TomcoTechtips
TM

ISSUE 39

Injector Patterns

In this issue we will take a closer look at injector patterns, and see what we can determine from them.

First a note on scope setup. I usually set the scope to 20 volts per division with a 2 to 5 millisecond time base. I try to put the pattern as close to the center of the screen as possible. This will give you a good view of the injector, and you can fine tune it to your liking. Be careful though. If you try to put too many injector patterns on the screen it may give you a false indication of what's happening in the injector due to the sampling rate of your scope.

In the figures on the right we have typical patterns for saturated style injectors. Figure 1a is a Chrysler application, figure 1b is a Ford application and figure 1c is a GM application.

Looking at the figures 2a, 2b, 2c, we will begin to examine the pattern. Point "A" in figure 2a is the voltage supplied to the injector, typically battery or charging system voltage. We can see in figure 2b that the voltage is 14.4 volts. If the voltage was lower than system voltage we would have to check the power supply or the circuit to find the problem.

Point "B" in figure 2a is where the PCM energizes the injector. This should bring the pattern down to ground. It is important to remember that this will not be the typical ground value we are used to seeing. This is because the

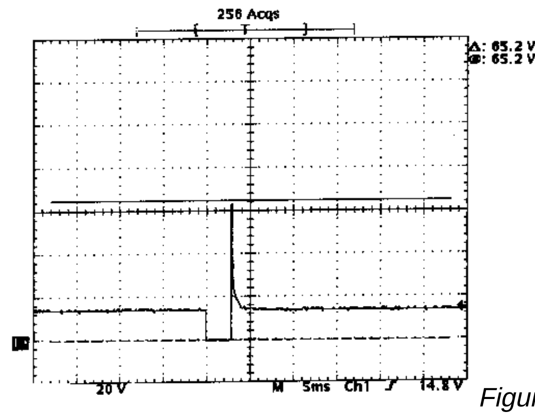


Figure 1a

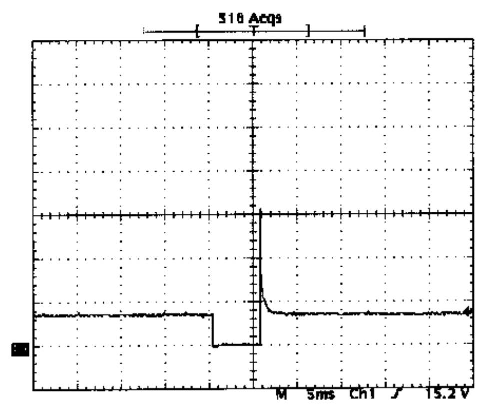


Figure 1b

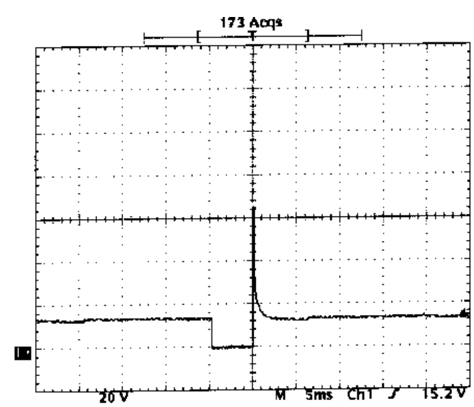


Figure 1c

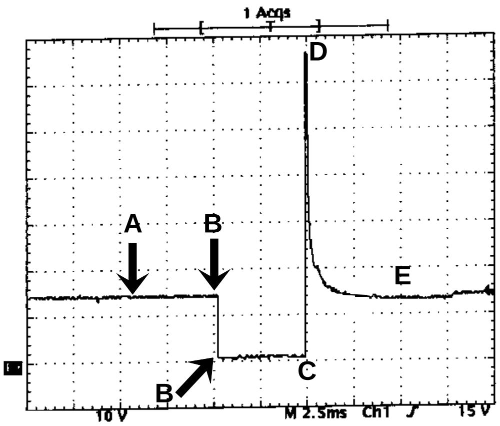


Figure 2a

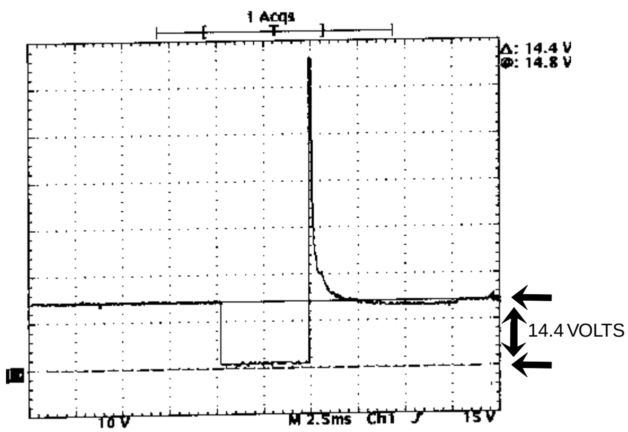


Figure 2b

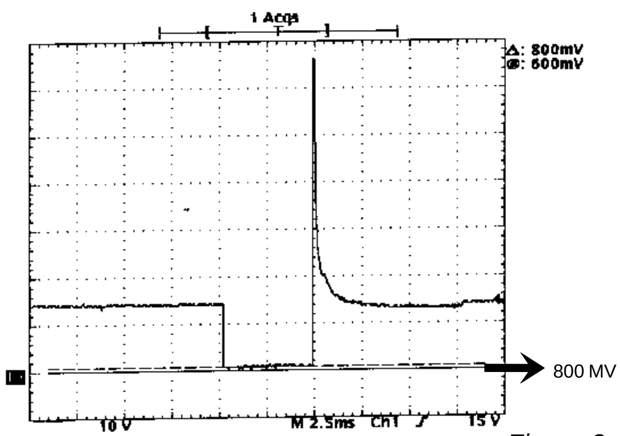


Figure 2c

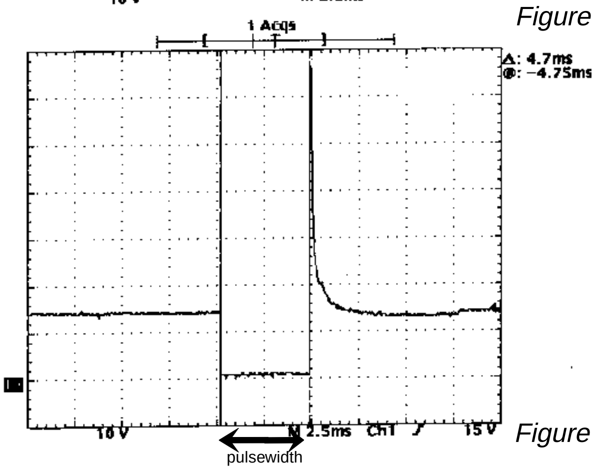


Figure 2d

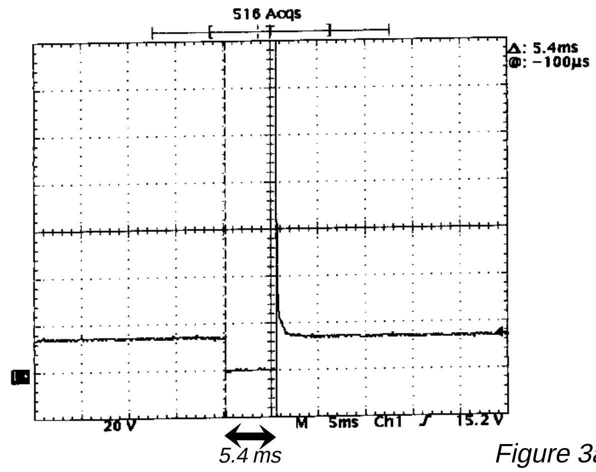


Figure 3a

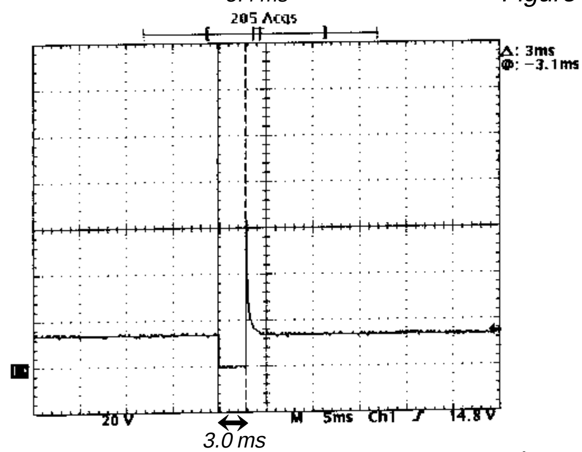


Figure 3b

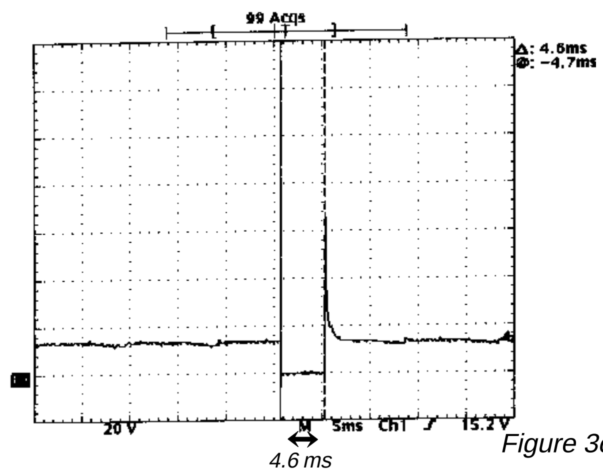


Figure 3c

injector is being grounded through a transistor. I have seen values as high as 1 volt off of ground. In figure 2c we see that this voltage is 800 mv.

