Common Measurement Errors
Part 1

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Topics to cover

Know what each measurement means

-

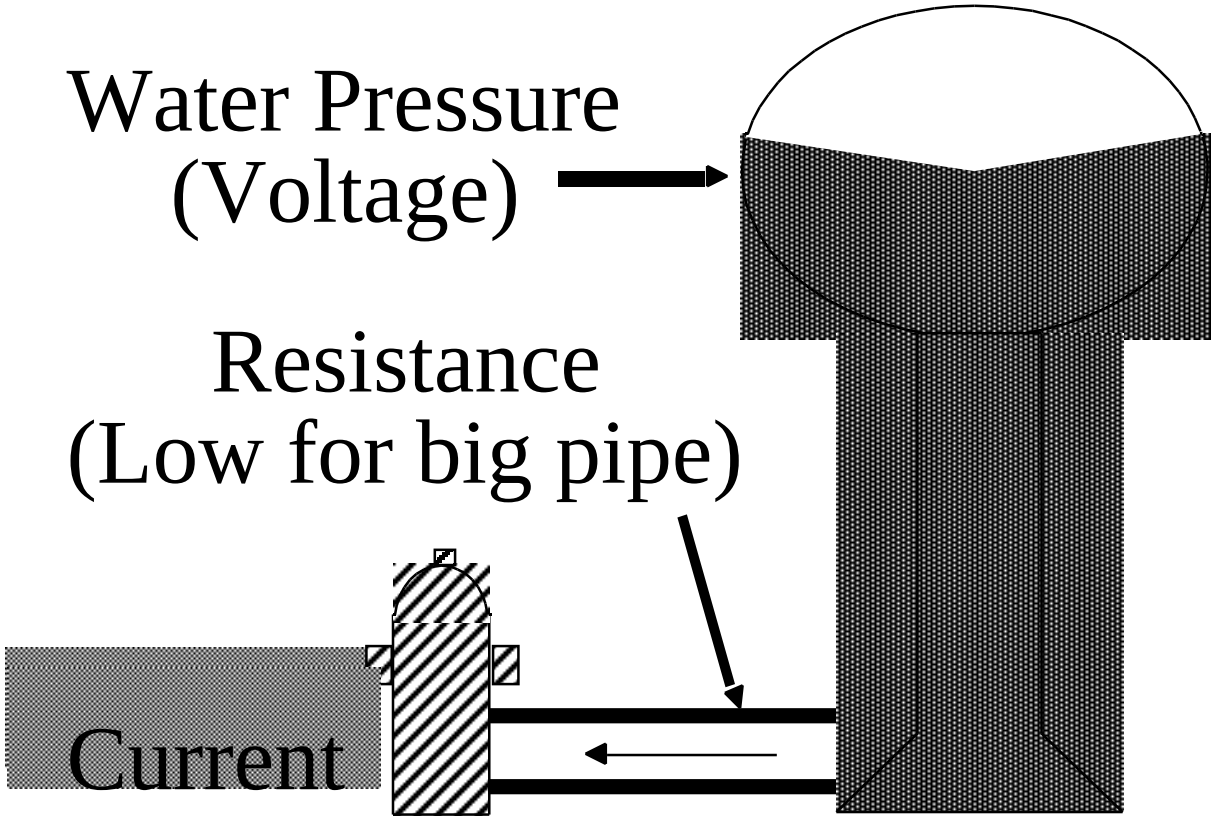
Know your connections

-

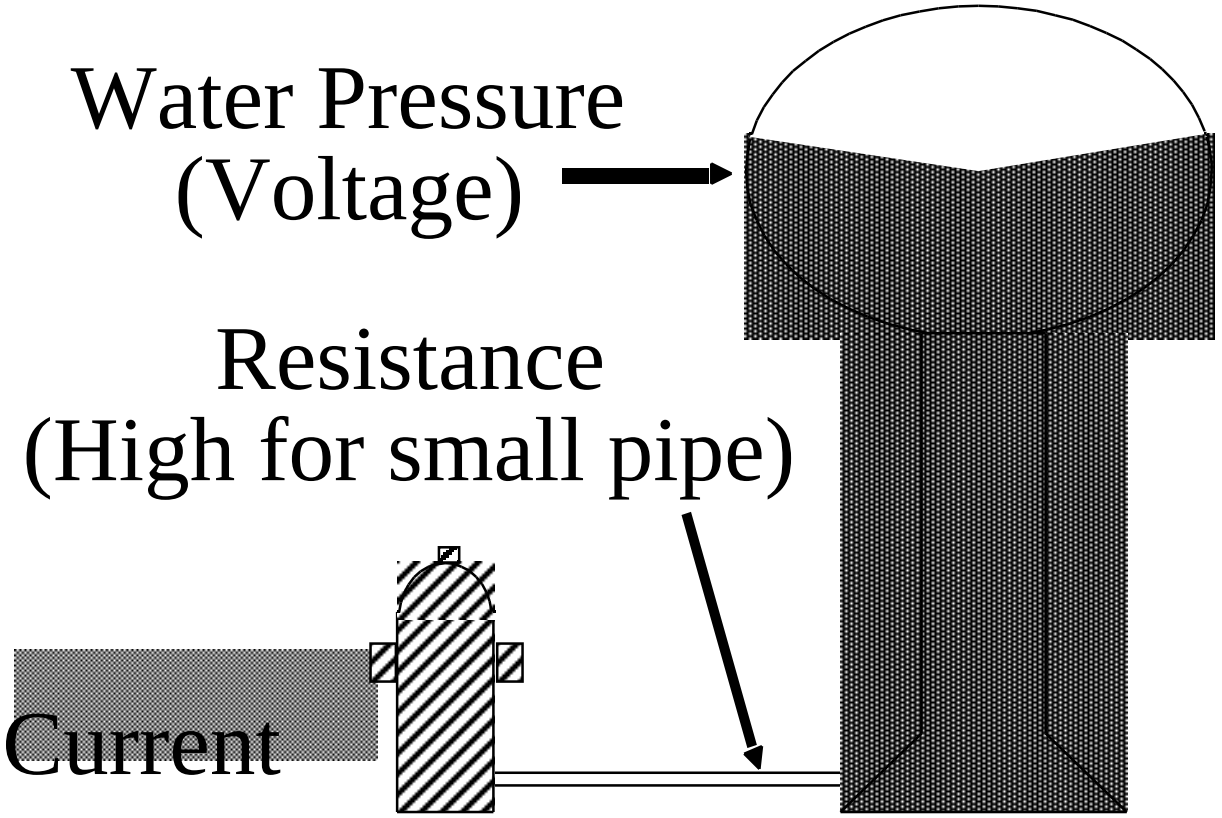
Know your instrument

Just some basics on electrical measurement….

AC and DC Voltage or Current - Review



AC and DC Voltage or Current - Review



Voltage is the **Pressure**
that forces the **Current**
through the **Resistance**
of the animal

DC Voltage

When discussing the difference between AC and DC all comments apply equally to voltage or current.

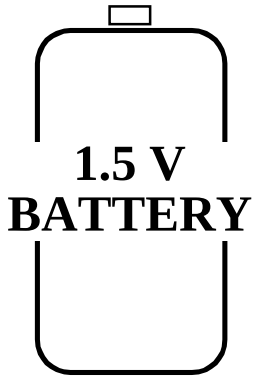
Polarity

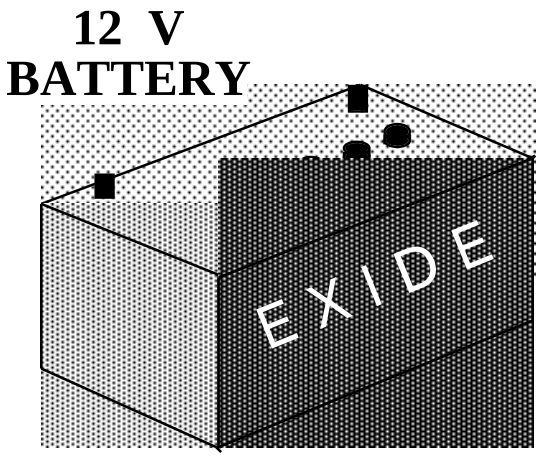
A **DC** voltage (or current) may have a positive or negative polarity.

The magnitude of the voltage (or current) may vary,

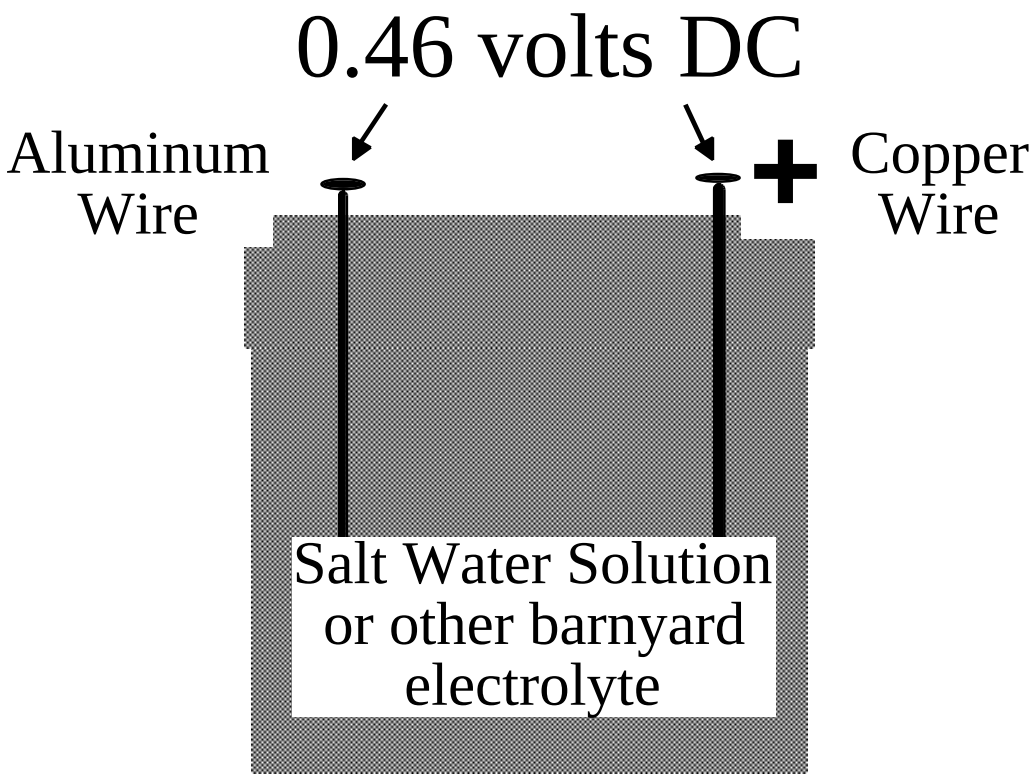
but the polarity does not change.

