Using Mr. Pulsar™ to field calibrate the WaveRider® stray voltage monitor.

The following application note will show you how to use the Mr. Pulsar unit to field calibrate your WaveRider stray voltage monitor.

This test is not intended to replace factory calibration, but will provide adequate verification that your WaveRider monitoring unit is ready for use.

Mr. Pulsar is a trademark of Phasor Labs   www.phasorlabs.com.
WaveRider and WaveReader are trademarks of   http://www.borg.com/~svtest/strayvoltage.htm

First some basic information:

> The WaveRider records “peak” voltages, not rms. When you print data from the WaverReader software and set the output to “rms”, the unit multiplies the “peak” value by 0.707 to provide a calculated “average” rms. The WaverRider system does not measure “true” rms.
>
> The Mr. Pulsar test unit outputs a continuous “square wave” or individual “pulses” of a set duration.
>
> Your Fluke 87, 189 or other meter probably measures in “true” rms.

Sound confusing? Not really, but if you forget these differences, comparing your meter readings could be confusing.

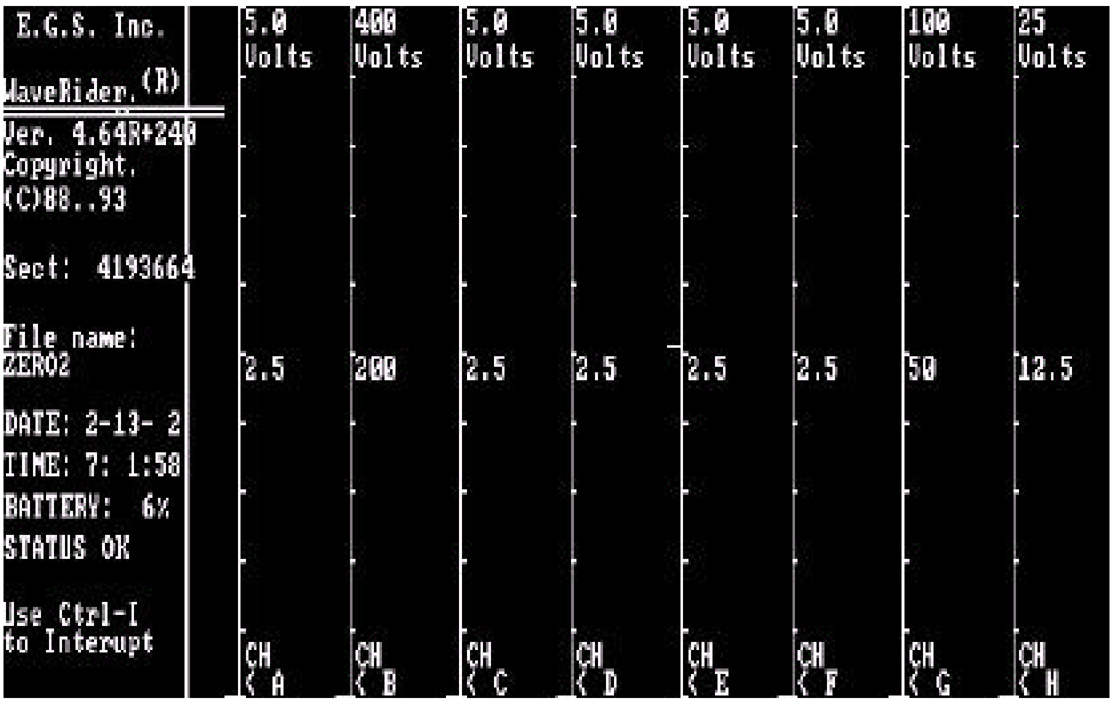
For these tests I am going to **log** WaveRider data with the WaveRider Plus version 4.64 logging software. This is an updated version of the original WaveRider software that works on the newer computers. A newer Windows version of the logging software is in testing as of February 2002.

For the **display** of logged data I am using the new WaveReader version 1.01 reader which works well on the newer computers.

If you are using the original “bar graph” logger or Grabber, the results will be the same; the computer screens will just look different.

Checking for Steady State voltages

Input a 0.060 kHz (60-Hertz) square wave from Mr. Pulsar into each channel of the WaveRider and note the value displayed on the computer. You should see approximately 2.5 volts on the computer display. Remember that the bar graph display is reading in "peak" volts. See Channel E on the computer screen below:



Mr. Pulsar's output is a square wave of 5.0 volts "peak-to-peak". When Mr. Pulsar's square wave output is read by a "true rms" voltmeter, it will read approximately 2.5 volts. When read by the WaveRider, it will read approximately 2.5 volts "peak" or 1.76 volts "rms". Why is this?