Point “B” to point “C” is the on-time of the injector. Of course this will vary depending on engine conditions. Typically at idle TBI injectors will be from 1 to 2 milliseconds. Typically at idle PFI injectors range from 2 to 6 milliseconds (Figure 2d). It is hard to give a set

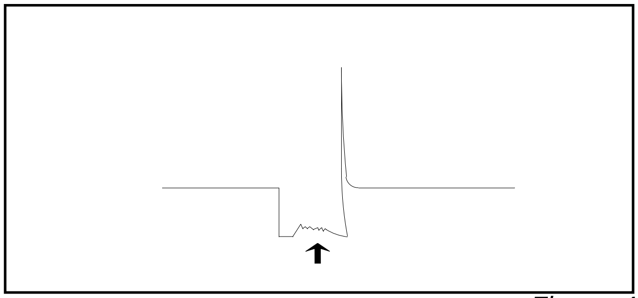
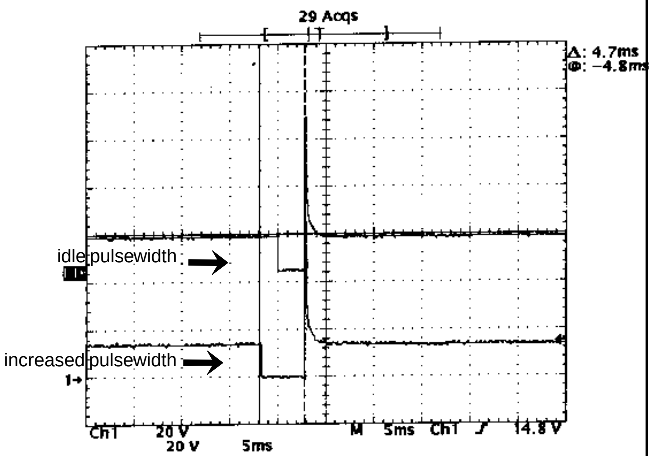


Figure 4



Injector opens sooner to increase pulse width.

Figure 5

injector pulse width that you can use as a rule of thumb to see if yours is correct. It varies from vehicle to vehicle. Figure 3a is the pulsewidth on a 1992 Taurus 3.0L. It is 5.4 ms. Figure 3b is the pulsewidth on a 1994 Dakota 5.2L. It is 3.0 ms. Figure 3c is the pulsewidth on a 1988 Ciera 3.8L. It is 4.6 ms. These were captured at idle in closed loop.

This part of the pattern should remain relatively flat, although it will have a slight upwards slope. If the on-time has an irregular shape as in figure 4, this is an indication that the driver is unable to keep the injector open. This means the PCM will have to be replaced.

Sometimes this part of the pattern may have a small square wave which we will talk about later. It is important to note that when the injector pulse width increases on PFI vehicles with saturated injectors, the on time starts sooner rather than the injector starting at the same point

