo.com/viewer/content_pop.aspx?content_no=DTC|ENG|2684|2011||en|98||&sitinfolist=14^1420^142...

SONATA(YFA) > 2011 > Engine > Engine Control > General Description

General Description Feedback

The Electronic Throttle Control(ETC) system"s components are the throttle body, Throttle Position Sensor(TPS)1&2 and Accelerator Position Sensor(APS) 1&2. The throttle body contains the actuator, the throttle plate and the throttle position sensor (potentiometer), which are integrated in one housing. The actuator consists of a DC motor with a two-stage gear. The opening angle of the throttle valve is detected by the throttle position sensor which is mounted on the throttle body. And it provides feedback to the PCM to control the throttle motor in order to control the throttle valve opening angle properly in response to the driving condition.

Hyundai Service Website - Google Chrome

Hyundai Motor America [US] | https://www.hyundaitechinfo.com/viewer/content_pop.aspx?content_no=DTC|ENG|2684|2011||imm|1||&sitinfolist=14^1420^14...

SONATA(YFA) > 2011 > Immobilizer > Immobilizer > General Description

General Description Feedback

The immobilizer system consists of a passive challenge-response (mutual authentication) transponder inside the key head, the encoded SMARTRA3 unit / key and the PCM can decode the secret code stored in the SMARTRA3.

The PCM carries out the immobilizer function, the SMATRA3 management and the key management. The immobilizer function is the unlocking of PCM only after detection of a valid ignition ke the SMATRA3 and the locking of PCM after switching off the engine. The PCM communicates the encoded messages to the SMARTRA3 via a dedicated communication line and confirms the key with the SMARTRA3.

The PCM related to immobilizer has the 3 kinds of software. At the first IGN on, the PCM concludes the software of each option (smart key, non-encoded SMARTRA3, encoded SMARTRA3) b communication. It is called "The autodection for PCM"The PCM keeps the previous option before being neutral when it is setted to each option.

Hyundai Service Website - Google Chrome

Hyundai Motor America [US] | https://www.hyundaitechinfo.com/viewer/content_pop.aspx?content_no=DTC|ENG|2684|2011||imm|1||&sitinfolist=92^9274^92...

SONATA(YFA) > 2011 > Immobilizer > Immobilizer > General Description

General Description Feedback

The vehicle immobilizer system consists of the PCM, the SMARTRA3 and ignition keys with built-in transponder.

The PCM carries out the check of ignition key by special encryption algorithm with SMARTRA3 and Transponder.

The encryption algorithm (between PCM and SMARTRA3) is the one offered from BOSCH.

The encryption algorithm (between PCM and Transponder) is Hitag type 2 which is a high level system. With IGN On, the PCM executes the key Authentication after SMARTRA3 authentication. The Engine can be started when the key authentication is confirmed by the SMARTRA3.

The Key teaching procedure starts with PCM request of PIN from Scanner. The "virgin" PCM stores the PIN and the key Learning can be started. The "learnt" PCM compares the PIN from tester with the vehicle password in Transponder. If the data are correct, the key Learning can be started.

Scanner requests the Learning of the first key, the SMARTRA3 is registered at first and then the first key is registered by PCM. If the SMARTRA3 status is learnt and PIN number is different, the SMARTRA3 will return the incorrect PIN data to the PCM. In this case, The PCM can't excute the key learning process.

The immobilizer function is the unlocking of PCM after detection of a valid ignition key; the PCM locks after switching off of the engine. The throttle valve actuator motor adjusts the throttle plate to a throttle plate position between the close position at 0 degrees and a fully open position between 100 and 105 degrees.

Figure 10

Throttle Position Sensor (TPS) [integrated into ETC Module]
Type: Variable resistor type
Specification

Throttle Angle(°)	Output Voltage (V)	
	TPS1	TPS2
0	0	5.0
10	0.48	4.52
20	0.95	4.05
30	1.43	3.57
40	1.90	3.10
50	2.38	2.62
60	2.86	2.14
70	3.33	1.67
80	3.81	1.19
90	4.29	0.71
100	4.76	0.24
105	5.0	0

For example, the ECM and TPS learn the closed throttle voltage when the throttle plate is positioned at engine shutdown to prevent freezing.

Throttle Stop Screw (minimum air setting)

The throttle stop screw's primary function is to prevent the throttle blade from closing too far and getting wedged/stuck in the throttle bore. However, it serves as a secondary function to adjust the minimum air setting. The "minimum air setting" is what is used to describe the amount of air that is allowed to enter the engine thru a "closed" throttle. Because the throttle valve cannot be allowed to completely close (because this would result in it getting wedged/stuck closed in the throttle bore), some air will always be allowed to enter the engine around the throttle valve.

Setting the throttle stop screw can be accomplished a couple of different ways. If you have a scan tool, I recommend allowing the engine to warm up to operating temperature and then adjust the throttle stop screw in or out until the observed IAC position counts come to rest within the spec range I provided earlier. After adjusting the throttle stop screw, it may be necessary to adjust the Throttle Position Sensor, which we discussed in my Jan/Feb 2008 segment. On cars that don't have an adjustable throttle position sensor, the ECM automatically learns the "closed throttle" voltage when the ignition is keyed on (after the key has been off for at least 10 seconds).

http://www.gmtuners.com/tech/TPS_IAC.htm

Figure 11- Description of Power Train Control Module and Communication with Ignition Switch and PCM/ECM Functions with Ignition Switch

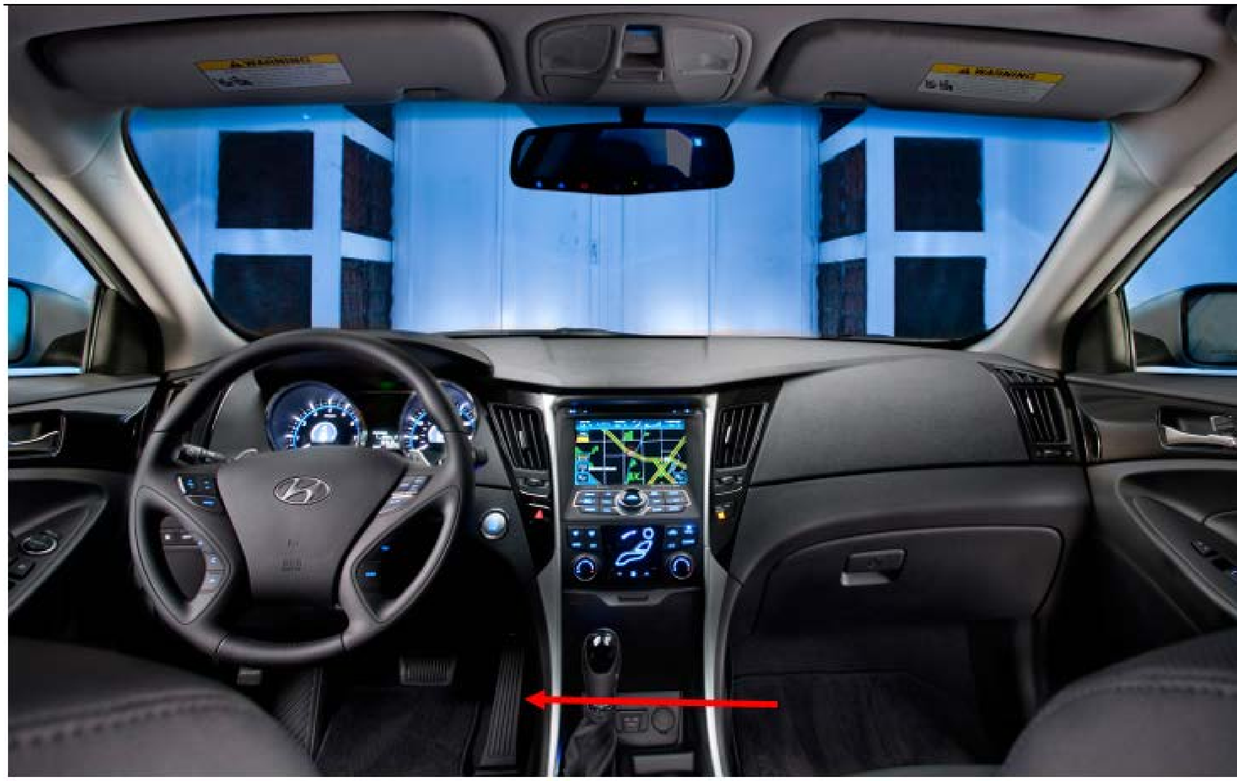
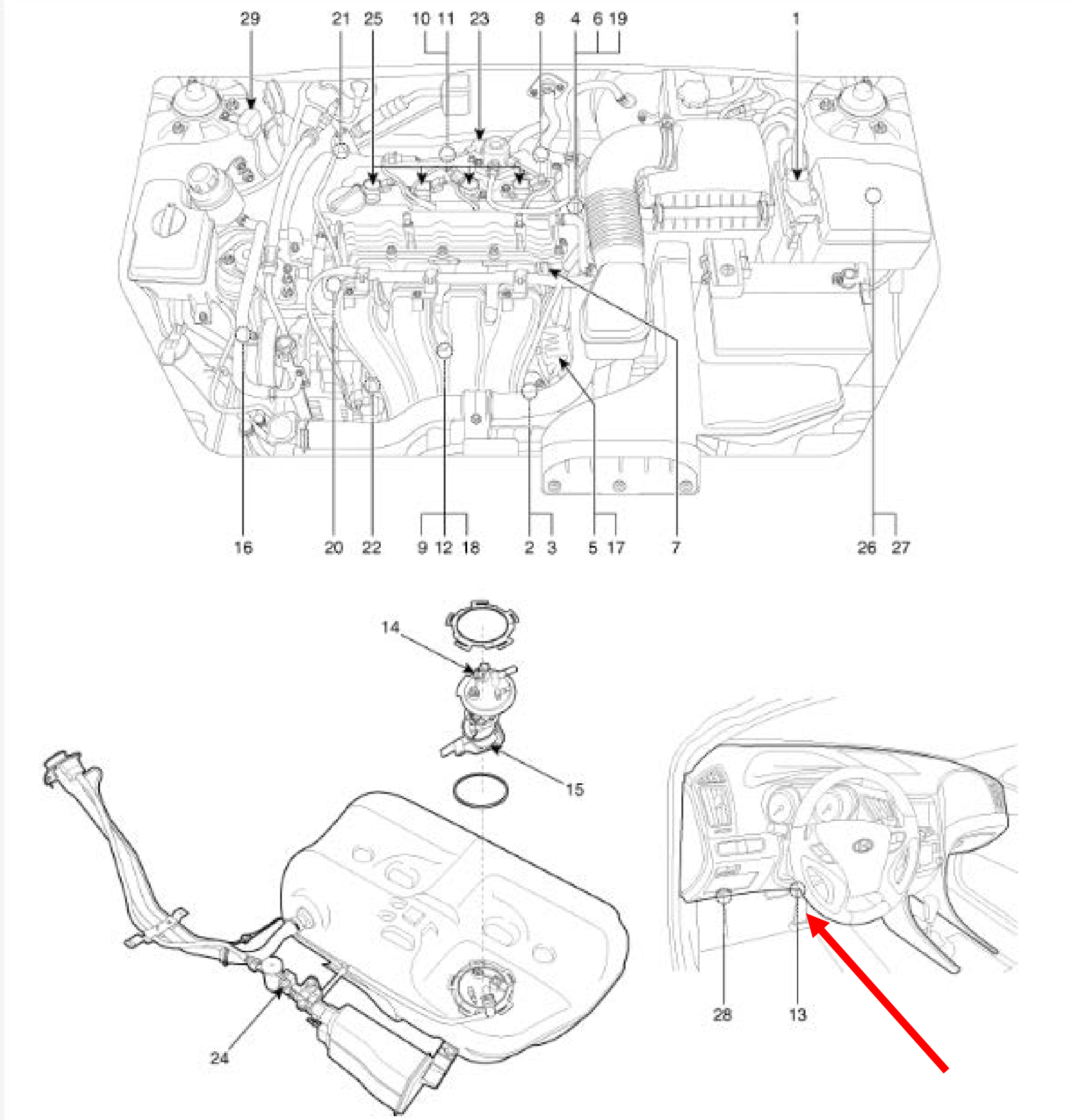


Figure 12- Accelerator Pedal



1. Engine Control Module (ECM)	16. A/C Pressure Transducer (APT)
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3. Intake Air Temperature Sensor (IATS)	18. Injector
4. Engine Coolant Temperature Sensor (ECTS)	19. Purge Control Solenoid Valve (PCSV)
5. Throttle Position Sensor (TPS) [integrated into ETC Module]	20. CVVT Oil Control Valve (OCV) [Bank 1 / Intake]
6. Crankshaft Position Sensor (CKPS)	21. CVVT Oil Control Valve (OCV) [Bank 1 / Exhaust]
7. Camshaft Position Sensor (CMPS) [Bank 1 / Intake]	22. Variable Intake Solenoid (VIS) Valve
8. Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]	23. Fuel Pressure Regulator Valve
9. Knock Sensor (KS)	24. Canister Close Valve (CCV)
10. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 1]	25. Ignition Coil
11. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2]	26. Main Relay
12. Rail Pressure Sensor (RPS)	27. Fuel Pump Relay
13. Accelerator Position Sensor (APS)	28. Data Link Connector (DLC) [16-Pin]
14. Fuel Tank Pressure Sensor (FTPS)	29. Multi-Purpose Check Connector [20-Pin]
15. Fuel Level Sensor (FLS)	

Figure 13 - Accelerator Position Sensor

SONATA(YFA) > 2012 > Engine > Engine Control > Description

Description

Feedback

Accelerator Position Sensor (APS) is installed on the accelerator pedal module and detects the rotation angle of the accelerator pedal. The APS is one of the most important sensors in engine control system, so it consists of the two sensors which adapt individual sensor power and ground line. The second sensor monitors the first sensor and its output voltage is half of the first one. If the ratio of the sensor 1 and 2 is out of the range (approximately 1/2), the diagnostic system judges that it is abnormal.

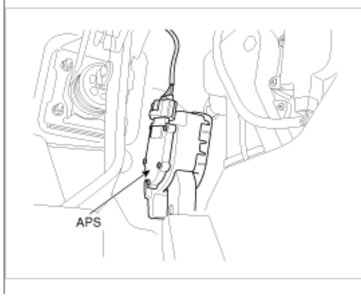


Figure 14 - Accelerator Position Sensor Description

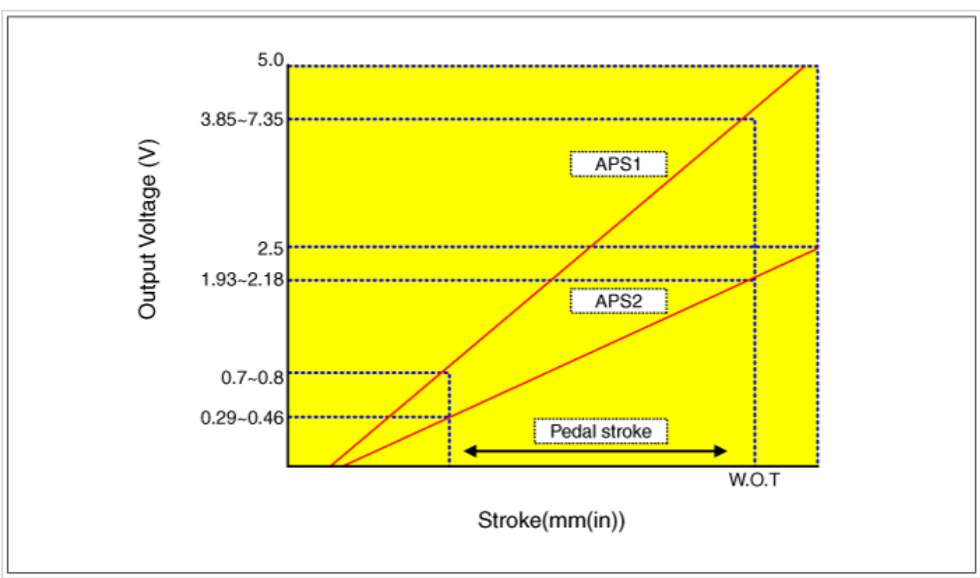
SONATA(YFA) > 2012 > Engine > Engine Control > Component Inspection

Component Inspection

1. Accelerator Pedal Rod Inspection
   (1) Verify that the accelerator pedal operate freely without binding between full closed and wide open position by operating the accelerator pedal.
   (2) Check for poor carpet fit under the accelerator controls pedal.
   (3) Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure. If OK, go to next step as below.
2. APS1 Inspection
   (1) IG KEY "ON".
   (2) Connect GDS and monitor the "APS1" parameter on the data list.

Specification : Refer to "Signal Waveform & Data" in the "General Information".

Accelerator Position	Output Voltage (V)	
	APS1	APS2
C.T	0.7~0.8	0.29~0.46
W.O.T	3.85~4.35	1.93~2.18

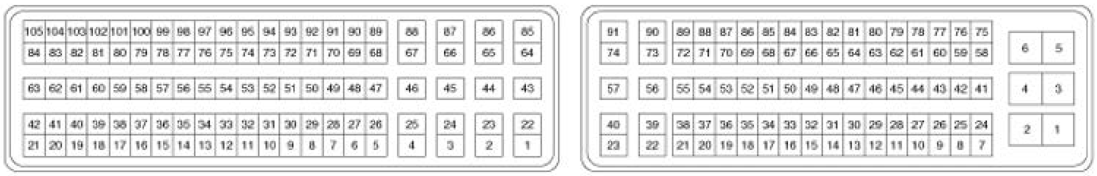


(3) Is data in accordance with "Data Anaysis"?

Figure 15 - Accelerator Position Sensor for Developing Actual Pedal Position Signal

SONATA(YFA) > 2012 > Engine > Engine Control > ECM Terminal And Input/Output signal

ECM Terminal And Input/Output signal



Connector [CHG-AG] Connector [CHG-BG]

ECM Terminal Function

54	Sensor ground	Throttle Position Sensor (TPS) 1,2
55	Sensor ground	Accelerator Position Sensor (APS) 2
56	Sensor ground	Accelerator Position Sensor (APS) 1
57	Immobilizer communication line	Smart Key Control Module [With Button Engine Start System] Immobilizer Control Module [Without Button Engine Start System]
75	Throttle Position Sensor (TPS) 2 signal input	Throttle Position Sensor (TPS) 2
76	Accelerator Position Sensor (APS) 2 signal input	Accelerator Position Sensor (APS) 2
77	Accelerator Position Sensor (APS) 1 signal input	Accelerator Position Sensor (APS) 1

75	Throttle Position Sensor (TPS) 2 signal input	C.T	Analog	4.2 ~ 5.0V
		W.O.T		3.3 ~ 3.8V
76	Accelerator Position Sensor (APS) 2 signal input	C.T	Analog	Max. 1.0V
		W.O.T		1.5 ~ 3.0V
77	Accelerator Position Sensor (APS) 1 signal input	C.T	Analog	Max. 1.0V
		W.O.T		Min. 4.0V

96	Throttle Position Sensor (TPS) 1 signal input	Throttle Position Sensor (TPS) 1
97	Sensor power (+5V)	Accelerator Position Sensor (APS) 2
98	Sensor power (+5V)	Accelerator Position Sensor (APS) 1

Figure 16 - ECM Terminal Input/Output Signal

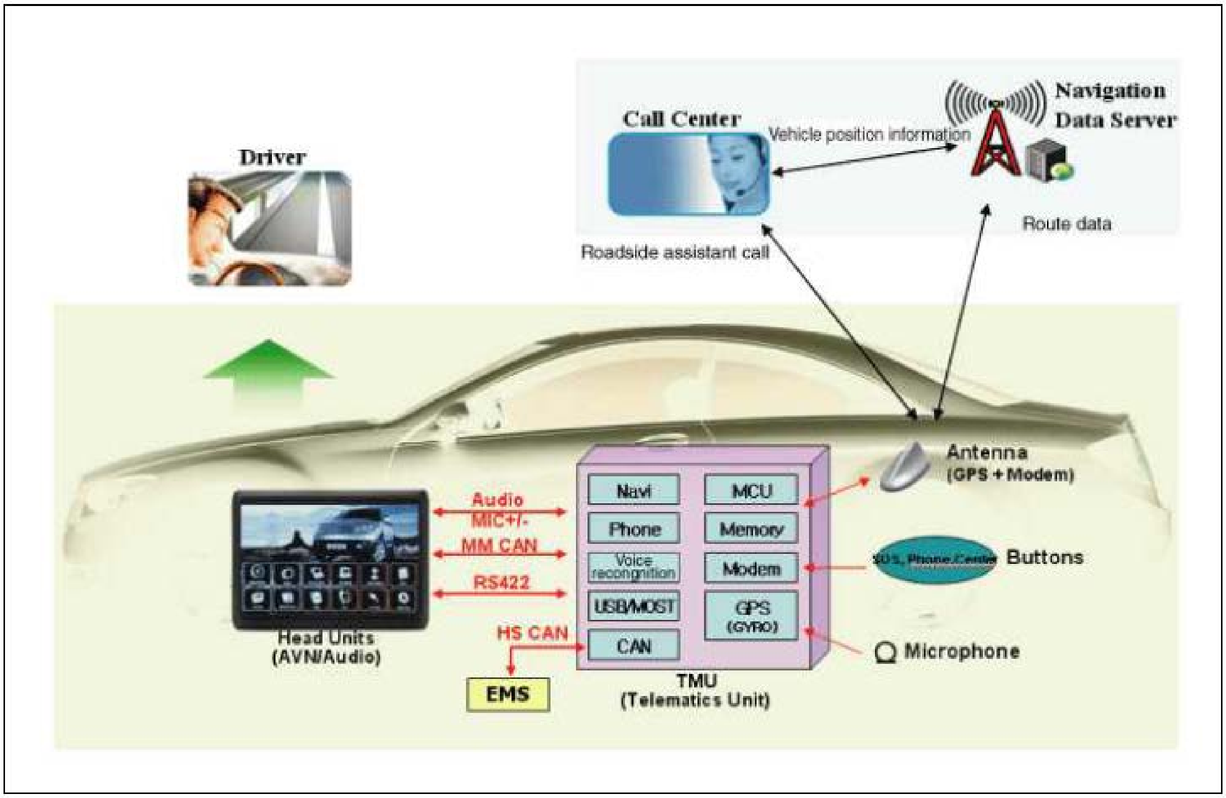


Figure 17- CAN Network

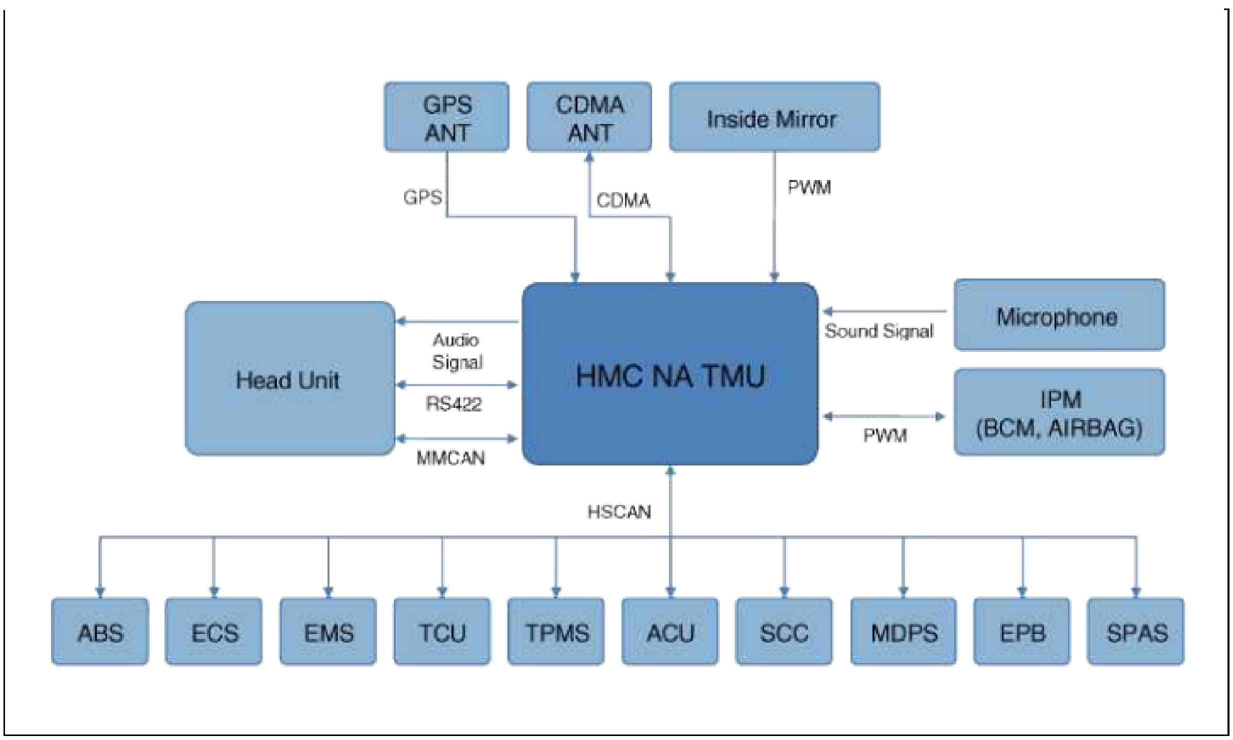
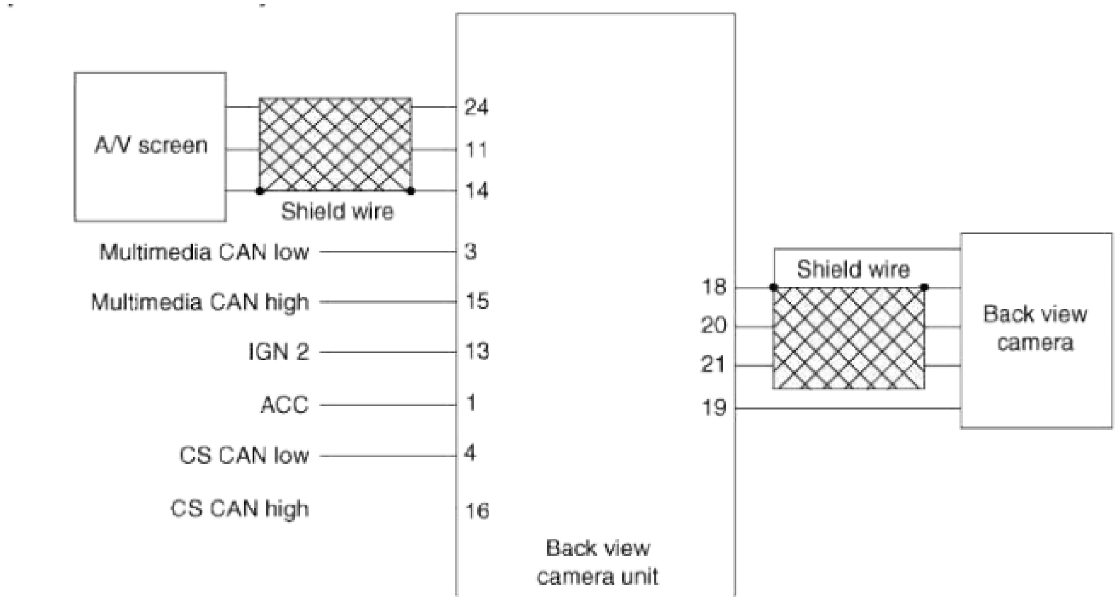
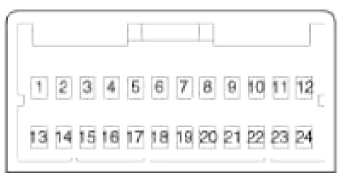


Figure 18- CAN Network





Pin NO	Description	Pin NO	Description
1	ACC	13	IGN 2
2	-	14	Ground
3	Multimedia CAN low	15	Multimedia CAN high
4	C-CAN low	16	C-CAN high
5	-	17	-
6	-	18	Back view camera ground
7	-	19	Back view camera power
8	-	20	Back view camera video input
9	-	21	Back view camera video ground
10	-	22	-
11	Video out	23	-
12	-	24	Video ground

Figure 19 - CAN Network

The center of the OBD-II system is a microprocessor called the Engine Control Module (ECM) or Powertrain Control Module(PCM).
The ECM or PCM receives input from sensors and other electronic components (switches, relays, and others) based on information received and programmed into its memory (keep alive random access memory, and others), the ECM or PCM generates output signals to control various relays, solenoids and actuators.
2. Configuration of hardware and related terms
1) GST (Generic scan tool)

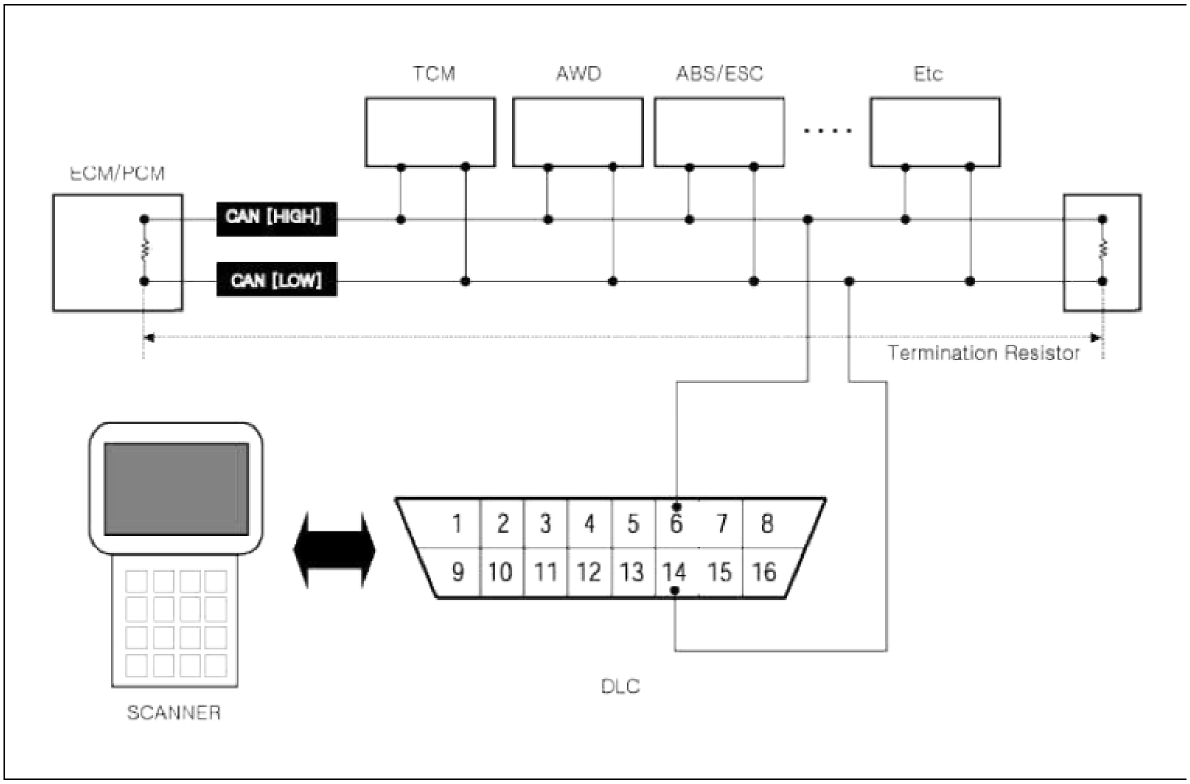


Figure 20 - Microprocessor OBD-II Note: Controls ECM or PCM

COUNT II – INFRINGEMENT OF U.S. PATENT NO. 6,619,106

16. The allegations set forth in the foregoing paragraphs 1 through 15 are incorporated into this Second Claim for Relief.

17. On September 16, 2003, U.S. Patent No. 6,619,106 (“the ’106 patent”), entitled “*High-resolution Electronic Throttle Position System,*” was duly and legally issued by the United States Patent and Trademark Office. A true and correct copy of the ’106 patent is attached as Exhibit 2.

18. Plaintiff is the assignee and owner of the right, title and interest in and to the ’106 patent, including the right to assert all causes of action arising under said patents and the right to any remedies for infringement of them.

19. Upon information and belief, Defendants have directly infringed at least claim 1 of the ’106 patent by making, using, selling, importing and/or providing and causing to be used the 2011-2017 Hyundai Sonata (2.0L), 2010-2017 Hyundai Genesis Coupe (2.0L), 2013-2017 Hyundai Santa Fe (2.0L), 2011-2017 Hyundai Sonata (2.4L), 2010-2017 Hyundai Tucson (2.4L), 2010-2017 Hyundai Santa Fe (the “Accused Instrumentalities”).

20. Upon information and belief, the Accused Instrumentalities incorporate the Theta II Engine which comprises a high-resolution position sensing apparatus for determining the angular position of a throttle plate located in an electronic throttle and controlled by a power train control module (PCM).

21. In particular, claim 1 of the ’106 patent recites a high-resolution position sensing apparatus for determining the angular position of a throttle plate located in an electronic throttle and controlled by a PCM, said sensing apparatus comprising: a first throttle position sensor coupled to the throttle plate and generating a first throttle position sensor output signal, said first throttle position sensor output signal being affine to a position of the throttle plate and different over a first range of motion of the throttle plate; and a second throttle position sensor coupled to the throttle plate and generating a second throttle position sensor output signal, said second throttle position sensor output signal being affine to a position of the throttle plate and different over a second range of motion of the throttle plate, where said second range is less than said first range, and wherein said first range of motion of the throttle plate extends from approximately full closed to approximately full open.

22. On information and belief, the Accused Instrumentalities infringe at least claim 1 of the ’106 patent. The Accused Instrumentalities comprise a high-resolution position sensing apparatus for determining the angular position of a throttle plate located in an electronic throttle and controlled by a PCM (*Figures 3, 7*), said sensing apparatus comprising: a first throttle position sensor coupled to the throttle plate and generating a first throttle position sensor output signal (*Figures 3-4, 7, 16, 22*), said first throttle position sensor output signal being affine to a position of the throttle plate and different over a first range of motion of the throttle plate (*Figures 21-22*); and a second throttle position sensor coupled to the throttle plate and generating a second throttle position sensor output signal (*Figure 22*), said second throttle position sensor output signal being affine to a position of the throttle plate and different over a second range of motion of the throttle plate (*Figure 22*), where said second range is less than said first range at least given the closed throttle (“CT”) and wide open throttle (“WOT”) tolerances of the two sensors (*Figure 21*), and wherein said first range of motion of the throttle plate extends from approximately full closed to approximately full open (*Figures 3-4, 7, 16, 22*).

Fuel System > Engine Control System > ETC (Electronic Throttle Control) System > Description and Operation

Description

The Electronic Throttle Control (ETC) System consists of a throttle body with an integrated control motor and throttle position sensor (TPS). Instead of the traditional throttle cable, an Accelerator Position Sensor (APS) is used

Throttle Position Sensor (TPS) [integrated into ETC Module]

Type: Variable resistor type

Specification

Throttle Angle(°)	Output Voltage (V)	
	TPS1	TPS2
0	0	5.0
10	0.48	4.52
20	0.95	4.05
30	1.43	3.57
40	1.90	3.10
50	2.38	2.62
60	2.86	2.14
70	3.33	1.67
80	3.81	1.19
90	4.29	0.71
100	4.76	0.24
105	5.0	0

Fuel System > Engine Control System > ETC (Electronic Throttle Control) System > Specifications

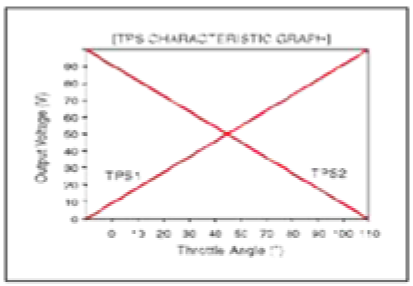
Specification

[Throttle Position Sensor (TPS)]

Throttle Angle(°)	Output Voltage(V)	
	TPS1	TPS2
0	0.0	5.0
10	0.48	4.52
20	0.95	4.05
30	1.43	3.57
40	1.90	3.10
50	2.38	2.62
60	2.86	2.14
70	3.33	1.67
80	3.81	1.19
90	4.29	0.71
100	4.76	0.24
105	5.0	0
C.T (6 ~ 15°)	0.29 ~ 0.71	4.29 ~ 4.71
W.O.T (93 ~ 102°)	4.43 ~ 4.86	0.14 ~ 0.57

Closed throttle range tolerance

Wide open throttle range tolerance



Item	Sensor Resistance(kΩ)
TPS1	0.875 ~ 1.625 [20°C(68°F)]
TPS2	0.875 ~ 1.625 [20°C(68°F)]

[ETC Motor]

Item	Specification
Coil Resistance (Ω)	1.2 ~ 1.8 [20°C(68°F)]

Figure 21 -The throttle position sensor 2 (TPS 2) output signal corresponds to (is affine to) a position of the throttle plate and different over a second range of motion of the plate, where a second range is less than a first range.

Figure 22- Description of Electronic Throttle Control System Note: Includes Throttle Position Sensor, Accelerator Position Sensor, Actuator, Throttle Plate, and Throttle Position Sensor Integrated In One Housing

COUNT III – INFRINGEMENT OF U.S. PATENT NO. 6,588,260

23. The allegations set forth in the foregoing paragraphs 1 through 22 are incorporated into this Third Claim for Relief.

24. On July 8, 2003, U.S. Patent No. 6,588,260 ("the '260 patent"), entitled "*Electronic Throttle Disable Control Test System*," was duly and legally issued by the United States Patent and Trademark Office. A true and correct copy of the '260 patent is attached as Exhibit 3.

25. Plaintiff is the assignee and owner of the right, title and interest in and to the '260 patent, including the right to assert all causes of action arising under said patents and the right to any remedies for infringement of them.

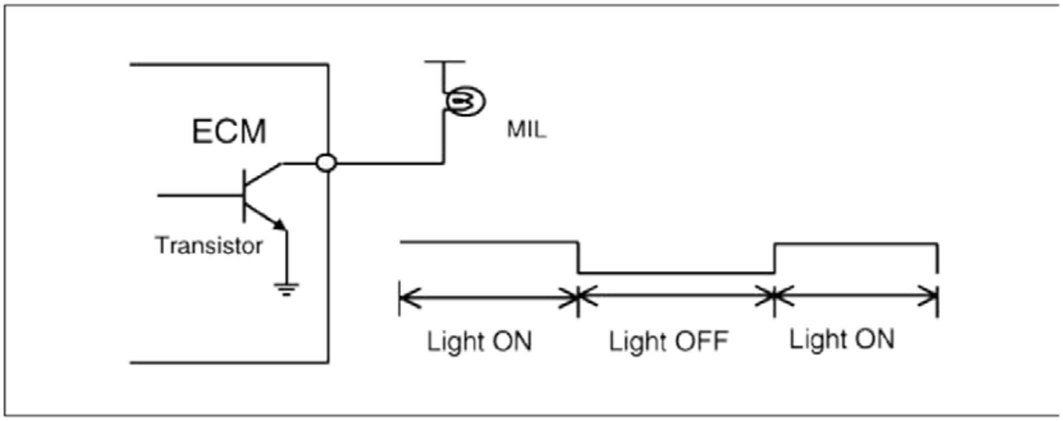
26. Upon information and belief, Defendants have directly infringed at least claim 1 of the '260 patent by making, using, selling, importing and/or providing and causing to be used the 2011-2017 Hyundai Sonata (2.0L), 2010-2017 Hyundai Genesis Coupe (2.0L), 2013-2017 Hyundai Santa Fe (2.0L), 2011-2017 Hyundai Sonata (2.4L), 2010-2017 Hyundai Tucson (2.4L), 2010-2017 Hyundai Santa Fe (the "Accused Instrumentalities").

27. Upon information and belief, the Accused Instrumentalities incorporate the Theta II Engine which comprises an electronic throttle control apparatus for testing integrity of a motor drive electronics.

28. In particular, claim 1 of the ’260 patent recites an electronic throttle control apparatus for testing integrity of a motor drive electronics disable feature comprising: a PCM having drive electronics for controlling a motor coupled to an electronic throttle plate, said PCM having control logic to disable said drive electronics and return said electronic throttle plate to a default position, determine a default throttle position sensor (TPS) output voltage corresponding to said default position, command a full closing motor voltage, compare a full closing TPS output voltage to said default TPS output voltage, and engage failure mode management when said full closing TPS output voltage and said default TPS output voltage are significantly different from each other.

29. On information and belief, the Accused Instrumentalities infringe at least claim 1 of the ’260 patent. The Accused Instrumentalities comprise an electronic throttle control apparatus (*Figures 3,*) for testing integrity of a motor drive electronics disable feature (*Figures 3-4, 11, 20-23*) comprising: a PCM having drive electronics for controlling a motor coupled to an electronic throttle plate (*Figures 11, 20, 22-23*), said PCM having control logic to disable said drive electronics and return said electronic throttle plate to a default position (*Figures 3-4, 11, 20, 22-24*), determine a default throttle position sensor (TPS) output voltage corresponding to said default position, command a full closing motor voltage, compare a full closing TPS output voltage to said default TPS output voltage (*Figures 3-4, 11, 20, 22-25*), and engage failure mode management when said full closing TPS output voltage and said default TPS output voltage are significantly different from each other (*Figures 3-4, 11, 20, 22-25*).

2) MIL (Malfunction indication lamp) - MIL activity by transistor



The Malfunction Indicator Lamp (MIL) is connected between ECM or PCM-terminal Malfunction Indicator Lamp and battery supply (open collector amplifier).

In most cars, the MIL will be installed in the instrument panel. The lamp amplifier can not be damaged by a short circuit.

Lamps with a power dissipation much greater than total dissipation of the MIL and lamp in the tester may cause a fault indication.

At ignition ON and engine revolution (RPM)< MIN. RPM, the MIL is switched ON for an optical check by the driver.

3) MIL illumination

When the ECM or PCM detects a malfunction related emission during the first driving cycle, the DTC and engine data are stored in the freeze frame memory. The MIL is illuminated only when the ECM or PCM detects the same malfunction related to the DTC in two consecutive driving cycles.

4) MIL elimination

● Misfire and Fuel System Malfunctions:

For misfire or fuel system malfunctions, the MIL may be eliminated if the same fault does not reoccur during monitoring in three subsequent sequential driving cycles in which conditions are similar to those under which the malfunction was first detected.

● All Other Malfunctions:

For all other faults, the MIL may be extinguished after three subsequent sequential driving cycles during which the monitoring system responsible for illuminating the MIL functions without detecting the malfunction and if no other malfunction has been identified that would independently illuminate the MIL according to the requirements outlined above.

5) Erasing a fault code

The diagnostic system may erase a fault code if the same fault is not re-registered in at least 40 engine warm-up cycles, and the MIL is not illuminated for that fault code.

6) Communication Line (CAN)

• Bus Topology : Line (bus) structure
• Wiring : Twisted pair wire
• Off Board DLC Cable Length : Max. 5m
• Data Transfer Rate
- Diagnostic : 500 kbps
- Service Mode (Upgrade, Writing VIN) : 500 or 1Mbps)

PCM/ECM Malfunction Indicator Lamp Description Note: Includes Function

SONATA(YFA) > 2012 > G 2.4 GDI > Engine > Engine Control > P0638 Throttle Actuator Control Range/Performance (Bank 1)

DTC Description Feedback

PCM sets DTC P0638 if the PCM detects TPS adaptation value exceeds threshold value.

DTC Detecting Condition

Item		Detecting Condition	Possible Cause
DTC Strategy	Case1	• TPS adaptation condition check	
	Case2	• ETC Limp Home position check	
	Case3	• Lower mechanical stop adaptation voltage range check	
Enable Conditions		• During TPS adaptation	
Threshold Value	Case1	• TPS adaptation is requested but not possible	1. Poor c
	Case2	• Difference between Throttle sensor voltage in limphome and limphome setpoint > 0.3V	2. Faulty
	Case3	• Difference between Throttle sensor voltage in lower mechanical stop position and lower mechanical stop position setpoint > 0.3V	3. Faulty
Diagnostic Time		• 1.2 sec.	
Limp-Home		• Forced limited RPM mode : The PCM limits engine speed to 1500rpm • Electrical check of the ETC system is prohibited	
MIL On Condition		• Immediate	

Testing integrity of a motor drive electronics disable feature

Motor drive electronics disable feature

There is an Electronic Throttle Control (ETC) system which tests integrity of a motor drive electronics disable feature.

SONATA(YFA) > 2012 > G 2.4 GDI > Engine > Engine Control > P0652 Sensor Reference Voltage 'B' Circuit Low

DTC Description Feedback

PCM sets P0652 when detects a reference voltage is out of normal range.

DTC Detecting Condition

Item		Detecting Condition	Possible Cause
Case 1	DTC Strategy	• Short to Ground	
	Enable Conditions	• IG ON	
	Threshold Value	• TPS power supply voltage < 0.7 V	
Case 2	DTC Strategy	• Sensor or circuit error	1. Short to ground in Power circuit 2. Poor connection or damaged harness 3. Faulty ETC
	Enable Conditions	• IG ON	
	Threshold Value	• 0.7 V ≤ TPS power supply voltage < 4.5 V	
Diagnostic Time		• 0.04 sec.	
Mil On Condition		• 1 Drive Cycles	
Limp-Home		• Forced limited RPM mode : The PCM limits engine speed to 1500rpm • Electrical check of the ETC system is prohibited	

Control logic is the command from the PCM which triggers “Limp-Home” mode in Case 2 where there is a sensor or circuit error effecting the ETC (disable drive electronics). When there is an error detected the PCM returns the electronic throttle plate to a default position. Further, the

PCM disables check of the ETC system inferring that the PCM relinquishes control of the ETC which remains in a default position.

SONATA(YFA) > 2012 > G 2.4 GDI > Engine > Engine Control > P2119 Throttle Actuator Control Throttle Body Range/Performance

DTC Description Feedback

PCM sets DTC P2119 if the PCM detects TPS adaptation procedure is abnormal.

DTC Detecting Condition

Item		Detecting Condition	Possible Cause
DTC Strategy	Case1	• TPS adaptation Lower position check	1. Poor connection or damaged harness 2. Faulty ETC motor
	Case2	• TPS adaptation error low return spring check	
	Case3	• TPS adaptation upper position check	
	Case4	• TPS adaptation error upper return spring check	
	Case5	• TPS start check error in spring check	
	Case6	• TPS start check error in limp-home-check	
Enable Conditions	Case1	• During TPS adaptation • TPS setpoint = 11.9%	
	Case2,4	• During TPS adaptation	
	Case3	• During TPS adaptation • TPS setpoint = 29%	
	Case5	• During TPS start check • TPS setpoint = 24.2%	
	Case6	• During TPS start check • No engine start condition	
Threshold Value	Case1	• Throttle position for the lower return spring check is not reached within a limit maximum time(Difference between throttle position and setpoint > 0.48%")	
	Case2	• When ETC power stage is off, Throttle can not return by spring power in the limp-home position within a limit maximum time(Difference between Throttle position and adapted voltage in limphome position > 0.18 V)	
	Case3	• Throttle position for the upper return spring check is not reached within a limit maximum time(Difference between throttle position and setpoint > 0.48%)	
	Case4	• When ETC power stage is off, Throttle cannot return by spring power in the limp-home position within a limit maximum time(Difference between Throttle position and adapted voltage in limphome position > 0.18 V)	
	Case5	• Throttle flap cannot reach the setpoint within the hysteresis within a limit maximum time(Difference between throttle position and requested position > 0.48%)	
	Case6	• When ETC power stage is off, Throttle cannot return by spring power in the limp-home position within a limit maximum time(Difference between Throttle position and adapted voltage in limphome position > 0.18V)	
Diagnostic Time		• 0.8~1.2 Seconds	
Limp-Home		• Forced limited RPM mode : The PCM limits engine speed to 1500rpm • Electrical check of the ETC system is prohibited	
MIL On Condition		• Immediate	

Check from TPS start (a default TPS output voltage)

Limp home position indicative of full closing output voltage

Failure mode management

As part of the DTC strategy case 6 shows that a start check is done to check the limp home position of the throttle based on TPS feedback. Limp-home mode is representative of disabled control logic and zero closing/opening output voltage.

Figure 23

Fuel System > Engine Control System > ETC (Electronic Throttle Control) System > Troubleshooting

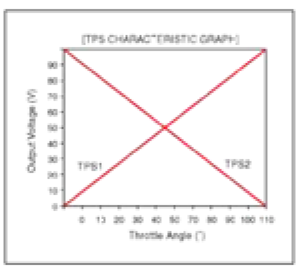
Fail-Safe Mode

Item	Fail-Safe	
ETC Motor	Throttle valve stuck at 5°	
TPS	TPS 1 fault	ECM looks at TPS2
	TPS 2 fault	ECM looks at TPS1
	TPS 1,2 fault	Throttle valve stuck at 5°
APS	APS 1 fault	ECM looks at APS 2
	APS 2 fault	ECM looks at APS 1
	APS 1,2 fault	Throttle valve stuck at 5°

NOTE

When throttle value is stuck at 5°, engine speed is limited at below 1,500rpm and vehicle speed at maximum 40 ~ 50 km/h (25 ~ 31 mph)

Throttle Angle(°)	Output Voltage(V)	
	TPS1	TPS2
0	0.0	5.0
10	0.48	4.52
20	0.95	4.05
30	1.43	3.57
40	1.90	3.10
50	2.38	2.62
60	2.86	2.14
70	3.33	1.67
80	3.81	1.19
90	4.29	0.71
100	4.76	0.24
105	5.0	0
C.T (6 ~ 15°)	0.29 ~ 0.71	4.29 ~ 4.71
W.O.T (93 ~ 102°)	4.43 ~ 4.86	0.14 ~ 0.57



Item	Sensor Resistance(kΩ)
TPS1	0.875 ~ 1.625 [20°C(68°F)]
TPS2	0.875 ~ 1.625 [20°C(68°F)]

SONATA(YFA) > 2012 > G 2.4 GDI > Engine > Engine Control > P2119 Throttle Actuator Control Throttle Body Range/Performance

DTC Description — Feedback

PCM sets DTC P2119 if the PCM detects TPS adaptation procedure is abnormal.

DTC Detecting Condition

Item		Detecting Condition	Possible Cause
DTC Strategy	Case1	• TPS adaptation Lower position check	1. Poor connection or damaged harness 2. Faulty ETC motor
	Case2	• TPS adaptation error low return spring check	
	Case3	• TPS adaptation upper position check	
	Case4	• TPS adaptation error upper return spring check	
	Case5	• TPS start check error in spring check	
	Case6	• TPS start check error in limp-home-check	
Enable Conditions	Case1	• During TPS adaptation • TPS setpoint = 11.9%	
	Case2,4	• During TPS adaptation	
	Case3	• During TPS adaptation • TPS setpoint = 29%	
	Case5	• During TPS start check • TPS setpoint = 24.2%	
	Case6	• During TPS start check • No engine start condition	
Threshold Value	Case1	• Throttle position for the lower return spring check is not reached within a limit maximum time(Difference between throttle position and setpoint > 0.48%")	
	Case2	• When ETC power stage is off, Throttle can not return by spring power in the limp-home position within a limit maximum time(Difference between Throttle position and adapted voltage in limphome position > 0.18 V)	
	Case3	• Throttle position for the upper return spring check is not reached within a limit maximum time(Difference between throttle position and setpoint > 0.48%)	
	Case4	• When ETC power stage is off, Throttle cannot return by spring power in the limp-home position within a limit maximum time(Difference between Throttle position and adapted voltage in limphome position > 0.18 V)	
	Case5	• Throttle flap cannot reach the setpoint within the hysteresis within a limit maximum time(Difference between throttle position and requested position > 0.48%)	
	Case6	• When ETC power stage is off, Throttle cannot return by spring power in the limp-home position within a limit maximum time(Difference between Throttle position and adapted voltage in limphome position > 0.18V)	
Diagnostic Time		• 0.8~1.2 Seconds	
Limp-Home		• Forced limited RPM mode : The PCM limits engine speed to 1500rpm • Electrical check of the ETC system is prohibited	
MIL On Condition		• Immediate	

The Threshold Value in Cases 1-6 show default throttle position sensor output voltage corresponding to a default position.

SONATA(YFA) > 2012 > G 2.4 GDI > Engine > Engine Control > P2118 Throttle Actuator Control Motor Current Range/Performance

DTC Description — Feedback

PCM sets DTC P2118 if the PCM detects motor"s PWM signal exceeds threshold value.

DTC Detecting Condition

Item		Detecting Condition	Possible Cause
DTC Strategy	Case1	• PWM range check	
	Case2	• Deviation between throttle position and constant setpoint check	Setpoint check is a default closed position.
	Case3	• Deviation between throttle position and moving setpoint check	
Enable Conditions	Case1	• TPS adaptation finished • Battery voltage >10V • No relevant error	
	Case2	• TPS adaptation finished • Constant TPS setpoint • No relevant error	1. Open in Control circuit 2. Poor connection or damaged harness
	Case3	• TPS adaptation finished • No relevant error	3. Faulty ETC Motor
Threshold Value	Case1	• Moving mean value of the controller output > 95%	
	Case2	• Throttle position - Throttle position setpoint >2.4%	Throttle valve position.
	Case3	• Throttle position - Throttle position setpoint >9.5%	
Diagnostic Time		• 0.5 Seconds	
Limp-Home		• Forced limited RPM mode : The PCM limits engine speed to 1500rpm • Electrical check of the ETC system is prohibited	
MIL On Condition		• Immediate	

A command for full motor closing voltage (setpoint check) is compared to a full closing TPS output voltage to said default TPS output voltage (deviation between the throttle position and moving setpoint check in Case 3).

SONATA(YFA) > 2012 > G 2.4 GDI > Engine > Engine Control > P2119 Throttle Actuator Control Throttle Body Range/Performance

DTC Description Feedback

PCM sets DTC P2119 if the PCM detects TPS adaptation procedure is abnormal.

DTC Detecting Condition

Item		Detecting Condition	Possible Cause
DTC Strategy	Case1	• TPS adaptation Lower position check	
	Case2	• TPS adaptation error low return spring check	
	Case3	• TPS adaptation upper position check	
	Case4	• TPS adaptation error upper return spring check	
	Case5	• TPS start check error in spring check	
	Case6	• TPS start check error in limp-home-check	← Check from TPS start (a default TPS output voltage)
Enable Conditions	Case1	• During TPS adaptation • TPS setpoint = 11.9%	
	Case2,4	• During TPS adaptation	
	Case3	• During TPS adaptation • TPS setpoint = 29%	
	Case5	• During TPS start check • TPS setpoint = 24.2%	
	Case6	• During TPS start check • No engine start condition	1. Poor connection or damaged harness
Threshold Value	Case1	• Throttle position for the lower return spring check is not reached within a limit maximum time(Difference between throttle position and setpoint > 0.48%*)	2. Faulty ETC motor
	Case2	• When ETC power stage is off, Throttle can not return by spring power in the limp-home position within a limit maximum time(Difference between Throttle position and adapted voltage in limphome position > 0.18 V)	
	Case3	• Throttle position for the upper return spring check is not reached within a limit maximum time(Difference between throttle position and setpoint > 0.48%)	
	Case4	• When ETC power stage is off, Throttle cannot return by spring power in the limp-home position within a limit maximum time(Difference between Throttle position and adapted voltage in limphome position > 0.18 V)	
	Case5	• Throttle flap cannot reach the setpoint within the hysteresis within a limit maximum time(Difference between throttle position and requested position > 0.48%)	
	Case6	• When ETC power stage is off, Throttle cannot return by spring power in the limp-home position within a limit maximum time(Difference between Throttle position and adapted voltage in limphome position > 0.18V)	← Limp home position indicative of full closing output voltage
Diagnostic Time		• 0.8~1.2 Seconds	
Limp-Home		• Forced limited RPM mode : The PCM limits engine speed to 1500rpm • Electrical check of the ETC system is prohibited	← Failure mode management
MIL On Condition		• Immediate	

Engine failure management mode (limp-home mode) is commanded when a zero opening/closing output voltage TPS output voltage (TPS adaptation (adapted voltage)) and default TPS output voltage (position from which the start error check measures) are significantly different from each other.

Figure 24- Diagnostic Trouble Codes obtained from http://www.hyundaitechninfo.com demonstrate an exemplary condition wherein TPS is in failure mode.

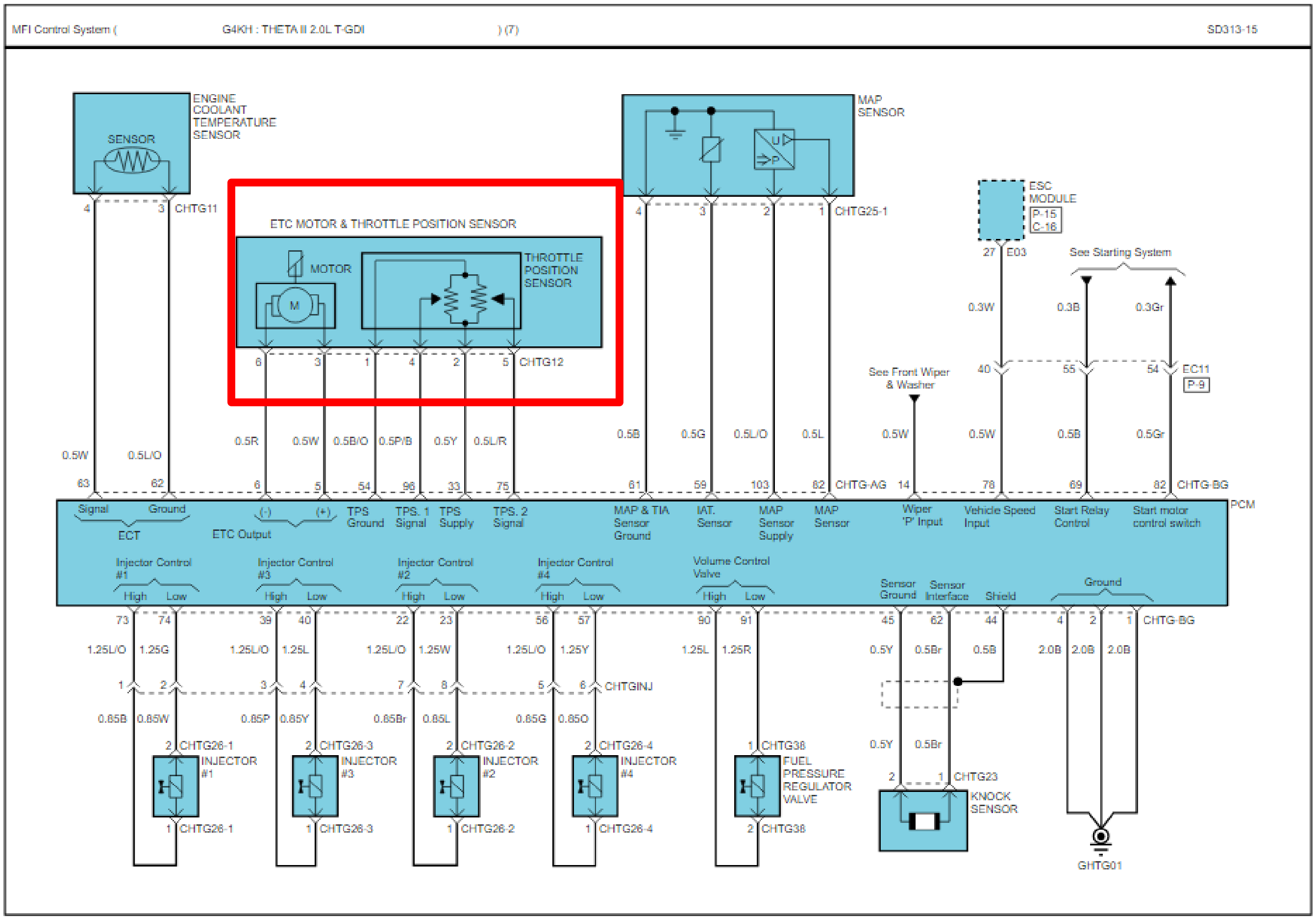


Figure 25- Throttle Position Sensor (TPS) Schematic Diagram –Note: TPS is Connected in Network to CAN and Various Sensors

<u>COUNT IV – INFRINGEMENT OF U.S. PATENT NO. 6,443,128</u>

30. The allegations set forth in the foregoing paragraphs 1 through 29 are incorporated into this Forth Claim for Relief.

31. On September 3, 2002, U.S. Patent No. 6,443,128 ("the '128 patent"), entitled "*Method of Controlling an Internal Combustion Engine*," was duly and legally issued by the United States Patent and Trademark Office. A true and correct copy of the '128 patent is attached as Exhibit 4.

32. Plaintiff is the assignee and owner of the right, title and interest in and to the ’128 patent, including the right to assert all causes of action arising under said patents and the right to any remedies for infringement of them.

33. Upon information and belief, Defendants have directly infringed at least claims 1, 2, 6, 7, 11 and 12 of the ’128 patent by making, using, selling, importing and/or providing and causing to be used the 2011-2017 Hyundai Sonata (2.0L), 2010-2017 Hyundai Genesis Coupe (2.0L), 2013-2017 Hyundai Santa Fe (2.0L), 2011-2017 Hyundai Sonata (2.4L), 2010-2017 Hyundai Tucson (2.4L), 2010-2017 Hyundai Santa Fe (2.4L) (the “Accused Instrumentalities”).

34. Upon information and belief, the Accused Instrumentalities incorporate the Theta II Engine which practices a method of controlling an internal combustion engine.

35. In particular, claim 1 of the ’128 patent recites a method of controlling an internal combustion engine, the engine having an engine controller and an electronically controlled throttle including a throttle control motor driven by a throttle control circuit, the method comprising: determining a throttle position command for the throttle control motor; applying the throttle position command to the throttle control motor with the throttle control circuit; detecting an open circuit condition in the throttle control circuit; detecting a closed circuit condition in the throttle control circuit; after detection of the closed circuit condition, clipping the throttle position command; and applying the clipped throttle position command to the throttle control motor with the throttle control circuit.

36. On information and belief, the Accused Instrumentalities infringe at least claim 1 of the ’128 patent. The Accused Instrumentalities practice a method of controlling an internal combustion engine (*Figures 17-18, 20, 25-26*), the engine having an engine controller and an electronically controlled throttle including a throttle (*Figures 2-5*) control motor driven by a

throttle control circuit (*Figures 2-5, 16*), the method comprising: determining a throttle position command for the throttle control motor (*Figures 2-4*); applying the throttle position command to the throttle control motor with the throttle control circuit (*Figures 2-5, 16*); detecting an open circuit condition in the throttle control circuit (*Figures 2-5, 16*); detecting a closed circuit condition in the throttle control circuit (*Figures 2-5, 16*); after detection of the closed circuit condition, clipping the throttle position command (*Figures 2-5, 16, 26*); and applying the clipped throttle position command to the throttle control motor with the throttle control circuit (*Figures 2-5, 16, 26*).

37. Claim 2 of the ’128 patent recites the method of claim 1 wherein the electronically controlled throttle further includes a throttle position sensor, and wherein detecting the open circuit condition further comprises: determining an actual throttle position with the throttle position sensor; comparing the throttle position command to the actual throttle position; and detecting the open circuit condition based on the comparison.

38. On information and belief, the Accused Instrumentalities infringe at least claim 2 of the ’128 patent. The Accused Instrumentalities practice the method of claim 1 wherein the electronically controlled throttle further includes a throttle position sensor (*Figures 2-5, 16*), and wherein detecting the open circuit condition further comprises: determining an actual throttle position (*Figures 2-5, 7, 16*) with the throttle position sensor; comparing the throttle position command to the actual throttle position (*Figures 2-5, 16, 26*); and detecting the open circuit condition based on the comparison (*Figures 2-5, 16, 26*).

39. Claim 6 of the ’128 patent recites a system for controlling an internal combustion engine, the system including an engine controller and an electronically controlled throttle

including a throttle control motor driven by a throttle control circuit, the system being configured to: determine a throttle position command for the throttle control motor; apply the throttle position command to the throttle control motor with the throttle control circuit; detect an open circuit condition in the throttle control circuit; detect a closed circuit condition in the throttle control circuit; after detection of the closed circuit condition, clip the throttle position command; and apply the clipped throttle position command to the throttle control motor with the throttle control circuit .

40. On information and belief, the Accused Instrumentalities infringe at least claim 6 of the ’128 patent. The Accused Instrumentalities comprise a system for controlling an internal combustion engine, the system including an engine controller (*Figures 2-5, 16, 26*) and an electronically controlled throttle including a throttle control motor driven by a throttle control circuit (*Figures 2-5, 16, 24, 26*), the system being configured to: determine a throttle position command for the throttle control motor (*Figures 2-5, 16, 24, 26*); apply the throttle position command to the throttle control motor with the throttle control circuit (*Figures 2-5, 16, 24, 26*); detect an open circuit condition in the throttle control circuit; detect a closed circuit condition in the throttle control circuit (*Figures 2-5, 16, 24, 26*); after detection of the closed circuit condition, clip the throttle position command; and apply the clipped throttle position command to the throttle control motor with the throttle control circuit (*Figures 2-5, 16, 24, 26*).