For steady state voltages with waveforms such as sine waves, square waves or other distorted waveforms, the input DC blocking capacitor in the WaveRider causes the voltage being read to average between the peak positive value and the peak negative value. This means a 5.0 volt peak to peak square wave will average such that the positive value is +2.5 volts and the negative value is –2.5 volts. Since the WaveRider actually measures the peak (either positive or negative) value it will display 2.5 volts "peak".

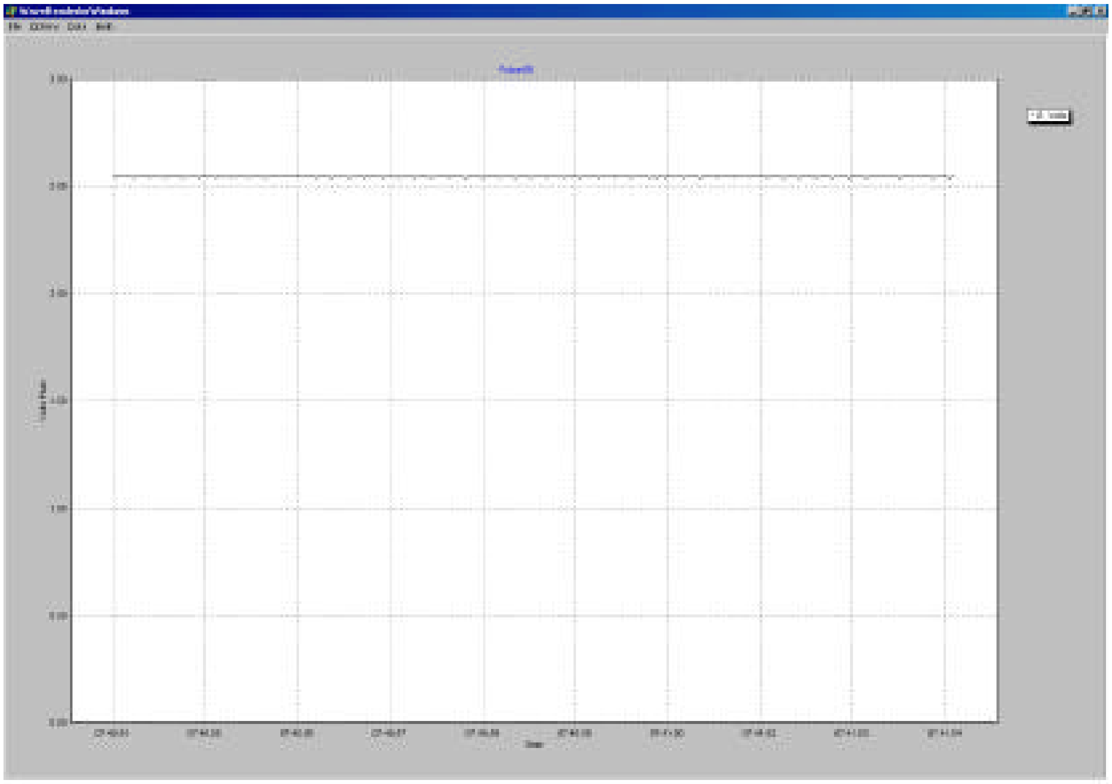
If you put a sine wave into the WaveRider with an "rms" value of 1.76 (volts as you would read on your Fluke 87), it will be displayed as 2.5 volts "peak" on the WaveRider. This is correct because the maximum positive and negative value of a 1.76 volt rms sine wave is +/- 2.5 volts. (2.5 * 0.707=1.76).

So why not use a 60 Hertz sine wave to check the steady state performance of the WaveRider? Well, you could! But the Mr. Pulsar unit only outputs a square wave and pulses. By testing with a square wave you are also checking the performance of the "true rms" section of your digital voltmeter.

