

# CowContact<sup>tm</sup>

Volume 2002 Issue G

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## **If you use FLUKE<sup>®</sup> ScopeMeters and FlukeView logging software.....**

FLUKE<sup>®</sup> ScopeMeters and FlukeView logging software provide a powerful means of recording electrical events.

In the “Do it Yourself” series I am preparing using the FLUKE Model 189 recording digital voltmeter you will be able to obtain a great deal of useful data at a relatively low cost. An oscilloscope provides additional information that can be used for detailed diagnosis, but at a higher cost and more complexity for the average person.

Like any good recording system, if operated outside of the conditions planned by the manufacture, the data recorded can be in error.

I discovered that the FLUKE<sup>®</sup> ScopeMeter and FlukeView logging software can, under certain settings, report electrical events that did not exist at the measurement points. The engineers at FLUKE were very helpful and confirmed that this situation could exist. I am attaching a white paper from the engineers at FLUKE discussing my concern.

The error seems to occur when the ScopeMeter horizontal sweep speed is slow relative to the duration of impulse events. At every farm site there are numerous short duration impulses. An example used in the FLUKE paper is a 2-microsecond impulse or series of impulses, which can be reported as a constant voltage for periods much greater than the duration of each impulse.

*The duration (time between zero voltage crossings) of each impulse is important for stray voltage analysis.*

This situation came to my attention after several people using the ScopeMeter and FlukeView logging software reported sustained voltages of relatively high magnitude. When other meters and recording systems were used, the reported voltages could not be observed. There had to be a logical reason.

On every farm there are numerous bursts of “noise” or electrical events that consist of multiple impulses of very short duration. The shortest duration impulses are normally the largest in magnitude. This burst of impulses may not affect the dairy animal, but will be confusing to the ScopeMeter and FlukeView logging software.

**If the ScopeMeter sweep speed is set so the farm owner can watch the Scope screen and compare it to the FlukeView computer screen, the sweep speed will inherently be too slow. The FlukeView software will show a long duration electrical event when only a short duration impulse occurred.**

**The first paper I am including is from the FLUKE Corporation engineers and is reprinted with their permission.**

**The second paper is the experiment that I prepared to demonstrate the condition that can result in inaccurate data recordings.**

**Used properly, the ScopeMeter and FlukeView logging software can be a powerful survey tool for stray voltage. It is important that the system be used properly.**

Please see the liability disclaimer at the end of Volume 2001 Issue B.

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Fluke products can be viewed at [www.fluke.com](http://www.fluke.com)

Mr. Pulsar can be viewed at [www.phasorlabs.com](http://www.phasorlabs.com)



## ScopeMeter Tools to Capture and Log Stray Voltages or Impulses:

Certain electrical circumstance or applications require that you capture and log impulses or transients for further study. Impulses are typically random, short duration electrical events that can cause disturbances in electrical systems. While many different meters and even specific functions within meters can capture and log data, not all these functions are able to accurately and consistently capture these unknown impulses.

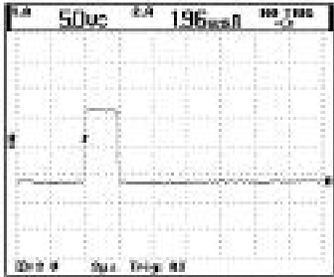
When using the ScopeMeter to address this task, we'll use a simulated impulse to highlight the correct use and setup of the ScopeMeter. For this example we'll use a 2 us Impulse randomly generated.

### What functions are available?

The ScopeMeter by its design includes many functions, those pertinent to capturing or measuring impulses are Oscilloscope, Multi-Meter, or a built in Recorder.

### Oscilloscope:

As an oscilloscope, the ScopeMeter dissects an unknown input signal into as many segments as there is enough memory. These segments are digitized or converted from an unknown analog voltage to a known digital quantity that can be stored and used to eventually plot the trace on the display. The objective being to segment or sample the unknown input with as many samples as possible to accurately re-produce the waveform on the display.

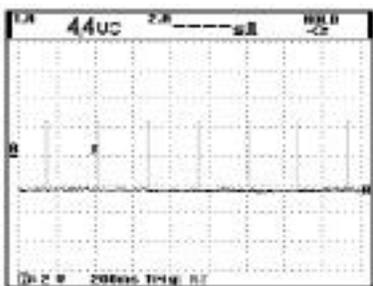


Waveform of a typical impulse, simulated using a function generator.

In this mode the ScopeMeter utilizes a fast acquisition memory of 1000 sample points. A memory depth of 1000 samples will display a trace for duration of 50 nano seconds (5ns/division) to as long as 50 seconds. Typically the oscilloscope mode would be used to view individual cycles of fast signals but over a short periods of time. This mode could be useful for viewing impulses if you are only interested in seeing the pulse occur once, over a very short period of time (nano-seconds to milli-seconds duration).

In Oscilloscope mode, you can apply automated readings to quantify waveform parameters like pulse width or peak voltage. Using waveform readings to measure impulses is probably not an ideal method due to the measurement update rate. While the waveform is being updated many times per second, in order to view the input signal as real time as possible, the automated waveform measurement takes second precedence only being updated approximately 2 times per second. When capturing repetitive impulses a possibility exists that you may not update the measurement when an impulse is displayed on screen. Therefore relying on a measured value to indicate the extent of impulses could lead to in-consistent conclusions.