41. Claim 7 of the ’128 patent recites the system of claim 6 wherein the electronically controlled throttle further includes a throttle position sensor, and wherein detecting the open circuit condition further comprises: determining an actual throttle position with the throttle position sensor; comparing the throttle position command to the actual throttle position; and detecting the open circuit condition based on the comparison.

42. On information and belief, the Accused Instrumentalities infringe at least claim 7 of the '128 patent. The Accused Instrumentalities comprise the system of claim 6 wherein the electronically controlled throttle further includes a throttle position sensor (*Figures 2-5*), and wherein detecting the open circuit condition further comprises: determining an actual throttle position with the throttle position sensor (*Figures 2-5, 16, 24, 26*); comparing the throttle position command to the actual throttle position; and detecting the open circuit condition based on the comparison (*Figures 2-5, 16, 24, 26*).

43. Claim 11 of the '128 patent recites an internal combustion engine, the engine having an engine controller and an electronically controlled throttle including a throttle control motor driven by a throttle control circuit, the engine being configured to: determine a throttle position command for the throttle control motor; apply the throttle position command to the throttle control motor with the throttle control circuit; detect an open circuit condition in the throttle control circuit; detect a closed circuit condition in the throttle control circuit; after detection of the closed circuit condition, clip the throttle position command; and apply the clipped throttle position command to the throttle control motor with the throttle control circuit.

44. On information and belief, the Accused Instrumentalities infringe at least claim 11 of the '128 patent. The Accused Instrumentalities comprise an internal combustion engine (*Figure 1*), the engine having an engine controller and an electronically controlled throttle including a throttle control motor driven by a throttle control circuit (*Figures 2-5, 16, 24-26*), the engine being configured to: determine a throttle position command for the throttle control motor (*Figures 2-5, 16, 24, 26*); apply the throttle position command to the throttle control motor with the throttle control circuit (*Figures 2-5, 16, 24, 26*); detect an open circuit condition in the throttle control circuit (*Figures 2-5, 16, 24, 26*); detect a closed circuit condition in the throttle

control circuit (*Figures 2-5, 16, 24, 26*); after detection of the closed circuit condition, clip the throttle position command (*Figures 2-5, 16, 24, 26*); and apply the clipped throttle position command to the throttle control motor with the throttle control circuit (*Figures 2-5, 16, 24, 26*).

45. Claim 12 of the ’128 patent recites the engine of claim 11 wherein the electronically controlled throttle further includes a throttle position sensor, and wherein detecting the open circuit condition further comprises: determining an actual throttle position with the throttle position sensor; comparing the throttle position command to the actual throttle position; and detecting the open circuit condition based on the comparison.

46. On information and belief, the Accused Instrumentalities infringe at least claim 12 of the ’128 patent. The Accused Instrumentalities comprise the engine as in claim 11 wherein the electronically controlled throttle further includes a throttle position sensor (*Figures 2-5, 16, 24-26*), and wherein detecting the open circuit condition further comprises: determining an actual throttle position with the throttle position sensor (*Figures 2-5, 16, 24, 26*); comparing the throttle position command to the actual throttle position (*Figures 2-5, 16, 24, 26*); and detecting the open circuit condition based on the comparison (*Figures 2-5, 16, 24, 26*).

SONATA(YFA) > 2012 > G 2.4 GDI > Engine > Engine Control > P0638 Throttle Actuator Control Range/Performance (Bank 1)

DTC Description Feedback

PCM sets DTC P0638 if the PCM detects TPS adaptation value exceeds threshold value.

DTC Detecting Condition

Item		Detecting Condition	Possible Cause
DTC Strategy	Case1	• TPS adaptation condition check	1. Poor connection or damaged harness 2. Faulty ETC Motor 3. Faulty TPS
	Case2	• ETC Limp Home position check	
	Case3	• Lower mechanical stop adaptation voltage range check	
Enable Conditions		• During TPS adaptation	
Threshold Value	Case1	• TPS adaptation is requested but not possible	
	Case2	• Difference between Throttle sensor voltage in limphome and limphome setpoint > 0.3V	
	Case3	• Difference between Throttle sensor voltage in lower mechanical stop position and lower mechanical stop position setpoint > 0.3V	
Diagnostic Time		• 1.2 sec.	
Limp-Home		• Forced limited RPM mode : The PCM limits engine speed to 1500rpm • Electrical check of the ETC system is prohibited	
MIL On Condition		• Immediate	

Clipped throttle position command

A circuit which removes the peak of a waveform is known as a clipper. A clipper is designed to prevent the output of a circuit from exceeding a predetermined voltage level. *https://www.allaboutcircuits.com/textbook/semiconductors/chpt-3/clipper-circuits/*

Clipping prohibits a surge in engine power which results from an Accelerator Position Sensor (APS) signaling to the Throttle Position Sensor (TPS) through the Electronic Control Module (ECM) that a sharp increase in power is needed. An open circuit condition, which may cause the TPS to malfunction, may result in a driver applying more pressure to the accelerator pedal thereby causing the APS to send a higher voltage signal through the Powertrain Control Module (PCM). However, if there is a malfunction detected by the system, such as an open circuit condition in one drive cycle, which is later followed by a closed circuit condition in a successive drive cycle (not a malfunction), then the throttle command will be correlative with the APS before the malfunction.

The throttle position command is limited or clipped (adaptation) prior to application to the throttle control motor, resulting in smooth changing of the applied throttle position command.

Hyundai Service Website - Google Chrome

Hyundai Motor America [US] | https://www.hyundaitechinfo.com/viewer/content_pop.aspx?content_no=DTC|ENG|2684|2011||en|98||&sitinfolist=14^14...

SONATA(YFA) > 2011 > Engine > Engine Control > DTC Detecting Condition

DTC Detecting Condition Feedback

Item	Detecting Condition	Possible Cause
DTC Strategy	• Plausibility check between TPS1 and TPS2	1. Faulty TPS1 2. Poor connection or damaged harness
Enable Conditions	• No engine stop and engine start • No TPS adaptation request • No relevant failure	
Threshold Value	• An absolute value of TPS2 - TPS1 > 7.6%	
Diagnostic Time	• 0.3 seconds	
MIL On Condition	• 1 Drive Cycle	
Limp-Home	• Forced limited power mode : When the DTC is set, the PCM reduces engine torque by 25% of normal value. • The PCM uses TPS2 signal to monitor the controlled opening angle of the throttle valve.	

Diagnostic Trouble Code (DTC) Strategy: Plausibility check between throttle position 1 and throttle position 2 in .3 seconds. If the Malfunction Indicator Lamp (MIL) proceeds for more than 1 Drive Cycle, the vehicle enters "limp-home" mode wherein the vehicle operates in "forced limited power mode" and the Powertrain Control Module (PCM) reduces or (clips) the engine torque by 25% of normal value. The PCM uses the throttle position 2 signal to monitor the controlled opening angle of the throttle valve. The possible causes of the MIL could be faulty throttle position 1 or poor connection, either of which could be due to an open circuit condition.

Hyundai Service Website - Google Chrome

Hyundai Motor America [US] | https://www.hyundaitechinfo.com/viewer/content_pop.aspx?content_no=DTC|ENG|2684|2011||en|98||&sitinfolist=14^14...

SONATA(YFA) > 2011 > Engine > Engine Control > DTC Detecting Condition

DTC Detecting Condition Feedback

Item	Detecting Condition	Possible Cause
DTC Strategy	• Plausibility check between TPS1 and TPS2	1. Faulty TPS1 2. Poor connection or damaged harness
Enable Conditions	• No engine stop and engine start • No TPS adaptation request • No relevant failure	
Threshold Value	• An absolute value of TPS2 - TPS1 > 7.6%	
Diagnostic Time	• 0.3 seconds	
MIL On Condition	• 1 Drive Cycle	
Limp-Home	• Forced limited power mode : When the DTC is set, the PCM reduces engine torque by 25% of normal value. • The PCM uses TPS2 signal to monitor the controlled opening angle of the throttle valve.	

Diagnostic Trouble Code (DTC) Strategy: Plausibility check between throttle position 1 and throttle position 2 in .3 seconds. If the Malfunction Indicator Lamp (MIL) proceeds for more than 1 Drive Cycle, the vehicle enters "limp-home" mode wherein the vehicle operates in "forced limited power mode" and the Powertrain Control Module (PCM) reduces or (clips) the engine torque by 25% of normal value. The PCM uses the throttle position 2 signal to monitor the controlled opening angle of the throttle valve. The possible causes of the MIL could be faulty throttle position 1 or poor connection, either of which could be due to an open circuit condition.

A closed circuit condition is indicative of a closed system that can transmit electrical current and is not open. If the system were open, it could not transmit electrical current.

Figure 26

COUNT V – INFRINGEMENT OF U.S. PATENT NO. 6,581,565

47. The allegations set forth in the foregoing paragraphs 1 through 46 are incorporated into this Fifth Claim for Relief.

48. On June 24, 2003, U.S. Patent No. 6,581,565 ("the '565 patent"), entitled "*Engine Torque Controller*" was duly and legally issued by the United States Patent and Trademark Office. A true and correct copy of the '565 patent is attached as Exhibit 5.

49. Plaintiff is the assignee and owner of the right, title and interest in and to the '565 patent, including the right to assert all causes of action arising under said patents and the right to any remedies for infringement of them.

50. Upon information and belief, Defendant has directly infringed at least claims 1 and 7 of the '565 patent by making, using, selling, importing and/or providing and causing to be used the 2011-2017 Hyundai Sonata (2.0L), 2010-2017 Hyundai Genesis Coupe (2.0L), 2013-2017 Hyundai Santa Fe (2.0L), 2011-2017 Hyundai Sonata (2.4L), 2010-2017 Hyundai Tucson (2.4L), 2010-2017 Hyundai Santa Fe (2.4L) (the "Accused Instrumentalities").

51. Upon information and belief, the Accused Instrumentalities incorporate the Theta II Engine which comprises a device for controlling a torque output of an engine.

52. In particular, claim 1 of the '565 patent recites a device for controlling a torque output of an engine, the device comprising: a torque demand controller for generating a torque demand signal; and a torque producer which receives the torque demand signal, the torque producer includes: an estimator which receives as inputs a current spark angle signal, a current

air/fuel ratio signal and an estimated air charge signal and outputs an estimated torque signal; a comparator which receives as inputs the estimated torque signal and a desired torque signal and outputs a difference signal; a high pass filter which receives as an input the difference signal and outputs a filtered difference signal in which low frequency components are absent; and a transient torque controller which receives as an input the filtered difference signal and outputs a fuel adjustment signal and a spark adjustment signal.

53. On information and belief, the Accused Instrumentalities infringe at least claim 1 of the ’565 patent. The Accused Instrumentalities comprise a device for controlling (*Figures 17-18, 26*) a torque output of an engine, the device comprising: a torque demand controller for generating a torque demand signal (*Figure 30*); and a torque producer which receives the torque demand signal (*Figures 26 and 30*), the torque producer includes: an estimator which receives as inputs a current spark angle signal (*Figures 31-32*), a current air/fuel ratio signal and an estimated air charge signal and outputs an estimated torque signal (*Figure 33-35*); a comparator which receives as inputs the estimated torque signal and a desired torque signal and outputs a difference signal (*Figures 26, 30, 36*); a high pass filter which receives as an input the difference signal and outputs a filtered difference signal in which low frequency components are absent (*Figures 21, 26, 30, 36*); and a transient torque controller which receives as an input the filtered difference signal and outputs a fuel adjustment signal and a spark adjustment signal (*Figures 21, 26, 30, 36*).

Hyundai Motor America [US] | https://www.hyundaitechinfo.com/viewer/content_pop.aspx?content_no=DTC|ENG|2684|2012||br|19||&sitinfolist=41^4160^416(

SONATA(YFA) > 2012 > Brake > Electronic Stability Control > DTC Description

DTC Description Feedback

With the driver torque demand and the lateral acceleration a driver braking demand is calculated. Unless the pump motor is opreating or there is a brake signal, The offset compensation is executed.
A failure is detected if offset value exceeded ±15 bar.

Figure 27 – Note: Description of Torque Demand Calculation

ESC Operation Mode

1. STEP 1
The ESC analyzes the intention of the driver.

Position of steering wheel
+ Vehicle speed
+ Acceleration pedal
→ ECU decides the intention of the driver.

2. STEP 2
It analyzes the movement of the ESC vehicle.

Vehicle rotation speed
+ Operated power to the side
→ ECU decides movement of the ESP vehicle.

3. STEP 3
The HECU calculates the required strategy, then actuates the appropriate valves and sents torque control requests via CAN to maintain vehicle stability.

ESC Operation Mode
1. ESC Non-operation-Normal braking.

	Inlet valve(IV)	Outlet valve(OV)	Traction Control Valve(TCV)	High pressure switch valve(HSV)	Return pump
Normal braking	Open	Close	Open	Close	OFF

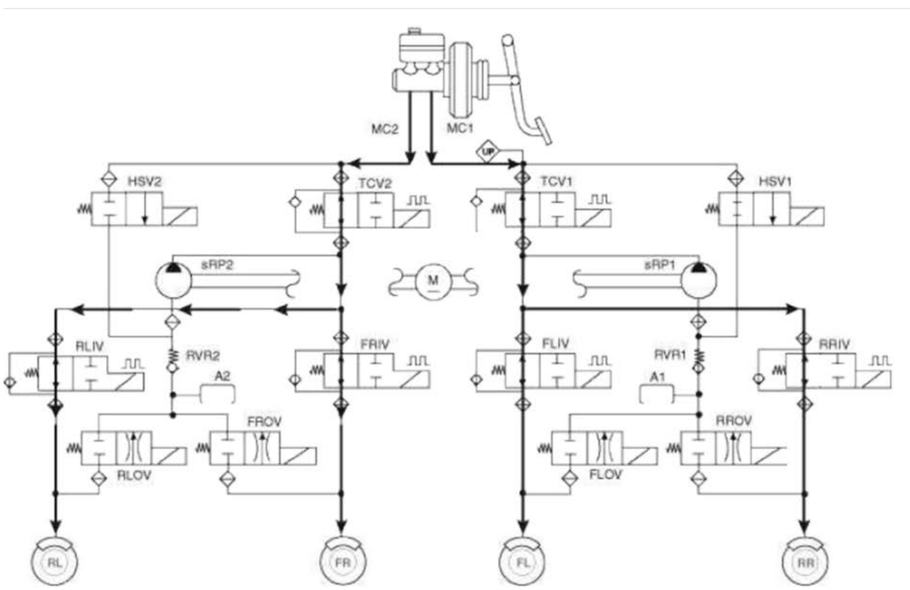


Figure 28- Note: Explanation of Torque Control Calculation and Requests via the CAN

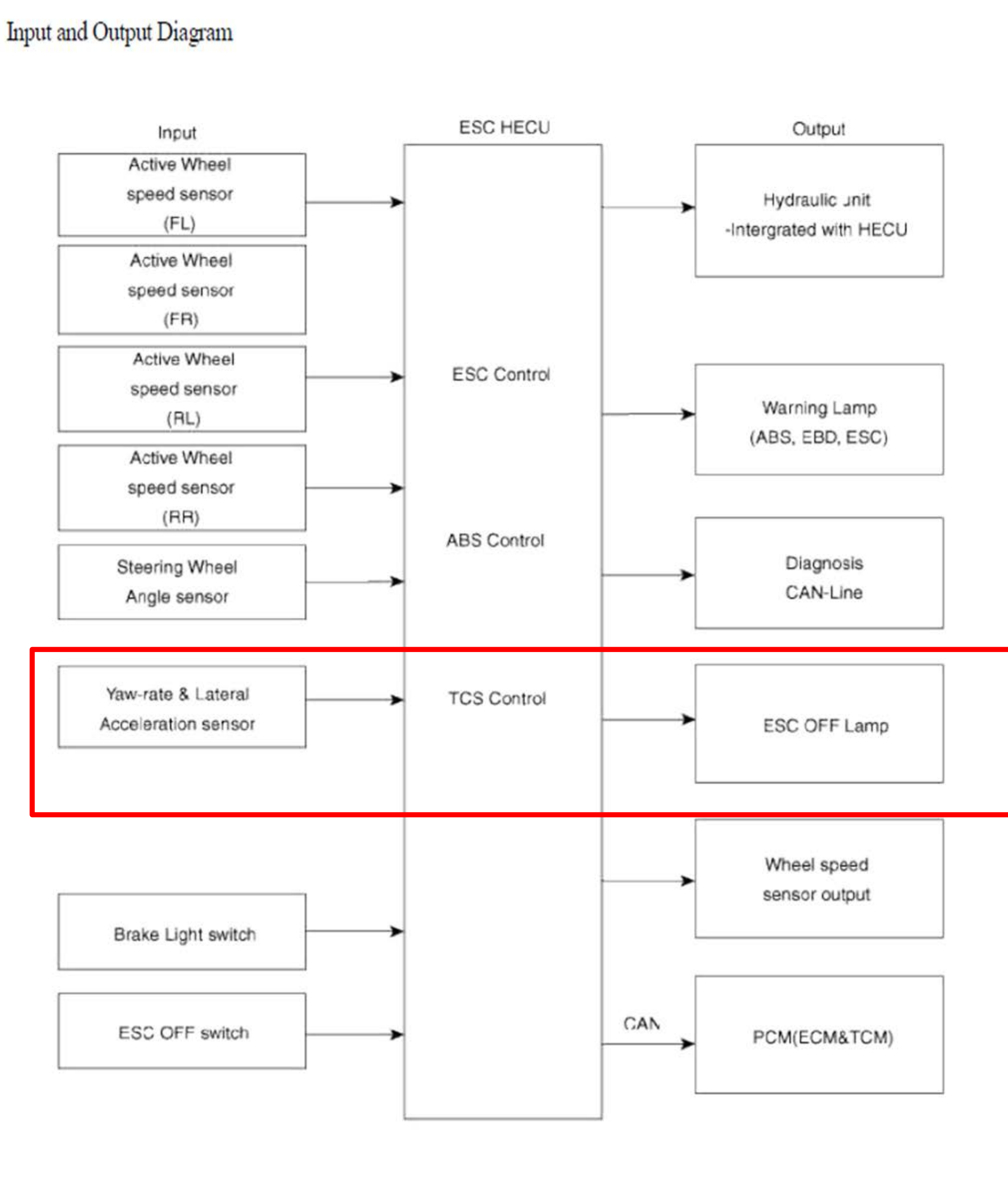
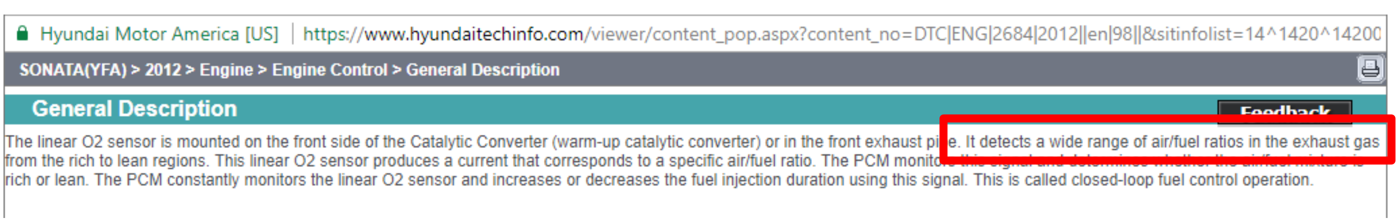


Figure 29 -Note: Diagram of input from various sensors through ESC HECU via the CAN and corresponding Output including TCS control


Hyundai Motor America [US] | https://www.hyundaitechinfo.com/viewer/content_pop.aspx?content_no=DTC|ENG|2684|2012||en|98||&sitinfolist=14^1420^14200

SONATA(YFA) > 2012 > Engine > Engine Control > General Description

General Description

Feedback

The linear O2 sensor is mounted on the front side of the Catalytic Converter (warm-up catalytic converter) or in the front exhaust pipe. It detects a wide range of air/fuel ratios in the exhaust gas from the rich to lean regions. This linear O2 sensor produces a current that corresponds to a specific air/fuel ratio. The PCM monitors this signal and determines whether the air/fuel mixture is rich or lean. The PCM constantly monitors the linear O2 sensor and increases or decreases the fuel injection duration using this signal. This is called closed-loop fuel control operation.

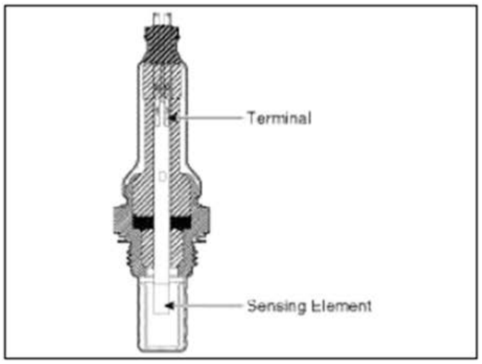
Figure 30- Note: Description of Oxygen Sensor which detects air/fuel ratio

Fuel System > Engine Control System > Heated Oxygen Sensor (HO2S) > Description and Operation

Description

Heated Oxygen Sensor (HO2S) consists of zirconium and alumina and is installed both upstream and downstream of the Manifold Catalytic Converter. The sensor output voltage varies in accordance with the air/fuel ratio.

The sensor must be hot in order to operate normally. To keep it hot, the sensor has a heater which is controlled by the ECM via a duty cycle signal. When the exhaust gas temperature is lower than the specified value, the heater warms the sensor tip.



Emission Control System > Exhaust Emission Control System > Description and Operation

Description

Exhaust emissions (CO, HC, NOx) are controlled by a combination of engine modifications and the addition of special control components.

Modifications to the combustion chamber, intake manifold, camshaft and ignition system form the basic control system.

These items have been integrated into a highly effective system which controls exhaust emissions while maintaining good drivability and fuel economy.

Air/Fuel Mixture Control System [Multiport Fuel Injection (MFI) System]

The MFI system uses signals from the heated oxygen sensor to activate and control the injector installed in the manifold for each cylinder, thus precisely regulating the air/fuel mixture ratio and reducing emissions.

This in turn allows the engine to produce exhaust gas of the proper composition to permit the use of a three way catalyst. The three way catalyst is designed to convert the three pollutants [hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx)] into harmless substances. There are two operating modes in the MFI system.

1. Open Loop air/fuel ratio is controlled by information pre-programmed into the ECM.
2. Closed Loop air/fuel ratio is constantly adjusted by the ECM based on information supplied by the oxygen sensor.

Figure 31 – Note: Diagram and description of Oxygen Sensor

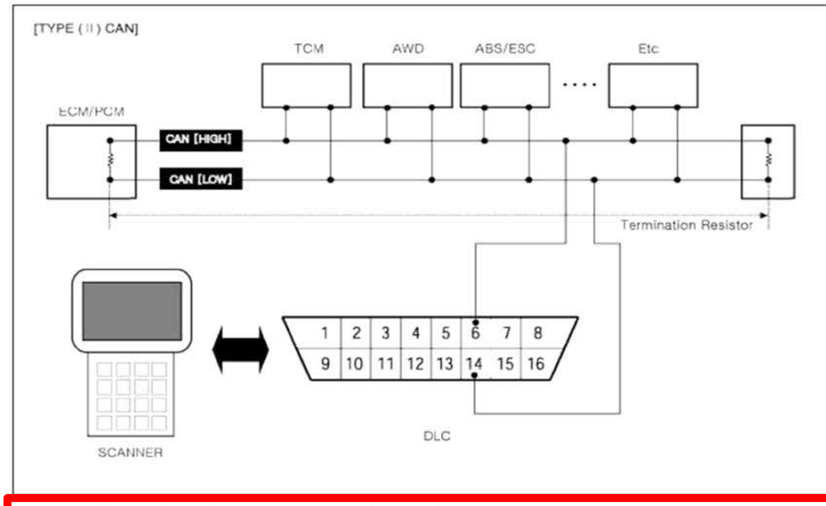
Brake System > ESC(Electronic Stability Control) System > Steering Angle Sensor > Description and Operation

Description

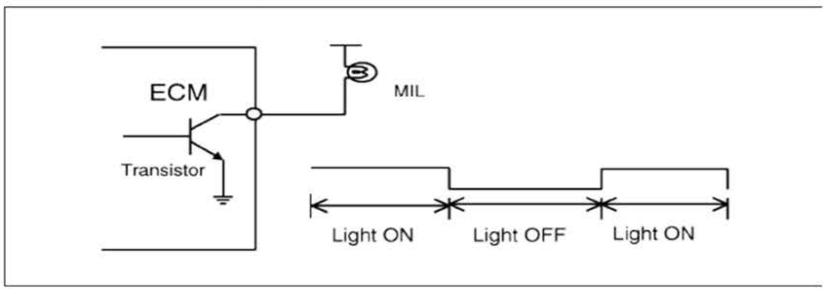
The Steering Angle Sensor (SAS) is installed in EPS (Electric Power Steering) and it sends messages to HECU through CAN communication line.
The SAS is used to determine turning direction and speed of the steering wheel.
The HECU uses the signals from the SAS when performing ESP-related calculations.
Components (Steering Angle Sensor, Torque Sensor, Failsafe relay, etc.) of the EPS system are located inside the steering column & EPS unit assembly and the steering column & EPS unit assembly must not be disassemble to inspect or replace them. (Refer to "ST (Steering system) Gr.")

Figure 32 – Note: Description of Electronic Stability Control which uses signals from HECU to assess Electronic Power Steering (EPS) related calculations. The EPS system components include the torque sensor.

2. Configuration of hardware and related terms
1) GST (Generic scan tool)



2) MIL (Malfunction indication lamp) - MIL activity by transistor



The Malfunction Indicator Lamp (MIL) is connected between ECM or PCM-terminal Malfunction Indicator Lamp and battery supply (open collector amplifier).
In most cars, the MIL will be installed in the instrument panel. The lamp amplifier can not be damaged by a short circuit.
Lamps with a power dissipation much greater than total dissipation of the MIL and lamp in the tester may cause a fault indication.
At ignition ON and engine revolution (RPM)< MIN. RPM, the MIL is switched ON for an optical check by the driver.
3) MIL illumination
When the ECM or PCM detects a malfunction related emission during the first driving cycle, the DTC and engine data are stored in the freeze frame memory. The MIL is illuminated only when the ECM or PCM detects the same malfunction related to the DTC in two consecutive driving cycles.
4) MIL elimination
● Misfire and Fuel System Malfunctions:
For misfire or fuel system malfunctions, the MIL may be eliminated if the same fault does not reoccur during monitoring in three subsequent sequential driving cycles in which conditions are similar to those under which the malfunction was first detected.
● All Other Malfunctions:
For all other faults, the MIL may be extinguished after three subsequent sequential driving cycles during which the monitoring system responsible for illuminating the MIL functions without detecting the malfunction and if no other malfunction has been identified that would independently illuminate the MIL according to the requirements outlined above.
5) Erasing a fault code
The diagnostic system may erase a fault code if the same fault is not re-registered in at least 40 engine warm-up cycles, and the MIL is not illuminated for that fault code.
6) Communication Line (CAN)
- Bus Topology : Line (bus) structure
- Wiring : Twisted pair wire
- Off Board DLC Cable Length : Max. 5m
- Data Transfer Rate
  - Diagnostic : 500 kbps
  - Service Mode (Upgrade, Writing VIN) : 500 or 1Mbps)

Figure 33 – Note: Description of Malfunction Indicators and monitoring signals during drive cycles, which are then compared to non-faulty operating conditions. In the event that the comparison reveals that there is a fault in the system, indicated by the signal received from various sensors, the MIL is activated.

54. Claim 7 of the ’565 patent recites a method for controlling a torque output of an engine, the method comprising: estimating a current torque signal from a received current spark angle signal, a received current air/fuel ratio signal and a received estimated air charge signal; comparing the estimated current torque signal with a desired torque signal to output a difference signal; filtering out a plurality of low frequency components from the difference signal; and controlling a fuel adjustment signal and a spark adjustment signal in dependence upon a filtered difference signal.

55. On information and belief, the Accused Instrumentalities infringe at least claim 7 of the ’565 patent. The Accused Instrumentalities practice a method for controlling (*Figures 17-18, 26*) a torque output of an engine, the method comprising: estimating a current torque signal from a received current spark angle signal, a received current air/fuel ratio signal and a received estimated air charge signal; comparing the estimated current torque signal with a desired torque signal to output a difference signal (*Figures 26, 30-35*); filtering out a plurality of low frequency components from the difference signal; and controlling a fuel adjustment signal and a spark adjustment signal in dependence upon a filtered difference signal (*Figures 21, 26, 30, 36*).

<u>COUNT VI – INFRINGEMENT OF U.S. PATENT NO. 6,379,281</u>

56. The allegations set forth in the foregoing paragraphs 1 through 55 are incorporated into this Sixth Claim for Relief.

57. On April 30, 2002, U.S. Patent No. 6,379,281 (“the ’281 patent”), entitled “*Engine Output Controller*” was duly and legally issued by the United States Patent and Trademark Office. A true and correct copy of the ’281 patent is attached as Exhibit 6.

58. Plaintiff is the assignee and owner of the right, title and interest in and to the ’281 patent, including the right to assert all causes of action arising under said patents and the right to any remedies for infringement of them.

59. Upon information and belief, Defendants have directly infringed at least claims 1, 7 and 10 of the ’281 patent by making, using, selling, importing and/or providing and causing to be used the 2011-2017 Hyundai Sonata (2.0L), 2010-2017 Hyundai Genesis Coupe (2.0L), 2013-2017 Hyundai Santa Fe (2.0L), 2011-2017 Hyundai Sonata (2.4L), 2010-2017 Hyundai Tucson (2.4L), 2010-2017 Hyundai Santa Fe (2.4L) (the “Accused Instrumentalities”).

60. Upon information and belief, the Accused Instrumentalities incorporate the Theta II Engine which practices an engine output control method for a vehicle having a drive by wire engine system.

61. In particular, claim 1 of the ’281 patent recites an engine output control method for a vehicle having a drive by wire engine system responsive to a desired engine torque signal, the method comprising the steps of: generating a driver demanded acceleration value corresponding to an operator input; generating a gear value as a function of a vehicle speed value and said driver demanded acceleration value; deriving a driveline torque demand comprising an inertial model torque value of said vehicle driveline corresponding to said driver demanded acceleration and said gear value, and a dynamic transmission model torque value for said gear value; deriving a demanded engine torque value from said driveline torque demand and a torque converter model; and controlling said engine output as a function of said demanded engine torque value.

62. On information and belief, the Accused Instrumentalities infringe at least claim 1 of the ’281 patent. The Accused Instrumentalities practice an engine output control method for a

vehicle having a drive by wire engine system (*Figures 17-21, 25-26, 36-37*) responsive to a desired engine torque signal (*Figures 30-36*), the method comprising the steps of: generating a driver demanded acceleration value corresponding to an operator input (*Figures 12-16*); generating a gear value as a function of a vehicle speed value and said driver demanded acceleration value *(Figure 38*); deriving a driveline torque demand comprising an inertial model torque value of said vehicle driveline corresponding to said driver demanded acceleration and said gear value, and a dynamic transmission model torque value for said gear value (*Figures 30, 37-38*); deriving a demanded engine torque value from said driveline torque demand and a torque converter model *(Figures 4, 39*); and controlling said engine output as a function of said demanded engine torque value (*Figures 40-41*).

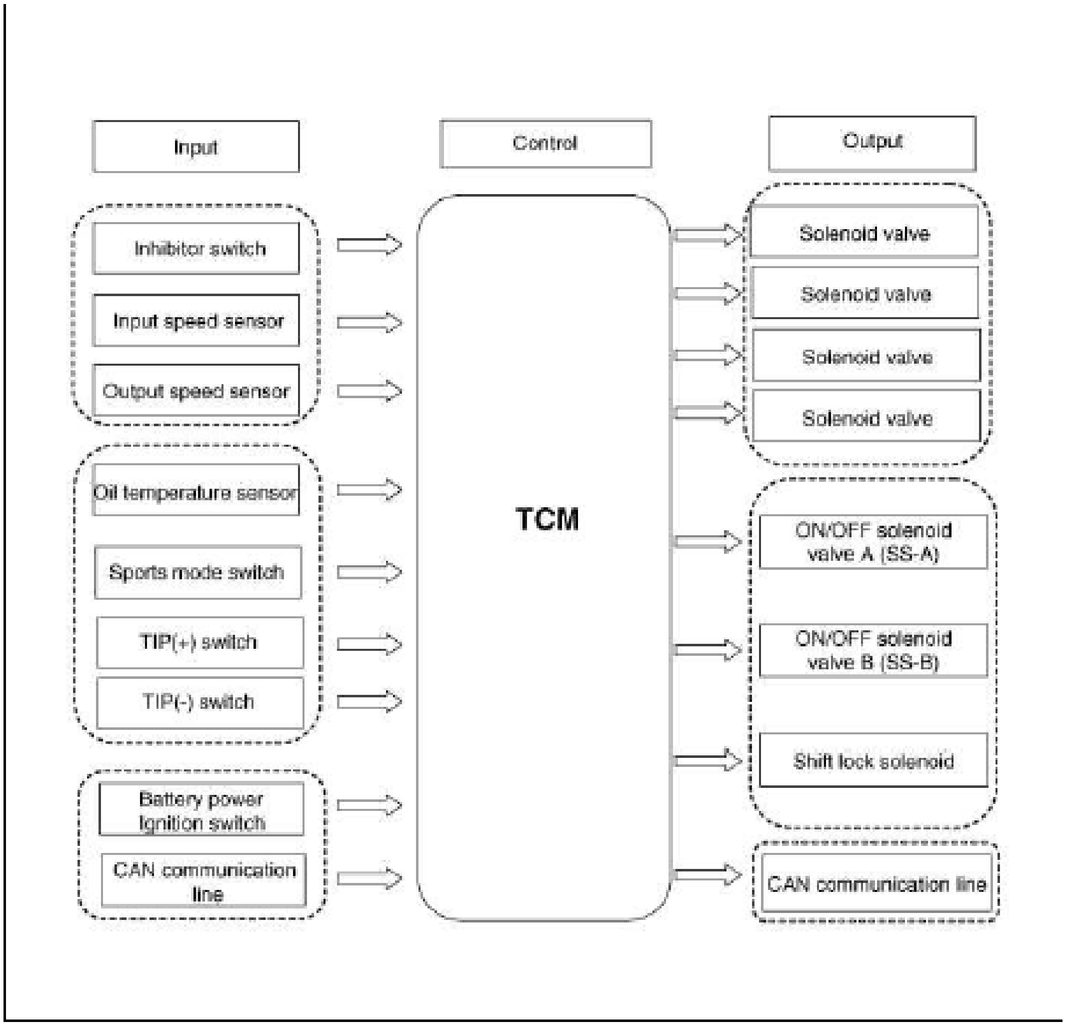


Figure 34- CAN Communication (Drive by Wire system)

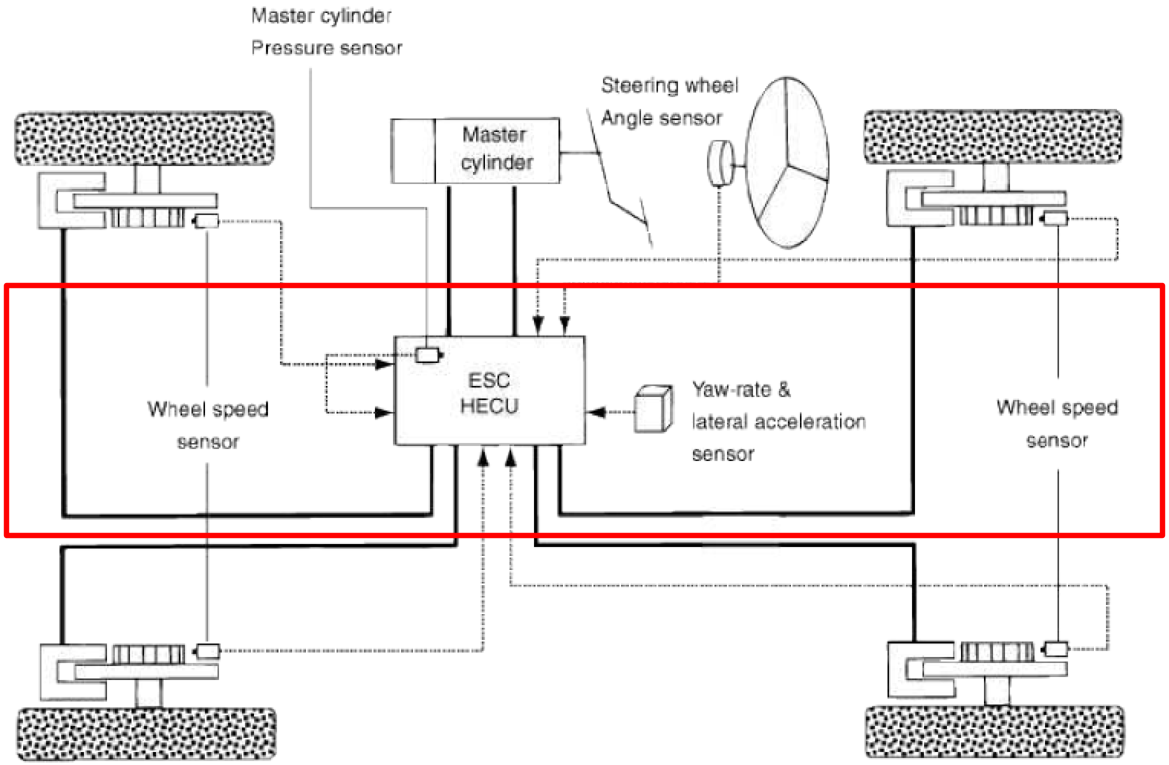


Figure 35- Note: Vehicle speed sensor providing the vehicle speed value

Automatic Transaxle System > Automatic Transaxle Control System > Transaxle Control Module (TCM) > Description and Operation

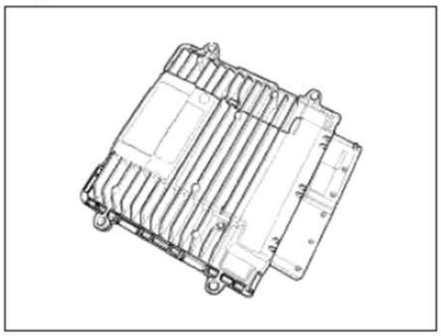
Description

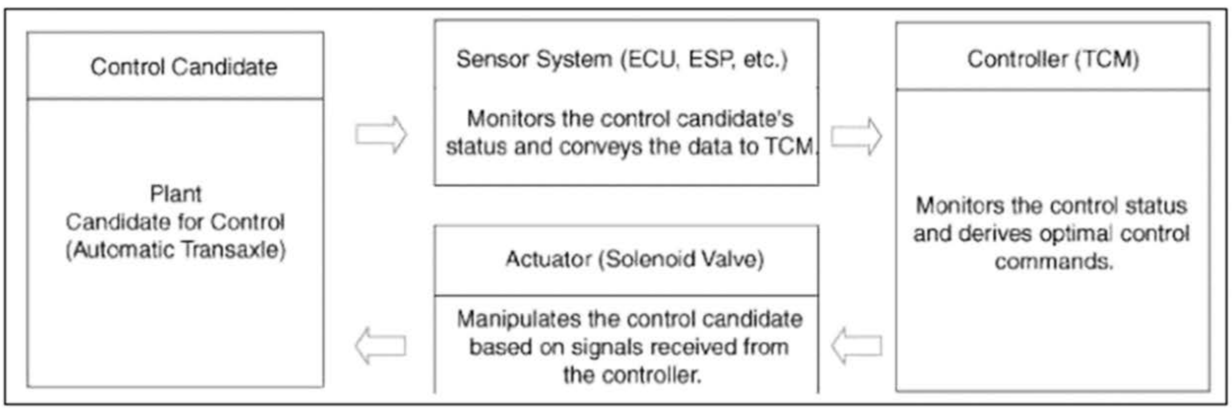
Transaxle Control Module (TCM) is the automatic transaxle's brain. The module receives and processes signals from various sensors and implements a wide range of transaxle controls to ensure optimal driving conditions for the driver. TCM is programmed for optimal response to any on-road situation. In the event of a transaxle failure or malfunction, TCM stores the fault information in memory so that the technician may reference the code and quickly repair the transaxle.

Functions

- Monitors the vehicle's operating conditions to determine the optimal gear setting.
- Performs a gear change if the current gear setting differs from the identified optimal gear setting.
- Determines the need for damper clutch (D/C) activation and engages the clutch accordingly.

- **Calculates the optimal line pressure level by constantly monitoring the torque level and adjusts the pressure accordingly.**
- **Diagnoses the automatic transaxle for faults and failures.**





Components (Steering Angle Sensor, Torque Sensor, Failsafe relay, etc.) of the EPS system are located inside the steering column & EPS unit assembly and the steering column & EPS unit assembly must not be disassemble to inspect or replace them. (Refer to "ST (Steering system) Gr.")

Figure 36 – Note: Description and Operation of Automatic Transaxle System including monitoring and adjusting torque level

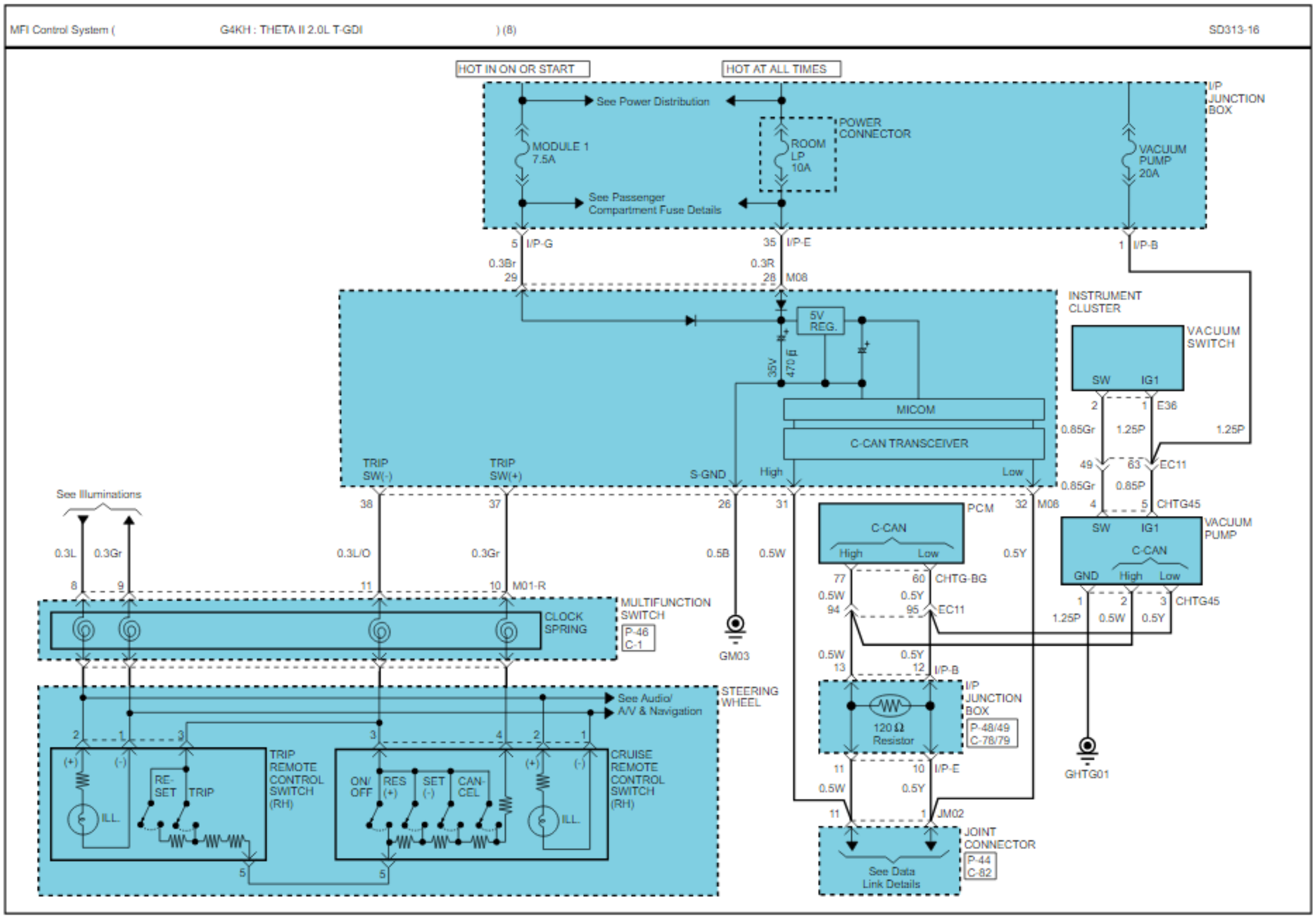
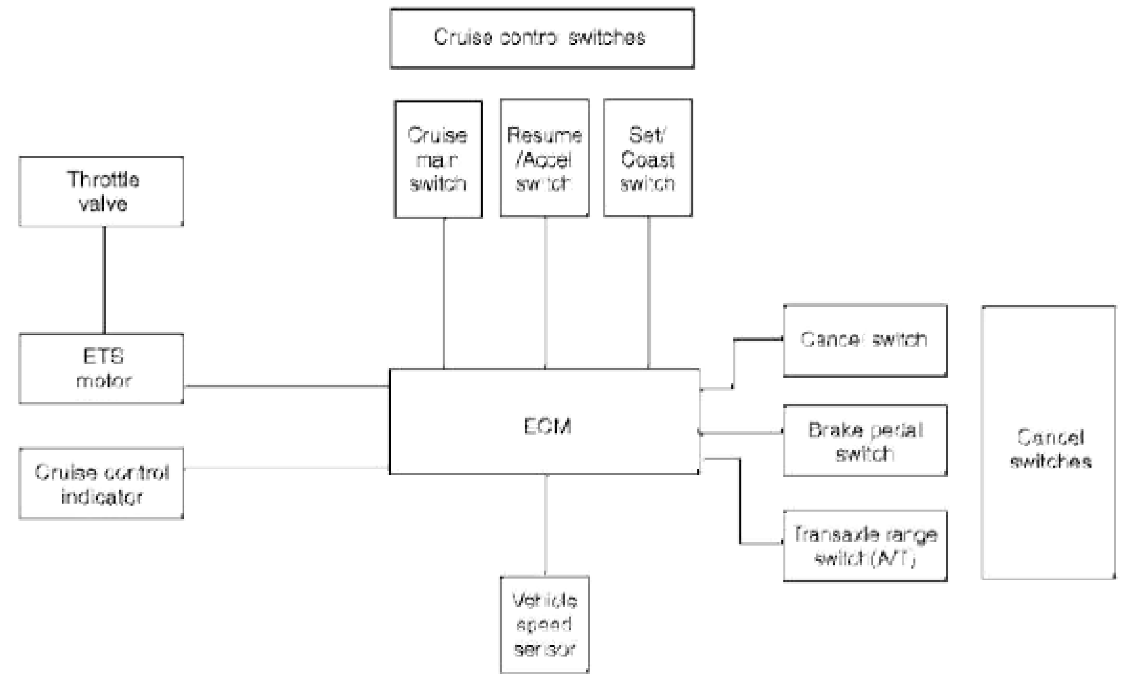


Figure 37 - MFI Control System - CAN System controller diagram



Component Parts And Function Outline

Component part		Function
Vehicle speed sensor		Converts vehicle speed to pulse.
ECM		Receives signals from sensor and control switches.
Cruise control indicator		Illuminate when CRUISE main switch is ON (Built into cluster)
Cruise control switches	ON/OFF switch	Switch for automatic speed control power supply.
	Resume/Accel switch	Controls automatic speed control functions by Resume/Accel switch (Set/Coast switch)
	Set/Coast switch	
Cancel switches	Cancel switch	Sends cancel signals to ECM.
	Brake pedal switch	
	Transaxle range switch (A/T)	
ETS motor		Regulates the throttle valve to the set opening by ECM.

Figure 38- Note: Components depicted are instrumental in regulating and sending sensor signals over CAN

63. Claim 7 of the ’281 patent recites an engine output control method for a vehicle having a drive by wire engine system responsive to a desired engine torque signal, the method comprising the steps of: generating a driver demanded acceleration value corresponding to an operator input; generating a gear value as a function of a vehicle speed value and said driver

demanded acceleration value; deriving a driveline torque demand comprising the sum of a feedforward torque value corresponding to said driver demanded acceleration value and said gear value, and a feedback torque value corresponding to said driver demanded acceleration value, said gear value, and a actual acceleration value; deriving a demanded engine torque value from said driveline torque demand and a torque converter model; and controlling said engine output as a function of said demanded engine torque value.

64. On information and belief, the Accused Instrumentalities infringe at least claim 7 of the ’281 patent. The Accused Instrumentalities practice an engine output control method for a vehicle having a drive by wire engine system (*Figures 17-21, 25-26, 36-37*) responsive to a desired engine torque signal (*Figures 30-36*), the method comprising the steps of: generating a driver demanded acceleration value corresponding to an operator input (*Figures 12-16*); generating a gear value as a function of a vehicle speed value and said driver demanded acceleration value (*Figure 38*); deriving a driveline torque demand comprising the sum of a feedforward torque value corresponding to said driver demanded acceleration value and said gear value, and a feedback torque value corresponding to said driver demanded acceleration value, said gear value, and a actual acceleration value (*Figures 30, 37-38*); deriving a demanded engine torque value from said driveline torque demand and a torque converter model (*Figures 4, 39*); and controlling said engine output as a function of said demanded engine torque value (*Figures 40-41*).

65. Claim 10 of the ’281 patent recites a powertrain control system for controlling the operation of a drive by wire internal combustion engine comprising: a microprocessor and associated memory including a model of the vehicle driveline dynamics and a torque converter model, said microprocessor programmed to: generate a driver demanded acceleration value

corresponding to an operator input; generate a gear value as a function of a vehicle speed value and said driver demanded acceleration value; derive a driveline torque demand as a function of said vehicle driveline dynamic model, said driver demanded acceleration value, and said gear value; derive a demanded engine torque value from said driveline torque demand and a torque converter model; and control said engine output as a function of said demanded engine torque value.

66. On information and belief, the Accused Instrumentalities infringe at least claim 10 of the ’281 patent. The Accused Instrumentalities comprise a powertrain control system for controlling the operation of a drive by wire internal combustion engine (*Figures 17-21, 25-26, 36-37*) comprising: a microprocessor (*Figure 20*) and associated memory including a model of the vehicle driveline dynamics and a torque converter model (*Figures 30, 37-38*), said microprocessor programmed to: generate a driver demanded acceleration value corresponding to an operator (*Figures 13-16, 31-32*) input; generate a gear value as a function of a vehicle speed value and said driver demanded acceleration value (*Figures 30, 37-38*); derive a driveline torque demand as a function of said vehicle driveline dynamic model, said driver demanded acceleration value, and said gear value (*Figures 30, 37-38*); derive a demanded engine torque value from said driveline torque demand and a torque converter model *(Figures 4, 39*); and control said engine output as a function of said demanded engine torque value (*Figures 40-41*).

COUNT VII – INFRINGEMENT OF U.S. PATENT NO. 6,763,804

67. The allegations set forth in the foregoing paragraphs 1 through 66 are incorporated into this Seventh Claim for Relief.

68. On July 20, 2004, U.S. Patent No. 6,763,804 (“the ’804 patent”), entitled “*Electronic Throttle Servo Overheat Protection System*,” was duly and legally issued by the

United States Patent and Trademark Office. A true and correct copy of the ’804 patent is attached as Exhibit 7.

69. Plaintiff is the assignee and owner of the right, title and interest in and to the ’804 patent, including the right to assert all causes of action arising under said patents and the right to any remedies for infringement of them.

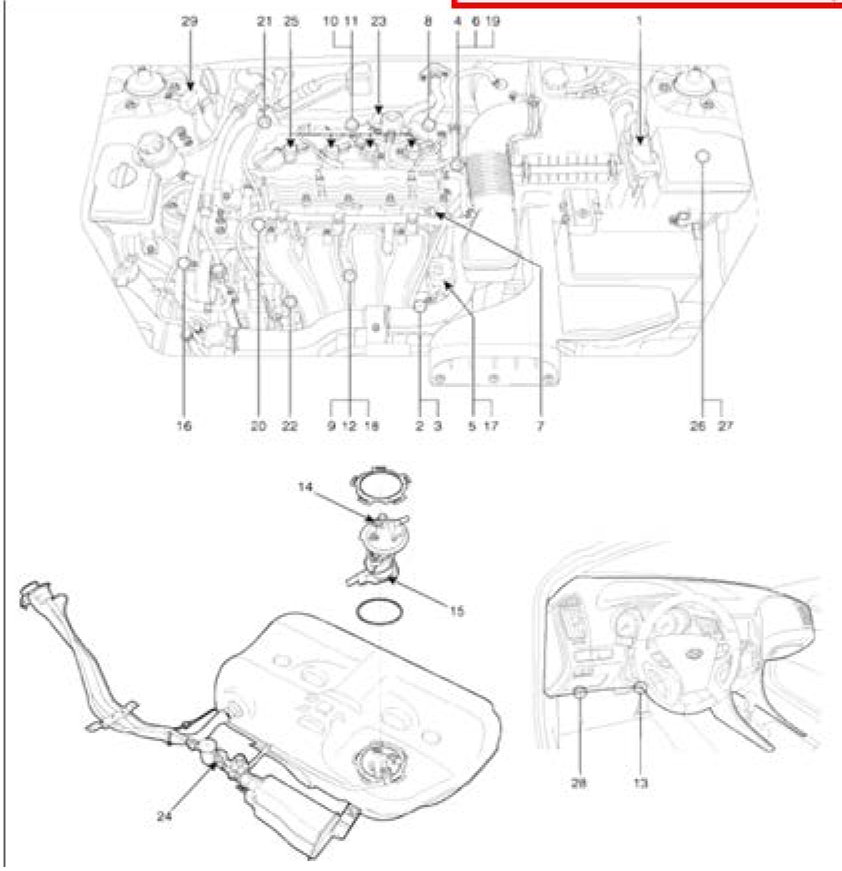
70. Upon information and belief, Defendant has directly infringed at least claims 1 and 11 of the ’804 patent by making, using, selling, importing and/or providing and causing to be used the 2011-2017 Hyundai Sonata (2.0L), 2010-2017 Hyundai Genesis Coupe (2.0L), 2013-2017 Hyundai Santa Fe (2.0L), 2011-2017 Hyundai Sonata (2.4L), 2010-2017 Hyundai Tucson (2.4L), 2010-2017 Hyundai Santa Fe (2.4L) (the “Accused Instrumentalities”).

71. Upon information and belief, the Accused Instrumentalities incorporate the Theta II Engine which practices a method for controlling a positioning device of an internal combustion engine.

72. In particular, claim 1 of the ’804 patent recites a method for controlling a positioning device of an internal combustion engine, the method comprising the steps of: providing an electric motor for actuating the positioning device; commanding the positioning device to change to a commanded position; detecting a control effort required to change to said commanded position; determining whether said control effort exceeds a threshold for a predetermined time period; and reducing said control effort when said control effort exceeds said threshold for said predetermined time period; wherein commanding the positioning device to change to said commanded position comprises at least one of commanding the positioning device to open to a hold open mode and commanding the positioning device to close to a hold close mode.

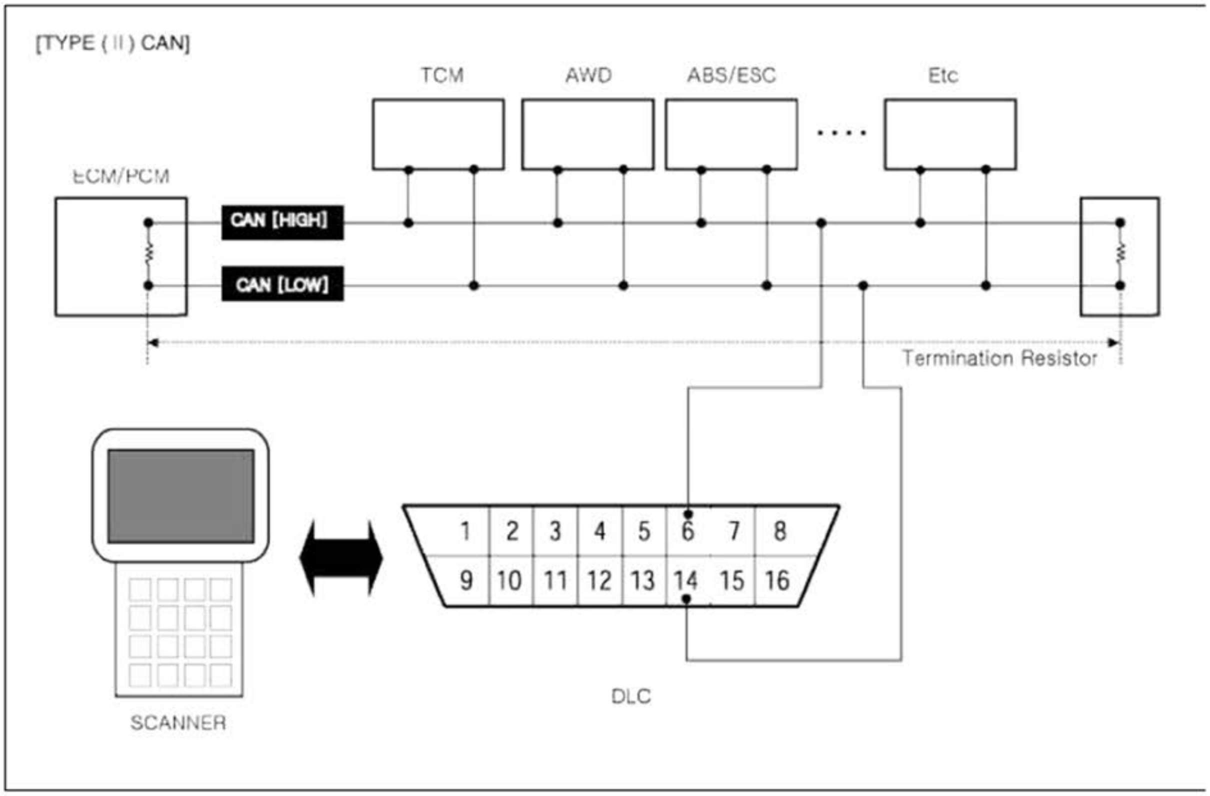
73. On information and belief, the Accused Instrumentalities infringe at least claim 1 of the '804 patent. The Accused Instrumentalities practice a method for controlling a positioning device of an internal combustion engine (*Figure 39*), the method comprising the steps of: providing an electric motor for actuating the positioning device (*Figure 39*); commanding the positioning device to change to a commanded position (*Figure 40*); detecting a control effort required to change to said commanded position (*Figure 40*); determining whether said control effort exceeds a threshold for a predetermined time period (*Figure 40*); and reducing said control effort when said control effort exceeds said threshold for said predetermined time period (*Figure 40*); wherein commanding the positioning device to change to said commanded position comprises at least one of commanding the positioning device to open to a hold open mode and commanding the positioning device to close to a hold close mode (*Figure 40*).

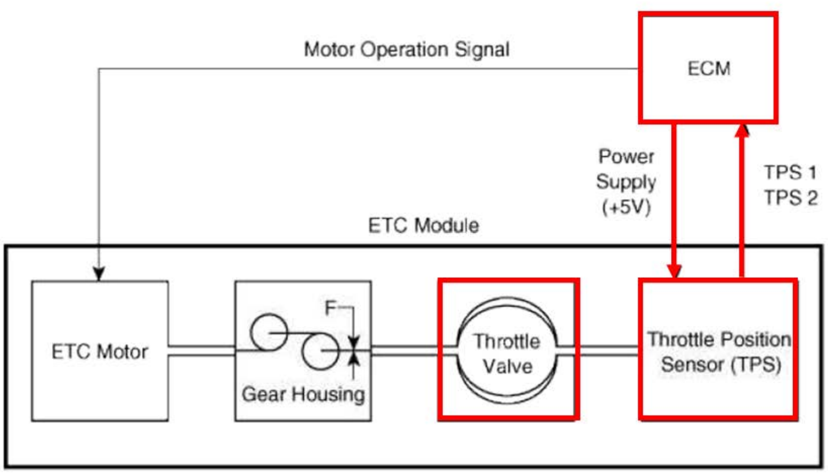
1. Engine Control Module (ECM)	16. A/C Pressure Transducer (APT)
2. Manifold Absolute Pressure Sensor (MAPS)	17. ETC Motor [integrated into ETC Module]
3. Intake Air Temperature Sensor (IATS)	18. Injector
4. Engine Coolant Temperature Sensor (ECTS)	19. Purge Control Solenoid Valve (PCSV)
5. Throttle Position Sensor (TPS) [integrated into ETC Module]	20. CVVT Oil Control Valve (OCV) [Bank 1 / Intake]
6. Crankshaft Position Sensor (CKPS)	21. CVVT Oil Control Valve (OCV) [Bank 1 / Exhaust]
7. Camshaft Position Sensor (CMPS) [Bank 1 / Intake]	22. Variable Intake Solenoid (VIS) Valve
8. Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]	23. Fuel Pressure Regulator Valve
9. Knock Sensor (KS)	24. Canister Close Valve (CCV)
10. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 1]	25. Ignition Coil
11. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2]	26. Main Relay
12. Rail Pressure Sensor (RPS)	27. Fuel Pump Relay
13. Accelerator Position Sensor (APS)	28. Data Link Connector (DLC) [16-Pin]
14. Fuel Tank Pressure Sensor (FTPS)	29. Multi-Purpose Check Connector [20-Pin]
15. Fuel Level Sensor (FLS)	



Note: Figures comprising Engine Control Module (ECM); Manifold Absolute Pressure Sensor (MAPS); Accelerator Position Sensor (APS); Data Link Connector and Multi-purpose check connector - all components combined are operative in commanding the positioning device, detecting the control effort required to change to commanded position, and determining the control effort required in comparison to the required threshold.

2. Configuration of hardware and related terms
1) GST (Generic scan tool)





A positioning device the Electronic Throttle Control (ETC) (electric motor) actuates the positioning device (gear housing).

The Controller Area Network (CAN) with microprocessors Engine Control Module (ECM) and Powertrain Control Module (PCM) control a positioning device (gear housing) which is connected (the Electronic Throttle Control (ETC) motor and controls the throttle valve of an internal combustion engine (Theta II).

Figure 39

Fuel System > Engine Control System > ETC (Electronic Throttle Control) System > Troubleshooting

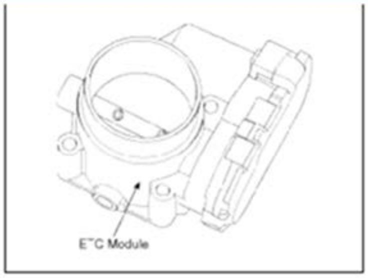
Fail-Safe Mode

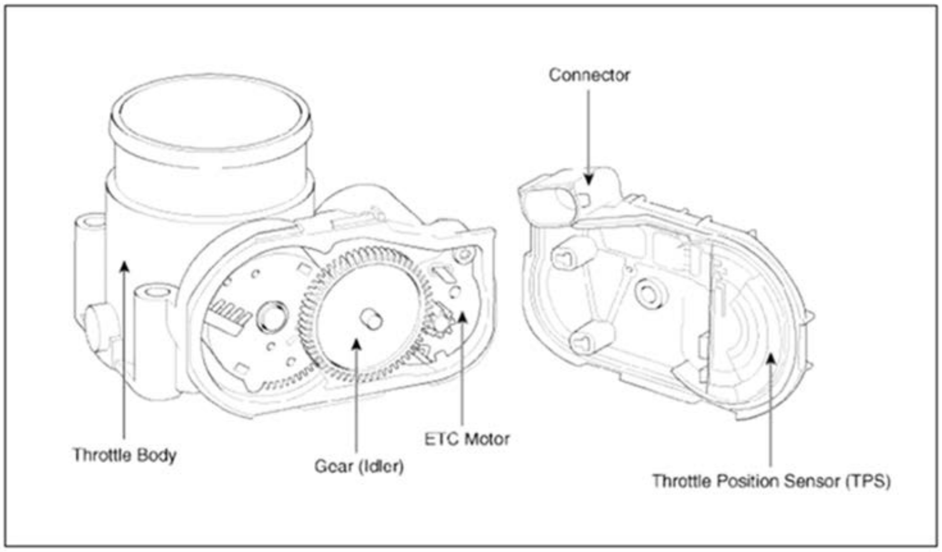
Item	Fail-Safe	
ETC Motor	Throttle valve stuck at 5°	
TPS	TPS 1 fault	ECM looks at TPS2
	TPS 2 fault	ECM looks at TPS1
	TPS 1,2 fault	Throttle valve stuck at 5°
APS	APS 1 fault	ECM looks at APS 2
	APS 2 fault	ECM looks at APS 1
	APS 1,2 fault	Throttle valve stuck at 5°

Fuel System > Engine Control System > ETC (Electronic Throttle Control) System > Description and Operation

Description

The Electronic Throttle Control (ETC) System consists of a throttle body with an integrated control motor and throttle position sensor (TPS). Instead of the traditional throttle cable, an Accelerator Position Sensor (APS) is used to receive driver input. The ECM uses the APS signal to calculate the target throttle angle; the position of the throttle is then adjusted via ECM control of the ETC motor. The TPS signal is used to provide feedback regarding throttle position to the ECM. Using ETC, precise control over throttle position is possible; the need for external cruise control modules/cables is eliminated.





