eSCOPE Electronic Lab Scope

Training

eSCOPE Article - Cascade Diagnostic

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I was called to a shop for a complaint of erratic engine operation on a 2007 Jeep Grand Cherokee with a 5.7L engine (Figure #1). The engine would run fine with no problems, but after running at any given time period it would begin to abruptly surge up and down and cut out. The engine could be immediately restarted with no problems and would run perfect again until the next episode. The shop had previously installed high performance spark plugs and ignition coils a few weeks earlier but there were no drivability complaints at the time. The shop even put the old ignition coils back into the engine but the problem still prevailed. There were no codes stored in the ECM memory and the shop did not want to start playing Russian Roulette with auto parts so they called me in for tech assistance.

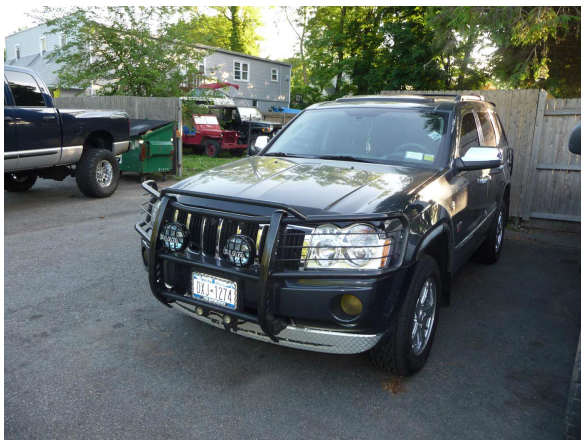

Fig. 1

When I arrived at the shop I placed my eSCAN generic OBDII scan tool on the vehicle to check for codes and there we no codes recorded in memory (Figure #2). I started the vehicle and it seemed to run okay with no problems but then it suddenly started to run erratic with a bouncing tachometer and the engine seemed to dip in and out with a near stall condition.

