A New Look At Some Old Sensors

By
Al Santini
ConsuLab
Who??

• Al Santini
• College of DuPage – 22 years
• NACAT member for 36 years
• Yes, a bit older than dirt....
• Currently with ConsuLab – technical trainer
• asantini@consulab.com
What are we going to do?

• Review operating principles of
  – Inductive sensors
  – Hall-Effect
  – Magneto-resistive

• Use a DMM to diagnosis

• Use a DSO to diagnosis
  – Paying attention to speed and distance
I will be using...ConsuLab Speed and Position Sensor Trainer
Which has...

• 1. Passive Inductive sensor (CKP sensor, 2008 Hyundai Accent)
• 2. Hall Effect Sensor (CMP sensor, 2008 Hyundai Accent)
• 3. Magneto-Resistive sensor with internal magnet (Front ABS sensor, 2008 GMC Pickup)
• 4. Magneto-Resistive sensor with external magnetic strip (Front ABS sensor, 2008 Honda Civic)
• 5. Electric Drive Motor (0-1200 RPM)
• 6. Master Power Switch and trainer fuse
• 7. Drive Motor Speed Control
• 8. 5V Voltage Supply Switch
• 9. Sensor Connected/Disconnected Switches
• 10. Active Radial Sensor Adjustment Screw Hole
• 11. Passive Inductive Sensor Adjustment Screw Hole
Why Teach Sensors?

• Fundamental building block of very common electronic devices

• Allows use of and training in DMM and DSO
  – Basic tools
  – Required in diagnosis daily

• Frequent failure
  – Position (weather, heat etc)

• Basic to understanding of system
Review – Magnetic Inductive

- Permanent magnetic
- Metal core with coil of wire
- Ferromagnetic tooth reluctor
- Magnetic induction
- Produces AC voltage (sine wave)
- Increases with speed
- Decreases with distance
- Usually used to count revolutions or position
Common Uses...

- Distributor Pickup coils
- CKP & CMP
- ABS wheel sensors
Ohmmeter Useful Diagnostic

0.870kΩ
Magnetic Induction
Output Voltage Proportional to Speed
As Air Gap Increases - Output Decreases
As Air Gap Decreases - Output Increases
Voltmeter Shows Average

0.347V

Operating Mode
- AC Voltage

Lead Help

Print
Sensor Failure - iATN

1997 Toyota Camry CE, Ignition Waveform
By: Jamey Thornton  11/22/2013 9:53:26 AM
Sensor failing-engine died

1997 Toyota Camry CE
VIN  [No VIN Available]
Engine  3.0 L / 6 cyl / Gas
Trans  4-speed Automatic Transaxle (Electronic)
Delivery  Fuel Injection
Subsystem  Ignition
Component  CKP Sensor, CMP Sensor
Condition  Known Bad

References
- TECH: Failing CKP
- My iATN
  - BAD CKP
New Sensor - iATN

1997 Toyota Camry CE, Ignition Waveform

By: Jamey Thornton  11/22/2013  9:49:27 AM

New Sensor

Vehicle Data

1997 Toyota Camry CE

VIN  [No VIN Available]
Engine  3.0 L / 6 cyl / Gas
Trans  4-speed Automatic Transaxle (Electronic)
Delivery  Fuel Injection
Subsystem  Ignition
Component  CKP Sensor, CMP Sensor
Condition  Known Good

References

Forum
- TECH: Failing CKP

File Controls
- Save to My iATN
- Send Me This via Email
- Hide Details
Review – Hall Effect Sensor

- When a current is passed through...
- A Hall Voltage is generated
- Proportional to the magnetic field (permanent magnet)
- Produces a square wave signal (DC)
  - As notches and teeth pass by
  - Influencing magnetic field
  - Does not vary in strength
  - Many allow for gap adjustment (critical)
Common Uses...

- Distributor pickup units
- CKP and CMP
- ABS wheel sensors
Applied Regulated Voltage

4.99V
DSO Applied Regulated Voltage
2011 Chevrolet Malibu LS, ECM/Inputs/Outputs Waveform

By: Gavin Overweg  3/16/2014 7:17:18 PM

Map sensor signal and 5v ref. Taken at sensor. Wiggle test on wires reveals 5v ref dropout.