The positioning device (gear housing) is controlled by the ETC motor which is commanded by the ECM, to change to commanded position (based on the driver demand commanded from the Accelerator Position Sensor (APS)).

SONATA(YFA) > 2012 > G 2.4 GDI > Engine > Engine Control > P0638 Throttle Actuator Control Range/Performance (Bank 1)

General Description Feedback

The Electronic Throttle Control(ETC) system"s components are the throttle body, Throttle Position Sensor(TPS)1&2 and Accelerator Position Sensor(APS) 1&2. The throttle body contains the actuator, the throttle plate and the throttle position sensor (potentiometer), which are integrated in one housing. The actuator consists of a DC motor with a two-stage gear. The opening angle of the throttle valve is detected by the throttle position sensor which is mounted on the throttle body. And it provides feedback to the PCM to control the throttle motor in order to control the throttle valve opening angle properly in response to the driving condition.

Control effort corresponds to the amount of motor torque (ETC Motor) to change the position of the throttle valve. The commanded position is determined by the ECM based on information from the APS derived from driver demand.

SONATA(YFA) > 2012 > G 2.4 GDI > Engine > Engine Control > P2119 Throttle Actuator Control Throttle Body Range/Performance

DTC Description Feedback

PCM sets DTC P2119 if the PCM detects TPS adaptation procedure is abnormal.

DTC Detecting Condition

Item		Detecting Condition	Possible Cause
DTC Strategy	Case1	• TPS adaptation Lower position check	1. Poor connection or damaged harness 2. Faulty ETC motor
	Case2	• TPS adaptation error low return spring check	
	Case3	• TPS adaptation upper position check	
	Case4	• TPS adaptation error upper return spring check	
	Case5	• TPS start check error in spring check	
	Case6	• TPS start check error in limp-home-check	
Enable Conditions	Case1	• During TPS adaptation • TPS setpoint = 11.9%	
	Case2,4	• During TPS adaptation	
	Case3	• During TPS adaptation • TPS setpoint = 29%	
	Case5	• During TPS start check • TPS setpoint = 24.2%	
	Case6	• During TPS start check • No engine start condition	
Threshold Value	Case1	• Throttle position for the lower return spring check is not reached within a limit maximum time(Difference between throttle position and setpoint > 0.48%")	
	Case2	• When ETC power stage is off, Throttle can not return by spring power in the limp-home position within a limit maximum time(Difference between Throttle position and adapted voltage in limphome position > 0.18 V)	
	Case3	• Throttle position for the upper return spring check is not reached within a limit maximum time(Difference between throttle position and setpoint > 0.48%)	
	Case4	• When ETC power stage is off, Throttle cannot return by spring power in the limp-home position within a limit maximum time(Difference between Throttle position and adapted voltage in limphome position > 0.18 V)	
	Case5	• Throttle flap cannot reach the setpoint within the hysteresis within a limit maximum time(Difference between throttle position and requested position > 0.48%)	
	Case6	• When ETC power stage is off, Throttle cannot return by spring power in the limp-home position within a limit maximum time(Difference between Throttle position and adapted voltage in limphome position > 0.18V)	
Diagnostic Time		• 0.8~1.2 Seconds	
Limp-Home		• Forced limited RPM mode : The PCM limits engine speed to 1500rpm • Electrical check of the ETC system is prohibited	
MIL On Condition		• Immediate	

Thresholds for predetermined time periods

As shown above, threshold values cases 1 – 6 demonstrate a determination being made by the PCM regarding whether a control effort exceeds a threshold for a predetermined time period.

SONATA(YFA) > 2012 > G 2.4 GDI > Engine > Engine Control > P2119 Throttle Actuator Control Throttle Body Range/Performance

DTC Description

Feedback

PCM sets DTC P2119 if the PCM detects TPS adaptation procedure is abnormal.

DTC Detecting Condition

Item		Detecting Condition	Possible Cause
DTC Strategy	Case1	• TPS adaptation Lower position check	Control effort is provided by the ETC motor based on the signal sent by the PCM. The PCM signal is derived from the APS based on driver demanded acceleration input. The throttle vale is actuated by the ETC motor, sending a TPS to the PCM/ECM. The Case 1 lower position check shows a threshold valve. The ETC motor will attempt to close the throttle valve further with feedback from the TPS, the TPS does not lower with the increased closing force, then the closing force will reduce (i.e. limp home mode).
	Case2	• TPS adaptation error low return spring check	
	Case3	• TPS adaptation upper position check	
	Case4	• TPS adaptation error upper return spring check	
	Case5	• TPS start check error in spring check	
	Case6	• TPS start check error in limp-home-check	
Enable Conditions	Case1	• During TPS adaptation • TPS setpoint = 11.9%	
	Case2,4	• During TPS adaptation	
	Case3	• During TPS adaptation • TPS setpoint = 29%	
	Case5	• During TPS start check • TPS setpoint = 24.2%	
	Case6	• During TPS start check • No engine start condition	1. Poor connection or damaged harness 2. Faulty ETC motor
Threshold Value	Case1	• Throttle position for the lower return spring check is not reached within a limit maximum time(Difference between throttle position and setpoint > 0.48%*)	
	Case2	• When ETC power stage is off, Throttle can not return by spring power in the limp-home position within a limit maximum time(Difference between Throttle position and adapted voltage in limphome position > 0.18 V)	
	Case3	• Throttle position for the upper return spring check is not reached within a limit maximum time(Difference between throttle position and setpoint > 0.48%)	
	Case4	• When ETC power stage is off, Throttle cannot return by spring power in the limp-home position within a limit maximum time(Difference between Throttle position and adapted voltage in limphome position > 0.18 V)	Predetermined time period
	Case5	• Throttle flap cannot reach the setpoint within the hysteresis within a limit maximum time(Difference between throttle position and requested position > 0.48%)	
	Case6	• When ETC power stage is off, Throttle cannot return by spring power in the limp-home position within a limit maximum time(Difference between Throttle position and adapted voltage in limphome position > 0.18V)	
Diagnostic Time		• 0.8~1.2 Seconds	
Limp-Home		• Forced limited RPM mode : The PCM limits engine speed to 1500rpm • Electrical check of the ETC system is prohibited	
MIL On Condition		• Immediate	

Control effort is provided by the ETC motor based on the signal sent by the PCM. The PCM signal is derived from the APS based on driver demanded acceleration input. The throttle vale is actuated by the ETC motor, sending a TPS to the PCM/ECM. The Case 1 lower position check shows a threshold valve. The ETC motor will attempt to close the throttle valve further with feedback from the TPS, the TPS does not lower with the increased closing force, then the closing force will reduce (i.e. limp home mode).

SONATA(YFA) > 2012 > G 2.4 GDI > Engine > Engine Control > P2119 Throttle Actuator Control Throttle Body Range/Performance

DTC Description

Feedback

PCM sets DTC P2119 if the PCM detects TPS adaptation procedure is abnormal.

DTC Detecting Condition

Item		Detecting Condition	Possible Cause
DTC Strategy	Case1	• TPS adaptation Lower position check	Upper position check is the hold open mode; lower position check is the hold closed mode
	Case2	• TPS adaptation error low return spring check	
	Case3	• TPS adaptation upper position check	
	Case4	• TPS adaptation error upper return spring check	
	Case5	• TPS start check error in spring check	
	Case6	• TPS start check error in limp-home-check	
Enable Conditions	Case1	• During TPS adaptation • TPS setpoint = 11.9%	
	Case2,4	• During TPS adaptation	
	Case3	• During TPS adaptation • TPS setpoint = 29%	
	Case5	• During TPS start check • TPS setpoint = 24.2%	
	Case6	• During TPS start check • No engine start condition	1. Poor connection or damaged harness 2. Faulty ETC motor
Threshold Value	Case1	• Throttle position for the lower return spring check is not reached within a limit maximum time(Difference between throttle position and setpoint > 0.48%*)	
	Case2	• When ETC power stage is off, Throttle can not return by spring power in the limp-home position within a limit maximum time(Difference between Throttle position and adapted voltage in limphome position > 0.18 V)	
	Case3	• Throttle position for the upper return spring check is not reached within a limit maximum time(Difference between throttle position and setpoint > 0.48%)	
	Case4	• When ETC power stage is off, Throttle cannot return by spring power in the limp-home position within a limit maximum time(Difference between Throttle position and adapted voltage in limphome position > 0.18 V)	
	Case5	• Throttle flap cannot reach the setpoint within the hysteresis within a limit maximum time(Difference between throttle position and requested position > 0.48%)	
	Case6	• When ETC power stage is off, Throttle cannot return by spring power in the limp-home position within a limit maximum time(Difference between Throttle position and adapted voltage in limphome position > 0.18V)	
Diagnostic Time		• 0.8~1.2 Seconds	
Limp-Home		• Forced limited RPM mode : The PCM limits engine speed to 1500rpm • Electrical check of the ETC system is prohibited	
MIL On Condition		• Immediate	

As shown above, the positioning device (ETC motor) is commanded (by PCM/ECM) to change to a commanded position (upper position or lower position) comprising at least one of the commands to the positioning device to open to a hold open mode (upper position) and one of the commands to the positioning device to close to a hold close mode (lower position check).

Figure 40

74. Claim 11 of the ’804 patent recites a system for controlling a positioning device of an internal combustion engine to prevent overheat conditions, the system comprising: an electric motor for actuating the positioning device with a control effort; a control effort detector coupled to said electric motor and intended to detect said control effort; and a controller coupled to said electric motor and said control effort detector, said controller including control logic operative to command the positioning device to change to a commanded position, detect a control effort required to change to said commanded position, determine whether said control effort exceeds a threshold for a predetermined time period, and reduce said control effort when said control effort exceeds said threshold for said predetermined time period; wherein said controller further includes control logic operative to command the positioning device to close to said commanded position in a hold close mode.

75. On information and belief, the Accused Instrumentalities infringe claim 11 of the ’804 patent. The Accused Instrumentalities comprise a system for controlling a positioning device of an internal combustion engine to prevent overheat conditions (*Figure 39*), the system comprising: an electric motor for actuating the positioning device with a control effort (*Figure 39*); a control effort detector coupled to said electric motor and intended to detect said control effort (*Figure 40*); and a controller coupled to said electric motor and said control effort detector, said controller including control logic operative to command the positioning device to change to a commanded position, detect a control effort required to change to said commanded position, determine whether said control effort exceeds a threshold for a predetermined time period, and

reduce said control effort when said control effort exceeds said threshold for said predetermined time period (*Figure 40*); wherein said controller further includes control logic operative to command the positioning device to close to said commanded position in a hold close mode (*Figure 40*).

COUNT VIII – INFRINGEMENT OF U.S. PATENT NO. 6,347,680

76. The allegations set forth in the foregoing paragraphs 1 through 75 are incorporated into this Eighth Claim for Relief.

77. On February 19, 2001, U.S. Patent No. 6,347,680 ("the '680 patent"), entitled "*Engine Output Controller,*" was duly and legally issued by the United States Patent and Trademark Office. A true and correct copy of the '680 patent is attached as Exhibit 8.

78. Plaintiff is the assignee and owner of the right, title and interest in and to the '680 patent, including the right to assert all causes of action arising under said patents and the right to any remedies for infringement of them.

79. Upon information and belief, Defendants have directly infringed at least claims 1, 8 and 13 of the '680 patent by making, using, selling, importing and/or providing and causing to be used the 2011-2017 Hyundai Sonata (2.0L), 2010-2017 Hyundai Genesis Coupe (2.0L), 2013-2017 Hyundai Santa Fe (2.0L), 2011-2017 Hyundai Sonata (2.4L), 2010-2017 Hyundai Tucson (2.4L), 2010-2017 Hyundai Santa Fe (2.4L) (the "Accused Instrumentalities").

80. Upon information and belief, the Accused Instrumentalities incorporate the Theta II Engine which practices an engine output control method for a vehicle having a drive by wire engine system.

81. In particular, claim 1 of the '680 patent recites an engine output control method for a vehicle having a drive by wire engine system responsive to a desired engine speed signal, the method comprising the steps of: generating a driver demanded engine speed value

corresponding to an operator input; generating a speed control system engine speed value corresponding to a predetermined speed value to permit vehicle operation at a constant speed by a speed control system; arbitrating between said driver demanded engine speed value and said speed control system engine speed value to derive a first desired engine speed value; limiting said first desired engine speed value by a vehicle speed limit value, engine speed limit value, and transmission speed limit value to generate a second desired engine speed value; and controlling said engine output as a function of said second desired engine speed value and an actual engine speed value.

82. On information and belief, the Accused Instrumentalities infringe at least claim 1 of the ’680 patent. The Accused Instrumentalities practice an engine output control method for a vehicle having a drive by wire engine system responsive (*Figures 17-20*) to a desired engine speed signal (*Figures 17-20, 40-41, 50-52*), the method comprising the steps of: generating a driver demanded engine speed value corresponding to an operator input *(Figures 12-13, 20, 47-49*); generating a speed control system engine speed value corresponding to a predetermined speed value to permit vehicle operation at a constant speed by a speed control system (*Figures 41-43*); arbitrating between said driver demanded engine speed value and said speed control system engine speed value to derive a first desired engine speed value (*Figures 12-13, 20, 41-43, 47-49*); limiting said first desired engine speed value by a vehicle speed limit value, engine speed limit value, and transmission speed limit value to generate a second desired engine speed value (*Figures 43*, *45-46*, *47-49*); and controlling said engine output as a function of said second desired engine speed value and an actual engine speed value (*Figures 43-46, 47-48*).

SONATA(YFA) > 2012 > Engine > Engine Control > Description

Description

Feedback

Manifold Absolute Pressure Sensor (MAPS) is a speed-density type sensor and is installed on the surge tank. It senses absolute pressure of the surge tank and transfers the analog signal proportional to the pressure to the ECM. By using this signal, the ECM calculates the intake air quantity and engine speed.

The MAPS consists of a piezo-electric element and a hybrid IC amplifying the element output signal. The element is silicon diaphragm type and adapts pressure sensitive variable resistor effect of semi-conductor. Because 100% vacuum and the manifold pressure apply to both sides of the sensor respectively, this sensor can output analog signal by using the silicon variation proportional to pressure change.

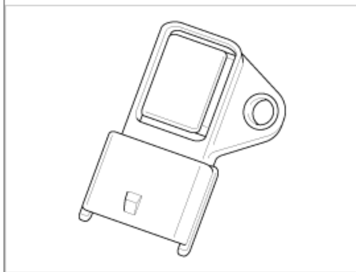


Figure 41 – Note: Description of the Manifold Absolute Pressure Sensor (MAPS) which senses the absolute pressure of the surge tank and transfers the signal proportion to the pressure to the ECM, which calculates the engine speed.

Component Parts And Function Outline

Component part		Function
Vehicle speed sensor		Converts vehicle speed to pulse.
ECM		Receives signals from sensor and control switches.
Cruise control indicator		Illuminate when CRUISE main switch is ON (Built into cluster)
Cruise control switches	ON/OFF switch	Switch for automatic speed control power supply.
	Resume/Accel switch	Controls automatic speed control functions by Resume/Accel switch (Set/Coast switch)
	Set/Coast switch	
Cancel switches	Cancel switch	Sends cancel signals to ECM.
	Brake pedal switch	
	Transaxle range switch (A/T)	
ETS motor		Regulates the throttle valve to the set opening by ECM.

* ETS : Electronic Throttle System

Figure 42- Components of the Electronic Throttle System (ETS) including the vehicle speed sensor

Hyundai Motor America [US] | https://www.hyundaitechinfo.com/viewer/content_pop.aspx?content_no=DTC|ENG|2684|2012||en|98||&sitinfolist=14^1420^14201

SONATA(YFA) > 2012 > Engine > Engine Control > DTC Description

DTC Description

Feedback

The PCM evaluates engine speed and mass air flow if there is no vehicle speed signal. This evaluation of both values will detect open circuit or short circuit errors on the wheel speed sensor. The PCM sets DTC P2159 if there is no vehicle speed signal from wheel speed sensor while both engine speed and mass air flow are higher than predetermined threshold during the predetermined time.

Hyundai Motor America [US] | https://www.hyundaitechinfo.com/viewer/content_pop.aspx?content_no=DTC|ENG|2684|2012||en|98||&sitinfolist=14^1420^14202

SONATA(YFA) > 2012 > Engine > Engine Control > DTC Detecting Condition

DTC Detecting Condition

Feedback

Item	Detecting Condition	Possible Cause
DTC Strategy	• Monitoring deviation between target idle speed and actual engine speed	1. A stuck or binding throttle body 2. Air leakage 3. Poor connection or damaged harness 4. Faulty ETC
Enable Conditions	• Coolant temp. >73°C(163°F) • Engine idle status(closed throttle valve & vehicle speed=0) • Idle speed controller active(idle status) • 11< Battery voltage <16 • After engine start >20 Seconds • No relevant failure	
Threshold Value	• Engine Speed - Nominal Idle Speed > 200rpm	
Diagnostic Time	• 21 Seconds	
Mil On Condition	• -	

Figure 43 - DTC Description

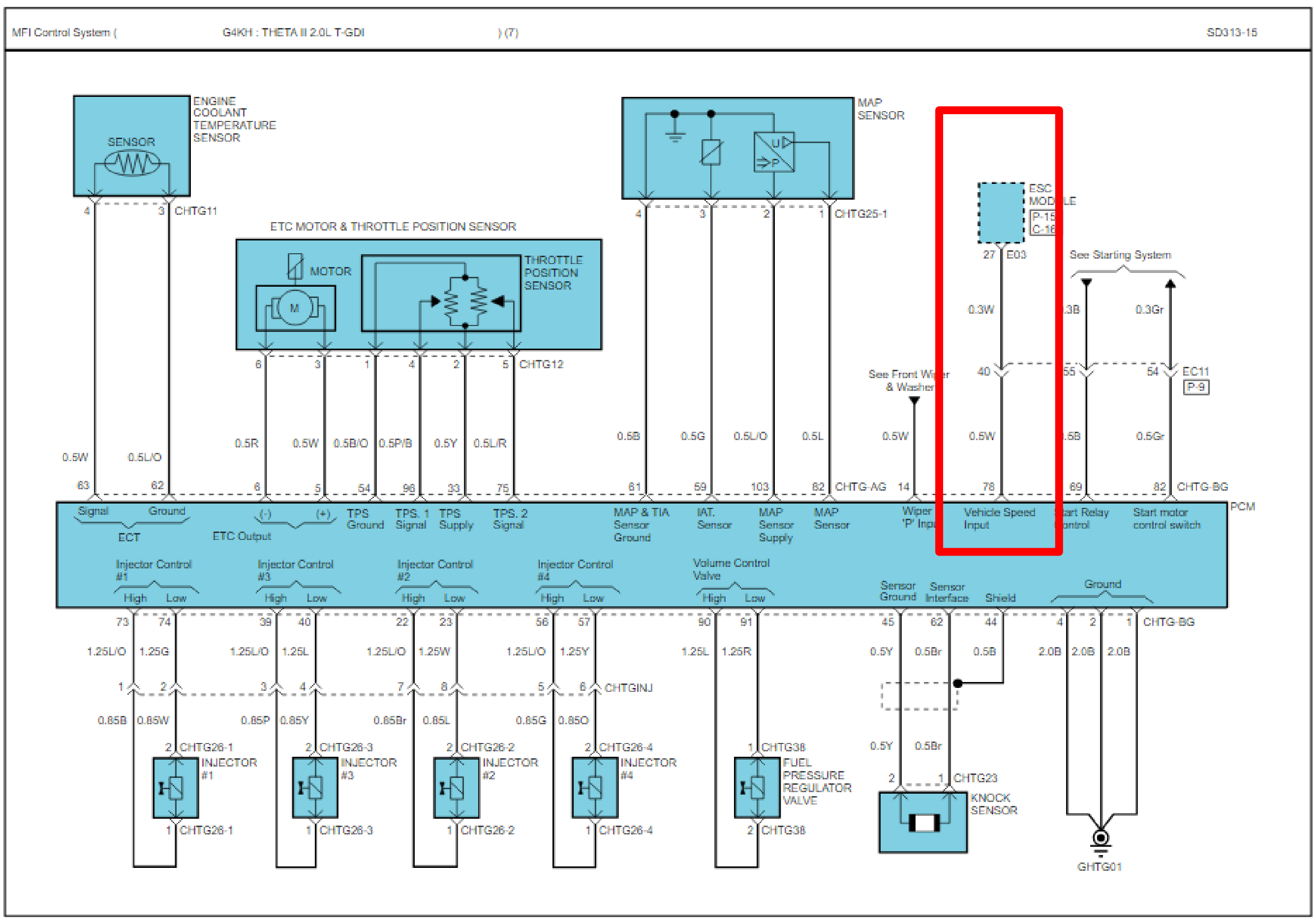


Figure 44- Note: Control System including vehicle speed sensor input

SONATA(YFA) > 2012 > Engine > Engine Control > Fail-Safe Mode

Fail-Safe Mode

Feedback

Item	Fail-Safe	
ETC Motor	Throttle valve stuck at 5°	
TPS	TPS 1 fault	ECM looks at TPS2
	TPS 2 fault	ECM looks at TPS1
	TPS 1,2 fault	Throttle valve stuck at 5°
APS	APS 1 fault	ECM looks at APS 2
	APS 2 fault	ECM looks at APS 1
	APS 1,2 fault	Throttle valve stuck at 5°

NOTICE

When throttle value is stuck at 5°, engine speed is limited at below 1,500rpm and vehicle speed at maximum 40 ~ 50 km/h (25 ~ 31 mph)

Figure 45 – Note: Description of ETC fail safe mode limiting vehicle, engine, and transmission speed values

SONATA(YFA) > 2012 > Brake > Electronic Stability Control > DTC Detecting Condition

DTC Detecting Condition

Feedback

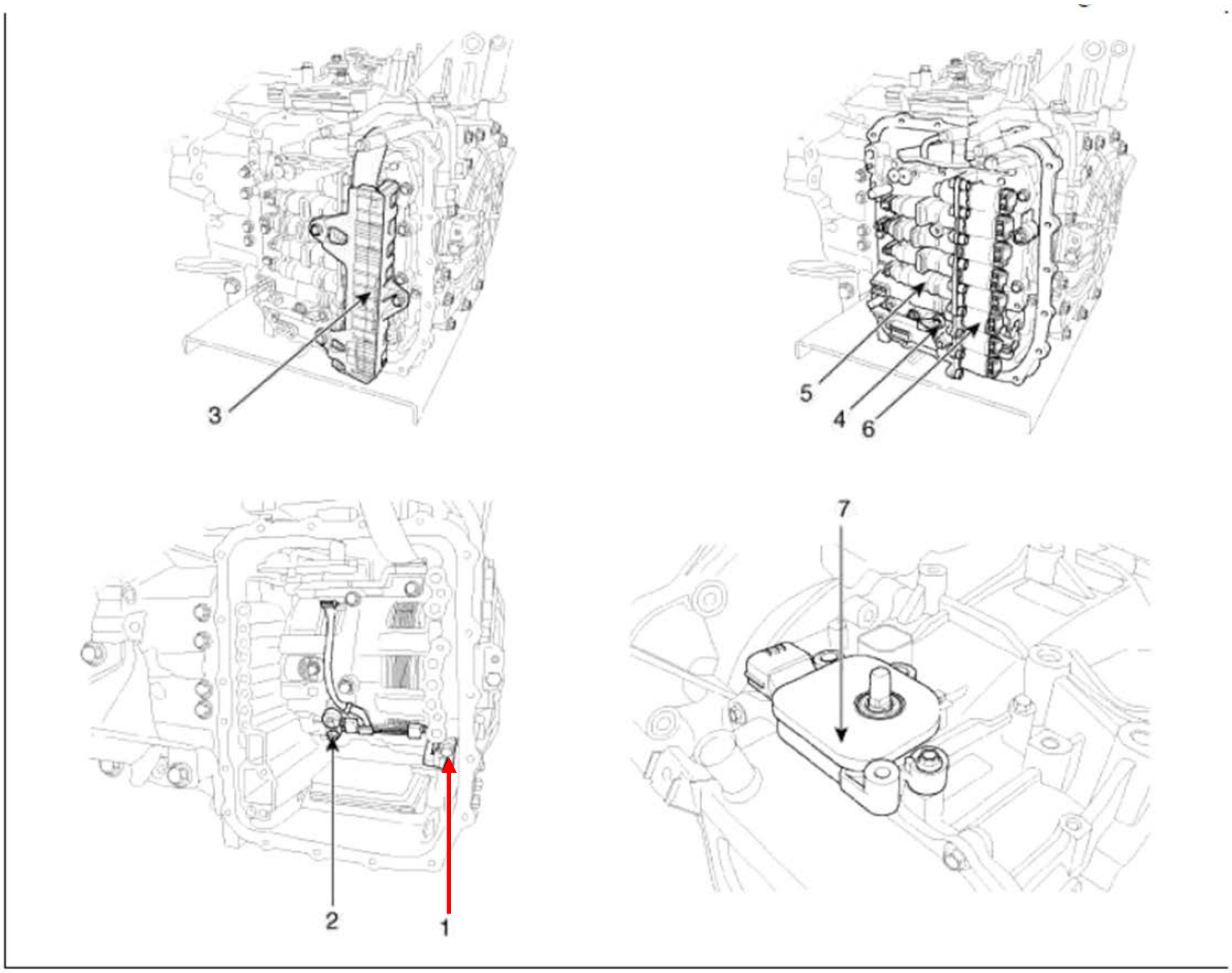
Item		Detecting Condition	Possible Cause
DTC Strategy		• Signal monitoring	1. Improper installation of wheel speed sensor 2. Abnormal Rotor and wheel bearing 3. Faulty Wheel speed sensor(FL) 4. Exteral noise
Case1	Monitoring Period	• The monitoring is active from 10 km/h to 80km/h and if no ABS-control is active at a front wheel and a rear wheel.	
	Enable Conditions	• Every time, if a gap in the wheel speed sensor signal occurs cyclically with one wheel rotation, a fault counter is increased by one. If the fault counter exceeds its limit of 10, a wheel specific fault is stored in the EEPROM.	
Case2	Monitoring Period	• Continuous	
	Enable Conditions	• If following interference and signal disturbance is detected, a failure is set after 10s. - non-plausible high frequency received. - non-plausible high wheel acceleration. - non-plausible high wheel jurk. - non-plausible delta T and edges at low speed.	
Case3 (WSS Dynamic monitoring)	Monitoring Period	• Continuous (If vehicle speed > 12 m/s (43,2 km/h)) - but this monitoring is disabled in the following event 1. aquaplaning. 2. interference. 3. supply voltage below 7.1 or above 18 Volts.	
	Enable Conditions	• No wheel speed signals within 10 ms to 20 ms at a vehicle speed > 12 m/s (43,2 km/h). - If the dynamic sensor monitor resconses, the failures will be stored into failure memory immediately after a waiting period of 60ms. - If occurs low voltage active sensors during the waiting period of 60 ms no failure is stored in the EEPROM.	
Fail-Safe		• Sensor failure outside of the ABS control cycle 1. 1~2 wheel failure - Only the ABS/ESC functions are inhibited. - The ABS/ESC warning lamps are activated and the EBD warning lamp is not activated. 2. More than 3 wheels failure - The ABS/EBD/ESC functions are inhibited. - The ABS/EBD/ESC warning lamps are activated. • Sensor failure inside the ABS control cycle 1. 1~2 wheel failure - The ABS/ESC functions are inhibited after end of control. - The ABS/ESC warning lamps are activated and the EBD warning lamp is not activated. 2. More than 3 wheels failure - The ABS/EBD/ESC functions are inhibited. - The ABS/EBD/ESC warning lamps are activated. ※ Control of the corresponding wheel is no longer possible. If a sensor fault occurs on a front wheel, pressure is increased; on a rear wheel, pressure is decreased.	

Figure 46 – Note: Description of DTC (traction control) monitoring vehicle, engine, and transmission speed values and communicated through drive by wire system

83. Claim 8 of the ’680 patent recites an engine output control method for a vehicle having a drive by wire engine system responsive to a desired engine speed signal, the method comprising the steps of: generating a driver demanded vehicle speed value corresponding to an operator input; generating a speed control system value corresponding to a predetermined speed value to permit vehicle operation at a constant speed by a speed control system; arbitrating between said driver demanded vehicle speed value, said speed control system value, and a vehicle speed limit value to derive a first desired vehicle speed value; converting said first desired vehicle speed value to a first desired engine speed value; limiting said first desired engine speed value by an engine speed limit value, and transmission speed limit value to generate a second desired engine speed value; and controlling said engine output as a function of said second desired engine speed value and an actual engine speed value.

84. On information and belief, the Accused Instrumentalities infringe at least claim 8 of the ’680 patent. The Accused Instrumentalities practice an engine output control method for a vehicle having a drive by wire engine system (*Figures 17-20*) responsive to a desired engine speed signal (*Figures 17-20, 40-41*), the method comprising the steps of: generating a driver demanded vehicle speed value corresponding to an operator input *(Figures 12-13, 20, 47*); generating a speed control system value corresponding to a predetermined speed value to permit vehicle operation at a constant speed by a speed control system (*Figures 41-43, 47-49*); arbitrating between said driver demanded vehicle speed value, said speed control system value, and a vehicle speed limit value to derive a first desired vehicle speed value (*Figures 41-43, 47-49*); converting said first desired vehicle speed value to a first desired engine speed value (*Figures 41-43, 47-49*); limiting said first desired engine speed value by an engine speed limit value, and transmission speed limit value to generate a second desired engine speed value

(*Figures 41-43, 47-49*); and controlling said engine output as a function of said second desired engine speed value and an actual engine speed value (*Figures 41-43, 47-49*).



1. Input speed sensor 2. Output speed sensor 3. Solenoid valve connect 4. Oil temperature sensor	5. Valve body assembly 6. Solenoid valve 7. Inhibitor switch

Figure 47 - Input speed sensor

Engine Electrical System > Cruise Control System > Description and Operation

Cruise Control

The cruise control system is engaged by the cruise "ON/OFF" main switch located on right of steering wheel column. The system has the capability to cruise, coast, accelerate and resume speed.
It also has a safety interrupt, engaged upon depressing brake or shifting select lever.
The ECM is the control module for this system. The main components of cruise control system are mode control

Page 49 of 54

switches, transmission range switch, brake switch, vehicle speed sensor, ECM and ETS motor that connect throttle body.
The ECM contains a low speed limit which will prevent system engagement below a minimum speed of 40km/h (25mph).
The operation of the controller is controlled by mode control switches located on steering wheel.
Transmission range switch and brake switch are provided to disengage the cruise control system. The switches are on brake pedal bracket and transmission. When the brake pedal is depressed or select lever shifted, the cruise control system is electrically disengaged and the throttle is returned to the idle position.

Cruise main switch (ON/OFF)

The cruise control system is engaged by pressing the cruise "ON/OFF" main switch. Pressing the cruise "ON/OFF" main switch again releases throttle, clears cruise memory speed, and puts vehicle in a non-cruise mode.

Set/Coast switch (SET/–)

The "SET/–" switch located on right of steering wheel column has two functions.
The set function - Push the "SET/–" switch and release it at the desired speed. The SET indicator light in the instrument cluster will illuminate. Release the accelerator pedal. The desired speed will automatically be maintained.
The coast function - Push the "SET/–" switch and hold it when the cruise control is on. The vehicle will gradually slow down. Release the switch at the desired speed. The desired speed will be maintained.
Push the "SET/–" switch and release it quickly. The cruising speed will decrease by 1.6km/h (1.0mph).

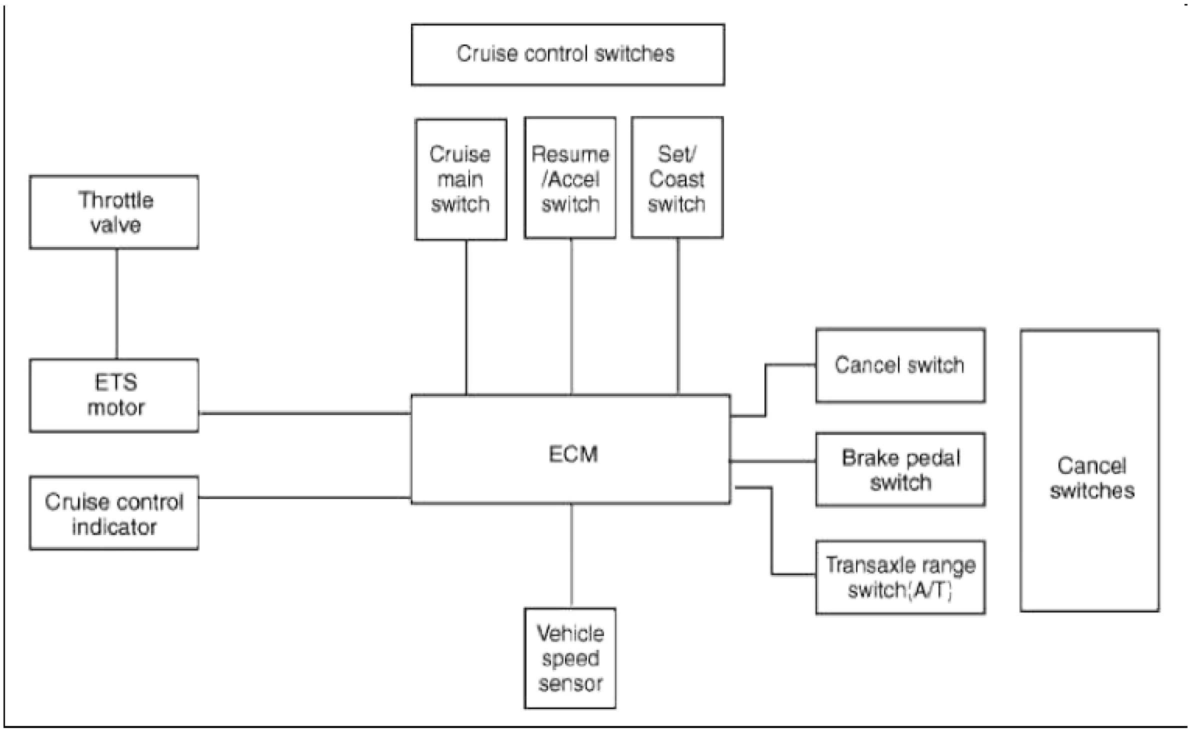
Resume/Accel switch (RES/+)

The "RES/+" switch located on right of steering wheel column has two functions.
The resume function - If any method other than the cruise "ON/OFF" main switch was used to cancel cruising speed temporarily and the system is still activated, the most recent set speed will automatically resume when the "RES/+" switch is pushed. It will not resume, however, if the vehicle speed has dropped below approximately 40km/h (25mph).
The accel function - Push the "RES/+" switch and hold it when the cruise control is on. The vehicle will gradually accelerate. Release the switch at the desired speed. The desired speed will be maintained.
Push the "RES/+" switch and release it quickly. The cruising speed will increase by 1.6km/h (1.0mph).

Cancel switch (CANCEL)

The cruise control system is temporarily disengaged by pushing the "CANCEL" switch.
Cruise speed canceled by this switch can be recovered by pushing the "RES/+" switch.

Figure 48 – Note: Cruise control system description and operation; cruise control system includes transmission, brake, vehicle, and throttle position sensors



Component Parts And Function Outline

Component part		Function
Vehicle speed sensor		Converts vehicle speed to pulse.
ECM		Receives signals from sensor and control switches.
Cruise control indicator		Illuminate when CRUISE main switch is ON (Built into cluster)
Cruise control switches	ON/OFF switch	Switch for automatic speed control power supply.
	Resume/Accel switch	Controls automatic speed control functions by Resume/Accel switch (Set/Coast switch)
	Set/Coast switch	
Cancel switches	Cancel switch	Sends cancel signals to ECM.
	Brake pedal switch	
	Transaxle range switch (A/T)	
ETS motor		Regulates the throttle valve to the set opening by ECM.

Figure 49- Cruise control system diagram

85. Claim 13 of the ’680 patent recites an engine output control method for a vehicle having a drive by wire engine system responsive to a desired engine acceleration signal, the method comprising the steps of: generating a driver demanded engine acceleration value corresponding to an operator input; generating a speed control system engine acceleration value

corresponding to a predetermined speed value to permit vehicle operation at a constant speed by a speed control system; arbitrating between said driver demanded engine acceleration value and said speed control system engine acceleration value to derive a first desired engine acceleration value; limiting said first desired engine acceleration value by a vehicle speed limit value, engine speed limit value, transmission speed limit value, and traction control value to generate a second desired engine acceleration value; and controlling said engine output as a function of said second desired engine acceleration value and an actual engine acceleration value.

86. On information and belief, the Accused Instrumentalities infringe claim 13 of the '680 patent. The Accused Instrumentalities practice an engine output control method for a vehicle having a drive by wire engine system (*Figures 17-20*) responsive to a desired engine acceleration signal (*Figures 12-13, 20, 50-52*), the method comprising the steps of: generating a driver demanded engine acceleration value corresponding to an operator input (*Figures 12-13, 20, 47-49*); generating a speed control system engine acceleration value corresponding to a predetermined speed value to permit vehicle operation at a constant speed by a speed control system (*Figures 41-43, 47-49*); arbitrating between said driver demanded engine acceleration value and said speed control system engine acceleration value to derive a first desired engine acceleration value (*Figures 41-49*); limiting said first desired engine acceleration value by a vehicle speed limit value, engine speed limit value, transmission speed limit value, and traction control value to generate a second desired engine acceleration value (*Figures* 41-49; and controlling said engine output as a function of said second desired engine acceleration value and an actual engine acceleration value (*Figures 17-20, 41-49*).

<u>COUNT IX – INFRINGEMENT OF U.S. PATENT NO. 6,561,166</u>

87. The allegations set forth in the foregoing paragraphs 1 through 86 are incorporated into this Ninth Claim for Relief.

88. On May 13, 2003, U.S. Patent No. 6,561,166 ("the '166 patent"), entitled "*Purge Fuel Canister Measurement Method and System*," was duly and legally issued by the United States Patent and Trademark Office. A true and correct copy of the '166 patent is attached as Exhibit 9.

89. Plaintiff is the assignee and owner of the right, title and interest in and to the '166 patent, including the right to assert all causes of action arising under said patents and the right to any remedies for infringement of them.

90. Upon information and belief, Defendants have directly infringed at least claim1 of the '166 patent by making, using, selling, importing and/or providing and causing to be used the 2011-2017 Hyundai Sonata (2.0L), 2010-2017 Hyundai Genesis Coupe (2.0L), 2013-2017 Hyundai Santa Fe (2.0L), 2011-2017 Hyundai Sonata (2.4L), 2010-2017 Hyundai Tucson (2.4L), 2010-2017 Hyundai Santa Fe (2.4L) (the "Accused Instrumentalities").

91. Upon information and belief, the Accused Instrumentalities incorporate the Theta II Engine which practices a method of controlling a direct injection spark ignited internal combustion engine.

92. In particular, claim 1 of the '166 patent recites a method of controlling a direct injection spark ignited internal combustion engine that is capable of operating in a stratified mode where fuel is injected during a compression stroke of the engine and a homogeneous mode where fuels is injected during an intake stroke of the engine, the internal combustion engine having a catalytic converter and an NOx trap, comprising: measuring a first temperature of an NOx trap that is in contact with an exhaust gas exhausted from a combustion chamber while the engine is operating in the stratified mode; enabling evaporated fuel vapors to enter the combustion chamber at a flow rate while the engine is operating in the stratified mode;

measuring a second temperature of the NOx trap while the engine is operating in the stratified mode; and adjusting the flow rate of the evaporated fuel vapors as a function of the second temperature when the second temperature is within a lower temperature threshold and an upper temperature threshold.

93. On information and belief, the Accused Instrumentalities infringe at least claim 1 of the '166 patent. The Accused Instrumentalities practice a method of controlling a direct injection spark ignited internal combustion engine (*Figures 17-20, 50*) that is capable of operating in a stratified mode (*Figure 51*) where fuel is injected during a compression stroke of the engine (*Figure 52*) and a homogeneous mode (*Figure 53*) where fuels is injected during an intake stroke of the engine, the internal combustion engine having a catalytic converter (*Figure 54*) and an NOx trap (*Figures 55-64*), comprising: measuring a first temperature of an NOx trap that is in contact with an exhaust gas exhausted from a combustion chamber while the engine is operating in the stratified mode (*Figures 56-64*); enabling evaporated fuel vapors to enter the combustion chamber at a flow rate while the engine is operating in the stratified mode (*Figure 61-63*); measuring a second temperature of the NOx trap while the engine is operating in the stratified mode (*Figures 34-36, 61-63*); and adjusting the flow rate of the evaporated fuel vapors as a function of the second temperature when the second temperature is within a lower temperature threshold and an upper temperature threshold (F*igures 34-36, 64*).

To help meet its goals of environmental leadership, Hyundai unveiled the 2.4 Theta II GDI, its first Gasoline Direct Injection engine, last November. Representing the biggest advance in fuel injection, an '80s technology that replaced the carburetor, GDI puts Hyundai at the cutting edge of engine design and management by achieving three seemingly incompatible goals: GDI lowers emissions while raising power output and improving fuel economy. Prior to GDI, a gain in one area came at the expense of the other two.

With a compression ratio of 11.3:1, the 2.4 Theta II GDI delivers 201ps/6300rpm and 25.5kg.m/4250rpm in its Korean domestic market specification. "The Theta II GDI convincingly demonstrates Hyundai's advanced powertrain engineering capabilities," said Dr. Lee Hyun-Soon, Vice-Chairman and Chief Technology Officer.

Developed with a budget of 170 billion won over a 46 month-long research period, the new 2.4 Theta II GDI engine will make its debut in the first half of 2010 starting with the recently launched Sonata, beating the mid-size sedan competition to market with this exciting new technology. GDI application will subsequently be expanded across the gasoline engine family and applied to other Hyundai and Kia models.

Figure 50 – Note: Description of Theta II GDI

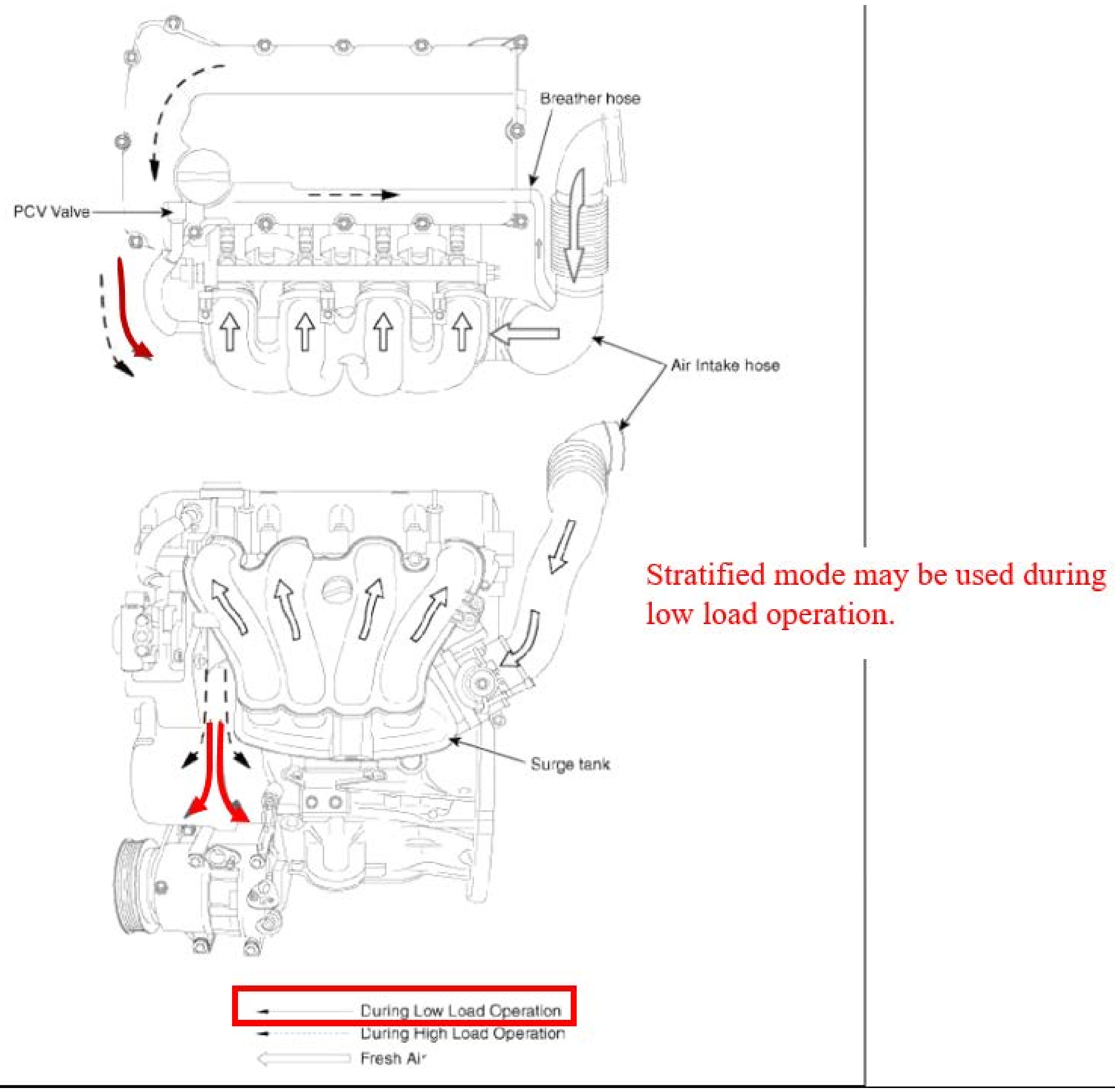


Figure 51 – Note: Stratified mode may be used during low load operation

Emission Control System > Evaporative Emission Control System > Schematic Diagrams

Schematic Diagram

Page 9 of 19

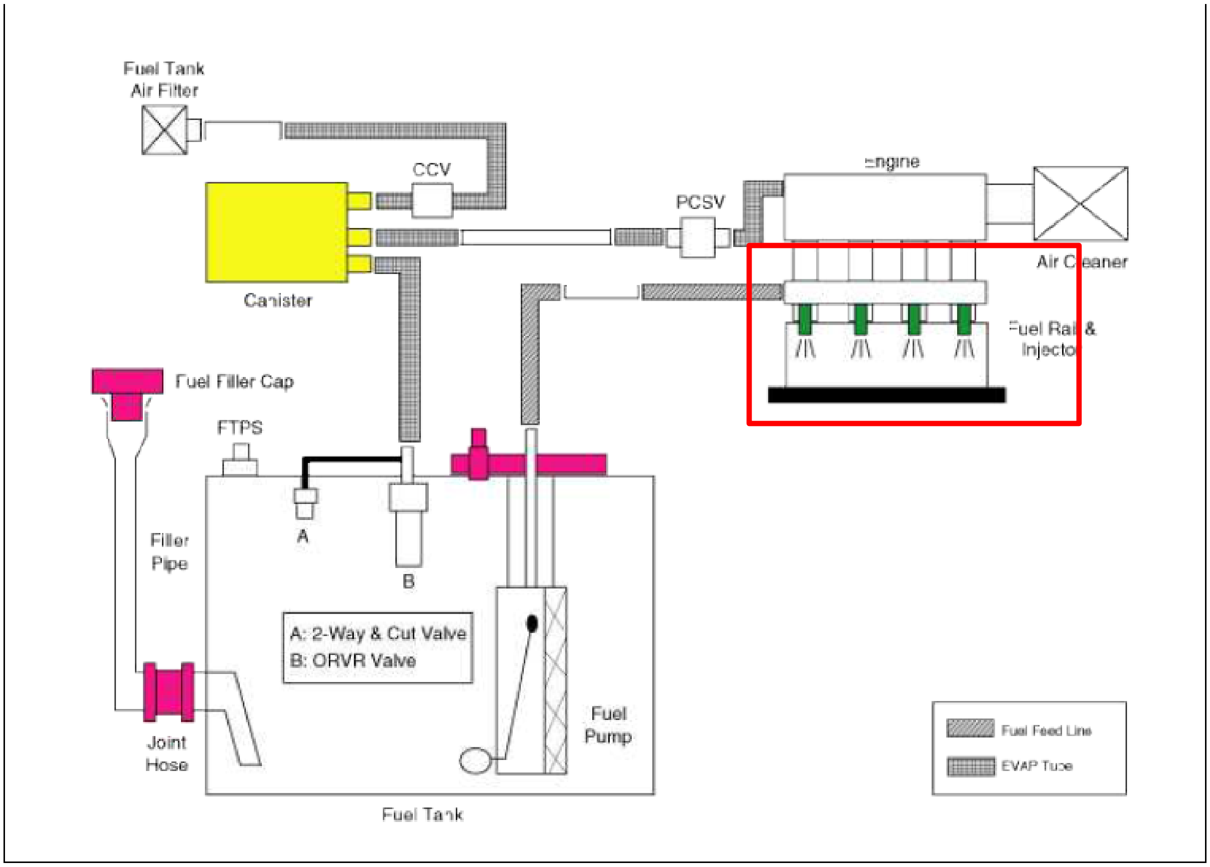
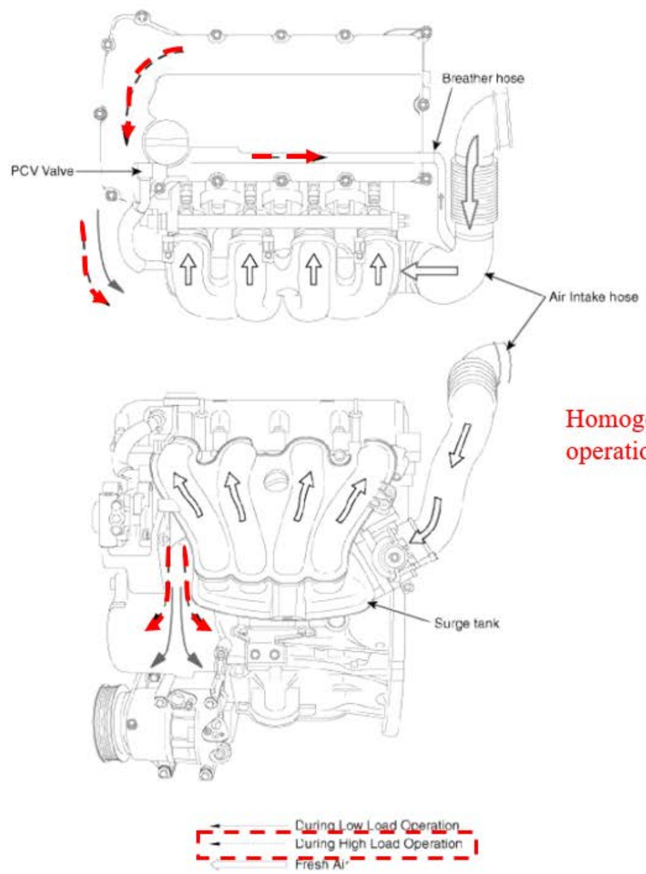


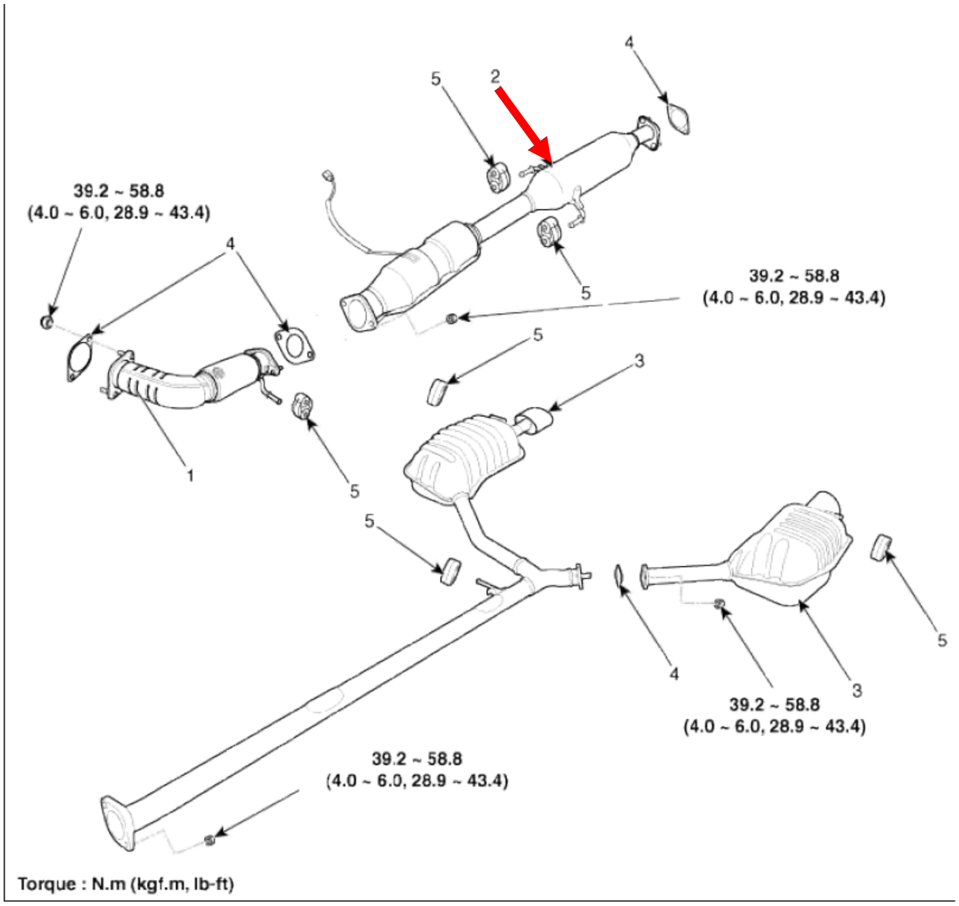
Figure 52 – Note: Theta II Direct Injection Engine Diagram



Homogenous mode may be used during high load operation.

Same here

Figure 53 – Note: Homogenous mode may be used during high load operation



1. Front muffler 2. Catalytic converter & center muffler assembly 3. Main muffler	4. Gasket 5. Hanger

Figure 54 – Catalytic Converter

SONATA(YF) > 2012 > G 2.0 T-GDI > Emission Control System

Emission Control System > General Information > Description and Operation

Description

Emissions Control System consists of three major systems.

- The Crankcase Emission Control System prevents blow-by gas from releasing into the atmosphere. This system recycles gas back into the intake manifold (Closed Crankcase Ventilation Type).
- The Evaporative Emission Control System prevents evaporative gas from releasing into the atmosphere. This system burns gas at appropriate engine operating condition after gathering it in the canister.
- The Exhaust Emission Control System converts the three pollutants [hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx)] into harmless substances by using the 3-way catalytic converter.

Figure 55 – Note: Exhaust Emission Control System converts the three pollutants hydrocarbons, carbon monoxide, and oxides of nitrogen into harmless substances via the 3-way catalytic converter

Emission Control System > Exhaust Emission Control System > Description and Operation

Description

Exhaust emissions (CO, HC, NOx) are controlled by a combination of engine modifications and the addition of special control components.

Modifications to the combustion chamber, intake manifold, camshaft and ignition system form the basic control system.

These items have been integrated into a highly effective system which controls exhaust emissions while maintaining good drivability and fuel economy.

Air/Fuel Mixture Control System [Multiport Fuel Injection (MFI) System]

The MFI system uses signals from the heated oxygen sensor to activate and control the injector installed in the manifold for each cylinder, thus precisely regulating the air/fuel mixture ratio and reducing emissions.

This in turn allows the engine to produce exhaust gas of the proper composition to permit the use of a three way catalyst. The three way catalyst is designed to convert the three pollutants [hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx)] into harmless substances. There are two operating modes in the MFI system.

1. Open Loop air/fuel ratio is controlled by information pre-programmed into the ECM.
2. Closed Loop air/fuel ratio is constantly adjusted by the ECM based on information supplied by the oxygen sensor.

Figure 56 – Note: Description of Emission Control System wherein CO, HC, and NOx are controlled

Emission Control System > Exhaust Emission Control System > Catalytic Converter > Description and Operation

Description

The catalytic converter of the gasoline engine is a three way catalyst. It oxidizes carbon monoxide and hydrocarbons (HC), and separates oxygen from the oxides of nitrogen (NOx).

Page 17 of 19

There are two types of three-way catalyst; Palette type and Monolith type.

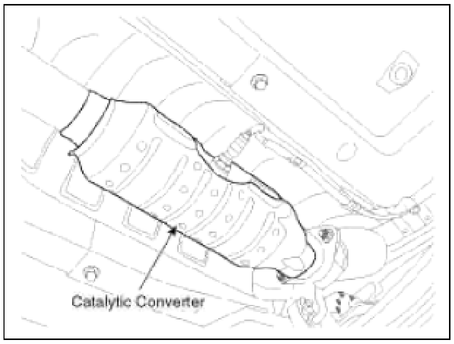


Figure 57 – Note: Description of catalytic converter and the oxidation of NOx and HC

Emission Control System > General Information > Schematic Diagrams

Schematic Diagram

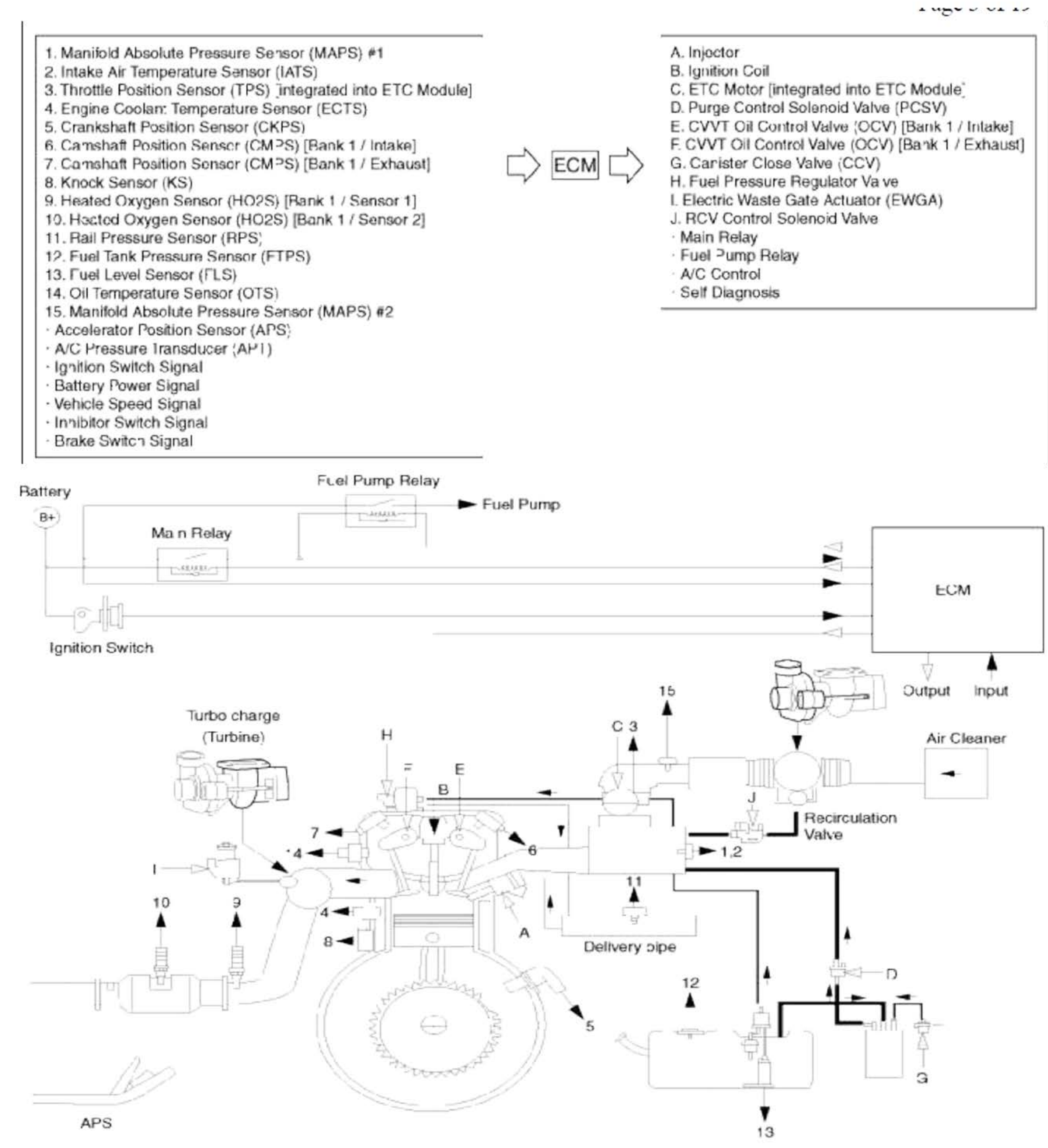
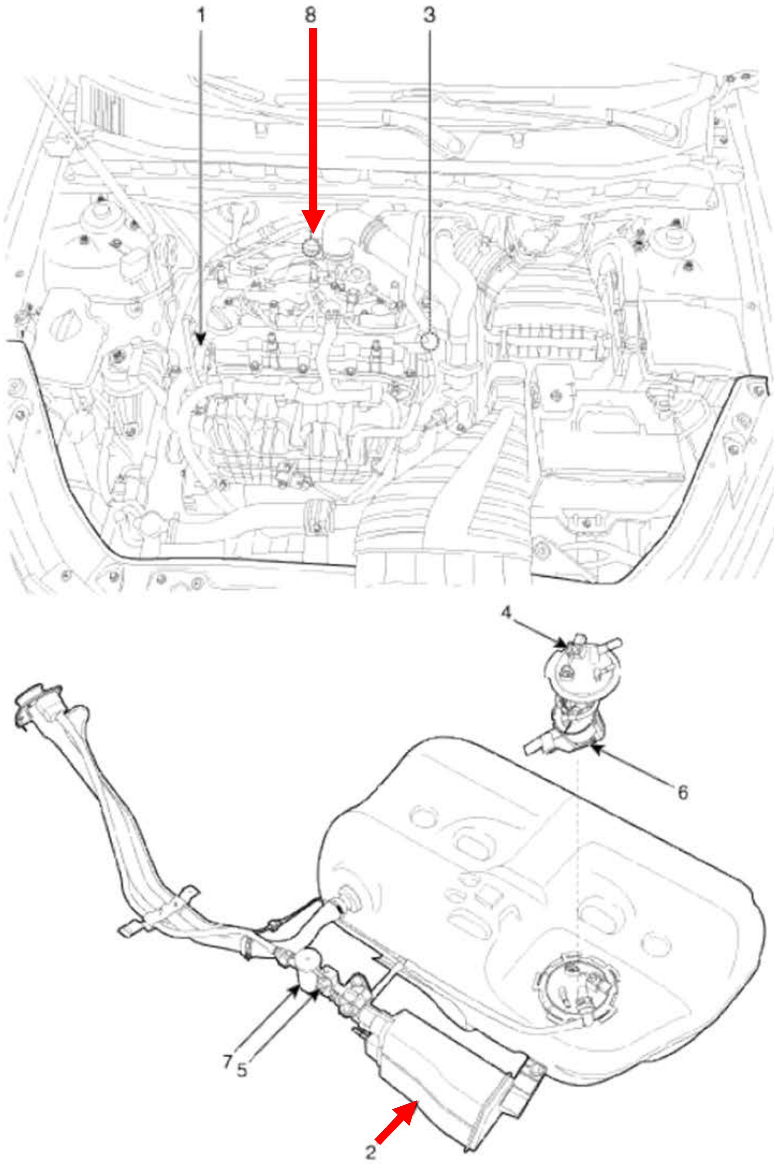


Figure 58- Diagram of Emission Control System Note: includes combustion chamber for evaporated fuel vapors



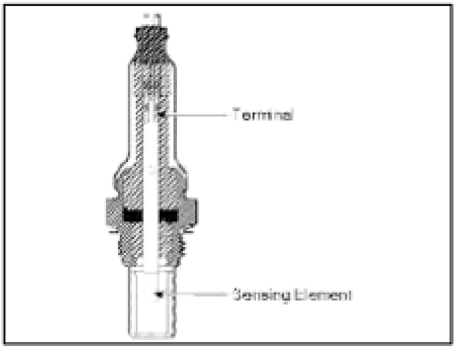
1. PCV Valve 2. Canister 3. Purge Control Solenoid Valve (PCSV) 4. Fuel Tank Pressure Sensor (FTPS)	5. Canister Close Valve (CCV) 6. Fuel Level Sensor (FLS) 7. Fuel Tank Air Filter 8. Catalytic Converter

Figure 59 – Canister and Catalytic Converter

Fuel System > Engine Control System > Heated Oxygen Sensor (HO2S) > Description and Operation

Description

Heated Oxygen Sensor (HO2S) consists of zirconium and alumina and is installed both upstream and downstream of the Manifold Catalytic Converter. The sensor output voltage varies in accordance with the air/fuel ratio.
The sensor must be hot in order to operate normally. To keep it hot, the sensor has a heater which is controlled by the ECM via a duty cycle signal. When the exhaust gas temperature is lower than the specified value, the heater warms the sensor tip.



