TECHELP
The Automotive & Smog Training Center

Tech Tip

2007 Dodge Charger
3.5 Liter SOHC V6

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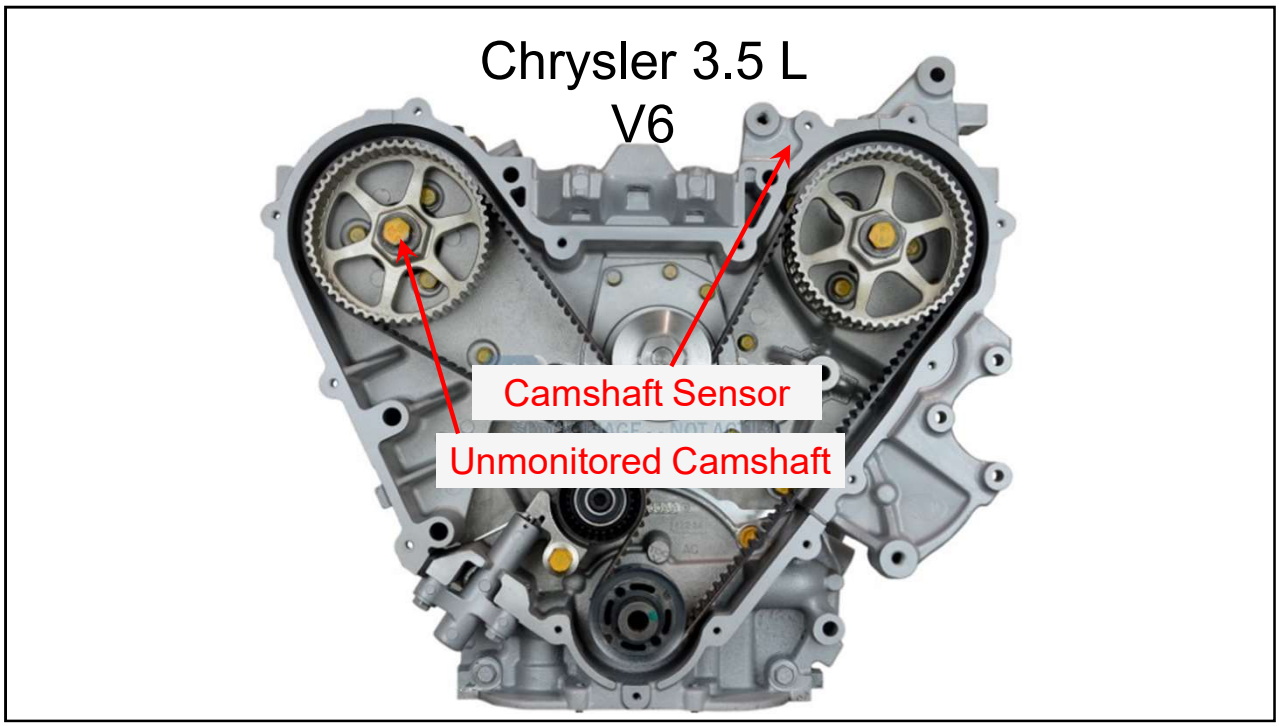
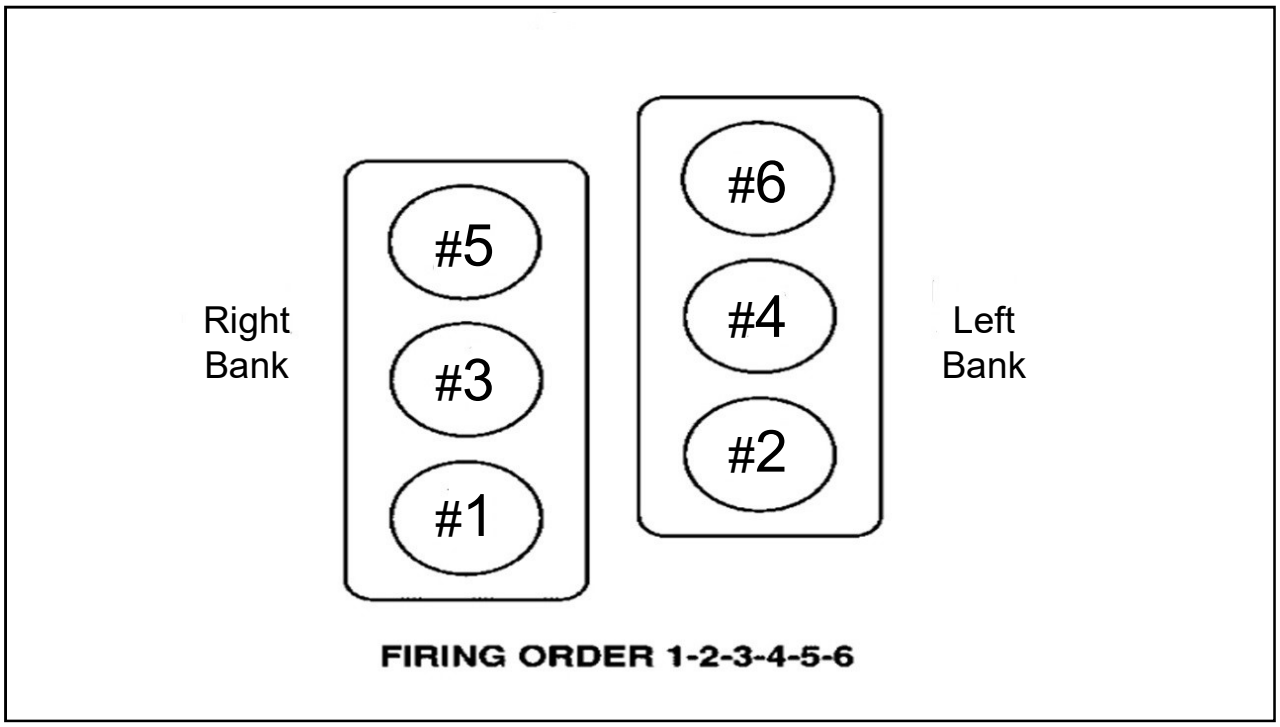
3.5 Liter V6 SOHC

