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# Comparison of Stray Voltage Recording Devices
# Plus
# Impulse Recorder Performance Tests

This paper discusses the ability of stray voltage recording devices to provide useful data when investigating a farm or similar operation for stray electricity as it may affect animals.

The instruments reviewed were those I use or had access to for testing. This paper does not include all devices available for use in 2007.

**There are two (2) basic criteria to consider when selecting an acceptable stray voltage-recording device:**

Will the device determine if a power supplier meets the guidelines of a regulatory agency?

Will the device identify the presence of stray electricity that may be outside the scope of regulatory requirements?

**What are the guidelines of a regulatory agency?**

The typical regulatory guidelines limit the magnitude of 60 hertz alternating voltage (AC), with the magnitude stated in "rms" or "true rms" values.

The rms magnitude is normally averaged value over a specific time period. This is referred to as the "steady state" value, or the averaged value after momentary fluctuations have ceased.

Within the rms value averaged over time events such as increased stray voltage during motor starts are automatically included.

Since most recording devices have “true rms” detectors, effects of power line harmonics are also included in the averaged rms value.

**The recording devices I tested that provide adequate data to evaluate compliance with regulatory guidelines are as follows:**

Metrasonics SRV-4

PMI SV-10

WaveRider (manual averaging is required)

Fluke 189 Digital voltmeter with recording option

Each of the above instruments must be set to average the rms reading over the proper recording interval.

**The recording devices I tested that DO NOT provide adequate data to evaluate compliance with regulatory guidelines are as follows:**

Fluke 199C or any other recording oscilloscope

An oscilloscope can record data that could be analyzed by a skilled operator, but it is not the most convenient measurement technique.

**What type of stray electricity might be outside the scope of regulatory requirements?**

The most significant examples are short duration electrical events that may be measured in cow contact areas. These electrical events are referred to as impulses or transients.

The largest source of impulses on a farm is the electric fencer, followed next by the cow trainer. Hand held electric animal prods are also a source of impulses.

Electrical equipment turning on and off on the farm can create impulses.

Off-farm sources are lightning, utility electrical switching or short duration electrical events created by other customers.

Some regulatory guidelines require a brief review of short duration electrical events if the magnitude of these impulses appears excessive in a cow contact area.

**The recording devices I tested that provide adequate data to evaluate short duration electrical events are as follows:**

A Fluke 199C or any other recording oscilloscope operating in a "triggered" mode to properly record the impulse event showing BOTH magnitude in peak voltage above or below the zero axis and the duration of the electrical event. Duration refers to the time the electrical event crosses the zero axis, rises to the peak value and returns through the zero axis.

**The recording devices I tested that provide data to NOTIFY the investigator additional investigation with respect to short duration impulses may be required are as follows:**

Fluke 190 series oscilloscope using "Scope Record" recording. This unit will capture the magnitude of the shortest duration events. The data usually gives the false impression that a concern exists. It is important to properly record both the magnitude and duration of the

electrical events in a “triggered” mode to determine if they are significant.

WaveRider – This unit has a practical response level to short duration events.

Metrasonics SRV-4 or PMI SV-10 with sub-cycle recording enabled.

Fluke 189 Digital voltmeter – This unit is marginal but useful as a survey tool when investigation short duration events.

**The recording devices I tested that DO NOT provide adequate data to evaluate short duration electrical events are as follows:**

Fluke View software used with a recording oscilloscope for logging.

Fluke 190 series oscilloscope using “Trend Plot” recording.

The following data shows my recordings of short duration impulses on several instruments used for stray voltage monitoring.

Instruments examined were as follows:

Metrasonics SRV-4 Serial number 1084

PMI SV-10 Serial number 11089

WaveRider Serial number 5066

Fluke 189 Digital voltmeter with recording option

Fluke 199C Serial number DM8510273

Mr. Pulsar test unit Serial number 1014 (Impulse test generator)

Each of the above instruments where connected in parallel during the entire test. Impulse recordings were repeated for each monitoring system to allow a reasonable time to log and download the test results.

The PMI unit had a built in 500 ohm resistor, all others had normal high impedance input circuits.

A Mr. Pulsar unit was used as the test source producing a 60-hertz square wave output and short duration pulses from 0 to 5 vdc. The internal impedance of the Mr. Pulsar unit is approximately 100 ohms.