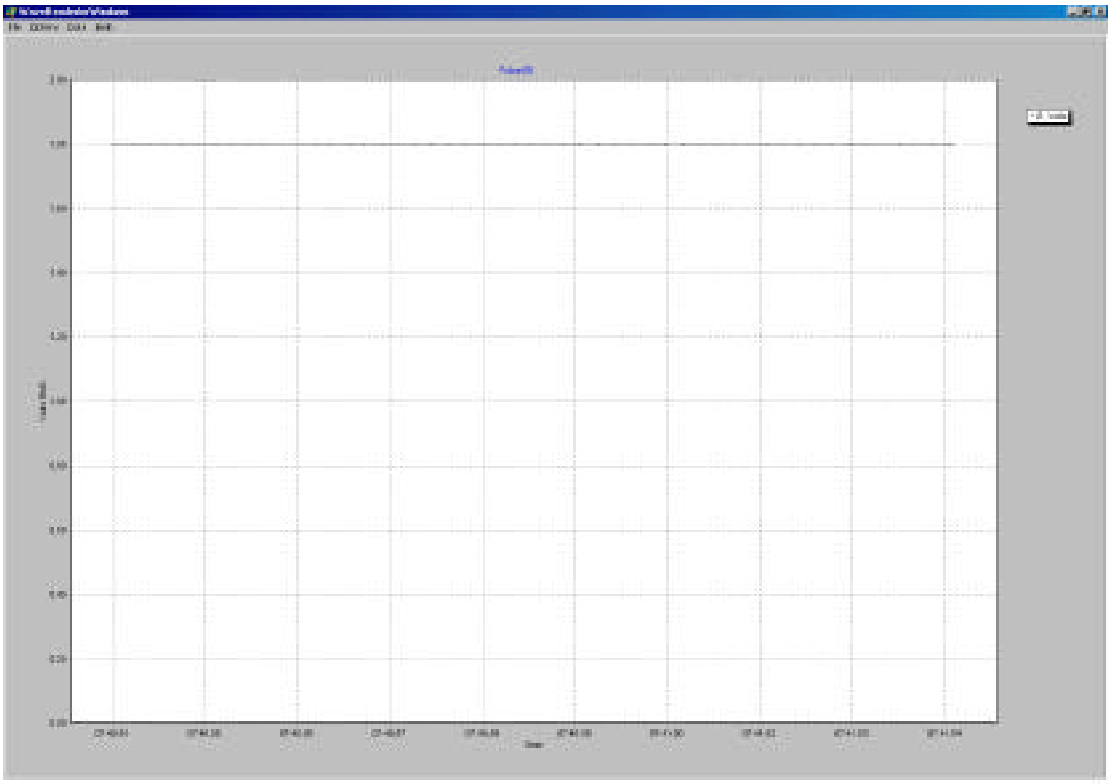
Remember that Channels B, G and H on the WaveRider are 400, 100 and 25 volts full scale so the 2.5 volt value will be hard to read on the display. You can check these values closer when you review the recorded tests on WaveREADER.

Below are four (4) computer displays using the version 1.01 WaveReader software. I measured using both 60 Hertz steady state "square" waves and 60 Hertz "sine" waves. In addition I had the WaveReader software display the recorded value in "peak" and "rms" values.

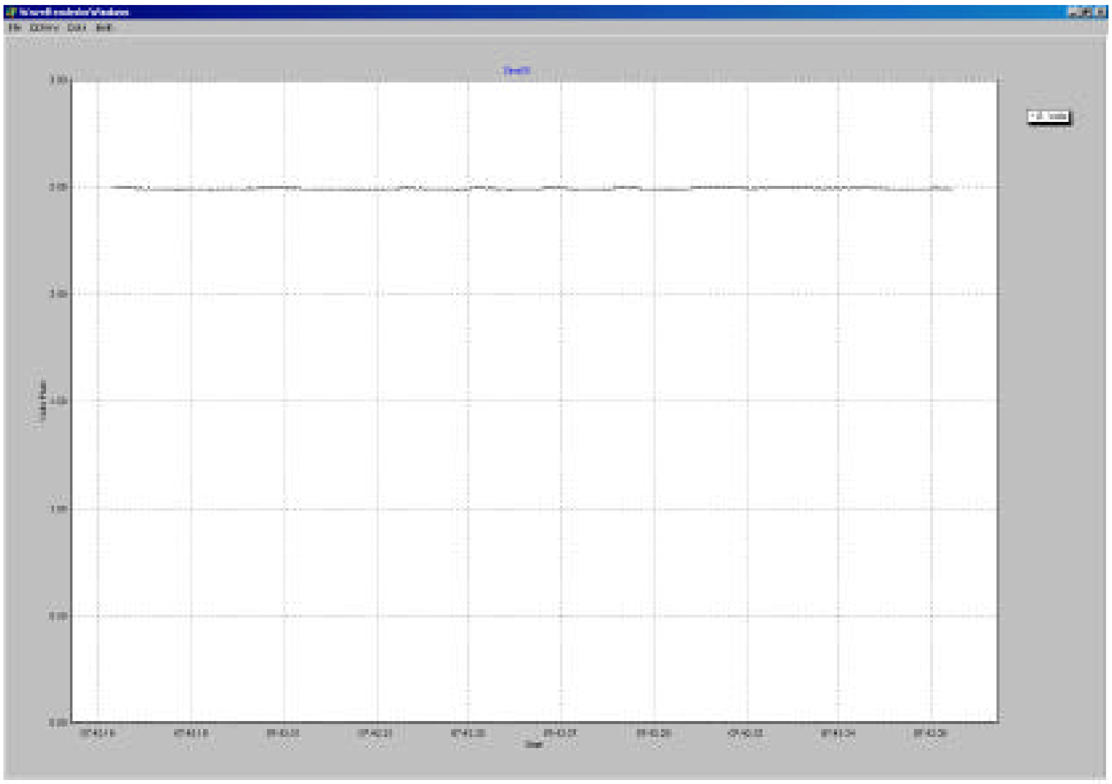
With a 60 Hertz square wave the “peak” value on the WaveRider should be approximately 2.5 volts as shown below:



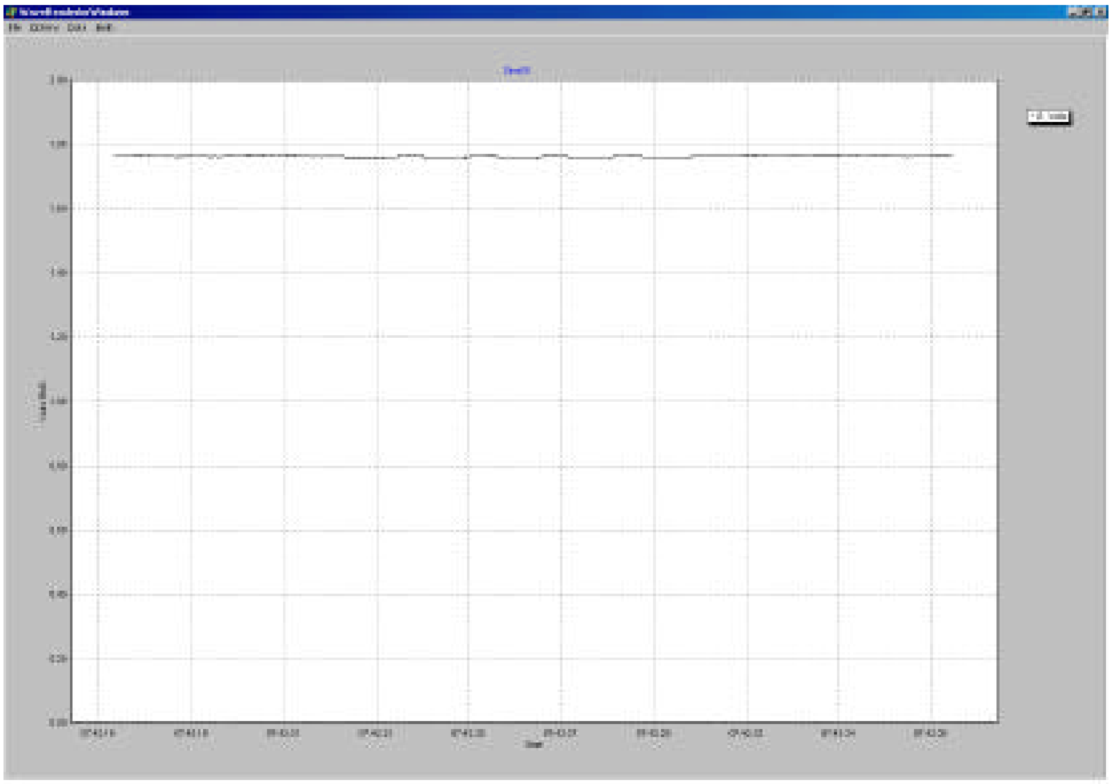
With a 60 Hertz square wave the “rms” value on the WaveRider should be approximately 1.76 volts as shown below:



With a 1.76 volt rms 60 Hertz sine wave the "peak" value on the WaveRider should be approximately 2.5 volts as shown below:



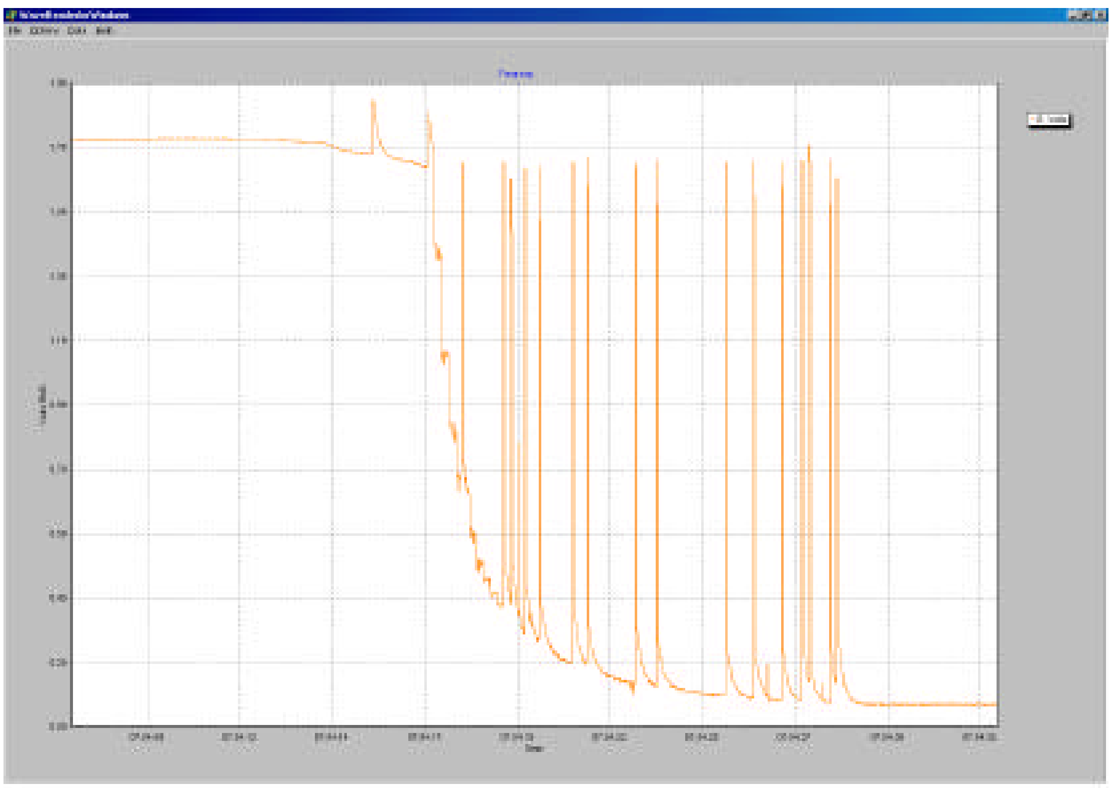
With a 1.76 volt rms 60 Hertz sine wave the “rms” value on the WaveRider should be approximately 1.76 volts as shown below:



Checking for steady state frequency response

With a steady state input of a square, sine or distorted waveform, as the "frequency" of the input increases the WaveRider's ability to measure the voltage decreases. This also happens to most hand-held digital voltmeters at about 5-20 kHz. A digital scope has a greater frequency response so the reduced sensitivity does not occur until 10,000 kHz (10 MHz) or greater.

I applied a square wave at 45 Hz to the WaveRider. Then I held the frequency "up" button on the Mr. Pulsar unit until it reached 60 kHz (60,000 Hz). At that point I used WaveReader to look at the recorded output as shown below:



If you watch the computer monitor during logging you should find that at about 4-5 kHz the WaveRider is recording about 1/2 the voltage it did at 45 Hz. The above plot shows how the sensitivity of the WaveRider decreases with frequency. The digitizer in the WaveRider reading causes the numerous "spikes" due to the leading or trailing edge of the square wave as I move through the frequency range. If I move through the frequency range of Mr. Pulsar at a slower pace, the spikes will be reduced. The above occurrence is not a problem.

Checking for impulse response

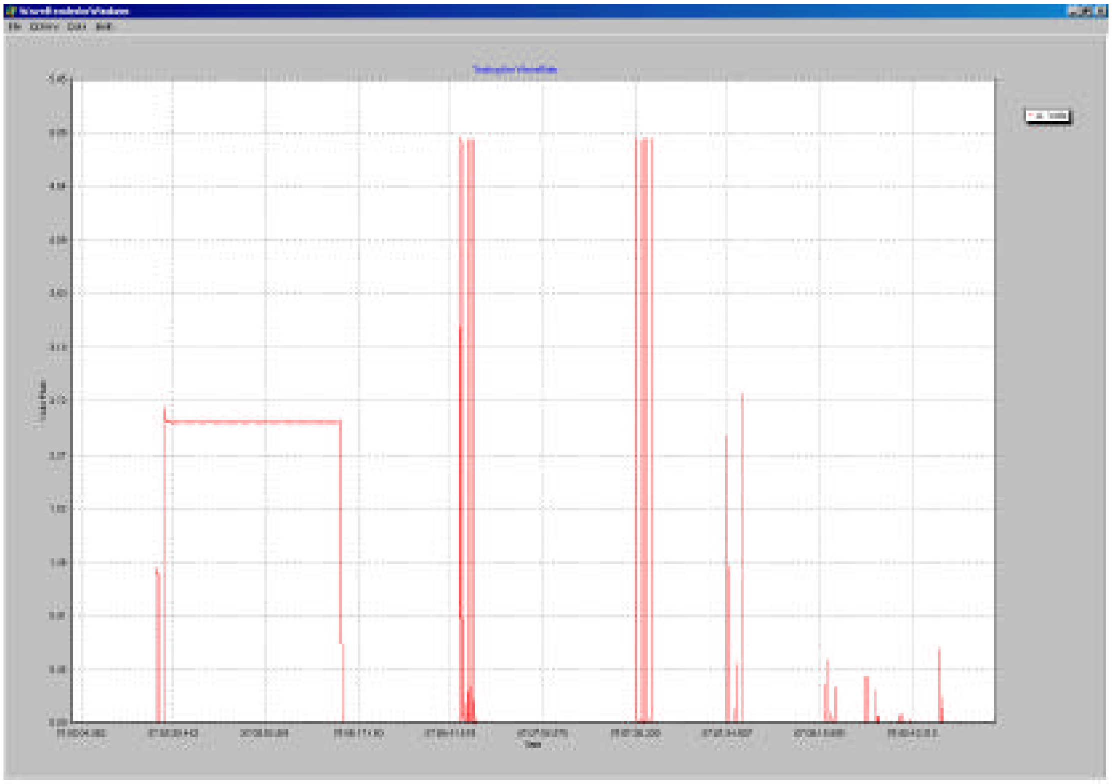
One of the nice features of the WaveRider is that in addition to steady state voltages, it can detect impulses and display "peak" values correctly.