DC Usually Comes From Batteries

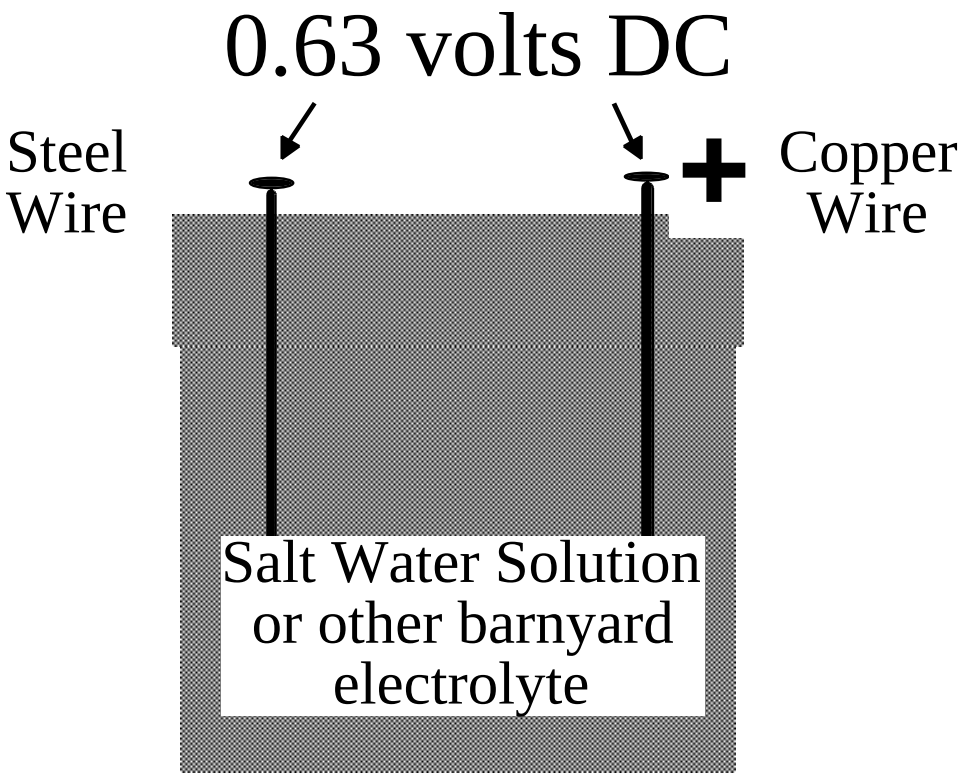




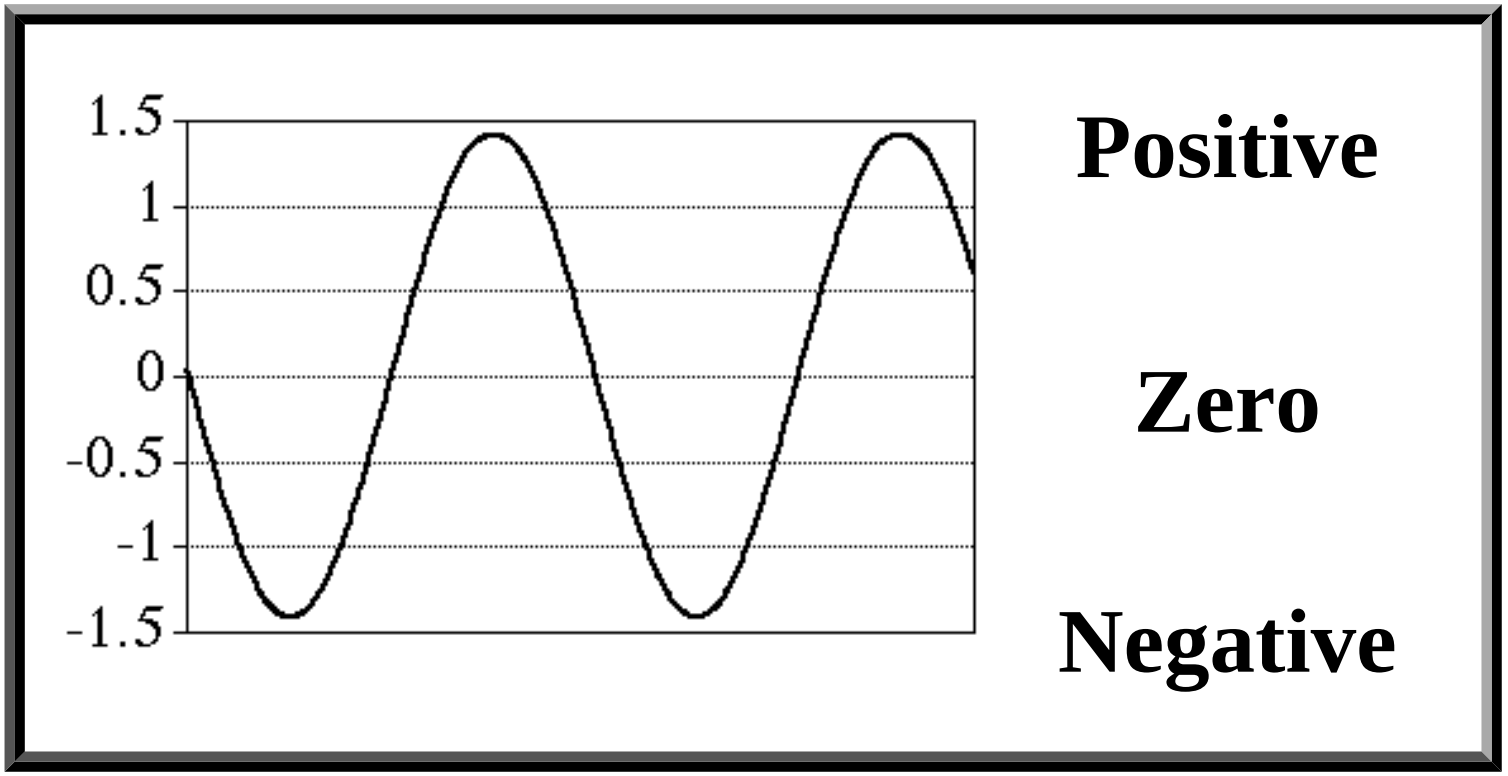
DC also comes from dis-similar metals



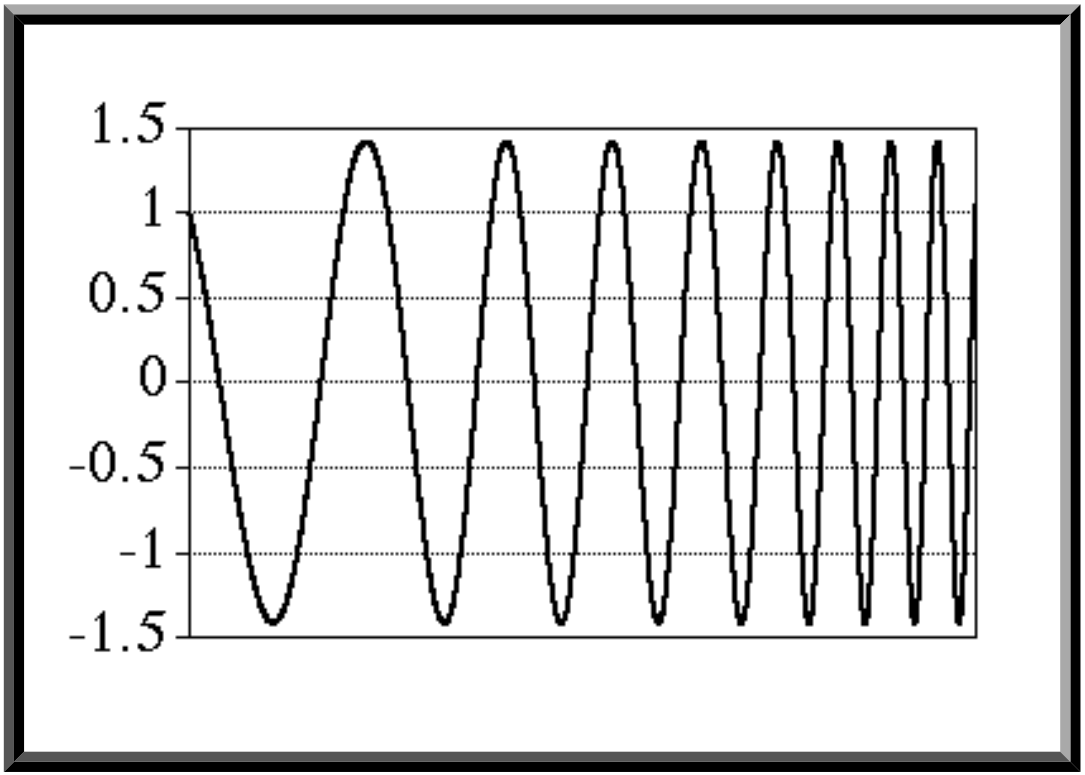
The type of metal determines the voltage



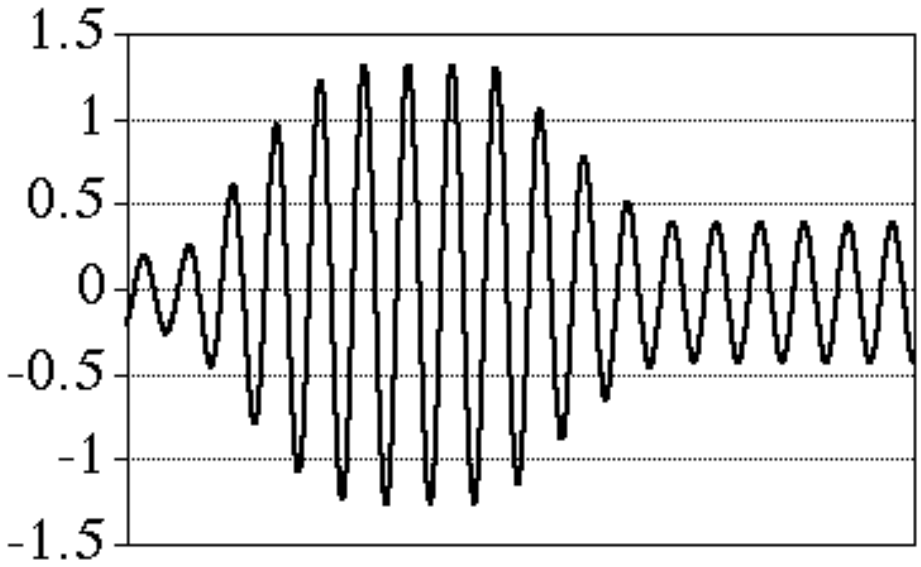
An AC voltage (or current) usually alternates between a positive and negative polarity



The RATE of alternation is the frequency of the AC voltage (or current)



The MAGNITUDE can change for an AC voltage (or current)



Comparison of AC and DC

- An RMS value is a way to compare AC and DC voltage or currents.