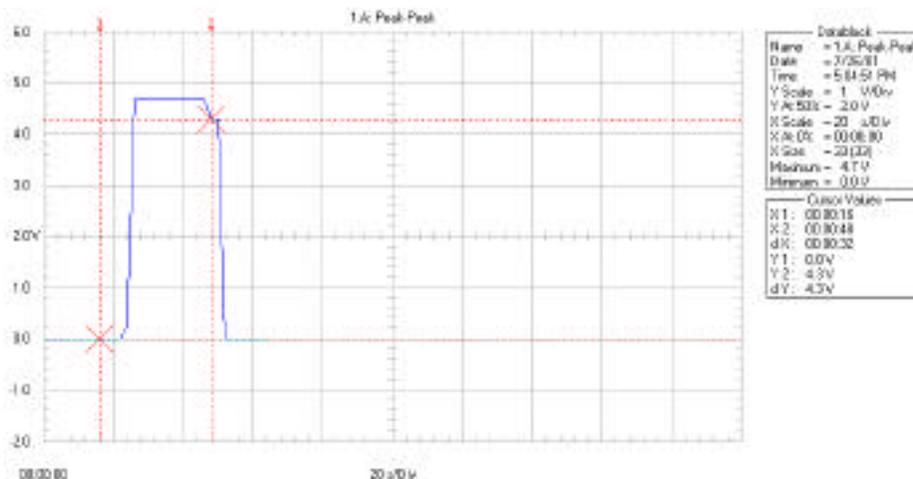
An interesting note to point out is when there is a need to capture or log data to a PC for later analysis some limitations exist. When using FlukeView to log or transfer measurements or waveforms from the ScopeMeter, dependant on the logging interval, the resultant display could show the presence or even the lack of events that may not necessarily be reflective of the actual input signal.



2 us pulses occurring every 240 ms at ~4 V pk-pk

Because the measured value is based on the entire 1000 point acquisition memory, and not the individual events, when you log a measured value to the PC once every 2 seconds for example, the resultant graph could indicate that there is an impulse with a long duration.

Consider the example of 2 microsecond pulse 240 milli-seconds apart, which with an automated volt peak to peak oscilloscope measurement, will always display a measured pk-pk voltage of approximately 4.4 volts. When this value is sent to and graphed on the PC, the resultant trend line on the graph is an image that appears to show a very long impulse.

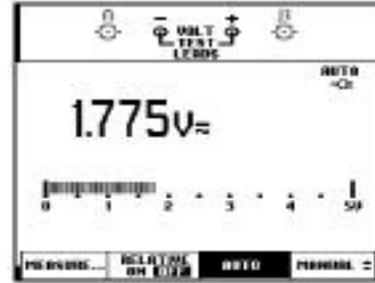


The measurements in the oscilloscope screen capture above logged to a pc every 2 seconds, results in a graph showing a 4 V pk-pk pulse occurring for approximately 20 seconds.

To conclude, as an oscilloscope, you can see the instantaneous impulses with high resolution but relying on logging the automated measurement with software to a PC, to quantify or analyze the impulse could lead to an incorrect assessment.

## As a Multi-Meter

When using the ScopeMeter in the Multi-Meter mode, one limiting factor to immediately consider is input bandwidth. For the ScopeMeter, meter input has a bandwidth of dc-10kHz or in terms of the pulse width, the amplitude of an impulse will rapidly start to attenuate or “roll off” when faster than 100 microseconds. Also the meter’s sample and display update rate will greatly effect its ability to capture and display random generated impulses.



Let’s say under ideal circumstances, the meter’s sample and display rate is fast enough that it can display random impulses of faster than 2 microseconds. The numerical digits on the digital readout would change so rapidly you would not be able to read the value of an instantaneous impulse as it occurred. Therefore dependant on the conversion technique used, multimeters today will sample the input at a higher rate. Through various algorithms the meter will then display the resultant at a rate which will enable the eye to read each updated value. Along with these processing algorithms, some meters will have a specific mode that captures and stores these impulses to a min or max memory to be recalled and displayed after the fact. In this case the bandwidth and minimum impulse width still need to be considered.

In conclusion, the best a meter can indicate is that an impulse of  $x$  Vrms occurred sometime in a past period of time, unless the DMM has built in functions to specifically capture impulses or events. Be sure to check the DMM sampling and input specifications exceed the impulse characteristics. The ScopeMeter in meter mode or a DMM does not indicate the time width of the impulse or the exact amplitude of each impulse. The meter readout is typically based on a number of sample values accumulated and averaged over some time period.

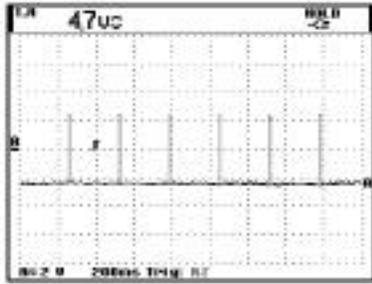
## As a Recorder;

The ScopeMeter has a unique mode whereby it can operate as a paperless recorder. This paperless recorder operates in two modes, Trendplot or ScopeRecord. In either mode the ScopeMeter will accumulate sample points to additional memory. The deeper the memory, the more sample points (higher resolution) and the longer the record length can be stored and displayed.



TrendPlot recorder will accumulate into deep memory (13500 points) numerical values from either the Automatic Oscilloscope or Multimeter measurements that are then graphically plotted showing a “trend” line on the display. In ScopeRecord mode, high-resolution waveform sample points accumulated from the fast A to D converter are stored to deep memory (27500 points) to be graphically plotted over time.

Since in Trendplot mode the trend-line is based on either meter or oscilloscope measurements, for the reasons stated above, this method should not be used to display input impulses over time.

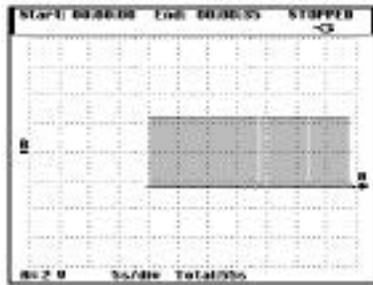


2 microsecond repetitive impulses.

