Automotive FUSE PEEKER Adapter User's Manual

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Preface

The FUSE-Peeker was created as an answer to finding issues using current-ramping techniques. Current Ramping is the ability to analyze current flow to detect faulty issues.

Imagine you have a fuel flow or a transmission fluid flow issue. Both of these components, the fuel injector and the transmission shift solenoid can be diagnose "Faster" and "Reliable" using the Fuse-Peeker. The procedure is simple, remove the fuel injector or shift solenoid FUSE. Then, connect the Fuse-Peeker in place of the fuse. Now, that's faster than any other technique you know. The Fuse-Peeker is like a normal Clamp-On Amp Probe, but way more accurate and easier to read. It is also able to detect minute issues, such as injector/solenoid valve needle-pintle opening, shorted windings, motor issues, and virtually any other current driven actuator component issue.

The solution is the Fuse-Peeker that can either be "Used with your own oscilloscope or with our own "Scope-1" which uses automated signal fault recognition technology (SIGNALATOR). The Fuse Peeker by itself helps you in the following ways:

1. Simple remove and connect the Fuse-Peeker in place of the fuse, saving you lots of time.
2. Ever used those clamp-on Amp probes? They're not that sensitive right? The Fuse-Peeker uses current amplification technology. It is driven by 5 volts from the car's battery.
3. It has it's own 5-volt voltage regulator, so it's very stable.
4. No dis-assembly required, since it's only - remove the fuse and install the Fuse-Peeker.
5. You can also use the Fuse-Peeker somewhere else other than the fuse panel using the alligator clip cable lead. So, say a cooling fan motor, just disconnect and use the Fuse-Peeker in series.
6. The Fuse-Peeker has its own guided software to help you interpret the signal, but it's independent. So, no need to use the software if you don't want to.
7. If the guided software is not good enough, then the "Signalator" Scope-1 software (not included) module is the answer. Enjoy….

The FUSE-PEEKER is a simple device. It has a fuse like lead (alligator clips) that connects in place of the fuse, at the fuse panel. Now, the way you connect the Fuse-Peeker is important. If you see the waveform upside down, then either invert the wave using your scope or swap the FUSE alligator clips. Also set your scope to AC coupling.

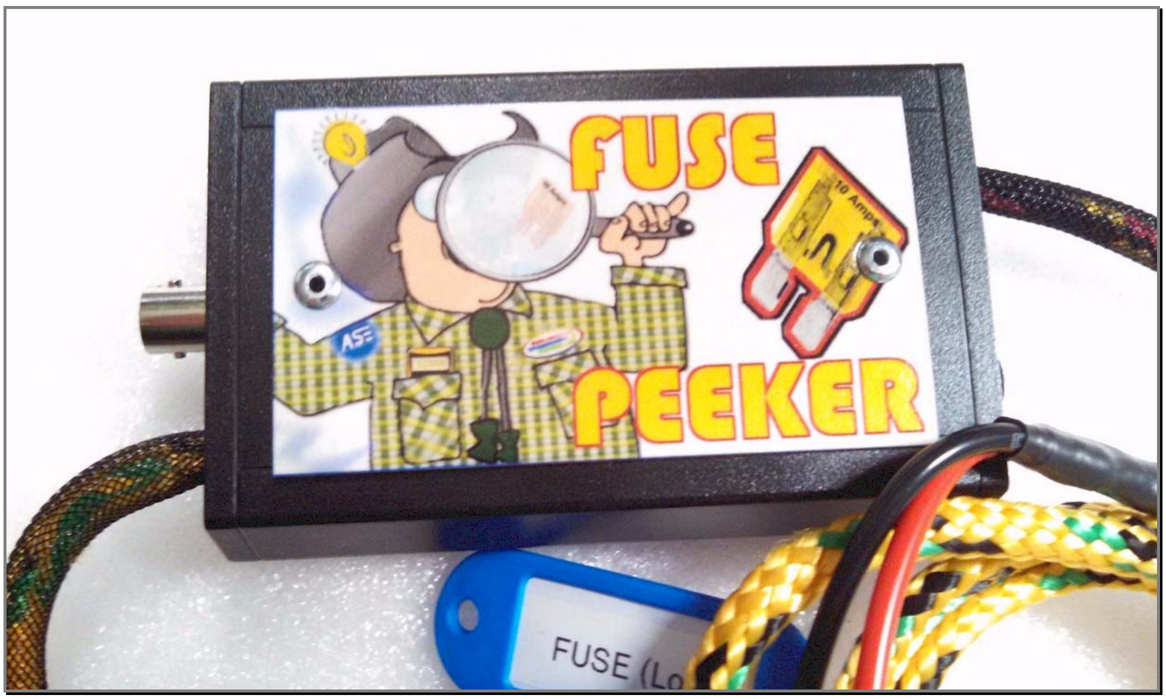
IMPORTANT: The Fuse-Peeker has two same color terminals or leads that go to the fuse. Connect the alligator clips disregarding polarity. If the waveform is upside down, "Invert" using your scope or swap the fuse alligator clips.

