Dorman Training Center Presents:

AIR FUEL SENSORS - INFO & TESTING

DORMAN® TRAINING CENTER

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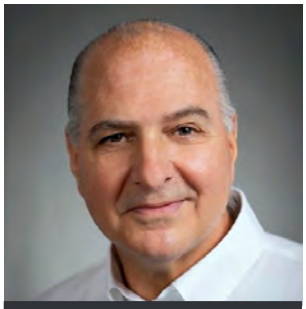
Your instructor for this webinar

Our DTC Director has extensive experience in the automotive field as a technician, service manager and owner of a dozen different repair shops. “G,” as he is known throughout the industry, is one of fewer than 2,000 professionals certified as a World-Class Technician. He brings world-class training experience and automotive technical expertise to Dorman Training Center.

G is a recognized expert on automotive systems and best practices for their repair and has trained technicians on all popular domestic and international vehicle brands all over North America and Europe. He has authored several FMCSA-approved inspection manuals and training programs for state governments, is ASE-certified and a Golden Wrench winner.
G serves as an adjunct professor at Rutgers University (NJ, USA) and is also an in-demand speaker at industry events. He has often presented at some of the most prestigious conferences in the United States, including the SAE World Congress Conference.

With decades of hands-on experience in every aspect of vehicle repair and education expertise unmatched in the automotive aftermarket industry, G strives to make every DTC student the best technician he or she can be.



"G" Jerry Truglia

gtruglia@dormanproducts.com

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What Will Be Covered:

Instructions for this Webinar:

- This seminar will be approx. 1 hour long
- All slides that are presented are in your handout and are numbered
- Have a pen or pencil and paper for notes
- Questions can be asked at anytime

01 AF Voltage Levels Info

02 AFR Voltage Levels Terms

03 AF Data

04 Case Studies

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AF Voltage Levels Info

AF Sensor :

For example, vehicles that use AF sensors always have this sensor before the catalytic converter and a regular HO2S after the catalytic converter. HO2S switches voltage from rich to lean, while the A/F stays at close to a steady voltage state. Note: Some newer vehicles now use A/F sensor in the rear/post converter.

That steady voltage differs by the vehicle manufacturer. Plus, it can only be measured accurately in most cases with a scan tool in Enhanced OBD II mode or by factory software, as well as with a meter. Because many foreign vehicles use the AF sensor, be aware that many aftermarket scan tools may not read or display the readings properly in Generic OBD II.

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Air Fuel / Wide Range

- **The normal range for a Toyota AF sensor is 2.8 - 3.8 volts at idle, but don't be surprised to see the actual readings in an idling engine hover very close to the 3.3 volt center point that indicates a stoichiometric air/fuel mixture of 14.7:1.**
- **Remember, this sensor doesn't bracket the mixture with high and low voltage toggles, it measures the mixture exactly. Voltage does not dither with the AF sensor.**

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Air Fuel / Wide Range

- **Generic / Global scan tools may not display the true voltage.**

- **OBD II standards requiring O2 sensor PID voltage to be displayed in a range between zero and 1 volt.**

- **Instead, what you'll see is a *percentage* of true voltage. To display the *actual* PCM PID voltage, you'll need a scan tool with enhanced/factory software.**

