TECHELP
The Automotive & Smog Training Center

Tech Tip

2012 Dodge Ram Pickup
5.7 Liter Hemi V8

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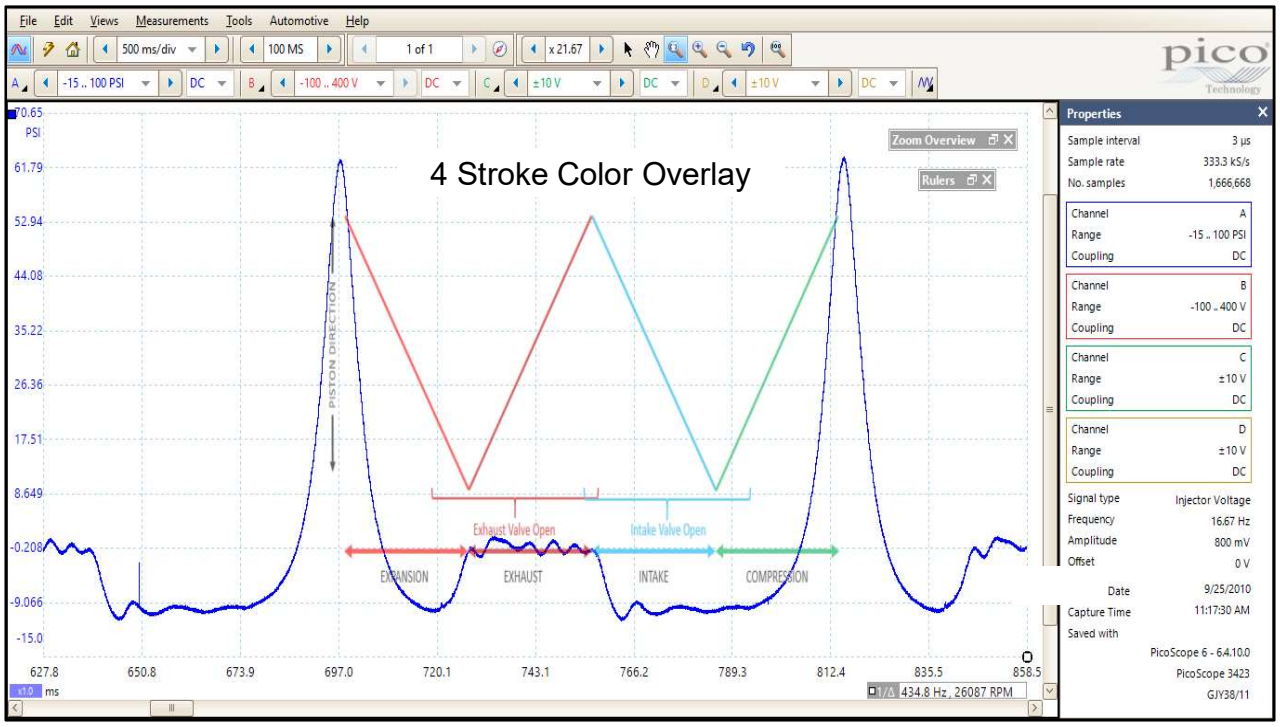
The vehicle came from Woodland with an illuminated MIL (Check Engine Light). The stored code was a P0308 (Cylinder 8 Misfire). The Freeze Frame Data showed the fault was occurring at 4,500 to 4,800 rpm. At idle, during testing, the vehicle didn't present itself as having a misfiring cylinder.

The 2012 5.7 Liter Hemi V8 is equipped with Chrysler's Cylinder De-Activation System. This system allows the ECM to shut down 4 of the 8 cylinders during "Light Throttle Scenarios" in order to maximize fuel economy. This Cylinder De-Activation System effects cylinder 1, 3, 5 & 7 and so because our problem is with cylinder #8 the Cylinder De-Activation System could not be the cause of our misfire.

With the Freeze Frame Data showing the misfire event happening at higher engine speeds it was decided that In-Cylinder Pressure Testing was our best bet for figuring out the "Root Cause" of the problem.