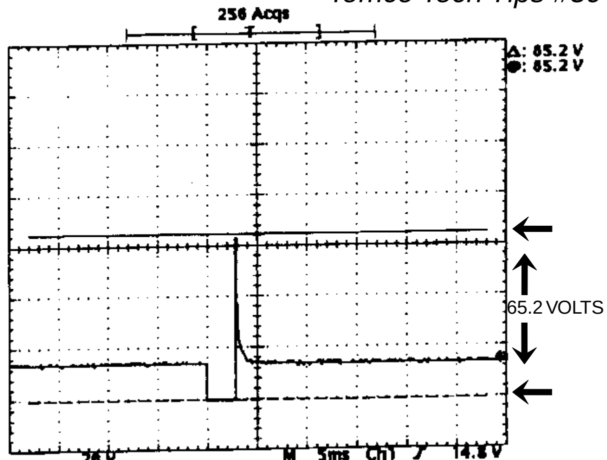


Figure 6a

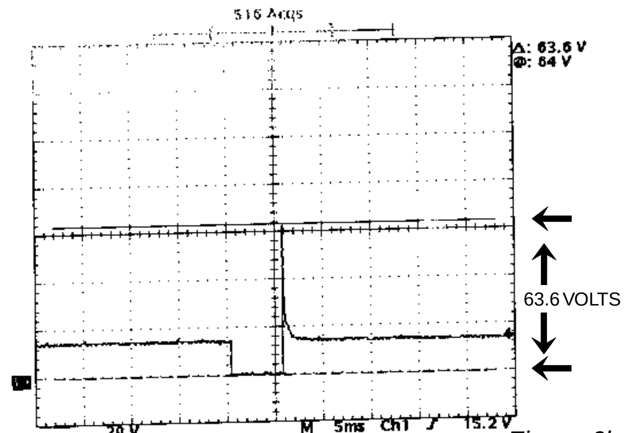


Figure 6b

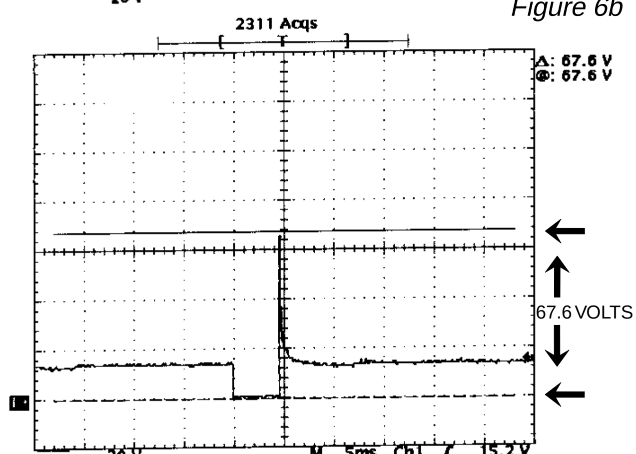


Figure 6c

and staying open longer (See figure 5). This is because the injector must be fired and the fuel delivered before a certain point in time. If the injector is just kept on longer from the same starting point, the fuel may miss or be too late for the spark event. This is called injector timing. We often think about ignition timing as being critical, but so is injector timing.

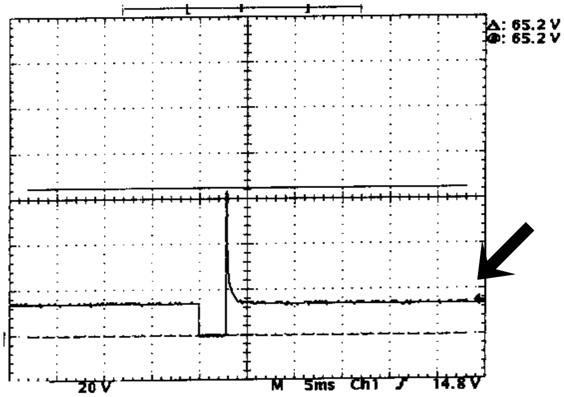


Figure 7

Point “C” (in figure 2a) is also the point at which the PCM de-energizes the injector. Point “D” in figure 2a is the spike voltage. This is a result of the injector coil being energized and then de-energized, creating an inductive kick. This spike voltage can be from 20 to 125 volts, depending on the vehicle. The spike voltage in figure 6a is from a 1994 Dakota 5.2L. As you can see, the spike voltage is 65.2 volts. Figure 6b is from a 1991 Ford Taurus 3.0L and its spike voltage is 63.6 volts. Figure 6c is from a 1988 Ciera 3.8L and its spike voltage is 67.6 volts. These spike voltages are typical of these three types of vehicles. Remember though, I have seen some GM vehicles as high as 125 volts.

This spike voltage is an important value. When an ignition coil primary is energized and then deenergized, we expect a certain amount of secondary inductive kick. If not we say the coil may be shorted. This is the same with an injector coil. When we energize the coils a magnetic field is developed. When the injector coil is deenergized that field collapses and we induce a voltage. So if we energize and then deenergize the coil we should see a certain amount of kickback voltage. If we don't, that may mean we have a problem with the injector coil. I have used the following rule of thumb with some amount of success. The spike voltage should be above 20 volts. If it is lower than 20 volts check to make sure that you have proper supply voltage and the injector is going to ground. If these are correct the injector coil is probably shorted. This is because when the injector shorts, its saturation is less and the spike voltage will be lower.

Point “E” in figure 2a is where the pattern returns to system supply voltage. The pattern will then repeat itself when the PCM turns the injector on again. In Figure #7 you can see a small hump in the return to voltage slope. This is the injector pintle closing. This appears because the magnetic filed is collapsing and the metal pintle is moving through that collapsing magnetic field. This induces a small voltage surge which is reflected in the hump. This is not readily visible in all patterns but you will see it from time to time.

Next issue we will take a look at more injector patterns.

TOMCO TI INC.