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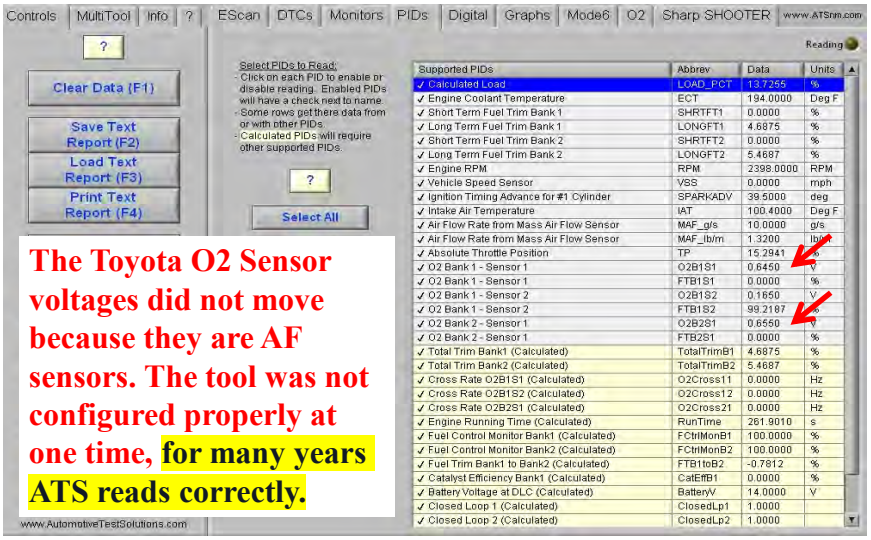
Understanding AFR Voltage Levels On Scan Tools



The Toyota O2 Sensor voltages did not move because they are AF sensors. The tool was not configured properly at one time, for many years ATS reads correctly.

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Terms To Know

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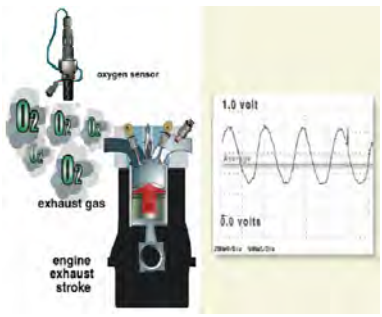
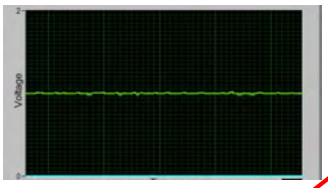
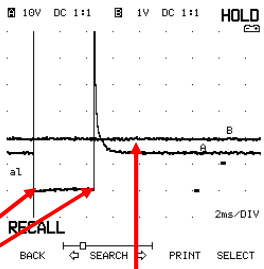
O2 & AF Sensor Fuel Control





Air Fuel



Fuel Injector (more pulse width = RICH, less = LEAN)

HO2S Sensor (HIGH voltage/ up RICH, LOW = LEAN condition)

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O2 / AF and Fuel Trim

The PCM constantly adjusts fuel delivery commands up and down, trying to bring the engine as close to as a perfect air - fuel mixture as possible. O2 or AFR sensor issues could have a profound effect on Fuel Trim.

The wrong voltage reading from either sensor can cause Fuel Trims to go off course and cause a driveability problem or DTC.

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Basic Term Review

- **Short Term Correction**
- **Long Term Correction**
- **Total Fuel Trim Correction**
- **Lambda**

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Short Term Fuel Trim Correction

- Occurs as a direct result of changes in the oxygen content of the exhaust stream
- Oxygen sensor signal voltage generated is directly proportional to the oxygen content of the exhaust stream
- The correction made is an immediate one (Adds or Subtracts Fuel)

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Long Term Fuel Trim Correction

- Learned response based on the activity of the STFT
- Once enough fuel has been added or deleted to correct the condition
- The long term will adjust itself based on short term fuel trim value
- The goal is to get STFT to go back as close as possible to zero

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Total Fuel Trim Correction (TFT)

- **TFT = Short-Term + Long-Term (Correction)**
- **ETFT = Short Term + Long Term + Rear Fuel Trim (Correction)**
- **Acceptable Range: +/- 10%**
- **Optimal Range: +/- 5%**

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Lambda

- **The ideal value for Lambda = 1**
- **If the value is greater that 1, the system is running lean**
- **If the value is less than 1, the system is running rich**

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Basic Term Review

- Short Term = .36% - varying (Positive)
- Long Term = -18% (Negative)
- Correcting for Rich condition
- If the PCM correction is correct, what value would we notice for Lambda on our scan tool or 5 gas analyzer?