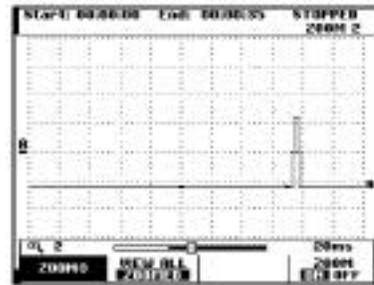
In ScopeRecord mode, since we are accumulating to deep memory the high-resolution sample data points representing the unknown input signal, we can capture, store and display impulses over a long time span. The following example shows a 2-microsecond impulse occurring repetitively.

In a real world scenario, since we are sampling the unknown input at a rate of 20 MSa/s or once per 50 nano second, the resultant display would represent the actual random nature of the impulses or stray signals with changes in amplitude and time.

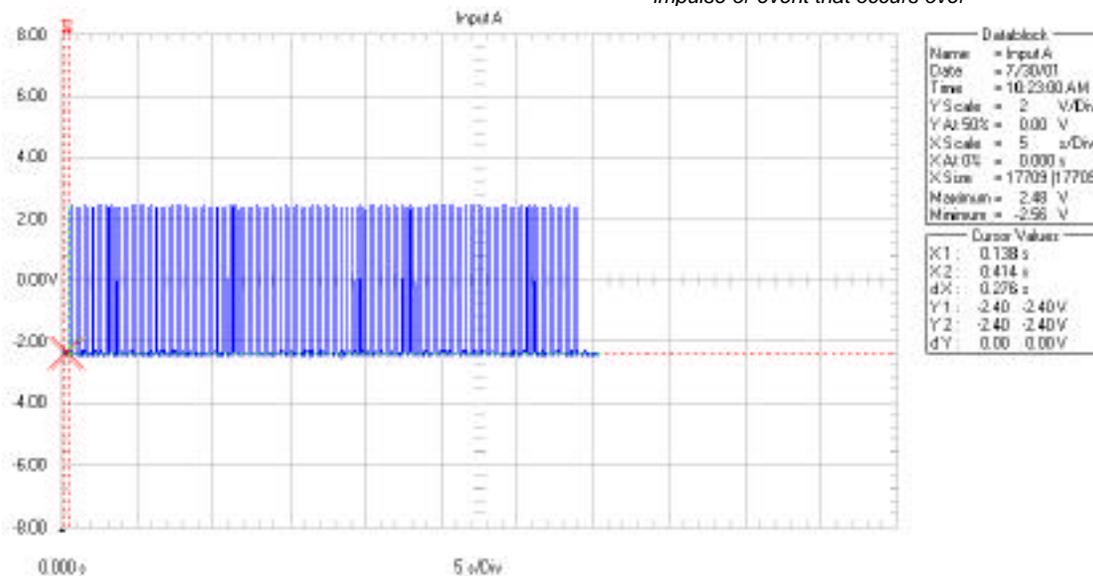
Once these samples have been acquired and stored to the ScopeMeter's internal memories you can at a later stage import these data points to a PC for analysis or documentation.



High resolution sample points plotted at 5s per division



With high resolution sample points you can "zoom" into the waveform thereby analyze each individual impulse or event that occurs over



Once sample points are acquired and stored internal to the ScopeMeter they can be imported into a PC (FlukeView for ScopeMeter) to be used for later analysis or documentation.

To conclude, unless you are sampling the unknown input at fast rates, at least fast enough to acquire high speed impulses and transients, as well as accumulate and display these over time, there is very little that can be derived about the nature or extent of impulses or stray voltages. The best method of acquiring these samples is to use a high-resolution recording system that can accumulate accurate high-resolution data over time.

## Testing the limits of the Fluke 123 & FlukeView 3.0

These application notes are designed to explore the limits of your electronic equipment and systems. This time we will experiment with the Fluke 123 Scopemeter™ and Fluke View Version 3.0™ recording software.

Our experiment will test the instrument on its ability to record short duration impulses that occur at a random rate. For any digital recording instrument there is a point at which a non-repetitive impulse will not register on the unit in a reliable manner. This point depends upon the sweep speed setting (horizontal axis) and the length of the impulse (duration).

It is important that you are familiar with the scopemeter and its functions. Here is a photo of the front of the unit.

The next step is to make sure the unit has ALL the settings in a known state. Sometimes settings made for past measurements will remain in the instrument, adding confusion for future measurements.



After turning on the unit, push the **Channel A V-Hz-A-ohms-Cap** button.

Select the one option noted below:

VAC	
VDC	
VAC+DC	
dB	
OHM	
CONTINUITY	
DIODE	
CAP	
Hz	
AMPERE PROBE 0.1 mV/A	
AMPERE PROBE 1 mV/A	
AMPERE PROBE 10 mV/A	
AMPERE PROBE 100 mV/A	
AMPERE PROBE 1 V/A	
AMPERE PROBE 10 mV/mA	
PROBE TYPE AMP AC	
PROBE TYPE AMP DC	
PROBE TYPE AMP AC+DC	
TEMPERATURE 1 mV/deg C	
TEMPERATURE 1 mV/deg F	
PEAK MAXIMUM	
PEAK TO PEAK	<b>select</b>
PEAK MINIMUM	
DUTY CYCLE POSITIVE	
DUTY CYCLE NEGATIVE	
PULSE WIDTH POSITIVE	
PULSE WIDTH NEGATIVE	
CREST	
PHASE	



Push F1 for METER OPTIONS

Select the options noted below:

COUPLING AC+DC	<b>select</b>
COUPLING AC ONLY	
SMOOTHING FAST	<b>select</b>
SMOOTHING NORMAL	
SMOOTHING SMOOTH	
ZERO REF OFF	<b>select</b>
ZERO REF ON	

Push F2 for TREND PLOT options

Select the options noted below:

TREND OFF (F1)	<b>select</b>
TREND RESTART(F2)	n/a
MIN/MAX AVERAGE (F3)	n/a
CONTRAST (F4)	n/a

Push the **SCOPE MENU** button

Select the options noted below:

INPUT A - DC	<b>select</b>
INPUT A - AC	
INPUT A NORMAL	<b>select</b>
INPUT A INVERT	
INPUT B - DC	<b>select</b>
INPUT B - AC	
INPUT B NORMAL	
INPUT B INVERT	
INPUT B OFF	<b>select</b>



Push F1 for Scope Options

SCOPE MODE NORMAL	<b>select</b>
SCOPE MODE SINGLE SHOT	
SCOPE MODE ROLL	
WAVEFORM MODE NORMAL	<b>select</b>
WAVEFORM MODE SMOOTH	
WAVEFORM MODE ENVELOPE	

Push F2 for PROBES

Push ENTER to set up probes on A

PROBE ON A 1:1 LEADS	<b>select</b>
PROBE ON A 10:1 V	
PROBE ON A 20:1 V	
PROBE ON A 100:1 V	
PROBE ON A 200:1 V	
PROBE ON A 1,000:1 LEADS	
PROBE ON A 0.1 mV/A	
PROBE ON A 1 mV/A	
PROBE ON A 10 mV/A	
PROBE ON A 100 mV/A	
PROBE ON A 1 V/A	
PROBE ON A 10 mV/mA	
PROBE ON A 1mV/deg C	
PROBE ON A 1mV/deg F	

Repeat for PROBES on Ch B if B is used:

PROBE ON B 1:1 LEADS	n/a
PROBE ON B 10:1 V	n/a
PROBE ON B 20:1 V	n/a
PROBE ON B 100:1 V	n/a
PROBE ON B 200:1 V	n/a
PROBE ON B 1,000:1 LEADS	n/a
PROBE ON B 0.1 mV/A	n/a
PROBE ON B 1 mV/A	n/a
PROBE ON B 10 mV/A	n/a
PROBE ON B 100 mV/A	n/a
PROBE ON B 1 V/A	n/a
PROBE ON B 10 mV/mA	n/a
PROBE ON B 1mV/deg C	n/a
PROBE ON B 1mV/deg F	n/a

Push the **SCOPE MENU** button

Push F2 for PROBES

Select PROBE AC ADJUST.....

PROBE AC ADJUST=NO ADJUST	select
PROBE AC ADJUST=ADJ 10:1 PROBE	

Push the **SCOPE MENU** button

Push F3 for TRIGGER

INPUT A	select
INPUT B	
EXT	
VIDEO ON A	
SCREEN UPDATE=FREE RUN	select
SCREEN UPDATE=ON TRIG	
AUTO RANGE=>15 Hz	select
AUTO RANGE=>1 Hz	

Push the **USER OPTIONS**

Select GRID TYPE ...

GRID TYPE=LINES	select
GRID TYPE=DOT	
GRID TYPE=NO GRID	

Push the **USER OPTIONS**

Select DATE ADJUST ...

SET the DATE	set
SET the FORMAT	set

Push the **USER OPTIONS**

Select DATE ADJUST ...

SET the TIME	set
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Push the **USER OPTIONS**

Select AUTOSET ADJUST ...

SIGNAL>15 Hz	select
SIGNAL>1 Hz	
COUPLING	
SET TO DC	select
UNCHANGED	

Push the **USER OPTIONS**

Select POWER DOWN ...

POWERDOWN

AFTER 5 MINUTES	
AFTER 30 MINUTES	
NEVER	select

Push the **USER OPTIONS**

Push F3 for VERSION & CAL...

MODEL NUMBER	123	varies
SOFTWARE VERSION	V01.04	varies
CAL NUMBER	#1	varies
CAL DATE	3/17/99	varies
BATTERY REFRESH DATE	3/17/99	varies