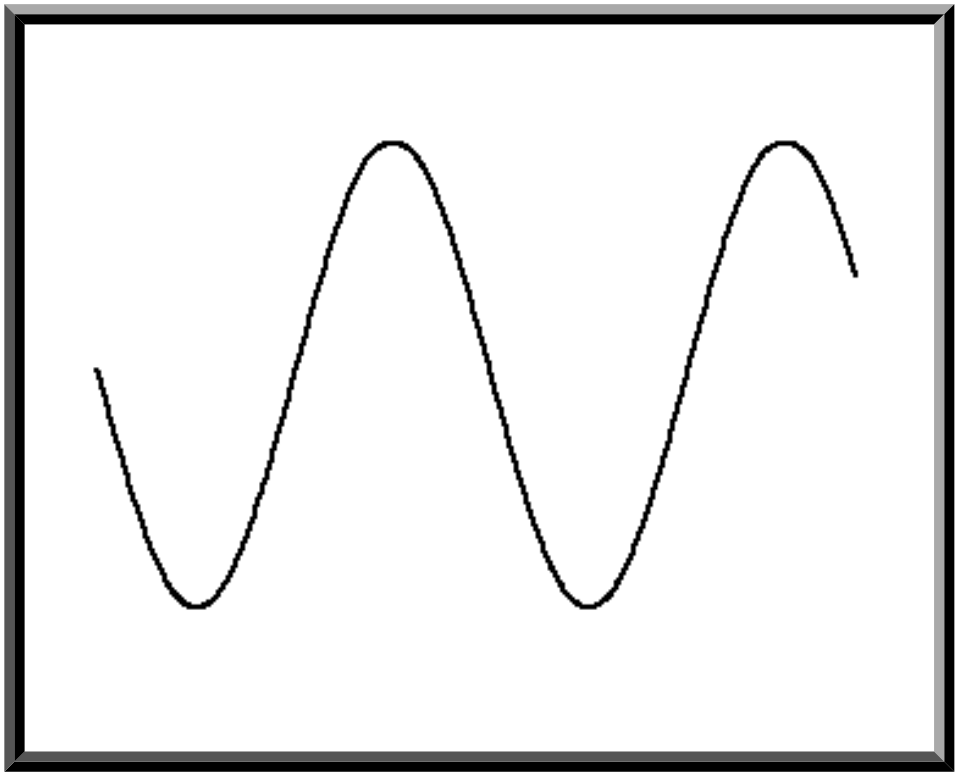
- A milk house heater powered with 120 volts DC would produce the same amount of heat as it would when powered by 120 volts RMS AC.

For AC only

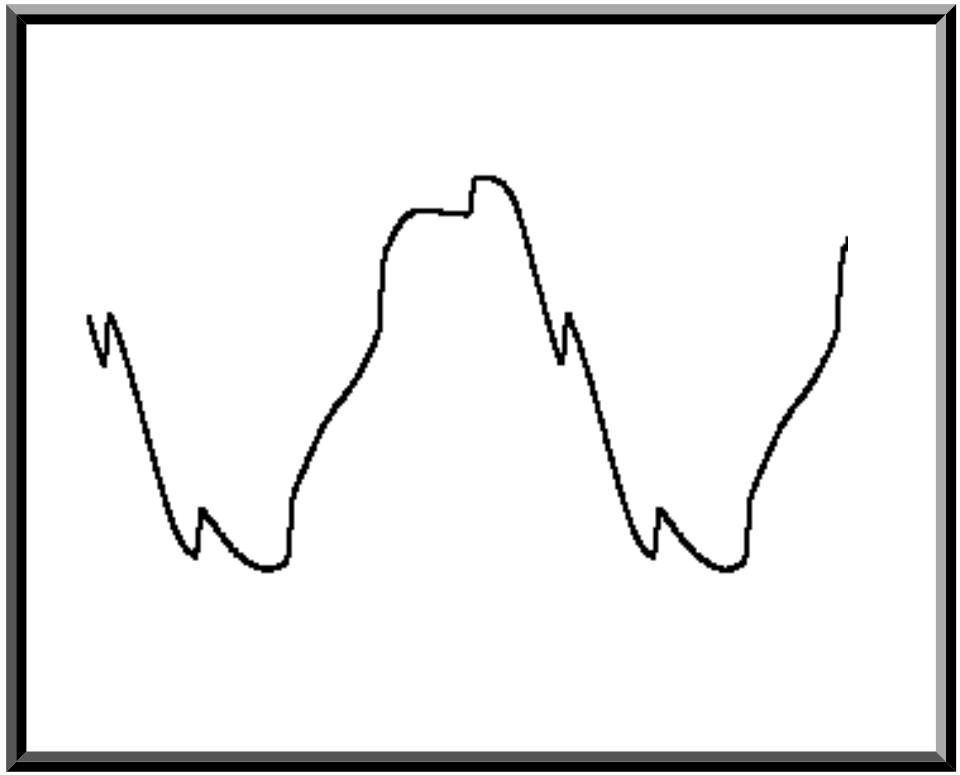
All AC voltages and currents are not pure sinusoids.

This can affect meters.

Pure Sinewave



Distorted wave form



Harmonics Made Simple

Whenever a wave form deviates from a perfect sinusoidal wave form, it is said to be distorted.

ALL distorted wave forms have harmonics.

Important Characteristics of Voltage and Current Measurements

Peak Value

Peak to Peak Value

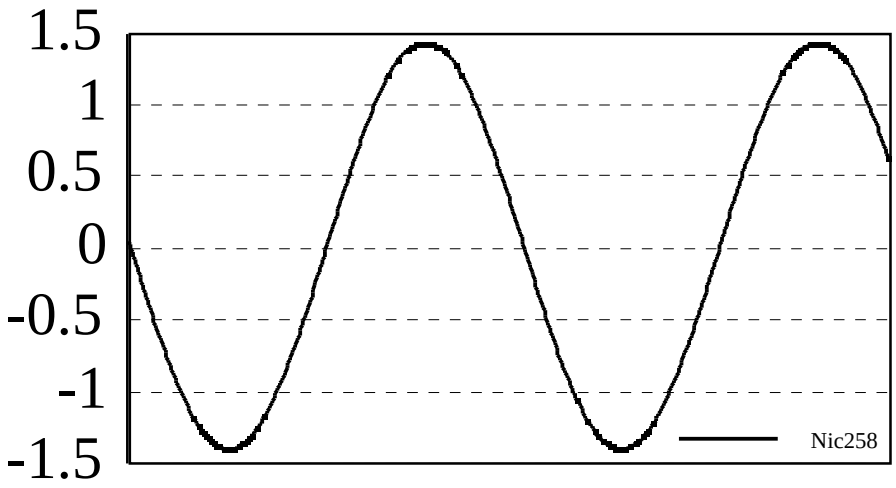
Average (RMS) Value

True RMS Value

When Does RMS = RMS?

When a meter has trouble accurately reading a waveform, there usually is a difference in “Average” RMS and “True” RMS values