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Testing Exhaust For Leaks Using Air Pressure Testing

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Scan Tool Data

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AF Scan Data

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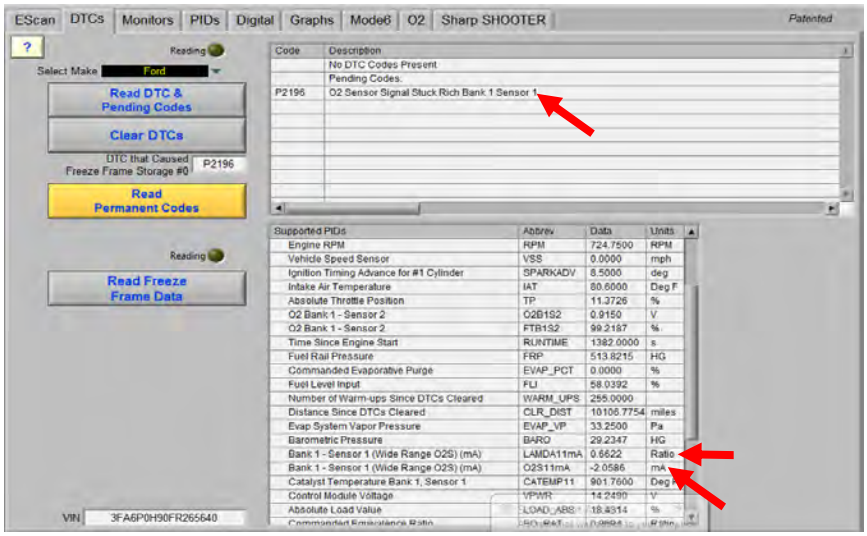
2015 Ford 2.0L Scan Tool Air Fuel



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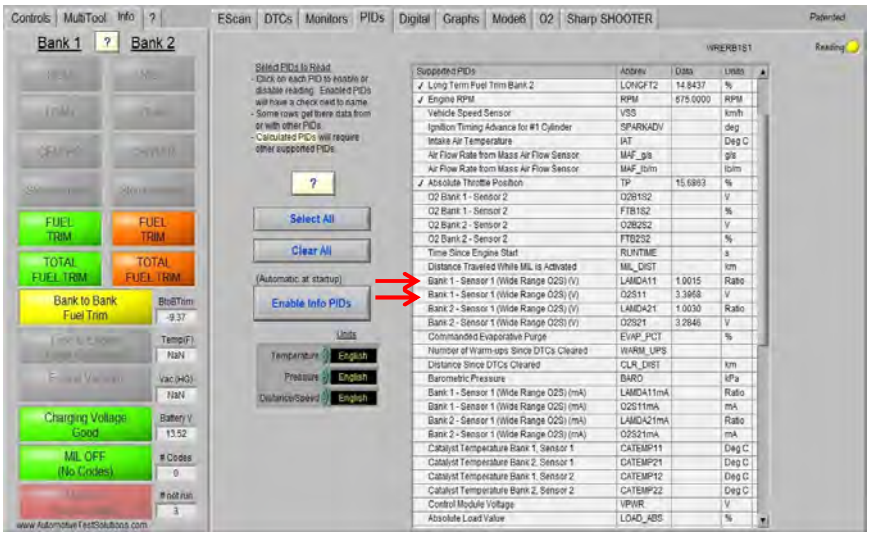
Toyota Wide Range (WR) / Air Fuel (AF)