There is a limit to how short of duration impulse can be recorded with the WaveRider. This test is designed to determine the minimum value.

Input a 0.060 kHz (60 Hertz) square wave into a channel of the WaveRider for about 5 seconds and then switch to pulse mode.

Send five (5) pulses with a 9,999 microsecond (10 millisecond) duration.
Then send five (5) pulses with a 1,000 microsecond (1.0 millisecond) duration.
Then send five (5) pulses with a 100 microsecond (0.1 millisecond) duration.
Then send five (5) pulses with a 50 microsecond (0.05 millisecond) duration.
Then send five (5) pulses with a 2 microsecond (0.002 millisecond) duration.

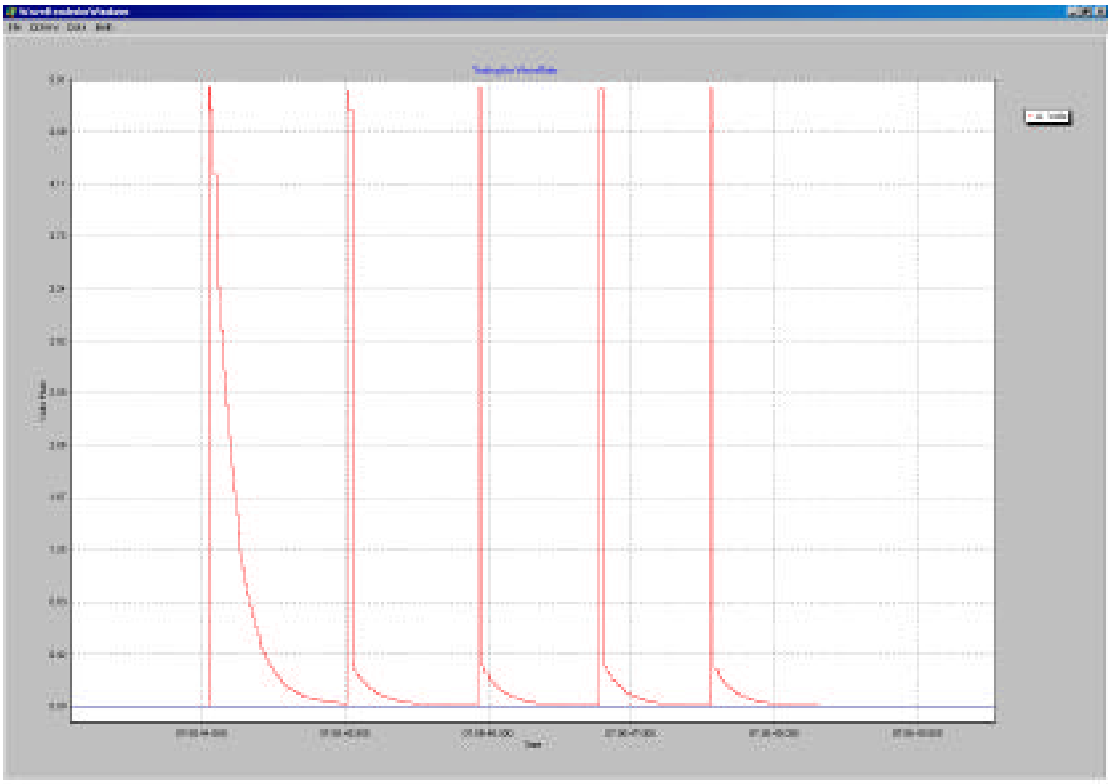
Look at the recorded data with WaveReader. The results should be similar to that shown below:



The reason the steady state 60 Hertz voltage level is lower than the pulse magnitudes is that the input DC blocking capacitor averages a steady state voltage about the zero axis, but not the short duration pulses.

The short duration pulses do not give the input blocking capacitor time to average; therefore the “peak” value of the pulse is recorded correctly.