How Peak, Peak-to-Peak and RMS Compare



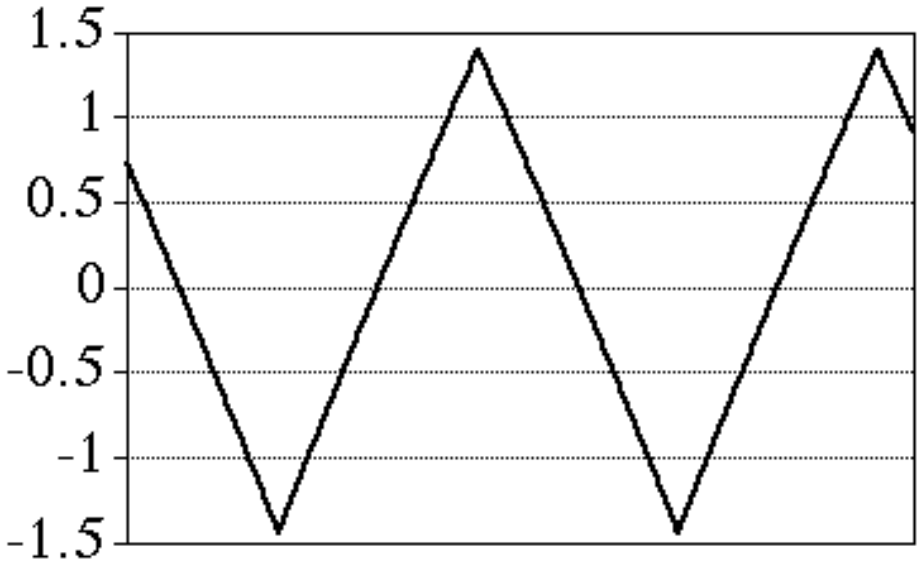
1.4 V Peak

1.0 V RMS(Avg)

1.0 V True RMS

2.8 V Pk-Pk

Triangular Waveform



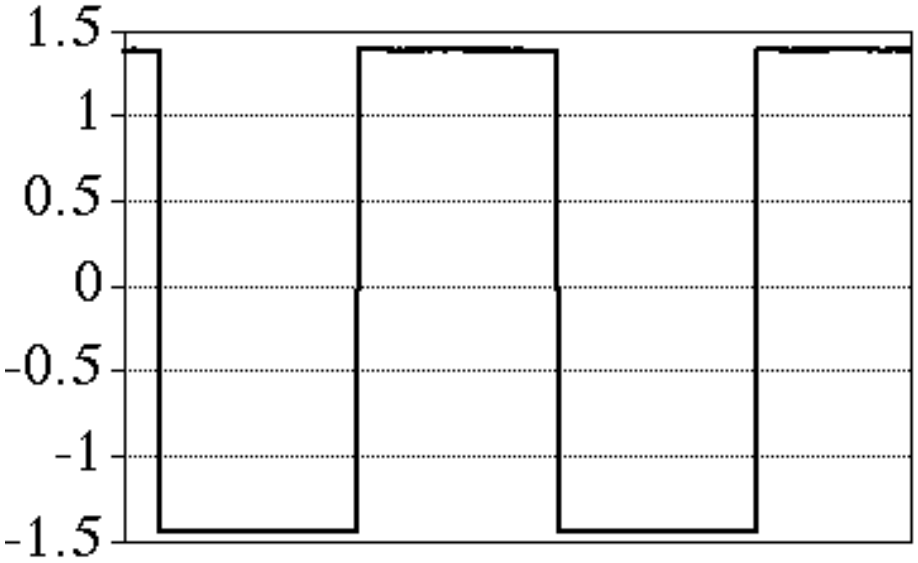
1.4 V Peak

0.785 V RMS(Avg)

0.82 V True RMS

2.8 V Pk-Pk

Square Waveform



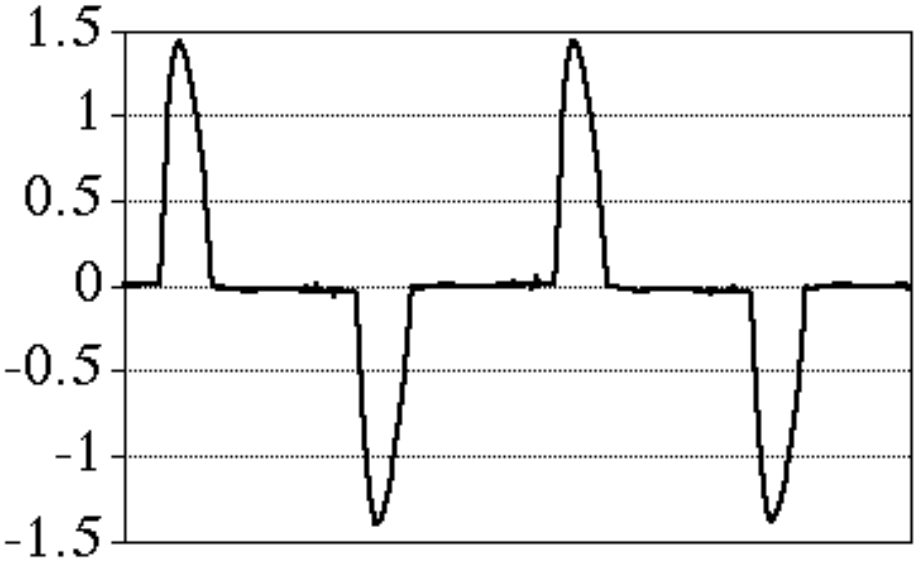
1.4 V Peak

1.56 V RMS(Avg)

1.4 V True RMS

2.8 V Pk-Pk

Switching Power Supply Current Waveform



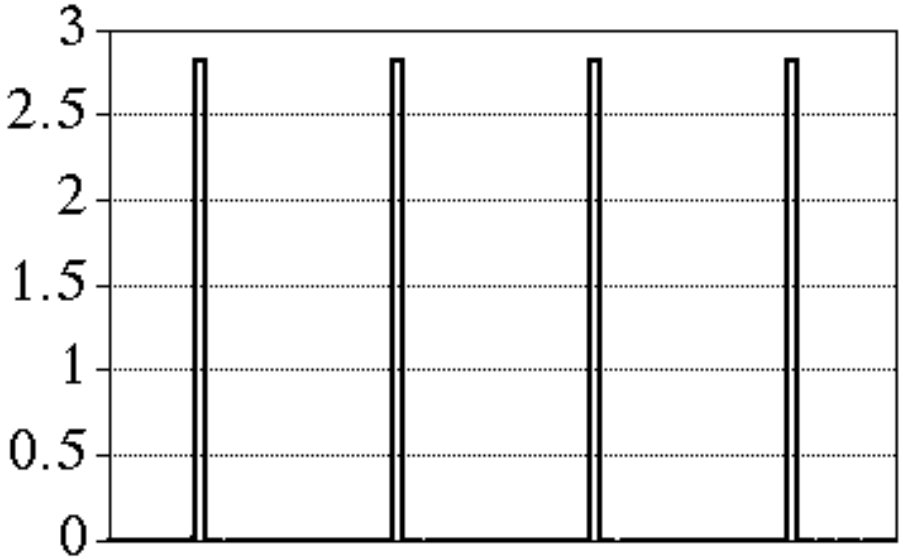
1.4 V Peak

0.28 V RMS(Avg)

0.52 V True RMS

2.8 V Pk-Pk

Short Duration Pulse Waveform



1.4 V Peak

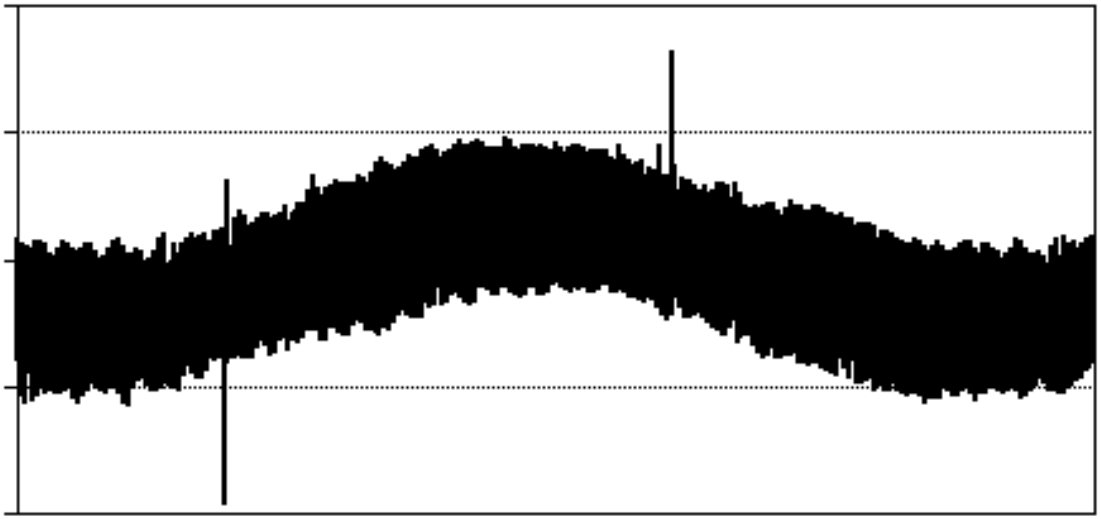
If AC coupled!

0.24 V RMS(Avg)

0.56 V True RMS

2.8 V Pk-Pk

60 Hz in Noise



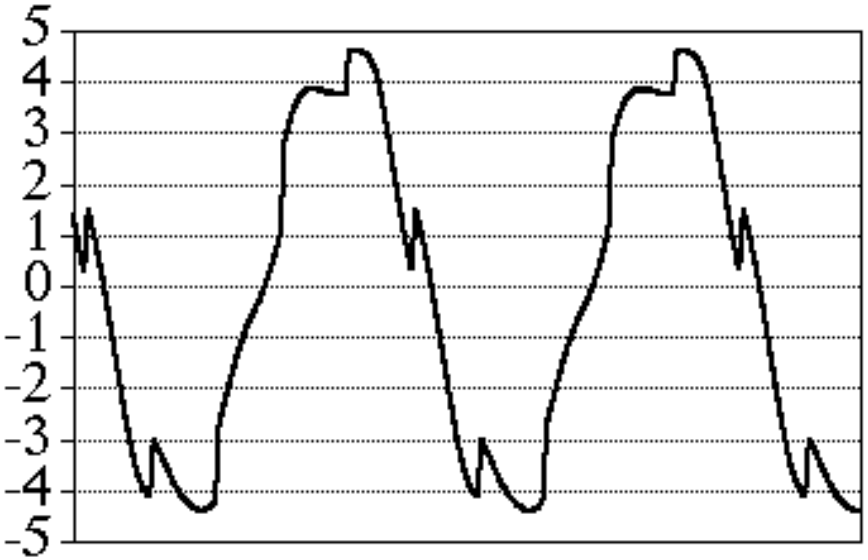
25 V Peak

7.7 V RMS(Avg)

11 V True RMS

50 V Pk-Pk

Distorted 60 Hz - Worst Case Stray Voltage Situation?



4.5 V Peak

3.07 V RMS(Avg)

3.13 V True RMS

9 V Pk-Pk

Summary - True RMS or Average RMS Meter?

- If the waveform comes close to resembling a 60 Hz sinewave, the error will be minimal.
- Most “on-farm” Cow-Contact voltages will be in this category.
- Neutral-to-earth voltages should be measured by both types of meters, or viewed on an oscilloscope.