Fuel System > Engine Control System > Heated Oxygen Sensor (HO2S) > Specifications

Specification

HO2S [Bank 1/Sensor 1]

Item	Specification
Heater Resistance (Ω)	2.5 ~ 4.0 [20°C(68°F)]

HO2S [Bank 1/Sensor 2]

A/F Ratio (λ)	Output Voltage(V)
RICH	Approx. 0.9
LEAN	Approx. 0.04

Item	Specification
Heater Resistance (Ω)	3.3 ~ 4.1Ω[21°C(69.8°F)]

Figure 60 – Heated Oxygen Sensor

Emission Control System > Exhaust Emission Control System > Description and Operation

Description

Exhaust emissions (CO, HC, NOx) are controlled by a combination of engine modifications and the addition of special control components.

Modifications to the combustion chamber, intake manifold, camshaft and ignition system form the basic control system.

These items have been integrated into a highly effective system which controls exhaust emissions while maintaining good drivability and fuel economy.

Air/Fuel Mixture Control System [Multiport Fuel Injection (MFI) System]

The MFI system uses signals from the heated oxygen sensor to activate and control the injector installed in the manifold for each cylinder, thus precisely regulating the air/fuel mixture ratio and reducing emissions.

This in turn allows the engine to produce exhaust gas of the proper composition to permit the use of a three way catalyst. The three way catalyst is designed to convert the three pollutants [hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx)] into harmless substances. There are two operating modes in the MFI system.

1. Open Loop air/fuel ratio is controlled by information pre-programmed into the ECM.
2. Closed Loop air/fuel ratio is constantly adjusted by the ECM based on information supplied by the oxygen sensor.

The NOx trap is in contact with an exhaust gas exhausted from a combustion chamber.

Hyundai Motor America [US] | https://www.hyundaitechinfo.com/viewer/content_pop.aspx?content_no=DTC|ENG|2684|2011||en|98||&sitinfolist=13^1350^1350C

SONATA(YFA) > 2011 > Engine > Engine Control > DTC Detecting Condition

DTC Detecting Condition Feedback

Item	Detecting Condition	Possible Cause
DTC Strategy	• Check catalyst oxygen storage capacity by evaluating downstream O2 sensor fluctuations	1. Exhaust gas leaks 2. Faulty rear HO2S 3. Faulty three way catalyst converter
Enable Conditions	• Coolant temperature >73°C(163°F) • 550°C(1022°F)< Modeled catalyst temp<850°C(1562°F) • Vehicle speed >3mph • 1300< Engine speed <3200 • 0.3g/rev.< MAF < 0.8g/rev. • Ambient pressure > 70kPa(700hPa) • Canister load < 0.5 • Lambda control active & Stable driving condition • Downstream O2 sensor operative readiness • No opening / closing of Canister Purge Valve • No relevant failure • 11V < Battery voltage < 16V	
Threshold Value	• Average malfunction index > 1	
Diagnostic Time	• 50 Lambda Controller Cycles	
MIL On Condition	• 2 Drive Cycles	

The DTC shown above enable strategy reveals the modeling of catalyst temperature; thereby, inferring that there is a first temperature of a NOx trap.

Driving Condition	Exhaust Valve		Intake Valve	
	Valve Timing	Effect	Valve Timing	Effect
(1) Low Speed /Low Load	Completely Advance	* Valve Under-lap * Improvement of combustion stability	Completely Retard	* Valve Under-lap * Improvement of combustion stability
(2) Part Load	Retard	* Increase of expansion work * Reduction of pumping loss * Reduction of HC	Retard	* Reduction of pumping loss
(3) Low Speed /High Load	Retard	* Increase of expansion work	Advance	* Prevention of intake back flow (Improvement of volumetric efficiency)
(4) High Speed /High Load	Advance	* Reduction of pumping loss	Retard	* Improvement of volumetric efficiency

Engine operation in stratified mode

Engine operation in stratified mode.

Figure 61

SONATA(YFA) > 2012 > G 2.4 GDI > Engine > Engine Control > P0444 Evaporative Emission System-Purge Control Valve Circuit Open

General Description Feedback

The evaporative emission control system prevents hydrocarbon (HC) vapors from the fuel tank from escaping into the atmosphere where they could form photochemical smog. Gasoline vapors are collected in the charcoal canister. The PCM controls the Purge Control Solenoid Valve (PCSV) to purge any collected vapors from the canister back to the engine for combustion. This valve is actuated by the purge control signal from the PCM and controls fuel vapor flow from the canister to the intake manifold.

SONATA(YFA) > 2012 > G 2.4 GDI > Engine > Engine Control > P0444 Evaporative Emission System-Purge Control Valve Circuit Open

DTC Description Feedback

PCM sets DTC P0444 if the PCM detects that the PCSV control circuit is open.

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Electrical Check	1. Open in PCSV harness 2. Poor connection or damaged harness 3. Faulty PCSV
Enable Conditions	• 10V < Battery voltage < 16V • 2% < Canister purge duty < 98%	
Threshold Value	• Open in control circuit	
Diagnostic Time	• 3 Seconds	
MIL On Condition	• 2 Drive Cycles	

As shown above, the Powertrain Control Module (PCM)/Engine Control Module (ECM) controls engine system. The PCM enables evaporated fuel vapors to enter the combustion chamber at a flow rate implied by the canister purge duty cycle. This occurs during all modes of engine operation.

Figure 62

Hyundai Motor America [US] | https://www.hyundaitechinfo.com/viewer/content_pop.aspx?content_no=DTC|ENG|2684|2011||en|98||&sitinfolist=13^1350^13500

SONATA(YFA) > 2011 > Engine > Engine Control > DTC Detecting Condition

DTC Detecting Condition Feedback

Item	Detecting Condition	Possible Cause
DTC Strategy	• Check catalyst oxygen storage capacity by evaluating downstream O2 sensor fluctuations	1. Exhaust gas leaks 2. Faulty rear HO2S 3. Faulty three way catalyst converter
Enable Conditions	• Coolant temperature >73°C(163°F) • 550°C(1022°F)< Modeled catalyst temp<850°C(1562°F) • Vehicle speed >3mph • 1300< Engine speed <3200 • 0.3g/rev.< MAF < 0.8g/rev. • Ambient pressure > 70kPa(700hPa) • Canister load < 0.5 • Lambda control active & Stable driving condition • Downstream O2 sensor operative readiness • No opening / closing of Canister Purge Valve • No relevant failure • 11V < Battery voltage < 16V	
Threshold Value	• Average malfunction index > 1	
Diagnostic Time	• 50 Lambda Controller Cycles	
MIL On Condition	• 2 Drive Cycles	

The DTC enable conditions strategy shown above reveals the modeling of catalyst temperature; thereby, inferring that there is a second temperature of an NOx trap.

Driving Condition	Exhaust Valve		Intake Valve	
	Valve Timing	Effect	Valve Timing	Effect
(1) Low Speed /Low Load	Completely Advance	* Valve Under-lap * Improvement of combustion stability	Completely Retard	* Valve Under-lap * Improvement of combustion stability
(2) Part Load	Retard	* Increase of expansion work * Reduction of pumping loss * Reduction of HC	Retard	* Reduction of pumping loss
(3) Low Speed /High Load	Retard	* Increase of expansion work	Advance	* Prevention of intake back flow (Improvement of volumetric efficiency)
(4) High Speed /High Load	Advance	* Reduction of pumping loss	Retard	* Improvement of volumetric efficiency

Engine operation in stratified mode

Engine operation in stratified mode. Measuring a second temperature of the NOx trap while engine is operating in stratified mode.

Figure 63

SONATA(YFA) > 2012 > G 2.4 GDI > Engine > Engine Control > P0444 Evaporative Emission System-Purge Control Valve Circuit Open

DTC Description Feedback

PCM sets DTC P0444 if the PCM detects that the PCSV control circuit is open.

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Electrical Check	1. Open in PCSV harness 2. Poor connection or damaged harness 3. Faulty PCSV
Enable Conditions	• 10V < Battery voltage < 16V • 2% < Canister purge duty < 98%	
Threshold Value	• Open in control circuit	
Diagnostic Time	• 3 Seconds	
MIL On Condition	• 2 Drive Cycles	

The flow rate is adjusted by the PCM/ECM through the duty cycle of the purge canister solenoid valve (PCSV).

SONATA(YFA) > 2012 > G 2.4 GDI > Engine > Engine Control > P0444 Evaporative Emission System-Purge Control Valve Circuit Open

General Description Feedback

The evaporative emission control system prevents hydrocarbon (HC) vapors from the fuel tank from escaping into the atmosphere where they could form photochemical smog. Gasoline vapors are collected in the charcoal canister. The PCM controls the Purge Control Solenoid Valve (PCSV) to purge any collected vapors from the canister back to the engine for combustion. This valve is actuated by the purge control signal from the PCM and controls fuel vapor flow from the canister to the intake manifold.

SONATA(YFA) > 2011 > G 2.4 GDI > Emission Control System

Description Feedback

The Evaporative Emission Control System prevents fuel vapor stored in fuel tank from vaporizing into the atmosphere. When the fuel evaporates in the fuel tank, the vapor passes through vent hoses or tubes to a canister filled with charcoal.

The canister temporarily holds the vapor in the charcoal. The ECM will control the system in order to draw the gathered vapor into the combustion chambers during certain operating conditions. Engine manifold vacuum is used to draw the vapor into intake manifold.

Evaporated fuel vapors are stored in the charcoal canister, and then go through the solenoid valve.

Hyundai Motor America [US] | https://www.hyundaitechinfo.com/viewer/content_pop.aspx?content_no=DTC|ENG|2684|2011||en|98||&sitinfolist=13^1350^1350C

SONATA(YFA) > 2011 > Engine > Engine Control > DTC Detecting Condition

DTC Detecting Condition Feedback

Item	Detecting Condition	Possible Cause
DTC Strategy	• Check catalyst oxygen storage capacity by evaluating downstream O2 sensor fluctuations	1. Exhaust gas leaks 2. Faulty rear HO2S 3. Faulty three way catalyst converter
Enable Conditions	• Coolant temperature >73°C(163°F) • 550°C(1022°F)< Modeled catalyst temp<850°C(1562°F) • Vehicle speed >3mph • 1300< Engine speed <3200 • 0.3g/rev.< MAF < 0.8g/rev. • Ambient pressure > 70kPa(700hPa) • Canister load < 0.5 • Lambda control active & Stable driving condition • Downstream O2 sensor operative readiness • No opening / closing of Canister Purge Valve • No relevant failure • 11V < Battery voltage < 16V	
Threshold Value	• Average malfunction index > 1	
Diagnostic Time	• 50 Lambda Controller Cycles	
MIL On Condition	• 2 Drive Cycles	

Because the catalyst temperature is modeled, as shown in the DTC above, it can be inferred that the second modeled temperature and range can be compared with a lower temperature threshold and an upper temperature threshold.

Figure 64

COUNT X – INFRINGEMENT OF U.S. PATENT NO. 6,557,540

94. The allegations set forth in the foregoing paragraphs 1 through 93 are incorporated into this Tenth Claim for Relief.

95. On May 6, 2003, U.S. Patent No. 6,557,540 ("the '540 patent"), entitled "*Method of Calculating a Valve Timing Command for an Engine*," was duly and legally issued by the United States Patent and Trademark Office. A true and correct copy of the '540 patent is attached as Exhibit 10.

96. Plaintiff is the assignee and owner of the right, title and interest in and to the '540 patent, including the right to assert all causes of action arising under said patents and the right to any remedies for infringement of them.

97. Upon information and belief, Defendants have directly infringed at least claim1 of the '540 patent by making, using, selling, importing and/or providing and causing to be used the 2011-2017 Hyundai Sonata (2.0L), 2010-2017 Hyundai Genesis Coupe (2.0L), 2013-2017 Hyundai Santa Fe (2.0L), 2011-2017 Hyundai Sonata (2.4L), 2010-2017 Hyundai Tucson (2.4L), 2010-2017 Hyundai Santa Fe (2.4L) (the "Accused Instrumentalities").

98. Upon information and belief, the Accused Instrumentalities incorporate the Theta II Engine which practices a method for calculating a valve timing command for an engine of a vehicle.

99. In particular, claim 1 of the '540 patent recites a method for calculating a valve timing command for an engine of a vehicle, comprising: obtaining an engine performance command; receiving an environmental conditions signal; determining a valve feedforward term based on the engine performance command and the environmental conditions signal; receiving an engine performance feedback; calculating a valve feedback term based on the engine

performance command and the engine performance feedback; and calculating a valve timing command based on the valve feedforward term and the valve feedback term.

100. On information and belief, the Accused Instrumentalities infringe at least claim 1 of the ’540 patent. The Accused Instrumentalities practice a method for calculating a valve timing command for an engine of a vehicle (*Figures 17-20, 65*) , comprising: obtaining an engine performance command (*Figure 44*); receiving an environmental conditions signal (*Figures 41, 66-68*); determining a valve feedforward term based on the engine performance command and the environmental conditions signal (*Figures 41, 44, 66-68*); receiving an engine performance feedback (*Figures 19-21, 26, 41, 44, 66-68*); calculating a valve feedback term based on the engine performance command and the engine performance feedback (*Figures 19-21, 26, 41, 44, 66-68*); and calculating a valve timing command based on the valve feedforward term and the valve feedback term (*Figures 19-21, 26, 41, 44, 66-68*).

SONATA(YFA) > 2011 > Engine > Engine Control > Description

Description Feedback

Continuous Variable Valve Timing (CVVT) system advances or retards the valve timing of the intake and exhaust valve in accordance with the ECM control signal which is calculated by the engine speed and load.

By controlling CVVT, the valve over-lap or under-lap occurs, which makes better fuel economy and reduces exhaust gases (NOx, HC) and improves engine performance through reduction of pumping loss, internal EGR effect, improvement of combustion stability, improvement of volumetric efficiency, and increase of expansion work.

This system consist of

– the CVVT Oil Control Valve (OCV) which supplies the engine oil to the cam phaser or runs out the engine oil from the cam phaser in accordance with the ECM PWM (Pulse With Modulation) control signal,

– the CVVT Oil Temperature Sensor (OTS) which measures the engine oil temperature,

– and the Cam Phaser which varies the cam phase by using the hydraulic force of the engine oil.

The engine oil getting out of the CVVT oil control valve varies the cam phase in the direction (Intake Advance/Exhaust Retard) or opposite direction (Intake Retard/Exhaust Advance) of the engine rotation by rotating the rotor connected with the camshaft inside the cam phaser.

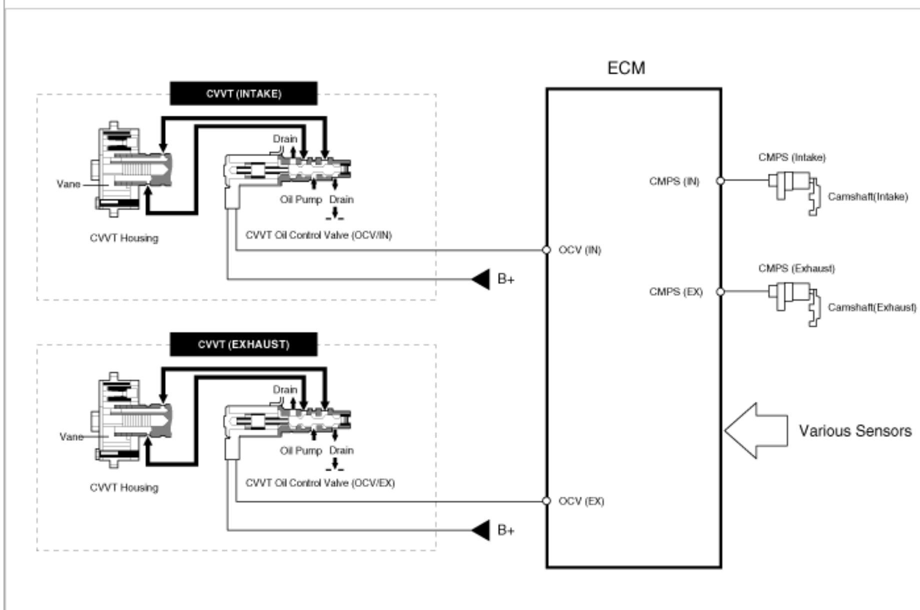


Figure 65 – Note: Explanation of Theta II valve timing, accomplished via the CAN using the ECM control signal calculated from engine load and speed.

SONATA(YFA) > 2012 > Engine > Engine Control > Description

Description Feedback

Intake Air Temperature Sensor (IATS) is included inside Manifold Absolute Pressure Sensor and detects the intake air temperature.

To calculate precise air quantity, correction of the air temperature is needed because air density varies according to the temperature. So the ECM uses not only MAPS signal but also IATS signal. This sensor has a Negative Temperature Coefficient (NTC) Thermister and it"s resistance changes in reverse proportion to the temperature.

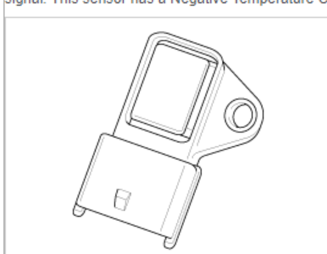


Figure 66 – Note: Description of Intake Air Temperature Sensor (IATS) which is included inside the Manifold Absolute Pressure Sensor and detects the intake air temperature. Air temperature is used to calculate precise air quantity. Both MAPS and IATS signals are sent to the ECM.

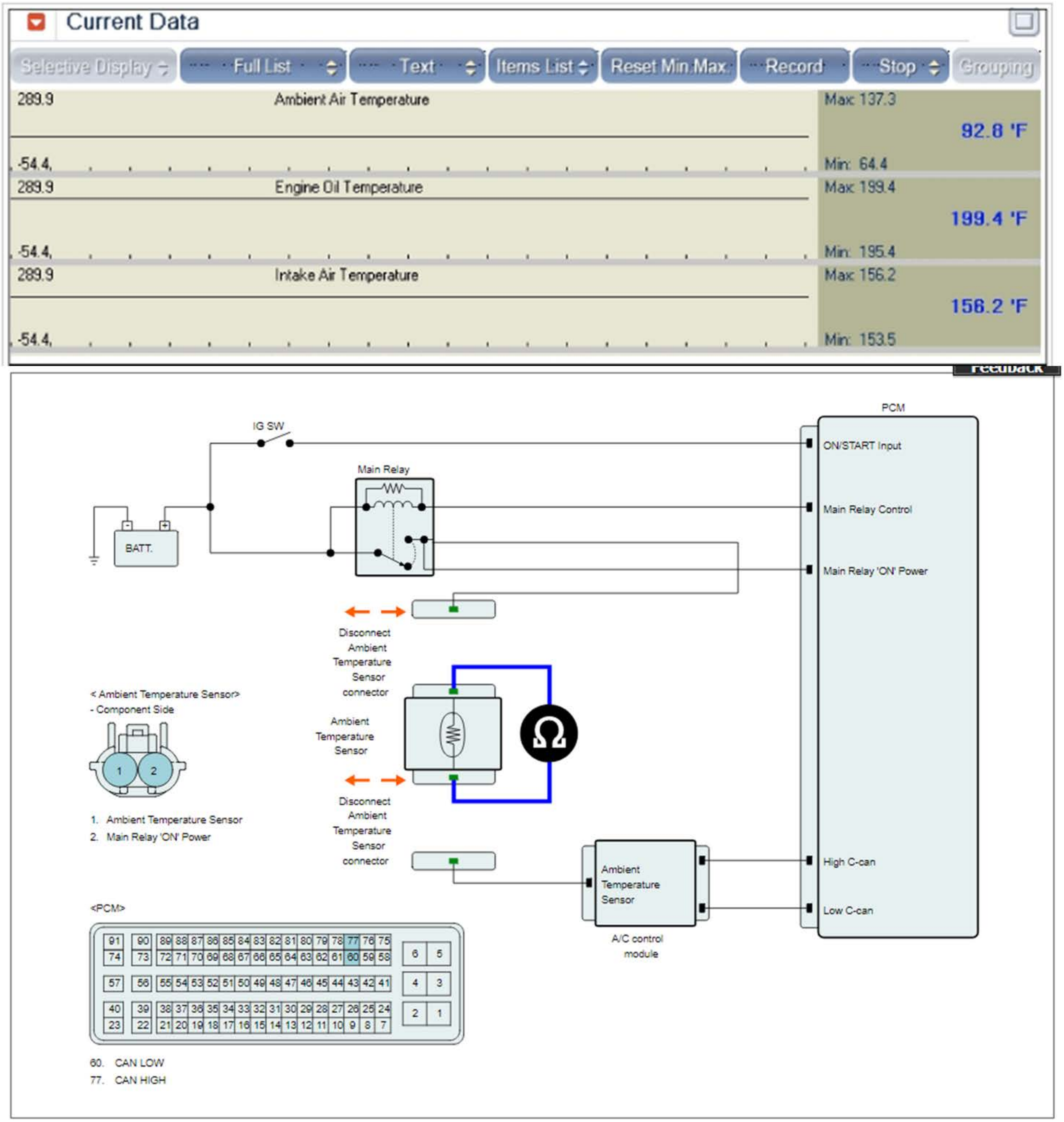
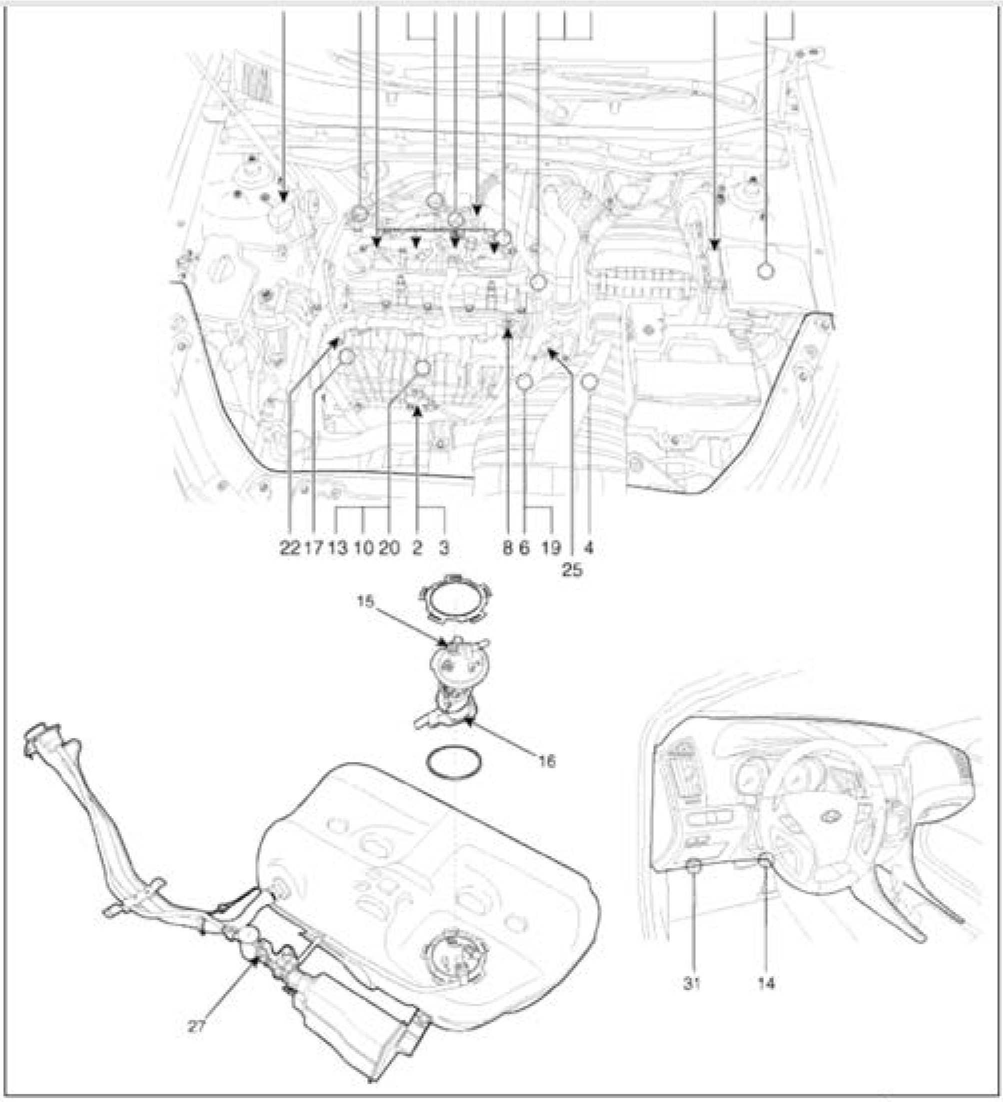


Figure 67 – Note: Ambient air temperature, engine oil temperature, intake air temperature data received from sensors and processed through CAN



1. Engine Control Module (ECM)	17. CVVT Oil Temperature Sensor (OTS)
2. Manifold Absolute Pressure Sensor (MAPS) #1	18. A/C Pressure Transducer (APT)
3. Intake Air Temperature Sensor (IATS)	19. ETC Motor [integrated into ETC Module]
4. Manifold Absolute Pressure Sensor (MAPS) #2	20. Injector
5. Engine Coolant Temperature Sensor (ECTS)	21. Purge Control Solenoid Valve (PCSV)
6. Throttle Position Sensor (TPS) [integrated into ETC Module]	22. CVVT Oil Control Valve (OCV) [Bank 1 / Intake]
7. Crankshaft Position Sensor (CKPS)	23. CVVT Oil Control Valve (OCV) [Bank 1 / Exhaust]
8. Camshaft Position Sensor (CMPS) [Bank 1 / Intake]	24. Electric Waste Gate Actuator (EWGA)
9. Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]	25. RCV Control Solenoid Valve
10. Knock Sensor (KS)	26. Fuel Pressure Regulator Valve
11. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 1]	27. Canister Close Valve (CCV)
12. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2]	28. Ignition Coil
13. Rail Pressure Sensor (RPS)	29. Main Relay
14. Accelerator Position Sensor (APS)	30. Fuel Pump Relay
15. Fuel Tank Pressure Sensor (FTPS)	31. Data Link Connector (DLC) [16-Pin]
16. Fuel Level Sensor (FLS)	32. Multi-Purpose Check Connector [20-Pin]

Figure 68 - Schematic diagram including IATS

COUNT XI – INFRINGEMENT OF U.S. PATENT NO. 6,988,031

101. The allegations set forth in the foregoing paragraphs 1 through 100 are incorporated into this Eleventh Claim for Relief.

102. On January 17, 2006 U.S. Patent No. 6,988,031 ("the '031 patent"), entitled "*System and Method for Determining Engine Stop Position*," was duly and legally issued by the United States Patent and Trademark Office. A true and correct copy of the '031 patent is attached as Exhibit 11.

103. Plaintiff is the assignee and owner of the right, title and interest in and to the '031 patent, including the right to assert all causes of action arising under said patents and the right to any remedies for infringement of them.

104. Upon information and belief, Defendants have directly infringed at least claim 1 of the '031 patent by making, using, selling, importing and/or providing and causing to be used the 2011-2017 Hyundai Sonata (2.0L), 2010-2017 Hyundai Genesis Coupe (2.0L), 2013-2017 Hyundai Santa Fe (2.0L), 2011-2017 Hyundai Sonata (2.4L), 2010-2017 Hyundai Tucson (2.4L), 2010-2017 Hyundai Santa Fe (2.4L) (the "Accused Instrumentalities").

105. Upon information and belief, the Accused Instrumentalities incorporate the Theta II Engine which comprises a system for determining a stop position of an engine.

106. In particular, claim 1 of the '031 patent recites a system for determining a stop position of an engine, the system comprising: a sensor configured to generate a signal corresponding to the angle of the engine; a controller coupled to the sensor and configured to receive the signal; and an air flow control device coupled to the engine to control air intake, the controller being configured to control the air flow control device to lower air pressure in the engine based on an engine shutdown signal.

107. On information and belief, the Accused Instrumentalities infringe claim 1 of the '031 patent. The Accused Instrumentalities comprise a system for determining a stop position of an engine (*Figures 17-20, 69-71*), the system comprising: a sensor configured to generate a signal corresponding to the angle of the engine (*Figures 69-71*); a controller coupled to the sensor and configured to receive the signal (*Figures 17-20, 69-71*); and an air flow control device coupled to the engine to control air intake (*Figure 72*), and upon information and belief the controller being configured to control the air flow control device to lower air pressure in the engine based on an engine shutdown signal (*Figures 72-73*).

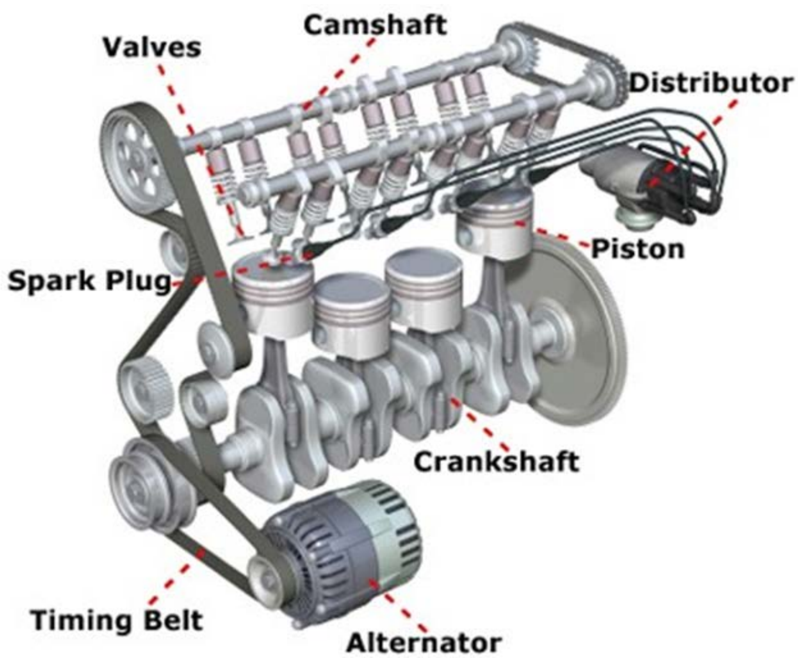


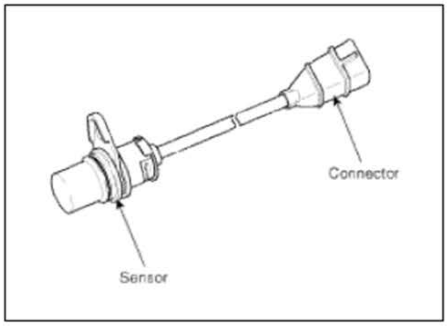
Figure 69 – Note: The camshaft and crankshaft control the piston position in an internal combustion engine. The Theta II comprises a camshaft position sensor and a crankshaft position sensor.

Fuel System > Engine Control System > Crankshaft Position Sensor (CKPS) > Description and Operation

Description

Crankshaft Position Sensor (CKPS) detects the crankshaft position and is one of the most important sensors of the engine control system. If there is no CKPS signal input, the engine may stop because of CKPS signal missing. This

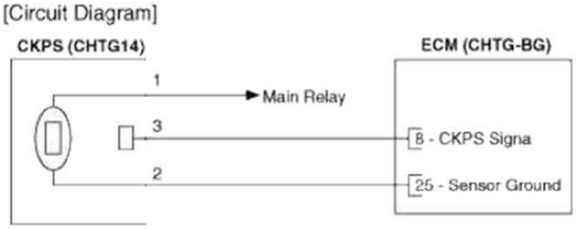
sensor is installed on the cylinder block or the transaxle housing and generates alternating current by magnetic flux field which is made by the sensor and the target wheel when engine runs.
The target wheel consists of 58 slots and 2 missing slots on 360 degrees CA (Crank Angle).



Fuel System > Engine Control System > Crankshaft Position Sensor (CKPS) > Schematic Diagrams

Circuit Diagram

[Circuit Diagram]



[Connection Information]

Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM CHTG-BG (25)	CKPS Signal
3	ECM CHTG-BG (8)	Sensor Ground

[Harness Connector]

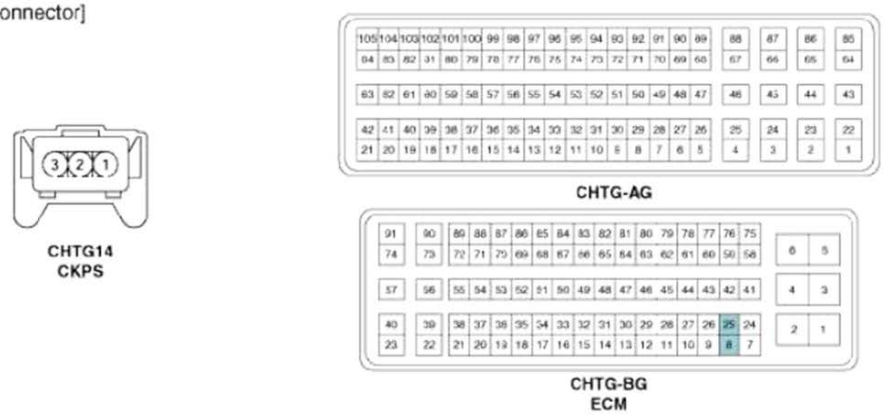


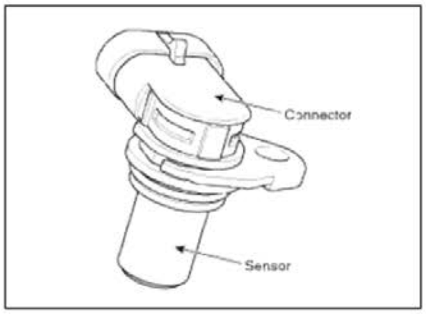
Figure 70 – Note: Operation of the Crankshaft Position Sensor (CKPS) - determines the position of the engine at all times

Fuel System > Engine Control System > Camshaft Position Sensor (CMPS) > Description and Operation

Description

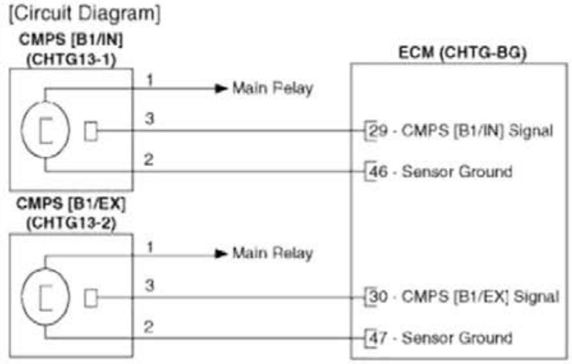
Camshaft Position Sensor (CMPS) is a hall sensor and detects the camshaft position by using a hall element.

It is related with Crankshaft Position Sensor (CKPS) and detects the piston position of each cylinder which the CKPS can't detect.
The CMPS is installed on engine head cover and uses a target wheel installed on the camshaft. The Cam Position sensor is a hall-effect type sensor. As the target wheel passes the Hall sensor, the magnetic field changes in the sensor. The sensor then switches a signal which creates a square wave.



Fuel System > Engine Control System > Camshaft Position Sensor (CMPS) > Schematic Diagrams

Circuit Diagram



[Connection Information]

CMPS [B1/IN] (CHTG13-1)

Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM CHTG-BG (46)	Sensor Ground
3	ECM CHTG-BG (29)	CMPS [B1/IN] Signal

CMPS [B1/EX] (CHTG13-2)

Terminal	Connected to	Function
1	Main Relay	Battery Power (B+)
2	ECM CHTG-BG (47)	Sensor Ground
3	ECM CHTG-BG (30)	CMPS [B1/EX] Signal

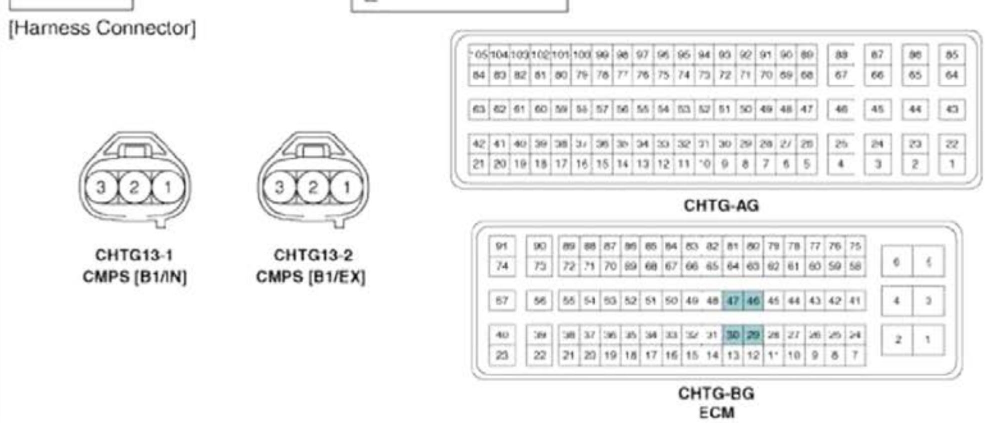


Figure 71 – Note: Camshaft Position Sensor (CMPS) description. The CMPS senses the position of the camshaft in the Theta II at all times.

HYUNDAI Sonata Mass Air Flow Sensor

Find the mass air flow sensor that fits a HYUNDAI Sonata - Enter Year 2012 ▼ Find Part

Description

The Air Flow Sensor or Mass Airflow Sensor (MAF) is one of the components of an electronic fuel injection system and is found in many of modern vehicles. Most mass air flow sensors are one piece hermetically sealed units with no moving components.

Purpose

The Mass Air Flow sensor is used to measure (actually weight) the amount of air entering the engine. This measurement is used by the engine computer or ECM to calculate proper amount of fuel injected into the cylinders in order to provide optimum combustion and low emissions.

Maintenance Tips/Suggestions

HYUNDAI Sonata Mass air flow sensor requires no regular maintenance. On mass air flow sensors with a sense wire, this wire can become contaminated with dust particles. These particles can be removed with automotive solvents that are safe for the use on mass air flow sensors. HYUNDAI Sonata mass air flow sensors are commonly misdiagnosed. Before replacing the mass air flow sensor check for air leaks in the connecting air ducts and intake manifold. These leaks can cause similar symptoms as a malfunctioning mass air flow sensor.

Failure symptoms

Problems with Mass Air Flow sensors are common. Bad or contaminated HYUNDAI Sonata Mass Air Flow sensor can possibly cause a wide range of various vehicle drivability problems such as stalling, especially when the engine is cold, misfiring, poor acceleration, etc. In addition, a problem with the Mass Air Flow sensor often causes the "check engine" or "service engine soon" light in the vehicle instrument panel to illuminate.

AKA

MAF, Air Flow Meter

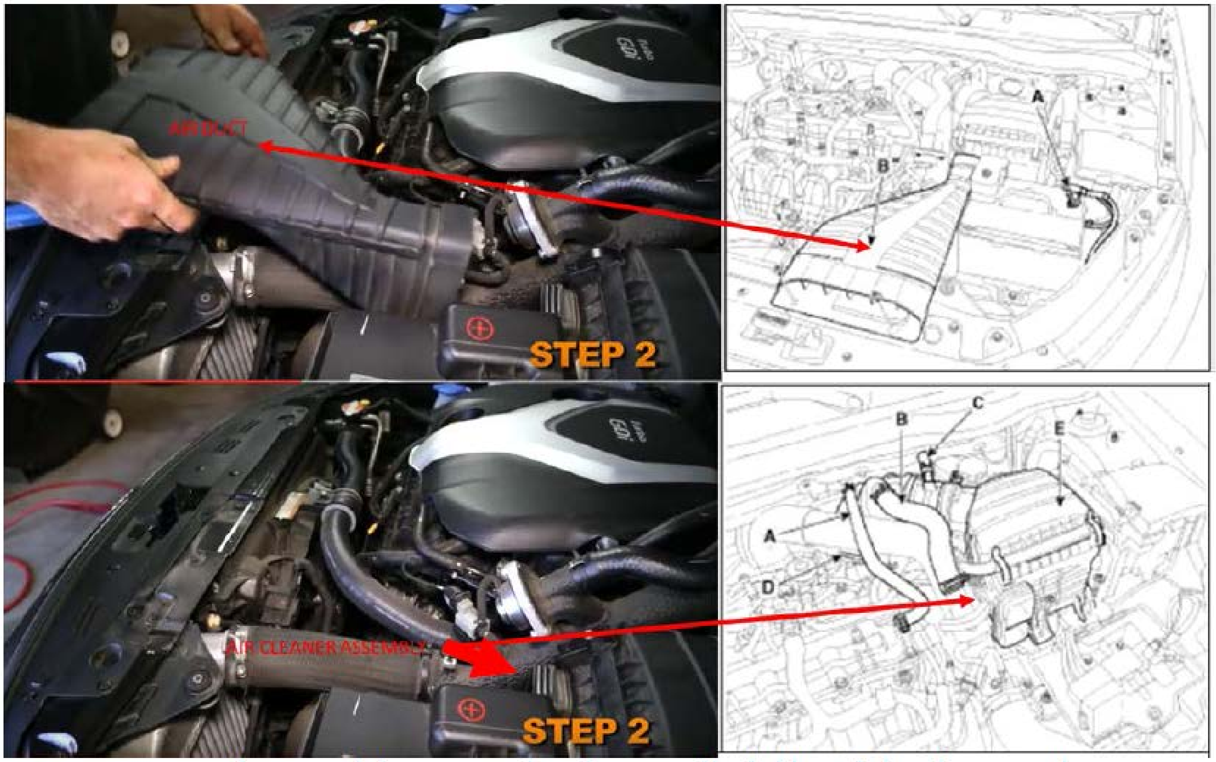
Location

The HYUNDAI Sonata Mass Air Flow sensor is usually installed in the intake air duct between the air filter and the throttle body mounted on the intake manifold. Some mass air flow sensors are mounted directly to the throttle body.

Disclaimer

Depending on the year and options your HYUNDAI Sonata has, the above information may not apply. Consult with a professional automotive technician or manufacturer for specifics on your HYUNDAI Sonata

Note: Industry standard Mass Air Flow Sensor description



Air Intake

Figure 72

8. Check the injectors, sensors, etc. (Refer to FL group)
   A. Check if the injectors operate properly.
   B. Check if the sensors, such as the mass air flow sensor (MAFS), intake air temperature sensor (IATS), boost pressure sensor (BPS), operate properly.
   C.
   If the injectors, sensors and etc. don't work properly, it may cause lack of engine power.
   If the cause of the problem is detected, replace the related parts with new ones.

Emission Control System > Exhaust Emission Control System > Description and Operation

Description

Exhaust emissions (CO, HC, NOx) are controlled by a combination of engine modifications and the addition of special control components.

Modifications to the combustion chamber, intake manifold, camshaft and ignition system form the basic control system.

These items have been integrated into a highly effective system which controls exhaust emissions while maintaining good drivability and fuel economy.

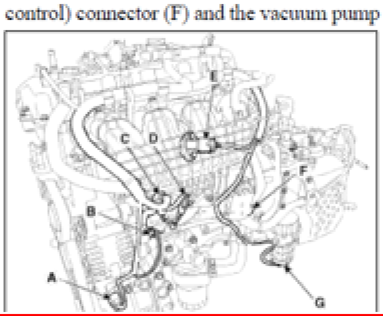
Air/Fuel Mixture Control System [Multiport Fuel Injection (MFI) System]

The MFI system uses signals from the heated oxygen sensor to activate and control the injector installed in the manifold for each cylinder, thus precisely regulating the air/fuel mixture ratio and reducing emissions.

This in turn allows the engine to produce exhaust gas of the proper composition to permit the use of a three way catalyst. The three way catalyst is designed to convert the three pollutants [hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx)] into harmless substances. There are two operating modes in the MFI system.

1. Open Loop air/fuel ratio is controlled by information pre-programmed into the ECM.
2. Closed Loop air/fuel ratio is constantly adjusted by the ECM based on information supplied by the oxygen sensor.

8. Disconnect the A/C compressor switch connector (A), the alternator connector (B), the OPS (Oil pressure switch) connector & injector extension connector (C), the knock sensor connector (D), the MAPS (Manifold absolute pressure sensor) & IATS (Intake air temperature sensor) connector (E), the ETC (Electronic throttle control) connector (F) and the vacuum pump connector (G).



When a freeze frame event is triggered by an emission related DTC, the ECM or PCM stores various vehicle information as it existed the moment the fault ocurred. The DTC number along with the engine data can be useful in aiding a technician in locating the cause of the fault. Once the data from the 1st driving cycle DTC ocurrence is stored in the freeze frame memory, it will remain there even when the fault occurs again (2nd driving cycle) and the MIL is illuminated.

- Freeze Frame List

1) Calculated Load Value
2) Engine RPM
3) Fuel Trim
4) Fuel Pressure (if available)
5) Vehicle Speed (if available)
6) Coolant Temperature
7) Intake Manifold Pressure (if available)
8) Closed-or Open-loop operation
9) Fault code

Figure 73- Note: The Mass Air Flow Sensor (MAFS) works with the emission system to determine the amount of air entering the engine. This data from the MAFS is used by the ECM to make determinations regarding engine conditions, including engine shut down.

COUNT XII – INFRINGEMENT OF U.S. PATENT NO. 6,510,839

108. The allegations set forth in the foregoing paragraphs 1 through 107 are incorporated into this Twelfth Claim for Relief.

109. On January 28, 2003 U.S. Patent No. 6,510,839 ("the '839 patent"), entitled "*Electronic Throttle Spring Torque Adaptation System*," was duly and legally issued by the United States Patent and Trademark Office. A true and correct copy of the '839 patent is attached as Exhibit 12.

110. Plaintiff is the assignee and owner of the right, title and interest in and to the '839 patent, including the right to assert all causes of action arising under said patents and the right to any remedies for infringement of them.

111. Upon information and belief, Defendants have directly infringed at least claims 1, 7, and 12 of the '839 patent by making, using, selling, importing and/or providing and causing to be used the 2011-2017 Hyundai Sonata (2.0L), 2010-2017 Hyundai Genesis Coupe (2.0L), 2013-2017 Hyundai Santa Fe (2.0L), 2011-2017 Hyundai Sonata (2.4L), 2010-2017 Hyundai Tucson (2.4L), 2010-2017 Hyundai Santa Fe (2.4L) (the "Accused Instrumentalities").

112. Upon information and belief, the Accused Instrumentalities incorporate the Theta II Engine which practices a method for controlling a positioning device of an internal combustion engine.

113. In particular, claim 1 of the '839 patent recites a method for controlling a positioning device of an internal combustion engine, the positioning device having a spring bias torque, the method comprising the steps of: providing an electric motor for actuating the positioning device against the spring bias torque; actuating the positioning device using said

electric motor; learning a motor effort required to oppose the spring bias torque; summing said motor effort with a spring opposition term into a calculated control action; and controlling said electric motor based upon said calculated control action.

114. On information and belief, the Accused Instrumentalities infringe at least claim 1 of the ’839 patent. The Accused Instrumentalities practice a method for controlling a positioning device of an internal combustion engine (*Figures 17-20*, *69-71*) the positioning device having a spring bias torque (*Figures 2-5, 7-9, 12-20, 24-25, 74-75*) the method comprising the steps of: providing an electric motor for actuating the positioning device against the spring bias torque (*Figures 2-5, 7-9, 12-20, 24-25*); actuating the positioning device using said electric motor (*Figures 2-5, 7-9, 12-20, 24-25, 74-75*); learning a motor effort required to oppose the spring bias torque; summing said motor effort with a spring opposition term into a calculated control action (*Figure 77*); and controlling said electric motor based upon said calculated control action (*Figure 77*).

SONATA(YFA) > 2012 > Engine > Engine Control > General Description

General Description Feedback

The Electronic Throttle Control(ETC) system"s components are the throttle body, Throttle Position Sensor(TPS)1&2 and Accelerator Position Sensor(APS) 1&2. The throttle body contains the actuator, the throttle plate and the throttle position sensor (potentiometer), which are integrated in one housing. The actuator consists of a DC motor with a two-stage gear. The opening angle of the throttle valve is detected by the throttle position sensor which is mounted on the throttle body. And it provides feedback to the PCM to control the throttle motor in order to control the throttle valve opening angle properly in response to the driving condition.

Figure 74- Note: Electronic Throttle Control (ETC) system description including Throttle Position Sensor (TPS) and Accelerator Position Sensor (APS) with the throttle body containing an actuator, throttle plate, and throttle position sensor and motorized actuator

Hyundai Motor America [US] | https://www.hyundaitechinfo.com/viewer/content_pop.aspx?content_no=DTC|ENG|2684|2012||en|98||&sitinfolist=14^1420^14200

SONATA(YFA) > 2012 > Engine > Engine Control > Component Location

Component Location Feedback

1. ETC MOTOR & THROTTLE POSITION SENSOR

Figure 75- Electronic Throttle Control Motor and Throttle Position Sensor on Theta II Engine

Specification :1.2~1.8Ω at 20°C(68°F)

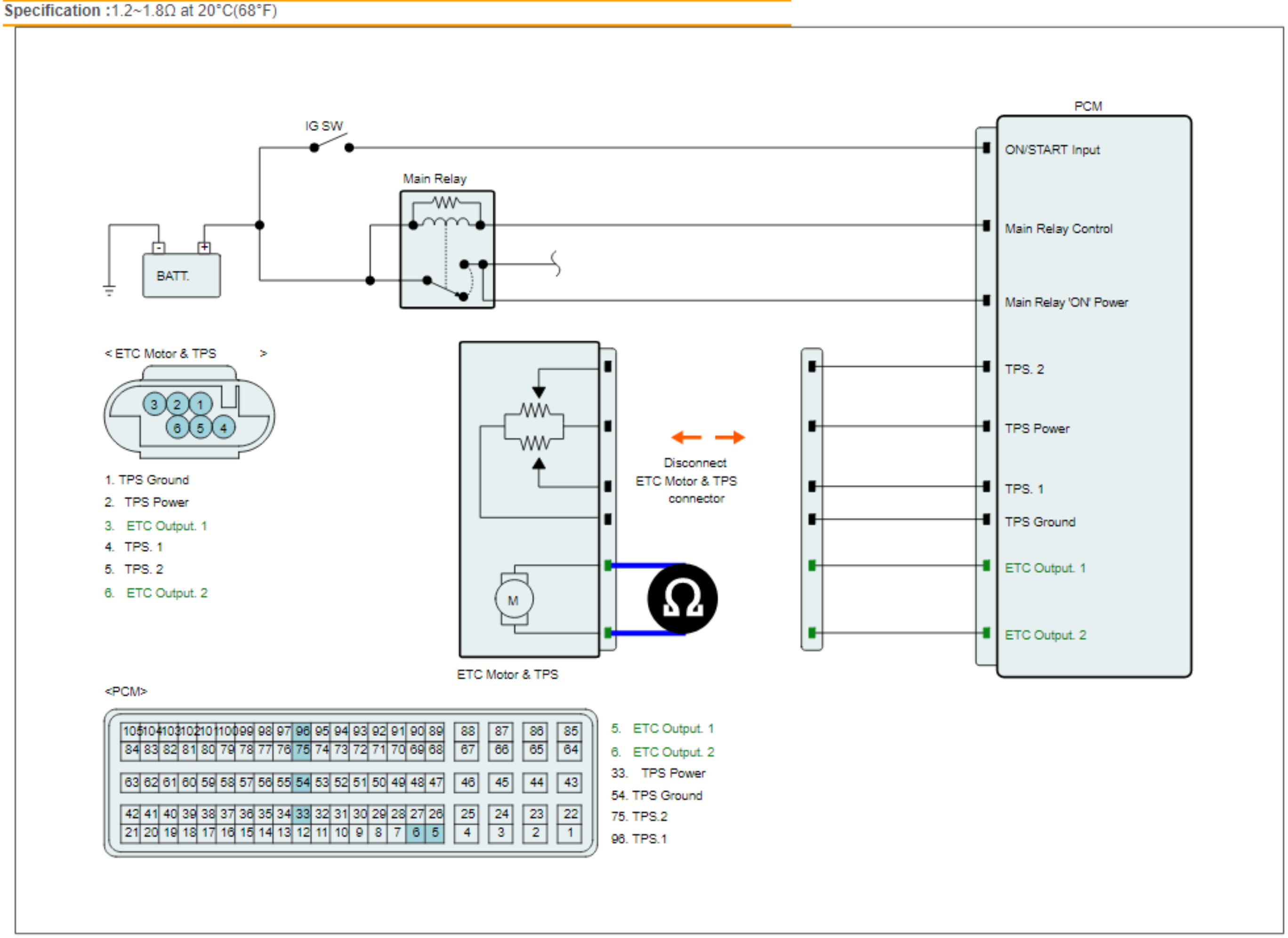


Figure 76 – Note: Throttle Position Sensor wiring including TPS1 and TPS2, TPS Power for actuating positioning device using electric motor

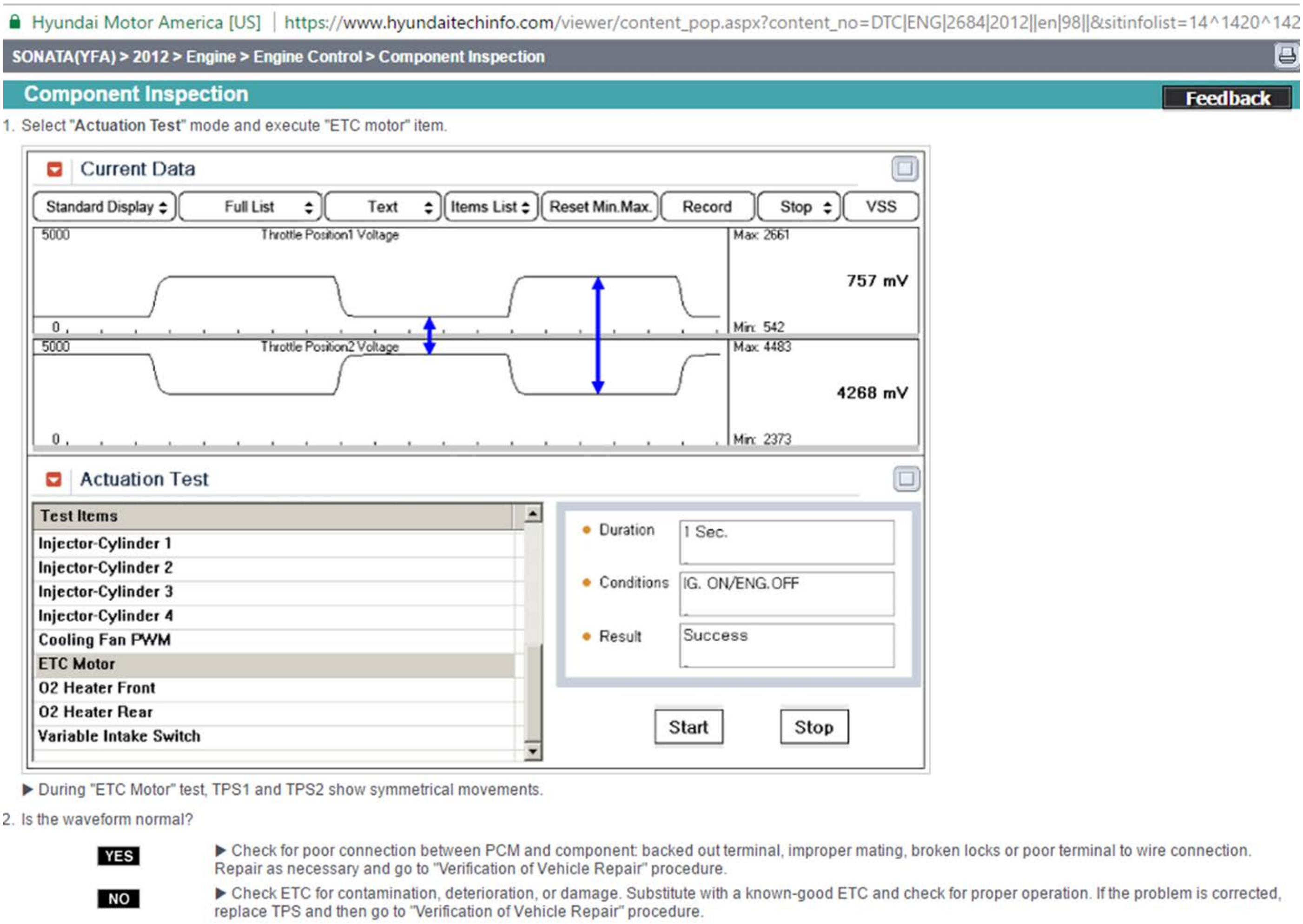


Figure 77- Electronic Throttle Control Actuation Test, calculating control action

115. Claim 7 of the ’839 patent recites a method for controlling a positioning device of an internal combustion engine, the positioning device having a spring bias torque, the method comprising the steps of: providing an electric motor for actuating the positioning device against the spring bias torque; supplying a first current to said electric motor to move the positioning device to an actual position; comparing said actual position to a requested position; monitoring said first current to determine a required current for opposing the spring bias torque at said actual position; summing said requested position with a spring opposition term based upon said

required current into an adjusted requested position; and supplying said required current to said electric motor to move the positioning device to an adjusted requested position.

116. On information and belief, the Accused Instrumentalities infringe at least claim 1 of the ’839 patent. The Accused Instrumentalities practice a method for controlling a positioning device of an internal combustion engine (*Figures 17-20, 69-71*), the positioning device having a spring bias torque (*Figures 2-5, 7-9, 12-20, 24-25, 74-75*), the method comprising the steps of: providing an electric motor for actuating the positioning device against the spring bias torque (*Figures 2-5, 7-9, 12-20, 24-25*); supplying a first current to said electric motor (*Figures 2-5, 7-9, 12-20, 24-25, 7*4-75) to move the positioning device to an actual position; comparing said actual position to a requested position (*Figures 3-5, 6, 8, 24-26, 40, 74*); monitoring said first current to determine a required current for opposing the spring bias torque at said actual position (*Figures 3-5, 6, 8, 24-26, 40, 74*); summing said requested position with a spring opposition term based upon said required current into an adjusted requested position; and supplying said required current to said electric motor to move the positioning device to an adjusted requested position (*Figures 3-5, 6, 8, 24-26, 40, 74*).

117. Claim 12 of the ’839 patent recites a method for controlling a positioning device of an internal combustion engine, the positioning device having a spring bias torque, the method comprising the steps of: providing an electric motor for actuating the positioning device against the spring bias torque; supplying a first voltage to said electric motor to move the positioning device to an actual position; comparing said actual position to a requested position; monitoring said first voltage to determine a required voltage for opposing the spring bias torque at said actual position; summing said requested position with a spring opposition term based upon said

required current into a adjusted requested position; and supplying said required voltage to said electric motor to move the positioning device to an adjusted requested position.

118. On information and belief, the Accused Instrumentalities infringe at least claim 12 of the ’839 patent. The Accused Instrumentalities practice a method for controlling a positioning device of an internal combustion engine (*Figures 17-20, 69-71*), the positioning device having a spring bias torque (*Figures 2-5, 7-9, 12-20, 24-25, 74-75*), the method comprising the steps of: providing an electric motor for actuating the positioning device against the spring bias torque (*Figures 2-5, 7-9, 12-20, 24-25*); supplying a first voltage to said electric motor (*Figures 2-5, 7-9, 12-20, 24-25, 74-75*) to move the positioning device to an actual position; comparing said actual position to a requested position (*Figures 3-5, 6, 8, 24-26, 43, 74*); monitoring said first voltage to determine a required voltage for opposing the spring bias torque at said actual position; summing said requested position with a spring opposition term based upon said required current into a adjusted requested position (*Figures 3-5, 6, 8, 24-26, 40, 74*); and supplying said required voltage to said electric motor to move the positioning device to an adjusted requested position (*Figures 3-5, 6, 8, 24-26, 40, 74*).

<u>COUNT XIII – INFRINGEMENT OF U.S. PATENT NO. 6,612,287</u>

119. The allegations set forth in the foregoing paragraphs 1 through 118 are incorporated into this Thirteenth Claim for Relief.

120. On September 2, 2003 U.S. Patent No. 6,612,287 (“the ’287 patent”), entitled “*Electronic Throttle Position Feedforward System*,” was duly and legally issued by the United States Patent and Trademark Office. A true and correct copy of the ’287 patent is attached as Exhibit 13.

121. Plaintiff is the assignee and owner of the right, title and interest in and to the ’287 patent, including the right to assert all causes of action arising under said patents and the right to any remedies for infringement of them.

122. Upon information and belief, Defendants have directly infringed at least claim 1 of the ’287 patent by making, using, selling, importing and/or providing and causing to be used the 2011-2017 Hyundai Sonata (2.0L), 2010-2017 Hyundai Genesis Coupe (2.0L), 2013-2017 Hyundai Santa Fe (2.0L), 2011-2017 Hyundai Sonata (2.4L), 2010-2017 Hyundai Tucson (2.4L), 2010-2017 Hyundai Santa Fe (2.4L) (the “Accused Instrumentalities”).

123. Upon information and belief, the Accused Instrumentalities incorporate the Theta II Engine which practices a method for controlling a positioning device of an internal combustion engine.

124. In particular, claim 1 of the ’287 patent recites a method for controlling a positioning device of an internal combustion engine, the method comprising the steps of: providing an electronic motor for actuating said positioning device with a torque being applied to said motor over the positioning range and said torque changing sign thereby defining a torque reversal point; detecting a commanded position of said positioning device; determining whether said positioning device's command is in the region of said torque reversal point; forming a drive signal for the motor on the basis of said commanded position for said positioning device; and changing said drive signal to abruptly change the motor voltage when said commanded position is in said region of said torque reversal point.

125. On information and belief, the Accused Instrumentalities infringe claim 1 of the ’287 patent. The Accused Instrumentalities practice a method controlling a positioning (*Figures 2-4, 4, 7-8, 17-20*) device of an internal combustion engine (*Figures 1-2*), the method comprising

the steps of: providing an electronic motor (*Figures 3-4*) for actuating said positioning device with a torque being applied to said motor over the positioning range and said torque changing sign thereby defining a torque reversal point (*Figure 16*); detecting a commanded position of said positioning device (*Figures 16-20*); determining whether said positioning device's command is in the region of said torque reversal point (*Figures 17-21*); forming a drive signal for the motor on the basis of said commanded position for said positioning device (*Figures 17-21*); and changing said drive signal to abruptly change the motor voltage when said commanded position is in said region of said torque reversal point (*Figures 17-21*).

COUNT XIV – INFRINGEMENT OF U.S. PATENT NO. 7,487,761

126. The allegations set forth in the foregoing paragraphs 1 through 125 are incorporated into this Fourteenth Claim for Relief.

127. On February 10, 2009 U.S. Patent No. 7,487,761 ("the '761 patent"), entitled "*Detection of Fuel System Problems,*" was duly and legally issued by the United States Patent and Trademark Office. A true and correct copy of the '761 patent is attached as Exhibit 14.

128. Plaintiff is the assignee and owner of the right, title and interest in and to the '761 patent, including the right to assert all causes of action arising under said patents and the right to any remedies for infringement of them.

129. Upon information and belief, Defendants have directly infringed at least claims 1 and 17 of the '761 patent by making, using, selling, importing and/or providing and causing to be used the 2011-2017 Hyundai Sonata (2.0L), 2010-2017 Hyundai Genesis Coupe (2.0L), 2013-2017 Hyundai Santa Fe (2.0L), 2011-2017 Hyundai Sonata (2.4L), 2010-2017 Hyundai Tucson (2.4L), 2010-2017 Hyundai Santa Fe (2.4L) (the "Accused Instrumentalities").

130. Upon information and belief, the Accused Instrumentalities incorporate the Theta II Engine which practices a method for detecting failures in a fuel system for a motor vehicle.

