Oscilloscope basics explained

Getting to grips with some Oscilloscope terminology and basic settings will go a long way towards demystifying this essential diagnostic tool. eXponentia explains some of these basics.

The difference in using an oscilloscope and a multi-meter to measure voltage, is like trying to determine the elevation of a mountain range with high peaks and deep valleys. You could pick a few points and say that is the height, but you wouldn't see that there are peaks and valleys. With some signals, it's the peaks and valleys that you need to see. To put it simply, a multimeter takes measurements at set time intervals and reports the measured value at that point in time. An oscilloscope takes measurements at intervals that can be changed as needed, and the measurements are displayed as a graph. The end result is that if you select the correct settings the scope will show all of the peaks and valleys, allowing you to see the signal to diagnose a problem.

An example would be using a multi-meter to measure voltage from a wheel speed sensor as you rotated the wheel. You could spin the wheel forever and never be able to learn anything worthwhile. You would only read a voltage that would fluctuate without any meaning. The scope would show you the square wave pattern shown in figure 1, a scope trace.. If one of the teeth in the wheel speed sensor was damaged/missing/deformed it could be easily seen using the scope and comparing the waves to each other. The ability to see the sensor signal allows you to see if there are any peculiarities or patterns that indicate the problem being diagnosed.

Many mechanics are puzzled by the terminology when looking at which oscilloscope to buy, or when trying to use it for the first time. The main concepts/terminology to understand are:

Selecting the correct leads
Selecting the correct range
Selecting the correct time scale
Selecting a trigger

As intimidating as it sounds, a bit of explanation and experience will soon make it clear.

Correct Leads

This is just like using a multi-meter, you choose the correct probe/leads based on what you want to measure. One difference is that many scopes will adjust to accommodate the measurement being made by recognising the lead selected. The scope may anticipate that you are measuring voltage, or may switch to measuring current if a current clamp is attached.

Correct Range

This is just like using a multi-meter. If you are measuring a voltage that should be around 5 volts, selecting a range of 12 volts should show the signal clearly. Selecting a range that is too high will make the signal very flat and close to zero on the scale. You will not be able to see much, if any, detail and the actual voltage may be difficult to read from the scale. If the signal is too flat, changing the range will zoom in on the signal and allow more detail to be seen. Changing the range is like zooming in or out to either fit the signal into the window or have it fill the screen.

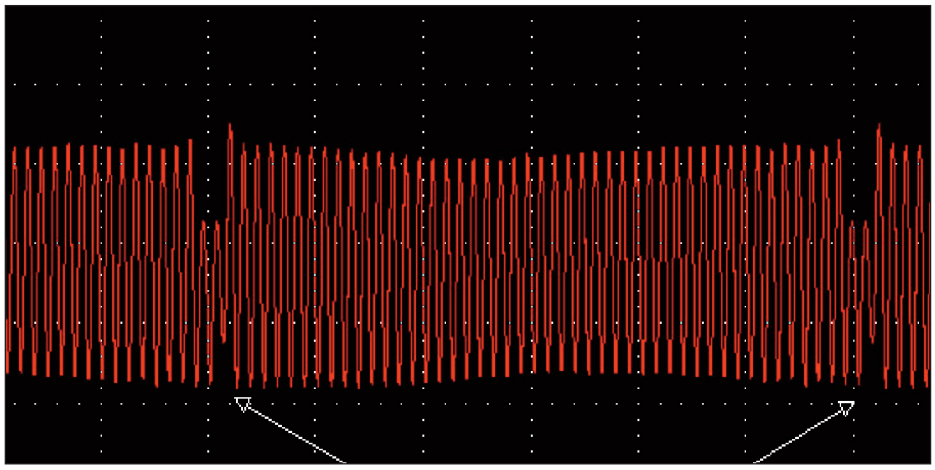

Figure 1: A typical digital wheel speed sensor signal (scope trace) of a wheel turning at a constant speed. A

Correct Time Scale

This is where the oscilloscope leaves the multi-meter behind, and makes the scope indispensable. The scope can be set to take measurements at a very high frequency. This is similar to changing the range until the signal fills the screen vertically. Changing the time scale will zoom in on the horizontal scale of the signal, allowing you to see the complete signal, in complete detail like being able to see all of the peaks and valleys in our example of the mountain range.

The ability to change the time scale means that you can see individual signals sent to an injector, or a series of signals to see if they are all consistent. Even at idle, the amount of time that it takes a 4 stroke engine to complete a cycle is less than 140 ms (0.140 seconds. The firing of a spark plug or an injector signal would be far less time than this.

Selecting a Trigger

Selecting a trigger allows the scope to display a waveform at a selected point, so that a repetitive scope trace can be shown in the same location on the screen every time. Without a trigger, each successive waveform would display randomly on the screen and you would never be able to see what was happening. A trigger can be set to detect when a specific event or threshold has been detected. Depending on what you are measuring, selecting the proper trigger will essentially freeze the waveform on the screen so you can see what each looks like.

The eXponentia Using an Oscilloscope course will give you the knowledge to better use and understand your scope, or provide you with enough information and familiarity to make the correct decisions when buying a scope.Seedetails about this course in the box below.

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