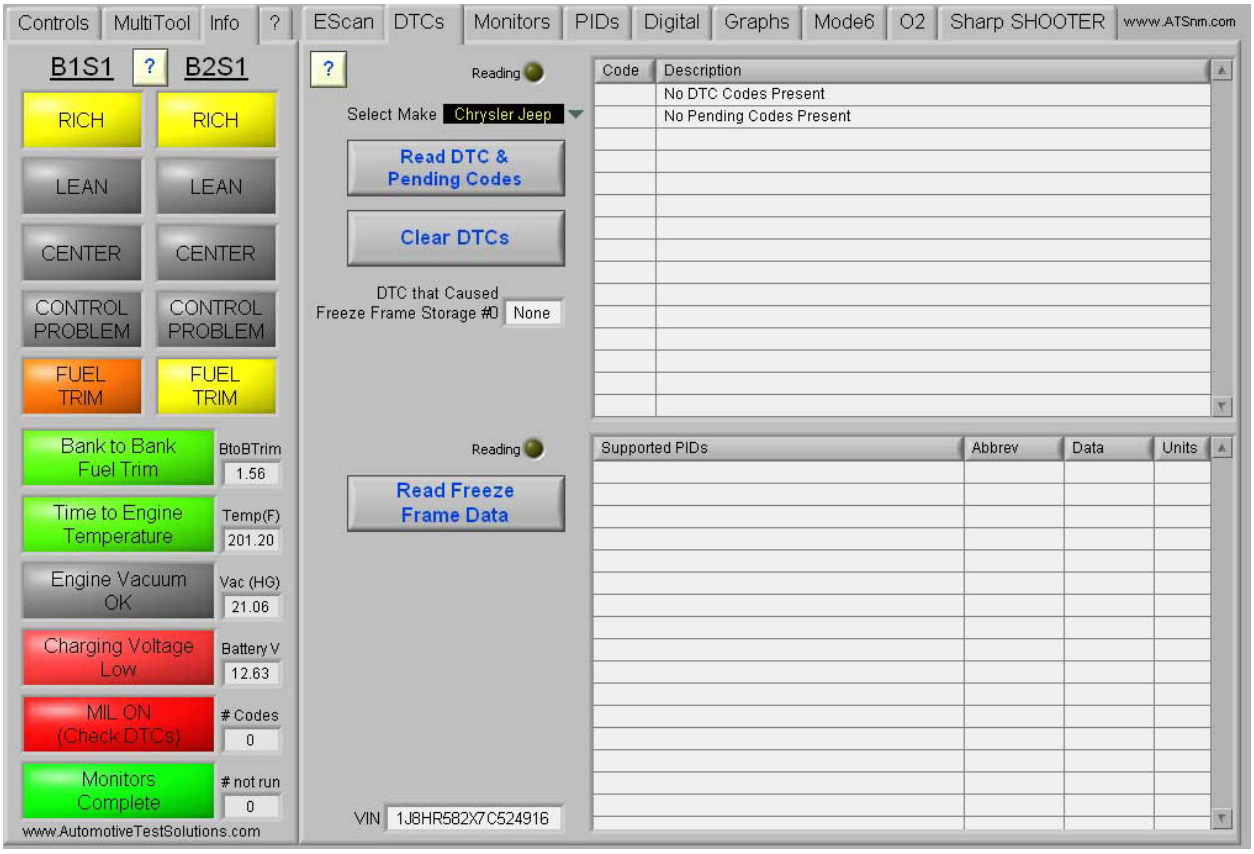

Fig. 2

After a few seconds the engine just cut out as if the ignition key had been turned off. I immediately restarted the engine and the problem was gone. I ran the engine again for quite a while and could not reproduce the problem. It was as if the crank or cam sensor was giving an erratic signal or the ECM had an internal board issue. I could no longer reproduce the problem so I offered the garage a free opinion to try a crank sensor due to their high failure rate in the industry. It would be a cheap fix if it worked.

The shop called back the next day and told me that the crank sensor did not fix the problem and that they had rechecked all the ECM power and ground feeds. The shop was willing to try an ECM due to the nature of the problem being so intermittent because everything seemed to lead to an erratic ECM operation. I agreed to program the ECM for them in hopes that the problem would go away because I could not think of anything else either that could cause such an erratic problem with the way the engine was running. I went there the next day after the ECM was delivered to program it with new software and configure it to match the vehicle. I started the truck and it ran fine for the first 15 minutes but then it went back into its dance. At this point I felt that feeling we all get when we realize that there is an expensive unwanted part that someone has to take the blame for. At this point both myself and the shop were now married to the vehicle and we had to find the problem or this ECM was going to be our meal for this evening.

I knew my time frame was short to find the culprit because I was unaware of how long the problem was going to stick around. I quickly placed my eSCAN tool on the vehicle and graphed some ECM parameters to see if anything looked unusual or out of range (Figure #3). I was monitoring the RPM, MAP and TPS sensors and you could see the Engine RPMs going into an idle roll. But then something unusual happened, I lost communication with the ECM as the problem got worse (Figure #4) and then the engine cut out. This had to be a loss of power / ground to the ECM or possibly a reference voltage feed momentarily shorting to ground because the ECM was shutting down operations when it decided to no longer communicate with my scan tool. The only way I was going to nail this problem would be with a multi trace scope to watch as many signals as I could before this problem decided to go away.