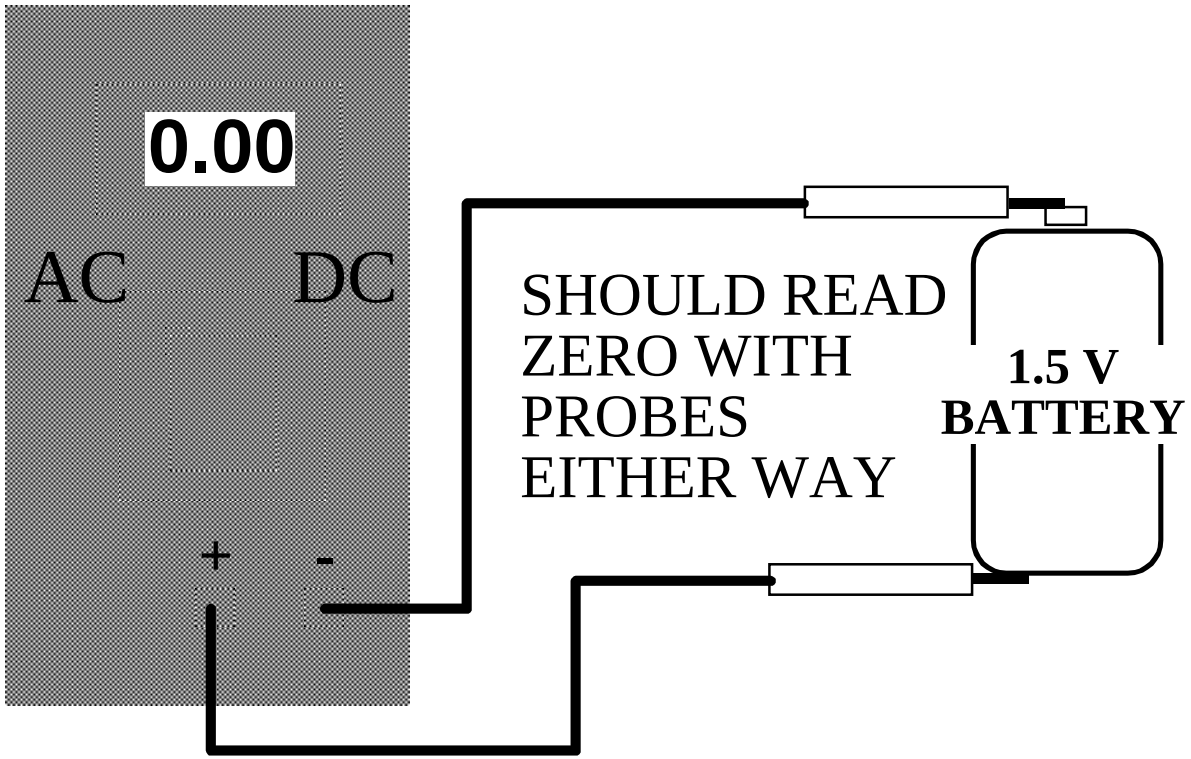
How DC blocking can affect your meter….

Potential Problems with AC Meters

- When a meter is set to read AC volts, it is important that the meter BLOCKS the input of DC voltages.

- To make sure your meter reads only AC volts when in the AC mode do the following:

DC Blocking Test



Making current measurements... correctly….

Instantaneous AC Current Meters Clamp-on Types

Many meters that read or record voltage can easily deal with AC current by the addition of a AC current probe.

- Measuring very low AC and DC VOLTAGES (0.5 volts and below) are simple to accomplish with digital meters.

- Measuring low current values in the milliampere region can be risky when a CLAMP-ON current device is used.

Using True RMS Meters, I Found The Following:

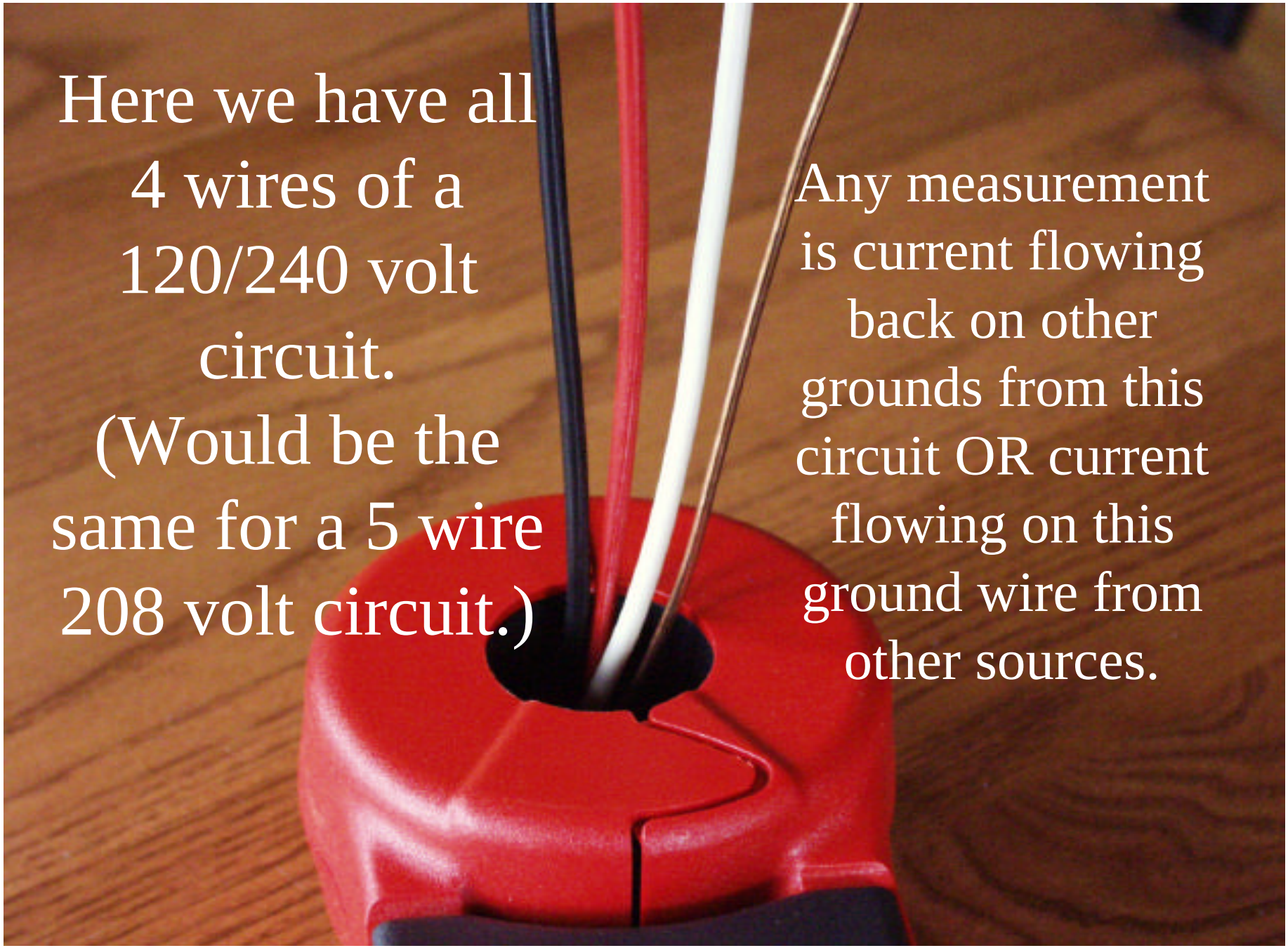
Actual Test mA	1000:1 CT & 200 uA Scale	1000:1 CT & 2 mA Scale
15	1.9	9
20	2.6	15
30	4.1	22
50	8	38
150	55	130
200	85	176

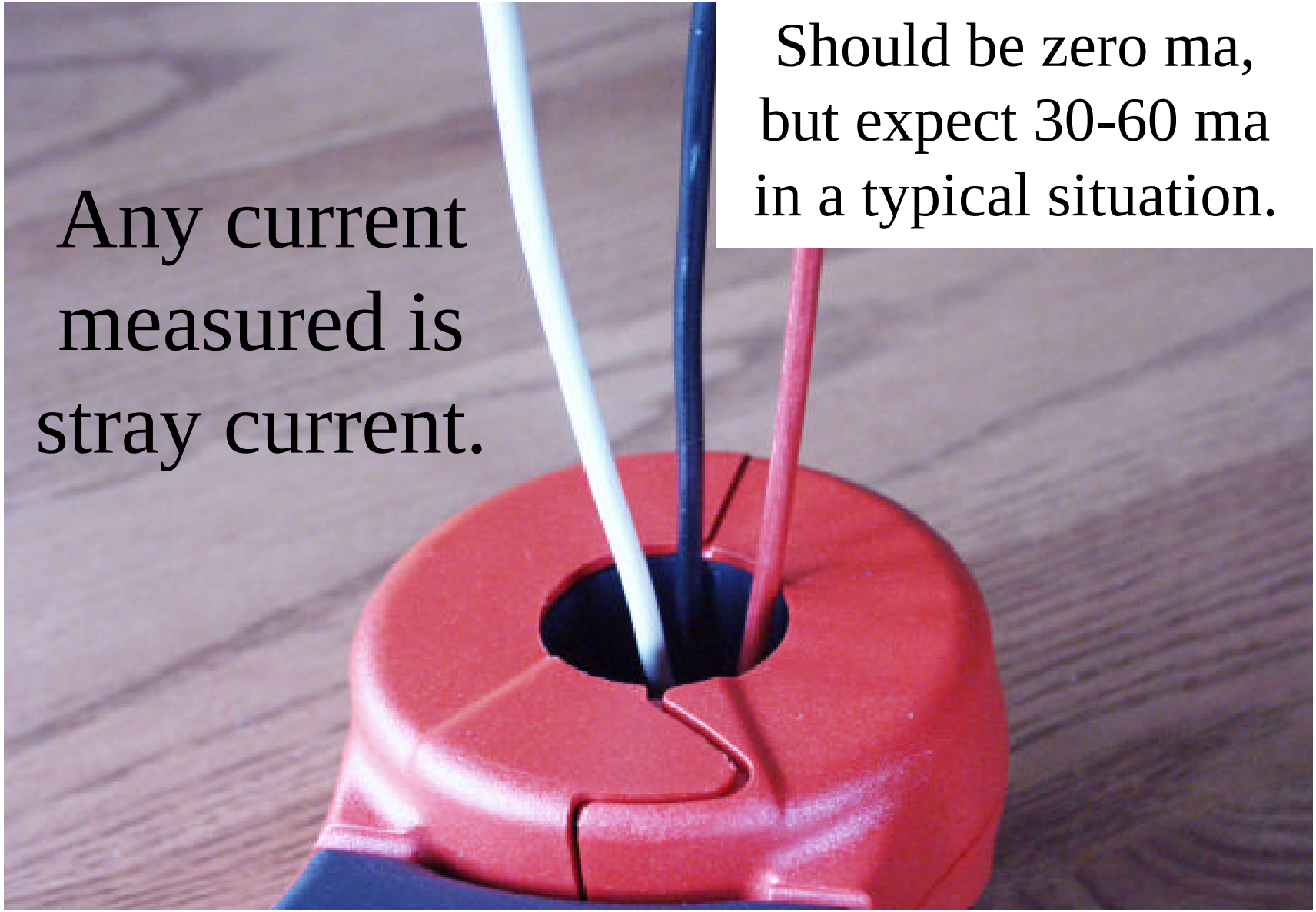
What's the best clamp-on type to use?

