ntelligent Engine Analyzer

Training

Wheel of Fortune

John Anello - Auto Tech on Wheels


Fig. 1

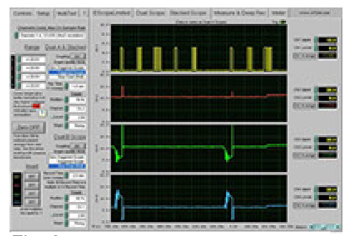
Fig. 2

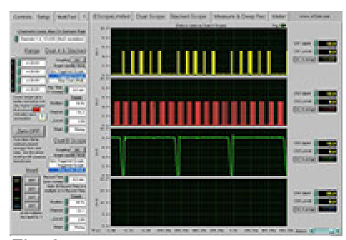
Fig. 3

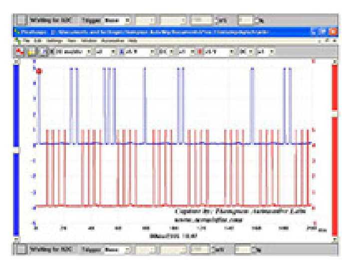
Fig. 4

I was called to a shop with a complaint of a no start condition on a 1996 Dodge Caravan with a 3.3L engine (figure 1). This shop only had a scan tool in its arsenal of equipment. No scope, no graphing meter combined with a component tester or even a repair information system. With no codes in memory the shop resorted to the feels like tactics. They used their best instincts to replace parts associated with their visual inspections and old school test procedures. The spark tester they were using only showed spark on one coil so the list included coil pack, crank sensor, cam sensor and an ECM. The old ECM was bad due to a damaged coil driver that was holding one coil primary constantly on. This I have seen many times in the field caused by a bad coil assembly with
a shorted coil primary winding. So I can justify their replacement of the coil assembly and the ECM but the vehicle at this point still had a problem with a no start. This shop is not alone in the way they diagnose cars. All too often I cater to these type of shops and I try my best to educate on site how important it is to keep themselves up to date on training and have the proper equipment to perform tasks that will only save them time and unwanted parts. It will only make them a better technician in the long run. It is never too late to step up to the plate to take it to the next level. The worst thing in any business is to let technology surpass you. You will only find yourself stuck in the past with not much of a future to keep afloat. When I arrived at the shop I attempted to start the car but it only spit back a few times like it wanted to start. The shop tech told me that the #2/5 ignition coil was the only coil firing during cranking. The other coils did not fire at all. At this point I decided to hook up my scope to some selected signal lines to get a visual concept of what was exactly going on. I used my EScope Limited 4-trace scope and placed my channels on the cam sensor and all three coil drivers. As I cranked the engine you could see (figure 2) that the cam sensor was providing the proper signal pattern but the ECM had a problem controlling the coil drivers. One driver attempted to ground the coil while another driver was held on for as long as 600mS of on time. By current ramping the one working coil against the crank and cam signals (figure 3) you could see that the coil driver was maintaining about 8.5 amps of current for almost one camshaft revolution. There is no way any driver would hold a coil primary that long unless that driver was in love and just did not want to let the coil go. It was a relationship that just went bad with no one to give advice to just let go. Someone was just not telling the ECM to let go of the coil. Now I am wondering if this caused the failure of the coil driver within the old ECM.
This erratic coil operation could only be caused by a defective ECM with an internal driver failure, a corrupted crank/cam signal input or a crank/cam sensor correlation problem. The cam and crank sensors seem to be producing the proper patterns with correct amplitude but I needed to compare their synch correlation. I used my Ace Misfire crank/cam waveform database and pulled up a good known crank/cam pattern for this vehicle (figure 4). You can see how the cam sensor pattern repeats the 1-2-3-1-2 pattern while the crank signal repeats the 4-4-4-4-4-4 pattern. It is between where