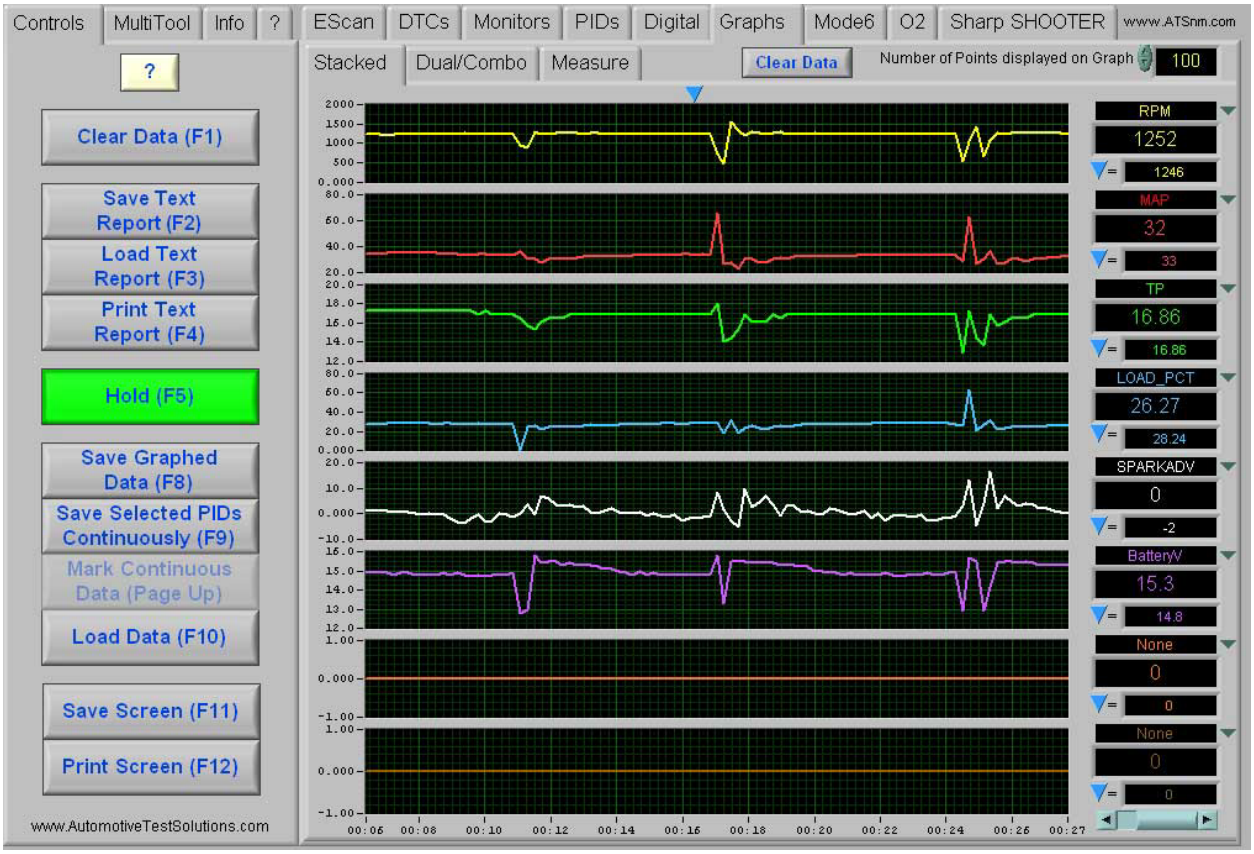

Fig. 3

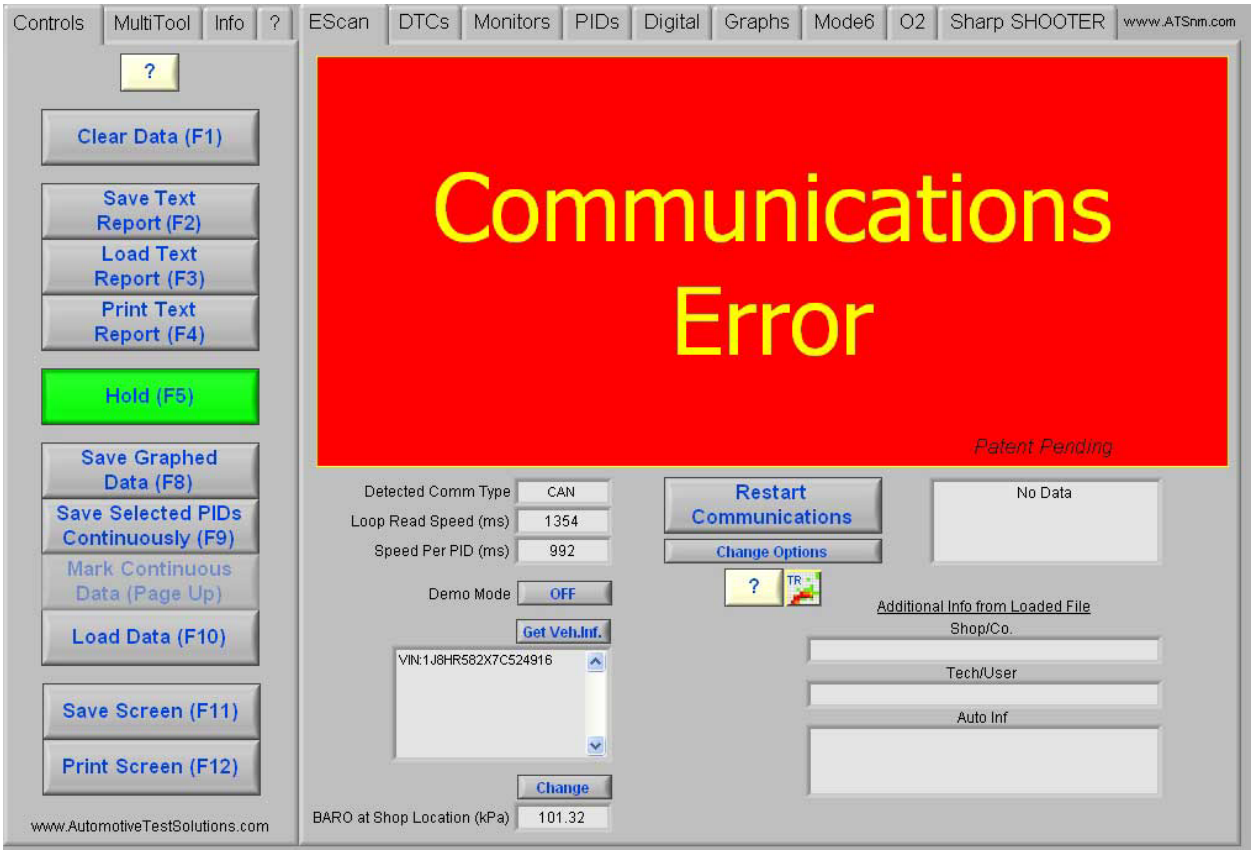

Fig. 4

I used my 8-trace eSCOPE and quickly selected 6 main items that would help me pinpoint my problem using my different colored leads as follows: I used my white for ECM battery feed, blue for ECM ignition feed, red for ECM Auto Shutdown Down relay feed, purple for ASD relay coil driver, yellow for 5 Volt reference and green for ECM ground. I monitored the problem and as soon as the engine started to run erratic I captured my first event (Figure #5).