What's the best way to measure stray currents or leakage currents?

Use “zero sequence” metering

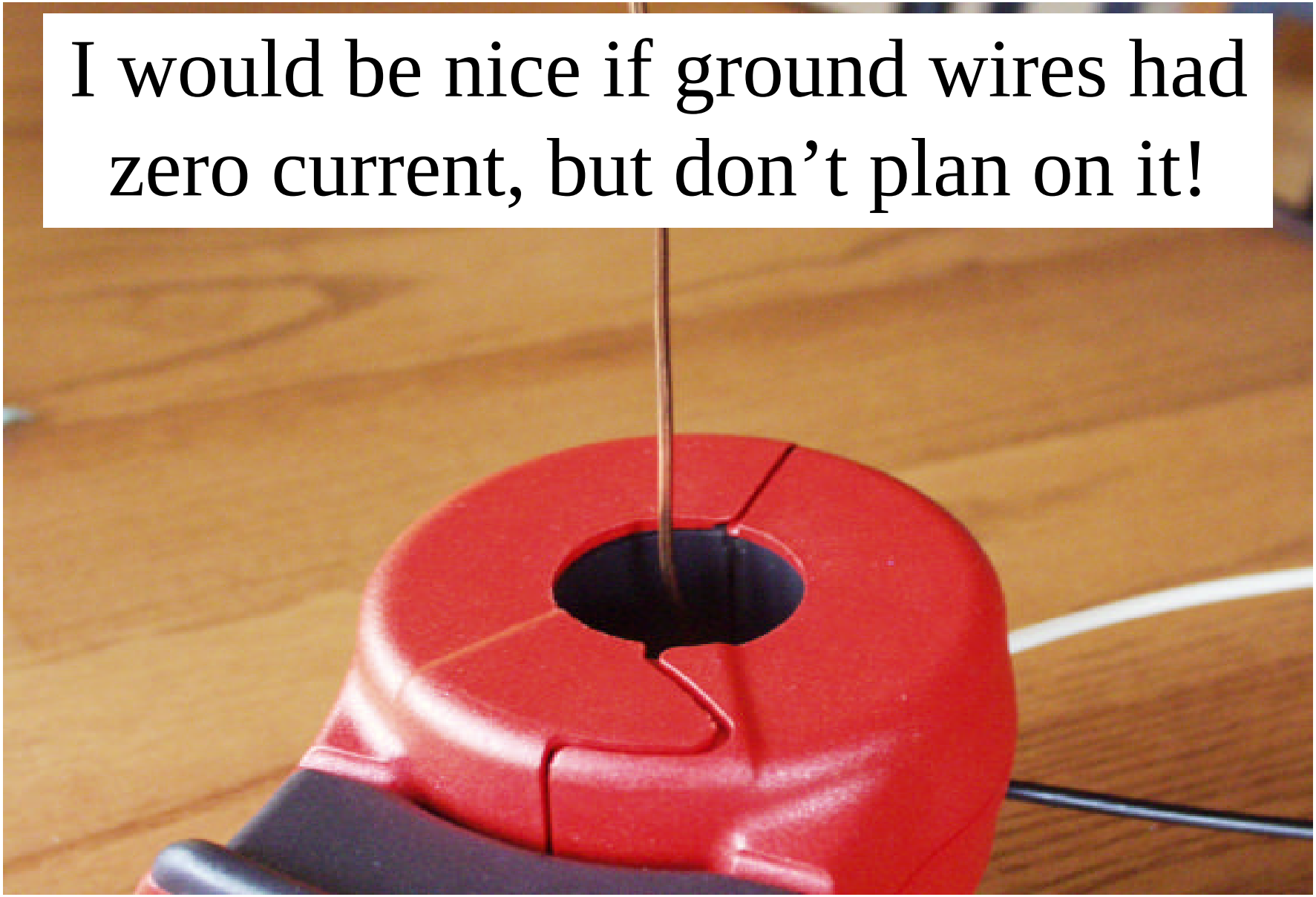
If you run all the wires of a circuit through a “donut type” current transformer, whatever is measured is current that is not staying on the wires as planned. This is the “stray current” we are looking for.


Here we have all 4 wires of a 120/240 volt circuit. (Would be the same for a 5 wire 208 volt circuit.)
Any measurement is current flowing back on other grounds from this circuit OR current flowing on this ground wire from other sources.

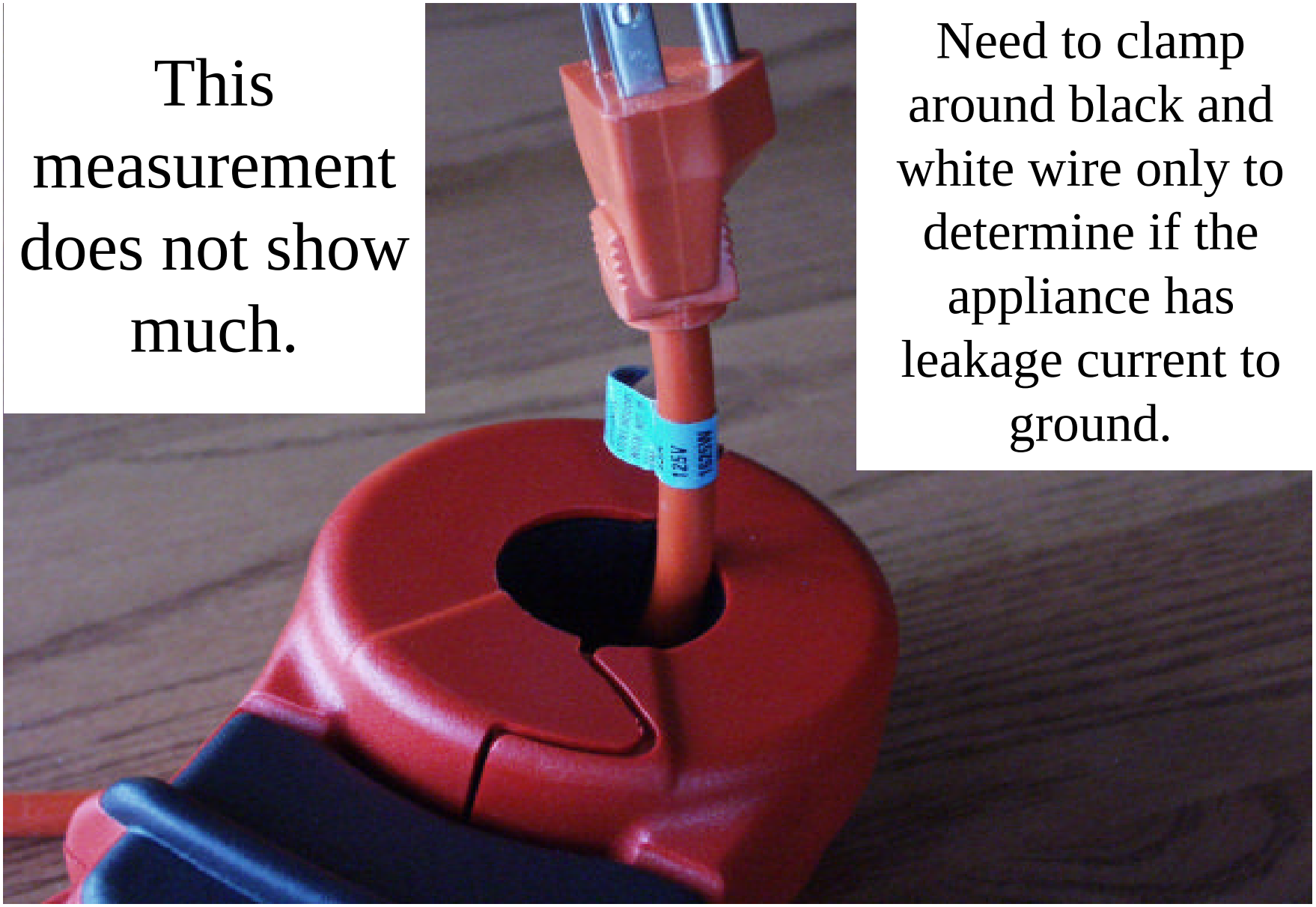

Any current measured is stray current.
Should be zero ma, but expect 30-60 ma in a typical situation.

Careful here! Normal neutral current and stray current will be measured.

