An oscilloscope-based tool reminds us that the automotive old-timers, with their rudimentary tools and deceptively simple tests, might have been on to something after all.

When I first started working on cars, in the last days of points and condensers, we often tested for misfire by holding a dollar bill in the exhaust stream. If the bill was periodically sucked back toward the tailpipe, you had a misfire. If the bill was sucked out of your hand and into the tailpipe, you had a burned exhaust valve.

Fast forward to 2003. SenX Technology introduces the FirstLook ADS ES 100 diagnostic pulse sensor (www.senxtech.com)—a pulse wave mass accelerometer. That means that the sensor will measure air movement. If you apply a vacuum to the sensor with a vacuum pump, the voltage output will rise quickly, then fall back to zero. The output falls back to zero even though the vacuum is still applied. The sensor measures only changes in pulse acceleration, not static vacuum or pressure conditions. Releasing the vacuum generates a complementary negative voltage pulse with a return to zero.

So the theory is you stick the sensor hose in the exhaust system and read the pulses to help diagnose various engine conditions. I had some difficulty wrapping my brain around how well this might work. Sure, each cylinder is going to produce a pressure pulse, but what about the effect of the muffler? After all, the muffler is a calibrated resonance chamber designed to create reflected waves to cancel exhaust noise. And what about the transport delay—the time it takes for the pressure wave to move down the tailpipe?

John Brock, the pulse sensor’s inventor, explained that you need to think of the exhaust as a tube of water. Pressure applied to one end will instantaneously be transferred to the other end in one continuous movement. Hmm. I thought air was compressible. Anyway, John further explained that with very little backpressure in the exhaust, the pulse has little transport delay/compressibility. It started to sound pretty interesting, but don’t take my word for it—I once owned an Olds diesel and an Eagle Premier.

After reading the instructions (it’s true, I did), I connected the sensor to my scope and inserted the hose into the tailpipe. The waveform shown in Fig. 1 was taken from my Honda Odyssey V6 at idle. The blue trace in the lower pane is the No. 4 cylinder injector waveform. The green trace (also in the lower pane) is the No. 4 cylinder ignition trigger to the coil-on-plug module. The yellow trace in the upper pane is the MAP sensor signal. The numbers with arrows point to the intake pulses for each cylinder in the firing order. The red trace (also in the upper pane) is the exhaust probe waveform.

Notice that the MAP sensor signal is varying around zero volts. The true MAP reading is
around 1 volt. To get better vertical scope resolution for this signal, I AC-coupled the scope. AC coupling filters out the DC offset so you can better see the variations in the waveform. When you're looking at an alternator diode pattern, you're using AC coupling to filter out the 14.5-volt DC offset. I'll cover AC coupling in greater depth in a future column. It's a powerful feature on your scope.

Okay, let's look at the red exhaust pulse waveform. It looks like there are three exhaust pulses for every intake pulse. What does that mean? Absolutely nothing. I was right; the resonance effect of the muffler and reflected waves in the exhaust will mask the pulse. John told me that moving the hose in the pipe would change the waveform. What you're looking for is just what the dollar bill indicated—a major change in the pulse wave. If the amplitude of the waveform is steady and low, there's no misfire. Note the amplitude here is less than ±.1 volt peak-to-peak.

Now let's introduce a misfire and use the probe with a trigger to find the bad cylinder (something the dollar bill test could not do). I triggered off the No. 4 cylinder, since it was easy to get at. I disconnected the No. 6 cylinder injector electrical connector, also because it was easy to get at.

The instructions with the probe indicate that to locate a six-cylinder exhaust pulse, it will synchronize with the ignition event two cylinders ahead. The No. 6 cylinder pulse is peaking when the No. 4 cylinder ignition is starting. Fig. 2 (above) shows the stroke events and firing order for the Odyssey six-cylinder. Look at the top of the green arrow pointing to the No. 4 cylinder ignition point in the four-stroke cycle. The bottom of the

---

**Fig. 2**

<table>
<thead>
<tr>
<th>Cylinder</th>
<th>0</th>
<th>60</th>
<th>120</th>
<th>180</th>
<th>240</th>
<th>300</th>
<th>360</th>
<th>420</th>
<th>480</th>
<th>540</th>
<th>600</th>
<th>660</th>
<th>720</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**THE WORLD’S BEST A/C LEAK DETECTION SYSTEM, JUST GOT BETTER!**

Introducing the NEW Spotgun™ Jr./Pico-Lite™ Kit

UView’s latest A/C leak detection kit is cost effective and has everything needed to find leaks quickly and accurately. It combines the ever-popular Spotgun™ Jr. injection system and the new PICO-Lite™, a compact high-intensity leak detection light that fluoresces all UV dyes.

The Spotgun™ Jr. delivers a precisely measured amount of dye into the A/C system with virtually no coupler wastage. This means more tests per dye cartridge and no messy spills to clean up. So when the competition tries to tell you how to perform the perfect A/C Leak detection test, tell them you're sticking with Spotgun™ Jr., the world's best injection method!

pin 32220
Kit includes:
- 1 Watt Luxeon LED leak detection light (3AA batteries included)
- Spotgun Jr. injector
- Universal A/C Dye cartridges (services up to 20 vehicles)
- R-134a Adapter & R12 Adapter
- UV protection glasses
- Service stickers
- Storage Case
Mees SAE J-2297 and OEM approved Dye

Circle #17

---

**PICO-LITE™**

1 watt Luxeon LED leak detection light. Also available on its own. (#413020)
green arrow points to the exhaust stroke of the No. 6 cylinder. Note that this is not the beginning of the exhaust stroke, but likely where the exhaust valve is reaching full open on the camshaft lobe ramp.

The exhaust pulse is delayed relative to the ignition event. This delay is one cylinder for a four-cylinder engine, two cylinders for a six-cylinder engine and three cylinders for an eight-cylinder engine. That’s what the instructions say.

In Fig. 3, the green trace is the cylinder 4 ignition event. From one ignition event to the next, I created seven equally spaced lines to show each cylinder pulse. I offset the firing order from No. 4 to No. 6, as indicated in the instructions. Wow, right on the money! The pulse wave dropped dramatically, to -.330 volts right at the cylinder 6 exhaust pulse. John was right; no transport delay. Okay, to tell the truth, he said a physicist worked out the typical transport delay to be 1.23 milliseconds (mS). With each cylinder event taking about 23mS, a 1.2mS delay is not significant. At very high rpm, you need to account for the delay.

The misfire causes a dip in the desired rpm. The computer compensates on the next firing events and overshoots in the opposite direction, causing a complementary pressure wave in the opposite direction. Remember, the idle air control motor (IAC) gets desired idle rpm close, then ignition timing is quickly adjusted for final idle rpm trim. After cylinders 1 and 4 exhaust, the wave starts to stabilize back to a more normal amplitude.

There are more tests to do with the SenX tool, including cranking engine, 1500 rpm, crankcase pulses and fuel pressure regulator diaphragm pulses. I’ll put it through its paces and let you know how it works out.