A recording sequence consisted of the following-

A period of continuous 60-hertz square wave.
5 pulses, each lasting 9999 microseconds (9.99 milliseconds)
5 pulses, each lasting 5000 microseconds (5.0 milliseconds)
5 pulses, each lasting 1000 microseconds (1 milliseconds)
5 pulses, each lasting 500 microseconds (0.5 milliseconds)
5 pulses, each lasting 100 microseconds (0.1 milliseconds)
5 pulses, each lasting 50 microseconds (0.05 milliseconds)
5 pulses, each lasting 2 microseconds (0.002 milliseconds)
A period of continuous 60-hertz square wave.

## Tests performed on a Metrasonics SRV-4 Serial number 1084

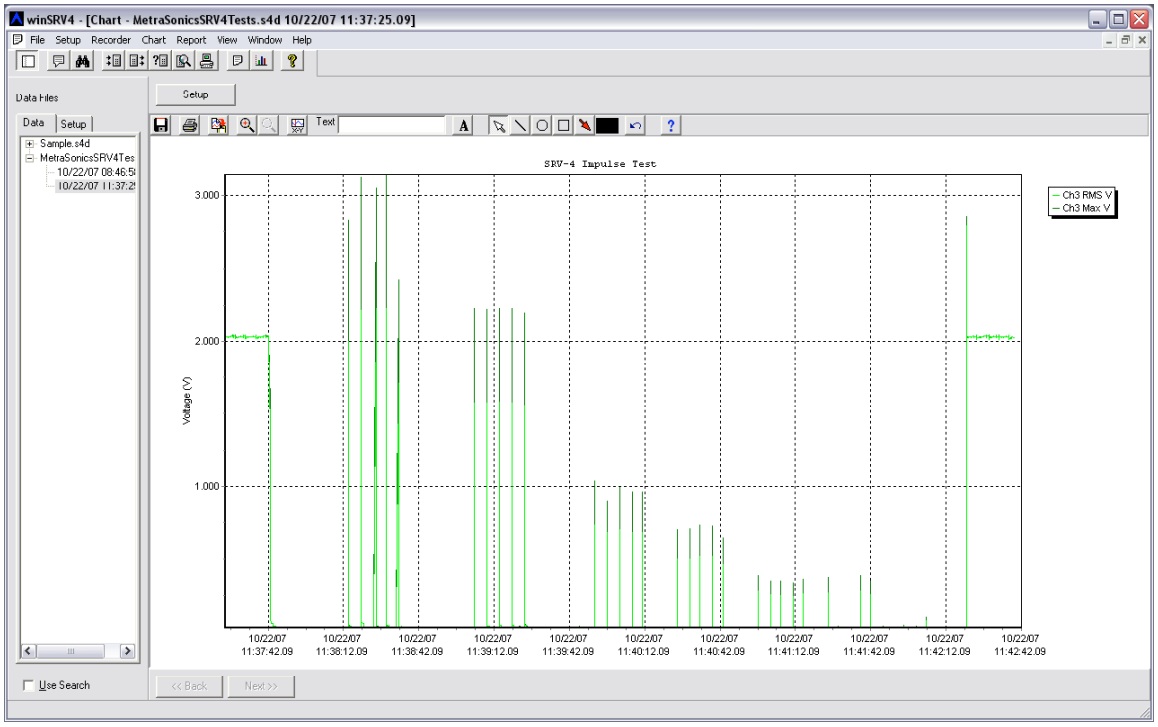
The unit was set to have a 2-cycle storage interval (16.7 milliseconds x 2).

True RMS was recorded. This is meaningful for the short period of 60-hertz square wave only.

Sub cycle event recording was enabled.

Only channel 3 (Blue channel) was enabled.

Waveform capture was not enabled.




The unit does a reasonable job of recording impulses with a duration as short as 9,999 microseconds (10 milliseconds). An expected decrease in magnitude level occurs as the duration of the impulse decreases, however impulses with a duration as low 50 microseconds (0.05 milliseconds) are recorded.

**Tests performed on a PMI SV-10 Serial number 11089**

The unit was set to have a 1 second storage interval (1,000 milliseconds).

True RMS was recorded. This is meaningful for the short period of 60-hertz square wave only.

Sub cycle event recording was enabled.

Only channel 4 (White channel) was used.

Waveform capture was not enabled


The unit does a reasonable job of recording impulses with a duration as short as 9,999 microseconds (10 milliseconds). An expected decrease in magnitude level occurs as the duration of the impulse decreases, however impulses with a duration as low 50 microseconds (0.05 milliseconds) are recorded.