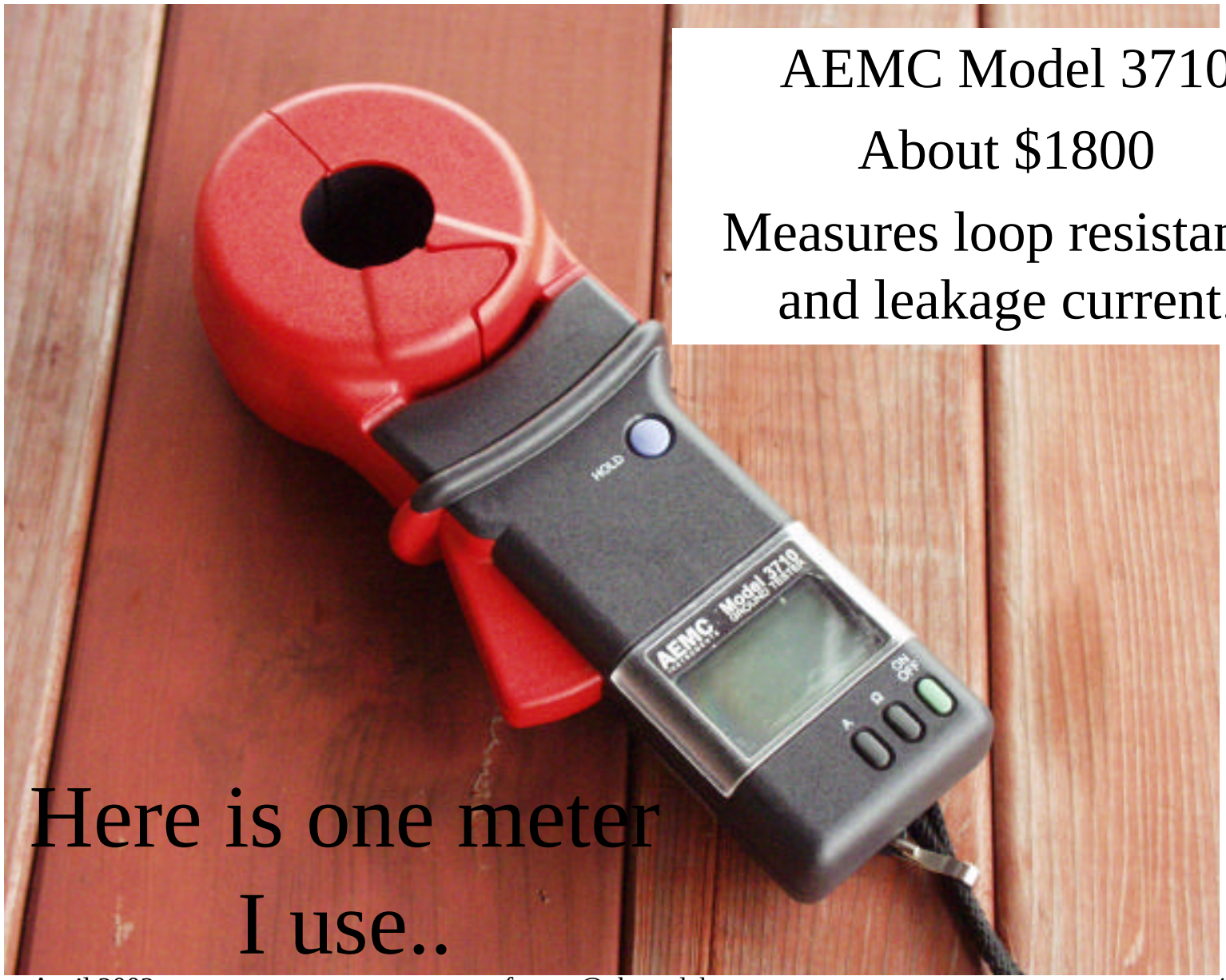
I would be nice if ground wires had zero current, but don’t plan on it!



This measurement does not show much.



Need to clamp around black and white wire only to determine if the appliance has leakage current to ground.



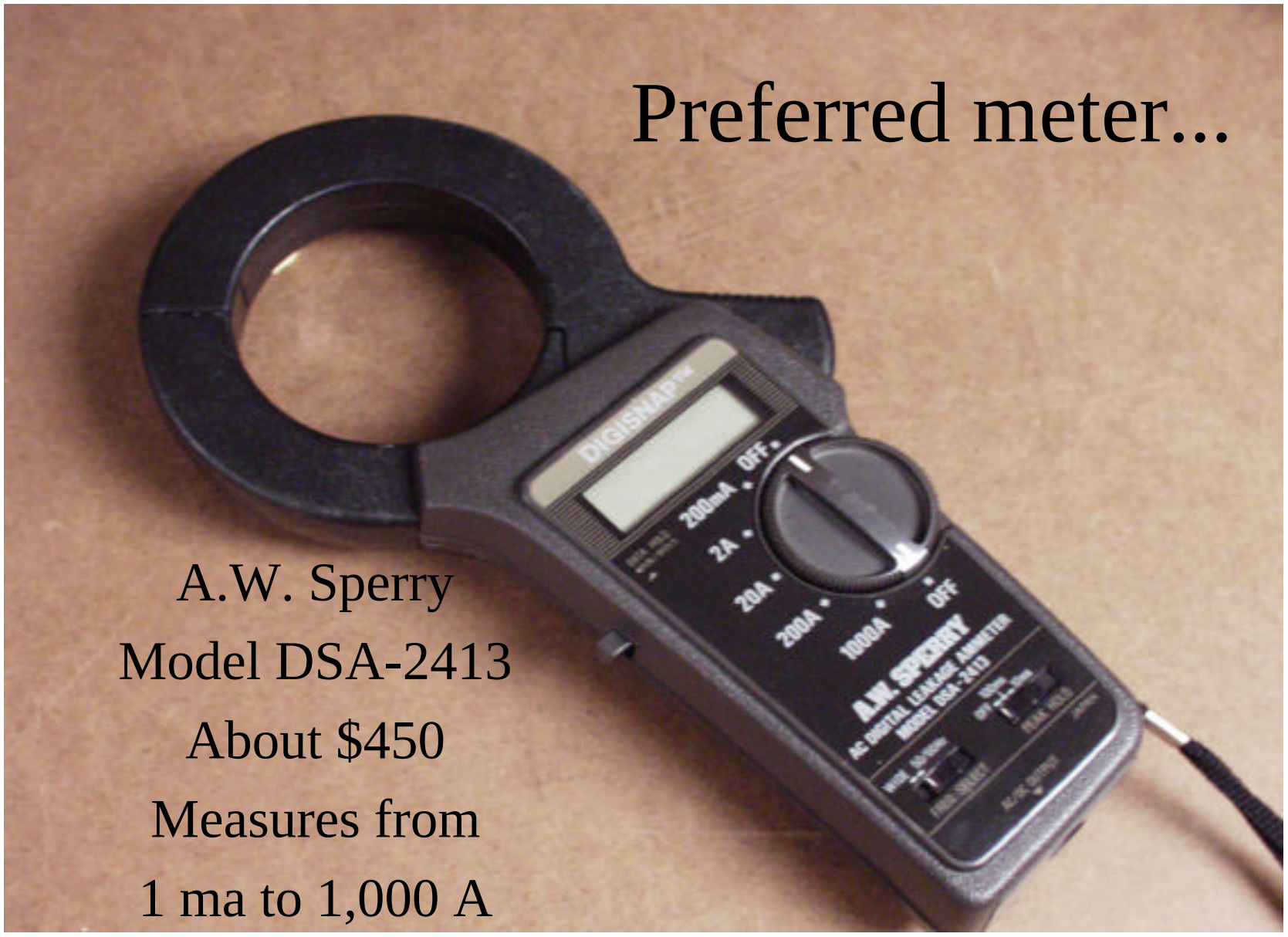
AEMC Model 3710

About $1800

Measures loop resistance and leakage current.

Here is one meter I use..

Preferred meter...



A.W. Sperry

Model DSA-2413

About $450

Measures from

1 ma to 1,000 A

A word of caution...

Brushing your teeth is important…..

Keeping your jaws clean is just as important.

Inspect the jaws on the clamp-on unit. The smallest amount of debris can affect your measurement.

Don’t let your leads lead you a-stray….

The type of connection you make can affect what you measure.

For the following experiments I am going to apply a 2 microsecond (µsec) pulse to one end of the leads, our “cow contact” end.

The scope will be at the other end of the leads and represent your meter, scope or other measuring device.

The question is: Do you accurately measure what is happening at the cow contact end?

Why use a short duration impulse?

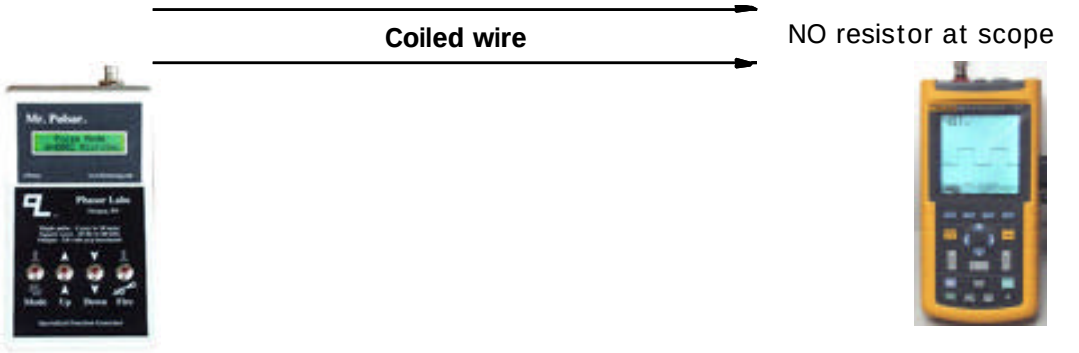
If a 2 microsecond (µsec) impulse can be measured without significant change in "Duration" or "Magnitude", then all voltage waveforms from 60 Hertz to over 1,000,000 Hertz will be measured accurately.

There are exceptions….

We can cover the exceptions after the experiment.

Experiment A

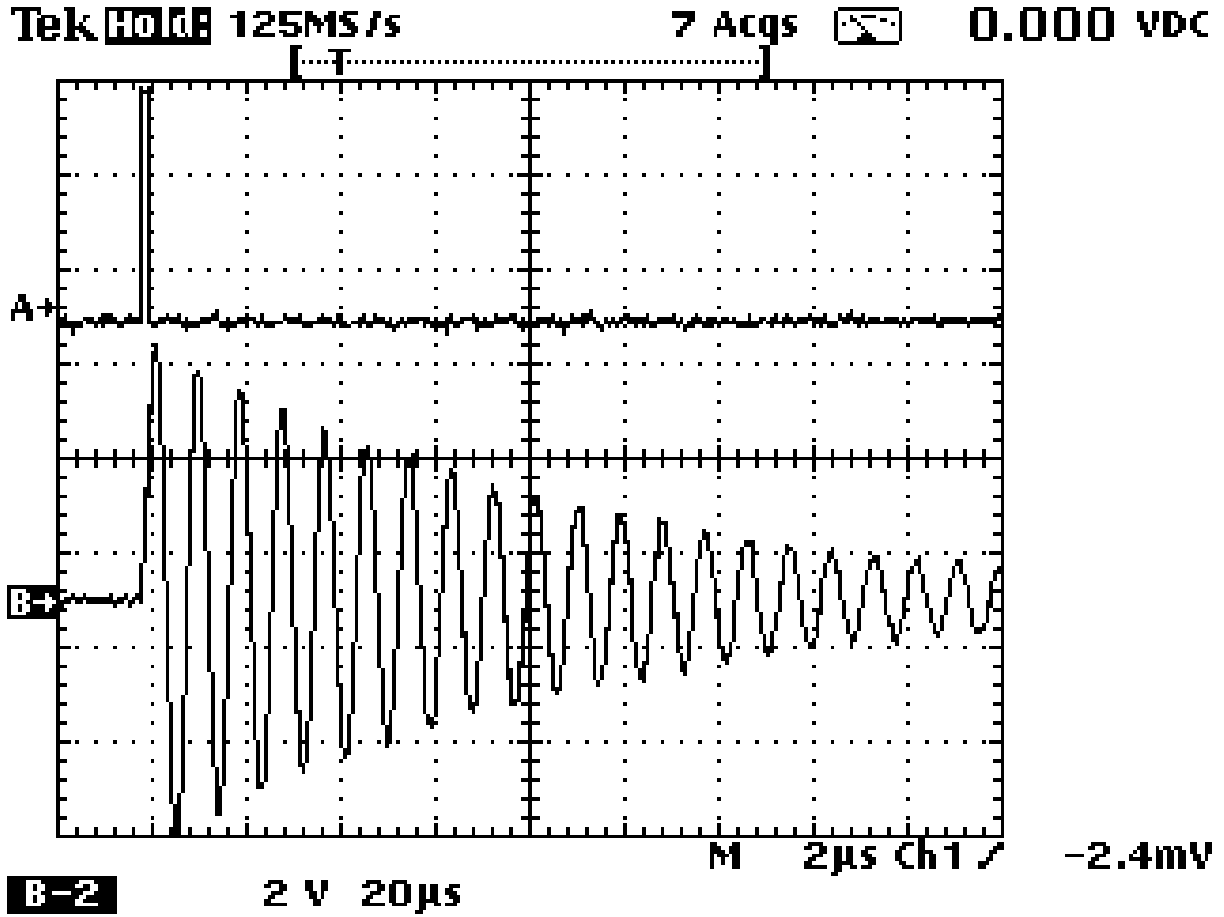
What happens if I use two (2) single conductor wires to the cow contact point and leave 100 feet of each wire coiled on a separate plastic spools?