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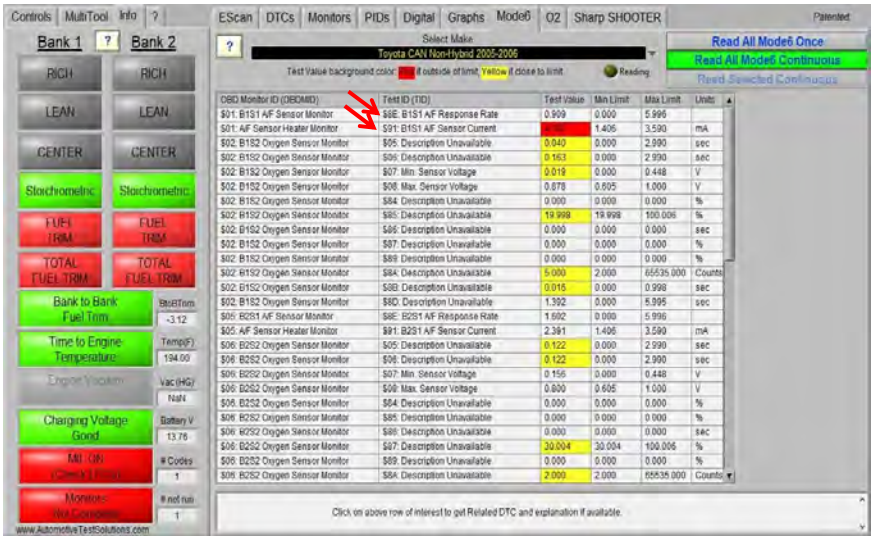
Toyota AF Mode 6



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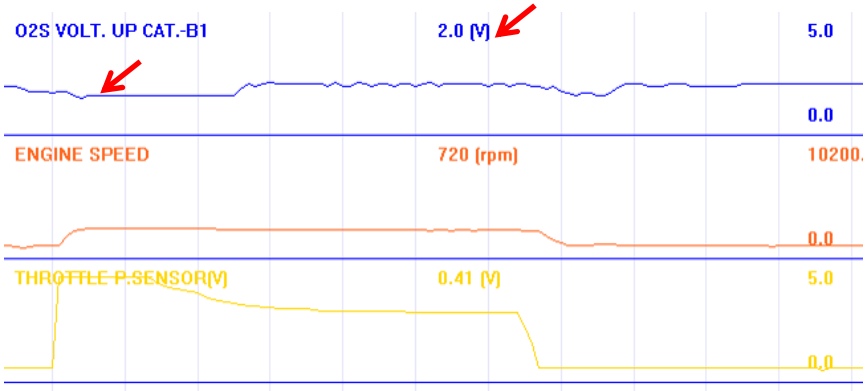
Understanding AF Voltage Levels On Scan Tools



The Hyundai - Kia and factory tool was not configured properly either. Take a look at the O2 Sensor voltage and you will notice it's stated as an O2S with a voltage average of 2.0 volts. The normal reading is 1.9 volts for their AF sensor.

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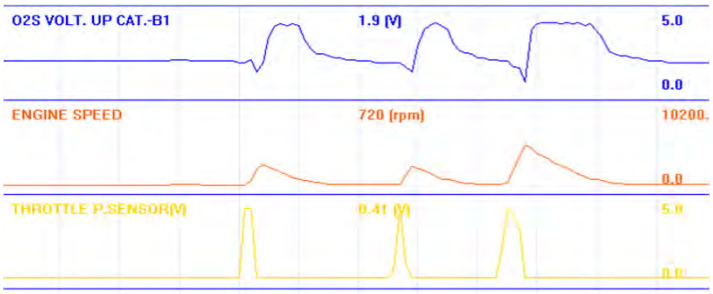
Air/Fuel Sensor Rich And Lean Conditions

To the contrary, when the condition is lean their voltage spikes. Look at the following graph as an example.