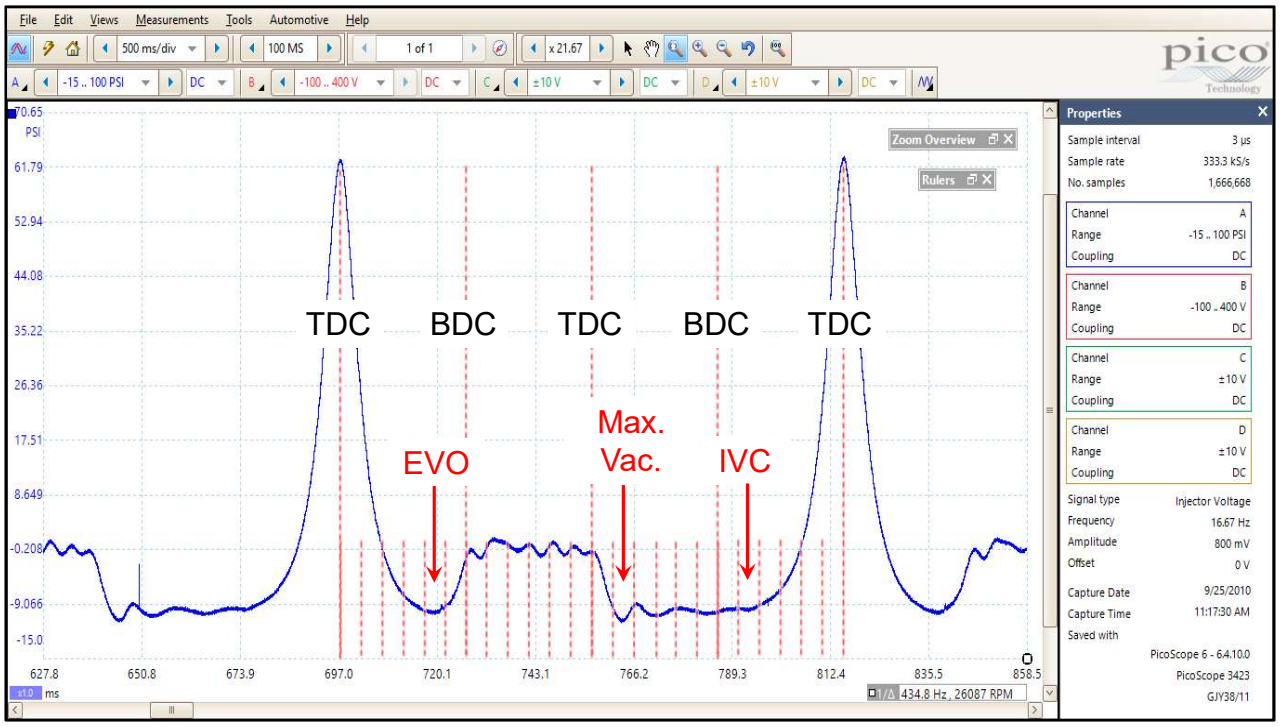


Before we get into the diagnosis of the Dodge Pickup let's review In-Cylinder Pressure Transducer Testing. Using a in-cylinder pressure transducer and a lab scope a digital image is traced over time which represents the "Volume of Air" moving inside a particular cylinder's combustion chamber. In the image above an overlay has been added to help illustrate what the In-Cylinder Pressure Trace is displaying. The "Peak" on the left side of the screen shot above represents Top Dead Center Compression. The "Peak" on the right side of the screen shot again represents Top Dead Center Compression (720 degrees of Crankshaft Rotation later).

Moving from left to right the In Cylinder Pressure Trace shows the changes in pressure as the cylinder goes through:

The Expansion Stroke
The Exhaust Stroke
The Intake Stroke
The Compression Stroke

Each piston stroke is 180 degrees of crankshaft rotation in duration. 4 strokes of 180 degrees each equals 720 degrees total.
(4 x 180 = 720 degrees total)



Another popular overlay is the 30 Degree Overlay, this overlay breaks up each 180 degree area into 30 degree smaller increments. It is used to accurately measure Valve Opening and Closing Points in relationship to Crankshaft / Piston Position.