Simple right, one side of the fuse goes to the power side. The other side goes to the actual circuit or component in questions. This is somewhat basic, but it's important to know. In other words, all fuses are like this: One side is connected to the component and the other to power, either the ignition switch, relay or constant power. The Fuse Peeker goes in "Series" with the circuit or in place of the fuse.

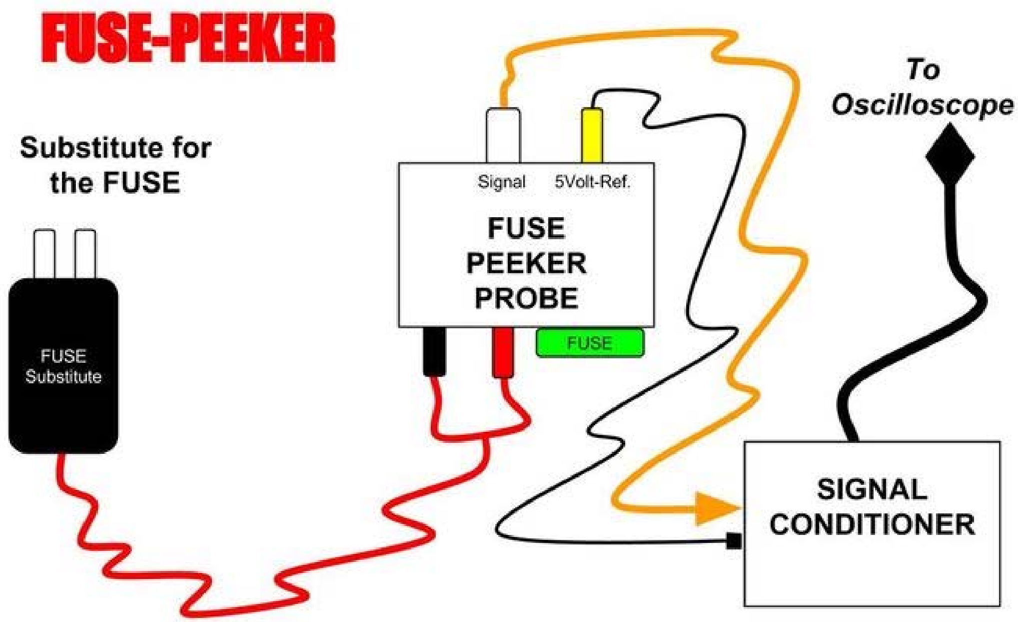
WARNING: The Fuse-Peeker can only take so much beating. So, if your fuse is "Blowing" due to a short, DO NOT connect the Fuse-Peeker. Solve your short circuit first.

If you connect the Fuse-Peeker in flipped polarity, no damage is done, but the signal will look upside down. So, again, NO DAMAGE DONE. Polarity just determines is the signal is up or inverted.

The reason for this is that the Fuse-Peeker is not just a simple SHUNT resistor in series, like most multimeters. There is no resistor in series. In fact, there is not resistance whatsoever to the LOAD placed or circuit being tested. The Fuse-Peeker has a proprietary dedicated electronics circuit that does the measuring. But, the polarity of the connection is somewhat important.



The Fuse-Peeker also has a "Gain" control knob. Often times, the component you're measuring has a higher current draw that the Fuse-Peeker circuit may get overloaded (not damaged). So, easy enough just tone down the gain and you'll be able to see the waveform again. Remember that the Fuse-Peeker is a dynamic (moving) current probe, not an Amp probe. It is meant for you to view current waveforms, determine operation like injector-pintle opening, motor (ie. Fuel pump) rotational speed, solenoid physical opening, etc. So, if you want to determine the actual current in mA, you'll need to calibrate the unit to a known component, then just divide whatever current in mA maximum, by the number of your scope's divisions on the screen. But all that defies the purpose of the Fuse-Peeker, which is to see the actual current waveform to determine component physical operation.



Seen here is a diagram of the Fuse-Peeker. Both the peeker probe and signal conditioner circuits are built into the whole case. The Fuse-Peeker also has circuitry to protect the circuit in question during testing. Always look and make sure the fuse is not blown. If so, correct your short circuit then connect the Fuse-Peeker to do whatever diagnostic you see fit.

Alligator clipped terminal.