Push the **SAVE/PRINT**

Make any setting you wish or none



Next we need to set the trigger level and polarity

Go back to the main menu, turn off the scope if necessary

Push mV/V to obtain 2 V/d on the Channel A gain setting



Push TIME to obtain 2 s/d on the Channel A sweep setting



Push F1 A MOVE

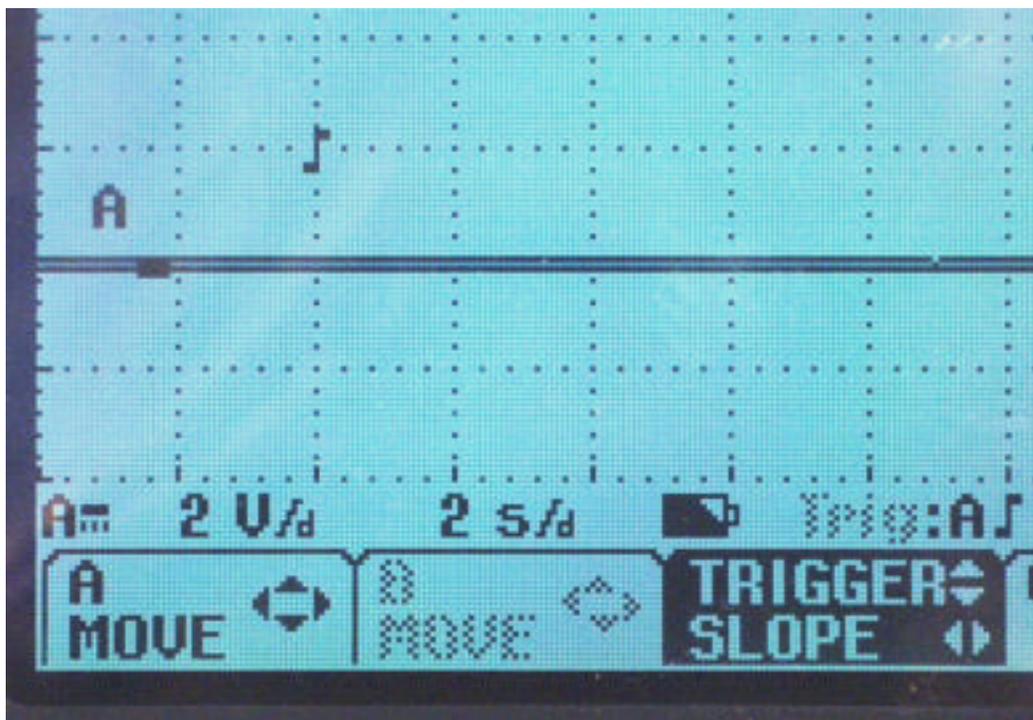
Use vertical cursors to place horiz. axis 2 divisions up

Push F3 TRIGGER/SLOPE

Use horizontal cursors to select positive rising trigger

Use vertical cursors to set trigger 3 divisions up

Scope screen should look the same as the view below:



**Mr. Pulsar™**

Pulse Mode  
W=0002 MicroSec

< Power

[www.forstereng.com](http://www.forstereng.com)



**Phasor Labs**

Oregon, WI

Single pulse - 2  $\mu$ sec to 10 msec  
Square wave - 45 Hz to 60 kHz  
Output - 5.0 volts p-p maximum



Mode



Up



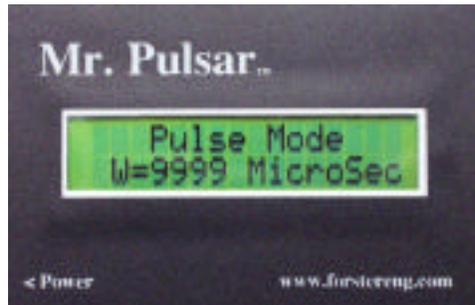
Down



Fire

Specialized Function Generator

Set Mr. Pulsar™ as shown below:

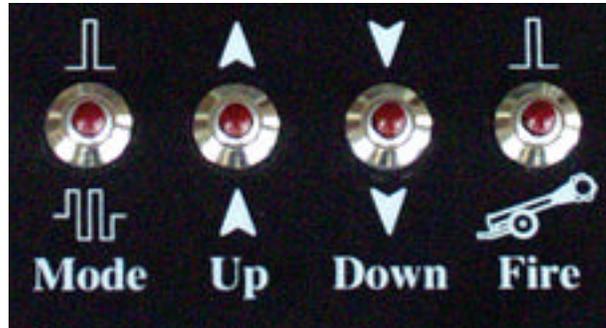


Use the MODE and UP/DOWN pushbuttons to get the above setting:

Connect the two instruments with a coaxial cable so the output of Mr. Pulsar is connected to the Channel A input of the scopemeter.

input to a BNC adapter. If you do not have coaxial cable, your nearby Radio Shack store will have the cable and or adapters to complete the connections. If all else fails, use the BNC to Binding post adapter provided with Mr. Pulsar to connect the test leads of the scopemeter. Remember, the red post goes to the probe on the scopemeter.

Now, every one or two seconds hit the FIRE button on Mr. Pulsar. You should see the impulse waveform appear for a brief time on the scopemeter.



Next perform the same test using various combinations of sweep speeds and pulse lengths.

Scopemeter sweep speed (SwSpd) can be set for nanoseconds per division, microseconds per division, milliseconds per division and seconds per division.

Some hints on timing:

1 second = 1,000 milliseconds

1 millisecond = 1,000 microseconds

1 microsecond = 1,000 nanoseconds

60 Hertz cycle = 16.666 milliseconds

60 Hertz cycle = 16,666 microseconds

60 Hertz cycle = 0.0167 seconds

Third Harmonic of 60Hz) cycle = 5.555 milliseconds

AM radio station (1000 on the dial) cycle = 1 microsecond

(~10milliseconds).

abbreviations:

ms = milliseconds

µsec = microseconds

ns = nanoseconds

The following tests will require you to use the triggering features of the scopemeter to capture single events. Your meter must be set to the correct settings noted below.

Push the **SCOPE MENU** button  
Push F3 for TRIGGER

INPUT A	<b>select</b>
INPUT B	
EXT	
VIDEO ON A	
SCREEN UPDATE=FREE RUN	
SCREEN UPDATE=ON TRIG	<b>select</b>
AUTO RANGE=>15 Hz	<b>select</b>
AUTO RANGE=>1 Hz	

The scope should show "NOTRIG" at the top of the screen

Push the FIRE button one time.

The horizontal sweep should start and "NOTRIG" should switch to "MANUAL"

About every two seconds hit the FIRE button, you should see the impulses on the scope.

When the sweep finishes, "NOTRIG" should appear.

Push the FIRE button one time.

The horizontal sweep should start and "NOTRIG" should switch to "MANUAL"

About every two seconds hit the FIRE button, you should see the impulses on the scope.

When the sweep finishes, "NOTRIG" should appear.

Repeat this until you feel comfortable with the triggering.

Adjust the TIME selector pushbutton to have a sweep speed of 200 ms/d.