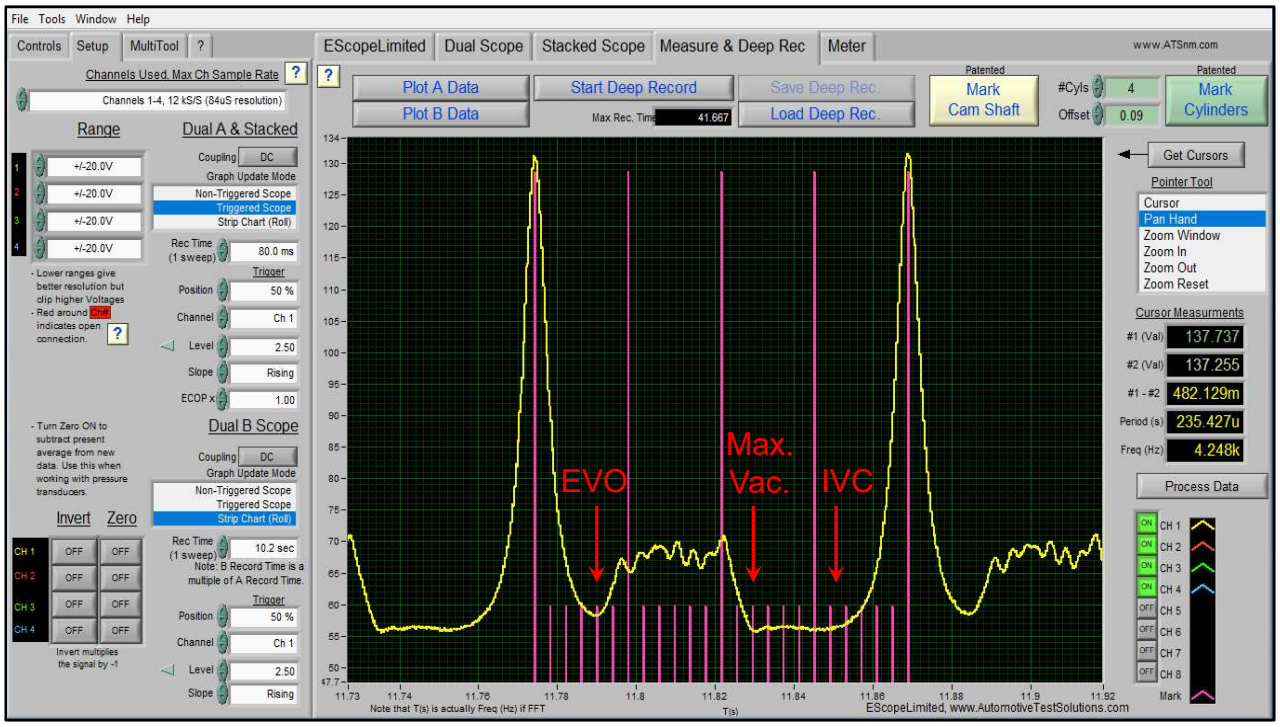
In the image above:

The Exhaust Valve Opens at approx. 45 Crankshaft Degrees Before Bottom Dead Center (EVO)