Another lead included with the Fuse-Peeker is a simple alligator clipped terminal. Why? The Fuse Peeker can also be used to test components away from the fuse panel. So, say you have a fuel pump that may not be delivering enough fuel to the injectors and you can't access the fuse and test because the fuse is shared by another component; so the reading will be mixed or skewed. Now all you do is access the fuel pump relay and connect the Fuse-Peeker in series. The resulting accurate waveform will show you the operation of the fuel pump motor, speed of rotation and if it's flowing enough fuel or not.

How is this possible? Later on will have an excerpt from our books, Using Automotive Diagnostic Equipment where current ramping is explained. Current ramping is a powerful technique with wide uses for diagnostic.

In Resume

1) The Fuse-Peeker has two same color terminals that go to the fuse panel, in place of the fuse, or in series with the component.
2) Connecting polarity at the fuse is no important, but will determine the orientation of the waveform, so invert if needed.
3) The Fuse-Peeker has a battery power connection cable. Why? To power the peeker's circuitry and to reference the proper power and ground.
4) The Fuse-Peeker has a BNC connector and cable that go to the Scope side. This is a highly shielded cable, so if you break the cable, get one similar or give us a call.
5) Become proficient with current ramping techniques. Read our book on the subject.

For further knowledge on using scopes and scanner, as well as many other automotive technology topics, read our books and watch our videos.

Our Website   PDF-Book Catalog   Software Catalog   Equipment

CURRENT RAMPING STRATEGY

THEORY OF OPERATION

Current ramping is one of the most powerful diagnostic techniques available to the modern automotive technician. It is by far the fastest and least intrusive way of assessing the working condition of an electronic circuit. It is also very unlikely, given enough knowledge and experience, to be confused or misguided by the results of a current ramping waveform analysis. Of course, as in any technical procedure, it also has certain drawbacks, which we will get into later. Current is the amount of electrons flowing through a conductor (wire). An analogy can be drawn from a water pipe. The bigger the diameter of the pipe the more water that can flow through it. By the same token, the thicker (lower wire gauge number) the electrical wire the more electrons that can flow though it.

It is virtually impossible to have a circuit or component with the correct current waveform and be shorted or open.

Hence the inherent power of this technique. A shorted or open circuit (and anything in between) will draw more or less current than that needed. Such an excess or lack of current will show as a specific waveform trace on the oscilloscope. The ability to read these scope waveforms will speed up the diagnostic process and provide you with higher returns, due to the time saved. In order to take advantage of current ramping, two pieces of equipment are needed.

An oscilloscope (DSO) and a low/ high amperage clamp-on amp probe are a definite must. Current ramping takes advantage of the latest advances in electronic equipment technology. Only a few years ago, it was impossible to adapt these procedures for automotive use because of the lack of available and affordable equipment.
The clamp-on amp probe is a device that converts an electromagnetic signal into a voltage signal that the scope can plot on the screen. It is important to know that all electrical/ electronic wiring have a magnetic field around it, whenever it is in operation. For example, a cranking starter has current flowing to it, so does a cooling fan, an ignition coil, a solenoid, etc. In all these cases, the magnetic field around the wires that go to such components is directly

proportional to the amount of current flowing though them. In other words, a starter draws more current than a cooling fan. Therefore, the magnetic field picked up by the amp probe is also bigger and so is the voltage amplitude (height of the waveform). The amp probe converts the wire's magnetic field into a voltage output for the scope. By analyzing these waveforms, current ramping techniques can be applied to almost any electrical/ electronic device. The main concept to remember in current ramping is that the oscilloscope, through the current probe, is actually measuring the magnetic field around the wiring of the particular circuit you want to analyze.

Current ramping will not pick-up voltage related issues with a particular circuit. This technique does exactly what it is called. It is a current measuring procedure which works by picking up the magnetic field around an electrical wire.

CURRENT RAMPING A FUEL PUMP

In essence, fuel pumps are electric motors. Electric motors work by flowing an electric current to the coil windings through a set of carbon contacts. These coil windings have a set of contact point called commutators. Every time the rotating coil windings rotate, the carbon contacts make a different connection, which actually shows up on the current waveform. By analyzing this waveform, we can deduce a couple of details about a fuel pump motor. First, a determination has to be made as to the amount of commutators on an electric motor. It is virtually impossible to know such a detail on all the possible fuel pumps out on the market today. The technique to find the amount of commutators in a motor will be explained later on, but for now it is important to know that most fuel pumps have 8 commutators.