This vehicle was brought into the Training Center for diagnosis of a Cranks No Start. There are no diagnostic trouble codes stored in the Electronic Control Module (ECM)

The back story on the vehicle is the shop rebuilt the 3.5 liter engine for a “Knocking Noise” and afterwards it “Started One Time”. Once the engine was “Turned Off” the engine never started again.

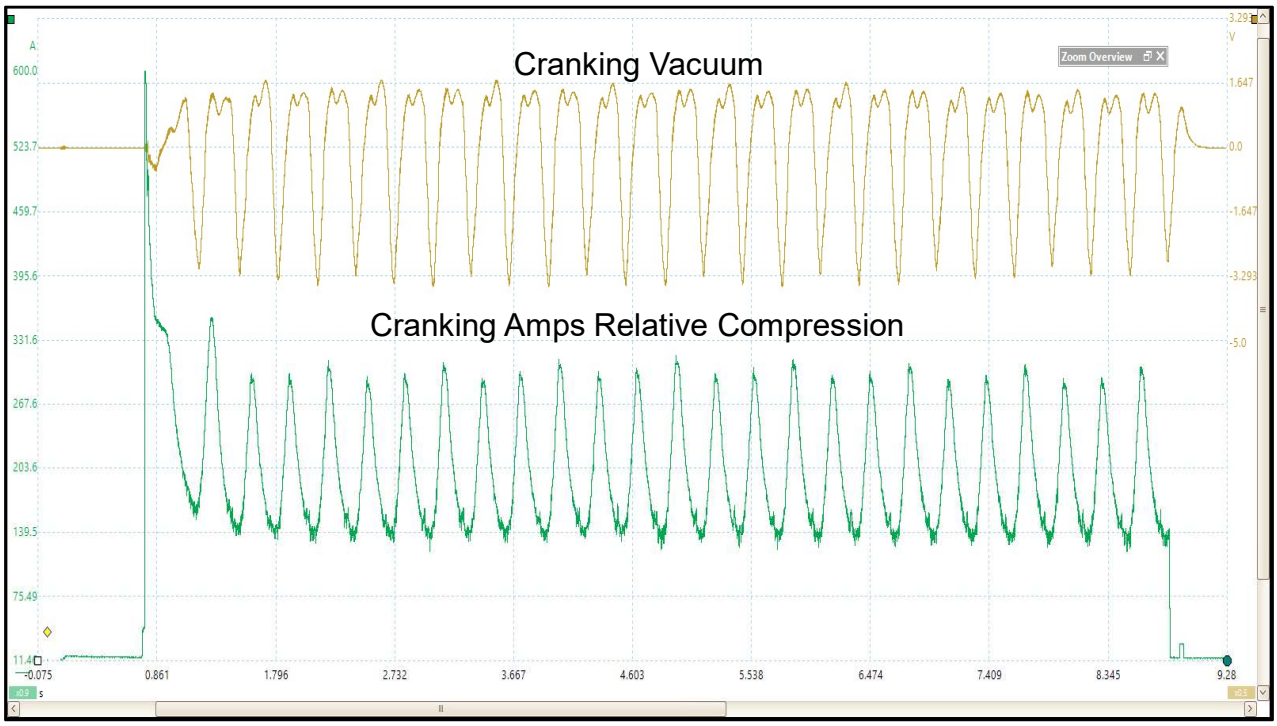


This 3.5 Liter V6 is equipped with Single Overhead Camshafts (one in each cylinder head) and is timing belt driven. The Camshaft Sensor monitors Bank 2 in relationship to the Crankshaft Sensor, nothing monitors Bank 1's Camshaft Position.