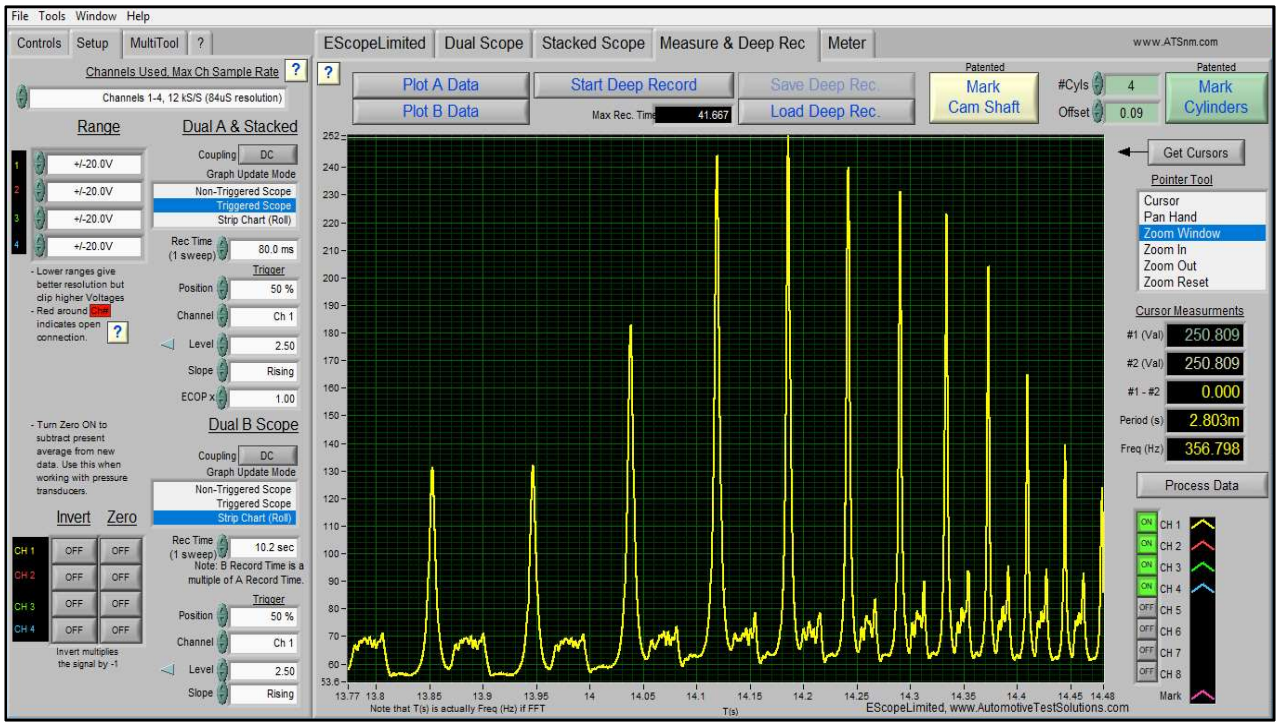
Maximum Vacuum happens at approx. 45 Crankshaft Degrees After Top Dead Center (Max Vac.)

The Intake Valve Closes at approx. 45 Crankshaft Degrees After Bottom Dead Center (IVC)

Understanding this “Known Good Waveform” will help you better understand the waveforms on the following pages.