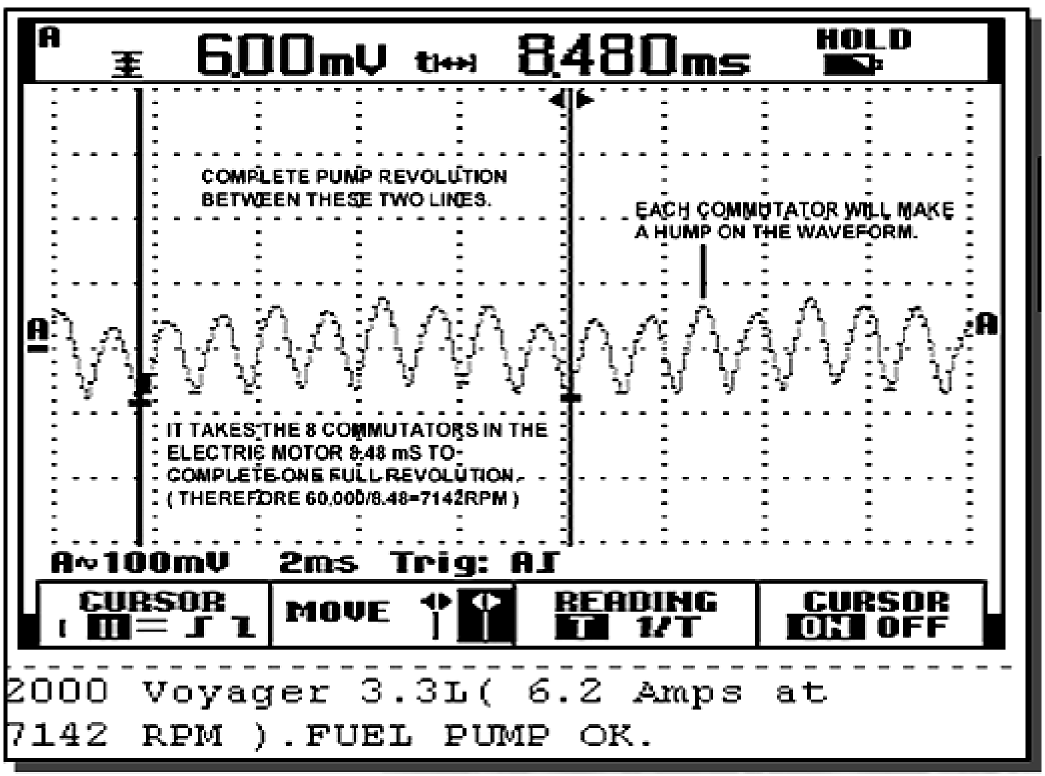


Fig 1 – Fuel pump current ramping waveform analysis.

With such information, it is possible to determine the speed of the motor and by doing so, the condition of the fuel pump.

By simply freezing the waveform and measuring the time it takes to make 8 current humps (8 commutators), all we have to do is divide 60, 000 by such figure. It takes 60 seconds to a minute and 1, 000 mS to a second. 60 sec * 1000 mS = 60, 000 mS. There are 60, 000 mS in one minute, which is why we always divide by 60, 000. This technique can actually be applied to any electric motor. By knowing the rotational speed and current draw of a fuel pump motor, we can determine its condition. A faster than normal fuel pump, with low current draw, points to a lack of resistance in the fuel flow.

A defective fuel pressure regulator letting too much fuel return back to the tank, a worn out pump impeller itself, a clogged suction filter sock, etc, can all lead to a fast spinning fuel pump. On the other hand a slow fuel pump with high current draw points to a restriction in the fuel lines. A clogged fuel filter, restricted fuel pressure regulator, etc, will slow down the fuel pump, since it has to push the fuel a lot harder. In cases where the specific amount of commutators is not known, the use of fairly high screen definition scope is needed.