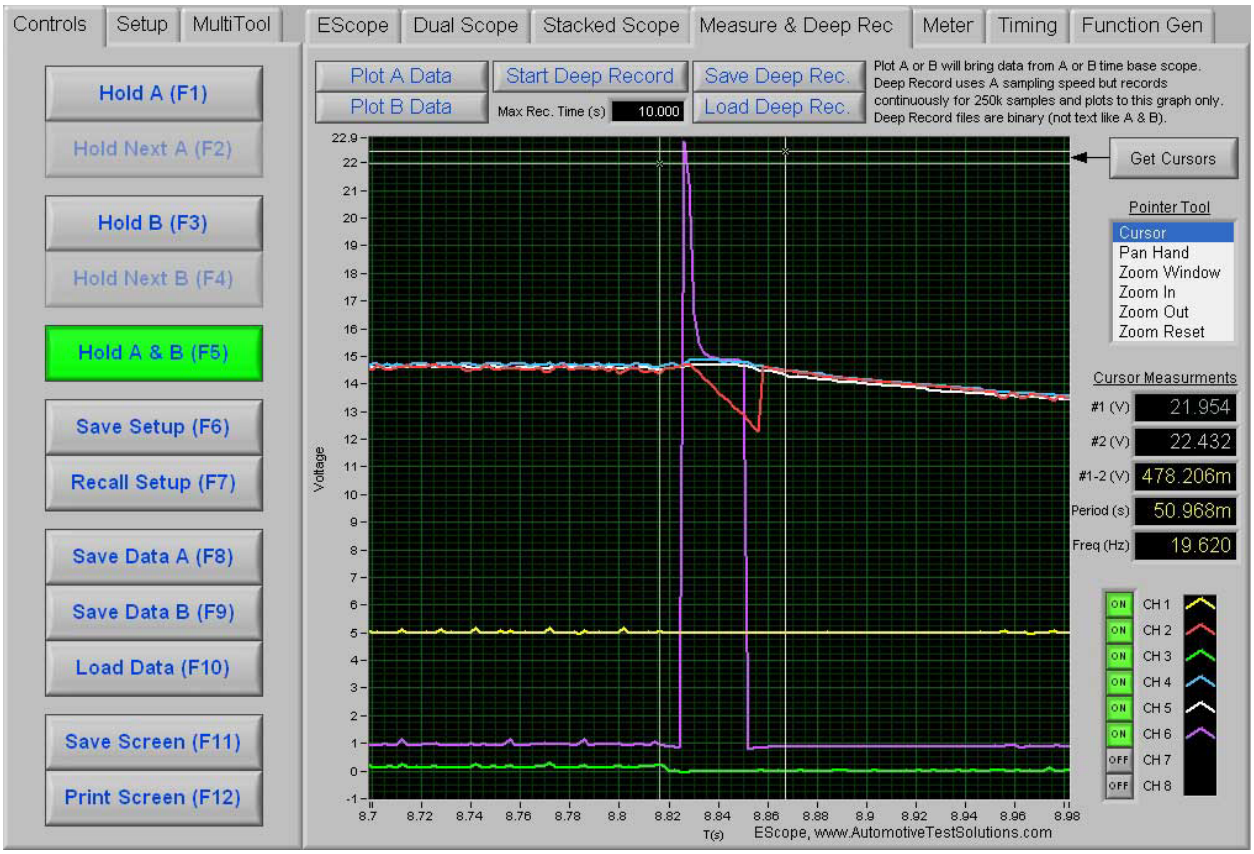

Fig. 5

You could see that the ASD relay driver momentarily was released by the ECM under 50ms but I never lost my 5 volt reference or my powers and grounds. It was as if something was telling the ECM to let go of the ASD relay coil so I now had to dig a little deeper. I wanted to see if I was losing a cam or crank signal so I captured 2 more events using my green lead on the cam signal (Figure #6) and my yellow lead on the crank signal (Figure #7). The waveform patterns did not show a loss of cam or crank signal when the ASD relay was being released but the tachometer was definitely following the cutting in and out of the engine.