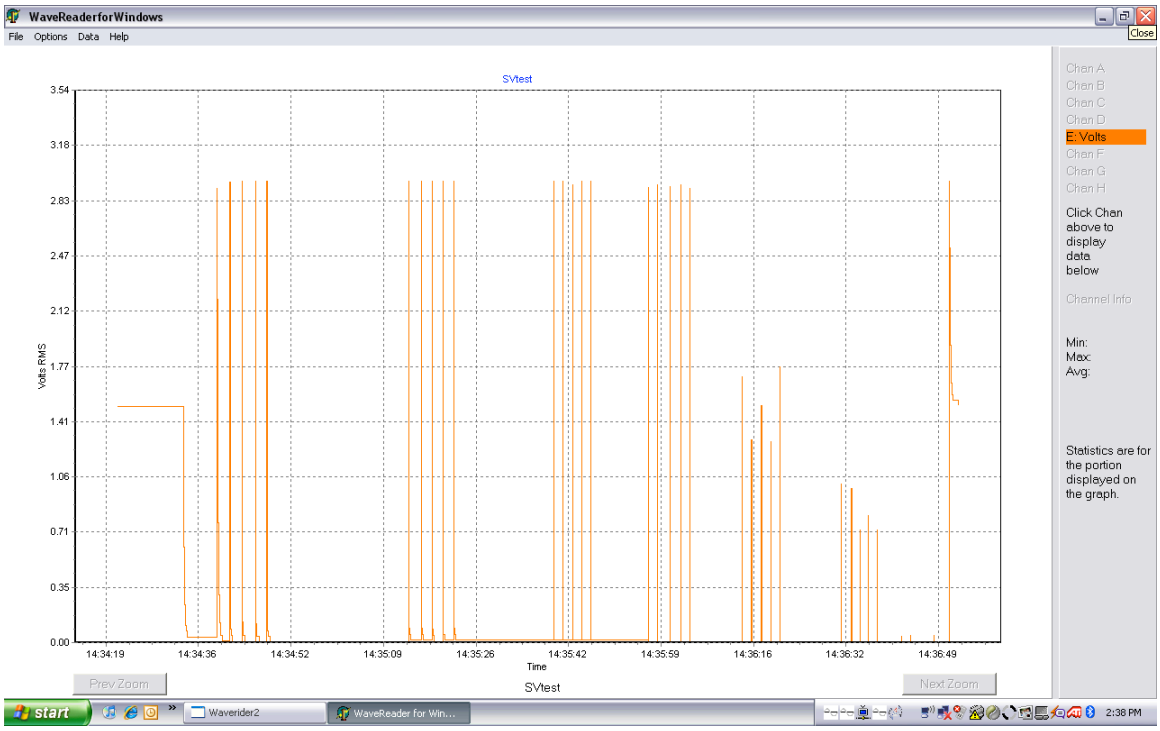
## Tests performed on a WaveRider Serial number 5066

RMS is displayed.

The unit does not record in storage intervals. It records as fast as it can capture and save data to the computer.

Only channel E was used.

Waveform capture was not available




The unit does a good job of recording impulses with a duration as short as 500 microseconds (0.5 milliseconds). An expected decrease in magnitude level occurs as the duration of the impulse decreases, however impulses with a duration as low 50 microseconds (0.05 milliseconds) are recorded.