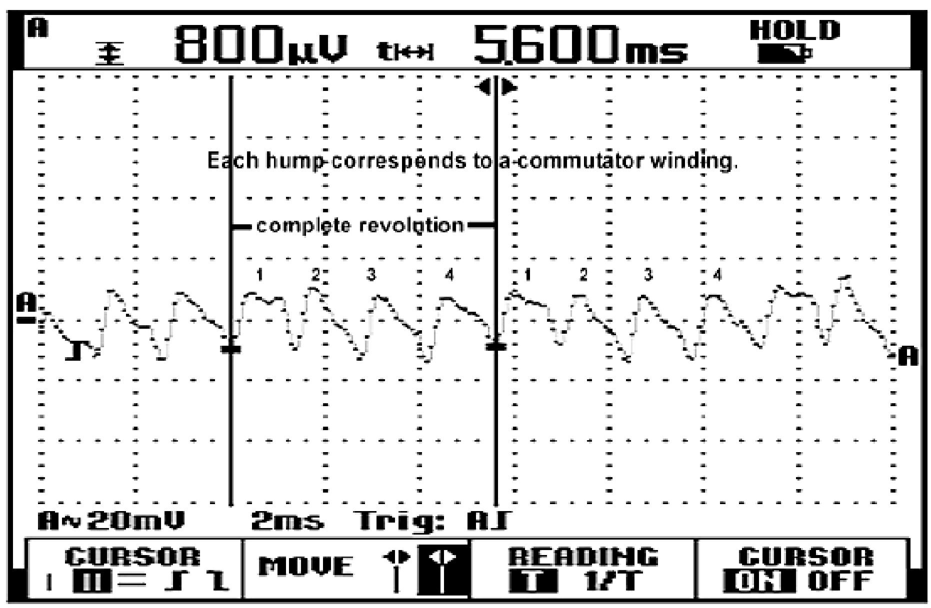
By actually looking for a repeating pattern in the humping fuel pump waveform, the exact amount of commutators can be arrived at. Not all oscilloscopes have the high screen resolution needed for this technique and no matter which scope is used; it should always have the cursor measuring feature so as to measure time between the two cursor lines. Power graphing multi-meters can also be used so long as the specific amount of commutators is known, since they lack the screen definition to detect a waveform repeating pattern. Whenever a current waveform is needed, the best and fastest place to get it is usually by jumping the fuel pump fuse with a wire and clamping on with the clamp-on amp probe, right at the jumper wire.

Be aware that this fuse should only be feeding the fuel pump. If any other component is tied to this circuit, you will also be reading its current draw and the reading would be useless. The fuel pump relay is also a good place so long as it is readily accessible.

Always measure current to the fuel pump with the engine running. An engine not running has by average 12.6 volts while a running engine has around 14.3 volts. By taking a current reading with the engine off the reading will indicate a bad fuel pump when in fact it's not.

This is because the lower voltage also means lower amperage hence weaker magnetic field around the fuel pump electrical feed wire.
In the previous illustration, the repeating nature of a fuel pump waveform was shown. Once a repeating pattern is found, the time is measured between one set of repeating humps and the fuel pumps speed can be calculated. In the case above, the pump has 4 commutators. It takes 5.3mS for one complete revolution.

By dividing 60, 000/5.3 mS a figure of 10714 RPM is arrived at. This is normal for a carbureted engine. It is important to note that speed specifications are virtually impossible to find for this test. Time and experience will dictate the success that you will enjoy with this technique.



Carburated fuel pump.10714RPM.
Current draw at 1.35 Amps.
This fuel pump is good.

Fig 2 – This fuel pump waveform clearly shows the repetitive nature of the internal commutators inside a fuel pump. The particular fuel pump in this example belongs to a carbureted engine. Notice the repetitive nature of the waveform. Humps # 1 ,2, 3, 4 will repeat again over and over. That is because every time the same commutators pass by the carbon brushes, they will leave behind exactly the same trace as in the previous revolution.

The pattern will keep repeating over and over. In this case, it's a 4 commutator fuel pump. It makes no difference how many commutators in the fuel pumps motor. The technique is the same.

IGNITION COIL CURRENT RAMPING WAVEFORM ANALYSIS

Current ramping techniques can be used to virtually analyze any electrical device. This diagnostic technique becomes even more powerful when checking ignition coils in order to find shorted coil elements, which are causing specific misfire codes.
Given today's coil-on plug (COP) ignition systems, where it is virtually impossible to have access to the coil's primary or secondary, a current ramping analysis of the ignition coil is both fast and conclusive.

By just jumping the particular fuse that feeds the ignition coils with a fused straight wire and using the clamp-on amp probe, a quick determination can be made as to the general health of the coil and spark output.

A shorted ignition coil will show up as a fast vertical line on the coil's current waveform. Ignition coils need to reach saturation in a slow timely manner. A sudden vertical line in the waveform will surely point to a shorted or semi-shorted ignition coil.