Vehicle Data

2011 Chevrolet Malibu LS

VIN [No VIN Available]
Engine 2.4 L / 4 cyl / Flex
Trans 6-speed Automatic Transaxle (Electronic)
Delivery Fuel Injection
Subsystem ECM/Inputs/Outputs
Component MAP Sensor
Condition Known Sensor

File Controls

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- Use in Forum Post

File ID: [File76554]
Voltage Unchanged with Speed
Left Rear Sensor - iATN

1998 BMW 540i, ABS/Inputs/Outputs Waveform

By: Andy Byers 5/27/2014 1:38:08 PM

Speed Sensor A glitch. Speed Sensor B OK

Vehicle Data

1998 BMW 540i

VIN [No VIN Available]
Engine 4.4 L / 8 cyl / Gas
Trans 6-speed Standard Transmission
Delivery Fuel Injection
Subsystem ABS/Inputs/Outputs
Component ABS Wheel Speed Sensor
Condition Unknown

References

Forum
- TECH: BMW ABS Codes and AllData

File Controls
Wheel Bearing Issue - iATN

2003 Honda Accord LX, ABS/Inputs/Outputs Waveform
By: Matt Batulis  4/14/2013 10:09:11 AM

chA- new wheel bearing installed backwards, chB good Rf signal

Vehicle Data

2003 Honda Accord LX
VIN  [No VIN Available]
Engine  3.0 L / 6 cyl / Gas
Trans  5-speed Automatic Transaxle (Electronic)
Delivery  Fuel Injection
Subsystem  ABS/Inputs/Outputs
Component  ABS Wheel Speed Sensor
Condition  Known Bad

References

Forum
• TECH: A tale of 3 wheel bearings

File Controls
Play in Bearing - iATN

2003 Honda Accord LX, ABS/Inputs/Outputs Waveform

By: Matt Batulis 4/14/2013 10:07:52 AM

ChA- new aftermarket wheel bearing, chB- good RF signal

Vehicle Data

2003 Honda Accord LX

VIN [No VIN Available]
Engine 3.0 L / 6 cyl / Gas
Trans 5-speed Automatic Transaxle (Electronic)
Delivery Fuel Injection
Subsystem ABS/Inputs/Outputs
Component ABS Wheel Speed Sensor
Condition Known Bad

References

Forum
- TECH: A tale of 3 wheel bearings

File Controls
- Save to My iATN
OE Bearing - iATN

2003 Honda Accord LX, ABS/Inputs/Outputs Waveform
By: Matt Batulis  4/14/2013 10:10:37 AM

chA- new OE Honda bearing installed, chB good Rf signal
‘97 K1500 “Runs Like Crap” iATN

<table>
<thead>
<tr>
<th>Vehicle Data</th>
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<tbody>
<tr>
<td><strong>VIN</strong></td>
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<td><strong>Engine</strong></td>
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<td>TECH: repost of K1500 w/ jpg images</td>
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</tbody>
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Data Capture Tool: pico
2003 Dodge Ram 1500 SLT, ECM/Inputs/Outputs Waveform

By: Dean Zweibohmer  3/10/2014 4:21:19 PM

Missing tooth

Vehicle Data

2003 Dodge Ram 1500 SLT
VIN 1D7HU18D33
Engine 5.7 L / 8 cyl / Gas
Trans 4-speed Automatic Transmission (Electronic)
Delivery Fuel Injection
Subsystem ECM/Inputs/Outputs
Component CKP Sensor
Condition Unknown

References

Forum
- TECH: Hard/no start

File Controls
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- Send Me This via Email
- Hide Details

Data Capture Tool: VERUS

Add your own comment (Show Form)
Review – Magneto-Resistive Sensor

• Requires external voltage
• Changes in resistance caused by angle of magnetic field
  – Called anisotropic magneto resistance effect (AMR)
• Output is 7 to 14 mA
• Converted to square DC (like Hall-Effect)
• Can use internal or external magnet to supply field.
Common Uses...

- CKP
- Steering angle sensors
- ABS

Magneto-resistive (Active) Sensor - 2 wires
As Speed Increases....
Eventually Increased Air Gap Causes...
Slightly Out – Distance....
Correct Distance...
Duty Cycle Low Speed...