This is the Engine Configuration and Firing Order. This is a Bank to Bank Firing Order meaning the engine fires Bank 1, Bank 2, Bank 1 and so on.

On this particular Charger model the engine is longitudinally mounted (faces forward) and the intake manifold sits atop Bank 1.



Using a Pico lab scope a Cranking Amps Relative Compression Test and a Cranking Vacuum Test were performed (see above).

The image above shows an engine with a rhythmic cadence. Each of the Compression Peaks look “Even” as do each of the Vacuum Pulls.

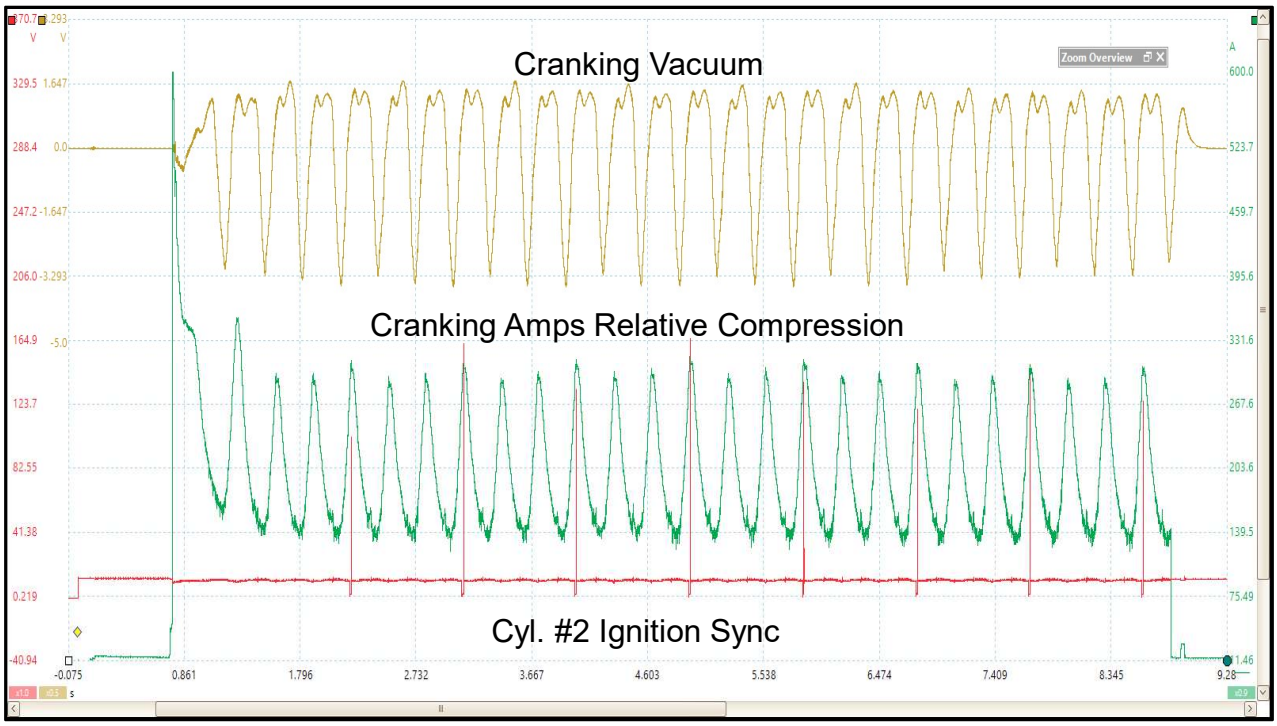
Additionally as this engine is cranking it sounds “Even” to the ear!!!