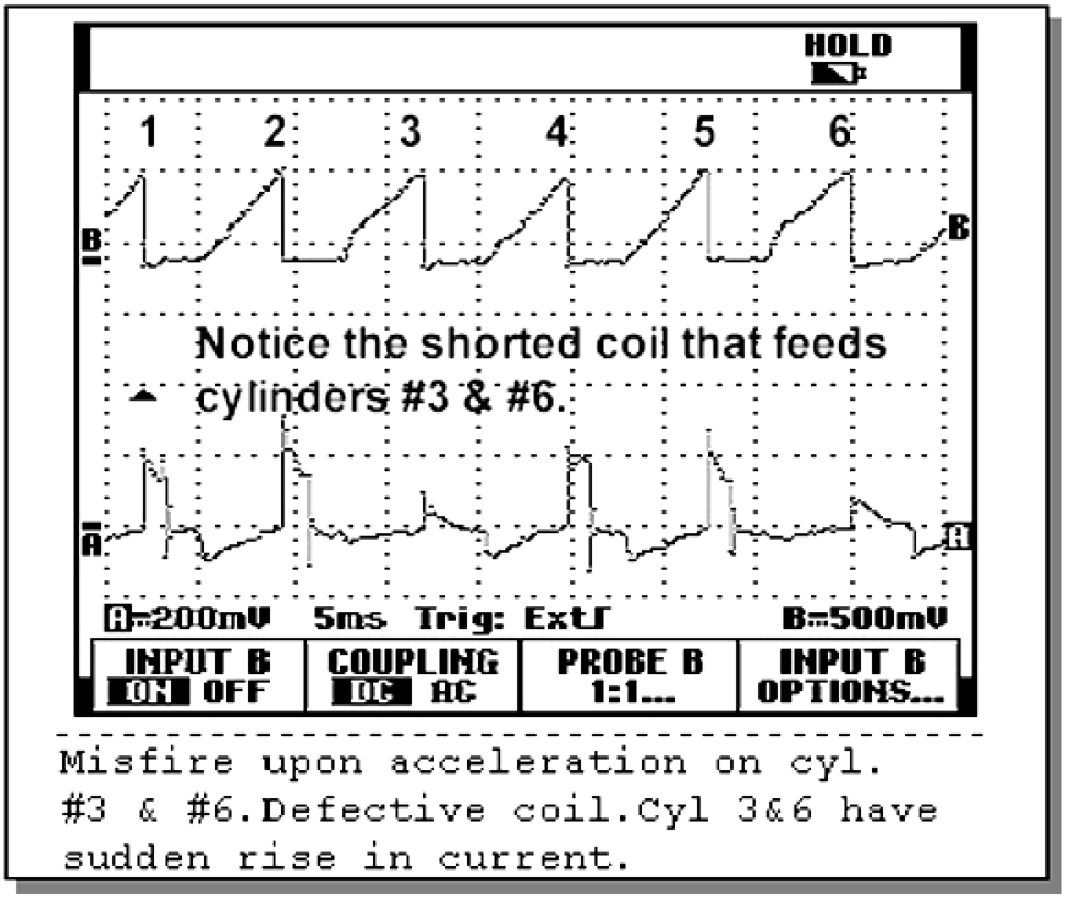


Fig 3 – Notice the sudden raise at the beginning of the waveform in coils # 3 & # 6. The slanted lines on the other firing coils indicate proper coil saturation. Notice also how the short in the coil makes the secondary firing line smaller, therefore, delivering less Kvolts to cylinder # 3 & # 6. This is a waste spark system and uses one coil per two cylinders. 3-6

CURRENT RAMPING AN INJECTOR

In the latest engine designs, it seems that tighter and tighter electronic component arrangement is the rule. This is another area in which current ramping can really shine. If access to the injector wiring is not possible, by simply jumping the main injector power feed fuse an injector current ramping waveform can be obtained. MPFI injectors operate at just under 1 amp of current. For this reason, a fairly good quality low-amp probe is needed if you are to look deep into the injector waveform.

Such analysis, as when the injector pinttle is opening (to detect clogged injector) or an ECM injector driver failure are only achievable with a high quality DSO and low-amp probe. Clogged or stuck shut injectors are sometimes fairly hard to detect using a current waveform. And will usually only affect the mechanical part of the injector and not necessarily the interior electrical coil windings.