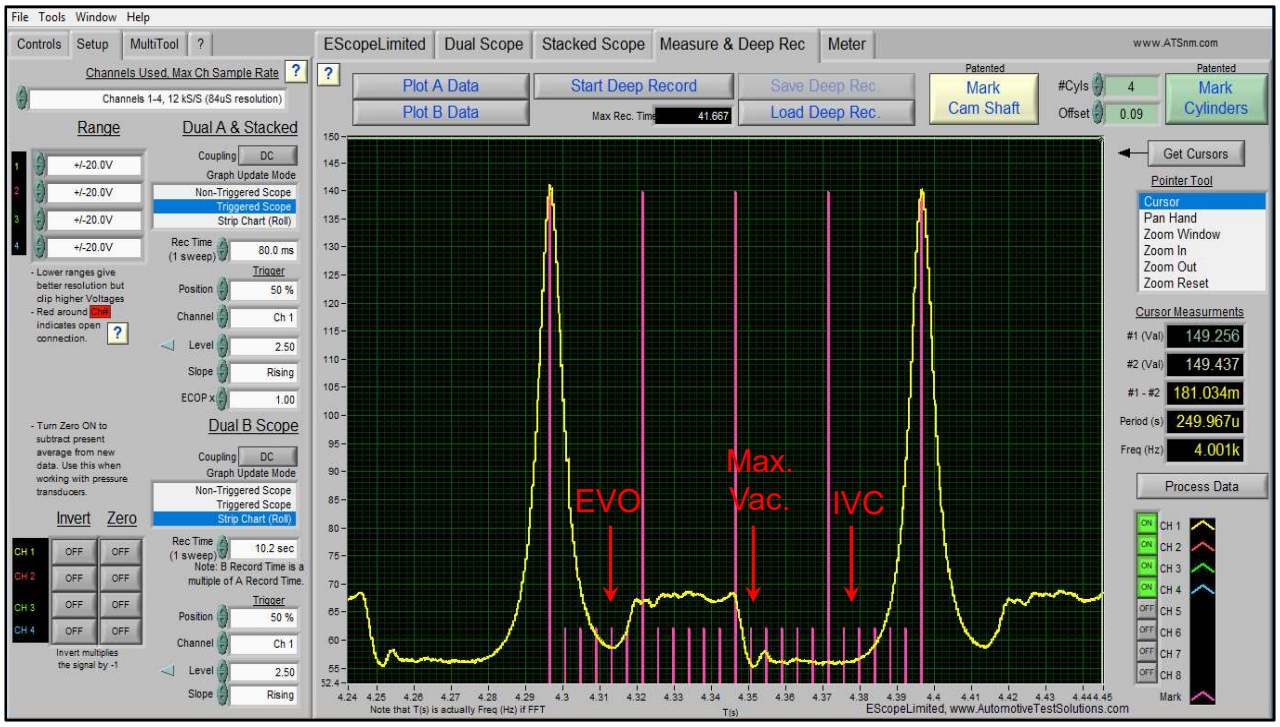
This image was taken using Automotive Test Solutions E-Scope Limited, this equipment was designed by Bernie Thompson & Neal Pederson and is available from www.aeswave.com. The screen shot above is of Cylinder #8 at Idle, looking at the image the only obvious irregularity is the time it takes for Cylinder #8 to reach Maximum Vacuum (it takes to long). Cylinder #8 doesn't reach Maximum Vacuum until approx. 60 Crankshaft Degrees after TDC Exhaust.



While the test equipment was still in Cylinder #8 a Snap Throttle Event was capture on the lab scope. During the Snap Throttle Event “Un-Wanted Pressure” was seen during the “Exhaust Portion” of the waveform. This “Un-Wanted Pressure” could be caused by an:

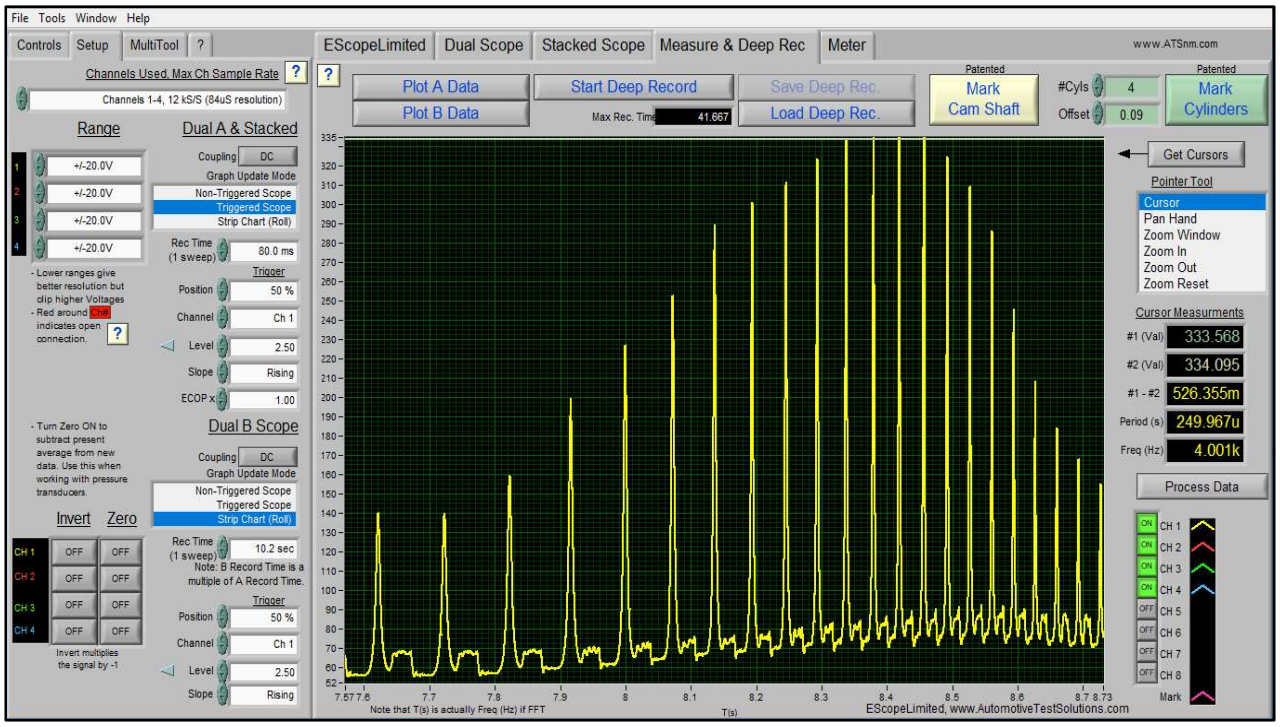
An Exhaust Valve Opening Late & Closing Early
An Intake Valve Opening Late & Closing Early
A Partially Plugged Catalytic Converter on Bank 2 (Cylinder # 8 is on Bank 2 of this engine)

In order to properly diagnose this waveform a “Known Good Waveform” will be required.