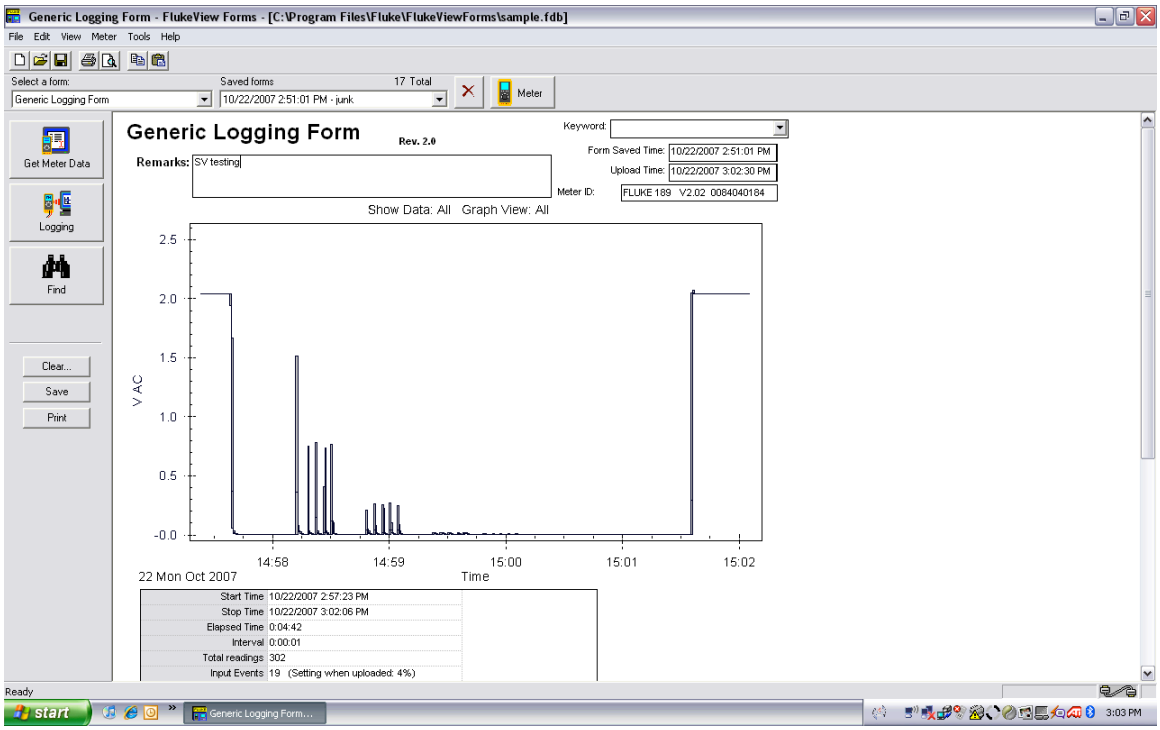
## Tests performed on a Fluke 189

The unit was set to have a 1 second storage interval (1,000 milliseconds).

True RMS was recorded. This is meaningful for the short period of 60-hertz square wave only.

Only one channel is available.

Waveform capture is not available

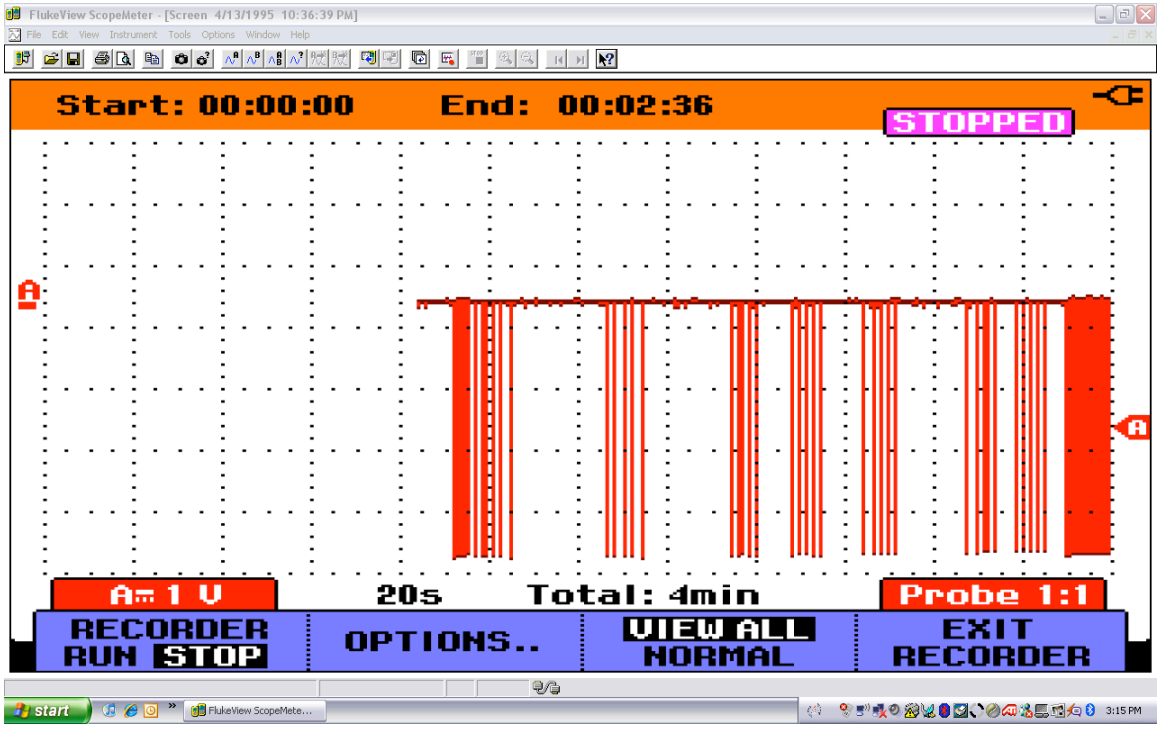



The unit does a reasonable job of recording impulses with a duration as short as 5,000 microseconds (5 milliseconds). A fast