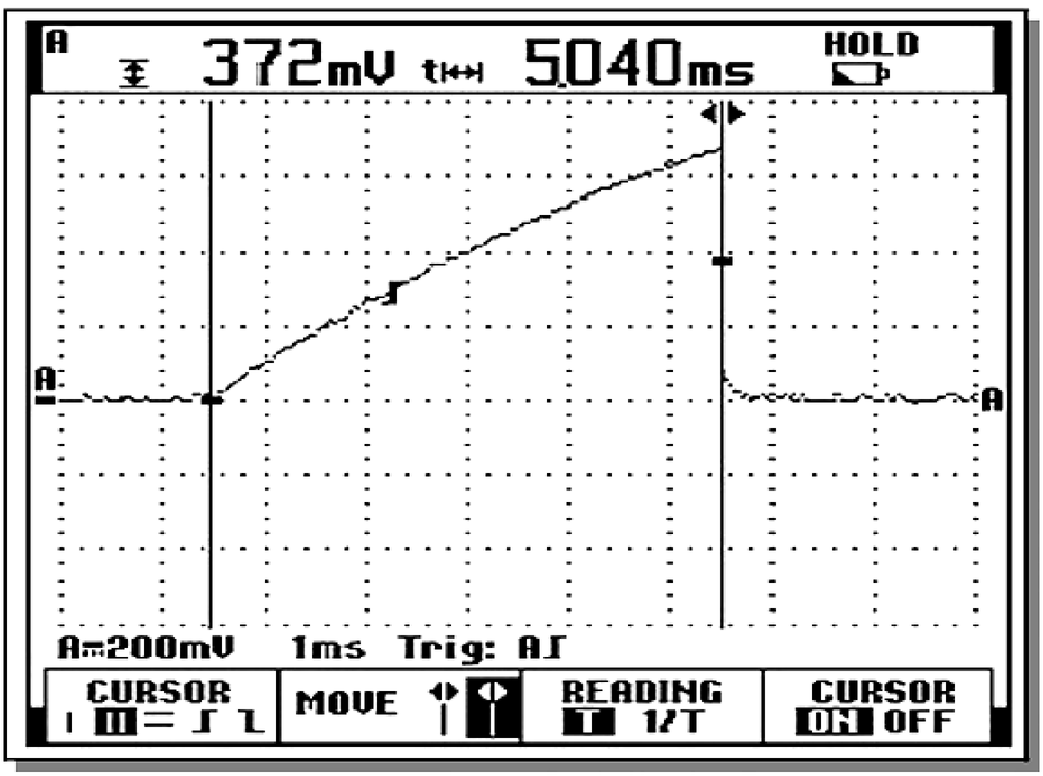


Fig 4 – This screen capture shows a perfect coil current waveform. Notice the slanted and timely current raise. This is indicative of proper coil saturation.

The space between the cursor lines is the actual on time that the ignition module is applying to the coil (in mS). This on time is called the coil dwell. Dwell times vary between 3.5mS at the lowest to 8mS on some heavy duty Vans. It all depends on the engine design.

CURRENT RAMPING COMPRESSION TEST

Yet another useful current ramping technique is the current compression test. By using a high amperage probe and clamping around either battery cable it is possible to measure the starter's cranking amperage. The starter will draw less current if a particular cylinder lacks compression at cranking time. These starter cranking current variations are picked up and measured by the amp probe and are plotted on the scope's screen.

A quick current compression test will quickly (within a minute) identify an offending cylinder without the need of more time consuming compression gauge tests. This test will not do away with the compression gauge but will point directly to the bad cylinder. Afterwards all further tests can be directed to that cylinder if necessary.