Push the FIRE button three (3) times as fast as you can.

The horizontal sweep should start and "NOTRIG" should switch to "MANUAL"

When the sweep finishes, "NOTRIG" should appear.

Repeat this until you feel comfortable with the triggering.

By the way, the vertical height of the impulse should be 2.5 divisions.

Adjust the TIME selector pushbutton to have a sweep speed of 20 ms/d.

Push the FIRE button three (3) times as fast as you can.

Not fast enough are  
you? The sweep is  
being completed in 20  
msec times 10 divisions  
or 0.2 seconds

When the sweep finishes, "NOTRIG" should appear.

Note that the width of the pulse is about 1/2 division or 10 milliseconds duration.

Repeat this until you feel comfortable with the triggering.

Adjust the TIME selector pushbutton to have a sweep speed of 10 ms/d.

Push the FIRE button one time.

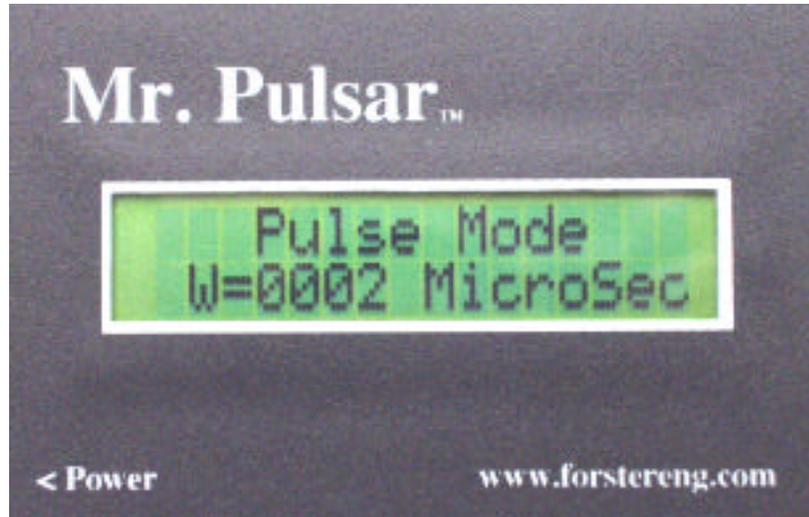
When the sweep finishes, "NOTRIG" should appear.

Note that the width of the pulse is about 1 division or 10 milliseconds duration.

Repeat this until you feel comfortable with the triggering.

Lets shorten the duration of the pulse and see what happens.

Push the DOWN arrow on Mr. Pulsar to get to 2 microseconds.



Adjust the TIME selector pushbutton to have a sweep speed of 10 ms/d.

Push the FIRE button one time.

The horizontal sweep should start and "NOTRIG" should switch to "MANUAL"

If the scope triggers, you should see the impulse on the scope.

When the sweep finishes, "NOTRIG" should appear.

If the unit does not trigger, the last impulse will still be there

Push MODE and go to a square wave to disturb the scope trace.

Push MODE again and go back the the 2 microsecond impulse.

Now if the scope triggers, you will see the impulse.

At this point you should find that triggering is not reliable.

Some impulses of this short duration would not be recorded.

Adjust the TIME selector pushbutton to have a sweep speed of 20  $\mu$ s/d.

Alternate between the UP and FIRE button or the DOWN and FIRE button.

This will make it easier to observe each new trigger as the duration changes.

Triggering should be reliable.

Do the same for a sweep speed of 2  $\mu$ s/d.

Triggering should be reliable.

Exactly where the scope fails to trigger properly will depend on many things. The voltage level of the trigger setting (vertical adjustment of the trigger symbol above the zero volt X axis.

The voltage level of the trigger setting (vertical adjustment of the trigger symbol above the zero volt X axis.

The shape of the input impulse.

The duration of the impulse. The shorter the impulse duration, the harder to trigger.

The polarity of the trigger setting. You set the trigger for a positive going impulse which is what Mr. Pulsar provides. Use the adapter provided with Mr. Pulsar and invert the impulse by connecting the probe to the Black terminal and the ground to the Red terminal.

settings. Use the horizontal cursors to set the trigger slope to negative. Triggering should resume for negative going impulses.

But you say the scope triggers for a positive going impulse, are you sure? It may be triggering for the end of the impulse from the Mr. Pulsar which is a negative going waveform.

Fortunately, in the real world of electrical noise, the impulses you will measure are usually a burst of impulses that will trigger the scope allowing you to detect the impulse of interest.

## Impulse Recording with the Flukeview version 3.0 software

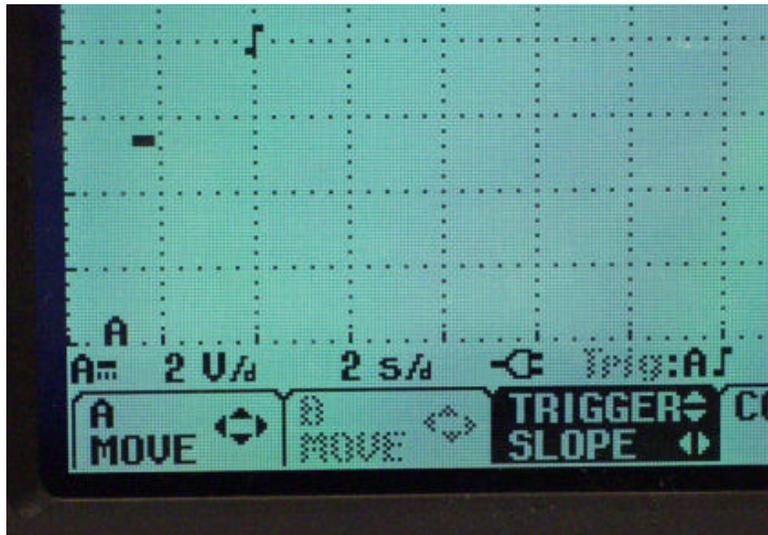
Push the **SCOPE MENU** button

Push F3 for TRIGGER

INPUT A	select
INPUT B	
EXT	
VIDEO ON A	
SCREEN UPDATE=FREE RUN	select
SCREEN UPDATE=ON TRIG	
AUTO RANGE=>15 Hz	select
AUTO RANGE=>1 Hz	

Start the FlukeView 3.0 program and connect to the scope.