**Tests performed on a Fluke 199C in "Scope Record Mode"**

The unit recorded the magnitude of all impulses with durations of 2 microseconds or larger.

The duration of the impulses (time between zero crossings) could not be determined when using the "Scope Record Mode".

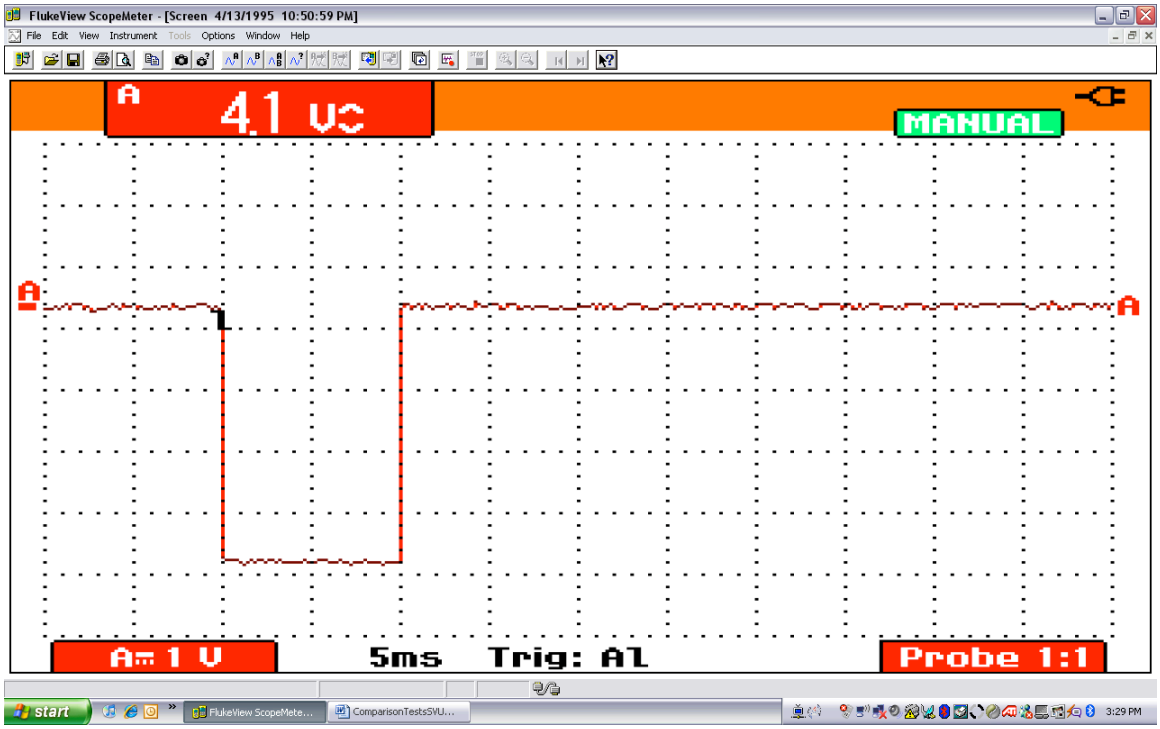


## Tests performed on a Fluke 199C in “Trigger” mode

The unit recorded the magnitude of all impulses with durations as short as 2 microseconds.