the cam pattern ends and begins that there should be equidistant 4-4 patterns. I imported the cam sensor signal into the measuring section of the scope (figure 5) and placed cursors to show one complete event of the cam sensor. By hitting the Mark Cam Shaft button, the program automatically placed 5 purple cursors on the screen creating 4 divisions each representing 180 degrees of crankshaft rotation and 5 smaller purple cursors creating 6 sub-divisions each representing 30 degrees within each 180 division. I superimposed the crank signal on top of the cam signal and zoomed into the end and beginning event of the cam signal (figure 6). Notice how the crank signal has shifted at lest 30 degrees to the left. This indicated that the crank and cam sensors were not properly synched. The cam sensor indexed off the front of the engine while the crank sensor indexed off the torque convertor at the rear of the engine. Now I had to decide whether this was caused by a problem in the front or rear of the engine. With 108,000 miles on the clock it was a better sell from a maintenance point of view to disassemble the front of the engine to inspect timing chain components then it was to pull the transmission to check the flywheel assembly. The cause at this point could be a jumped timing chain, sheared crank key way, sheared cam gear roll pin or even a damaged flywheel. There was no flywheel noise while cranking the engine so where do you start with this dilemma without having to spend unwanted labor? The answer to this question is a new test procedure I have been using to check valve train problems by simply using a 300 P.S.I. pressure transducer. You remove the spark plug from a selected cylinder and install a hose adapter to accommodate the pressure transducer. Next you place a spark tester on the spark plug wire representing that same cylinder, place an inductive clamp around the plug wire and just crank the engine. The resulting patterns (figure 7) will show you a peak to peak cylinder pressure rise representing a 720 degree event of a cylinder and an induction square wave representing the spark event in the cylinder. You then place your cursors on the compression peaks and select the Mark Cam Shaft button and look at where the purple cursors are laid out. The lowest point (u-curve) before BDC of the power stoke is where the exhaust valve begins to open. This I have found to be about 30-45 degrees before BDC of the power stroke on most of the cars I have been checking. The waveform pattern (figure 7) shows the exhaust valve to be opening close to 30 degrees before BDC of the power stroke. The spark was occurring only once in the cylinder when it should have occurred twice. The spark only fired the waste spark and fired wrong at about 40 degrees after TDC of the exhaust stroke. This was due to the incorrect coil primary control caused by the crank/cam correlation problem.

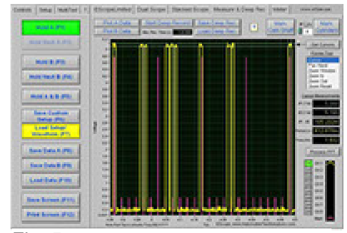

Fig. 5

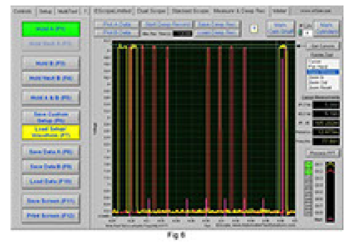

Fig. 6

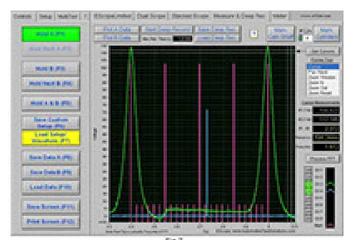

Fig. 7

By viewing a good known pattern of a 1997 Dodge Caravan with a 3.3L (figure 8) you can see the exhaust valve opening is happening at about 30 degrees before BDC of the power stroke. This file was from a running engine so the advance timing was added to the base timing to bring the timing to about 25 degrees (always use the first rise of the inductive clamp square waveform) before TDC of the compression stroke for ignition spark and 25 degrees before TDC of the exhaust stoke for waste spark. This method is such a great way to learn about combustion strategy and at the same time give you another tool in your arsenal to fine tune your diagnostics to which direction you want to head in. Even if this was a dual cam set-up you would have no problem in finding out which cam was off from spec without even pulling a timing cover. Just by having this information validated from doing other good known vehicles it was safe for me to instruct the garage to pull the transmission to inspect the flywheel

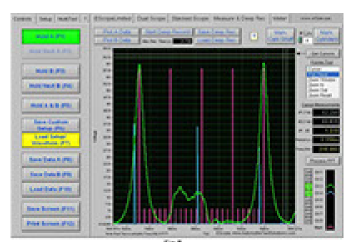

Fig. 8

About an hour later the shop had called to tell me that the transmission was pulled and I needed to comeback to see the damage they found. When I arrived there at the end of my day I was amazed at the damage. The center of the flywheel was completely cut out from the rest of the flywheel like a cookie would be cut out of rolled dough. The center piece spun slightly and wedged itself in place (figure 9). The amazing thing was that there was no noise associated with this flywheel while cranking. I helped the garage remove the flywheel and placed it on the ground. I pushed on the center piece and it fell out. The only thing holding these pieces together were the center thrust plate and flywheel bolts.This flywheel was like a wheel of fortune just making the shop spend time & money without a cure in site and at the same time sending them on a wild goose chase. It held the torque convertor and provided the crank triggers necessary to start the engine. Who would ever think a flywheel could break clean and spin but yet go undetected in its journey of unforgiving charades. I hope this story sheds some light on the value of a scope which allows you to have a window to see beyond the normal reach of a scanner.

Fig. 9