131. In particular, claim 1 of the ’761 patent recites a method for detecting failures in a fuel system for a motor vehicle, the fuel system includes a fuel pump providing fuel from a fuel tank to a fuel injector rail of an engine, a fuel pump controller is electrically connected to the fuel pump and a rail pressure sensor, the rail pressure sensor is attached to the fuel injector rail in fluid communication with fuel being provided from the fuel tank, the method comprises: monitoring an actual fuel pump parameter of the fuel pump and a fuel injector rail pressure; comparing the actual fuel pump parameter required to achieve a desired fuel injector rail pressure to an initial fuel pump parameter to achieve the desired fuel injector rail pressure; and signaling a fuel system problem if a difference between the actual fuel pump parameter and the initial fuel pump parameter exceeds a predetermined threshold.

132. On information and belief, the Accused Instrumentalities infringe at least claim 1 of the ’761 patent. The Accused Instrumentalities practice a method for detecting failures in a fuel system for a motor vehicle (*Figures 17-21, 78-79*), the fuel system includes a fuel pump providing fuel from a fuel tank to a fuel injector rail of an engine (*Figures 80-81*), a fuel pump controller is electrically connected to the fuel pump and a rail pressure sensor (*Figures 17-21, 81*), the rail pressure sensor is attached to the fuel injector rail in fluid communication with fuel being provided from the fuel tank (*Figures 78-82*), the method comprises: monitoring an actual fuel pump parameter of the fuel pump and a fuel injector rail pressure (*Figures 17-21*); comparing the actual fuel pump parameter required to achieve a desired fuel injector rail pressure to an initial fuel pump parameter to achieve the desired fuel injector rail pressure (*Figures 17-21, 78-79, 83*); and signaling a fuel system problem if a difference between the actual fuel pump parameter and the initial fuel pump parameter exceeds a predetermined threshold (*Figures 17-21, 78-79, 83*).

Fuel System > Engine Control System > Rail Pressure Sensor (RPS) > Description and Operation

Description

Rail Pressure Sensor (RPS) is installed on the delivery pipe and measures the instantaneous fuel pressure in the delivery pipe. The sensing element (Semiconductor element) built in the sensor converts the pressure to voltage signal. By using this signal, the ECM can control correct injection amount and timing and adjusts the fuel pressure with the fuel pressure regulator valve if the target pressure and the actual pressure calculated by the RPS output signal are different.

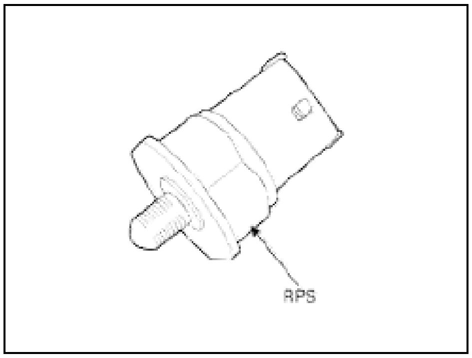


Figure 78 – Note: Rail Pressure Sensor (RPS) measures fuel pressure in the delivery pipe which converts the pressure to a voltage signal that the ECM can use to adjust the fuel pressure

Fuel System > Engine Control System > Rail Pressure Sensor (RPS) > Troubleshooting

Signal Waveform

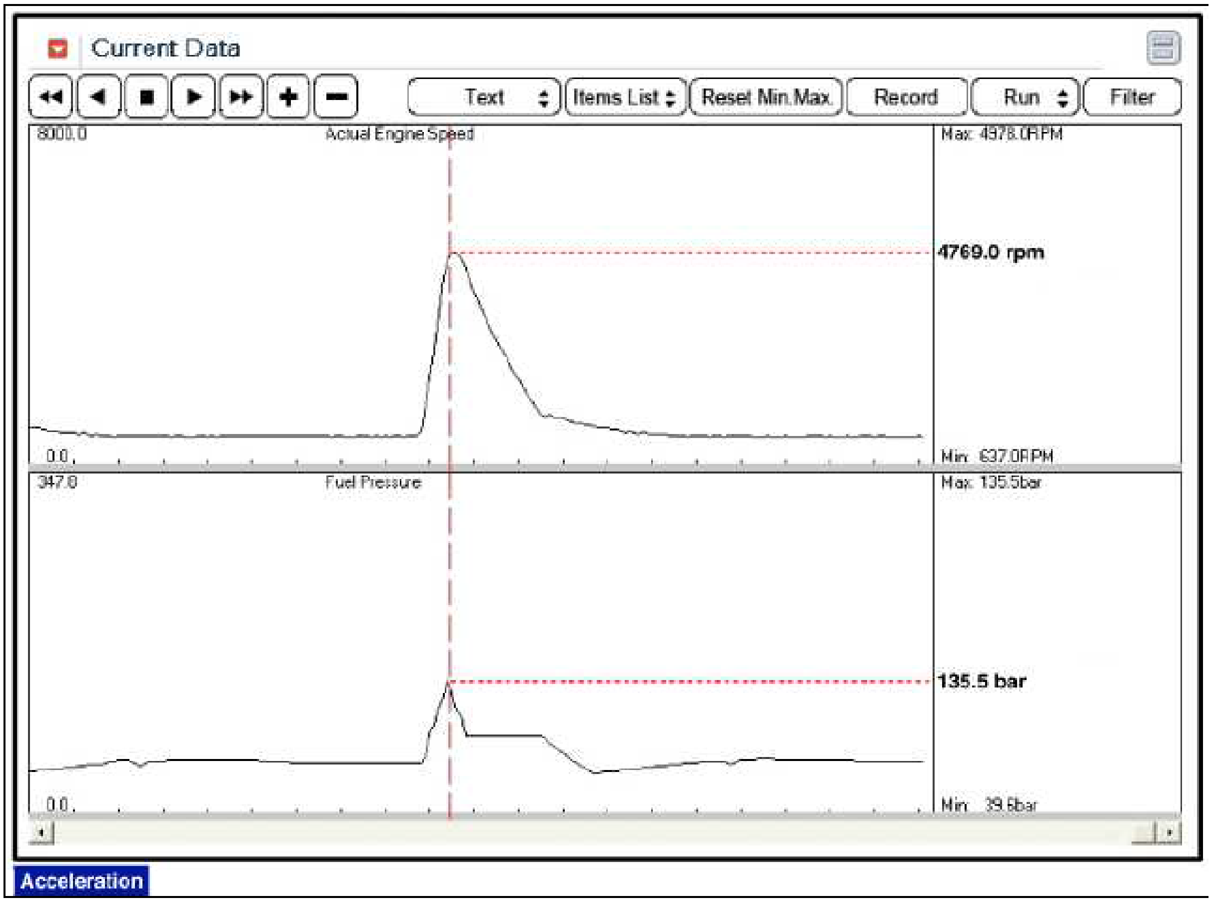


Figure 79- Data from RPS through ECM

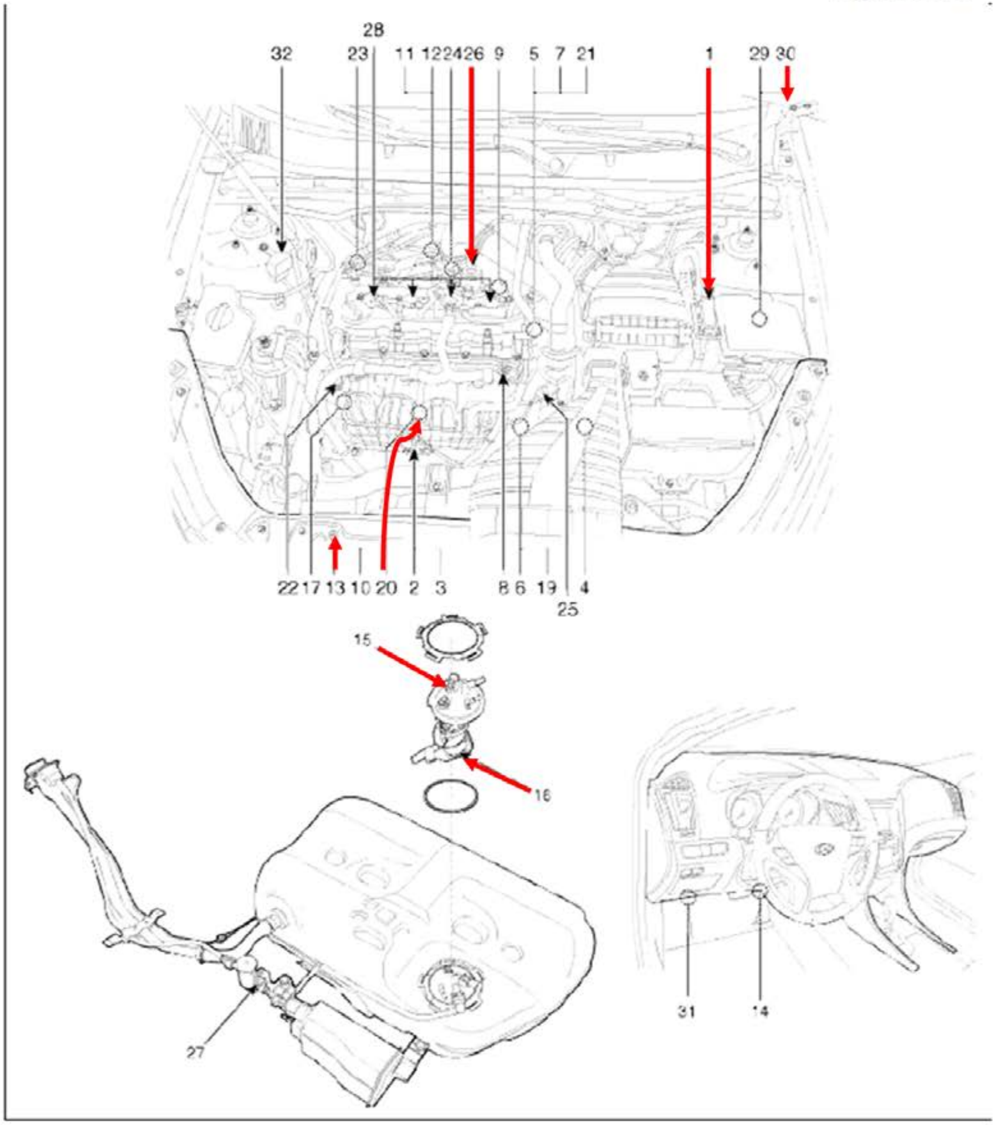
Fuel System > General Information > Specifications

Specifications

Fuel Delivery System

Items	**Specification**	
Fuel Tank	Capacity	70 lit. (18.5 U.S.gal., 74.0 U.S.qt., 61.6 Imp.qt.)
Fuel Filter	Type	Paper type
Fuel Pressure	Low Pressure Fuel Line	495 ~ 505 kPa (5.1 ~ 5.2 kgf/cm², 71.8 ~ 73.2 psi)
	High Pressure Fuel Line	5.0 ~ 12.0 MPa (51.0 ~ 122.4 kgf/cm², 725.2 ~ 1740.5 psi)
Fuel Pump	Type	Electrical, in-tank type
	Driven by	Electric motor
High Pressure Fuel Pump	Type	Mechanical type
	Driven by	Camshaft

Figure 80- Note: Components of the fuel delivery system including the fuel pump, fuel tank



1. Engine Control Module (ECM)	17. CVVT Oil Temperature Sensor (OTS)
2. Manifold Absolute Pressure Sensor (MAPS) #1	18. A/C Pressure Transducer (APT)
3. Intake Air Temperature Sensor (IATS)	19. ETC Motor [integrated into ETC Module]
4. Manifold Absolute Pressure Sensor (MAPS) #2	20. Injector
5. Engine Coolant Temperature Sensor (ECTS)	21. Purge Control Solenoid Valve (PCSV)
6. Throttle Position Sensor (TPS) [integrated into ETC Module]	22. CVVT Oil Control Valve (OCV) [Bank 1 / Intake]
7. Crankshaft Position Sensor (CKPS)	23. CVVT Oil Control Valve (OCV) [Bank 1 / Exhaust]
8. Camshaft Position Sensor (CMPS) [Bank 1 / Intake]	24. Electric Waste Gate Actuator (EWGA)
9. Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]	25. RCV Control Solenoid Valve
10. Knock Sensor (KS)	26. Fuel Pressure Regulator Valve
11. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 1]	27. Canister Close Valve (CCV)
12. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2]	28. Ignition Coil
13. Rail Pressure Sensor (RPS)	29. Main Relay
14. Accelerator Position Sensor (APS)	30. Fuel Pump Relay
15. Fuel Tank Pressure Sensor (FTPS)	31. Data Link Connector (DLC) [16-Pin]
16. Fuel Level Sensor (FLS)	32. Multi-Purpose Check Connector [20-Pin]

Figure 81- Components of fuel system

6. Remove the installation bolt (D), and then remove the delivery pipe and injector assembly from the engine.

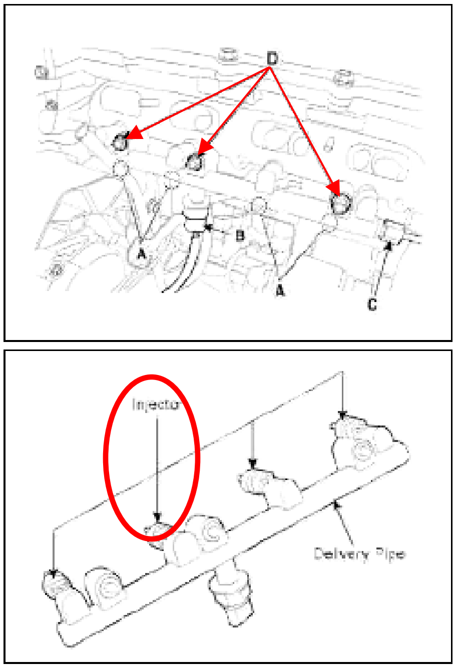


Figure 82- Fuel Injectors

The following is a list showing what numbers are assigned to each system.

1. Fuel and air metering
2. Fuel and air metering(injector circuit malfunction only)
3. Ignition system or misfire
4. Auxiliary emission controls
5. Vehicle speed controls and idle control system
6. Computer output circuits
7. Transmission

The last two numbers of the DTC indicates the component or section of the system where the fault is located.

11) Freeze frame data

When a freeze frame event is triggered by an emission related DTC, the ECM or PCM stores various vehicle information as it existed the moment the fault ocurred. The DTC number along with the engine data can be useful in aiding a technician in locating the cause of the fault. Once the data from the 1st driving cycle DTC ocurrence is stored in the freeze frame memory, it will remain there even when the fault occurs again (2nd driving cycle) and the MIL is illuminated.

- Freeze Frame List

1) Calculated Load Value
2) Engine RPM
3) Fuel Trim
4) Fuel Pressure (if available)
5) Vehicle Speed (if available)
6) Coolant Temperature
7) Intake Manifold Pressure (if available)
8) Closed-or Open-loop operation
9) Fault code

3. OBD-II system readiness tests

1) Catalyst monitoring

The catalyst efficiency monitor is a self-test strategy within the ECM or PCM that uses the downstream Heated Oxygen Sensor (HO2S) to determine when a catalyst has fallen below the minimum level of effectiveness in its ability to control exhaust emission.

2) Misfire monitoring

Misfire is defined as the lack of proper combustion in the cylinder due to the absence of spark, poor fuel metering, or poor compression. Any combustion that does not occur within the cylinder at the proper time is also a misfire. The misfire detection monitor detects fuel, ignition or mechanically induced misfires. The intent is to protect the catalyst from permanent damage and to alert the customer of an emission failure or an inspection maintenance failure by illuminating the MIL . When a misfire is detected, special software called freeze frame data is enabled. The freeze frame data captures the operational state of the vehicle when a fault is detected from misfire detection monitor strategy.

3) Fuel system monitoring

The fuel system monitor is a self-test strategy within the ECM or PCM that monitors the adaptive fuel table The fuel control system uses the adaptive fuel table to compensate for normal variability of the fuel system components caused by wear or aging. During normal vehicle operation, if the fuel system appears biased lean or rich, the adaptive value table will shift the fuel delivery calculations to remove bias.

4) Engine cooling system monitoring

The cooling system monitoring is a self-test strategy within the ECM or PCM that monitors ECTS (Engine Coolant Temperature Sensor) and thermostat about circuit continuity, output range, rationality faults.

5) O2 sensor monitoring

OBD-II regulations require monitoring of the upstream Heated O2 Sensor (H2OS) to detect if the deterioration of the sensor has exceeded thresholds. An additional HO2S is located downstream of the Warm-Up Three Way

Figure 83- Note: Functioning of ECM which receives data from various sensors associated with different systems and monitors the systems for threshold values in comparison to actual values

133. Claim 17 of the ’761 patent recites a device for detecting failures in a fuel system of a motor vehicle, the fuel system includes a fuel pump providing fuel from a fuel tank to a fuel injector rail of an engine, a rail pressure sensor is attached to the fuel injector rail in fluid communication with the fuel being provided from the fuel tank, the device comprises: a fuel pump controller being electrically connected to the fuel pump and the rail pressure sensor, the fuel pump controller being configured to monitor an actual fuel pump parameter of the fuel pump and an actual fuel injector rail pressure measured by the rail pressure sensor and to compare the actual fuel pump parameter required to achieve a desired fuel injector rail pressure to an initial fuel pump parameter and to signal a fuel system problem if a difference between the actual fuel pump parameter and the initial fuel pump parameter exceeds a predetermined threshold.

134. On information and belief, the Accused Instrumentalities infringe claim 17 of the ’761 patent. The Accused Instrumentalities comprise a device for detecting failures in a fuel system of a motor vehicle (*Figures 17-21, 78-79*), the fuel system includes a fuel pump providing fuel from a fuel tank to a fuel injector rail of an engine (*Figures 80-81*), a rail pressure sensor is attached to the fuel injector rail in fluid communication with the fuel being provided from the fuel tank (*Figures 17-21, 81*), the device comprises: a fuel pump controller being electrically connected to the fuel pump and the rail pressure sensor (*Figures 17-21, 78-82*), the fuel pump controller being configured to monitor an actual fuel pump parameter of the fuel pump and an actual fuel injector rail pressure measured by the rail pressure sensor and to compare the actual fuel pump parameter required to achieve a desired fuel injector rail pressure to an initial fuel pump parameter and to signal a fuel system problem if a difference between the

actual fuel pump parameter and the initial fuel pump parameter exceeds a predetermined threshold (*Figures 17-21*, *78-83*).

COUNT XV – INFRINGEMENT OF U.S. PATENT NO. 6,644,115

135. The allegations set forth in the foregoing paragraphs 1 through 134 are incorporated into this Fifteenth Claim for Relief.

136. On November 11, 2003 U.S. Patent No. 6,644,115 ("the '115 patent"), entitled "*Method and Device for Indicating Liquid Volume in a Tank*," was duly and legally issued by the United States Patent and Trademark Office. A true and correct copy of the '115 patent is attached as Exhibit 15.

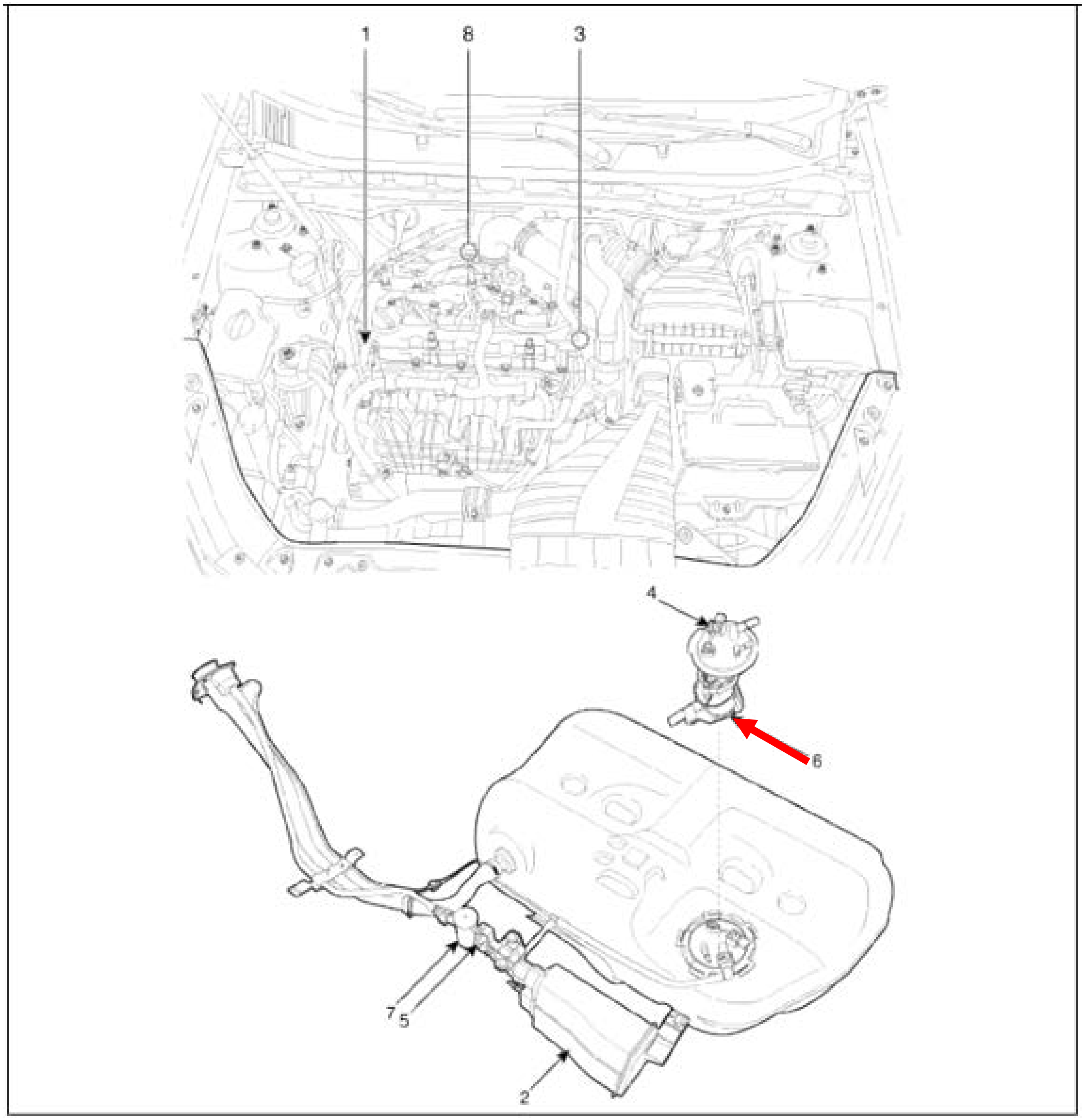
137. Plaintiff is the assignee and owner of the right, title and interest in and to the '115 patent, including the right to assert all causes of action arising under said patents and the right to any remedies for infringement of them.

138. Upon information and belief, Defendants have directly infringed at least claims 1 and 10 of the '115 patent by making, using, selling, importing and/or providing and causing to be used the 2011-2017 Hyundai Sonata (2.0L), 2010-2017 Hyundai Genesis Coupe (2.0L), 2013-2017 Hyundai Santa Fe (2.0L), 2011-2017 Hyundai Sonata (2.4L), 2010-2017 Hyundai Tucson (2.4L), 2010-2017 Hyundai Santa Fe (2.4L) (the "Accused Instrumentalities"). (the "Accused Instrumentalities").

139. In particular, claim 1 of the '115 patent recites a system for determining a level of a liquid present in a storage container in an automobile, the system comprising: a liquid level sensor for determining a preliminary liquid level of the liquid stored in the storage container; a vehicle speed sensor for determining the automobile's speed; a transmission gear selection sensor for determining a transmission gear position of a transmission of the automobile; and a processor for receiving input signals from the liquid level sensor, the vehicle speed sensor and the

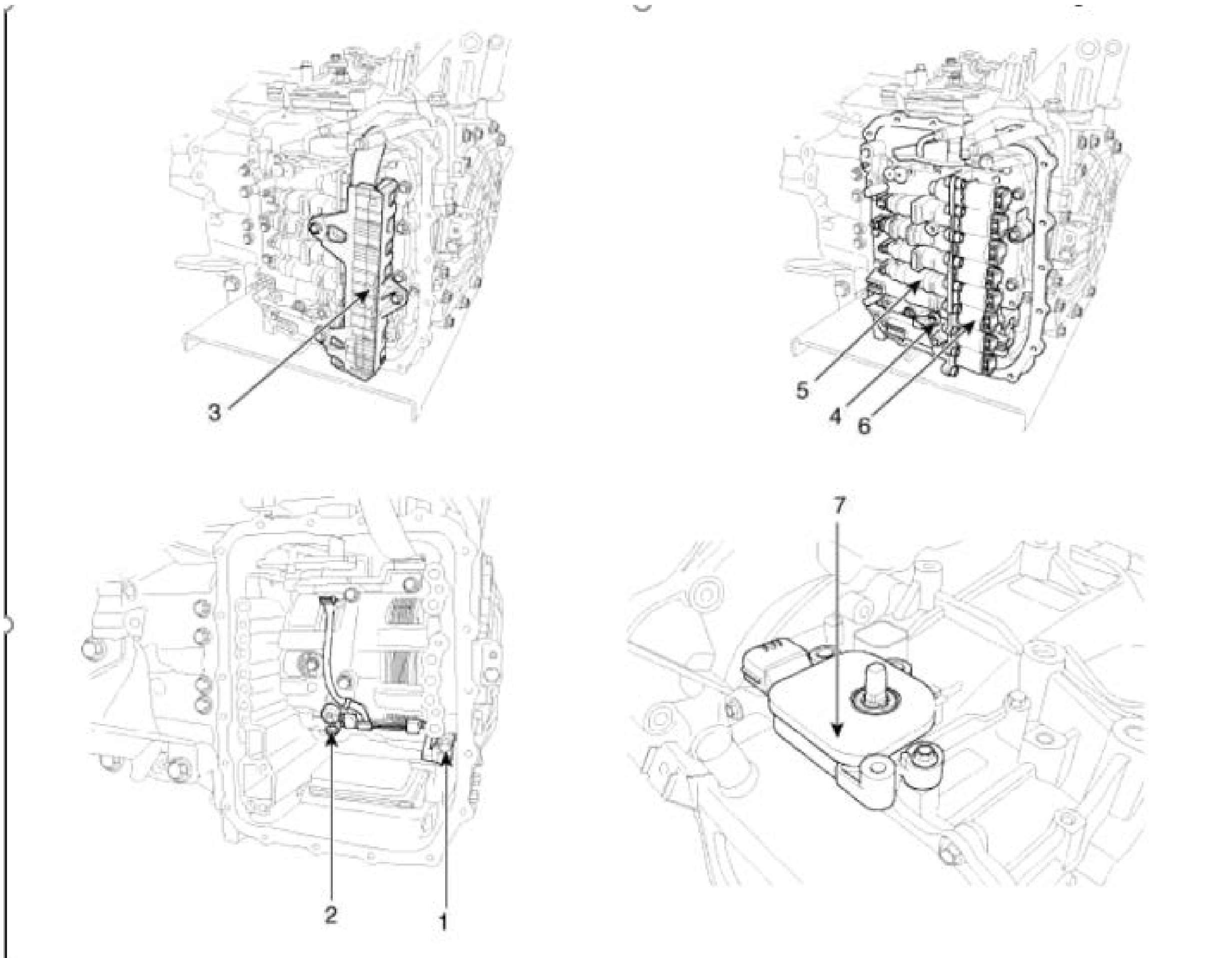
transmission gear selection sensor for modifying the preliminary liquid level to arrive at a final liquid level indication of the liquid present in the storage container when the automobile's speed is equal to zero, the automobile transmission gear is in park position, and the preliminary liquid level exceeds a predetermined threshold.

140. On information and belief, the Accused Instrumentalities infringe claim 1 of the ’115 patent. The Accused Instrumentalities comprise a system for determining a level of a liquid present in a storage container in an automobile (*Figures 17-21*), the system comprising: a liquid level sensor for determining a preliminary liquid level of the liquid stored in the storage container *(Figure 88*); a vehicle speed sensor for determining the automobile's speed (*Figure 89*); a transmission gear selection sensor for determining a transmission gear position of a transmission of the automobile; and a processor for receiving input signals from the liquid level sensor (*Figures 87-88*), the vehicle speed sensor and the transmission gear selection sensor (*Figures 87-88*) for modifying the preliminary liquid level to arrive at a final liquid level indication of the liquid present in the storage container when the automobile's speed is equal to zero (*Figure 87, 89*), the automobile transmission gear is in park position, and the preliminary liquid level exceeds a predetermined threshold (*Figures 87, 89*).



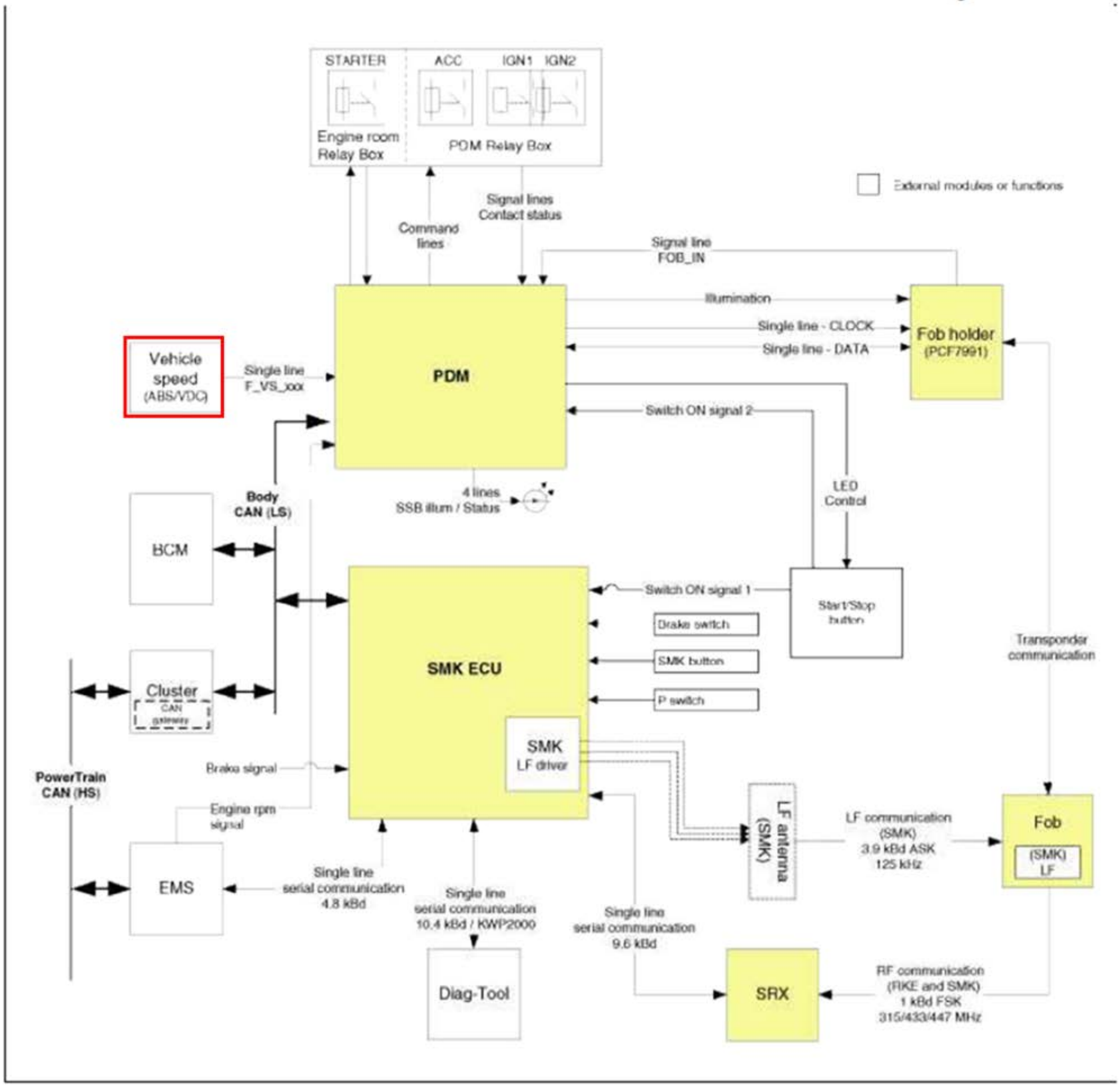
1. PCV Valve 2. Canister 3. Purge Control Solenoid Valve (PCSV) 4. Fuel Tank Pressure Sensor (FTPS)	5. Canister Close Valve (CCV) 6. Fuel Level Sensor (FLS) 7. Fuel Tank Air Filter 8. Catalytic Converter

Figure 84 - Fuel Level Sensor



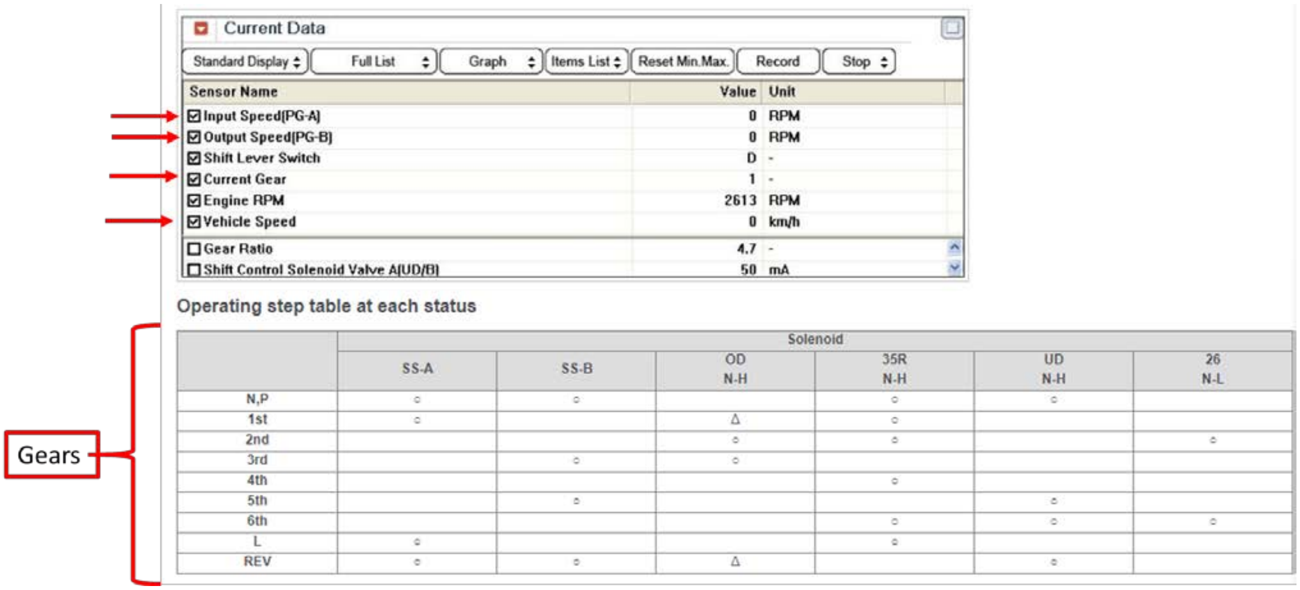
1. Input speed sensor 2. Output speed sensor 3. Solenoid valve connect 4. Oil temperature sensor	5. Valve body assembly 6. Solenoid valve 7. Inhibitor switch

Figure 85- Input and Output Speed Sensor



Circuit Diagram (2)

Figure 86 – Note: Processor receiving signals from vehicle speed sensor



Sensor Name	Value	Unit
☑ Input Speed[PG-A]	0	RPM
☑ Output Speed[PG-B]	0	RPM
☑ Shift Lever Switch	D	-
☑ Current Gear	1	-
☑ Engine RPM	2613	RPM
☑ Vehicle Speed	0	km/h
☐ Gear Ratio	4.7	-
☐ Shift Control Solenoid Valve A[UD/B]	50	mA

Operating step table at each status

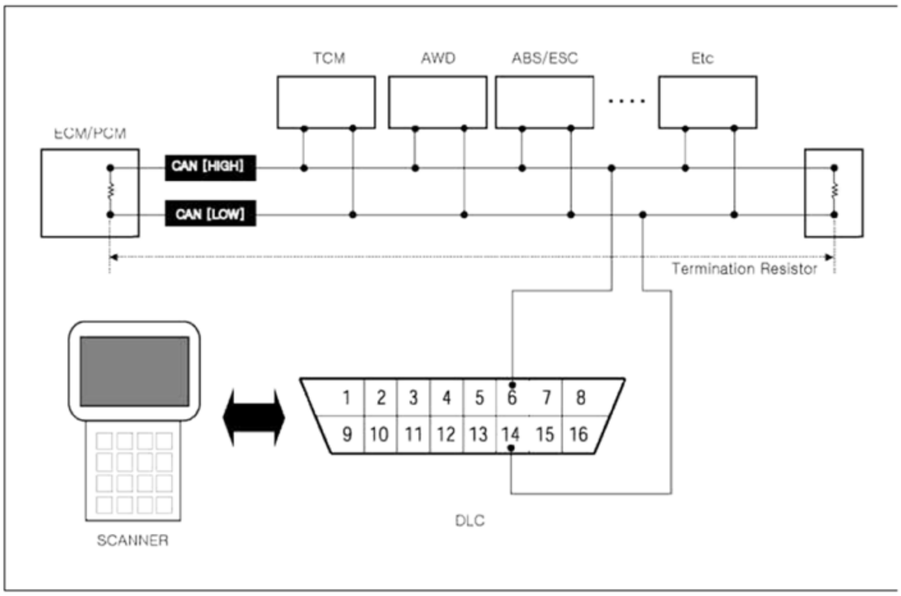
	Solenoid					
	SS-A	SS-B	OD N-H	35R N-H	UD N-H	26 N-L
N,P	○	○		○	○	
1st	○		Δ	○		
2nd			○	○		○
3rd		○	○			
4th				○		
5th		○			○	
6th				○	○	○
L	○			○		
REV	○	○	Δ		○	

Figure 87- Note: Input and Output speed sensor, gear selection sensor sending signals via the CAN

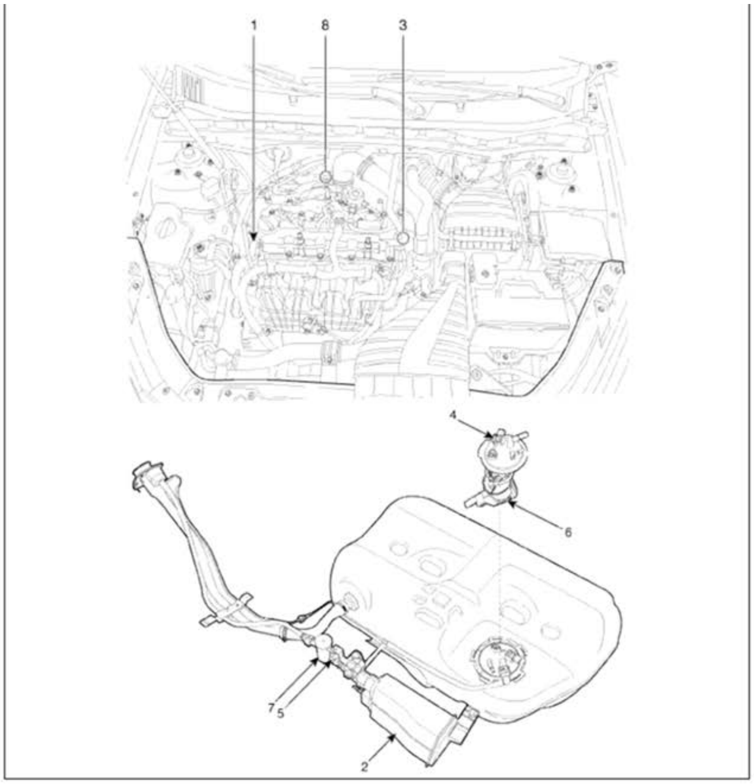
The diagnostic executive is a computer program in the Engine Control Module (ECM) or PowertrainControl Module (PCM) that coordinates the OBD-II self-monitoring system. This program controls all the monitors and interactions, DTC and MIL operation, freeze frame data and scan tool interface.
Freeze frame data describes stored engine conditions, such as state of the engine, state of fuel control, spark, RPM,

Page 20 of 128

load and warm status at the point the first fault is detected. Previously stored conditions will be replaced only if a fuel or misfire fault is detected. This data is accessible with the scan tool to assist in repairing the vehicle.
The center of the OBD-II system is a microprocessor called the Engine Control Module (ECM) or Powertrain Control Module(PCM).
The ECM or PCM receives input from sensors and other electronic components (switches, relays, and others) based on information received and programmed into its memory (keep alive random access memory, and others), the ECM or PCM generates output signals to control various relays, solenoids and actuators.
2. Configuration of hardware and related terms
1) GST (Generic scan tool)



The ECM or PCM are processors that receive input signals from the Fuel Level Sensor (liquid level sensor).



1. PCV Valve 2. Canister 3. Purge Control Solenoid Valve (PCSV) 4. Fuel Tank Pressure Sensor (FTPS)	5. Canister Close Valve (CCV) 6. Fuel Level Sensor (FLS) 7. Fuel Tank Air Filter 8. Catalytic Converter

Hyundai Motor America [US] | https://www.hyundaitechinfo.com/viewer/content_pop.aspx?content_no=DTC|ENG|2684|2012||en|97||&sitinfolist=14^1490^149...

SONATA(YFA) > 2012 > Engine > Engine Control > General Description

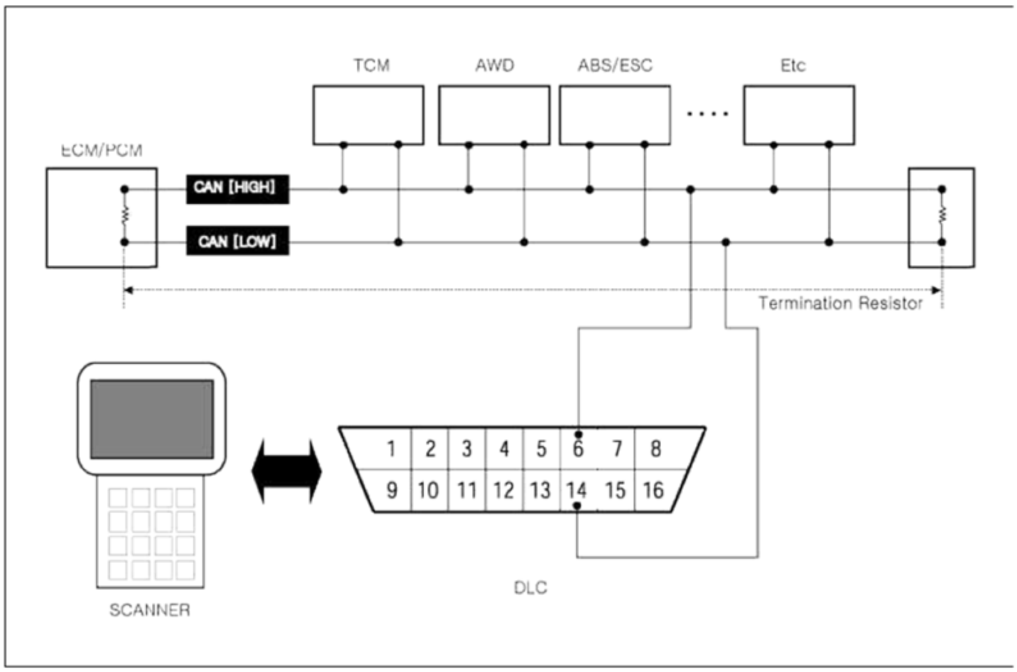
General Description

Feedback

The Fuel Level Sensor(FLS) measures the fuel level in fuel tank and its information is used to supply the PCM with information regarding the monitoring condition of the EVAP canister purge system for leak detection. If the fuel level sensor is monitored for high or low stuck or difference between voltage of fuel level sensor and voltage deviation of fuel level sensor is exceeds limited value while driving, this is interpreted by the PCM as a fault.

The diagnostic executive is a computer program in the Engine Control Module (ECM) or PowertrainControl Module (PCM) that coordinates the OBD-II self-monitoring system. This program controls all the monitors and interactions, DTC and MIL operation, freeze frame data and scan tool interface.
Freeze frame data describes stored engine conditions, such as state of the engine, state of fuel control, spark, RPM,

load and warm status at the point the first fault is detected. Previously stored conditions will be replaced only if a fuel or misfire fault is detected. This data is accessible with the scan tool to assist in repairing the vehicle.
The center of the OBD-II system is a microprocessor called the Engine Control Module (ECM) or Powertrain Control Module(PCM).
The ECM or PCM receives input from sensors and other electronic components (switches, relays, and others) based on information received and programmed into its memory (keep alive random access memory, and others), the ECM or PCM generates output signals to control various relays, solenoids and actuators.
2. Configuration of hardware and related terms
1) GST (Generic scan tool)



SONATA(YFA) > 2012 > G 2.4 GDI > Engine > Engine Control > P2159 Vehicle Speed Sensor 'B' Range / Performance(Wheel Speed Sensor)

General Description Feedback

The Wheel Speed Sensor (WSS) generates a waveform with a frequency proportional to the speed of the vehicle. The signal generated by the WSS informs the ESC Module not only if the vehicle speed is low or high but also if the vehicle is or is not moving. Then, ESC Module informs PCM of these information.
The PCM uses these information to control the fuel injection, ignition timing, transaxle shift scheduling and torque converter clutch scheduling. The WSS signal is also used to detect rough road conditions.

The Infringing Instrumentalities comprise a processor for receiving input signals from the vehicle speed sensor, as exemplified by the CAN in the circuit diagram above.

SONATA(YFA) > 2012 > G 2.4 GDI > Transmission > Automatic Transaxle > P0705 Transmission Range Sensor Circuit Malfunction

General Description Feedback

Shift lever positions P-range(Parking), R-range(Reverse), N-range(Neutral) and D-range(Driving) are changed by driver need and lever position is sent to PCM/TCM to control a gear ratio.

The Infringing Instrumentalities comprise a processor receiving input signals from the transmission gear selection sensor as exemplified by the figure above which demonstrates the data received from the transmission gear selection sensor.

Figure 88

7) Driving cycle
A driving cycle consists of engine start up, and engine shut off.
8) Warm-up cycle
A warm-up cycle means sufficient vehicle operation such that the engine coolant temperature has risen by at least 40 degrees Fahrenheit from engine starting and reaches a minimum temperature of at least 160 degrees Fahrenheit.
9) Trip cycle
A trip means vehicle operation (following an engine-off period) of duration and driving mode such that all components and systems are monitored at least once by the diagnostic system except catalyst efficiency or evaporative system monitoring when a steady-speed check is used, subject to the limitation that the manufacturer-defined trip monitoring conditions shall all be encountered at least once during the first engine start portion of the applicable FTP cycle.

3) Fuel system monitoring
The fuel system monitor is a self-test strategy within the ECM or PCM that monitors the adaptive fuel table The fuel control system uses the adaptive fuel table to compensate for normal variability of the fuel system components caused by wear or aging. During normal vehicle operation, if the fuel system appears biased lean or rich, the adaptive value table will shift the fuel delivery calculations to remove bias.

Page 84 of 414

Service Name	Service Trigger
- Eco Coach	1 Showing the eco-coach window. The customer can see the average efficiency curve of fuel consumption by selecting eco-coach software button into the Info menu or saying "eco-coach on" using PTT button on the inside mirror. - Selecting eco-coach button - Saying "Eco-coach on" menu : Press PTT button on the inside mirror, after heard "Please say command" sound, say "Eco- coach on" 2 See the fuel consumption on the web. Refer to the telematics web service manual for detail information.

As illustrated in the element above, the Controller Area Network (CAN) acts as a processor for processing the data associated with the preliminary and final liquid levels communicated by the fuel level sensor. The fuel level sensor is in the fuel storage tank, which is the storage container .

Further, as illustrated in 7) above, the driving cycle consists of engine start up and shut-off. At shut-off, the automobile's speed is equal to zero, and the transmission gear is in the park position. The final liquid level indication is arrived at when the automobile's speed is zero at engine shut off, and the fuel level is at least the minimal detectible fuel level, in other words the preliminary liquid level exceeds a predetermined threshold.

SONATA(YFA) > 2012 > G 2.4 GDI > Engine > Engine Control > P0464 Fuel Level Sensor 'A' Circuit Intermittent

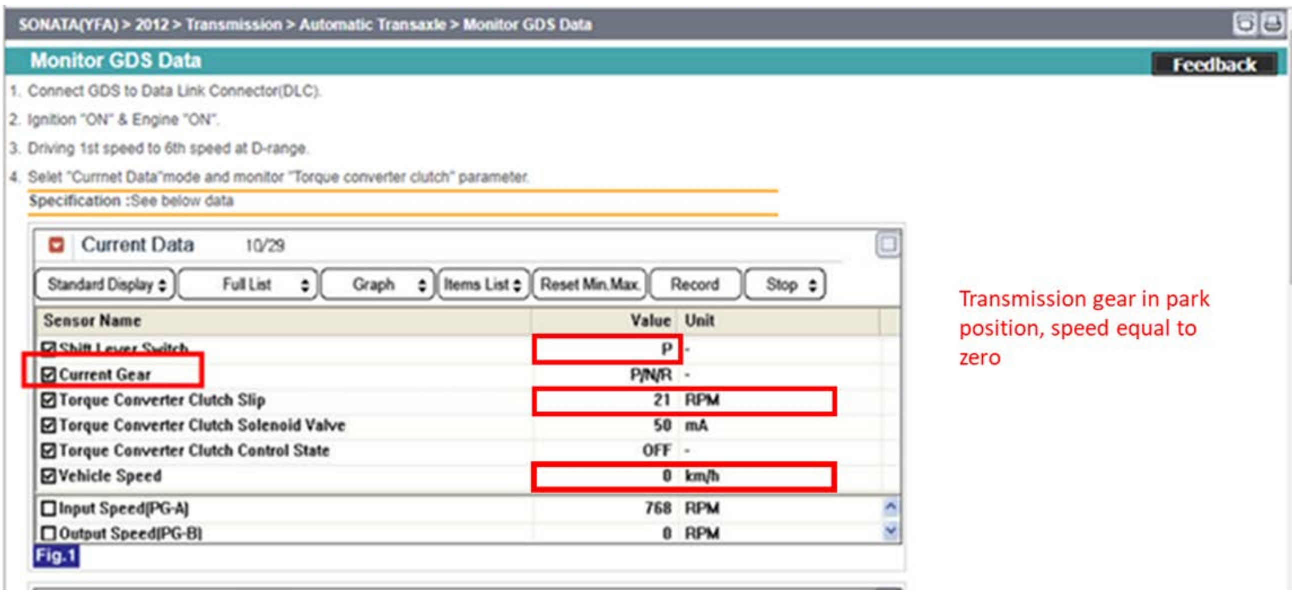
DTC Description Feedback

PCM compares fuel level measured with filtered value. If there is difference over 50% between each other, PCM sets P0464.

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Noisy signal	1. Poor connection or damaged harness 2. Faulty Fuel Level Sender "A"
Enable Conditions	• Vehicle Speed > 22 mph during 20 Seconds • No rough road • No relevant DTCs. • 11< Battery voltage <16	
Threshold Value	• FL measured - FL filtered value > 50 %	
Diagnostic Time	• 10 Seconds	
Mil On Condition	• 2 Drive Cycles	

The PCM compares a filtered fuel level with a measured fuel level.



When the transmission gear is in park, the vehicle speed is equal to zero.

Figure 89

141. Claim 10 of the ’115 patent recites a method for determining a level of a liquid present in a storage container in an automobile the method comprising: determining a preliminary liquid level of the liquid stored in the storage container using a liquid level sensor; determining the automobile's speed using a vehicle speed sensor; determining a transmission gear position of a transmission of the automobile using a transmission gear selection sensor; and receiving input signals from the liquid level sensor, the vehicle speed sensor and the transmission gear selection sensor for modifying the preliminary liquid level to arrive at a final liquid level

indication of the liquid present in the storage container the automobile's speed is equal to zero, the automobile transmission gear is in park position, and the preliminary liquid level exceeds a predetermined threshold.

142. On information and belief, the Accused Instrumentalities infringe claim 10 of the ’115 patent. The Accused Instrumentalities practice a method for determining a level of a liquid present in a storage container in an automobile the method comprising *(Figures 17-21*): determining a preliminary liquid level of the liquid stored in the storage container using a liquid level sensor *(Figure 84*); determining the automobile's speed using a vehicle speed sensor (*Figure 86-87*); determining a transmission gear position of a transmission of the automobile using a transmission gear selection sensor; and receiving input signals from the liquid level sensor, the vehicle speed sensor and the transmission gear selection sensor for modifying the preliminary liquid level to arrive at a final liquid level indication of the liquid present in the storage container the automobile's speed is equal to zero (*Figures 88-89*), the automobile transmission gear is in park position, and the preliminary liquid level exceeds a predetermined threshold (*Figure 89*).

<u>COUNT XVI – INFRINGEMENT OF U.S. PATENT NO. 6,581,574</u>

143. The allegations set forth in the foregoing paragraphs 1 through 142 are incorporated into this Sixteenth Claim for Relief.

144. On June 24, 2014 U.S. Patent No. 6,581,574 (“the ’574 patent”), entitled “*Method for Controlling Fuel Rail Pressure*,” was duly and legally issued by the United States Patent and Trademark Office. A true and correct copy of the ’574 patent is attached as Exhibit 16.

145. Plaintiff is the assignee and owner of the right, title and interest in and to the ’574 patent, including the right to assert all causes of action arising under said patents and the right to any remedies for infringement of them.

146. Upon information and belief, Defendants have directly infringed at least claims 1, 7, and 13 of the ’574 patent by making, using, selling, importing and/or providing and causing to be used the 2011-2017 Hyundai Sonata (2.0L), 2010-2017 Hyundai Genesis Coupe (2.0L), 2013-2017 Hyundai Santa Fe (2.0L), 2011-2017 Hyundai Sonata (2.4L), 2010-2017 Hyundai Tucson (2.4L), 2010-2017 Hyundai Santa Fe (2.4L) (the “Accused Instrumentalities”).

147. Upon information and belief, the Accused Instrumentalities incorporate the Theta II Engine which practices a method of controlling the fuel pressure within a fuel delivery system a system for determining a level of a liquid present in a storage container in an automobile.

148. In particular, claim 1 of the ’574 patent recites a method of controlling the fuel pressure within a fuel delivery system having a fuel pump which delivers fuel to a fuel rail of an internal combustion engine comprising: providing a set-point fuel pressure; providing the estimated average fuel flow through the system; generating a feed forward control signal based upon the set-point fuel pressure and the average fuel flow; measuring the fuel rail pressure with a fuel pressure sensor; filtering the output of the fuel pressure sensor to filter out pulses due to the opening and closing of the fuel injectors; comparing the fuel rail pressure to the set-point fuel pressure and generating an error signal based upon the difference between the fuel rail pressure and the set-point fuel pressure; and modifying the feed forward control signal based upon the error signal thereby generating a motor controller signal and sending the motor control signal to the fuel pump motor.

149. On information and belief, the Accused Instrumentalities infringe at least claim 1 of the ’574 patent. The Accused Instrumentalities practice a method of controlling (*Figures 17-21*) the fuel pressure within a fuel delivery system having a fuel pump which delivers fuel to a fuel rail of an internal combustion engine *(Figures 80-82, 90-94*) comprising: providing a set-

point fuel pressure (*Figure 83*); providing the estimated average fuel flow through the system (*Figure 83*); generating a feed forward control signal based upon the set-point fuel pressure and the average fuel flow (*Figures 78-79, 83*); measuring the fuel rail pressure with a fuel pressure sensor (*Figures 78-79, 90-94*); filtering the output of the fuel pressure sensor to filter out pulses due to the opening and closing of the fuel injectors (*Figure 83*); comparing the fuel rail pressure to the set-point fuel pressure and generating an error signal based upon the difference between the fuel rail pressure and the set-point fuel pressure; and modifying the feed forward control signal based upon the error signal thereby generating a motor controller signal and sending the motor control signal to the fuel pump motor (*Figure 83*).

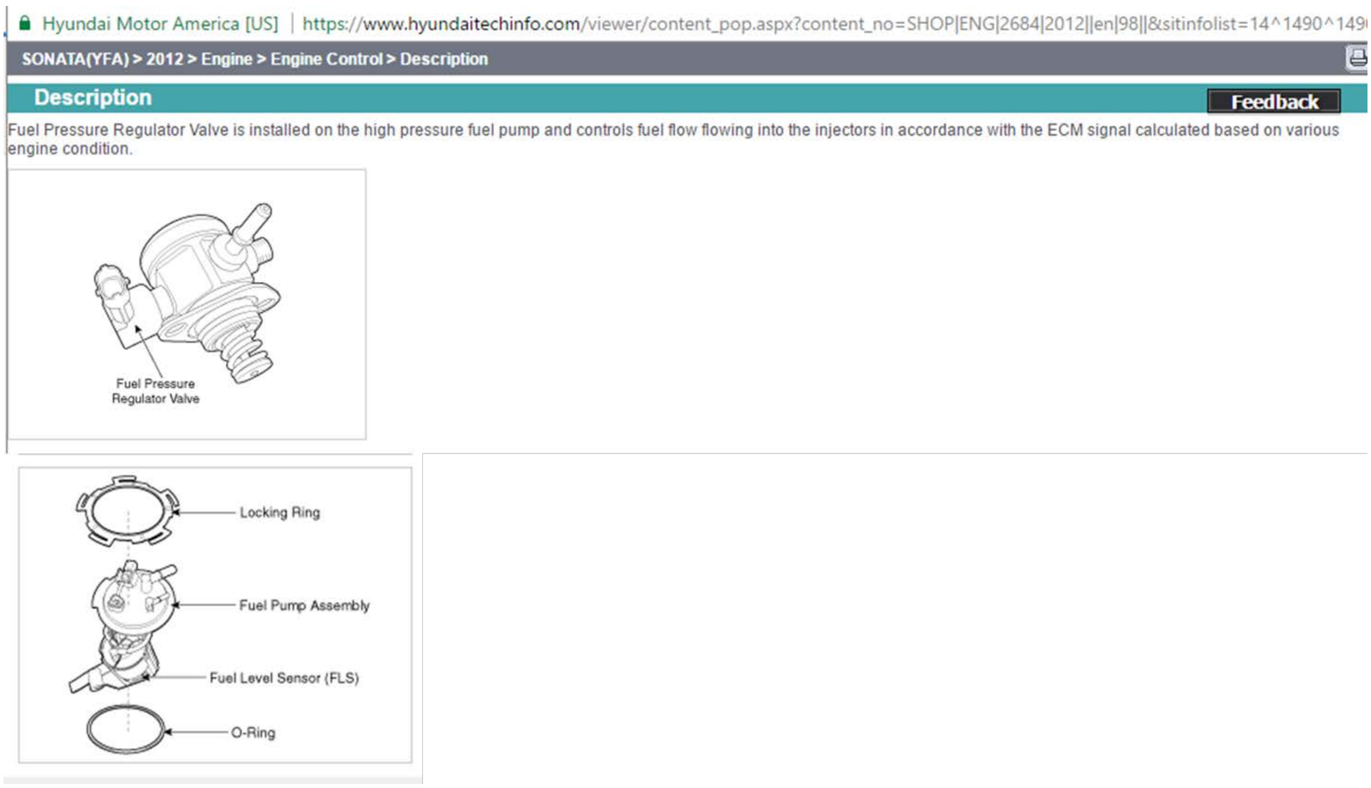


Figure 90 – Note: Fuel Pressure Regulator installed on high pressure fuel pump which controls fuel flow flowing into injectors in accordance with the ECM signal calculated based on various engine conditions and fuel pump assembly with fuel level sensor

Hyundai Service Website - Google Chrome

Hyundai Motor America [US] | https://www.hyundaitechinfo.com/viewer/content_pop.aspx?content_no=DTC|ENG|2684|2012||en|97||&sitinfolist=14^1420^14204

SONATA(YFA) > 2012 > Engine > Engine Control > General Description

General Description Feedback

The Low Pressure Pump (LPP) supplies 65 psi(4.5 bar) of fuel pressure to the High Pressure Pump (HPP).
Using the internally located Fuel Pressure Regulator Valve (FPR), the HPP will boost the fuel pressure from 580 psi(40 bar) at idle to a maximum of 1958 psi(135 bar).
The Fuel Pressure Sensor (FPS) confirms the fuel pressure and returns the signal to the Powertrain Control Module (PCM).
Fuel pressure during limp-home mode is 65 psi(4.5 bar).

Figure 91- Note: Description of low pressure fuel pump working in tandem with high pressure pump

Hyundai Service Website - Google Chrome

Hyundai Motor America [US] | https://www.hyundaitechinfo.com/viewer/content_pop.aspx?content_no=DTC|ENG|2684|2012||en|98||&sitinfolist=14^1420^14204

SONATA(YFA) > 2012 > Engine > Engine Control > DTC Detecting Condition

DTC Detecting Condition Feedback

Item	Detecting Condition	Possible Cause
DTC Strategy	• Plausibility Check	1. Overflow of fuel return 2. A leaky injector, a leak in the Fuel Rail 3. Mechanical failure in High Pressure Pump 4. Sticking by low pressure of rail pressure sensor
Enable Conditions	• Engine Speed: 512-7008 RPM	
Threshold Value	• Fuel Pressure: Less than 0 psi(0 bar)	
Diagnostic Time	• 5 sec.	
Mil On Condition	• 2 Drive Cycles	

Figure 92 – Note: Drive Cycle DTC detecting condition where threshold value is established; ECM monitors sensors and determines if set-point fuel pressure has been reached.

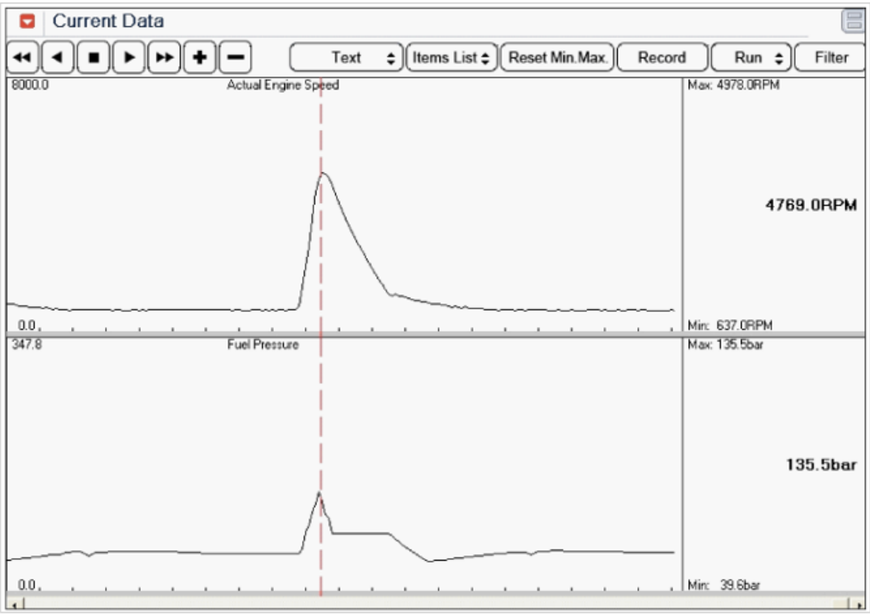
Condition	Possible Cause
Fuel Pressure is too low	Fuel filter,fuel pressure regulator, in-tank fuel hose or the fuel pump
Fuel Pressure is too high	Fuel pressure regulator, hose or pipe

Feedback

Check high pressure pump

1. Connect GDS to DLC(Data Link Cable).
2. Start the engine and monitor "Rail Pressure Sensor" parameter on GDS at accelerating.
3. Are the parameters displayed correctly?