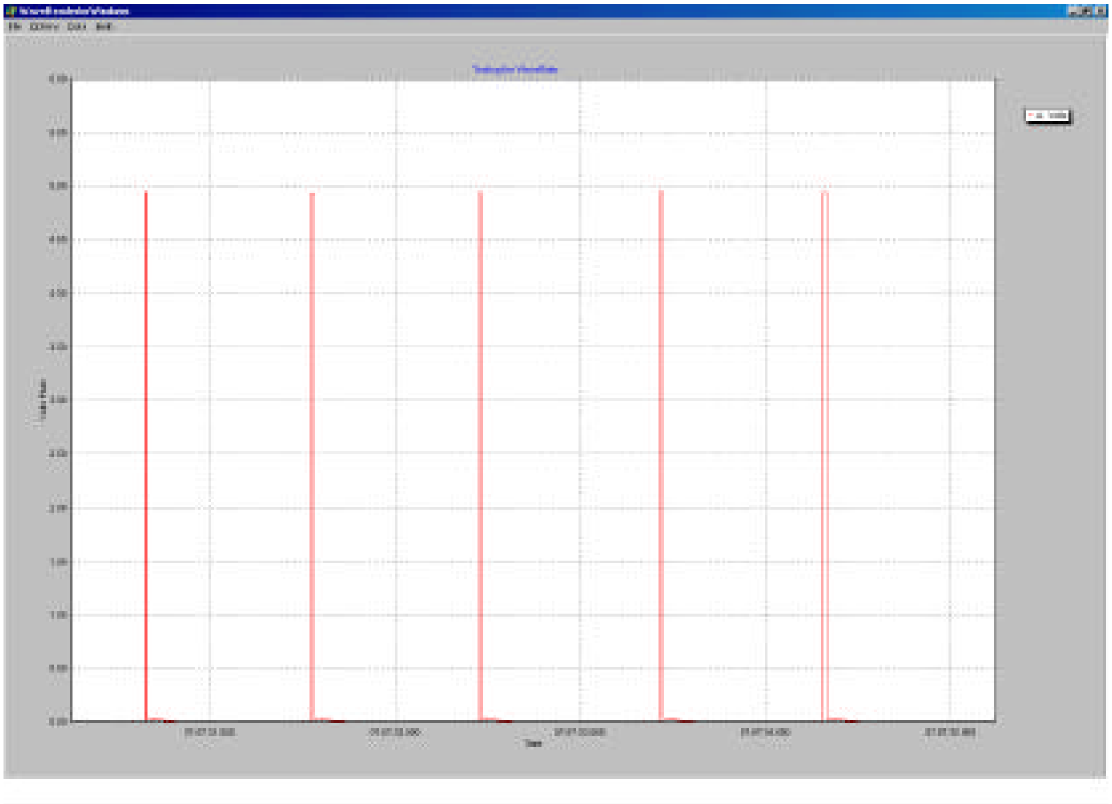
Here are the five (5) 10 millisecond pulses:



Note the slow decay of the voltage on the first pulse. This is due to the input capacitor. If I delayed sending the pulses, each pulse would have had a similar decay period. This is not important, but I just mentioned it in case you wondered.

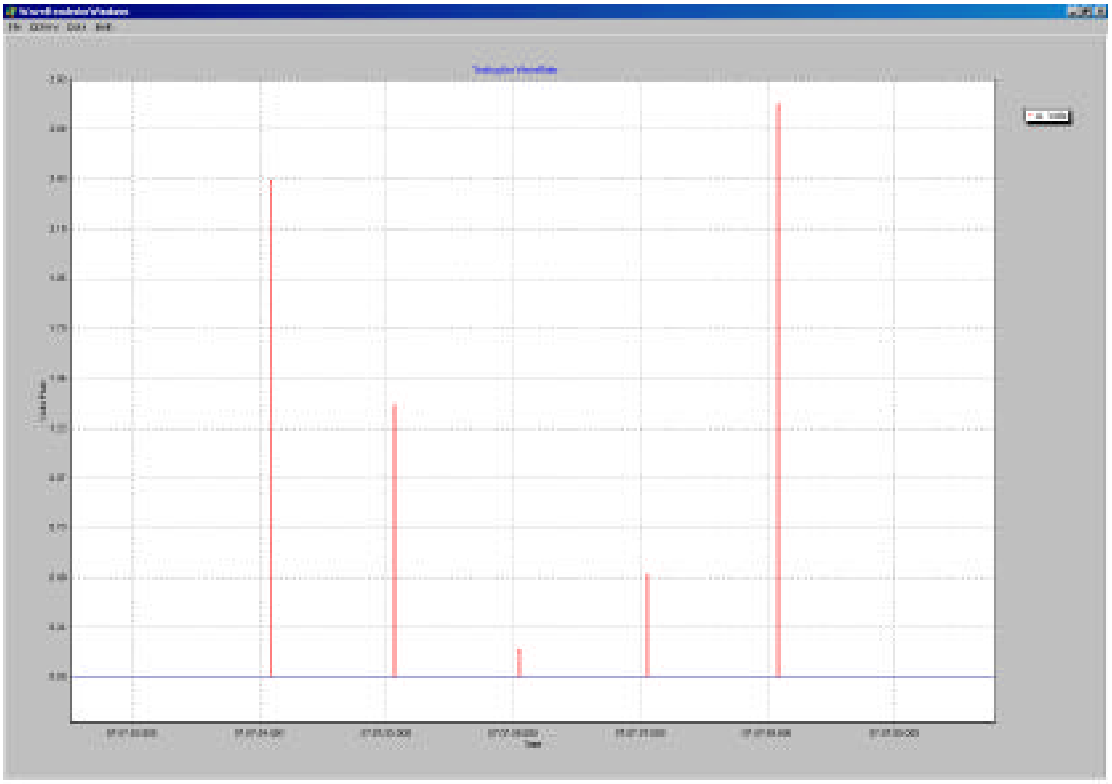
At 10 milliseconds, pulses are accurately recorded.