Don't get confused by scan tool PIDS. ***The graphs above can be confusing if you are not aware that the Hyundai factor scan tool displays A/F sensor as O2S.***

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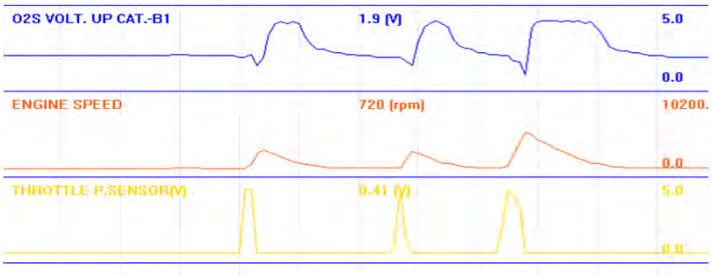
Air/Fuel Sensor Rich And Lean Conditions

As a throttle position and engine speed go up and the mixture gets richer, the voltage declines. Voltage goes up when engine speed and throttle position decline, as the mixture is leaned out to bring the car back to proper air - fuel mixture.



Don't get confused by scan tool PIDS. ***The graphs above can be confusing if you are not aware that the Hyundai - Kia factory scan tool displays A/F sensor as O2S.***

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AF Front & O2 Rear Sensor

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2005 Scion tc 2.4L Air Fuel

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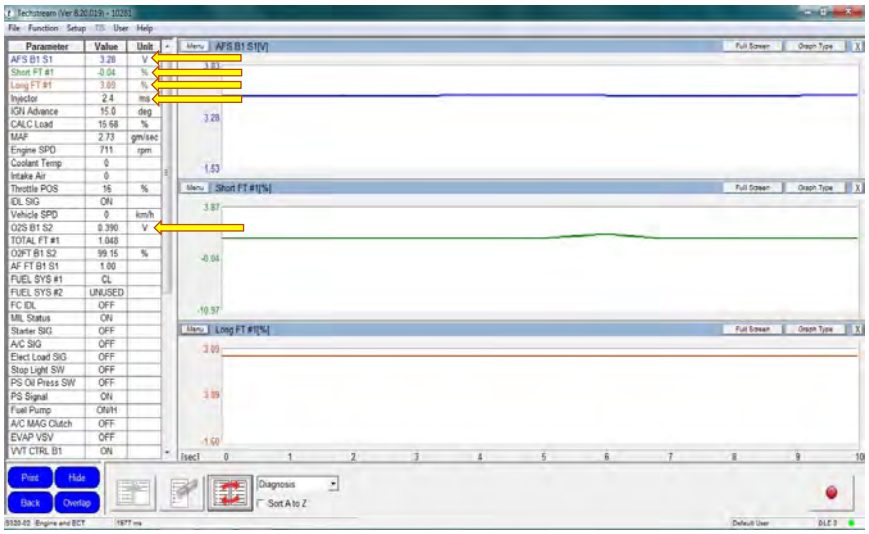
2005 Scion tc 2.4L Normal About 3.3 V AF Readings



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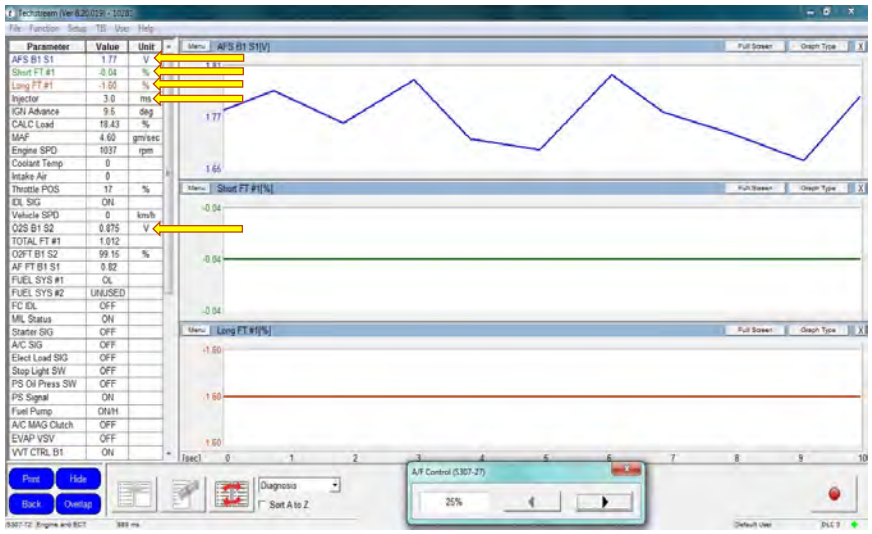
2005 Scion tc 2.4L 25% RICH Added AF Control