So where in the diagnostic strategy do we go next???

Do we look at ignition Timing, this engine has a Coil on Plug Ignition System.

Do we look at Fuel Injector Control? How about taking a sample of the Fuel and testing for contamination?

Do we abandon diagnostics and start performing Swapnostics. (randomly changing parts)?

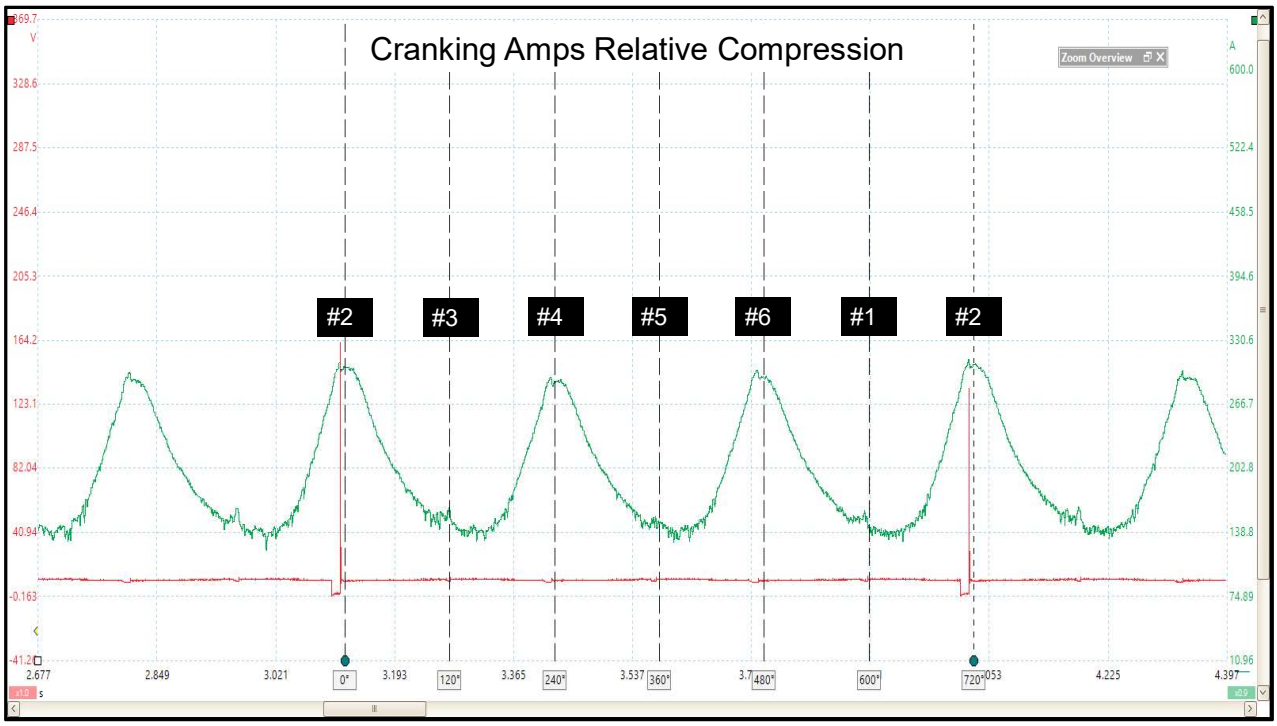


It was decided to add an Ignition Sync., to check Ignition Timing.

The Red Trace is Cylinder #2's Ignition Primary Voltage. As you can see in relationship to the Cranking Amps Relative Compression Waveform the Ignition Coil "Fires near Top Dead Center Compression" and on a cranking engine I would expect that.

So where to next?