With the scope set for 2 s/d and 2 v/d



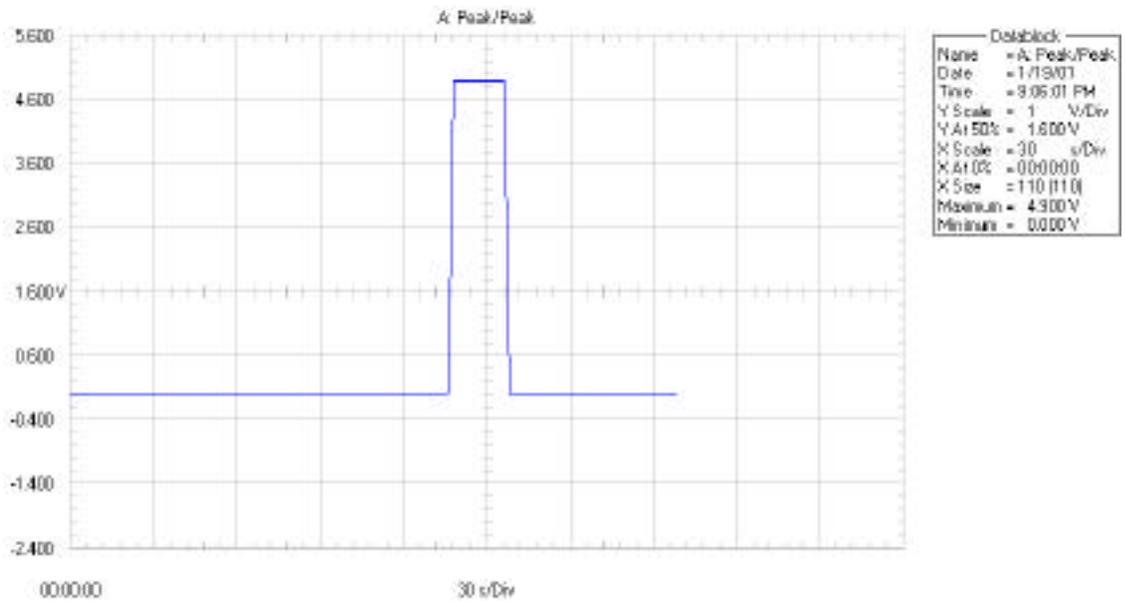
And FlukeView is set to update the data every 2 seconds:

Push the FIRE button to send a 2 microsecond pulse to the scope.

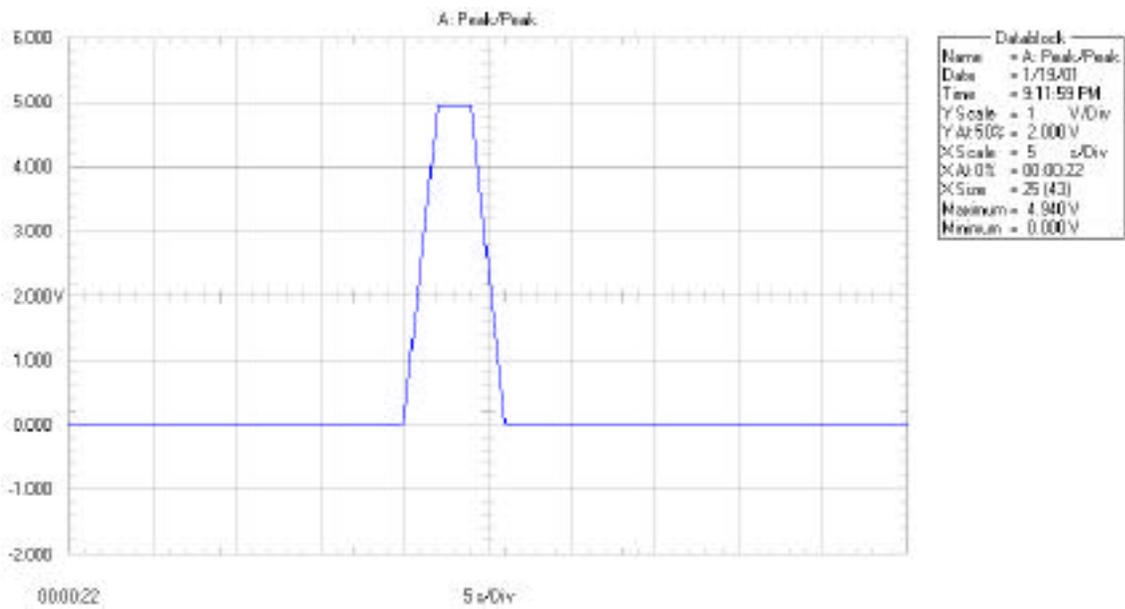
**Notice that the system records most impulses, but misses some.**

This is because the FlukeView software cannot continuously monitor the scope input.