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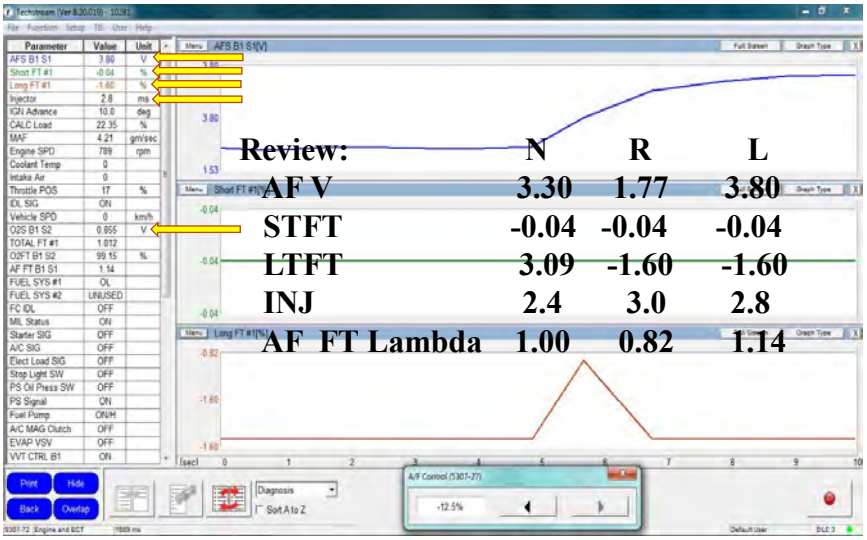
2005 Scion tc 2.4L -12.5% LEAN Taken AF Control



Review:	N	R	L
AF V	3.30	1.77	3.80
STFT	-0.04	-0.04	-0.04
LTFT	3.09	-1.60	-1.60
INJ	2.4	3.0	2.8
AF FT Lambda	1.00	0.82	1.14

Air Fuel Sensor Designs

4 And 5 Wire Air Fuel Sensors

- **Ford: 1997 intro (5 wire sensors)**
- **Subaru:1999 intro (4 wire sensors)**
- **Toyota: 1997 intro (4 wire sensors)**
- **Honda: 1998 intro (4 wire sensors)**
- **Nissan: 2007 intro (5 wire sensors)**

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4 And 5 Wire Air Fuel Sensors

- **All 4 wire sensors will be Denso**
- **All 5 wire sensors will be Bosch and NTK**
- **5 wire sensors may have 6 to 7 wires going out to the vehicle.**

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Honda Case Study
Failure Analysis

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Case Study

Vehicle: 2000 Honda Accord EX

Concern: The MIL is on. The PCM intermittently sets a P1167. The shop has changed the air fuel sensor for this code, and the code still comes back.

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Case Study

General Description

A heater for the sensor element is embedded in the air/fuel ratio (A/F) sensor (sensor 1) and is controlled by the engine control module (ECM)/powertrain control module (PCM). It is activated and heats the sensor to stabilize and speed the detection of oxygen content when the exhaust gas temperature is cold. The sensor cell resistance decreases as its temperature increases.
If the sensor cell resistance is not less than a set value after the lapse of a specified time period since the heater is turned on, a malfunction is detected and a DTC is stored.

Malfunction Threshold

The sensor cell resistance is 80 Ω or more for at least 60 seconds after the lapse of a specified time period since the heater is turned on.