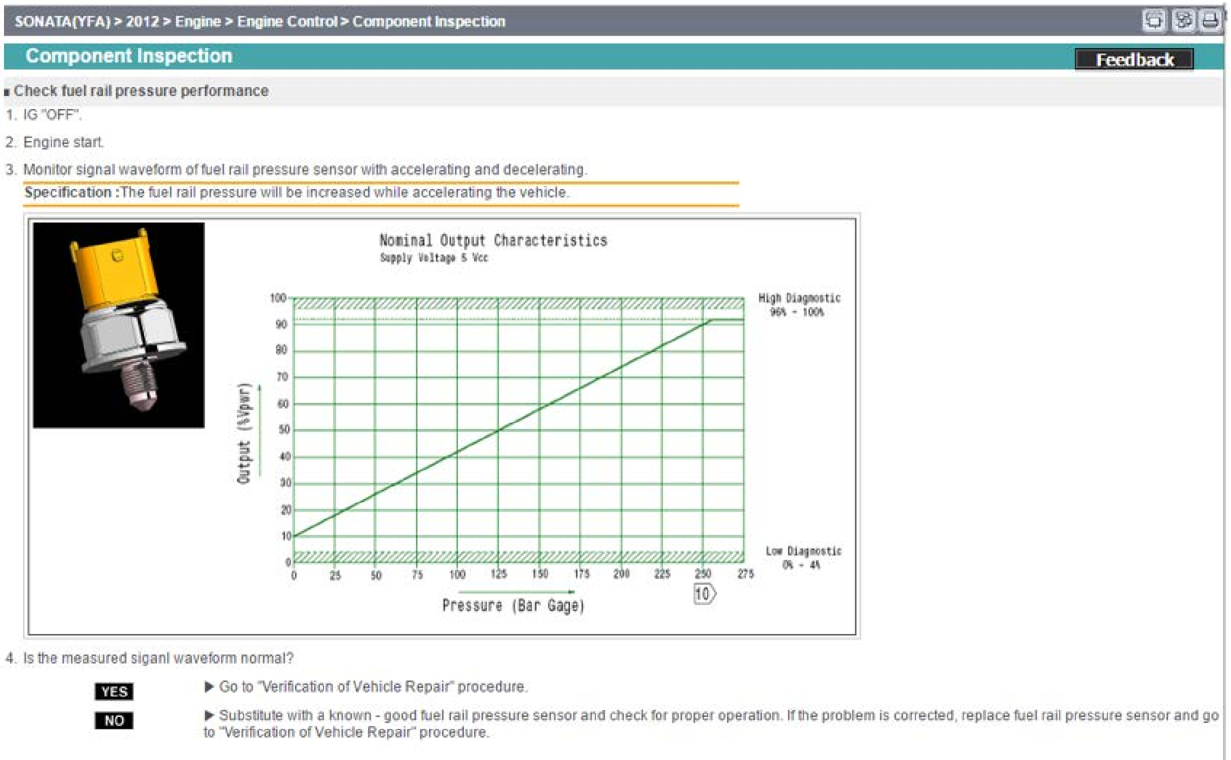
Specification : The fuel rail pressure will be increased while accelerating the vehicle.



YES ▶ Go to "Check injector" as follows.

NO ▶ Repair or replace high pressure pump, and go to "Verification of Vehicle Repair" procedure.

Figure 93 – Note: Exemplary data received from rail pressure sensor regarding the fuel pressure


SONATA(YFA) > 2012 > Engine > Engine Control > Component Inspection

Component Inspection

Feedback

■ Check fuel rail pressure performance

1. IG "OFF".
2. Engine start.
3. Monitor signal waveform of fuel rail pressure sensor with accelerating and decelerating.

Specification : The fuel rail pressure will be increased while accelerating the vehicle.

4. Is the measured siganl waveform normal?

YES ▶ Go to "Verification of Vehicle Repair" procedure.

NO ▶ Substitute with a known - good fuel rail pressure sensor and check for proper operation. If the problem is corrected, replace fuel rail pressure sensor and go to "Verification of Vehicle Repair" procedure.

Figure 94 – Note: Rail pressure sensor voltage signals received by the ECM and used to control the fuel pressure

150. Claim 7 of the ’574 patent recites a fuel delivery system comprising: a fuel rail adapted to deliver fuel to fuel injectors of an automotive vehicle, a fuel pump adapted to deliver fuel to said fuel rail, a fuel pressure sensor adapted to measure the fuel rail pressure, a low-pass filter adapted to filter the output of said fuel pressure sensor to filter out pulses due to the opening and closing of the fuel injectors, and a fuel pump motor controller having: a feed forward controller adapted to provide a feed forward signal having fuel pump motor control parameters based upon a set-point fuel pressure and the average fuel flow through said system; a first summing junction adapted to compare the fuel rail pressure to the set-point fuel pressure and to generate an error value based upon the difference between the fuel rail pressure and the set-point fuel pressure; a feed back controller adapted to receive the error value and to generate a feed back control signal; a second summing junction adapted to receive the feed back control

signal from said feed back controller and the feed forward control signal from the feed forward controller and to modify the fuel pump motor control parameters of the feed forward control signal based upon the feed back control signal to generate a motor controller signal; and a fuel pump motor controller driver adapted to receive the motor controller signal and to control the speed of said fuel pump based upon the motor controller signal.

151. On information and belief, the Accused Instrumentalities infringe claim 7 of the ’574 patent. The Accused Instrumentalities comprise a fuel delivery system comprising: a fuel rail adapted to deliver fuel to fuel injectors of an automotive vehicle, a fuel pump adapted to deliver fuel to said fuel rail, a fuel pressure sensor adapted to measure the fuel rail pressure (*Figures 78-79, 82, 93-94*), a low-pass filter adapted to filter the output of said fuel pressure sensor to filter out pulses due to the opening and closing of the fuel injectors (*Figure 96*), and a fuel pump motor controller (*Figures 19-21*) having: a feed forward controller adapted to provide a feed forward signal (*Figure 94-95*) having fuel pump motor control parameters based upon a set-point fuel pressure and the average fuel flow through said system (*Figures 19-21, 92-93*); a first summing junction adapted to compare the fuel rail pressure to the set-point fuel pressure and to generate an error value based upon the difference between the fuel rail pressure and the set-point fuel pressure (*Figures 19-21, 92-93*); a feed back controller adapted to receive the error value and to generate a feed back control signal (*Figures 19-21*); a second summing junction adapted to receive the feed back control signal from said feed back controller and the feed forward control signal from the feed forward controller and to modify the fuel pump motor control parameters of the feed forward control signal based upon the feed back control signal to generate a motor controller signal (*Figures 19-21*); and a fuel pump motor controller driver

adapted to receive the motor controller signal and to control the speed of said fuel pump based upon the motor controller signal (*Figures 19-21*).

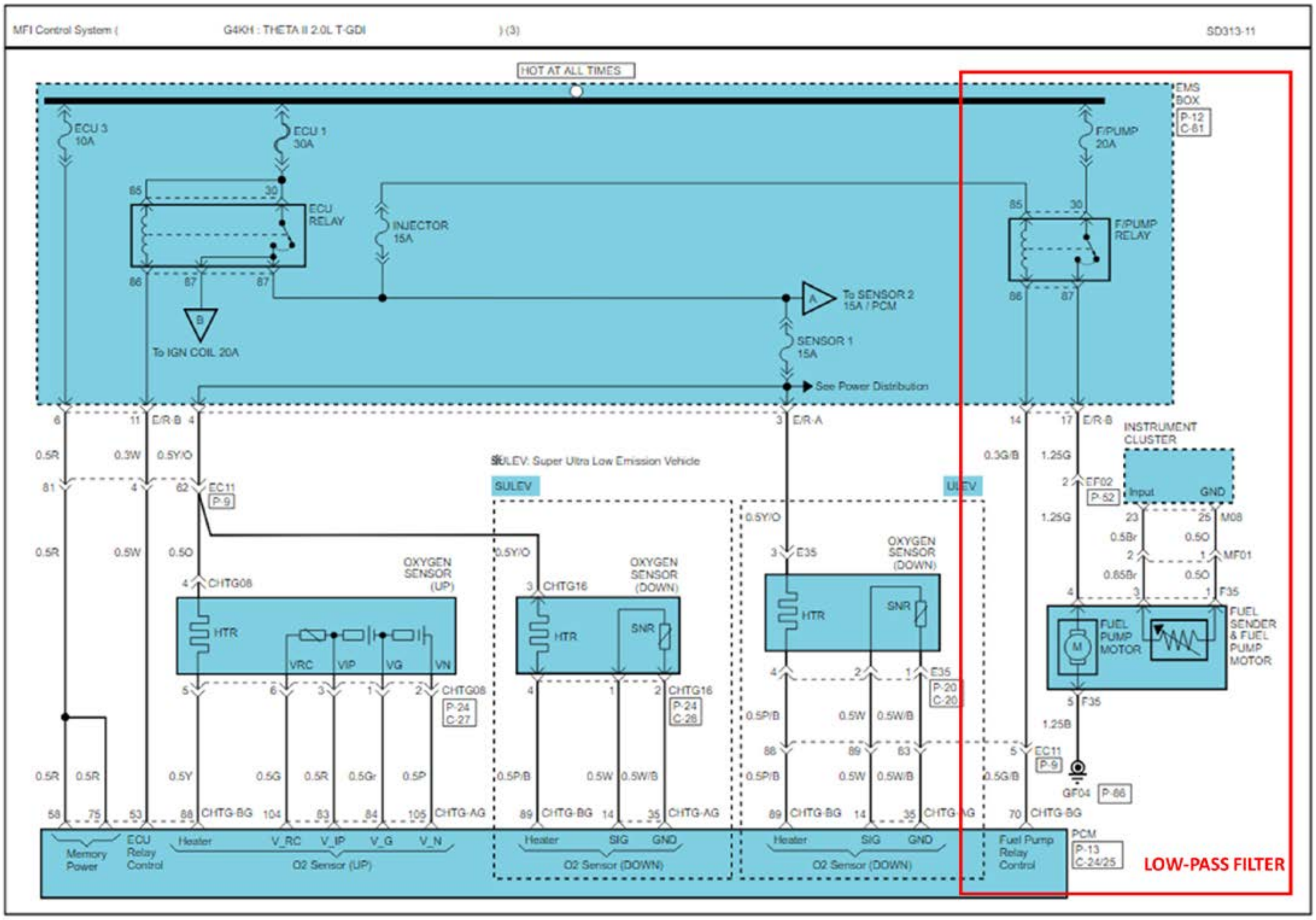


Figure 95- Fuel system signal diagram

152. Claim 13 of the ’574 patent recites a method of controlling the fuel pressure within a fuel delivery system having a fuel pump which delivers fuel to a fuel rail and fuel injectors of an internal combustion engine comprising: providing a set-point fuel pressure; providing the estimated average fuel flow through the system; generating a feed forward control signal based upon the set-point fuel pressure and the average fuel flow; measuring the fuel rail pressure with a fuel pressure sensor; comparing the fuel rail pressure to the set-point fuel

pressure and generating an error signal based upon the difference between the fuel rail pressure and the set-point fuel pressure; modifying the feed forward control signal based upon the error signal thereby generating a motor controller signal and sending the motor control signal to the fuel pump motor; detecting pulses in the signal from the fuel pressure sensor to establish when the fuel injectors open and close; measuring the time between when an injector opens and closes to determine how long the injector is open; using the injector flow rate and the injector open time to calculate the average fuel flow.

153. On information and belief, the Accused Instrumentalities infringe claim 13 of the ’574 patent. The Accused Instrumentalities practice a method of controlling the fuel pressure within a fuel delivery system (*Figures 17-21*) having a fuel pump which delivers fuel to a fuel rail and fuel injectors of an internal combustion (*Figures 80-82*) engine comprising: providing a set-point fuel pressure (*Figures 90-95*); providing the estimated average fuel flow through the system; generating a feed forward control signal (*Figure 95*) based upon the set-point fuel pressure and the average fuel flow; measuring the fuel rail pressure with a fuel pressure sensor (*Figures 90-95*); comparing the fuel rail pressure to the set-point fuel pressure and generating an error signal based upon the difference between the fuel rail pressure and the set-point fuel pressure (*Figures 90-95*); modifying the feed forward control signal based upon the error signal thereby generating a motor controller signal and sending the motor control signal to the fuel pump motor; detecting pulses in the signal from the fuel pressure sensor to establish when the fuel injectors open and close; measuring the time between when an injector opens and closes to determine how long the injector is open; using the injector flow rate and the injector open time to calculate the average fuel flow (*Figures 90-95*).

COUNT XVII – INFRINGEMENT OF U.S. PATENT NO. 6,609,497

154. The allegations set forth in the foregoing paragraphs 1 through 153 are incorporated into this Seventeenth Claim for Relief.

155. On August 26, 2003, U.S. Patent No. 6,609,497 ("the '497 patent"), entitled "*Method for Determining MBT Timing In an Internal Combustion Engine*," was duly and legally issued by the United States Patent and Trademark Office. A true and correct copy of the '497 patent is attached as Exhibit 17.

156. Plaintiff is the assignee and owner of the right, title and interest in and to the '497 patent, including the right to assert all causes of action arising under said patents and the right to any remedies for infringement of them.

157. Upon information and belief, Defendants have directly infringed at least claims 1 and 11 of the '497 patent by making, using, selling, importing and/or providing and causing to be used the 2011-2017 Hyundai Sonata (2.0L), 2010-2017 Hyundai Genesis Coupe (2.0L), 2013-2017 Hyundai Santa Fe (2.0L), 2011-2017 Hyundai Sonata (2.4L), 2010-2017 Hyundai Tucson (2.4L), 2010-2017 Hyundai Santa Fe (2.4L) (the "Accused Instrumentalities").

158. Upon information and belief, the Accused Instrumentalities incorporate the Theta II Engine which practices a method of controlling an internal combustion engine.

159. In particular, claim 1 of the '497 patent recites a method of controlling an internal combustion engine, said engine having at least one cylinder, said method comprising the steps of: measuring the combustion pressure in said at least one cylinder at at least two discrete times during a combustion cycle; calculating a net combustion pressure change in said at least one cylinder based on said measured combustion pressures; calculating the second derivative of said net combustion pressure change; calculating the maximum acceleration point of said net combustion pressure change from said second derivative of said net combustion pressure change;

and varying the spark timing of said engine until said maximum acceleration point is aligned with top dead center to achieve maximum braking torque spark timing.

160. On information and belief, the Accused Instrumentalities infringe claim 1 of the '497 patent. The Accused Instrumentalities practice a method of controlling an internal combustion engine (*Figures 17-21*), said engine having at least one cylinder (*Figures 1, 98*), said method comprising the steps of: measuring the combustion pressure in said at least one cylinder at at least two discrete times during a combustion cycle (*Figure 69-71, 97, 100-103*); calculating a net combustion pressure change in said at least one cylinder based on said measured combustion pressures; calculating the second derivative of said net combustion pressure change (*Figures 19-21, 100-106*); calculating the maximum acceleration point of said net combustion pressure change from said second derivative of said net combustion pressure change *(Figures 19-21, 100-106*); and varying the spark timing of said engine until said maximum acceleration point is aligned with top dead center to achieve maximum braking torque spark timing (*Figures 19-21, 100-106*).

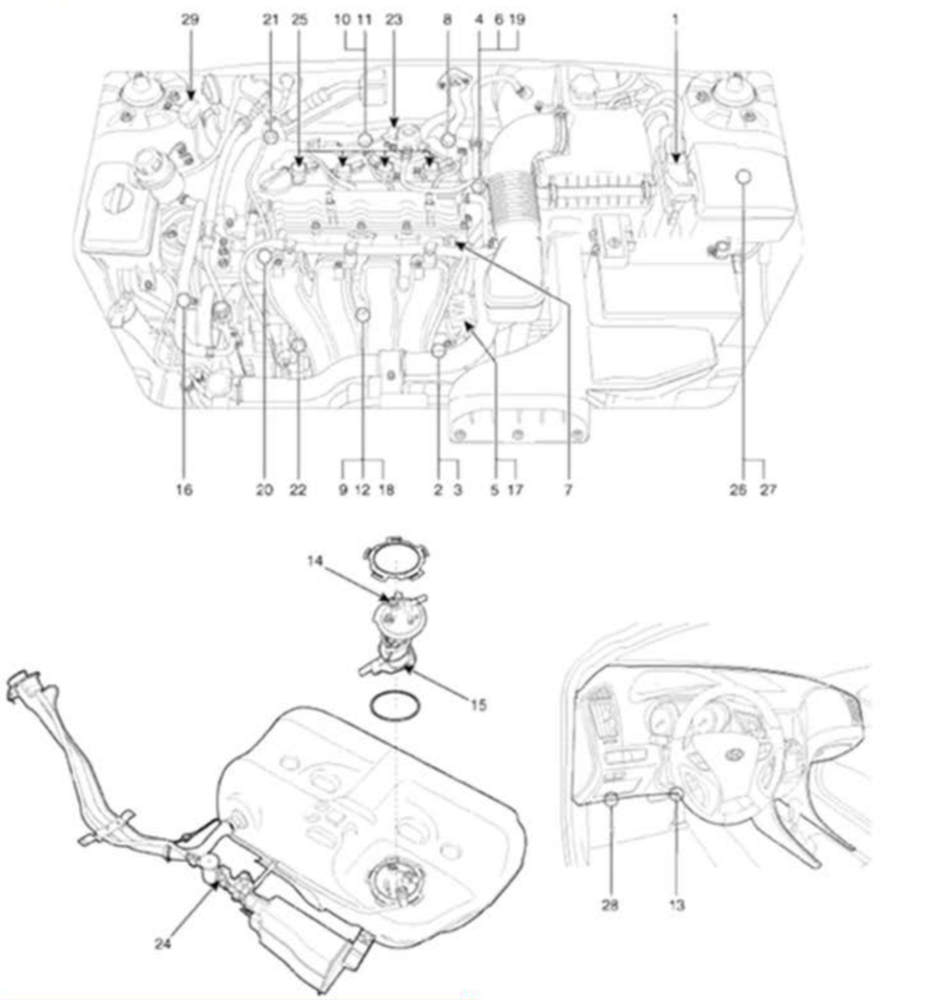
Specifications

Description	Specifications	Limit
General		
Type	In-line, DOHC	
Number of cylinders	4	
Bore	88mm (3.464in)	
Stroke	97mm (3.819in)	
Total displacement	2359cc (143.90cu.in)	
Compression ratio	11.3 ± 0.3 : 1	

Figure 96- Theta II Specifications

Fuel System > Engine Control System > Components and Components Location

Components Location



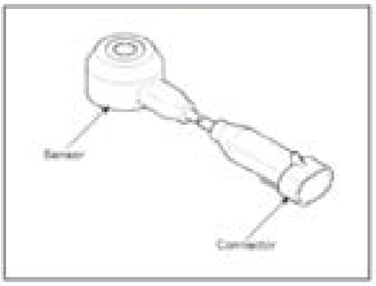
1. Engine Control Module (ECM)	16. A/C Pressure Transducer (APT)
2. Manifold Absolute Pressure Sensor (MAPS)	17. ETC Motor [integrated into ETC Module]
3. Intake Air Temperature Sensor (IATS)	18. Injector
4. Engine Coolant Temperature Sensor (ECTS)	19. Purge Control Solenoid Valve (PCSV)
5. Throttle Position Sensor (TPS) [integrated into ETC Module]	20. CVVT Oil Control Valve (OCV) [Bank 1 / Intake]
6. Crankshaft Position Sensor (CKPS)	21. CVVT Oil Control Valve (OCV) [Bank 1 / Exhaust]
7. Camshaft Position Sensor (CMPS) [Bank 1 / Intake]	22. Variable Intake Solenoid (VIS) Valve
8. Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]	23. Fuel Pressure Regulator Valve
9. Knock Sensor (KS)	24. Canister Close Valve (CCV)
10. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 1]	25. Ignition Coil
11. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2]	26. Main Relay
12. Rail Pressure Sensor (RPS)	27. Fuel Pump Relay
13. Accelerator Position Sensor (APS)	28. Data Link Connector (DLC) [16-Pin]
14. Fuel Tank Pressure Sensor (FTPS)	29. Multi-Purpose Check Connector [20-Pin]
15. Fuel Level Sensor (FLS)	

Figure 97 - Engine Control System components location

Fuel System > Engine Control System > Knock Sensor (KS) > Description and Operation

Description

Knocking is a phenomenon characterized by undesirable vibration and noise and can cause engine damage. Knock Sensor (KS) is installed on the cylinder block and senses engine knocking.
When knocking occurs, the vibration from the cylinder block is applied as pressure to the piezoelectric element. When a knock occurs, the sensor produces voltage signal. The ECM retards the ignition timing when knocking occurs. If the knocking disappears after retarding the ignition timing, the ECM will advance the ignition timing. This sequential control can improve engine power, torque and fuel economy.



Fuel System > Engine Control System > Knock Sensor (KS) > Specifications

Specification

Item	Specification
Capacitance (pF)	850 ~ 1,150

Figure 98 - Engine control system incorporating a piezo-electric element

Fuel System > Engine Control System > CVVT Oil Control Valve (OCV) > Description and Operation

Description

Continuous Variable Valve Timing (CVVT) system advances or retards the valve timing of the intake and exhaust valve in accordance with the ECM control signal which is calculated by the engine speed and load.
By controlling CVVT, the valve over-lap or under-lap occurs, which makes better fuel economy and reduces exhaust gases (NOx, HC) and improves engine performance through reduction of pumping loss, internal EGR effect, improvement of combustion stability, improvement of volumetric efficiency, and increase of expansion work.
This system consist of
-the CVVT Oil Control Valve (OCV) which supplies the engine oil to the cam phaser or cuts the engine oil from the cam phaser in accordance with the ECM PWM (Pulse With Modulation) control signal,

Page 96 of 123

- the CVVT Oil Temperature Sensor (OTS) which measures the engine oil temperature,
-and the Cam Phaser which varies the cam phase by using the hydraulic force of the engine oil.
The engine oil getting out of the CVVT oil control valve varies the cam phase in the direction (Intake Advance/Exhaust Retard) or opposite direction (Intake Retard/Exhaust Advance) of the engine rotation by rotating the rotor connected with the camshaft inside the cam phaser.

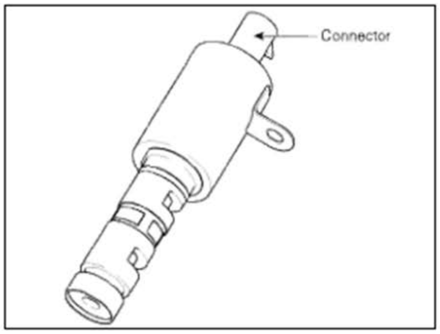


Figure 99- Description of CVVT sensor which issued to vary the cam phase based on the engine pressure

161. Claim 11 of the ’497 patent recites a method of controlling an internal combustion engine, said engine having at least one cylinder, said method comprising the steps of: measuring the combustion pressure in said at least one cylinder at at least two discrete intervals of a crank angle of at least one degree during a combustion cycle; calculating a net combustion pressure change in said at least one cylinder based on said measured combustion pressures; calculating the second derivative of said net combustion pressure change; calculating the maximum acceleration point of said net combustion pressure change from said second derivative of said net combustion

pressure change; and varying the spark timing of said engine until said maximum acceleration point is aligned with top dead center to achieve maximum braking torque spark timing.

162. On information and belief, the Accused Instrumentalities infringe claim 11 of the ’497 patent. The Accused Instrumentalities practice a method a method of controlling an internal combustion engine (*Figures 17-21*), said engine having at least one cylinder, said method comprising the steps of: measuring the combustion pressure in said at least one cylinder (*Figures 1, 96*) at at least two discrete intervals of a crank angle of at least one degree during a combustion cycle; calculating a net combustion pressure change in said at least one cylinder based on said measured combustion pressures (*Figures 19-21, 100-106*); calculating the second derivative of said net combustion pressure change (*Figures 19-21, 100-106*); calculating the maximum acceleration point of said net combustion pressure change from said second derivative of said net combustion pressure change (*Figures 19-21, 100-106*); and varying the spark timing of said engine until said maximum acceleration point is aligned with top dead center to achieve maximum braking torque spark timing (*Figures 19-21, 100-106*).

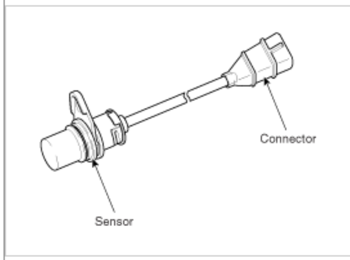
SONATA(YFA) > 2012 > Engine > Engine Control > Description

Description

Feedback

Crankshaft Position Sensor (CKPS) detects the crankshaft position and is one of the most important sensors of the engine control system. If there is no CKPS signal input, the engine may stop because of CKPS signal missing. This sensor is installed on the cylinder block or the transaxle housing and generates alternating current by magnetic flux field which is made by the sensor and the target wheel when engine runs.

The target wheel consists of 58 slots and 2 missing slots on 360 degrees CA (Crank Angle).



SONATA(YFA) > 2012 > Engine > Engine Control > General Description

General Description

Feedback

The Crankshaft Position Sensor (CKPS) is a hall effect type sensor that generates voltage using a sensor and a target wheel mounted on the crankshaft; there are 58 slots in the target wheel where one is longer than the others. When the slot in the wheel aligns with the sensor, the sensor voltage outputs low. When the metal (tooth) in the wheel aligns with the sensor, the sensor voltage outputs high. During one crankshaft rotation there are 58 rectangular signals and one longer signal. The PCM calculates engine RPM by using the sensor' s signal and controls the injection duration and the ignition timing. Using the signal differences caused by the longer slot, the PCM identifies which cylinder is at top dead center.

Hyundai Service Website - Google Chrome

Hyundai Motor America [US] | https://www.hyundaitechinfo.com/viewer/content_pop.aspx?content_no=DTC|ENG|2684|2011||en|97||&sitinfolist=14^1420^142...

SONATA(YFA) > 2011 > Engine > Engine Control > General Description

General Description

Feedback

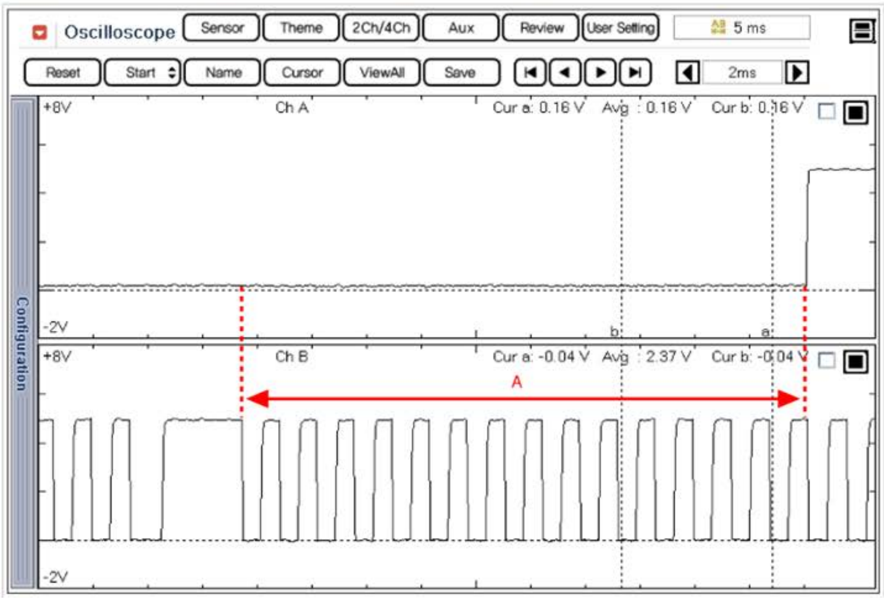
Cylinder compression pressure of the turbo engine is higher than non-turbo gasoline engine. Therefore pre-ignition in turbo engine brings damages of cylinder block and spark plug, piston. PCM monitors the signal of knock sensor to detect pre-ignition in each cylinder. PCM limits maximum torque by rich lamda control, reducing load, retarding ignition timing and reducing valve overlap when it detects pre-ignition.

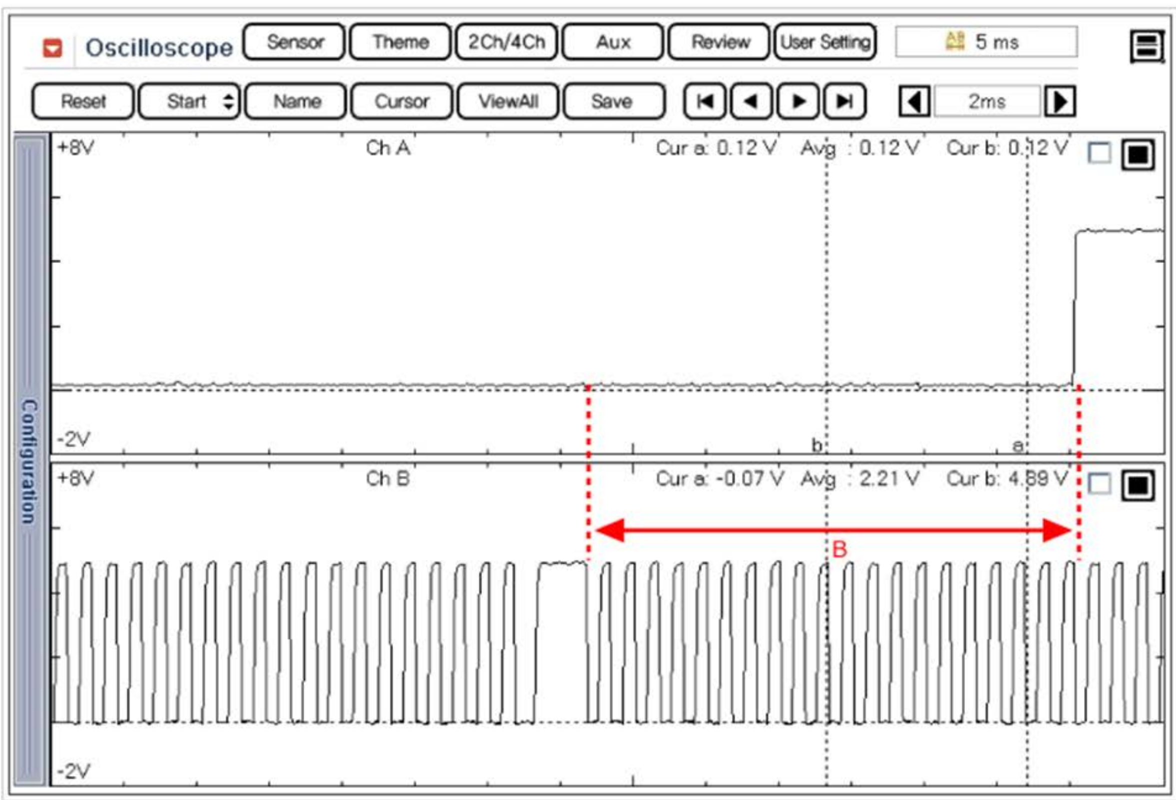
Figure 100 – Note: Crankshaft position sensor provides crank angle; Description of PCM controlling pre-ignition sensor which provides cylinder data

SONATA(YFA) > 2012 > Engine > Engine Control > Forme d'onde de signal et données

Signal Waveform & Data Feedback

1. Set up an oscilloscope as follows :
   Channel A (+): Signal terminal of the CMPS #2(back probe), (-): ground
   Channel B (+): Signal terminal of the CKPS(back probe), (-): ground
2. Start the engine and check for signal waveform compared with reference waveform as below.





A : CMPS and CKPS waveform of exhaust shaft at idle
B : CMPS and CKPS waveform of exhaust cam shaft at acceleration
(Tooth number is changed by CVVT operation)

Figure 101 – Waveform camshaft and crankshaft data gathered from CMPS and CKPS

ECM MISFIRE DETECTION METHOD

It can be tough to hear or feel a misfire, which is one reason why new emissions-control standards require the on-board diagnostics (OBD-II) of the engine control module (ECM) to monitor each cylinder for misfire.

Engine misfire detection is based on the difference of engine rotational speed between the firing cylinders and the missing cylinder. When a cylinder is misfiring, it takes a "longer time" for the crankshaft to rotate to the next cylinder in the firing order. This "time" is measured by the crankshaft angle sensor (CAS) which measures the actual rotational travel of the crankshaft in real time. This information is evaluated by the ECM. If the misfiring cylinder took "longer" to rotate the crankshaft than the other cylinders, the ECM will set the appropriate diagnostic trouble code (DTC) for that cylinder. As an example; an inline 4 cylinder engine's crankshaft rotates 180° as each cylinder fires through the firing order. In a properly running engine with a firing order of 1-3-4-2, the time between the firing of 1-3 will be the same as 3-4, 4-2, and 2-1. In an engine that has a misfire in cylinder #2; it takes the crankshaft longer to travel through the 2-1 firing rotation.

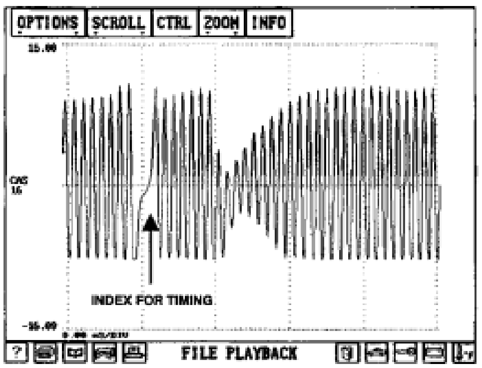
The repair of today's misfire is more difficult than pre-OBD-II vehicles because the ECM is programmed to detect the slightest change of crankshaft rotational speed. The criteria for detecting a misfire is set by the Federal Government and all vehicles sold in the U.S. must comply with these requirements. The engine management system must be able to perform three critical elements of misfire detection:

1. Monitor, identify and if severe enough, illuminate the "check engine" light for a misfiring cylinder;
2. Set separate diagnostic trouble codes for multiple cylinders;
3. During a misfire great enough to damage the catalyst, the "check engine" light must blink.

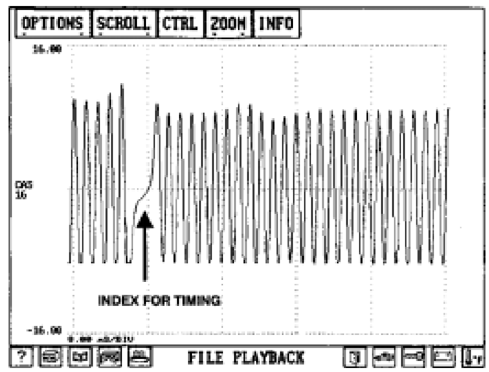
Figure 102- Note: ECM Misfire detection method

Crank Angle Sensor and Crankshaft Tone Wheel

The crank angle sensor (CAS) and crankshaft tone wheel work together to provide the ECM top dead center (crankshaft position) information. The tone wheel is mounted to the crankshaft and rotates with the crank. The CAS is mounted 0.020 - 0.059" from the tone wheel. As the tone wheel rotates past the CAS, the signal appears as shown in graphs 1 & 2 on HDS. Large voltage "drop-outs" can be an indicator of a loose or damaged tone wheel causing random and specific misfire codes (P0300, P0301, P0302 etc.).



The above example shows a damaged CAS at idle. Notice the drastic abnormal change of the amplitude of the CAS.



The above example shows normal CAS viewed on HDS for Accent and Elantra engine control systems at idle. Notice the consistency of the signal amplitude (height).

A loose tone wheel can quickly be checked while the CAS is removed from the engine. Use a long, narrow, flat blade screwdriver to push, pull and/or pry on the tone wheel through the CAS hole. Any movement of the tone wheel indicates its loose. The tone wheel is mounted to the crankshaft with four screws.

Coolant Temperature and Intake Air Temperature Sensor

The Hyundai scan tool should be used to measure the engine coolant temperature and the intake air temperature. When the engine is cold, both values should be near the ambient temperature. When the engine reaches operating temperature, verify that the coolant temperature reads higher than the intake air temperature. This check rules out any possibility that the wire harness connectors might have been inadvertently switched, or that there is a faulty sensor.

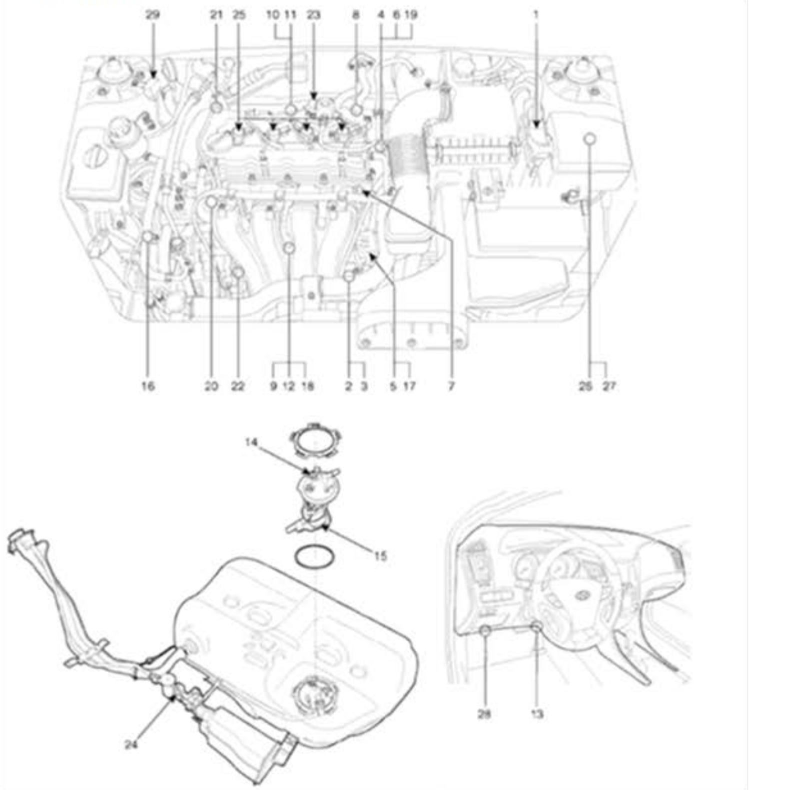
Oxygen (O_2) Sensor

If any misfire code is accompanied by an oxygen sensor code, repair the oxygen sensor code before attempting to repair the misfire code. Oxygen sensors that malfunction can cause excessive carbon in the cylinders, thus causing a misfire. If the carbon build-up is verified, consider the top engine cleaner treatment before proceeding with repairing the misfire code. Refer to TSB 97-36-004 for proper diagnosis of the oxygen sensor.

Figure 103-Note: Crank angle sensor description

Fuel System > Engine Control System > Components and Components Location

Components Location



1. Engine Control Module (ECM)	16. A/C Pressure Transducer (APT)
2. Manifold Absolute Pressure Sensor (MAPS)	17. ETC Motor [integrated into ETC Module]
3. Intake Air Temperature Sensor (IATS)	18. Injector
4. Engine Coolant Temperature Sensor (ECTS)	19. Purge Control Solenoid Valve (PCSV)
5. Throttle Position Sensor (TPS) [integrated into ETC Module]	20. CVVT Oil Control Valve (OCV) [Bank 1 / Intake]
6. Crankshaft Position Sensor (CKPS)	21. CVVT Oil Control Valve (OCV) [Bank 1 / Exhaust]
7. Camshaft Position Sensor (CMPS) [Bank 1 / Intake]	22. Variable Intake Solenoid (VIS) Valve
8. Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]	23. Fuel Pressure Regulator Valve
9. Knock Sensor (KS)	24. Canister Close Valve (CCV)
10. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 1]	25. Ignition Coil
11. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2]	26. Main Relay
12. Rail Pressure Sensor (RPS)	27. Fuel Pump Relay
13. Accelerator Position Sensor (APS)	28. Data Link Connector (DLC) [16-Pin]
14. Fuel Tank Pressure Sensor (FTPS)	29. Multi-Purpose Check Connector [20-Pin]
15. Fuel Level Sensor (FLS)	

The engine control system comprises the knock sensor.

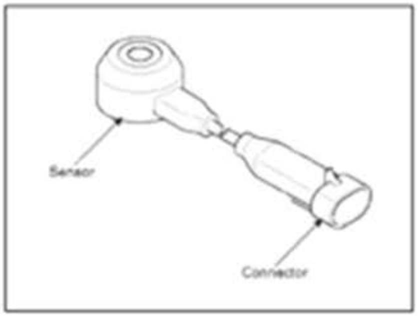
Figure 104 - CVVT waveform and data analysis

Fuel System > Engine Control System > Knock Sensor (KS) > Description and Operation

Description

Knocking is a phenomenon characterized by undesirable vibration and noise and can cause engine damage. Knock Sensor (KS) is installed on the cylinder block and senses engine knocking.

When knocking occurs, the vibration from the cylinder block is applied as pressure to the piezoelectric element. When a knock occurs, the sensor produces voltage signal. The ECM retards the ignition timing when knocking occurs. If the knocking disappears after retarding the ignition timing, the ECM will advance the ignition timing. This sequential control can improve engine power, torque and fuel economy.



Fuel System > Engine Control System > Knock Sensor (KS) > Specifications

Specification

Item	Specification
Capacitance (pF)	850 ~ 1,150

The PCM calculates combustion pressure derived from the knock sensor input.

Cylinder pressure

SONATA(YFA) > 2012 > G 2.0 T-GDI > Engine > Engine Control > P039B Cylinder 1 Pressure Too High

DTC Description Feedback

PCM sets DTC P039B if the PCM detects pre-ignition of cylinder 1.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Knock sensor signal monitoring	1. Abnormal engine oil level 2. Faulty spark plug 3. Clogging of injector
EnableConditions	• Engine coolant is higher than 30°C (86°F) • Engine speed is higher than 1200 RPM • Engine speed is lower than 4500 RPM • Mass air flow road is greater than 50% • Mass air flow road is less than 100% • Mass air flow is more than 500mg/stroke	
Threshold value	• More than 3 pre-ignition are detected in 600 stroke	
Diagnosis Time	• Immediately	
MIL On Condition	• No MIL	
Limp Home	• Actual torque is limited lower than 75% of target torque	

Cylinder pressure measured by knock sensor

As shown above, DTC P039B corresponds to a condition where Cylinder 1 pressure is too high (implying that at least combustion pressure is measured). The PCM calculates combusting pressure derived from the knock sensor input.

Hyundai Service Website - Google Chrome

Hyundai Motor America [US] | https://www.hyundaitechinfo.com/viewer/content_pop.aspx?content_no=DTC|ENG|2684|2012||en|97||&sitinfolist=14^14...

SONATA(YFA) > 2012 > Engine > Engine Control > General Description

General Description Feedback

Cylinder compression pressure of the turbo engine is higher than non-turbo gasoline engine. Therefore pre-ignition in turbo engine brings damages of cylinder block and spark plug, piston. PCM monitors the signal of knock sensor to detect pre-ignition in each cylinder. PCM limits maximum torque by rich lamda control, reducing load, retarding ignition timing and reducing valve overlap when it detects pre-ignition.

SONATA(YFA) > 2012 > G 2.0 T-GDI > Engine > Engine Control > P039B Cylinder 1 Pressure Too High

DTC Description Feedback

PCM sets DTC P039B if the PCM detects pre-ignition of cylinder 1.

DTC Detecting Condition

Item	Detecting Condition	Possible cause
DTC Strategy	• Knock sensor signal monitoring	
EnableConditions	• Engine coolant is higher than 30°C (86°F) • Engine speed is higher than 1200 RPM • Engine speed is lower than 4500 RPM • Mass air flow road is greater than 50% • Mass air flow road is less than 100% • Mass air flow is more than 500mg/stroke	1. Abnormal engine oil level 2. Faulty spark plug 3. Clogging of injector
Threshold value	• More than 3 pre-ignition are detected in 600 stroke	
Diagnosis Time	• Immediately	
MIL On Condition	• No MIL	
Limp Home	• Actual torque is limited lower than 75% of target torque	

The ECM/PCM has the ability to detect cylinder pressure as demonstrated by the Diagnostic Trouble Code (DTC) shown above. Upon information and belief, the ECM/PCM calculates a second derivative of a net combustion pressure change.

Figure 105

SONATA(YFA) > 2012 > G 2.0 T-GDI > Engine > Engine Control > P0326 Knock Sensor 1 Circuit Range/Performance (Bank 1 or Single Sensor)

Component Location Feedback

General Description

The knock sensor is attached to the cylinder block and senses engine knocking. The sensor contains a piezoelectric element that converts vibration (or noise) into voltage signal and sends this signal to PCM. With input signals from camshaft position and crankshaft position sensor, PCM can identify which cylinder is knocking. PCM filters vibrations and determines if the vibrations are knocking signal. The Engine Control Module (PCM) uses this signal to suppress knocking by retarding ignition timing. The PCM will set a code (Malfunction Indicator Lamp will Not turn on) if during two driving cycles the Knock sensor"s output voltage falls below minimum threshold. This code indicates an unexpected vibration is being read by the Knock sensor or PCM under normal engine operation.

DTC Description

The PCM monitors the range of the analog input signal from knock sensor to check sensor failure that is short circuit or open circuit. If the difference between knock signal and noise level is smaller than the threshold during defined time period, the DTC P0326 is set. P0326 will also set if the nose value exceeds the minimum or maximum thresholds.

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Plausibility check	
Enable Conditions	• Knock detection function active • Engine rpm >2700 rpm • Air mass >0.5g/rev(250mg/tdc.) • No relevant failure	1. Open/short in signal or ground circuit 2. Poor connection or damaged harness 3. Faulty knock sensor
Threshold Value	• Difference between the processed knock sensor signal and its mean does not exceed a threshold(0.08V) & the integral of the processed knock sensor signal does not reach the threshold(3V) for cylinders 2 and 3 • If the mean processed knock sensor signal of any one cylinder leaves the valid range(0.1V~4.5V).	
Diagnostic Time	• 100 rev.	
Mil On Condition	• -	

The ECM/PCM has the ability to retard ignition timing (vary spark timing) as demonstrated by the general description of the Diagnostic Trouble Code (DTC) shown above. On information and belief, the ECM/PCM varies the spark timing of the engine until maximum acceleration

point is aligned with top dead center to achieve maximum braking torque spark timing because such alignment leads to greater efficiency in engine operation.
Figure 106

COUNT XVIII – INVIIIFRINGEMENT OF U.S. PATENT NO. 6,571,157

163. The allegations set forth in the foregoing paragraphs 1 through 162 are incorporated into this Eighteenth Claim for Relief.

164. On May 23, 2003, U.S. Patent No. 6,571,157 ("the '157 patent"), entitled "*Oil Pressure Diagnostic Strategy for a Hybrid Electric Vehicle*," was duly and legally issued by the United States Patent and Trademark Office. A true and correct copy of the '157 patent is attached as Exhibit 18.

165. Plaintiff is the assignee and owner of the right, title and interest in and to the '157 patent, including the right to assert all causes of action arising under said patents and the right to any remedies for infringement of them.

166. Upon information and belief, Defendants have directly infringed at least claims 1, 14, and 17 of the '157 patent by making, using, selling, importing and/or providing and causing to be used the 2011-2017 Hyundai Sonata Hybrid (the "Accused Instrumentalities").

167. Upon information and belief, the Accused Instrumentalities incorporate the Theta II Engine which comprises a diagnostic system for controlling an engine low oil pressure indicator in a hybrid electric vehicle.

168. In particular, claim 1 of the '157 patent recites a diagnostic system for controlling an engine low oil pressure indicator in a hybrid electric vehicle, comprising: a powertrain having an engine and an electric traction motor; an oil pressure sensor/sending unit mechanically connected to the engine; an engine speed sensor/sending unit mechanically connected to the engine; a controller having connections to the oil pressure sensor and engine speed sensor; a low oil pressure indicator electrically connected to the controller; a mode selector having modes for

"off" and "run/start"; and the controller configured to prevent activation of the low oil pressure indicator when the mode selector is in the "run/start" mode and the engine is not running.

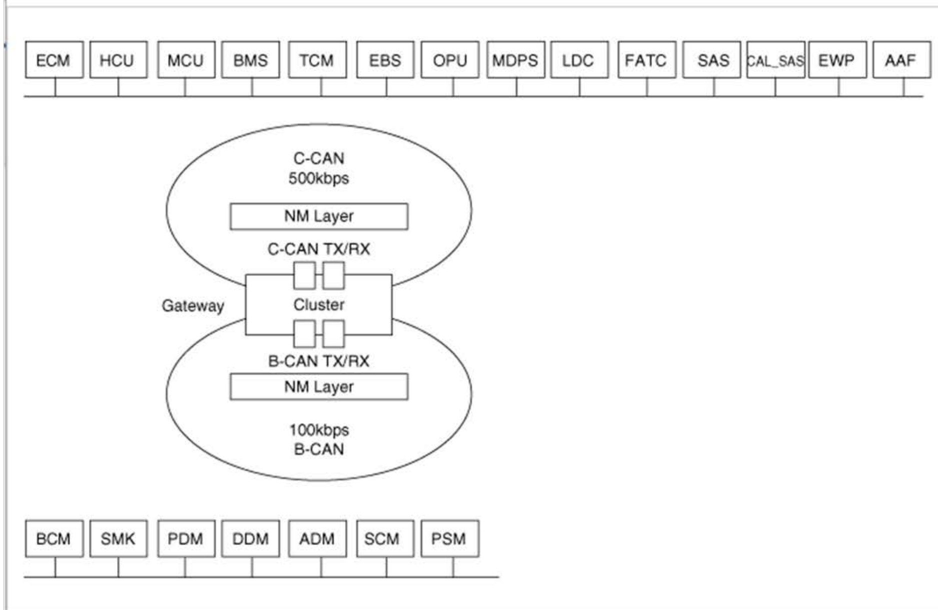
169. On information and belief, the Accused Instrumentalities infringe claim 1 of the '157 patent. The Accused Instrumentalities comprise a diagnostic system for controlling an engine low oil pressure indicator in a hybrid electric vehicle (*Figures 107-111*), comprising: a powertrain having an engine and an electric traction motor (*Figures 112-115*); an oil pressure sensor/sending unit mechanically connected to the engine (*Figures 116-117*); an engine speed sensor/sending unit mechanically connected to the engine (*Figure 118*); a controller having connections to the oil pressure sensor and engine speed sensor (*Figures 119, 121-122*); a low oil pressure indicator electrically connected to the controller (*Figures 119, 121-122*); a mode selector having modes for "off" and "run/start" (*Figure 120*); and the controller configured to prevent activation of the low oil pressure indicator when the mode selector is in the "run/start" mode and the engine is not running (*Figure 121*).

SONATA Hybrid(YF HEV) > 2012 > Immobilizer > Immobilizer > Description

Description

Feedback

Cluster Network Diagram



ECM	Engine Control Module
HCU	Hybrid Control Module
MCU	Motor Control Module
BMS	Battery Management System
TCM	Transaxle Control Module
EBS	Electronic Brake System
OPU	Oil Pump Unit
MDPS	Motor Driving Power Steering
LDC	Low DC/DC Converter
FATC	Full Automatic Temperature Control
EWP	Electronic Water Pump
AAF	Active Air Flap
BCM	Body Control Module
SMK	Smart Key unit
PDM	Power Distribution Module
DDM	Driver Door Module
ADM	Assist Door Module
SCM	Steering Control Module
PSM	Power Seat Module

SONATA Hybrid(YF HEV) > 2012 > Engine > Engine Control > Description générale

General Description

Feedback

A communication line exists between the Engine Control Module(PCM) and the Transaxle Control Module(TCM). The communication is through a Control Area Network(CAN). Without CAN communication, an independent pin and wiring is needed to receive a sensor information from a PCM. The more information to be communicated, the more wirings is required. In case of CAN communication type, all the information need to be communicated among control modules such as PCM and ABS control module use CAN lines.

Figure 107- Note: Hybrid CAN Controller System description

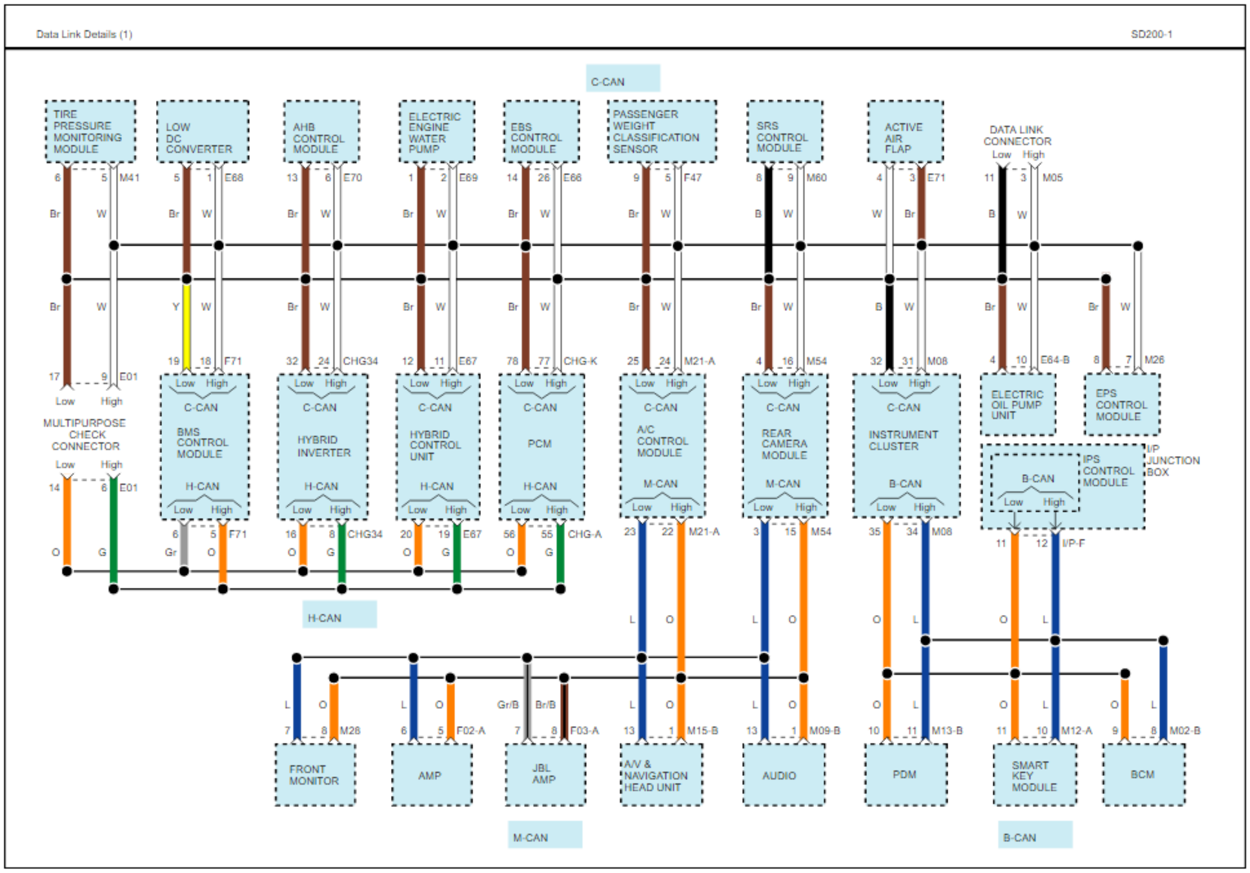


Figure 108 - Hybrid CAN Data Link Details

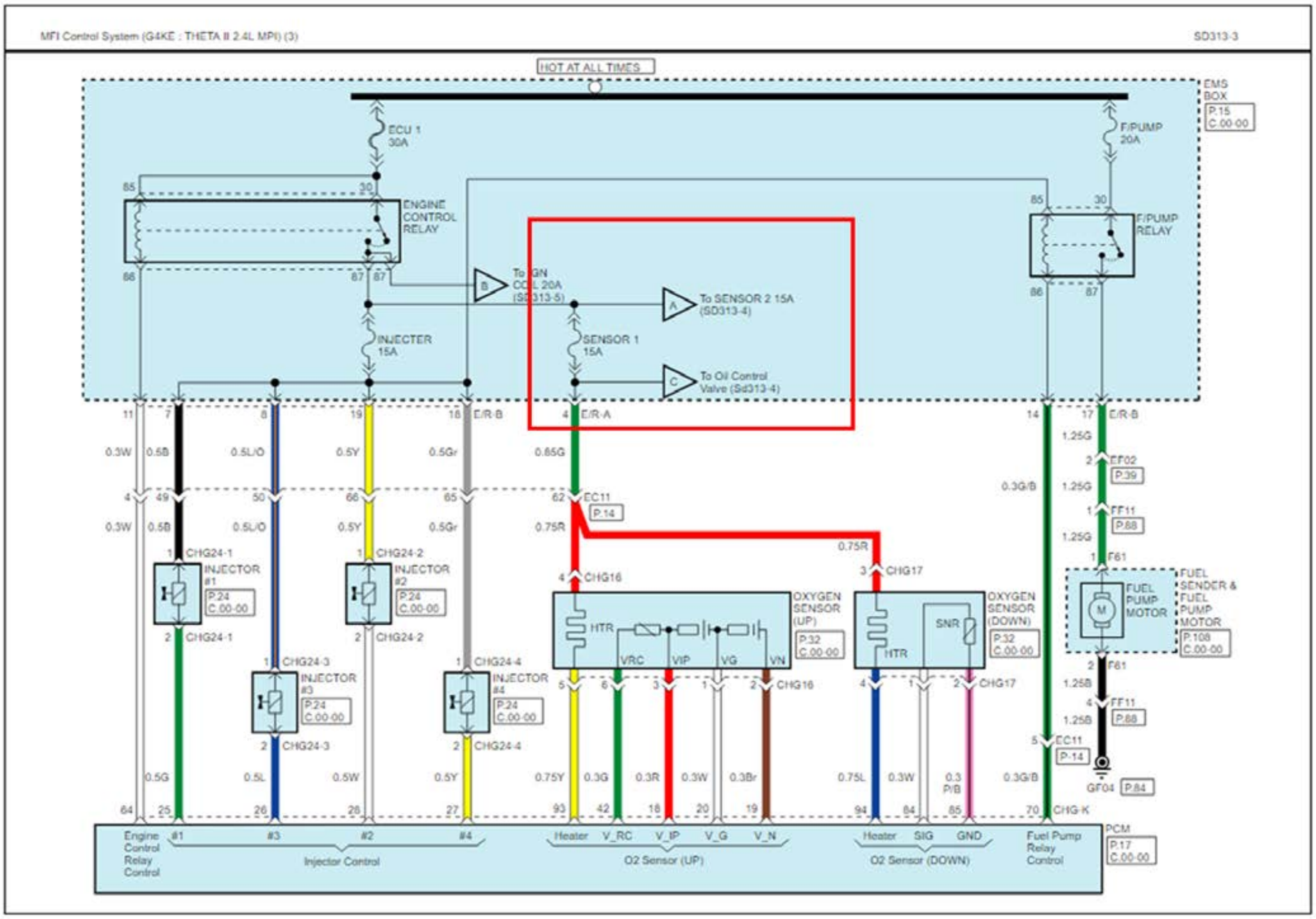


Figure 109 -Note: Hybrid CAN system with oil control valve and sensor which gathers oil pressure data

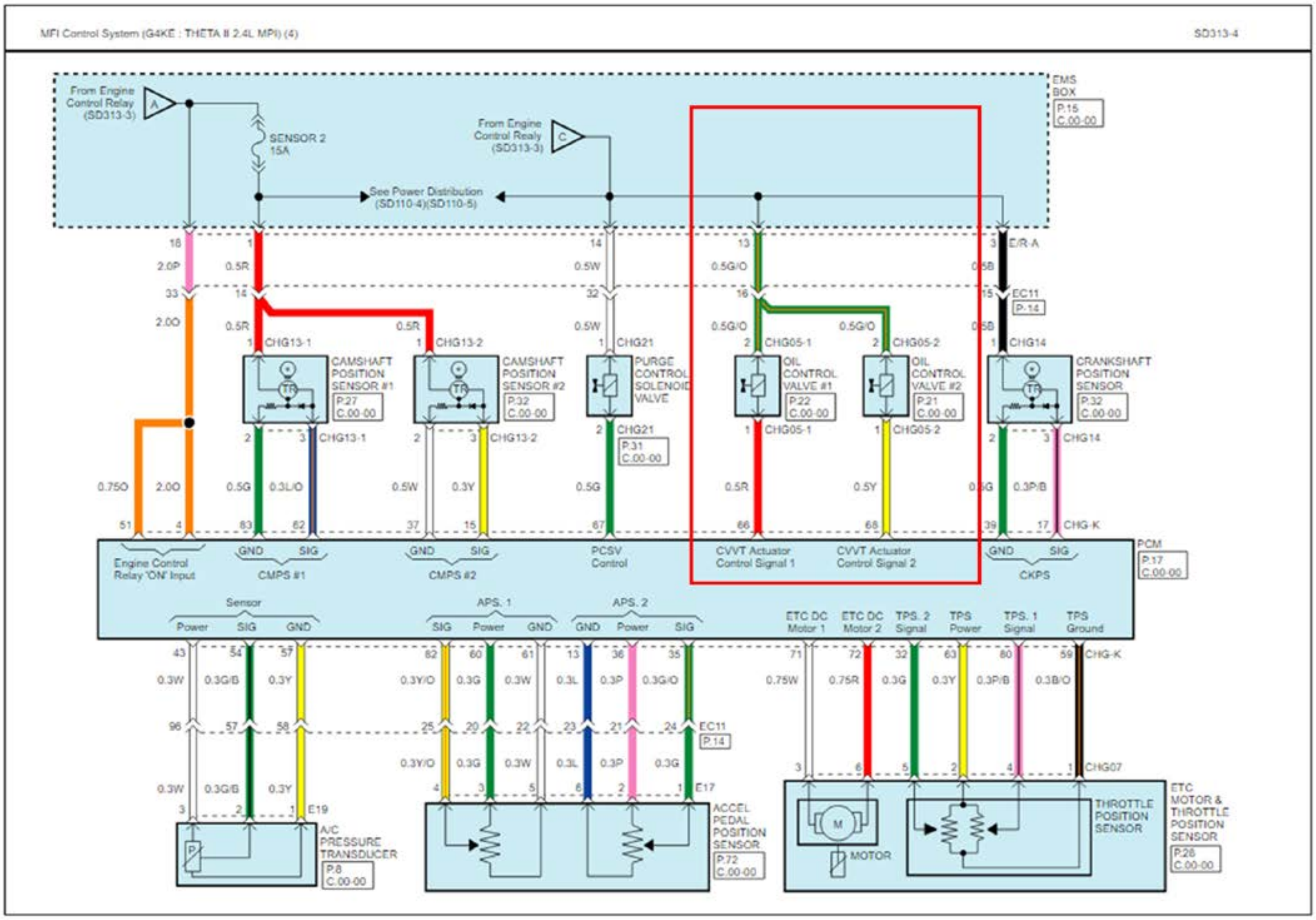


Figure 110 - Hybrid Oil Control valves and CVVT actuator signal

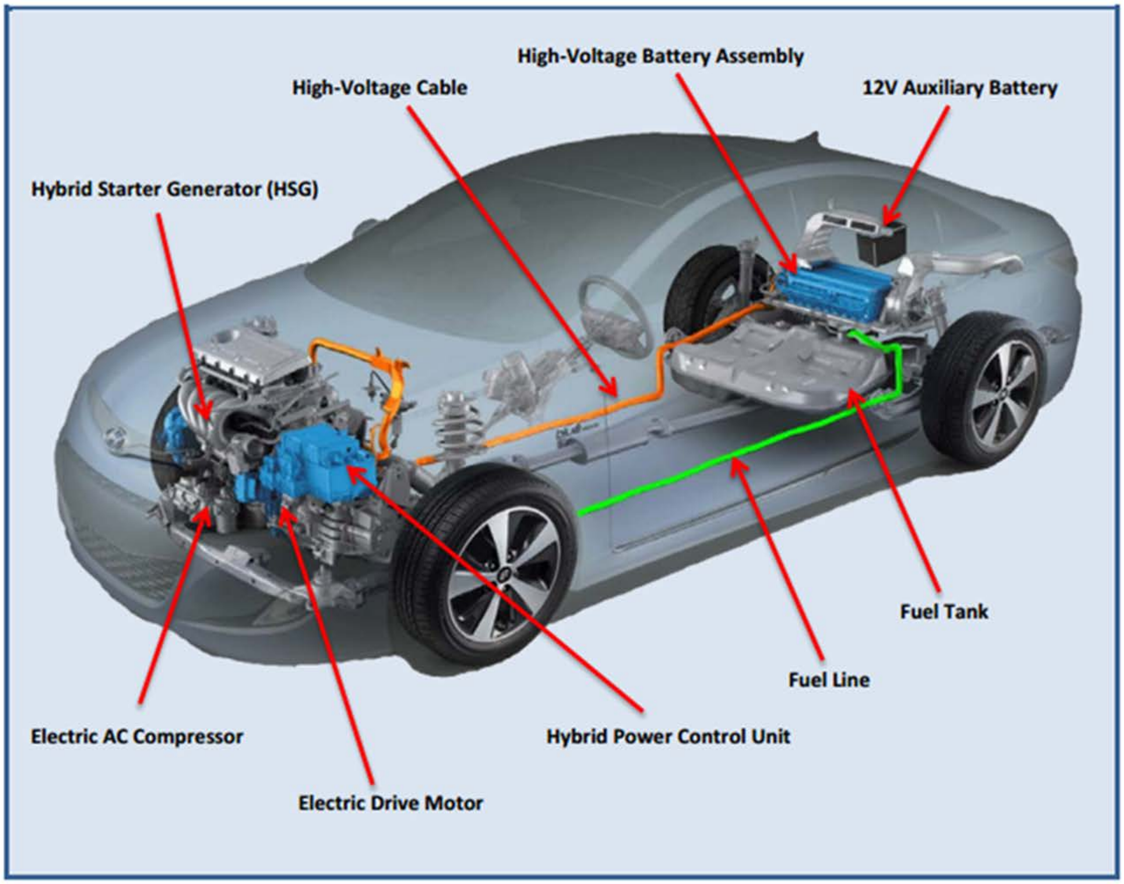
What is an engine oil light?