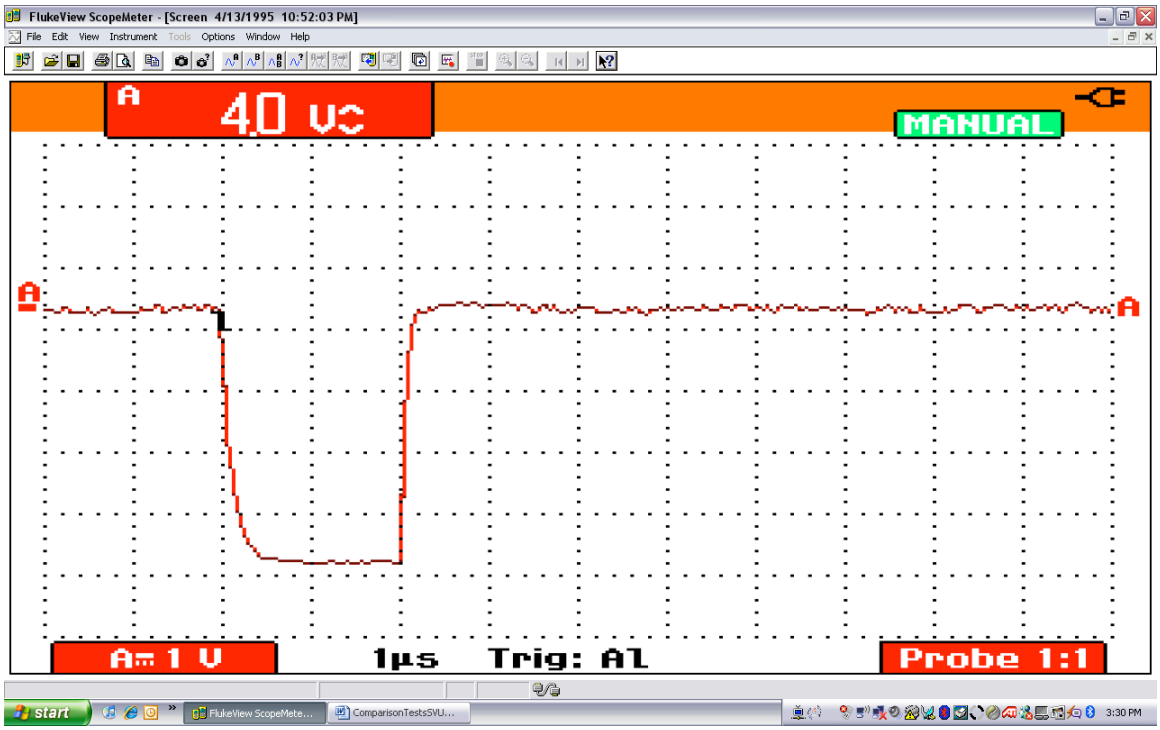
When used correctly, the magnitude and duration of the impulse can be accurately recorded.

The impulse below is a negative going impulse with a peak-to-peak amplitude of 4.1 volts and a duration of 9,999 microseconds (10 milliseconds).



## Fluke 199C in "Trigger" mode - continued

The impulse below is a negative going impulse with a peak-to-peak amplitude of 4.0 volts and a duration of 2 microseconds (0.002 milliseconds).




For additional information go to www.phasorlabs.com

The "Farmers Guide to Stray Electricity Measurements" will assist you when investigation steady-state events using the Fluke 189 recording digital voltmeter.

The file "MREC Conference 2007 - Measuring Transients" will assist you in recording short duration electrical events using a Fluke 199C oscilloscope.

**I you are planning to investigate stray voltage, I recommend that you consider the following instruments.**

For an electrician, farmer, equipment dealer or power supplier doing surveys or spot checks I recommend the Fluke 189 digital voltmeter with the optional "Fluke Forms" recording software. Estimated cost is $550.

For a power supplier that offers stray voltage investigation services, but the investigators do not have a trailer or sheltered vehicle to leave at the farm, the PMI SV-10 provides a nice solution. The Metrosonic units are similar but not being manufactured at this time. Estimated cost for a PMI SV-10 system is $4,800.

For a power supplier that offers stray voltage investigation services and has a trailer or sheltered vehicle to leave at the farm, the WaveRider unit provides more detailed analysis information than other recorders. Estimated cost for a WaveRider system is $4,000. A Windows computer is also required to operate the WaveRider system.

For a power supplier I recommend the use of a Fluke 190 series or Tektronix 720-730 series digital oscilloscope. This will allow proper evaluation of short duration electrical events. In addition, I recommend the use of Metratek "Waveform Manager software. This software allows capturing short duration electrical events and a single program works with many oscilloscope units. Estimated cost for the oscilloscope is $3,000 to $3,500. Waveform manager software is less than $300.

Obtain equipment information at:
http://www.fluke.com/
http://www.tek.com/
http://www.metratek.com/
http://www.powermonitors.com/
http://www.strayvoltagetesting.com/
http://www.phasorlabs.com/