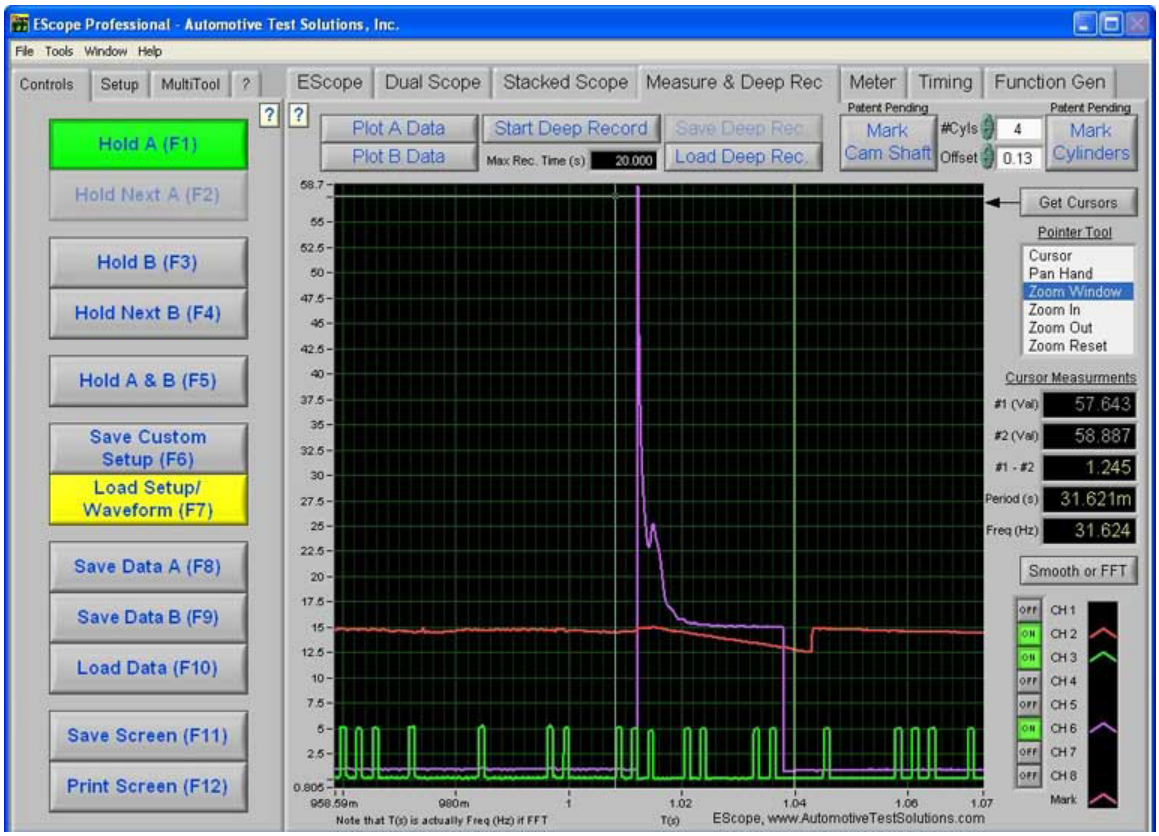

Fig. 6

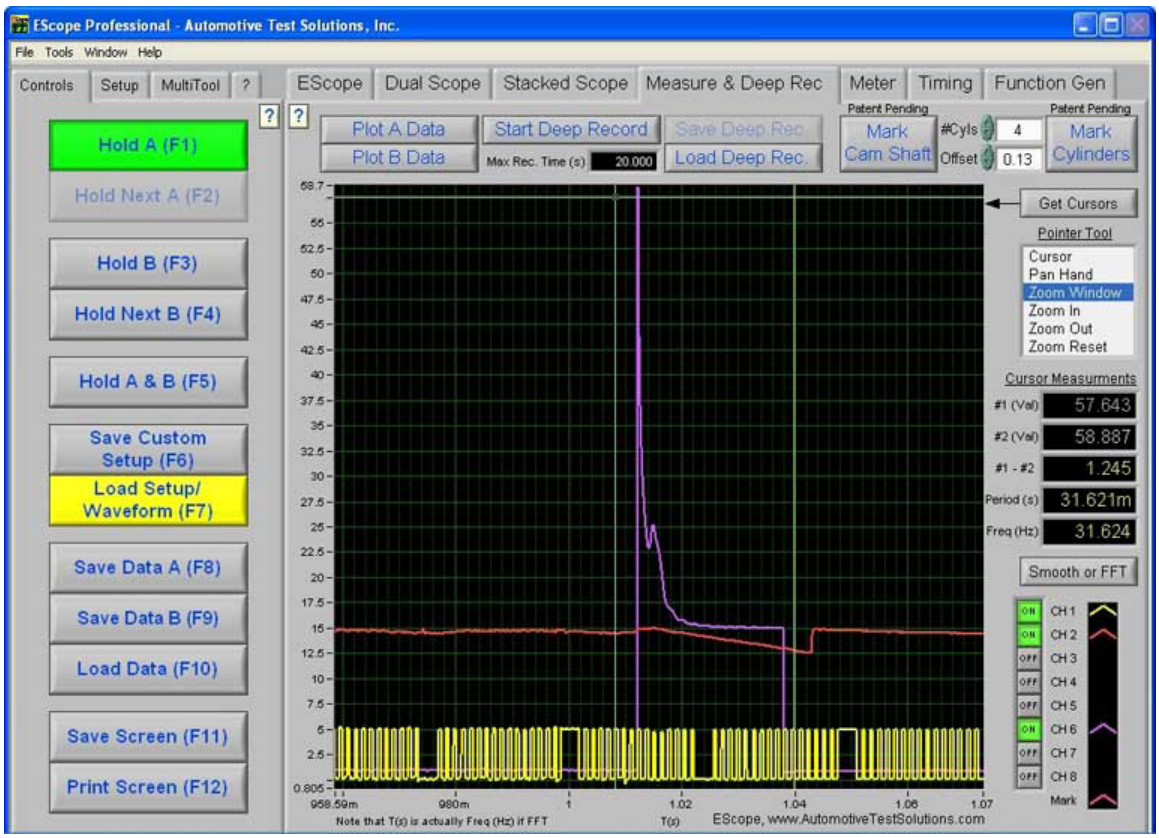

Fig. 7

I had an 8-trace scope so it was to my advantage to monitor all 8 ignition coil primary circuits to see if any coil trigger was being dropped out causing such an erratic engine & tachometer operation. I moved all my leads to the coil drivers and continued to monitor the engine operation. Today was my lucky day because this problem was only getting worse and it decided to stick around to put me on a joy ride. When I captured another event (Figure #8) I was surprised to see that I was losing all 8 coil drivers at the same time. The ECM was letting go of the ASD relay coil and it did not start to trigger the ignition coils again until about 300ms later. There was something making this ECM halt all operations momentarily or I possibly had a bad new ECM on hand. It would not be the first time I have come across a defective new part.