This warning light is displayed to alert the driver of low engine oil pressure. If this light illuminates, you should pull over to a safe place and shut off the engine immediately.

http://repairpal.com/estimator/hyundai/sonata+hybrid/engine-oil-light-diagnosis-cost

Figure 111 – Note: Description of functionality of engine oil light as correlates to engine oil pressure

Vehicle Component Locations:



ELECTRIC TRACTION MOTOR AND CLUTCH

The Sonata hybrid is equipped with a 30 kW permanent magnet synchronous electric traction motor that produces 151 pound-feet of torque from zero rpm. In an ingenious example of value-focused systems engineering, the motor itself is hard-coupled to the input of the transmission and completely replaces the torque converter. A multi-disc clutch pack sits within the inner circumference of the traction motor and is used to de-couple the motor from the 2.4-liter Theta II inline-four cylinder engine for idle stop and electric drive modes. This layout allows the entire package along with a torsional damper to fit within virtually the same volume as the traditional torque converter.

Separating the motor from the gear set has several functional advantages over more heavily integrated systems. In addition to providing the flexibility to accommodate different applications, it also is one of the main factors contributing to the Sonata's superior highway fuel efficiency.

Figure 112 – Note: Hybrid powertrain with electric traction motor and engine

ELECTRIC TRACTION MOTOR AND CLUTCH

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http://www.hyundainews.com/us/en/models/sonata-hybrid/2011

The hybrid setup deploys a 30-kW permanent magnet syn-chronous electric traction motor that provides 151 lb-ft of torque. It is hard-coupled to the input of the transmission where the torque converter would ordinarily be found. There is a multiple-disc clutch pack in the traction motor that is used to decouple the motor from the internal combustion engine when the vehicle is in electric drive mode (it is said to be able to drive in electric mode at up to 62 miles per hour, and this capability was essentially verified during a test drive on the 805 north of San Diego) or when the car is at idle-stop.

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http://www.adandp.media/articles/hyundais-remarkable-hybrid

Figure 113 – Note: Description of Hybrid powertrain with electric traction motor and engine

Electric Drive Motor

Mounted between the engine and transmission, the Electric Drive Motor is used for vehicle propulsion. During deceleration or braking, it acts as an alternator and charges the HV battery by converting the vehicle's kinetic energy into electrical energy.

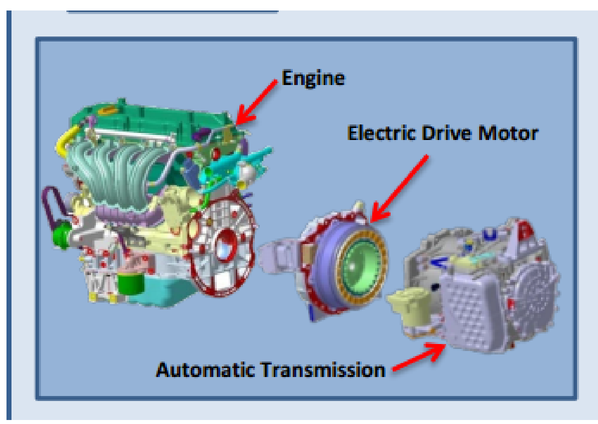


Figure 114 – Note: Description of Hybrid powertrain with electric traction motor and engine

Hybrid Motor System > Hybrid Motor Assembly > Description and Operation

Description

The electric motor is the core technology of a hybrid vehicle. The Hybrid motor system is equipped with two electric motors. These motors are the drive (traction) motor that is used as the primary power source and a HSG, which acts as the starter motor and alternator in a conventional engine. The traction motor operates to move the vehicle and to provide lower Noise, Vibration, Harshness (NVH) during driving and to achieve fuel efficiency.

The electric motor supplements the engine during acceleration to increase power output and to allow the engine to operate in a fuel efficient mode. In addition, the electric motor takes on the role of a generator during deceleration and braking to charge the high voltage battery. The Hybrid Starter Generator (HSG) starts the engine while the vehicle is in motion.

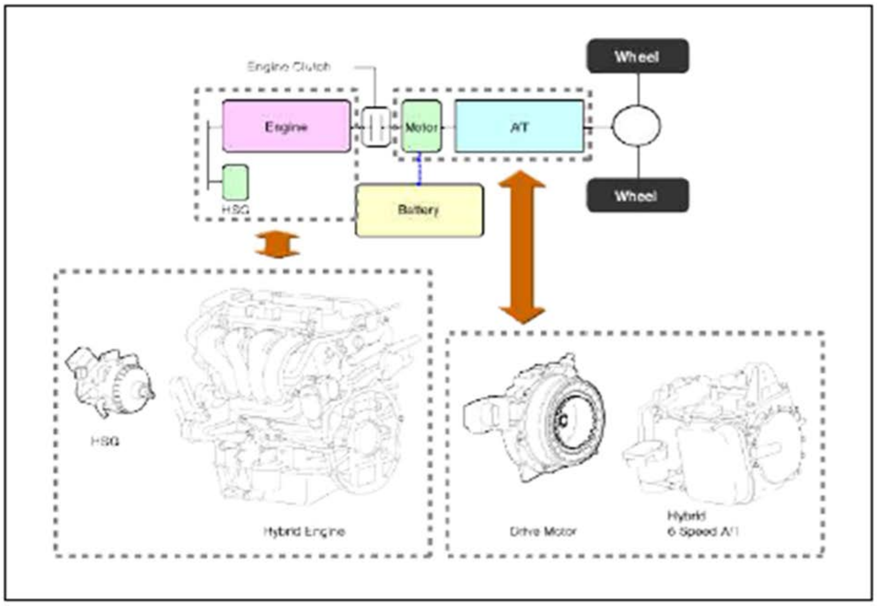


Figure 115 – Note: Description of Hybrid electric traction motor with engine

Import Direct Ignition - Oil Pressure Sender

Line: IDI | Part # 17-0658

Limited Lifetime Warranty

Oil Pressure Light Switch

With Light

Number Of Terminals: 1

Quantity Per Vehicle: 1

http://www.oreillyauto.com/site/c/search/Oil+Pressure+Switch!s!Sensor/03438/C2177.oap?model=Sonata&vi=1500964&year=2011&make=Hyundai

Figure 116 - Oil pressure sensor/sender

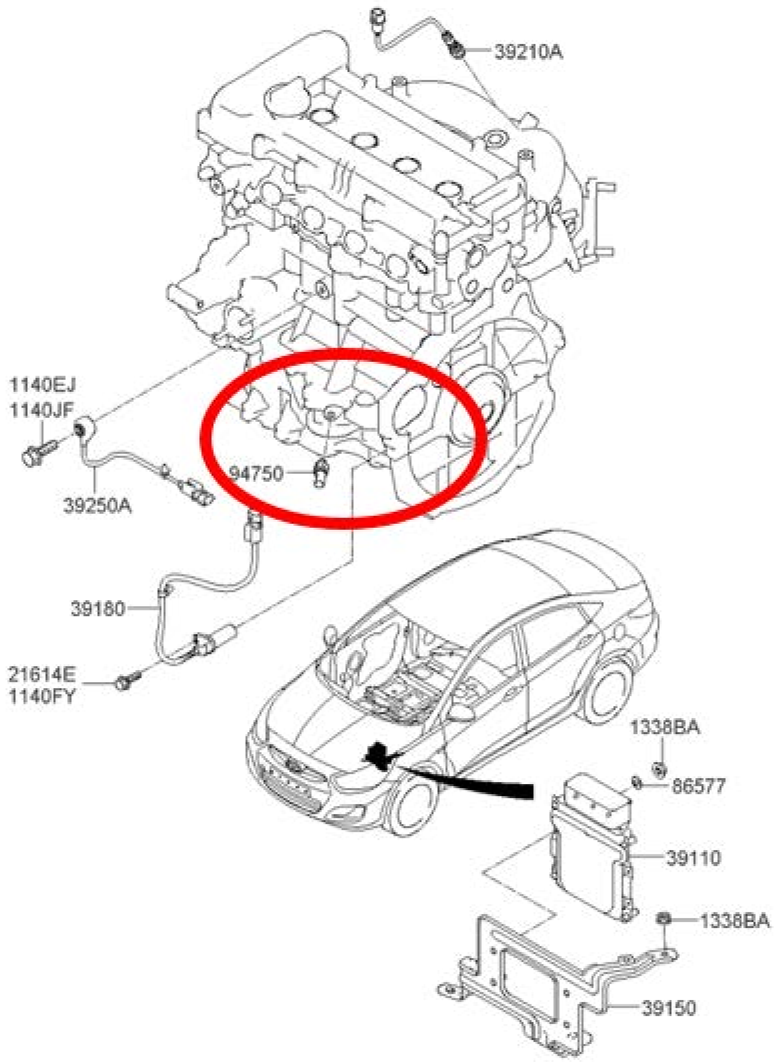


Figure 117 - Oil Pressure Sensor/ Sender

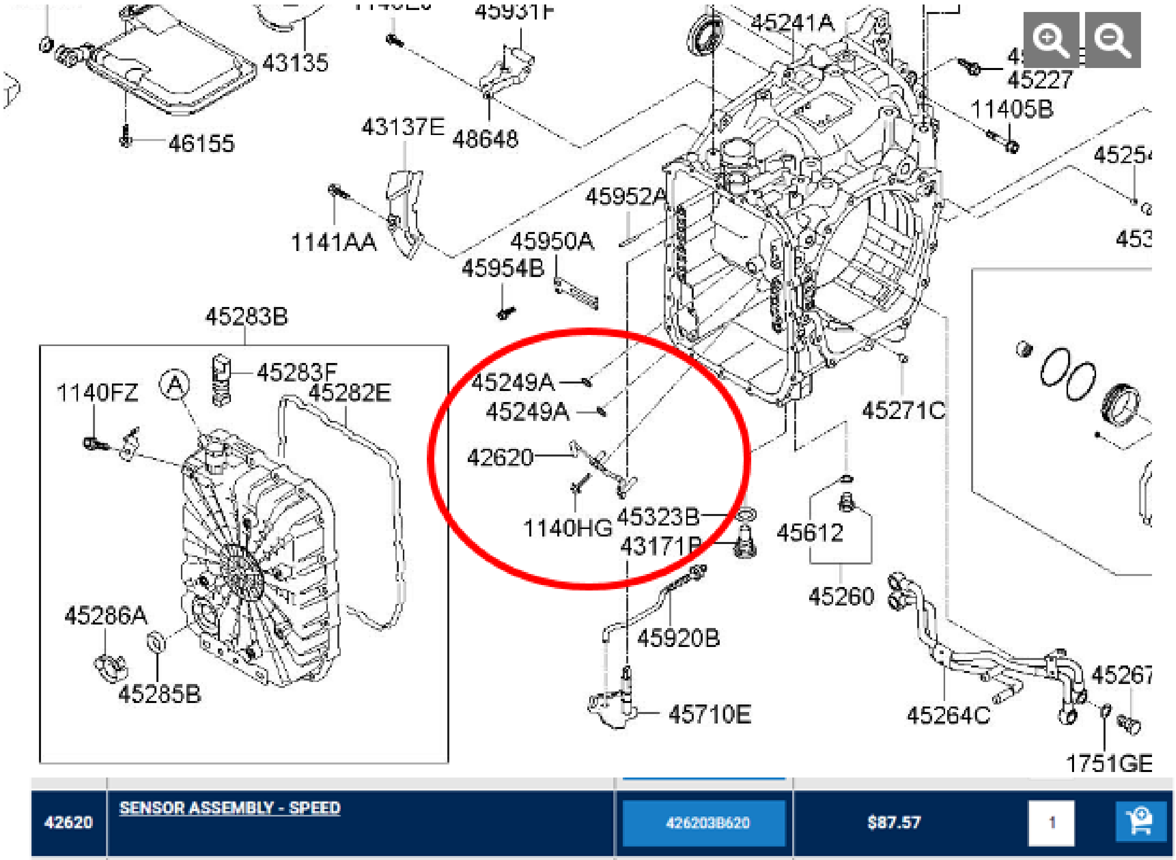


Figure 118 - Speed Sensor

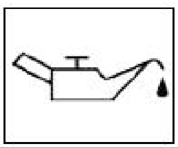
15		Oil Pressure	Hardwire	Input terminal is GND ISG control(MICOM)	LED/ IG

Figure 119 - Oil Pressure Indicator

Brake Pedal Not Applied

Press Engine START/STOP Button	LED Color on Engine START/STOP Button	State of Vehicle
-	OFF	OFF
1st time	AMBER	ACCESSORY
2nd time	BLUE	ON
3rd time	OFF	OFF

Brake Pedal Applied and Transmission in Park

Press Engine START/STOP Button	LED Color on Engine START/STOP Button	State of Vehicle
-	OFF	OFF
1st time	BLUE	START

Figure 120 – Note: Modes For Run/Stop & Off

The diagnostic executive is a computer program in the Engine Control Module (ECM) or PowertrainControl Module (PCM) that coordinates the OBD-II self-monitoring system. This program controls all the monitors and interactions, DTC and MIL operation, freeze frame data and scan tool interface.

Freeze frame data describes stored engine conditions, such as state of the engine, state of fuel control, spark, RPM, load and warm status at the point the first fault is detected. Previously stored conditions will be replaced only if a fuel or misfire fault is detected. This data is accessible with the scan tool to assist in repairing the vehicle.

The center of the OBD-II system is a microprocessor called the Engine Control Module (ECM) or Powertrain Control Module(PCM).

The ECM or PCM receives input from sensors and other electronic components (switches, relays, and others) based on information received and programmed into its memory (keep alive random access memory, and others), the ECM or PCM generates output signals to control various relays, solenoids and actuators.

- All Other Malfunctions:

For all other faults, the MIL may be extinguished after three subsequent sequential driving cycles during which the monitoring system responsible for illuminating the MIL functions without detecting the malfunction and if no other malfunction has been identified that would independently illuminate the MIL according to the requirements outlined above.

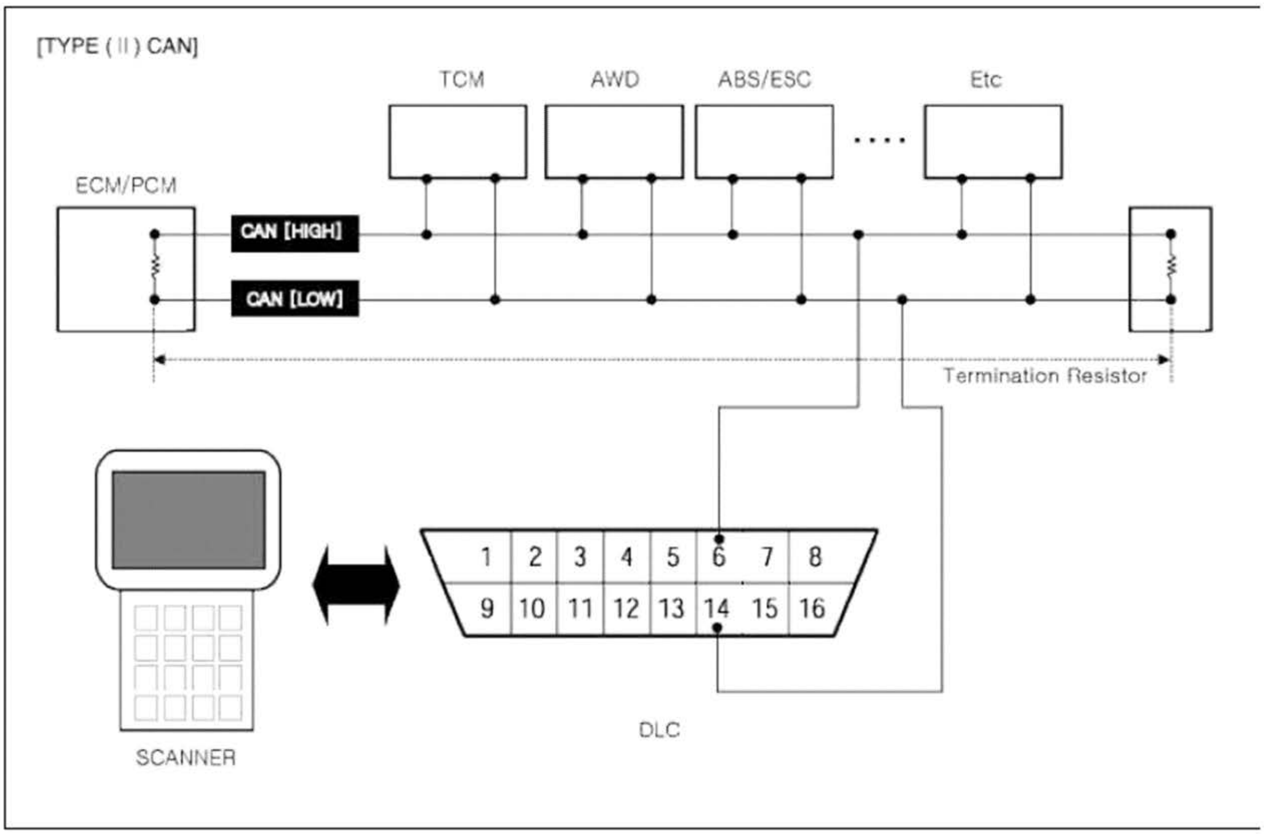


Figure 121 - CAN/ECM

How does the oil pressure sensor work?

Engine oil is kept in the engine oil pan on most engines, and an external oil reservoir on many high performance engines. In either case, the oil is pumped into the engine faster than the engine can use the oil. This creates a constant pressure as the oil is pushed through oil passages. The oil passages use targeted outlets to send oil to precise locations which need protection. Oil is less of a lubricant, and more of a barrier, as it prevents metal contact between internal engine components. When that barrier is weak, metal contact will occur at an increasing rate, relative to the rate of oil degradation. The barrier the oil creates is weakened or completely compromised without oil pressure. Oil pressure forces oil into the tight areas as fast as the oil is used. This means, when the oil pressure is too low, the component will run out of oil, and damage occurs. The oil pressure sensor protects from damage by alerting the computer when the oil pressure has dropped, and the computer will make changes to protect the engine.

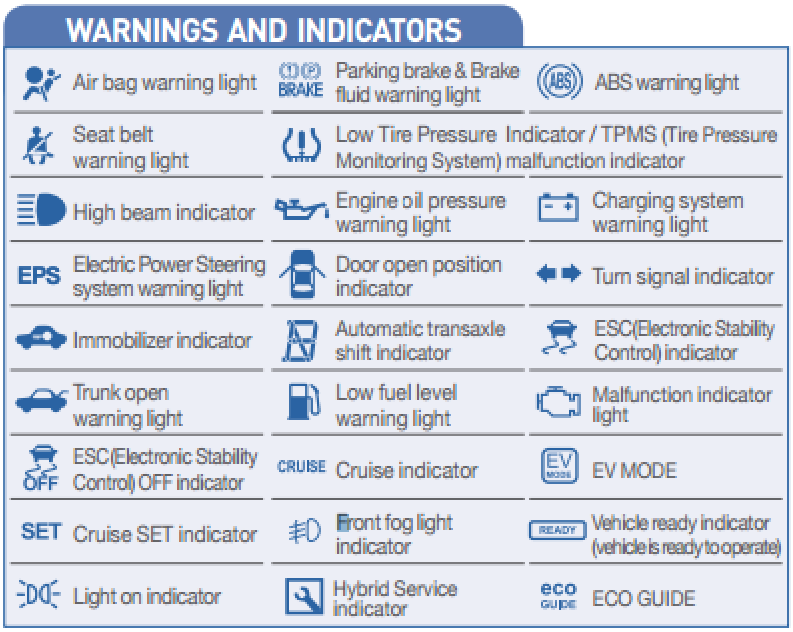
What are the symptoms related to a bad oil pressure sensor?

When the oil pressure sensor fails, the signal that it sends to the engine's computer will be inaccurate, causing the engine's computer to behave as through the oil pressure is too high or too low. This may cause the check engine light to illuminate on the instrument cluster, and the on-board diagnostic (OBD) trouble codes will reflect the readings of the faulty oil pressure sensor. Also, the engine may be placed in reduced power mode for engine protection.

Figure 122 – Note: Functionality of Oil Pressure Sensor

170. Claim 14 of the ’157 patent recites the diagnostic system of claim 1, wherein the low oil pressure indicator comprises a lamp.

171. On information and belief, the Accused Instrumentalities infringe claim 14 of the ’157 patent. The Accused Instrumentalities comprise the diagnostic system of claim 1, wherein the low oil pressure indicator comprises a lamp *(Figure 119, 123*).



http://www.hyundaiproductinformation.com/attachments/QRG_2013_Sonata_Hybrid.pdf

Figure 123- Hybrid warning indicators

172. Claim 17 of the '157 patent recites a diagnostic method for controlling an engine low oil pressure indicator in a hybrid electric vehicle having an engine and an electric traction motor powertrain, comprising the steps of: sensing engine oil pressure; sensing engine speed; inputting oil pressure sensor and engine speed sensor to a controller; connecting a low oil pressure indicator to the controller; indicating vehicle mode for "off" and "run/start"; and preventing activation of the low oil pressure indicator when the mode selector is in the "run/start" mode and the engine is not running.

173. On information and belief, the Accused Instrumentalities infringe claim 17 of the '157 patent. The Accused Instrumentalities practice a diagnostic method for controlling an engine low oil pressure indicator in a hybrid electric vehicle (*Figures 107-111*) having an engine and an electric traction motor powertrain (*Figures 112-115*), comprising the steps of: sensing engine oil pressure; sensing engine speed; inputting oil pressure sensor and engine speed sensor

to a controller; connecting a low oil pressure indicator to the controller; indicating vehicle mode for "off" and "run/start"; and preventing activation of the low oil pressure indicator when the mode selector is in the "run/start" mode and the engine is not running (*Figures 116-119, 121-122*).

COUNT XIX – INFRINGEMENT OF U.S. PATENT NO. 6,736,122

174. The allegations set forth in the foregoing paragraphs 1 through 173 are incorporated into this Nineteenth Claim for Relief.

175. On May 18, 2004, U.S. Patent No. 6,736,122 ("the '122 patent"), entitled "*Motor Vehicle Engine Synchronization*," was duly and legally issued by the United States Patent and Trademark Office. A true and correct copy of the '122 patent is attached as Exhibit 19.

176. Plaintiff is the assignee and owner of the right, title and interest in and to the '122 patent, including the right to assert all causes of action arising under said patents and the right to any remedies for infringement of them.

177. Upon information and belief, Defendants have directly infringed at least claims 1 and 2 of the '122 patent by making, using, selling, importing and/or providing and causing to be used the 2011-2017 Hyundai Sonata Hybrid (the "Accused Instrumentalities").

178. Upon information and belief, the Accused Instrumentalities incorporate the Theta II Engine which comprises a diagnostic system for controlling an engine low oil pressure indicator in a hybrid electric vehicle.

179. In particular, claim 1 of the '122 patent recites an internal combustion engine, comprising a number of cylinders, the or each cylinder containing a four-stroke reciprocating piston, an exhaust conduit, one or more engine operating condition sensors including an exhaust gas sensor in the exhaust conduit for measuring the composition of the exhaust gas, a fuel injection system, and an engine management system for controlling the operation of the engine

including the fuel injection system and the air/fuel ratio for at least one cylinder, wherein the engine management system contains engine operation data, the engine operation data being related to expected engine operation with engine fueling on the correct stroke and/or engine fueling on an incorrect stroke, and the engine management system is arranged to: a) receive from said sensor(s) respective signal(s); b) oscillate the air/fuel ratio between a relatively rich level and a relatively lean level, the exhaust gas composition varying depending on the air/fuel ratio; c) reverse the direction of change of the air/fuel ratio when the exhaust gas composition is sensed as being indicative of rich engine operation or lean engine operation; d) determine the temporal characteristics of the oscillation in the air/fuel ratio; and e) determine whether or not the engine is being fueled on the correct stroke by comparing said temporal characteristics with said relevant engine operation data.

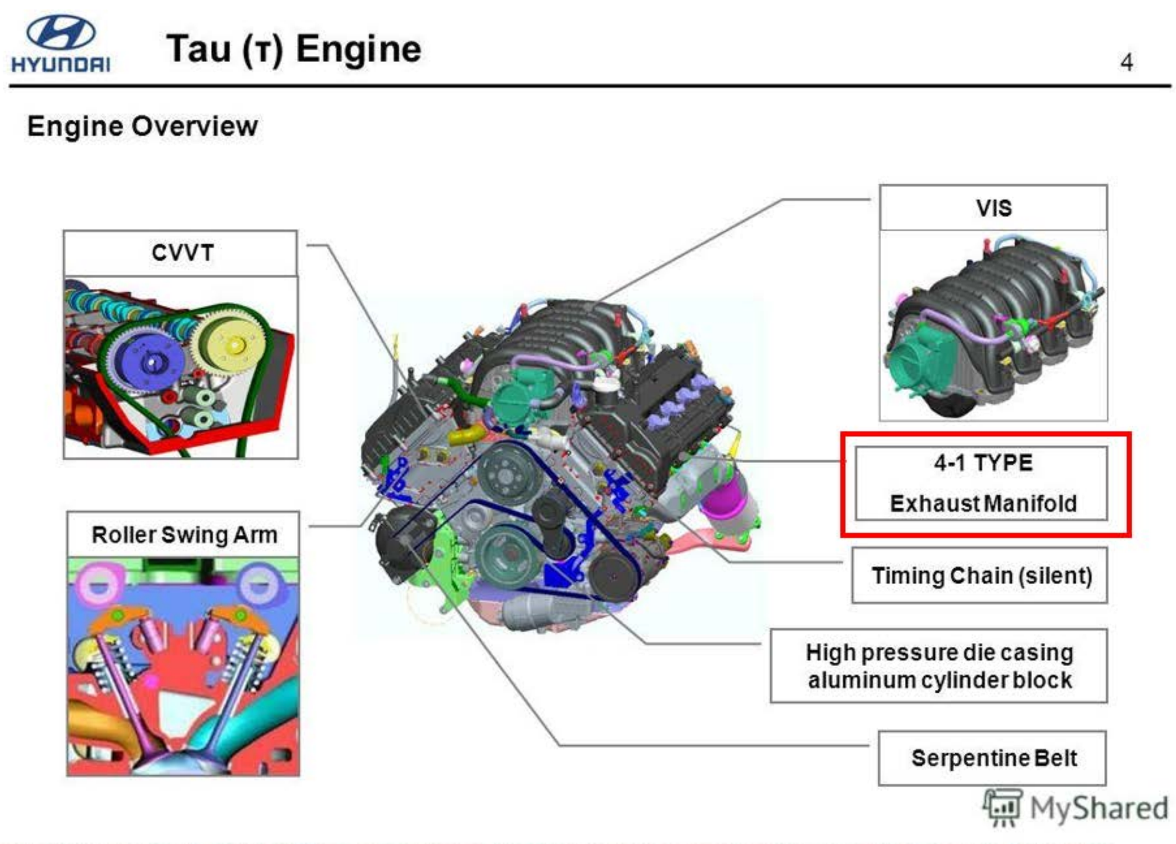
180. On information and belief, the Accused Instrumentalities infringe claim 1 of the '122 patent. The Accused Instrumentalities comprise an internal combustion engine (*Figures 98, 124*), comprising a number of cylinders (*Figure 98*), the or each cylinder containing a four-stroke reciprocating piston (*Figure 124*), an exhaust conduit (*Figure 125*), one or more engine operating condition sensors including an exhaust gas sensor in the exhaust conduit for measuring the composition of the exhaust gas (*Figures 126-127*), a fuel injection system (*Figure 128*), and an engine management system for controlling the operation of the engine including the fuel injection system and the air/fuel ratio for at least one cylinder (*Figure 121*), wherein the engine management system contains engine operation data, the engine operation data being related to expected engine operation with engine fueling on the correct stroke and/or engine fueling on an incorrect stroke (*Figures 129-131*), and the engine management system is arranged to: a) receive from said sensor(s) respective signal(s); b) oscillate the air/fuel ratio between a relatively rich

level and a relatively lean level, the exhaust gas composition varying depending on the air/fuel ratio; c) reverse the direction of change of the air/fuel ratio when the exhaust gas composition is sensed as being indicative of rich engine operation or lean engine operation; d) determine the temporal characteristics of the oscillation in the air/fuel ratio; and e) determine whether or not the engine is being fueled on the correct stroke by comparing said temporal characteristics with said relevant engine operation data (*Figures 121*, *126-135*).

In the Hyundai Hybrid Blue Drive system, the Theta II with multi-port fuel injection (MPI) operates on an Atkinson Cycle. Atkinson Cycle is a type of internal combustion engine strategy designed to dramatically increase fuel efficiency through changes in compression and power strokes in the four stroke engine. It is typically only used in hybrid systems where the high-torque electric motor boosts low-end power, which is traded off for internal combustion engine efficiency. By combining the electric motor and the Atkinson Cycle engine, the Hybrid Blue Drive system delivers best-in-class highway hybrid efficiency.

http://www.hyundainews.com/assets/Media_Kits/2011_Models/Sonata%20Hybrid/Untitled-1%20copy.jpg

Figure 124 – Note: Description of Hyundai Hybrid internal combustion engine



This is not a theta II engine. It is a non-hybrid V8 engine

Figure 125- Hybrid internal combustion engine with exhaust conduit

Emission Control System > General Information > Description and Operation

Description

Emissions Control System consists of three major systems.

- The Crankcase Emission Control System prevents blow-by gas from releasing into the atmosphere. This system recycles gas back into the intake manifold (Closed Crankcase Ventilation Type).

- The Evaporative Emission Control System prevents evaporative gas from releasing into the atmosphere. This system burns gas at appropriate engine operating condition after gathering it in the canister.
- The Exhaust Emission Control System converts the three pollutants [hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx)] into harmless substances by using the 3-way catalytic converter.

Figure 126 – Note: Description of Exhaust Emission Control System

Emission Control System > General Information > Schematic Diagrams

Schematic Diagram

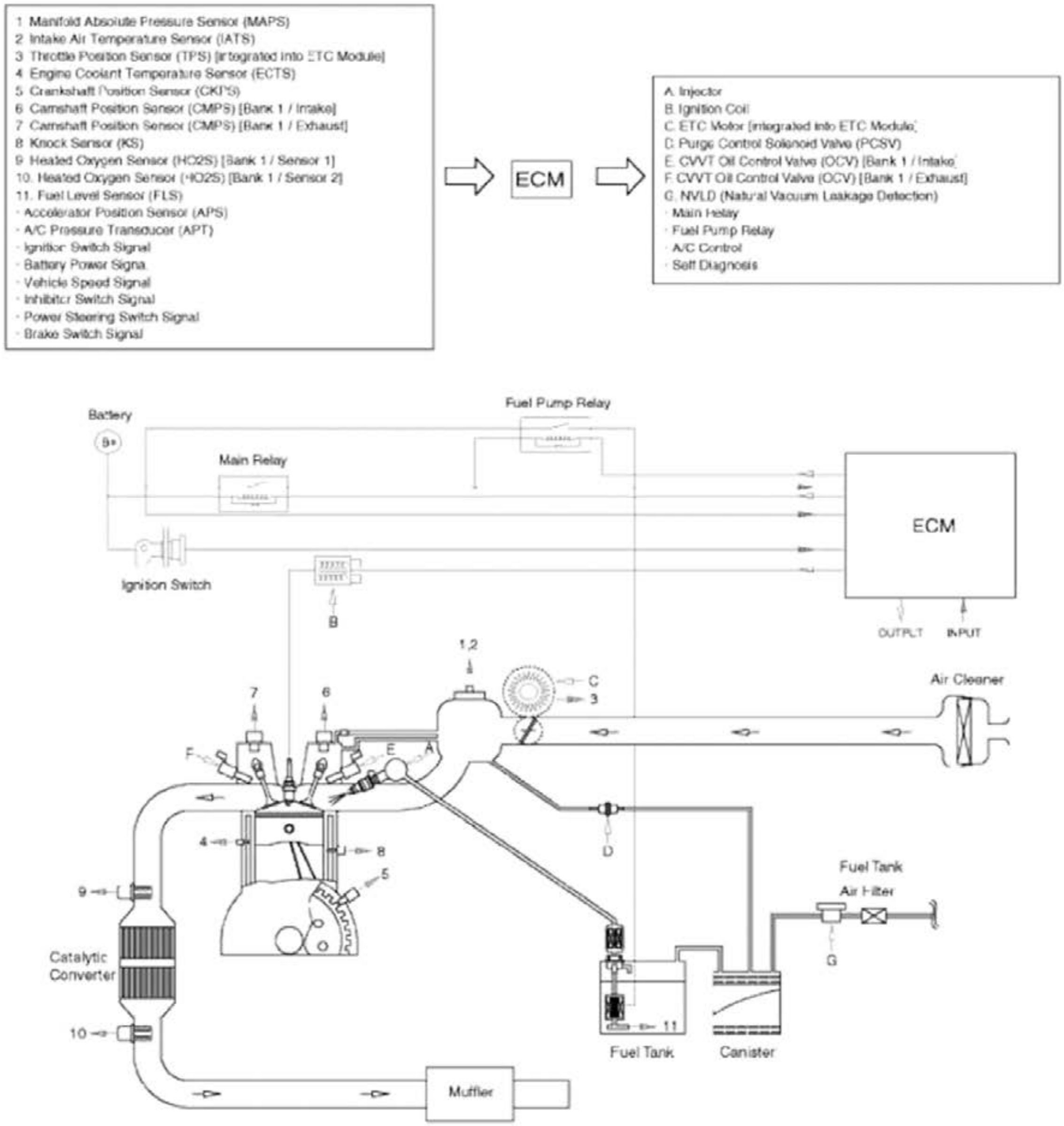


Figure 127 - Emission Control System

Emission Control System > Exhaust Emission Control System > Description and Operation

Description

Exhaust emissions (CO, HC, NOx) are controlled by a combination of engine modifications and the addition of special control components.

Modifications to the combustion chamber, intake manifold, camshaft and ignition system form the basic control system.

These items have been integrated into a highly effective system which controls exhaust emissions while maintaining good drivability and fuel economy.

Air/Fuel Mixture Control System [Multiport Fuel Injection (MFI) System]

The MFI system uses signals from the heated oxygen sensor to activate and control the injector installed in the manifold for each cylinder, thus precisely regulating the air/fuel mixture ratio and reducing emissions.

This in turn allows the engine to produce exhaust gas of the proper composition to permit the use of a three way catalyst. The three way catalyst is designed to convert the three pollutants [hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx)] into harmless substances. There are two operating modes in the MFI system.

1. Open Loop air/fuel ratio is controlled by information pre-programmed into the ECM.
2. Closed Loop air/fuel ratio is constantly adjusted by the ECM based on information supplied by the oxygen sensor.

Figure 128 – Note: Description of Hybrid Multiport Fuel Injection System (MFI)

Canister

The Canister is filled with charcoal and absorbs evaporated fuel vapor from the fuel tank. The gathered fuel vapor in canister is drawn into the intake manifold by the ECM/PCM when appropriate conditions are set.

Purge Control Solenoid Valve (PCSV)

The Purge Control Solenoid Valve (PCSV) is installed in the passage connecting the canister to the intake manifold. It is a duty type solenoid valve and is operated by ECM/PCM signal.

To draw the absorbed vapor into the intake manifold, the ECM/PCM will open the PCSV, otherwise the passage remains closed.

Fuel Filler Cap

A ratchet tightening device in the threaded fuel filler cap reduces the chances of incorrect installation, when sealing the fuel filler. After the gasket on the fuel filler cap and the fill neck flange make contact, the ratchet produces a loud clicking noise indicating the seal has been set.

NVLD (Natural Vacuum Leakage Detection)

NVLD (Natural Vacuum Leakage Detection) module is located between the canister and the fuel tank air filter. The NVLD module is an integral part of the monitoringsystem. The NVLD module has an internal pressureswitch position and a temperature sensor that reports the information to the ECM via on singlecommunication line. The ambient temperature andpressure switch positon are checked every 10 minutesduring car off for 2 hours.

Evaporative System Monitoring for Smaller Leaks

When the Evaporative System is closed off, any temperature change results in a pressure change. The system moniters the temperature drop as the vehicle is parked and cools off. When the temperature drops and a vacuum builds in the Evaperative System the switch in the NVLD will close. The switch is calibrated to -2.5 +/- 0.3 mbar. When the switch closes due to a vacuum building in the system, a timer is started in the ECM. Based on the amount of time until the switch opens, the ECM determins a leak.

Page 17 of 31

For Large leak and fuel cap off detection the test is performed during engine running condition.

Evaporative System Monitoring for Large Leak

At first, the OBD-II system checks the vapor generation due to fuel temperature is low enough to start monitoring. Then itpulls a vacuumin the evaporative system by means of PCSV. The PCSV is opened to allow vacuum to close the switch.

The final step is to moniter the switch to see if there is a loss of vacuum to determine is the is a leak in the system.

[Normal Diagnosis]

Figure 129- Note: ECM collecting engine operation data

[Normal Diagnosis]

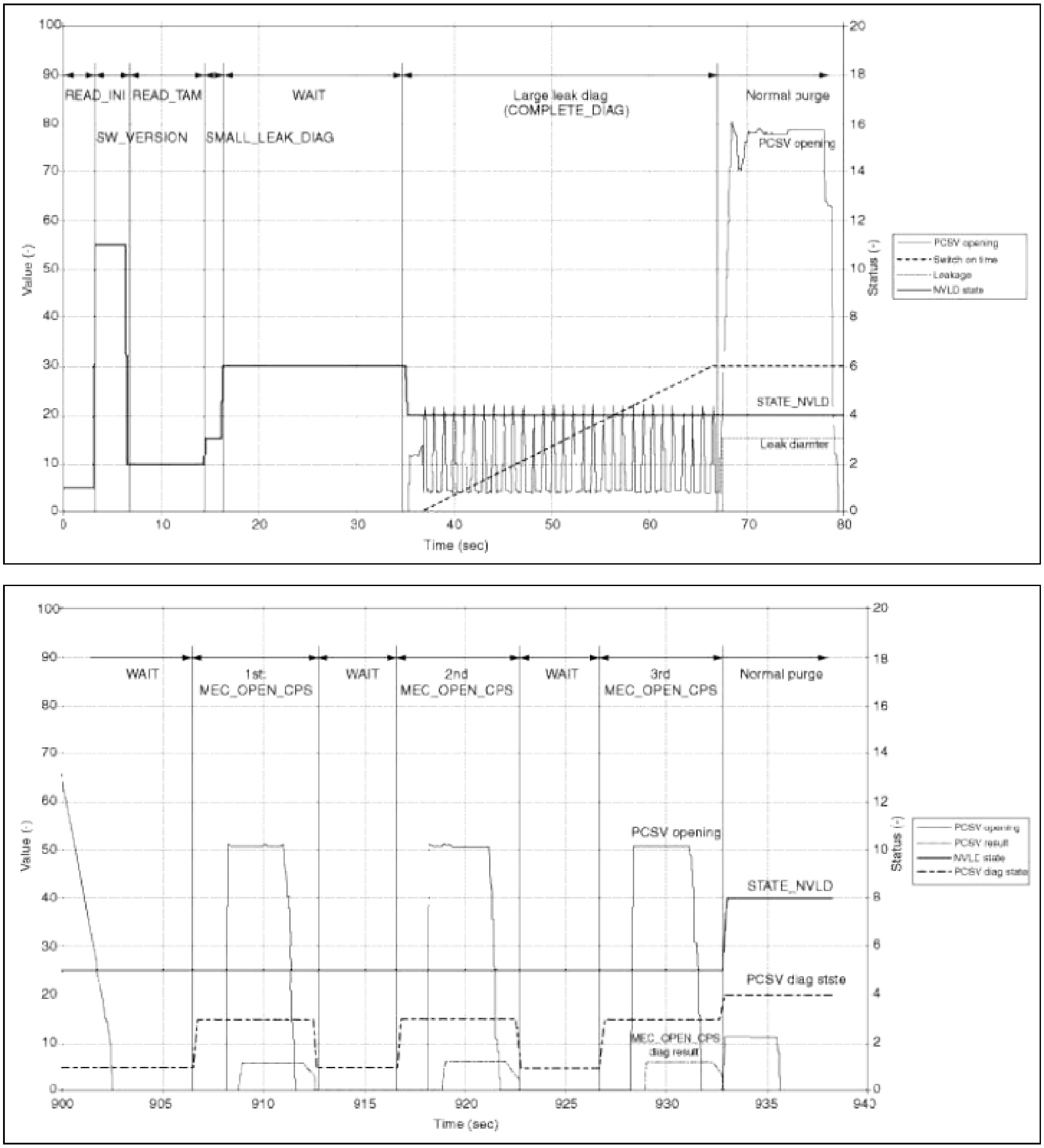
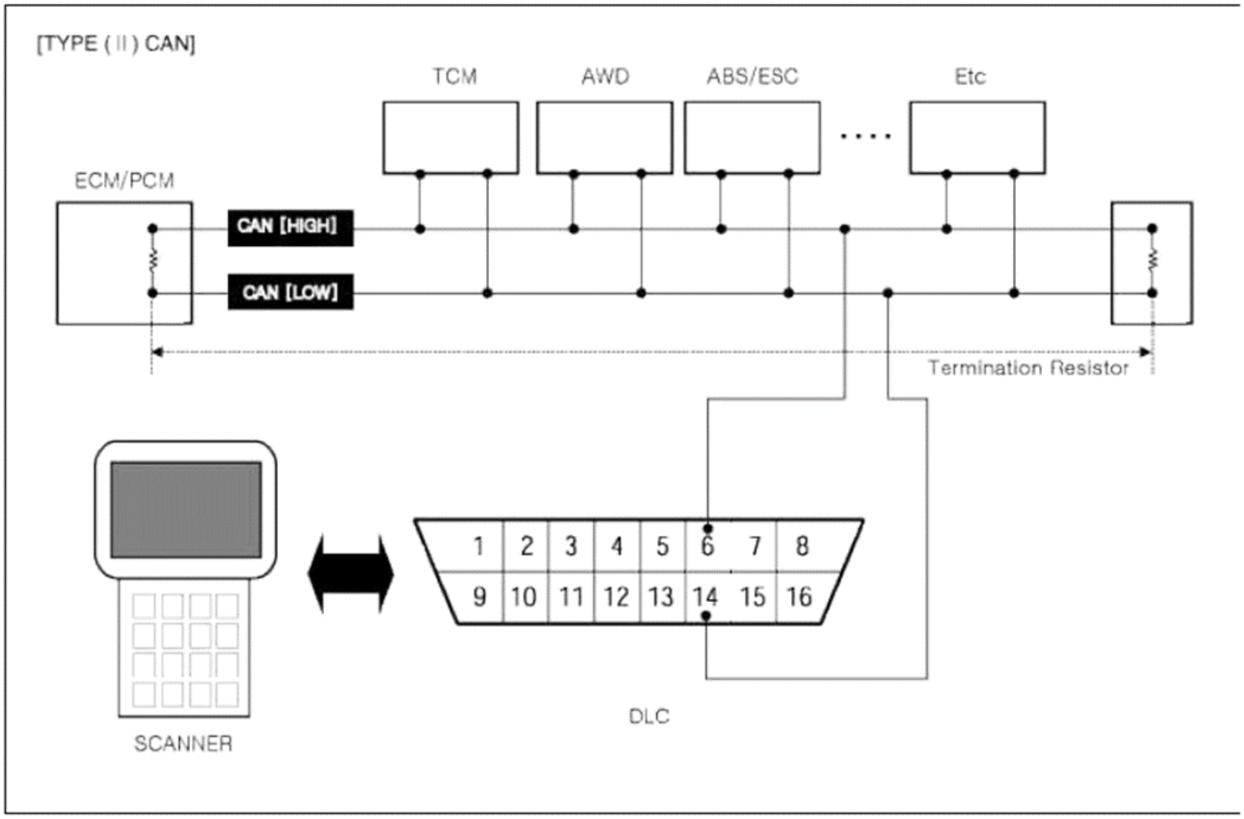


Figure 130 – Note: Exemplary Engine Operation Data

1. Reading information (READ_INI & INI)
   Ready to start diagnosis with initialization. Diagnosis starts with driver's request of vehicle start (key position at start)
   When the process starts, ECM reads the NVLD information & failures which are saved during vehicle key OFF period.
   The valid air temperature sensing range is -40°C to 120°C. An „out of range“ is reported, if the measured temperature is out of this range. After requesting, the memorized values from the NVLD are read. The following information is acquired from the NVLD module; air temperature 6C deviation for at least 2 hour during soaking, checking NVLD switch closed during soaking, air temperature sensor plausibility / electrical failure check, which is detected during soaking, pressure switch electrical failure check during soaking, and reset failures due to power loss
2. Reading information (SW_VERSION)
   NVLD sends the 8 bit software version value when the ECM performs a request.
3. Reading Air temperature (TAM_SWI_DIAG / READ_TAM)
   When ECM requests NVLD Air temperature, the measured temperature value is sent to HCU as an 8-bit value. In case an "out of range" error, maximum or minimum values are received. During the period, whenever ECM requests NVLD pressure switch electrical checking, NVLD returns the current and actual values for the electrical switch error. For the values are red from the NVLD, it is possible to return more than one electrical error at the same time, as all errors could have occurred during engine on phase.
4. Small leakage diagnosis (SMALL_LEAK_DIAG)
   To check small leak, ECM requests the saved information from NVLD. During soaking, the resolution of switch closed time is 10min. This means, a maximum time of 2.5h (15 * 10min) can be counted. The switch closed time is reported to the ECM.
5. WAIT
   Delay time to wait for the next process
6. Large leakage diagnosis (COMPLETE_DIAG)
   At this process, ECM checks large leak with checking switch position. During large leak diagnosis, ECM requests switch position information which includes the current switch position and the switch position transition, which has been monitored since engine run.
7. PCSV plausibility diagnosis (CPS_CHK)
   When Large leak error is detected or switch is closed at the beginning of engine start, canister purge valve (PCSV) stuck diagnosis is performed with opening PCSV.
8. STOP
   When all of diagnosis are finished, ECM requests STOP mode. During the period, whenever ECM requests NVLD pressure switch electrical checking, NVLD returns the current and actual values for the electrical switch error until end of driving cycle.
9. ERROR
   When any error is detected so EVAP monitoring can not be proceeded, ERROR status is performed.
10. OFF
    When engine is off with key-off, ECM request STOP status. NVLD is reactivated with a wake-up call at next driving cycle (key position at start). During the period, NVLD checks its timer function and reports error message if any problem is detected.
11. SLEEP
    If the key OFF monitoring conditions to detect small leak are not satisfied, ECM requests Sleep status. During the status, no calculations are done in NVLD during the key OFF period.

Figure 131- Note: Data collection via sensor regarding engine operation data



The Controller Area Network (CAN) and the microcontrollers (Powertrain Control Module (PCM)/ Engine Control Module (ECM)) is an engine management system for controlling the operation of the engine including the fuel injection system and the air/fuel ratio for at least one cylinder.

Emission Control System > Exhaust Emission Control System > Description and Operation

Description

Exhaust emissions (CO, HC, NOx) are controlled by a combination of engine modifications and the addition of special control components.

Modifications to the combustion chamber, intake manifold, camshaft and ignition system form the basic control system.

These items have been integrated into a highly effective system which controls exhaust emissions while maintaining good drivability and fuel economy.

Air/Fuel Mixture Control System [Multiport Fuel Injection (MFI) System]

The MFI system uses signals from the heated oxygen sensor to activate and control the injector installed in the manifold for each cylinder, thus precisely regulating the air/fuel mixture ratio and reducing emissions.

This in turn allows the engine to produce exhaust gas of the proper composition to permit the use of a three way catalyst. The three way catalyst is designed to convert the three pollutants [hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx)] into harmless substances. There are two operating modes in the MFI system.

1. Open Loop air/fuel ratio is controlled by information pre-programmed into the ECM.
2. Closed Loop air/fuel ratio is constantly adjusted by the ECM based on information supplied by the oxygen sensor.

The MFI is controlled by the ECM.

SONATA Hybrid(YF HEV) > 2012 > G 2.4 HEV > Engine > Engine Control > P0133 O2 Sensor Circuit Slow Response (Bank 1 / Sensor 1)

Component Location

Feedback

General Description

The linear O2 sensor is mounted on the front side of the Catalytic Converter (warm-up catalytic converter) or in the front exhaust pipe. It detects a wide range of air/fuel ratios in the exhaust gas from the rich to lean regions. This linear O2 sensor produces a current that corresponds to a specific air/fuel ratio. The PCM monitors this signal and determines whether the air/fuel mixture is rich or lean. The PCM constantly monitors the linear O2 sensor and increases or decreases the fuel injection duration using this signal. This is called closed-loop fuel control operation.

DTC Description

The PCM monitors front oxygen sensor amplitude level and compares it to predetermined minimum amplitude value which could increase emission or disturb lambda control by the effect of aging on the oxygen sensor. The PCM sets DTC P0133 when the amplitude of oxygen sensor is equal to or less than minimum amplitude threshold.

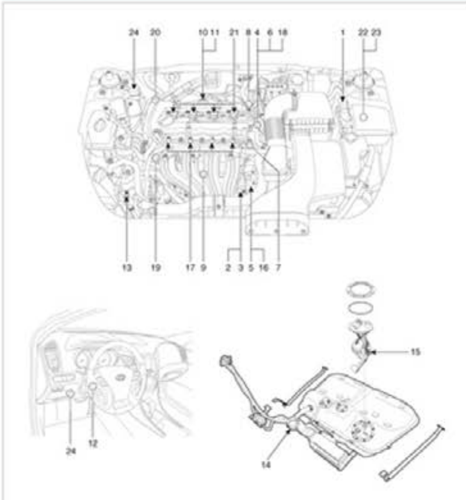
DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Check HO2S Signal Amplitude	1. Leak in intake or exhaust system. 2. Poor connection or damaged harness 3. HO2S contamination
Enable Conditions	• see catalyst diagnosis(P0420) activation condition • No relevant failure • 11V	
Threshold Value	• Integral (Lambda signal amplitude measured / Lambda signal amplitude of a slow sensor) > 1.0	
Diagnostic Time	• 25 lambda controller cycle	
Mil On Condition	• 2 Driving Cycles	

The PCM monitors and determines the air/fuel mixture.

SONATA Hybrid(YF HEV) > 2012 > G 2.4 HEV > Fuel System

Components Location



At least sensors 2- 14 provide engine operation data to the engine management system

1. ECM (Engine Control Module)
2. Manifold Absolute Pressure Sensor (MAPS)
3. Intake Air Temperature Sensor (IATS)
4. Engine Coolant Temperature Sensor (ECTS)
5. Throttle Position Sensor (TPS) [integrated into ETC Module]
6. Crankshaft Position Sensor (CKPS)
7. Camshaft Position Sensor (CMPS) [Bank 1 / Intake]
8. Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]
9. Knock Sensor (KS)
10. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 1]
11. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2]
12. Accelerator Position Sensor (APS)
13. A/C Pressure Transducer (APT)
14. Natural Vacuum Leakage Detection (NVLD)
15. Fuel Level Sender (FLS)
16. ETC Motor [integrated into ETC Module]
17. Injector
18. Purge Control Solenoid Valve (PCSV)
19. CVVT Oil Control Valve (OCV) [Bank 1 / Intake]
20. CVVT Oil Control Valve (OCV) [Bank 1 / Exhaust]
21. Ignition Coil
22. Main Relay
23. Fuel Pump Relay
24. Data Link Connector (DLC) [16 Pin]
25. Multi-Purpose Check Connector [20 Pin]

The sensors provide engine operation data to the engine management system.

General Description

When there are problems such as out of fuel , no engine starting or engine poor power , ECU detects a failure of engine poor power and informs driver , in order to protect vehicle system.
To run a hybrid vehicle only with battery for a long time in spite of such problems can cause it to be out of high power battery that cannot be recovered automatically.

DTC Description

ECU receives the Oxygen sensor voltages and driving information. It monitors whether the proper combustion of engine is achieved or not. When ECU detects that engine combustion is not achieved based on oxygen sensors" signal in engine running or starting , ECU detecteds abnormal conditions.

DTC Detecting Condition

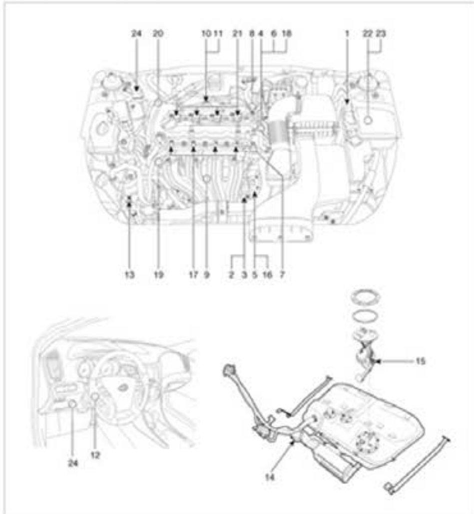
Item	Detecting Condition	Possible cause
DTC Strategy	• Engine no combustion detection	1. Fuel feeding system 2. Fuel pressure 3. Out of fuel 4. Hybrid control HCU 5. Ignition system (fuse , plug) 6. Injection system (fuse , injector) 7. Engine 8. Air induction system 9. Throttle (ETC)
Enable Conditions	• Engine RPM >800 rpm • Fuel Injection time >0.5ms/tdc	
Threshold value	• Upstream O2 sensor voltage > 3.5V and <4.9V • Downstream O2 sensor voltage <0.2V	
Diagnostic Time	• 500 revolution	
Mil on condition	• two trips	

The engine operation data related to expected engine operation (whether or not proper combustion of the engine is achieved or not) with engine fueling on the correct stroke (i.e. combustion) and/or engine fueling (fuel injection time) on an incorrect stoke (monitored proper combustion) by the Engine Control Unit (ECU).

Figure 132

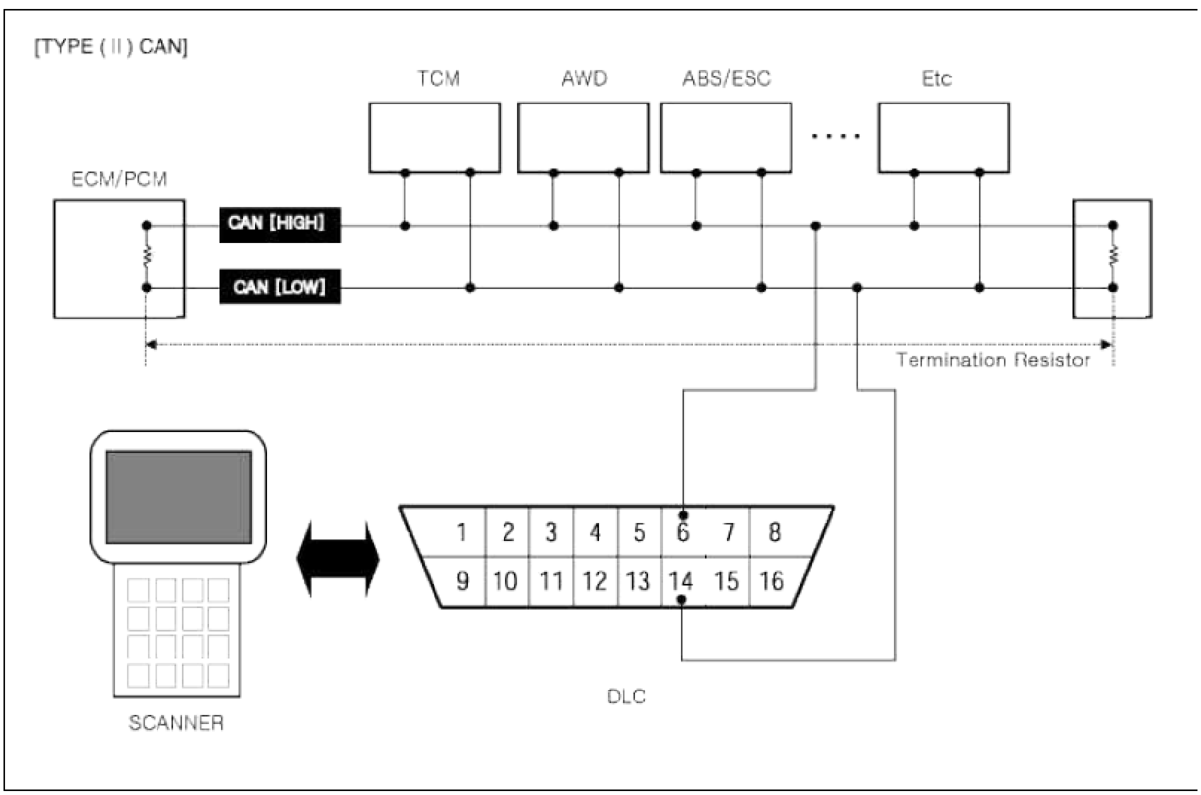
SONATA Hybrid(YF HEV) > 2012 > G 2.4 HEV > Fuel System

Components Location



1. ECM (Engine Control Module)
2. Manifold Absolute Pressure Sensor (MAPS)
3. Intake Air Temperature Sensor (IATS)
4. Engine Coolant Temperature Sensor (ECTS)
5. Throttle Position Sensor (TPS) [integrated into ETC Module]
6. Crankshaft Position Sensor (CKPS)
7. Camshaft Position Sensor (CMPS) [Bank 1 / Intake]
8. Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]
9. Knock Sensor (KS)
10. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 1]
11. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2]
12. Accelerator Position Sensor (APS)
13. A/C Pressure Transducer (APT)
14. Natural Vacuum Leakage Detection (NVLD)
15. Fuel Level Sender (FLS)
16. ETC Motor [integrated into ETC Module]
17. Injector
18. Purge Control Solenoid Valve (PCSV)
19. CVVT Oil Control Valve (OCV) [Bank 1 / Intake]
20. CVVT Oil Control Valve (OCV) [Bank 1 / Exhaust]
21. Ignition Coil
22. Main Relay
23. Fuel Pump Relay
24. Data Link Connector (DLC) [16 Pin]
25. Multi-Purpose Check Connector [20 Pin]

Figure 133



The ECM (1) receives signals from at least sensors 2-14.

SONATA Hybrid(YF HEV) > 2012 > G 2.4 HEV > Engine > Engine Control > P0133 O2 Sensor Circuit Slow Response (Bank 1 / Sensor 1)

Component Location Feedback

General Description

The linear O2 sensor is mounted on the front side of the Catalytic Converter (warm-up catalytic converter) or in the front exhaust pipe. It detects a wide range of air/fuel ratios in the exhaust gas from the rich to lean regions. This linear O2 sensor produces a current that corresponds to a specific air/fuel ratio. The PCM monitors this signal and determines whether the air/fuel mixture is rich or lean. The PCM constantly monitors the linear O2 sensor and increases or decreases the fuel injection duration using this signal. This is called closed-loop fuel control operation.

DTC Description

The PCM monitors front oxygen sensor amplitude level and compares it to predetermined minimum amplitude value which could increase emission or disturb lambda control by the effect of aging on the oxygen sensor. The PCM sets DTC P0133 when the amplitude of oxygen sensor is equal to or less than minimum amplitude threshold.

The engine management system oscillates the air/fuel ratio (the PCM increases or decrease fuel injection duration) depending on the air/fuel ratio (measured by the oxygen sensor in the exhaust stream.

SONATA Hybrid(YF HEV) > 2012 > G 2.4 HEV > Emission Control System

Description Feedback

Exhaust emissions (CO, HC, NOx) are controlled by a combination of engine modifications and the addition of special control components.
Modifications to the combustion chamber, intake manifold, camshaft and ignition system form the basic control system.
These items have been integrated into a highly effective system which controls exhaust emissions while maintaining good drivability and fuel economy.

Air/Fuel Mixture Control System [Multiport Fuel Injection (MFI) System]

The MFI system uses signals from the heated oxygen sensor to activate and control the injector installed in the manifold for each cylinder, thus precisely regulating the air/fuel mixture ratio and reducing emissions.
This in turn allows the engine to produce exhaust gas of the proper composition to permit the use of a three way catalyst. The three way catalyst is designed to convert the three pollutants [hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx)] into harmless substances. There are two operating modes in the MFI system.

1. Open Loop air/fuel ratio is controlled by information pre-programmed into the ECM.
2. Closed Loop air/fuel ratio is constantly adjusted by the ECM based on information supplied by the oxygen sensor.

The PCM reverses the direction of change of the air/fuel ration (from rich to lean, or lean to rich) when the exhaust gas composition sensed (measured by the oxygen sensor in the exhaust stream) as being indicative of rich engine operation or lean engine operation (detects a wide range of air fuel ratios; closed-loop fuel control operation changes direction between rich and lean).

Figure 134

SONATA Hybrid(YF HEV) > 2012 > G 2.4 HEV > Engine > Engine Control > P0133 O2 Sensor Circuit Slow Response (Bank 1 / Sensor 1)

Component Location Feedback

General Description

The linear O2 sensor is mounted on the front side of the Catalytic Converter (warm-up catalytic converter) or in the front exhaust pipe. It detects a wide range of air/fuel ratios in the exhaust gas from the rich to lean regions. This linear O2 sensor produces a current that corresponds to a specific air/fuel ratio. The PCM monitors this signal and determines whether the air/fuel mixture is rich or lean. The PCM constantly monitors the linear O2 sensor and increases or decreases the fuel injection duration using this signal. This is called closed-loop fuel control operation.

DTC Description

The PCM monitors front oxygen sensor amplitude level and compares it to predetermined minimum amplitude value which could increase emission or disturb lambda control by the effect of aging on the oxygen sensor. The PCM sets DTC P0133 when the amplitude of oxygen sensor is equal to or less than minimum amplitude threshold.

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Check HO2S Signal Amplitude	1. Leak in intake or exhaust system. 2. Poor connection or damaged harness 3. HO2S contamination
Enable Conditions	• see catalyst diagnosis(P0420) activation condition • No relevant failure • 11V	
Threshold Value	• Integral (Lambda signal amplitude measured / Lambda signal amplitude of a slow sensor) > 1.0	
Diagnostic Time	• 25 lambda controller cycle	
Mil On Condition	• 2 Driving Cycles	

The temporal characteristics (the measured amplitude versus the amplitude of a slow sensor) of the oscillation in the air/fuel ratio (oscillates between rich and lean).

Upon information and belief, a determination whether or not the engine is being fueled on the correct stroke is determined by the ECM/PCM and the MFI wherein temporal characteristics (shown above) are compared with relevant engine operation data (shown above)

Figure 135

181. In particular, claim 2 of the ’122 patent recites a method of operating an internal combustion engine the engine comprising a number of cylinders, the or each cylinder containing a four-stroke reciprocating piston, one or more engine operating condition sensors including an exhaust gas sensor, a fuel injection system, and an engine management system, wherein the engine management system contains engine operation data, the engine operation data being related to expected engine operation with engine fueling on the correct stroke and/or engine fueling on an incorrect stroke, wherein the method comprises the steps of: a) using the engine management system to control the operation of the engine including the fuel injection system and the air/fuel ratio for at least one cylinder; b) sending to the engine management system from said sensor(s) respective signal(s) indicative of engine operating conditions, including exhaust gas composition; c) oscillating the air/fuel ratio between a relatively rich level and a relatively lean level, the exhaust gas composition varying depending on the air/fuel ratio; d) using the engine

management system to reverse the direction of change of the air/fuel ratio when the exhaust gas composition is sensed as being indicative of rich engine operation or lean engine operation; e) using the engine management system to determine the temporal characteristics of the oscillation in the air/fuel ratio; and f) using the engine management system to determine whether or not the engine is being fueled on the correct stroke by comparing said temporal characteristics with said relevant engine operation data.

182. On information and belief, the Accused Instrumentalities infringe claim 1 of the ’122 patent. The Accused Instrumentalities practice a method of operating an internal combustion engine the engine comprising a number of cylinders, the or each cylinder containing a four-stroke reciprocating piston (*Figures 98, 124*), one or more engine operating condition sensors including an exhaust gas sensor (*Figures 125-127*), a fuel injection system, and an engine management system (*Figures 121, 128*), wherein the engine management system contains engine operation data (*Figures 121-131*), the engine operation data being related to expected engine operation with engine fueling on the correct stroke and/or engine fueling on an incorrect stroke, wherein the method comprises the steps of: a) using the engine management system to control the operation of the engine including the fuel injection system and the air/fuel ratio for at least one cylinder; b) sending to the engine management system from said sensor(s) respective signal(s) indicative of engine operating conditions, including exhaust gas composition; c) oscillating the air/fuel ratio between a relatively rich level and a relatively lean level, the exhaust gas composition varying depending on the air/fuel ratio (*Figures 121, 128*); d) using the engine management system to reverse the direction of change of the air/fuel ratio when the exhaust gas composition is sensed as being indicative of rich engine operation or lean engine operation; e) using the engine management system to determine the temporal characteristics of the oscillation

in the air/fuel ratio; and f) using the engine management system to determine whether or not the engine is being fueled on the correct stroke by comparing said temporal characteristics with said relevant engine operation data (*Figures 121, 126-131*).