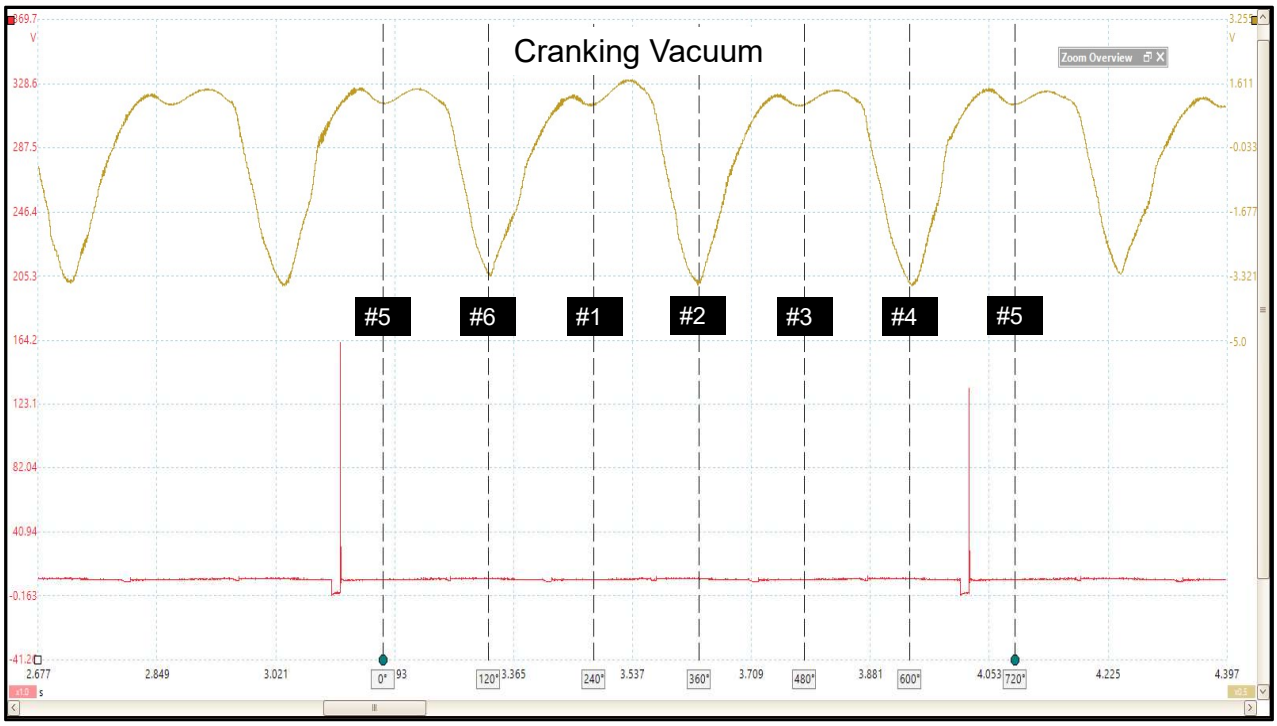
Is there a problem with the waveform relationships as seen above???



If you zoom into the waveform the issue is clear, half the engine has “No Compression”. The reason someone overlooked this issue is because the “No Compression Events ” are on every other cylinder in the firing order.

Bank 2, the monitored camshaft’s alignment, is correct and thus each cylinder on the driver’s side creates compression.

Bank 1, the unmonitored camshaft’s alignment, is in-correct and thus each cylinder on the passenger’s side does not create compression.