Courtesy Of Honda Motor Company

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Case Study

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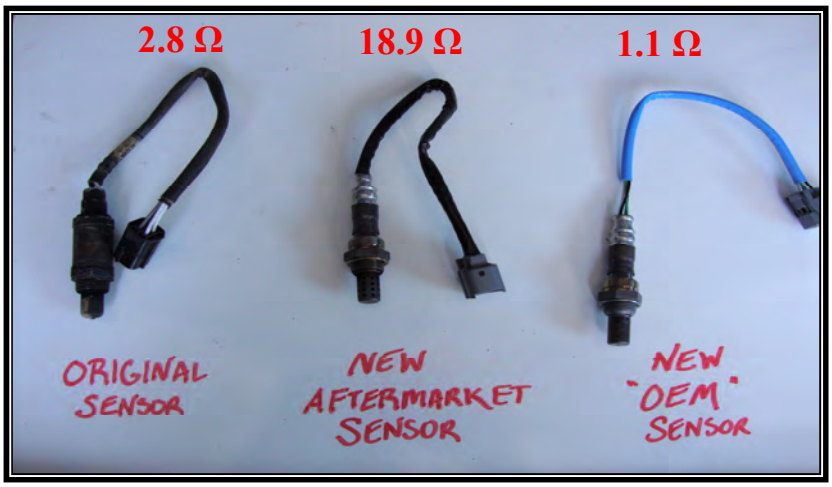
Case Study

- **Original A/F sensor heater internal resistance 2.8 ohms (14/2.8=5 amps).**
- **New Aftermarket A/F sensor heater internal resistance 18.9 ohms (14/18.9=0.740 amps).**
- **New OEM A/F sensor heater internal resistance 1.1 ohms (14/1.1=12.72 amps)**



P1167 Failed test due to minimum amperage draw.

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Case Study

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Honda Scan Data

- HO2S S1 represents air fuel sensor current in milliamps
- Positive current indicates a rich exhaust
- Negative current indicates a lean exhaust
- AF FB represents Short Term fuel trim
- AF FB AVG represents Long Term fuel trim

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Wednesday February 26th, 2025

Heavy Duty Lunch & Learn 12:00 pm to 1:00 pm ET

"HD Suspension A to Z"

The following will be covered:

- **Suspension systems**
- **All the components**
- **Case Study**

Instructor: Swede Oun

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"Dorman Training"

In Shop LIVE TRAINING gtruglia@dormanproducts.com

Hands on Lab Scope - Lansdale, PA

Tuesday, February 18, 2025
MACS (map)

5:30 p.m.—10:00 p.m. EST | Lansdale, PA | Hands-On

Join us for an engaging and comprehensive class on mastering the automotive digital storage oscilloscope (DSO). This hands-on training is designed for automotive technicians looking to enhance their diagnostic skills. You will learn the fundamental principles of oscilloscopes, including how to set up and operate a DSO effectively. The curriculum covers essential topics such as signal waveform analysis, voltage and current measurements, and the various triggering techniques that allow for precise data capture.

View Event →

Automotive Electronics - Meter & Voltage Drop Testing - Mahopac, NY

Tuesday, February 18, 2025
ATTS (map)

5:30 p.m.—10:00 p.m. EST | Mahopac, NY | Hands-On

Join us for an essential training class on the use of the automotive digital multimeter and the voltage drop testing method, tailored for both aspiring and experienced automotive technicians. This hands-on course will guide you through the fundamental functions of a digital multimeter, including how to measure voltage, current, and resistance accurately. You will learn to navigate the various settings and features of the multimeter, ensuring you can perform precise measurements in a workshop environment.

View Event →

LIVE WEBINAR PPV: Solving The Mystery Of Voltage Drop Testing

Tuesday, February 18, 2025
online (map)

LIVE PPV WEBINAR: 7:00pm to 9:00pm

Join us for an in-depth pay-per-view automotive training webinar titled "Ignition Systems A to Z," tailored for automotive technicians eager to expand their knowledge of ignition systems. This comprehensive session covers the different types of automotive ignition systems, including conventional, distributor-less ignition systems (DIS), and coil-on-plug (COP) setups.

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Questions?

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