COUNT XX – INFRINGEMENT OF U.S. PATENT NO. 6,757,149

183. The allegations set forth in the foregoing paragraphs 1 through 182 are incorporated into this Twentieth Claim for Relief.

184. On Jun. 29, 2004, U.S. Patent No. 6,757,149 ("the '149 patent"), entitled "*Method for Controlling Fuel Injector Valve Solenoid Current*," was duly and legally issued by the United States Patent and Trademark Office. A true and correct copy of the '149 patent is attached as Exhibit 20.

185. Michigan Motor is the assignee and owner of the right, title and interests in and to the '149 patent, including the right to assert all causes of action arising under said patents and the right to any remedies for infringement of them.

186. Upon information and belief, Defendants have directly infringed at least 1 claim of the '149 patent by making, using, selling, importing and/or providing and causing to be used the Accused Instrumentalities.

187. Upon information and belief, the Accused Instrumentalities incorporate, for example, the Theta II Engine which comprises an electronic throttle control apparatus for testing integrity of motor drive electronics.

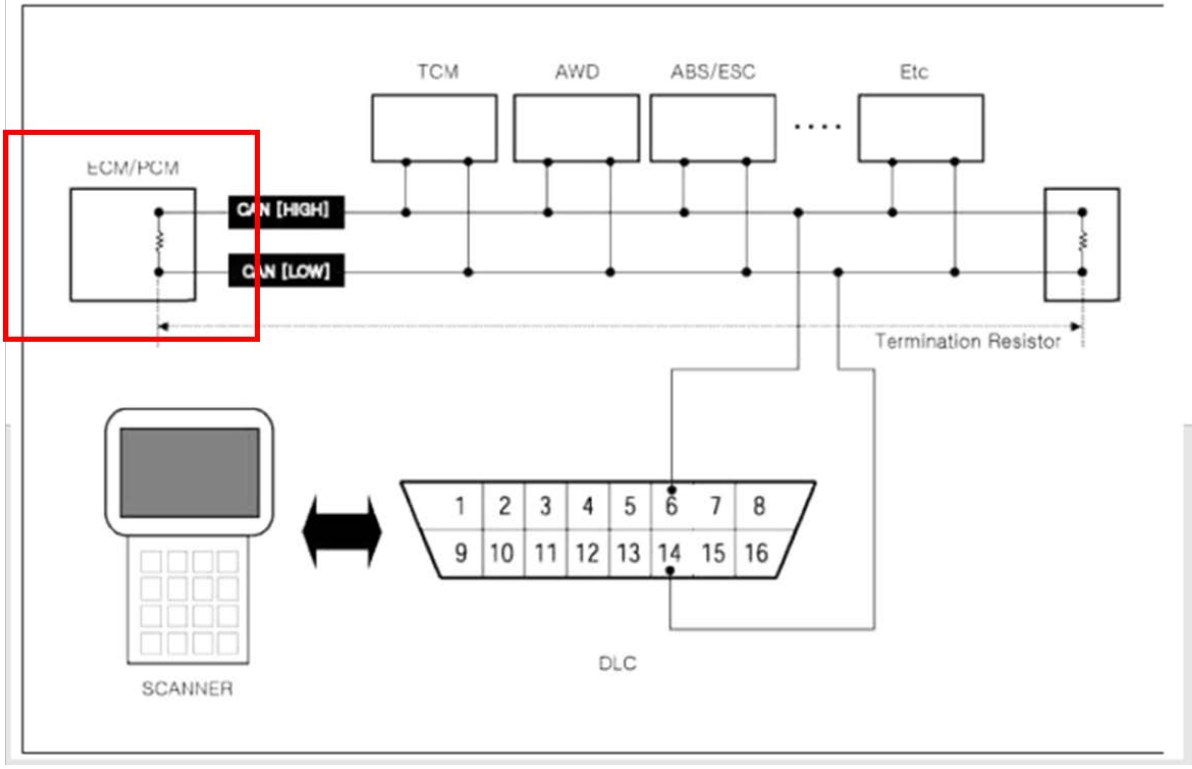
188. In particular, claim 1 of the '149 patent recites a method of controlling a fuel injector valve solenoid comprising: generating a set-point signal to model a desired current profile flowing through the valve solenoid; providing a current controller adapted to regulate the current flowing through the valve solenoid; and regulating the current flowing through the valve

solenoid such that the current flowing through the valve solenoid closely matches the set point signal.

189. On information and belief, the Accused Instrumentalities infringe claim 1 of the ’149 patent. The Accused Instrumentalities practice a method of controlling a fuel injector valve solenoid (*Figure 136*) comprising: generating a set-point signal to model a desired current profile flowing through the valve solenoid (*Figure 137*); providing a current controller adapted to regulate the current flowing through the valve solenoid (*Figure 138*); and regulating the current flowing through the valve solenoid such that the current flowing through the valve solenoid closely matches the set point signal (*Figure 139*).

The ECM or PCM receives input from sensors and other electronic components (switches, relays, and others) based on information received and programmed into its memory (keep alive random access memory, and others), the ECM or PCM generates output signals to control various relays, solenoids and actuators.

2. Configuration of hardware and related terms

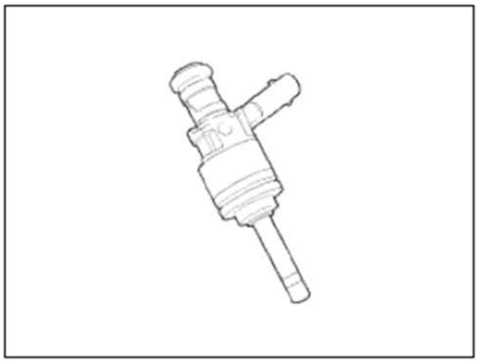


The Controller Area Network (CAN) is a controller, and the Engine Control Module (ECM) and Powertrain Control Module (PCM) are microcontrollers which practice a method of controlling.

Fuel System > Engine Control System > Injector > Description and Operation

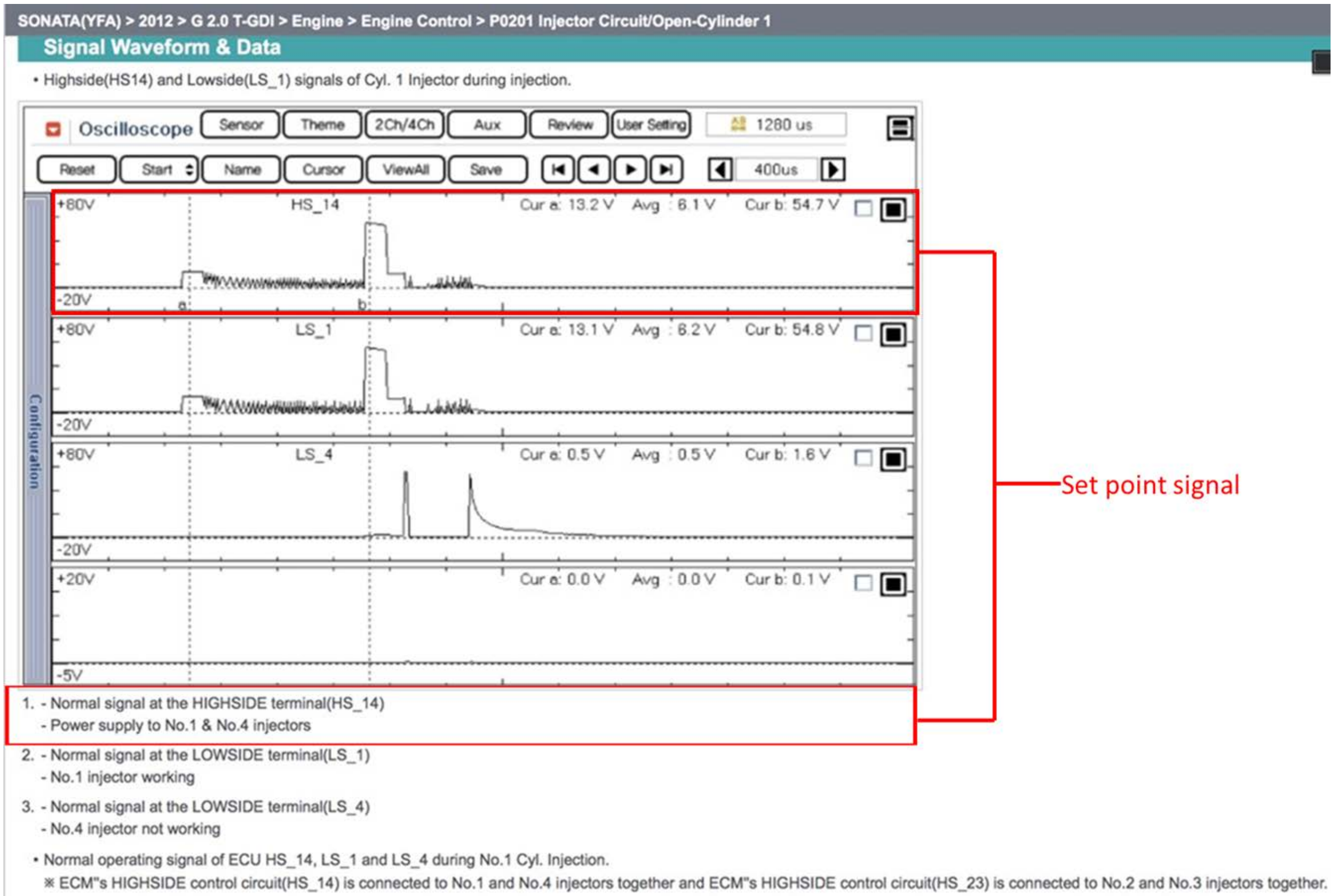
Description

Based on information from various sensors, the ECM can calculate the fuel amount to be injected. The fuel injector is a solenoid-operated valve and the fuel injection amount is controlled by length of injection time. The ECM controls each injector by grounding the control circuit. When the ECM energizes the injector by grounding the control circuit, the circuit voltage should be low (theoretically 0V) and the fuel is injected. When the ECM de-energizes the injector by opening control circuit, the fuel injector is closed and circuit voltage should momentarily peak, and then settle at system voltage.



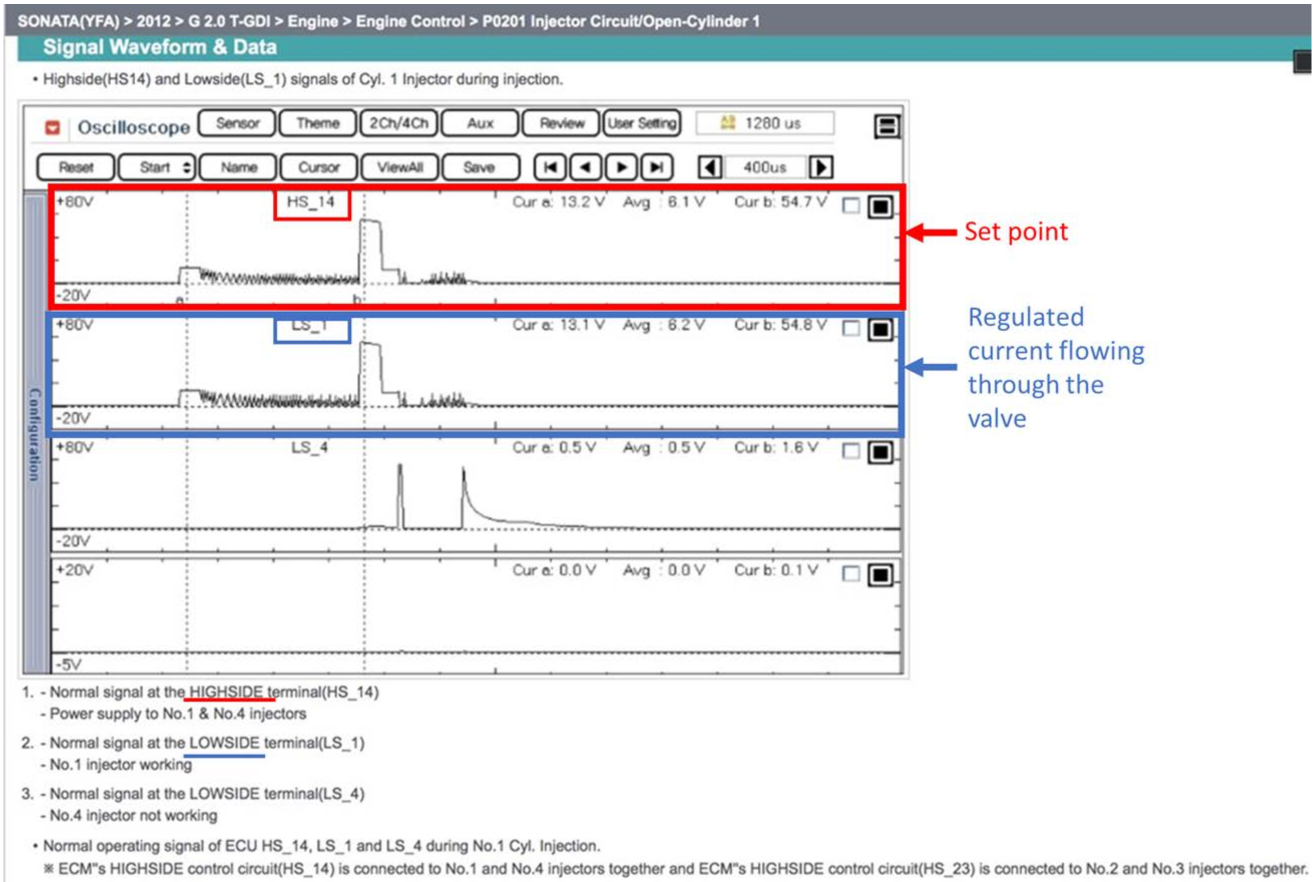
The ECM practices a method of controlling a fuel injector valve solenoid.

Figure 136



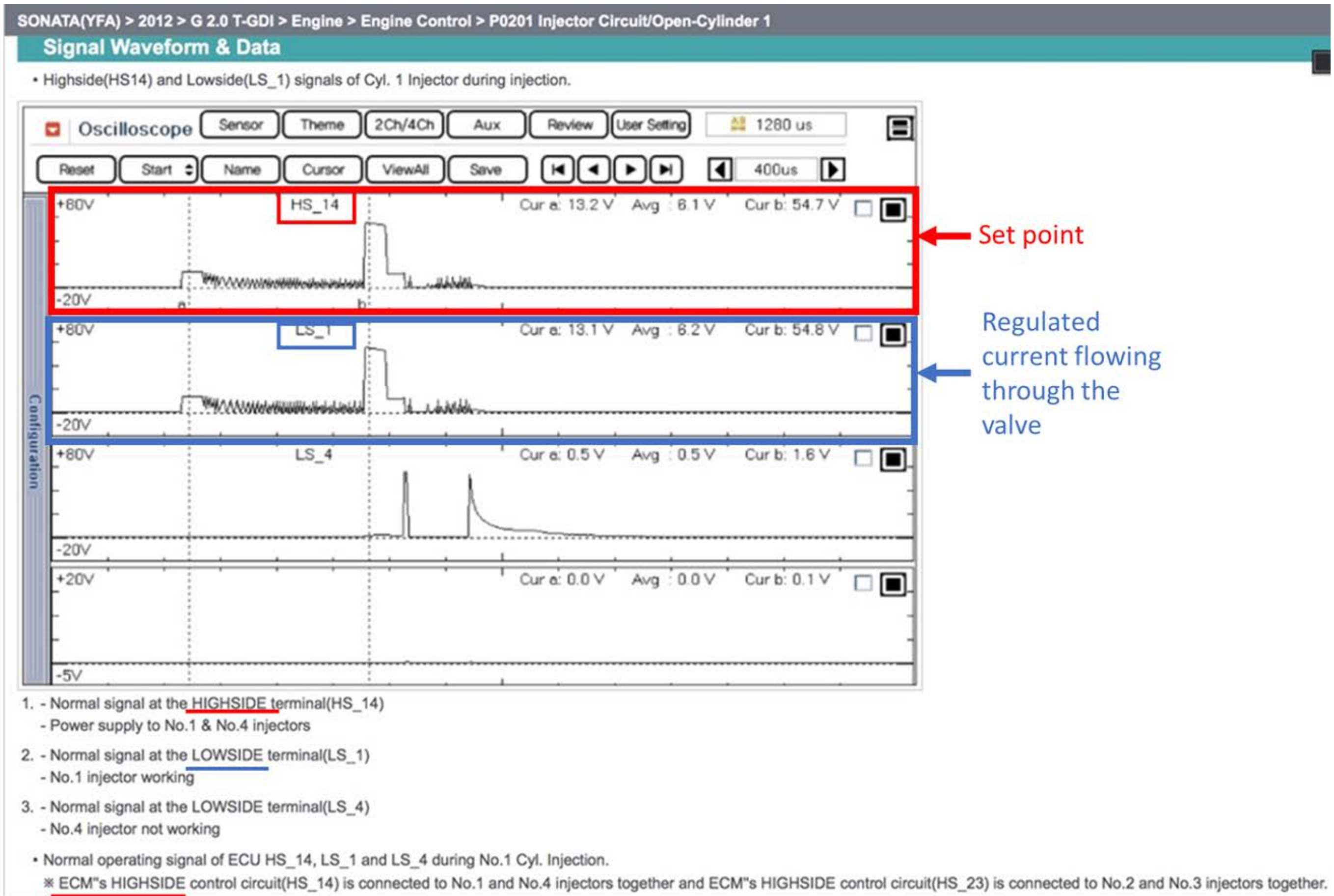
A set point signal is generated by the ECM to model a desired current profile flowing through the valve solenoid.

Figure 137



The ECM provides the current controller which is adapted (the Highside is the desired current, the Lowside is the actual current which is then adjusted to meet the desired current) to regulate the current flowing through the valve solenoid.

Figure 138



The controller (ECM) regulates the current flowing through the valve solenoid such that the current flowing through the valve solenoid closely matches the set point signal (the Highside is the desired current, the Lowside is the actual current which is then regulated by the ECM such that the current flowing through the valve matches the set point signal).

Figure 139

COUNT XXI – INFRINGEMENT OF U.S. PATENT NO. 7,143,501

190. The allegations set forth in the foregoing paragraphs 1 through 189 are incorporated into this Twenty First Claim for Relief.

191. On Dec. 5, 2006, U.S. Patent No. 7,143,501 ("the '501 patent"), entitled "*Method for Assembly of an Automotive Alternator Stator Assembly with Rectangular Continuous Wire*," was duly and legally issued by the United States Patent and Trademark Office. A true and correct copy of the '501 patent is attached as Exhibit 21.

192. Michigan Motor is the assignee and owner of the right, title and interests in and to the '501 patent, including the right to assert all causes of action arising under said patents and the right to any remedies for infringement of them.

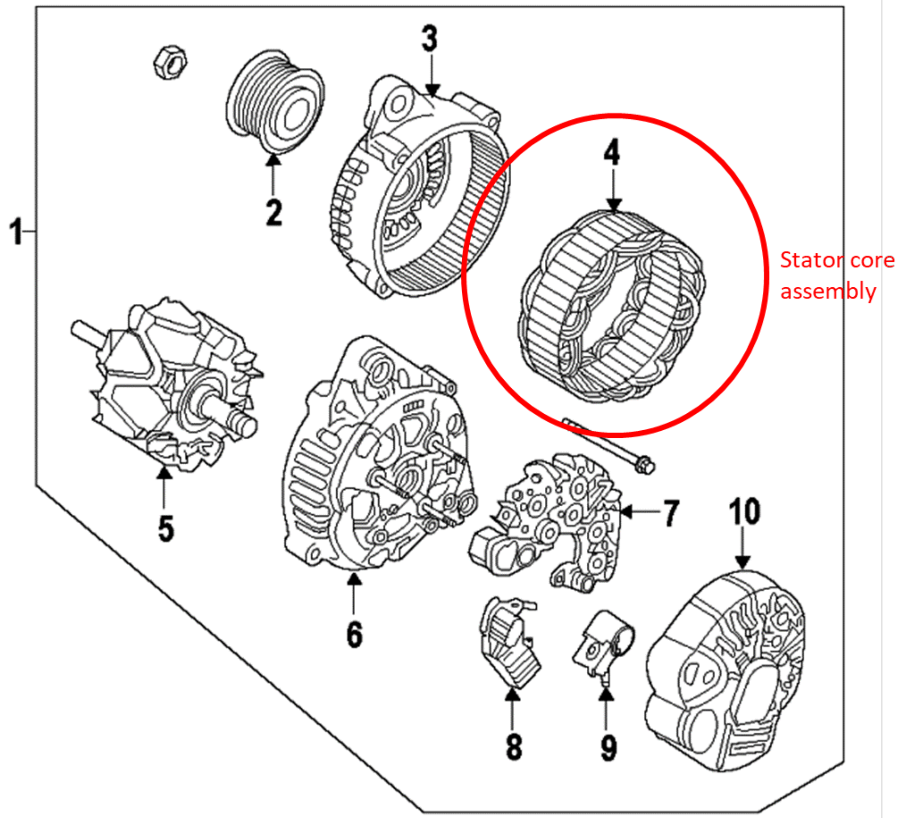
193. Upon information and belief, Defendants have directly infringed at least 1 claim of the '501 patent by making, using, selling, importing and/or providing and causing to be used the Accused Instrumentalities.

194. Upon information and belief, the Accused Instrumentalities incorporate, for example, the 2012 Hyundai Sonata which comprises a stator core assembly for an electronic machine.

195. In particular, claim 1 of the '501 patent recites A method of forming a stator core assembly for an electric machine comprising: providing a stator core having a plurality of radially extending slots; forming a wire pack having a plurality of continuous electrical wires, the wire pack being flat; shaping the flat wire pack into a hollow cylindrical shape; and engaging the hollow cylindrically shaped flat wire pack with the stator core such that the continuous electrical wires are interlaced within the slots of the stator core, wherein engaging the flat wire pack with the stator core includes one of radially expanding and compressing the hollow cylindrical shape of the flat wire pack radially into the slots of the stator core.

196. On information and belief, the Accused Instrumentalities infringe claim 1 of the '501 patent. The Accused Instrumentalities practice a method of forming a stator core assembly for an electric machine (*Figure 140*) comprising: providing a stator core having a plurality of radially extending slots (*Figure 141*); forming a wire pack having a plurality of continuous electrical wires, the wire pack being flat (*Figure 142*); shaping the flat wire pack into a hollow cylindrical shape (*Figure 143*); and engaging the hollow cylindrically shaped flat wire pack with

the stator core such that the continuous electrical wires are interlaced within the slots of the stator core, wherein engaging the flat wire pack with the stator core includes one of radially expanding and compressing the hollow cylindrical shape of the flat wire pack radially into the slots of the stator core (*Figure 144*).

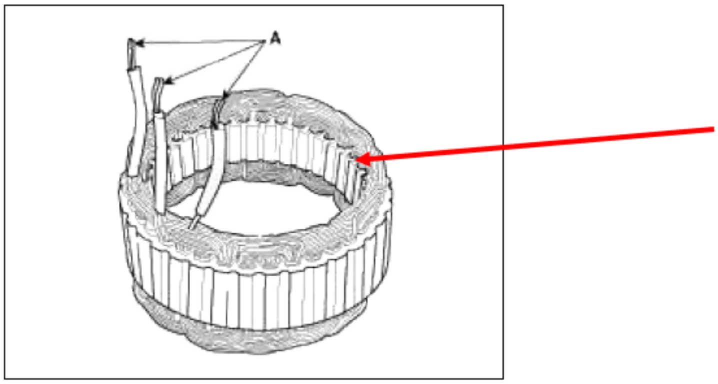


https://www.hyundaipartsdepartment.com/parts/2012/Hyundai/Sonata/Limited?siteid=217704&vehicleid=377725&diagram=F05F010&diagramCallOut=3

Figure 140 – A stator core assembly for an electric machine has been formed.

Inspect Stator

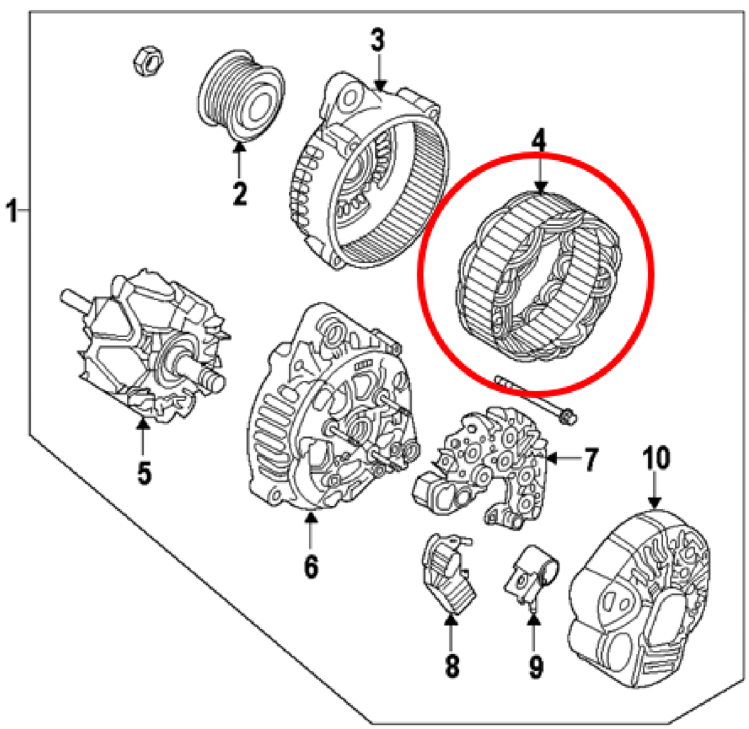
1. Check that there is continuity between each pair of leads (A).



2. Check that there is no continuity between each lead and the coil core.
3. If the coil fails either continuity check, replace the alternator.

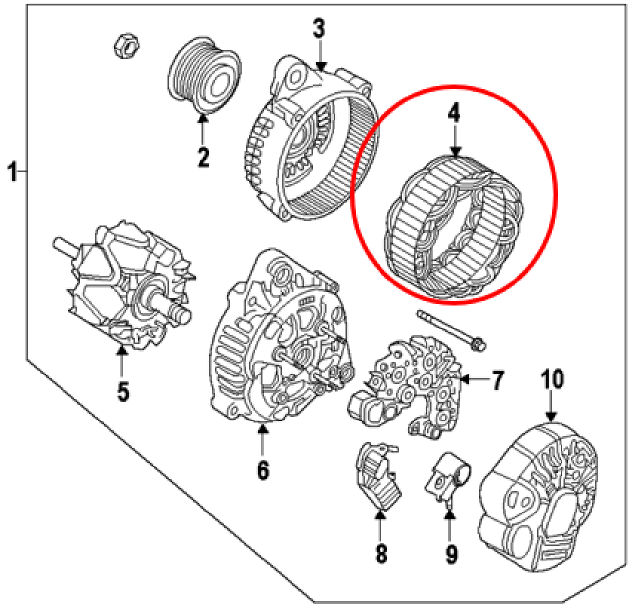
The stator core has a plurality of radially extending slots.

Figure 141



The wire pack has a plurality of continuous electrical wires with the wire being flat.

Figure 142

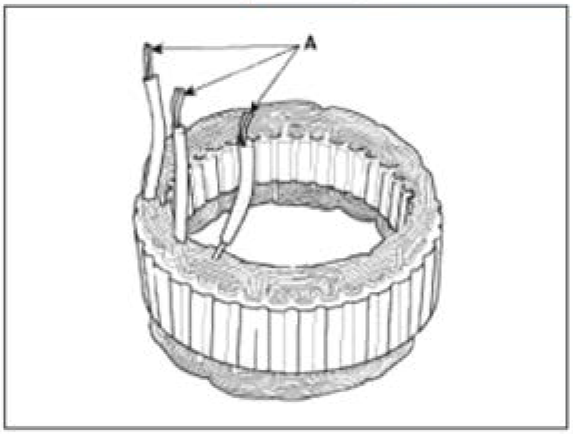


The flat wire packs are shaped into a hollow cylindrical shape.

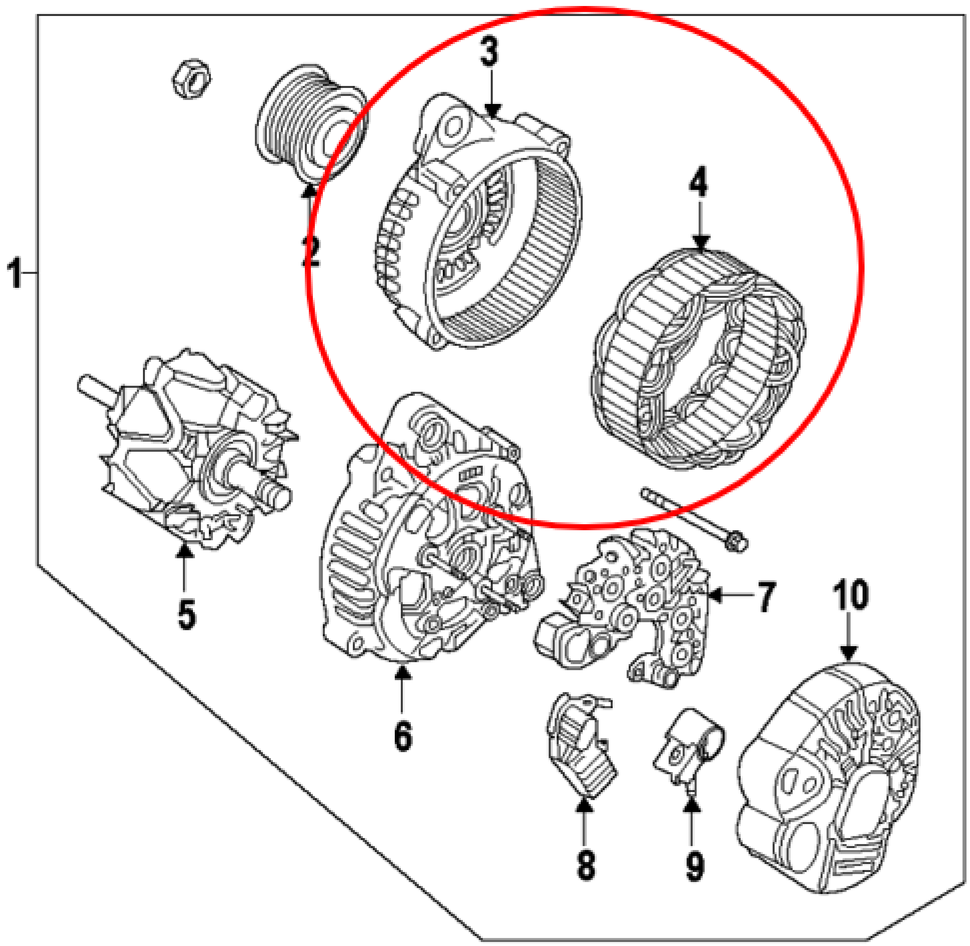
Figure 143

Inspect Stator

1. Check that there is continuity between each pair of leads (A).



2. Check that there is no continuity between each lead and the coil core.
3. If the coil fails either continuity check, replace the alternator.



There is a hollow cylindrically shaped flat wire pack with the stator core such that the continuous electrical wires are interlaced within the slats of the stator core, wherein engaging the flat wire pack with the stator core includes one of radially expanding and compressing the hollow cylindrical shape of the flat wire pack radially into the slots of the stator core.

Figure 144

COUNT XXII – INFRINGEMENT OF U.S. PATENT NO. 7,116,081

197. The allegations set forth in the foregoing paragraphs 1 through 196 are incorporated into this Twenty Second Claim for Relief.

198. On Oct. 3, 2006, U.S. Patent No. 7,116,081 ("the '081 patent"), entitled "*Thermal Protection Scheme for High Output Vehicle Alternator*," was duly and legally issued by the United States Patent and Trademark Office. A true and correct copy of the '081 patent is attached as Exhibit 22.

199. Michigan Motor is the assignee and owner of the right, title and interests in and to the '081 patent, including the right to assert all causes of action arising under said patents and the right to any remedies for infringement of them.

200. Upon information and belief, Defendants have directly infringed at least 1 claim of the '081 patent by making, using, selling, importing and/or providing and causing to be used the Accused Instrumentalities.

201. Upon information and belief, the Accused Instrumentalities incorporate, for example, the 2012 Hyundai Sonata which comprises a thermal protection system for a high output vehicle alternator.

202. In particular, claim 1 of the '081 patent recites a thermal protection system for a high output vehicle alternator, said system comprising: a duty cycle control system; an alternator having a temperature limit and at least one rotor speed limit, said alternator operably connected to said duty cycle control system; a field current supply to said alternator; an alternator rotor speed sensor in communication with said duty cycle control system for determining an alternator

rotor speed; and an alternator temperature sensor in communication with said duty cycle control system, for determining an alternator temperature, wherein said duty cycle control system regulates said field current supply to said alternator based on said alternator rotor speed and said alternator temperature in order to maintain said alternator temperature below said temperature limit and prevent excess heat from being generated.

203. On information and belief, the Accused Instrumentalities infringe claim 1 of the ’081 patent. The Accused Instrumentalities comprise a thermal protection system for a high output vehicle alternator (*Figure 145*), said system comprising: a duty cycle control system (*Figure 146*); an alternator having a temperature limit and at least one rotor speed limit, said alternator operably connected to said duty cycle control system (*Figure 147*); a field current supply to said alternator (*Figure 148*); an alternator rotor speed sensor in communication with said duty cycle control system for determining an alternator rotor speed (*Figure 149*); and an alternator temperature sensor in communication with said duty cycle control system, for determining an alternator temperature, wherein said duty cycle control system regulates said field current supply to said alternator based on said alternator rotor speed and said alternator temperature in order to maintain said alternator temperature below said temperature limit and prevent excess heat from being generated (*Figure 160*).

Hybrid Motor System > Hybrid Motor Assembly > Description and Operation

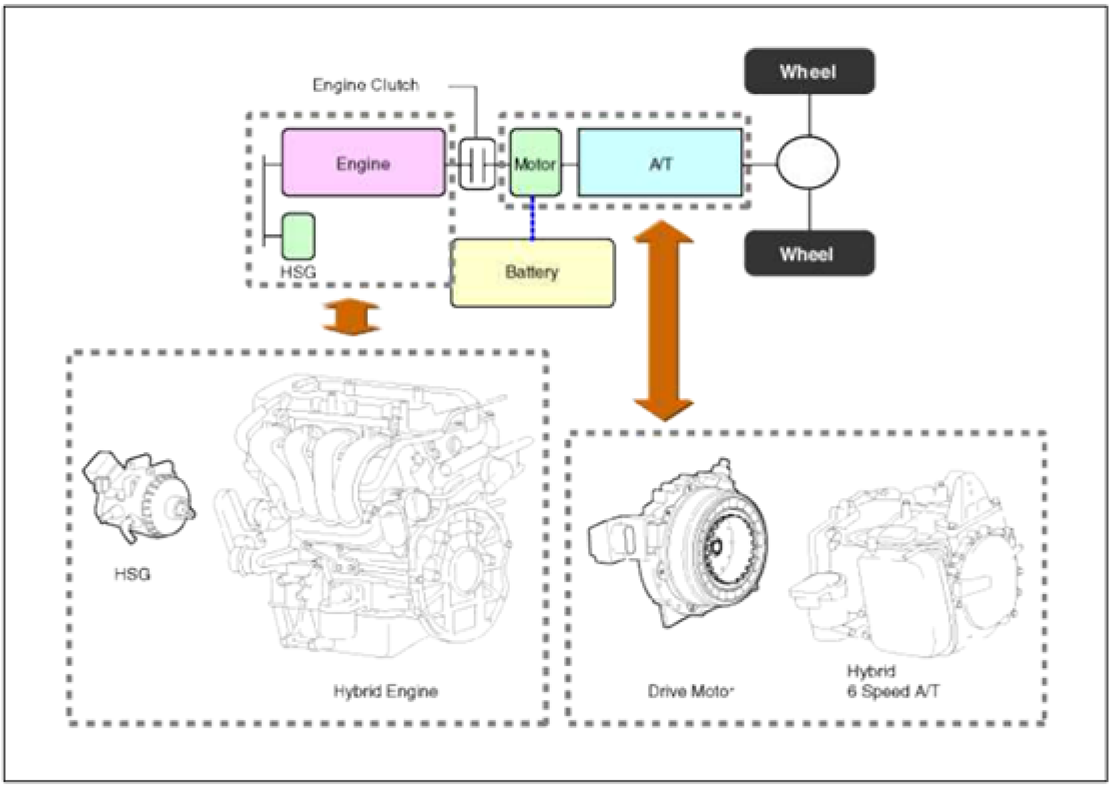
Description

The electric motor is the core technology of a hybrid vehicle. The Hybrid motor system is equipped with two electric motors. These motors are the drive (traction) motor that is used as the primary power source and a HSG, which acts as the starter motor and alternator in a conventional engine. The traction motor operates to move the vehicle

The HSG is the alternator

Page 10 of 54

and to provide lower Noise, Vibration, Harshness (NVH) during driving and to achieve fuel efficiency.
The electric motor supplements the engine during acceleration to increase power output and to allow the engine to operate in a fuel efficient mode. In addition, the electric motor takes on the role of a generator during deceleration and braking to charge the high voltage battery. The Hybrid Starter Generator (HSG) starts the engine while the vehicle is in motion.



The Hybrid Starter Generator (HSG), which is a high output vehicle alternator, has a temperature sensor that feeds input directly to the Motor Control Unit (MCU).

SONATA Plug-in Hybrid(LF PHEV) > 2017 > G 2.0 PHEV > Motor Control System > HEV Motor Control System > P0A37 Generator Temperature Sensor Circuit Range/Performance

DTC Description

Feedback

P0A37 is set when there is a performance problem in "HYBRID STARTER & GENERATOR MOTOR_TEMP. Sensor".

DTC Detecting Condition

Item		Conditions for setting DTC	Possible Cause
DTC Strategy		• Check the temperature	1. Sensor Poor connection 2. Faulty "HPCU" sensing circuit
Case 1	Enable Conditions	• IG key "ON" • Aux. Battery voltage is between 9V and 16V • No DTC P0A2C, P0A2D	
	Threshold Value	• Generator(HSG) Temperature change rate is over 5°C(41°F)/ms	
	Diagnostic Time	• 50 times	
Case 2	Enable Conditions	• IG key "ON" • Aux. Battery voltage is between 9V and 16V • Average input torque is over 3Nm for 300sec. • No DTC P0A38, P0A39	
	Threshold Value	• HSG temperature change is below 2°C(35.6°F)	
	Diagnostic Time	• Immediately	
Case 3	Enable Conditions	• IG key "ON" • Aux. Battery voltage is between 9V and 16V • Engine is soaking over 8hr	
	Threshold Value	• Deviation between HSG temperature and each temp. sensor(motor, motor inverter(MCU), HSG inverter(GCU)) is over 20°C(68°F)	
	Diagnostic Time	• Immediately	
MIL		• Immediately	
Service Lamp		• ON	

The Infringing Instrumentalities comprise a thermal protection system of the HSG with a Diagnostic Trouble Code (DTC) "P0A37"

Figure 145

SONATA Plug-in Hybrid(LF PHEV) > 2017 > G 2.0 PHEV > Motor Control System > HEV Motor Control System > P0E0C Generator Phase U-V-W Circuit/Open

DTC Description

Feedback

P0E0C is set when the hybrid starter generator 3 Phase Power Cable("HYBRID STARTER & GENERATOR MOTOR_Power_U, V, W") circuit is open.

DTC Detecting Condition

Item		Conditions for setting DTC	Possible Cause
DTC Strategy		• Check the current	1. Power Cable connector disconnection/poor connection 2. Power Cable open
Case 1	Enable Conditions	• IG key "ON" • Aux. Battery voltage is between 9V and 16V • Generator(HSG) speed is below 500rpm~2900rpm • HSG command current is 50A	
	Threshold Value	• The Current of 1 Phase of Generator(HSG) 3 Phase Power Cable is below 10A at the "Enable Conditions"	
	Diagnostic Time	• 30ms	
Case 2	Enable Conditions	• IG key "ON" • AUX. Battery voltage is between 9V and 16V • Apply the DQ high frequency current(30A, 50Hz) for 40ms at IG key "ON"	
	Threshold Value	• The Current of 1 Phase of Generator(HSG) 3 Phase Cable is below 10A at the "Enable Conditions"	
	Diagnostic Time	• 1 times after IG key "ON"	
MIL		• Immediately	
Service Lamp		• ON	

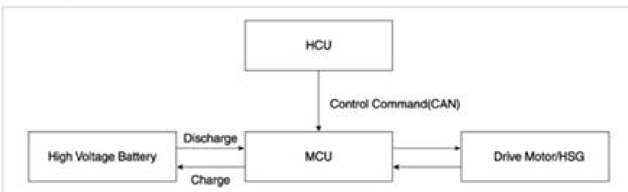
SONATA Plug-in Hybrid(LF PHEV) > 2017 > G 2.0 PHEV > Hybrid Motor System

Description

Feedback

The Hybrid vehicle is equipped with a high voltage controller that includes a HPCU. The Hybrid Power Control Unit (HPCU) is composed of various components. It is the core device among the Power Electronics (referred to as "PE") devices and acts as the brain. It commands the operation of the hybrid vehicle. It comprises a Hybrid Control Unit (HCU), an inverter [Motor Control Unit (MCU), a Generator Control Unit (GCU)] and a Low-voltage DC-DC Converter (LDC).

All these components are configured as a single package. To ensure effective cooling of the HPCU, there is an additional cooling line which is separate to the existing engine cooling line. Each control unit is organically connected to the HCU via CAN communication.



SONATA Plug-in Hybrid(LF PHEV) > 2017 > G 2.0 PHEV > Hybrid Motor System

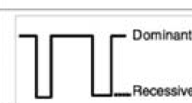
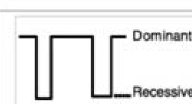
Feedback

87	H_REZ+	HSG resolver output(+)	IG ON	Differential,Analog	14Vpp Sine wave	
88	H_REZ-	HSG resolver output(-)				
89	-	-				
90	-	-				

SONATA Plug-in Hybrid(LF PHEV) > 2017 > G 2.0 PHEV > Hybrid Motor System

MCU Input/Output Signal

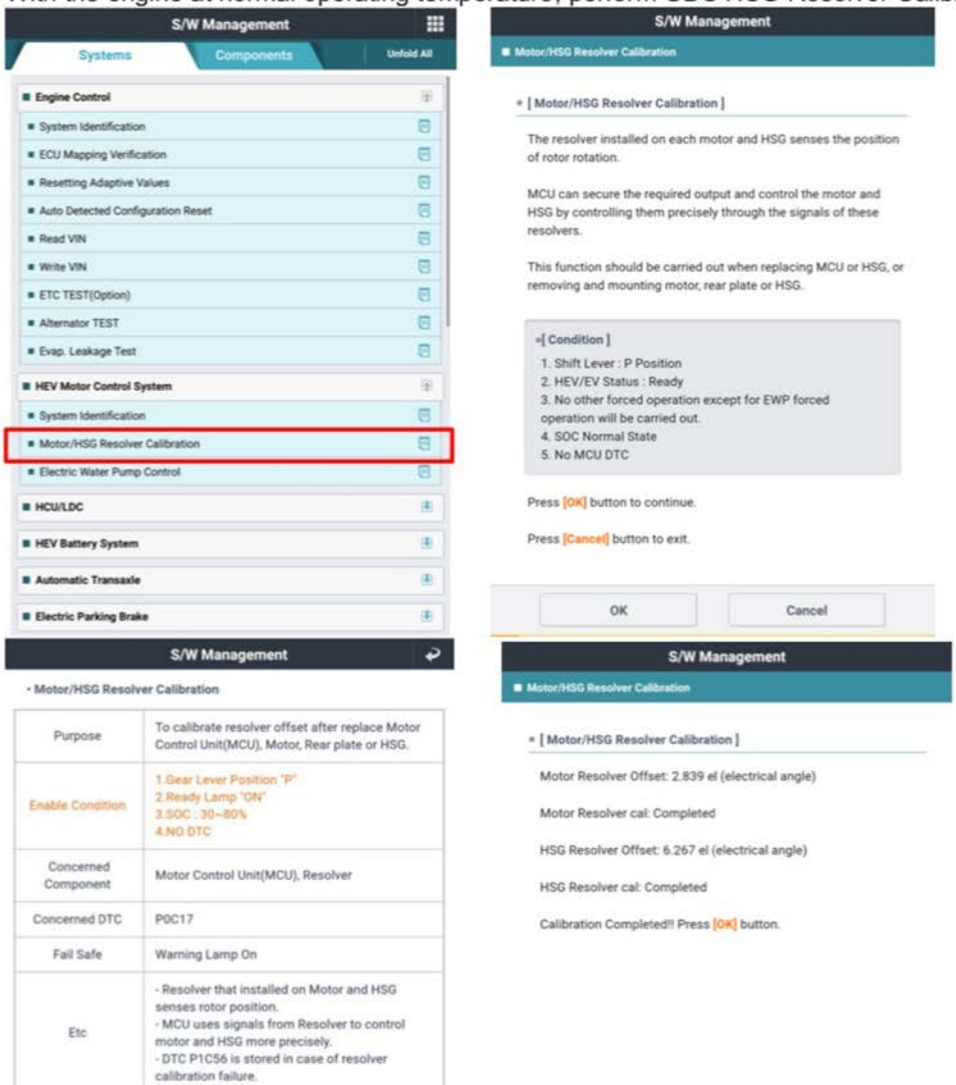
Feedback

Pin	Signal	Description	Condition	Type	Level	Wave from
5	VB1	Vehicle power 1(B+)	Always	DC Voltage	Battery power	
6	VB2	Vehicle power 2(B+)	Always	DC Voltage	Battery power	
3	GND1	Ground power 1	Always	DC Voltage	Max. 50mV	
4	VB3	Vehicle power 3(B+)	Always	DC Voltage	Battery power	
1	GND2	Ground power 2	Always	DC Voltage	Max. 50mV	
2	GND3	Ground power 3	Always	DC Voltage	Max. 50mV	
73	IGN	Ignition	IG ON	DC Voltage	Battery power	
74	-	-				
75	-	-				
76	-	-				
77	-	-				
78	P_CAN_H	P-CAN [High]	IG ON	Pulse	Dominant:2.75~4.5(3.5)V Recessive:2.0~3.0(2.5)V	 Dominant / Recessive
79	P_CAN_L	P-CAN [Low]	IG ON	Pulse	Recessive:2.0~3.0(2.5)V Dominant:0.5~2.25(1.5)V	
80	-	-				
81	H_CAN_H	H-CAN [High]	IG ON	Pulse	Dominant:2.75~4.5(3.5)V Recessive:2.0~3.0(2.5)V	 Dominant / Recessive
82	H_CAN_L	H-CAN [Low]	IG ON	Pulse	Recessive:2.0~3.0(2.5)V Dominant:0.5~2.25(1.5)V	
83	-	-				
84	-	-				
85	-	-				
86	-	-				
87	H_REZ+	HSG resolver output(+)	IG ON	Differential,Analog	14Vpp Sine wave	
88	H_REZ-	HSG resolver output(-)				
89	-	-				

SUBJECT: HYBRID STARTER GENERATOR (HSG) INSPECTION / REPLACEMENT – SERVICE CAMPAIGN T2E

33. Restore the customer's AM/FM/XM radio presets noted from step-1.

34. With the engine at normal operating temperature, perform GDS HSG Resolver Calibration:



As shown above, the Infringing Instrumentalities comprise a method for a duty cycle control system with a duty cycle control signal sent from the MCU to the HSG.

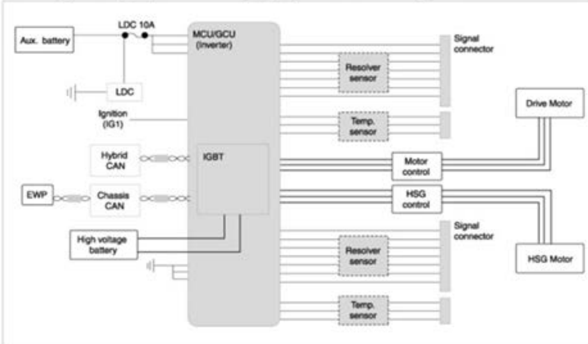
Figure 146

SONATA Plug-in Hybrid(LF PHEV) > 2017 > G 2.0 PHEV > Hybrid Motor System

System Circuit Diagram

Feedback

A high-capacity power module is applied to control 2 primary motors using high voltage. The power module is composed of a high-speed switching insulated gate bipolar transistor (IGBT) and a diode circuit. The high voltage battery capacity is about 270V, but to ensure stability and reliability the power module uses high capacity power with a maximum voltage of 650V.



SONATA Plug-in Hybrid(LF PHEV) > 2017 > G 2.0 PHEV > Motor Control System > HEV Motor Control System > P0A37 Generator Temperature Sensor Circuit Range/Performance

DTC Description

Feedback

P0A37 is set when there is a performance problem in "HYBRID STARTER & GENERATOR MOTOR_TEMP. Sensor".

DTC Detecting Condition

Item		Conditions for setting DTC	Possible Cause
DTC Strategy		• Check the temperature	1. Sensor Poor connection 2. Faulty "HPCU" sensing circuit
Case 1	Enable Conditions	• IG key "ON" • Aux. Battery voltage is between 9V and 16V • No DTC P0A2C, P0A2D	
	Threshold Value	• Generator(HSG) Temperature change rate is over 5°C(41°F)/ms	
	Diagnostic Time	• 50 times	
Case 2	Enable Conditions	• IG key "ON" • Aux. Battery voltage is between 9V and 16V • Average input torque is over 3Nm for 300sec. • No DTC P0A38, P0A39	
	Threshold Value	• HSG temperature change is below 2°C(35.6°F)	
	Diagnostic Time	• Immediately	
Case 3	Enable Conditions	• IG key "ON" • Aux. Battery voltage is between 9V and 16V • Engine is soaking over 8hr	
	Threshold Value	• Deviation between HSG temperature and each temp. sensor(motor, motor inverter(MCU), HSG inverter(GCU)) is over 20°C(68°F)	
	Diagnostic Time	• Immediately	
MIL		• Immediately	
Service Lamp		• ON	

Hyundai Motor America

SONATA Plug-in Hybrid(LF PHEV) > 2017 > Motor Control System > HEV Motor Control System > Monitor

Monitor DTC Status

Feedback

1. Connect GDS to "DATA LINK CONNECTOR(DLC)".
2. IG key "ON", Engine "OFF".
3. Select "Diagnostic Trouble Codes(DTC)" with GDS.
4. Monitor the diagnostic trouble code and present of the trouble code.
5. Erase the DTC and operate the vehicle within DTC Enable conditions in General information.

DTC

Erase All DTC | Freeze Frame | DTC Status | Erase Selective DTC | Hist/Pend DTC

Current DTC	Description	State
P0A37	Generator Temperature Sensor Circuit Range/Performance	Active

6. Is the DTC outputted again?

YES ▶ Go to "Current data Analysis" as below.

NO ▶ Fault is intermittent caused by poor contact in "HPCU""s connector or was repaired and "HPCU" memory was not cleared.
→ Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
→ Repair or replace as necessary and then go to "Verification of Vehicle Repair" procedure.

Current data Analysis

1. Select "Current Data" with GDS.
2. Monitor "Generator(HSG) Temperature" parameter.
3. Operate the vehicle within DTC Enable conditions in General information.

Reference Data

Normal	"Generator(HSG) Temperature" : Between -20°C(-4°F) and 200°C(392°F)
Abnormal	"Generator(HSG) Temperature" : 214°C(417°F) or 215°C(419°F)

4. Is the displayed current data normal?

SONATA Plug-in Hybrid(LF PHEV) > 2017 > G 2.0 PHEV > Motor Control System > HEV Motor Control System > P0A4B Generator Position Sensor Circuit

General Description

Feedback

Generator Position Sensor, which is located inside the Generator(HSG*), detects position and speed of the HSG Rotor.
"HYBRID INVERTER"(GCU*) controls HSG according to the position and speed of the HSG Rotor which is detected by HSG Position Sensor.

NOTICE

HSG* :Hybrid Starter Generator, "HYBRID STARTER & GENERATOR MOTOR"
GCU* :Generator Control Unit, "HYBRID INVERTER"
HSG Position Sensor* :Resolver, "HYBRID STARTER & GENERATOR MOTOR_Resolver"

SONATA Plug-in Hybrid(LF PHEV) > 2017 > G 2.0 PHEV > Hybrid Motor System

MCU Input/Output Signal Feedback

Pin	Signal	Description	Condition	Type	Level	Wave from
5	VB1	Vehicle power 1(B+)	Always	DC Voltage	Battery power	
6	VB2	Vehicle power 2(B+)	Always	DC Voltage	Battery power	
3	GND1	Ground power 1	Always	DC Voltage	Max. 50mV	
4	VB3	Vehicle power 3(B+)	Always	DC Voltage	Battery power	
1	GND2	Ground power 2	Always	DC Voltage	Max. 50mV	
2	GND3	Ground power 3	Always	DC Voltage	Max. 50mV	
73	IGN	Ignition	IG ON	DC Voltage	Battery power	
74	-	-				
75	-	-				
76	-	-				
77	-	-				
78	P_CAN_H	P-CAN [High]	IG ON	Pulse	Dominant:2.75~4.5(3.5)V Recessive:2.0~3.0(2.5)V	 Dominant / Recessive
79	P_CAN_L	P-CAN [Low]	IG ON	Pulse	Recessive:2.0~3.0(2.5)V Dominant:0.5~2.25(1.5)V	
80	-	-				
81	H_CAN_H	H-CAN [High]	IG ON	Pulse	Dominant:2.75~4.5(3.5)V Recessive:2.0~3.0(2.5)V	 Dominant / Recessive
82	H_CAN_L	H-CAN [Low]	IG ON	Pulse	Recessive:2.0~3.0(2.5)V Dominant:0.5~2.25(1.5)V	
83	-	-				
84	-	-				
85	-	-				
86	-	-				
87	H_REZ+	HSG resolver output(+)	IG ON	Differential,Analog	14Vpp Sine wave	
88	H_REZ-	HSG resolver output(-)				
89	-	-				

As shown above, the Infringing Instrumentalities comprise a method for an alternator (HSG) having a temperature limit and at least one rotor speed limit connected to a duty cycle control system (MCU). The temperature limit is measured by the MCU at the HSG temperature sensor and the rotor speed is also measured by the MCU at the HSG via a "resolver sensor." The duty cycle control of the HSG by the MCU, which is established as the duty cycle control system, is also shown below. Temperature limits are detailed in the Diagnostic Trouble Codes (DTCs) also shown above.

Figure 147

SONATA Plug-in Hybrid(LF PHEV) > 2017 > G 2.0 PHEV > Motor Control System > HEV Motor Control System > P0E0C Generator Phase U-V-W Circuit/Open

DTC Description Feedback

P0E0C is set when the hybrid starter generator 3 Phase Power Cable("HYBRID STARTER & GENERATOR MOTOR_Power_U, V, W") circuit is open.

DTC Detecting Condition

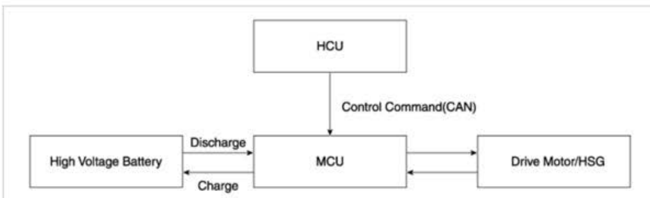
Item		Conditions for setting DTC	Possible Cause
DTC Strategy		• Check the current	1. Power Cable connector disconnection/poor connection 2. Power Cable open
Case 1	Enable Conditions	• IG key "ON" • Aux. Battery voltage is between 9V and 16V • Generator(HSG) speed is below 500rpm~2900rpm • HSG command current is 50A	
	Threshold Value	• The Current of 1 Phase of Generator(HSG) 3 Phase Power Cable is below 10A at the "Enable Conditions"	
	Diagnostic Time	• 30ms	
Case 2	Enable Conditions	• IG key "ON" • AUX. Battery voltage is between 9V and 16V • Apply the DQ high frequency current(30A, 50Hz) for 40ms at IG key "ON"	
	Threshold Value	• The Current of 1 Phase of Generator(HSG) 3 Phase Cable is below 10A at the "Enable Conditions"	
	Diagnostic Time	• 1 times after IG key "ON"	
MIL		• Immediately	
Service Lamp		• ON	

SONATA Plug-in Hybrid(LF PHEV) > 2017 > G 2.0 PHEV > Hybrid Motor System

Description Feedback

The Hybrid vehicle is equipped with a high voltage controller that includes a HPCU. The Hybrid Power Control Unit (HPCU) is composed of various components. It is the core device among the Power Electronics (referred to as 'PE') devices and acts as the brain. It commands the operation of the hybrid vehicle. It comprises a Hybrid Control Unit (HCU), an inverter [Motor Control Unit (MCU), a Generator Control Unit (GCU)] and a Low-voltage DC-DC Converter (LDC).

All these components are configured as a single package. To ensure effective cooling of the HPCU, there is an additional cooling line which is separate to the existing engine cooling line. Each control unit is organically connected to the HCU via CAN communication.



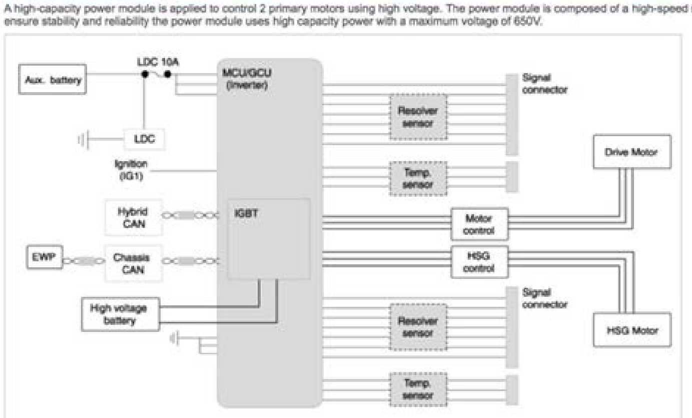
As shown above, the 3-phase power cable supplies the “field” current to the SMG (alternator).

Figure 148

SONATA Plug-in Hybrid(LF PHEV) > 2017 > G 2.0 PHEV > Hybrid Motor System

System Circuit Diagram Feedback

A high-capacity power module is applied to control 2 primary motors using high voltage. The power module is composed of a high-speed switching insulated gate bipolar transistor (IGBT) and a diode circuit. The high voltage battery capacity is about 270V, but to ensure stability and reliability the power module uses high capacity power with a maximum voltage of 650V.



As shown above, the HSG (alternator) resolver (rotor speed sensor) is in communication with the MCU (duty cycle control system) for determining the HSG (alternator rotor) speed.

Figure 149

Hyundai Motor America

SONATA Plug-in Hybrid(LF PHEV) > 2017 > Motor Control System > HEV Motor Control System >

General Description Feedback

Generator Position Sensor, which is located inside the Generator(HSG*), detects position and speed of the HSG Rotor.
"HYBRID INVERTER"(GCU*) controls HSG according to the position and speed of the HSG Rotor which is detected by HSG Position Sensor.

NOTICE

HSG* :Hybrid Starter Generator, "HYBRID STARTER & GENERATOR MOTOR"
GCU* :Generator Control Unit, "HYBRID INVERTER"
HSG Position Sensor* :Resolver, "HYBRID STARTER & GENERATOR MOTOR_Resolver"

Hyundai Motor America

SONATA Plug-in Hybrid(LF PHEV) > 2017 > Motor Control System > HEV Motor Control System >

General Description Feedback

Generator(HSG*) is supplied AC Power via 3 Phase Power Cable from "HYBRID INVERTER"(GCU*) and starts the engine.
GCU controls HSG according to the temperature detected by HSG Temperature Sensor which is located in HSG.

NOTICE

HSG* :Hybrid Starter Generator, "HYBRID STARTER & GENERATOR MOTOR"
GCU* :Generator(HSG) Control Unit, "HYBRID INVERTER"

Hyundai Motor America

SONATA Plug-in Hybrid(LF PHEV) > 2017 > Motor Control System > HEV Motor Control System >

General Description Feedback

There are two "HYBRID INVERTER" inside HPCU*. "HYBRID INVERTER"(MCU*) inverts BMS* DC power into 3 Phase AC Power, and MCU provides 3 Phase AC Power to a Drive Motor when it receives the control signal from HCU*, whereas "HYBRID INVERTER"(GCU*) provides it to a Generator(HSG*).
GCU inverts 3 Phase Power which is supplied from the engine to DC Power and stores it in the high voltage battery of BSM. It inverts or provides the power to the HSG via 3 Phase Power Cable.

NOTICE

HPCU* :"HYBRID POWER CONTROL UNIT"
MCU* :Motor Control Unit, "HYBRID INVERTER"
BMS* :Battery Manager System, "BMS CONTROL MODULE"
HCU* :Hybrid Control Unit, "HPCU"
GCU :Generator(HSG) Control Unit, "HYBRID INVERTER"
HSG* :Hybrid Starter Generator, "HYBRID STARTER & GENERATOR MOTOR"

As shown above, the HSG (alternator) temperature sensor is connected directly (in communication) with the MCU (a duty cycle control system) which receives temperature sensor input and determines HSG (alternator) temperature. The MCU/GCU controls the HSG (alternator) output according to speed of the HSG rotor and temperature of the HSG.

Figure 150

204. Each Defendant's infringement of each asserted patent has been and continues to be willful. On March 8, 2017, Plaintiff's affiliate (via its counsel) sent correspondence to Hyundai America Technical Center, Inc., Hyundai Motor America, and Kia Motors America, Inc. The correspondence indicated a claim of infringement related to power train and other subsystems of motor vehicles including vehicles produced by Defendants.

205. On March 13, 2017, Plaintiff's representative and counsel communicated by telephone with a Mark J. Goldzweig, a representative of KIA Motors America, Inc, an affiliate of each Defendant, regarding the issues of infringement and potential source code production.

206. Each Defendant was also made aware of the patents in issue and its infringement thereof at least as early as September 1, 2017 when MMT filed its Complaint, which provided notice of infringement of the '604, '106, '260, '128, '565, '281, '804, '680, '166, '540, '031, '839, '287, '761, '115, '574, '497, '157, and '122 patents.

207. Since at least March 8, 2017, and further since at least September 1 2017, each Defendant's infringement has been willful.

JURY DEMAND

Pursuant to Rule 38 of the Federal Rules of Civil Procedure, Plaintiff demands a trial by jury on all issues triable as such.

PRAYER FOR RELIEF

WHEREFORE, Plaintiff demands judgment for itself and against Defendants as follows:

A. An adjudication that Defendants have infringed the '604, '106, '260, '128, '565, '281, '804, '680, '166, '540, '031, '839, '287, '761, '115, '574, '497, '157, 122, '149, '501 and '081 patents;

B. An award of damages to be paid by Defendants adequate to compensate Plaintiff for Defendants' past infringement of the '604, '106, '260, '128, '565, '281, '804, '680, '166, '540, '031, '839, '287, '761, '115, '574, '497, '157, 122, '149, '501 and '081 patents;

C. and any continuing or future infringement through the date such judgment is entered, including interest, costs, expenses and an accounting of all infringing acts including, but not limited to, those acts not presented at trial;

D. A declaration that this case is exceptional under 35 U.S.C. § 285, and an award of Plaintiff's reasonable attorneys' fees; and

E. An award to Plaintiff of such further relief at law or in equity as the Court deems just and proper.

Date: April 30, 2018

/s/ *Timothy Devlin*
Devlin Law Firm, LLC
Timothy Devlin (DE No. 4241)
Robyn T. Williams (NY No. 5487301)
1306 N. Broom Street, 1st Floor
Wilmington, DE 19806
(302) 449-9010
tdevlin@devlinlawfirm.com
rwilliams@devlinlawfirm.com

Jackier Gould, P.C.
Eric A. Bean (P48676)
121 W. Long Lake Rd.
Bloomfield Hills, MI 48304
248-642-0500
ebean@jackiergould.com

Attorneys for Plaintiff
Michigan Motor Technologies LLC