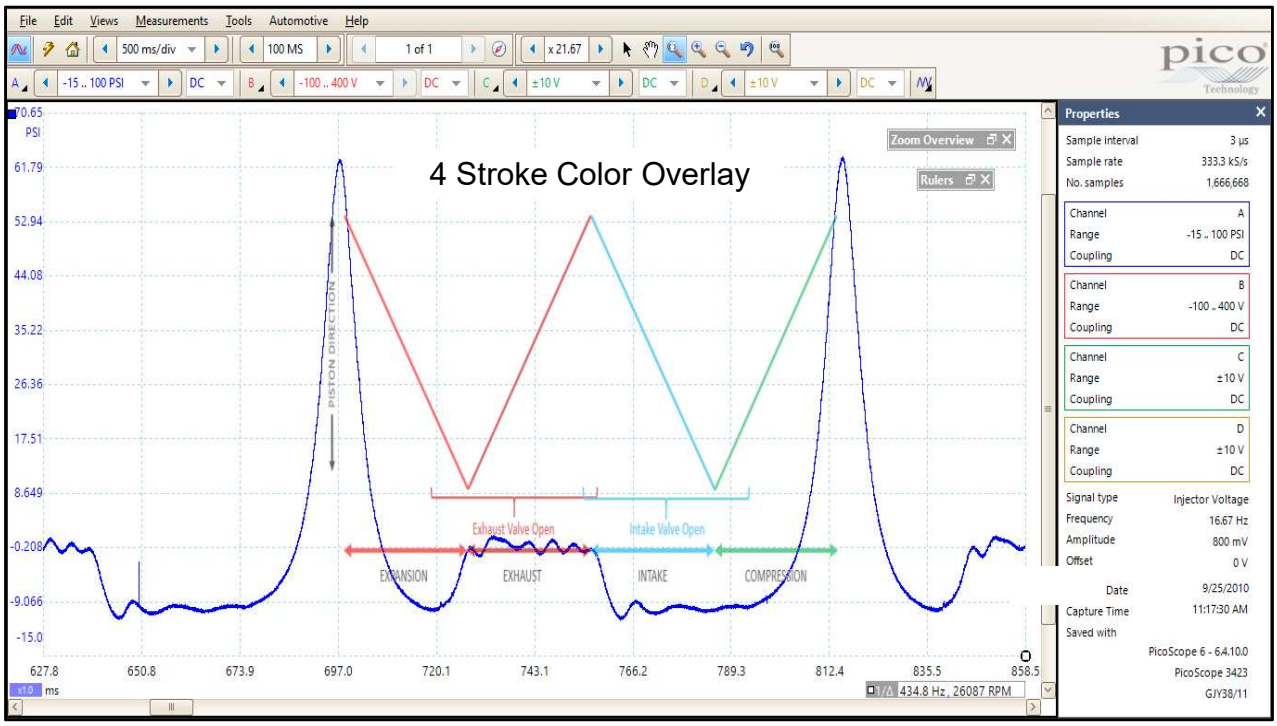


Zooming into the Cranking Vacuum Waveform there are three Vacuum Pulls missing, Cylinders 5, 1 and 3 are all on Bank 1.

Performing the Relative Compression Test and the Cranking Vacuum Test are only of value in this instance if a “Sync Signal” is also displayed.

This diagnosis could have gone a completely different direction based upon the initial waveforms if a “Sync Signal” hadn’t been added.

Looking back at page 4 a technician could of easily evaluated this engine as being “Good” based upon the rhythmic cadence of the two waveform along with what his or her ear was telling them