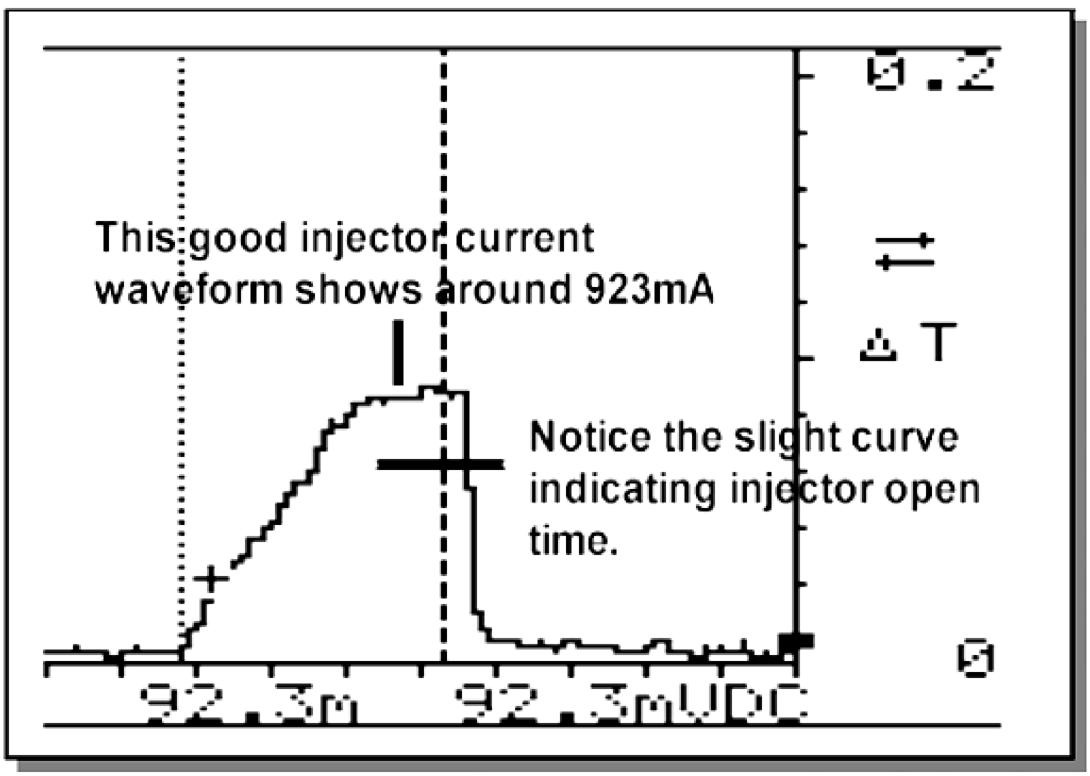


Fig 5 – Here an injector current reading indicates a current draw of little less than an Amp. Notice the slight curve on the raising edge of the current scope trace. This indicates the injector pinttle is opening.

If too far up it indicates a clogged injector. If the pinttle opening hump is too far down instead, it indicates weak sprigs.

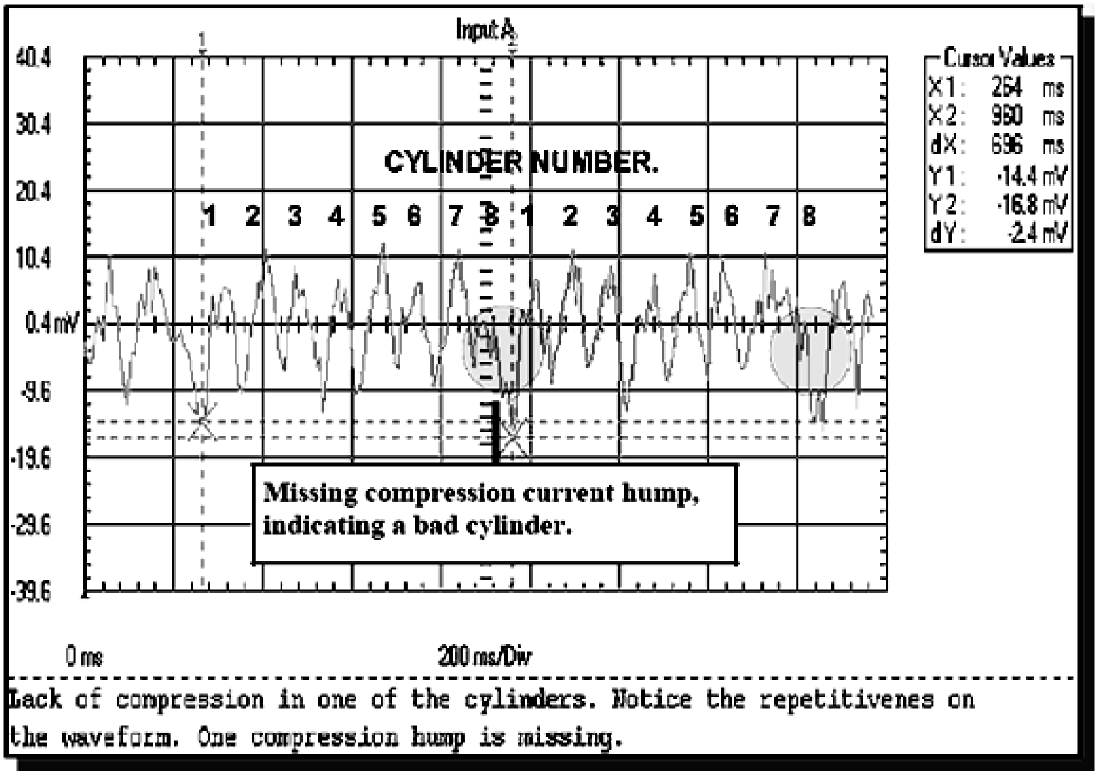


Fig 6 – This compression waveform indicates a lack of compression on cylinder # 8.

As you have seen in this article, current ramping techniques can be applied to fuel pumps, coils and starters with a high degree of success. This technique however could potentially be used with any electrical circuit like cooling fan motors, window motors, actuators and solenoids, etc. Use of your imagination and experience will lead you to a better and faster diagnosis. Missing compression current hump, indicating a bad cylinder.

Note: For more information and training please refer to our publications and video-DVD series on our website.

About the Author

Mandy Concepcion has worked in the automotive field for over 26 years. He holds a Degree in Applied Electronics Engineering as well as an ASE Master & L1 certification. For the past 16 years he has been exclusively involved in the diagnosis of all the different electronic systems found in today's vehicles. It is here where he draws extensive practical knowledge from his experience and hopes to convey it in his books. Mandy also designs and builds his own diagnostic equipment, DVD-Videos and repair software.