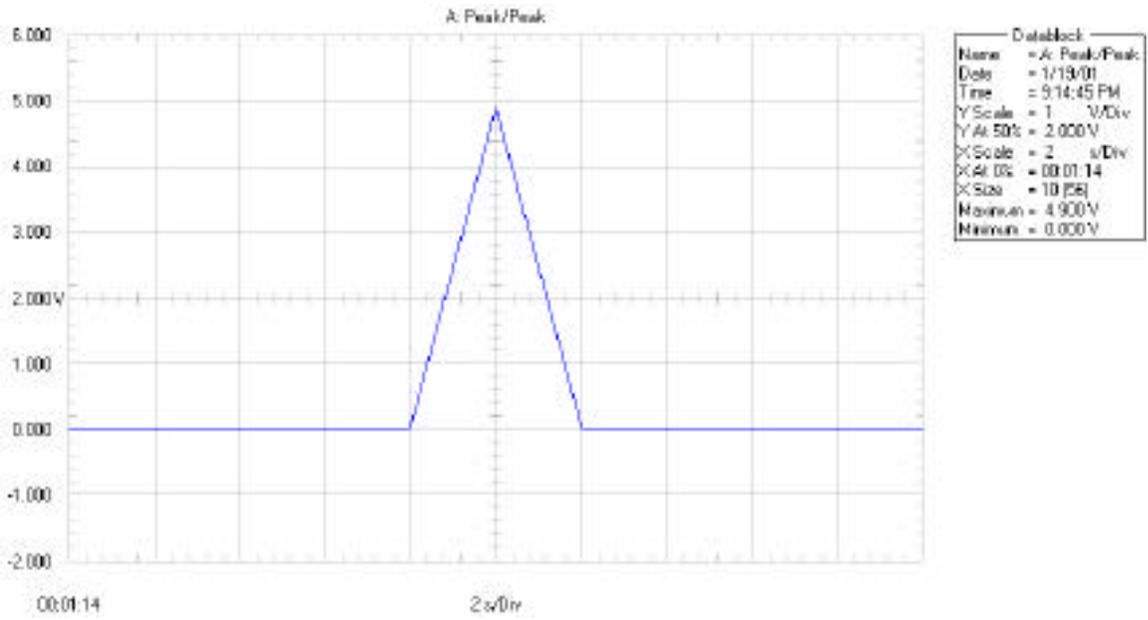
**Another problem is that you sent the scope a 2 microsecond impulse, but the FlukeView software displays it as a 20 second event.**



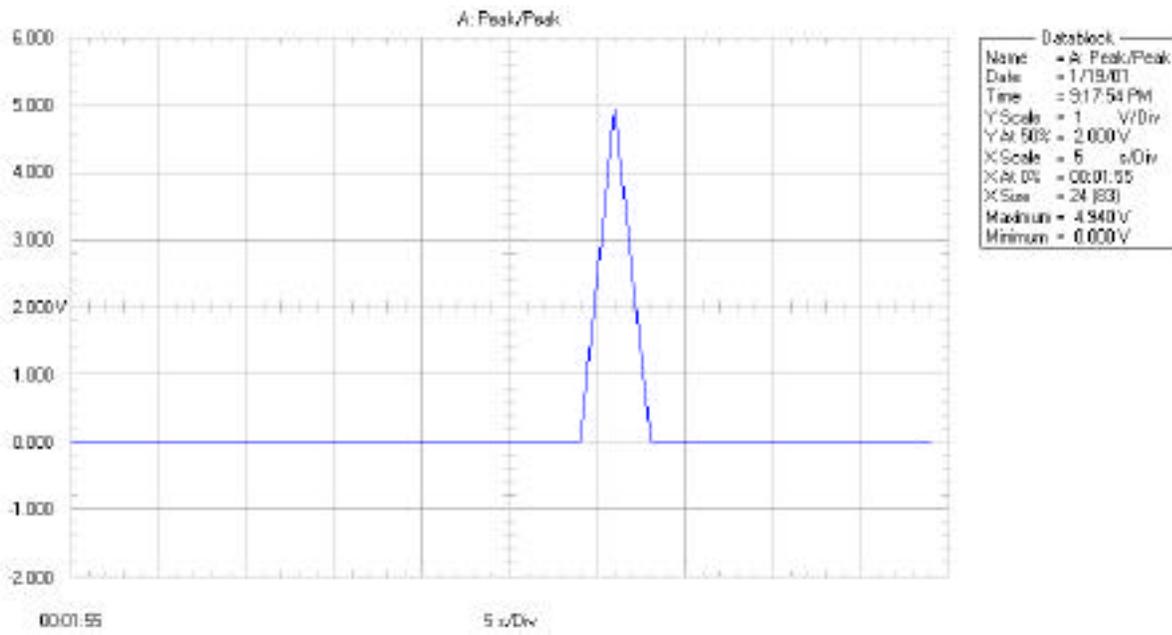
Set the scope sweep speed to 200 ms/d:  
**The FlukeView software still displays the 2 microsecond impulse as a 6 second event.**



Set the scope sweep speed to 20 ms/d:  
**The FlukeView software still displays the 2 microsecond impulse as a 4 second event.**  
**Notice how many impulses are missed.**



Set the scope sweep speed to 2 ms/d:  
**The FlukeView software still displays the 2 microsecond impulse as a 4 second event.**  
**Notice how many impulses are missed.**



## Conclusion:

The Fluke 123 Scopemeter is a great instrument, and FlukeView software is a great logging program, but each of these units has performance limits.

Using this system to record "High Frequency" or short duration impulses is not a good application of the instrumentation.

It is true that when data is recorded, input was observed. When we evaluate the effect of High Frequency impulses on dairy animals we must compare the duration of EACH impulse with the magnitude of each impulse.

The recording system we have just reviewed does not meet the necessary requirements to provide the data required.