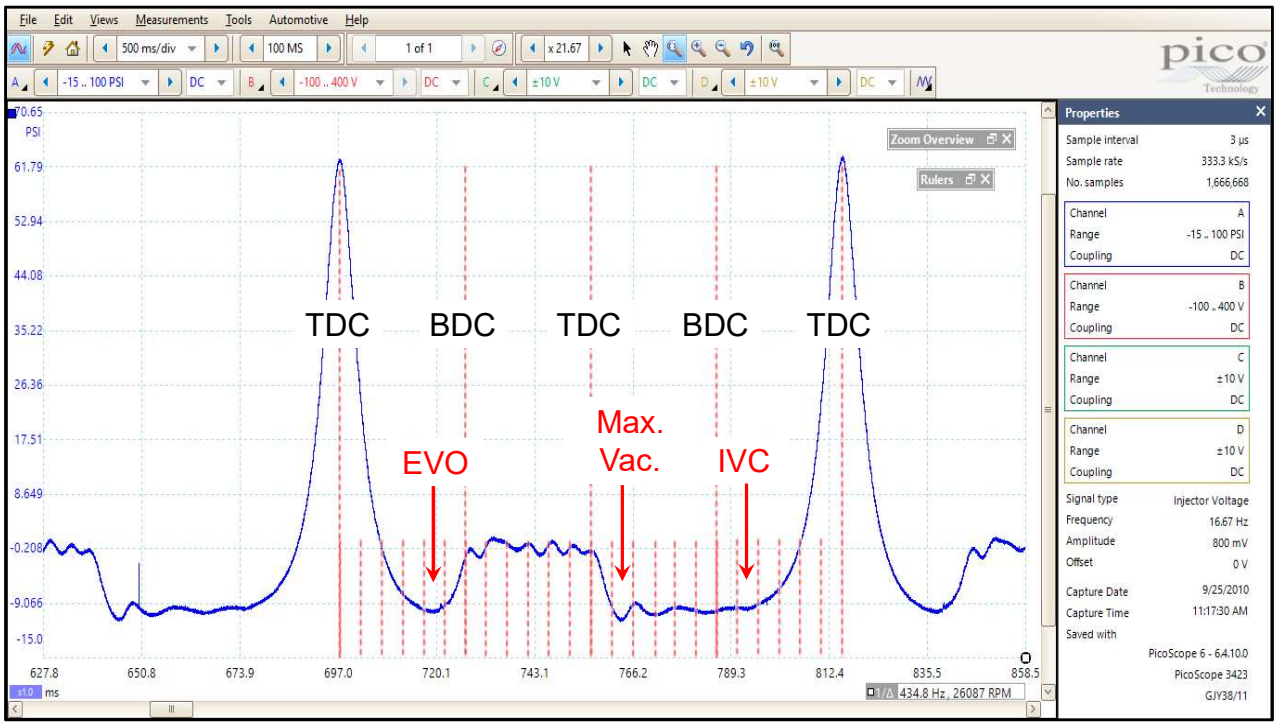


Before we get into the diagnosis of the Dodge let's review In-Cylinder Pressure Transducer Testing. Using a in-cylinder pressure transducer and a lab scope a digital image is traced over time which represents the "Volume of Air" moving inside a particular cylinder's combustion chamber. In the image above 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:

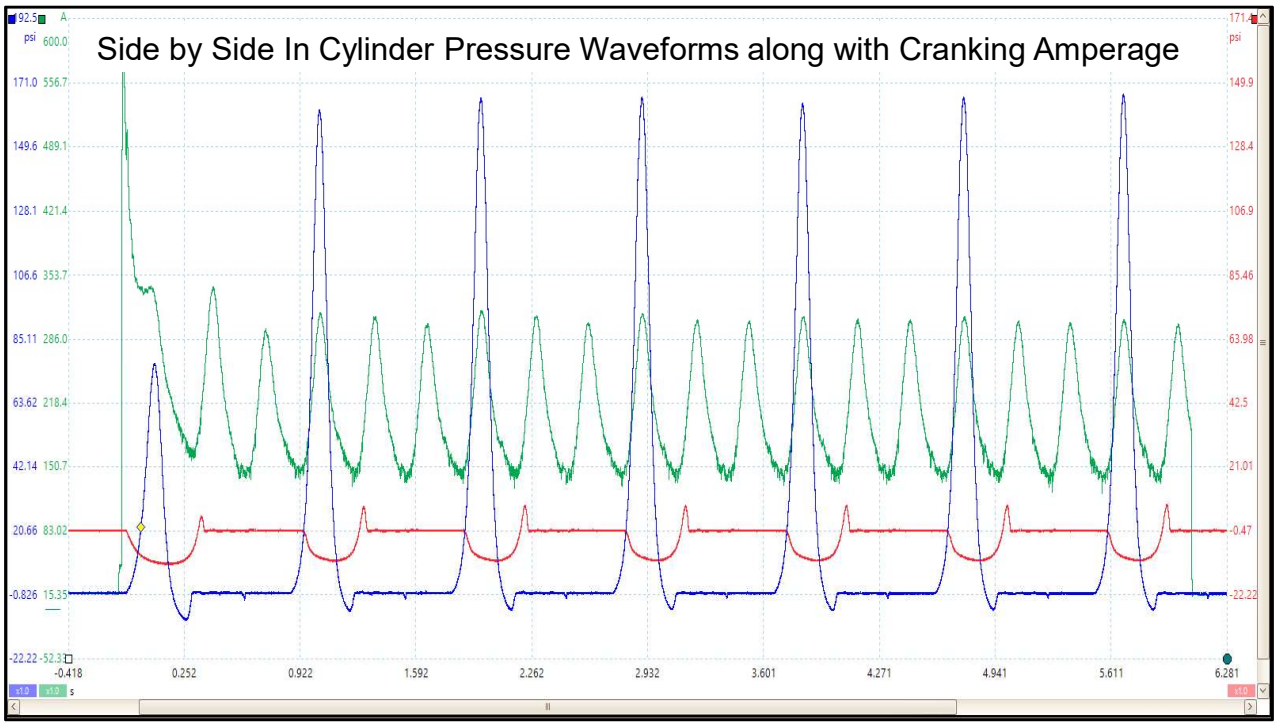
The Exhaust Valve Opens at approx. 45 Crankshaft Degrees Before Bottom Dead Center (EVO)

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.