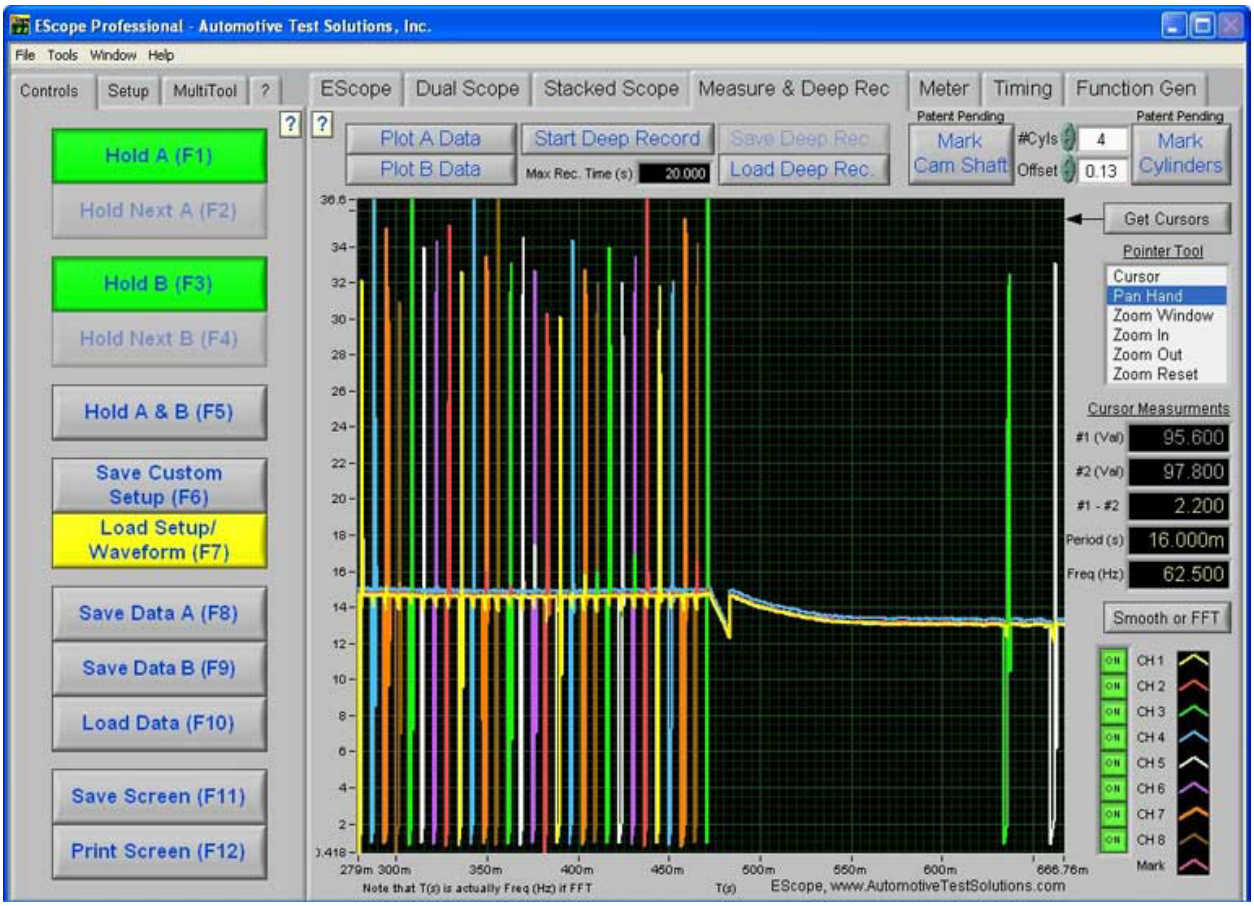

Fig. 8

I decided to call Bernie Thompson from Automotive Test Solutions just get his opinion on things because everything I have done so far has lead me to an erratic ECM operation and I just could not pinpoint the cause. You could see what the ECM was doing but what was its reasoning? Bernie basically wanted me to go back to my scope and look below my zero line for any secondary voltage kickback that could cause an ECM reset condition. An ECM reset condition is when outside noises penetrate the ECM through electromagnetic interference and disrupts its normal algorithm momentarily making it skip a beat. The engine in no way or fashion had an engine misfire due to a bad ignition coil or spark plug but it seemed like a logical possibility.

I went back to my primary pattern and this time lifted the pattern off the zero line to expose activity below the zero line (Figure #9), I was surprised to see multiple cylinders getting hit with secondary kickback voltage. Cars using ECMs that directly control coil primary may have a little secondary kick noticeable that may not have any effect on ECM operation but if the kick does get great enough it could give the ECM a momentary heart attack making it skip a beat or worse, causing damage to the ECM or internal coil driver.