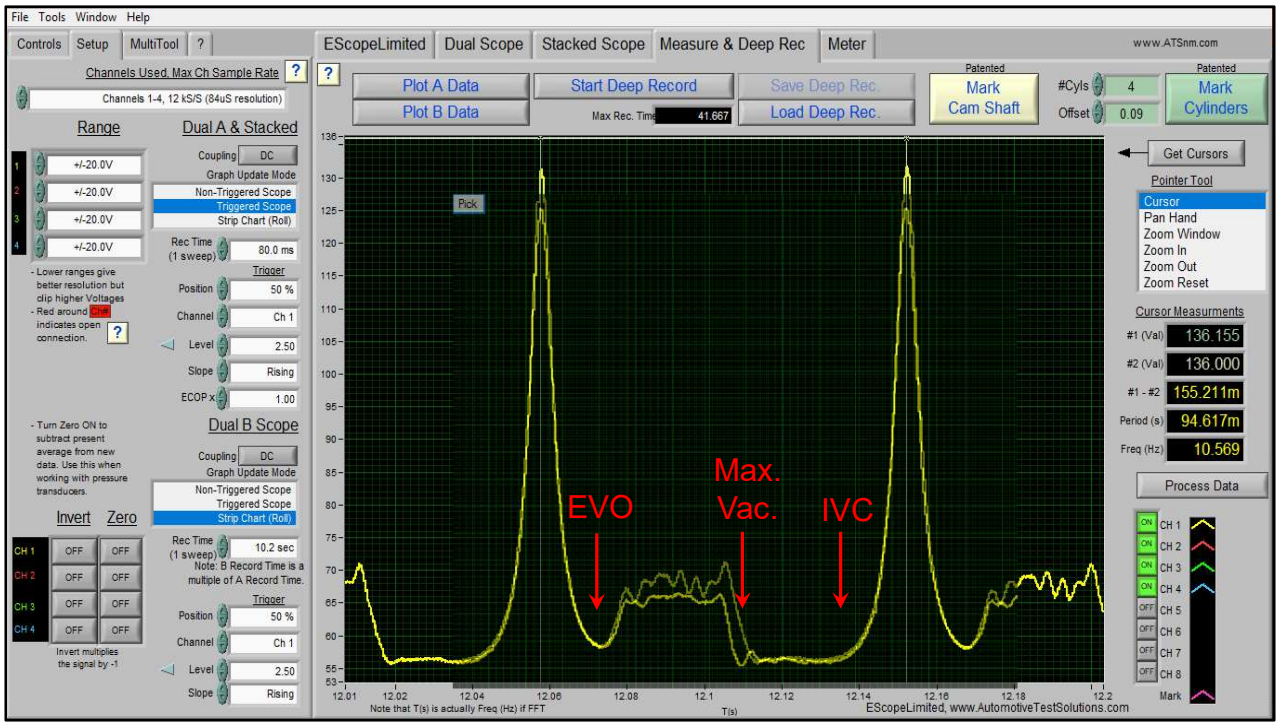


This image above was taken with the In-Cylinder Pressure Transducer equipment installed in Cylinder #3 (which is on Bank 1, the other side of the engine). Measuring the idle waveform, Cylinder #3 achieves Maximum Vacuum at 30 Crankshaft Degrees after TDC Exhaust (a full 30 Crankshaft Degrees sooner than Cylinder #8).

Using In-Cylinder Pressure Transducer Testing, technicians gain the ability to measure and compare pressure changes, valve opening and valve closing events either cylinder to cylinder or bank to bank. This testing method improves diagnostic accuracy without the need for time consuming engine disassembly.



During a Snap Throttle Event on Cylinder #3 it is clear there is not the same “Un-Wanted Pressure” during the Exhaust Stroke as viewed on Cylinder #8.