27.4%

Minimum: 26.5%
Average: 27.6%
Maximum: 29.5%

Operating Mode:
- Duty Cycle

Lead Connection:
- Oscilloscope CH1

Controls:
- Glitch On
- Freeze
- Lead Help
- Neg Trig
- Snap Shot
- % Low

%/Div: 12.5%

Time/Div: 1 s

Graph showing a duty cycle of 27.4%.
Duty Cycle High Speed...

- Duty Cycle High Speed: 28.3%
- Minimum: 26.2%
- Average: 27.8%
- Maximum: 31.0%

Controls:
- Operating Mode: Duty Cycle
- Lead Connection: Oscilloscope CH1
- Print, Run, Save, Recall
- %/Div: 12.5%
- Time/Div: 1 s
- % High, Pos Trig, Reset

Graph showing duty cycle over 10 seconds.
Teach Some Known Good Patterns

• Helpful to distinguish
  – Good
  – From bad

• Plenty available on iATN

• They are OK with use
  – Not for publishing
  – Give credit
  – Get permission to use in multiple presentations

• iATN is great source of both known good and bad
Audi Known Good - iATN

2004 Audi A4, ECM/Inputs/Outputs Waveform
By: Steven McGrew  9/1/2014 4:52:55 PM

Blue is CKP, Green is exh. CMP bank 2, Red is exh. CMP bank 1

Vehicle Data

2004 Audi A4
VIN [No VIN Available]
Engine 3.0 L / 6 cyl / Gas
Trans 5-speed Automatic
Transaxle (Electronic)
Delivery Fuel Injection
Subsystem ECM/Inputs /Outputs
Component CMP Sensor
Condition Known Good

File Controls

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File ID: [File79470]
This is a 2004 Ford Taurus with the 3.0L pushrod engine. The CKP gap vs the middle of the pulse from the CMP, is approximately 7 to 10 CKP pulses in distance/time. This is a properly timed engine and the CMP/CKP are in sync.
2000 Dodge Dakota, ECM/Inputs/Outputs Waveform

By: Michael Byer  4/7/2014 6:55:30 AM

2000 Dakota known good distributor cam and crank reference.

**Vehicle Data**

- **2000 Dodge Dakota**
- **VIN**: [No VIN Available]
- **Engine**: 2.5 L / 4 cyl / Gas
- **Trans**: 5-speed Standard Transmission
- **Delivery**: Fuel Injection
- **Subsystem**: ECM/Inputs /Outputs
- **Component**: CMP Sensor
- **Condition**: Known Good

**Data Capture Tool**: Pico 3423

**File Controls**

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**File ID**: [File77040]
2005 International 4400, ECM/Inputs/Outputs Waveform

By: Ryan Huebert  2/22/2014 9:46:40 AM

This waveform was taken after reassemble of the front cover. The capture appears to match the one supplied by Matthew Caroluzzi.

Vehicle Data

2005 International 4400

VIN [No VIN Available]
Engine 7.6 L / 6 cyl / Diesel
Trans 0-speed Automatic Transmission
Delivery Fuel Injection
Subsystem ECM/Inputs /Outputs
Component CKP Sensor, CMP Sensor
Condition Unknown

References

Forum
- HD/FLT: 2004-2006 DT466 CKP/CMP Waveform
- HD/FLT: 2004-2006 DT466 CKP/CMP Waveform

Data Capture Tool: PicoScope
Known Bad causing a P0017 code to set.

**Vehicle Data**

2008 GMC Canyon SL

- **VIN**: [No VIN Available]
- **Engine**: 2.9 L / 4 cyl / Gas
- **Trans**: 4-speed Automatic Transmission (Electronic)
- **Delivery**: Fuel Injection
- **Subsystem**: ECM/Inputs/Outputs
- **Component**: CKP Sensor, CMP Sensor
- **Condition**: Known Bad

**File Controls**

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File ID: [File75003]
Crank-cam sensor relationship with VVT in park position (not applied).
Fair Winds

• Hope to see you in Joliet, Illinois next year
• NACAT 2015
• Or
  – On the water
• Thanks for attending
• Think ConsuLab for your training needs!