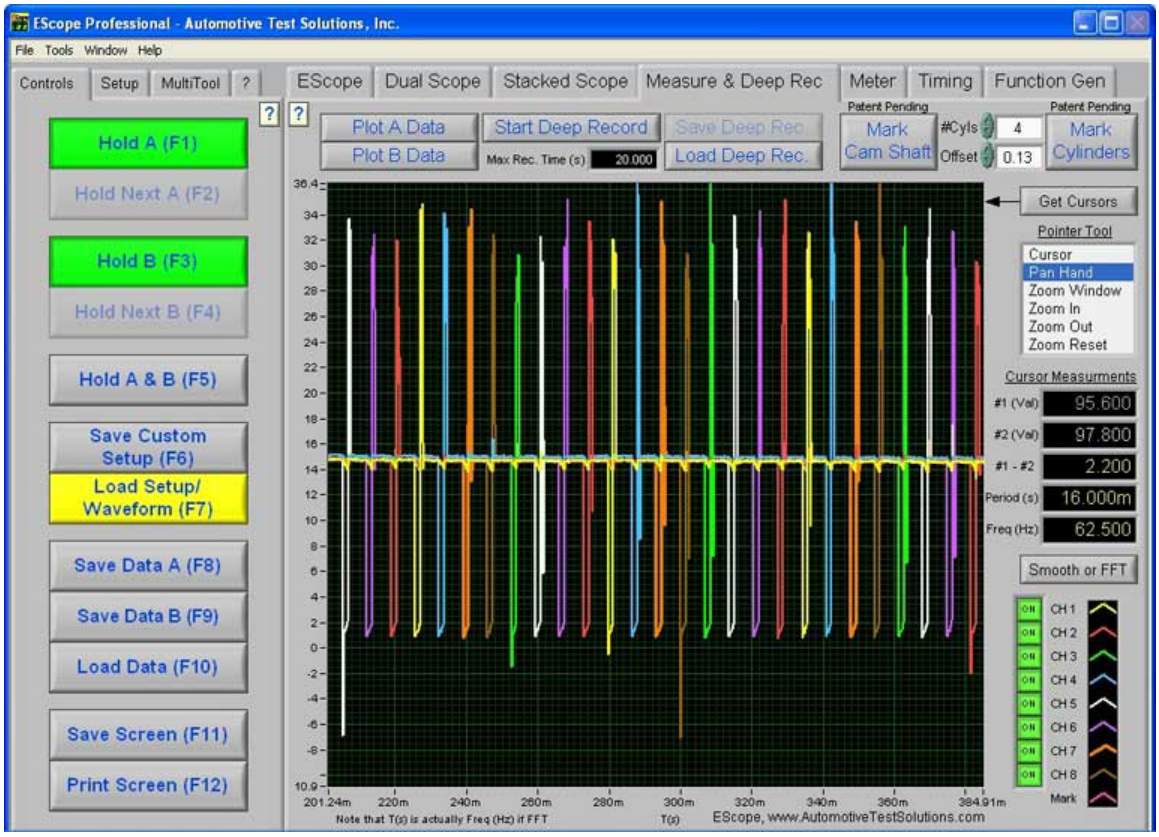

Fig. 9

I knew the original coils were put back in the vehicle but I was not so sure about the spark plugs. I had the shop pull a spark plug to get a view of what was currently installed in the engine. I looked at the spark plug installed in the engine and compared it to the original (Figure #10). There was something real funky about it. It actually had a triangle shaped electrode for a special performance feature that offered to fire the combustible mixture. I had the shop remove all the spark plugs and put back the factory spec spark plugs in the engine. Once this was done the problem was resolved.

Fig. 10

I can only tell you that I am so taken back by the turn of events. It is just so hard to believe that a company would manufacture a spark plug for performance purposes without any regard to its effects in a coil over plug environment. The problem it created mimicked a failed ECM that any tech would have changed in the field. There were no codes, no sensor failure or wiring issues. A multi trace scope would have to be used to find the cascading effect of events that would point you in the right direction. I own many 1, 2 and 4 trace scopes but with so many circuits involved with on-board control modules today it sometimes makes it easier to use a bigger net to throw at a problem vehicle then fishing around with only a few hooks.