Here are the 1 millisecond pulses, which are looking very good:

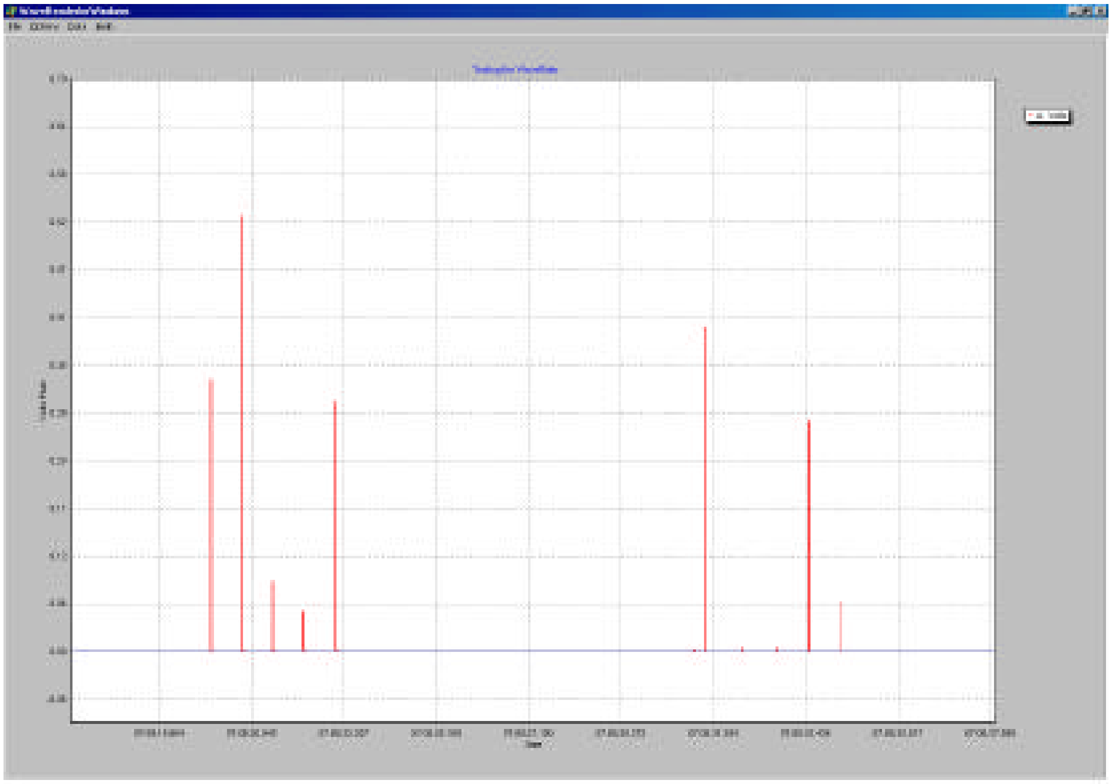


At 1 millisecond, pulses are accurately recorded.

Here are the 100 microsecond or 0.1 millisecond pulses which are starting to show the unit's upper limit:



Here are the 50 microsecond and 2 microsecond pulses which show the unit's upper limit:



Can the WaveRider be used for capturing electric fencer and cow trainer voltages?

Yes. In the case of the fencer and trainer, the voltages present are very repetitive and most of them will be recorded. Below I sent the WaveRider 50 pulses at 2 microseconds each. Note that most were captured.

If you observe these multiple events, use an oscilloscope connected directly at the cow contact points to check for fencer or trainer voltages.

A nearby or distant storm will also produce this short duration "noise".

How to get more information on Mr. Pulsar

Contact Chuck Forster at 608-835-9605 or cforster@mailbag.com. Check our website at www.phasorlabs.com.