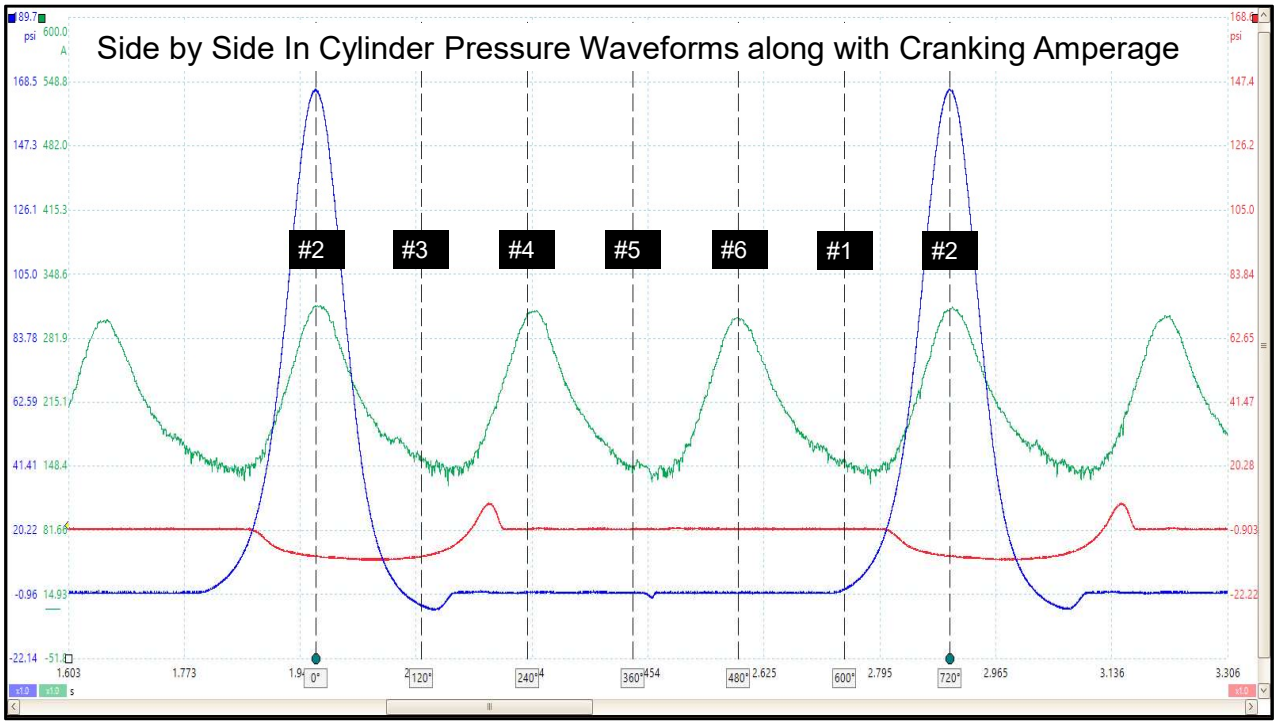
The image above shows the Upper Intake Manifold Removed and Two In Cylinder Pressure Transducers installed in Bank 1 on the left and Bank 2 on the right.



Side by Side In Cylinder Pressure Transducer Testing was performed along with the Cranking Amps Relative Compression Test (which is why the traces look different as compared to the previous examples).

Bank 2's In Cylinder Pressure Waveform is in Blue (taller trace).

Bank 1's In Cylinder Pressure Waveform is in Red (shorter trace)



Zooming into the waveform and adding back in the Firing Order it can be further determined that Bank 2 (taller trace) has the ability to build Cranking Compression but Bank 1 (shorter trace) cannot.

The “Root Cause” of this issue is Bank 1’s Camshaft Gear in damaged and is no longer properly indexed to the Camshaft. The Keyway that indexes the Gear to the Camshaft is missing and the Gear has “Spun” on the nose of the Camshaft.

Thank you for taking the time to read through this article.

T = Together
E = Everyone
A = Achieves
M = More

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