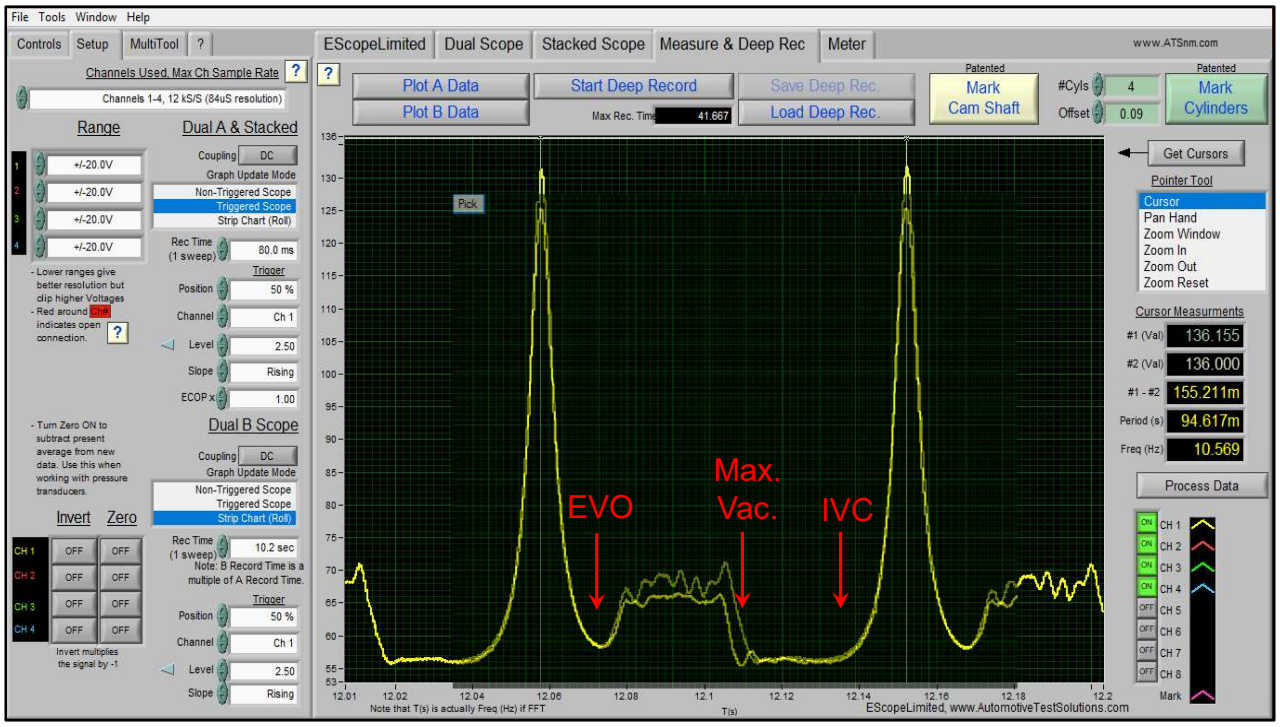


Using another feature of the Overlay Program a “Custom Overlay” can be created. Here an image of the “Known Good Cylinder” was overlaid atop of the “Known Bad Cylinder”. The differences in the time in took (measured in Crankshaft Degrees) for the two cylinders (Cylinder #8 & Cylinder #3) to achieve Maximum Vacuum is clear.

Before we go back and review our potential causes from page #5 let’s take a moment and discuss “Valve Overlap”. During Top Dead Center of the Exhaust Stroke, as the piston moves upward, the Intake Valve “Opens” prior to TDC and the Exhaust Valve “Closes” just after TDC. Under normal operation (by design) both the Intake Valve and the Exhaust Valves are open at the same time.

We listed our potential causes for the waveform from Cylinder #8 as:

1) An Exhaust Valve Opening Late & Closing Early? Using the overlaid images above, along with the two separate idle waveforms on pages 4 & 6, the Exhaust Valve Openings are identical measuring approx. 60 Crankshaft Degrees Before BDC.



Potential causes for the waveform from Cylinder #8 continued:

2) An Intake Valve Opening Late and Closing Early? Using the overlaid images above, along with the two separate idle waveforms on pages 4 & 6, the point at which each waveform reaches Maximum Vacuum is different by approx. 30 Crankshaft Degrees. If the Intake Valve Opens Late, the cylinder looses “Valve Overlap” so the possibility to see a “Rise in Pressure” at the end of the Exhaust Stroke (during Snap Throttle Testing) make sense. Also when comparing the results of the testing to the customer’s complaint along with the Freeze Frame Data the diagnosis makes sense. If at high engine speeds, the Intake Valve isn’t opening properly the cylinder won’t get enough Air / Fuel Volume for combustion.

3) Partially Plugged Catalytic Converter? If Bank 2’s Catalytic Converter was partially plugged “Yes” it would cause “Un-Wanted Pressure to Rise” during the Exhaust Stroke but that un-wanted pressure wouldn’t alter the “Time” it took for cylinder to achieve Maximum Vacuum and more than likely the vehicle would have more than a single cylinder misfire.

Maximum Vacuum differences between cylinders can only be altered by altering Intake Valve Timing, because this engine has a centrally located camshaft (which is used for both banks) camshaft timing can't be the root cause. This engine has a single cylinder misfire so the root cause must be confined to Cylinder #8, a Collapsed Intake Lifter, a Bent Intake Valve Push Rod or a Flat Intake Camshaft Lobe for cylinder #8 are all possibilities.

The two images above are of the Roller Lifter Assemblies used in the 5.7 Liter Hemi V8. The roller for Cylinder #8's Intake Valve has seized and actual ground itself away (the upper half of the roller is missing). This missing portion of the roller and subsequent damage to the camshaft journal (not pictured) was the reason for the Late Intake Valve Opening as seen using the In-Cylinder Pressure Transducer.

These Lifter Assemblies are located underneath the cylinder heads so in order to replace these units, the engine must be disassembled. Using In-Cylinder Pressure Transducer Testing this entire diagnosis was accomplished by removing two spark plugs and the total time was approximately 1 hour.

Thank you for taking the time to read this article.

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E = Everyone
A = Achieves
M = More

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