The upper trace A is a 2 microsecond (µsec) impulse from the test unit.
The lower trace B is what was recorded at the scope.

Note the ringing due to the inductance of the coil.

Also the larger P-P voltage!



Experiment B

What happens if I use single conductor wires to the cow contact point and laid the wires out in a parallel line pattern? (100 foot)

500 ohm at scope

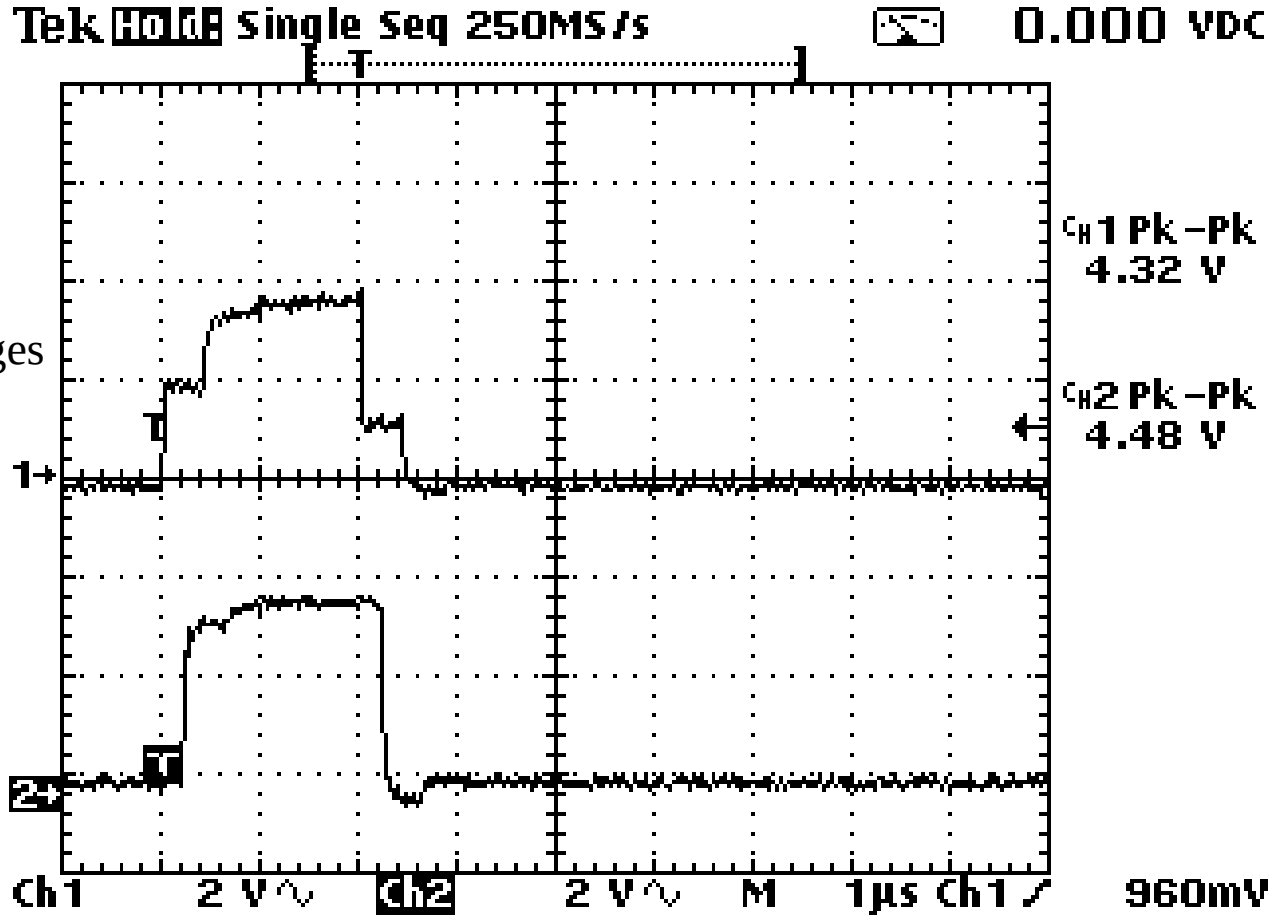
Typical Scope

Mr. Pulsar
at cow contact
Rs=102 ohms

I ADDED a 500 ohm resistor at the scope.

The upper trace 1 is a 2 microsecond (µsec) impulse from the test unit. The lower trace 2 is what was recorded at the scope.

Note that the distortion and magnitude changes are relatively small. Note the "loading" of the test set by impedance reflections.



Experiment C

What happens if I use single conductor wires to the cow contact point and laid the wires out in a parallel line pattern, PLUS add the coiled wire? (200 foot)

I ADDED a 500 ohm resistor at the scope.

Mr. Pulsar
at cow contact
Rs=102 ohms

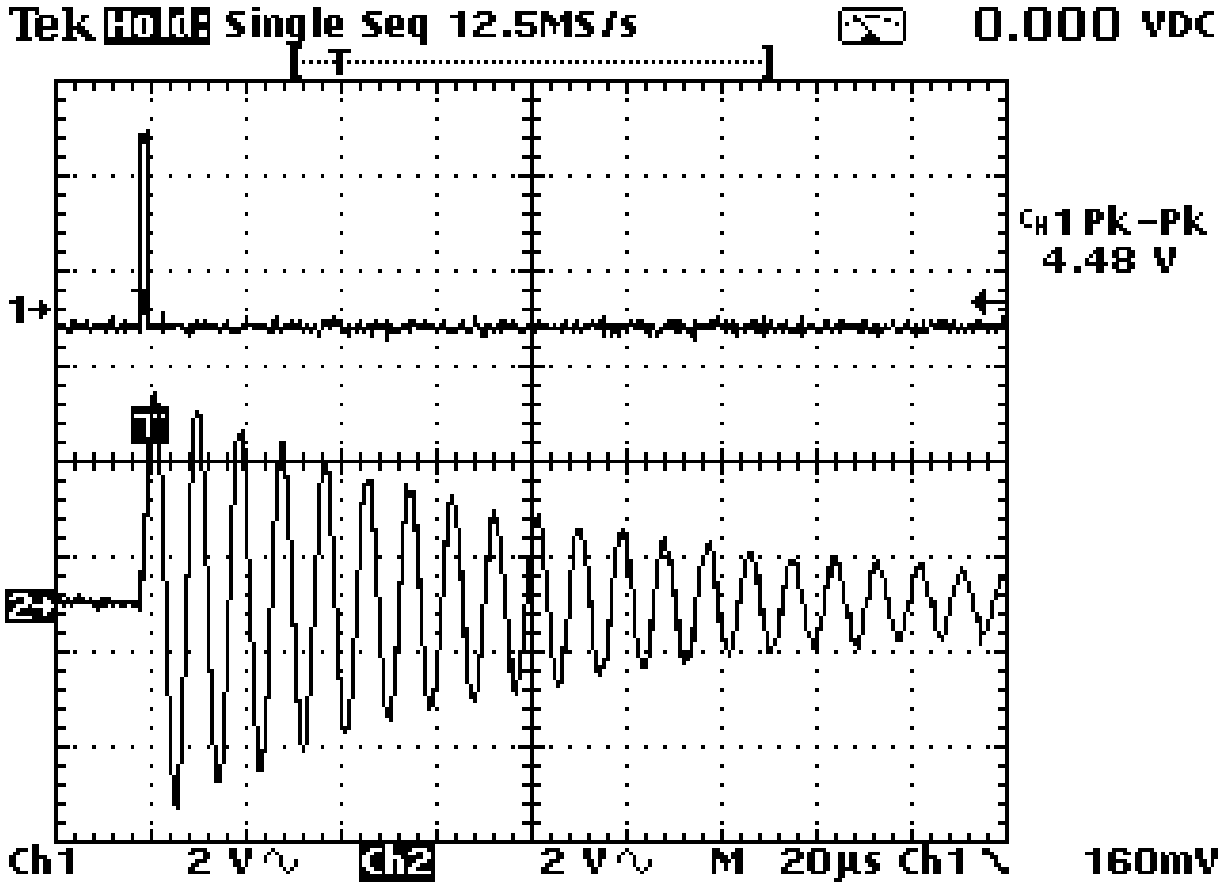
Open wires plus coiled wire

500 ohm at scope

Typical Scope

The upper trace 1 is a 2 microsecond (µsec) impulse from the test unit.
The lower trace 2 is what was recorded at the scope.

Note the problem with ringing and magnification remains



Experiment D - similar to B

What happens if I use single conductor wires to the cow contact point and laid the wires out in a straight line pattern? (100 foot shown)

Mr. Pulsar
at cow contact
Rs=102 ohms

Open wires - laying loose

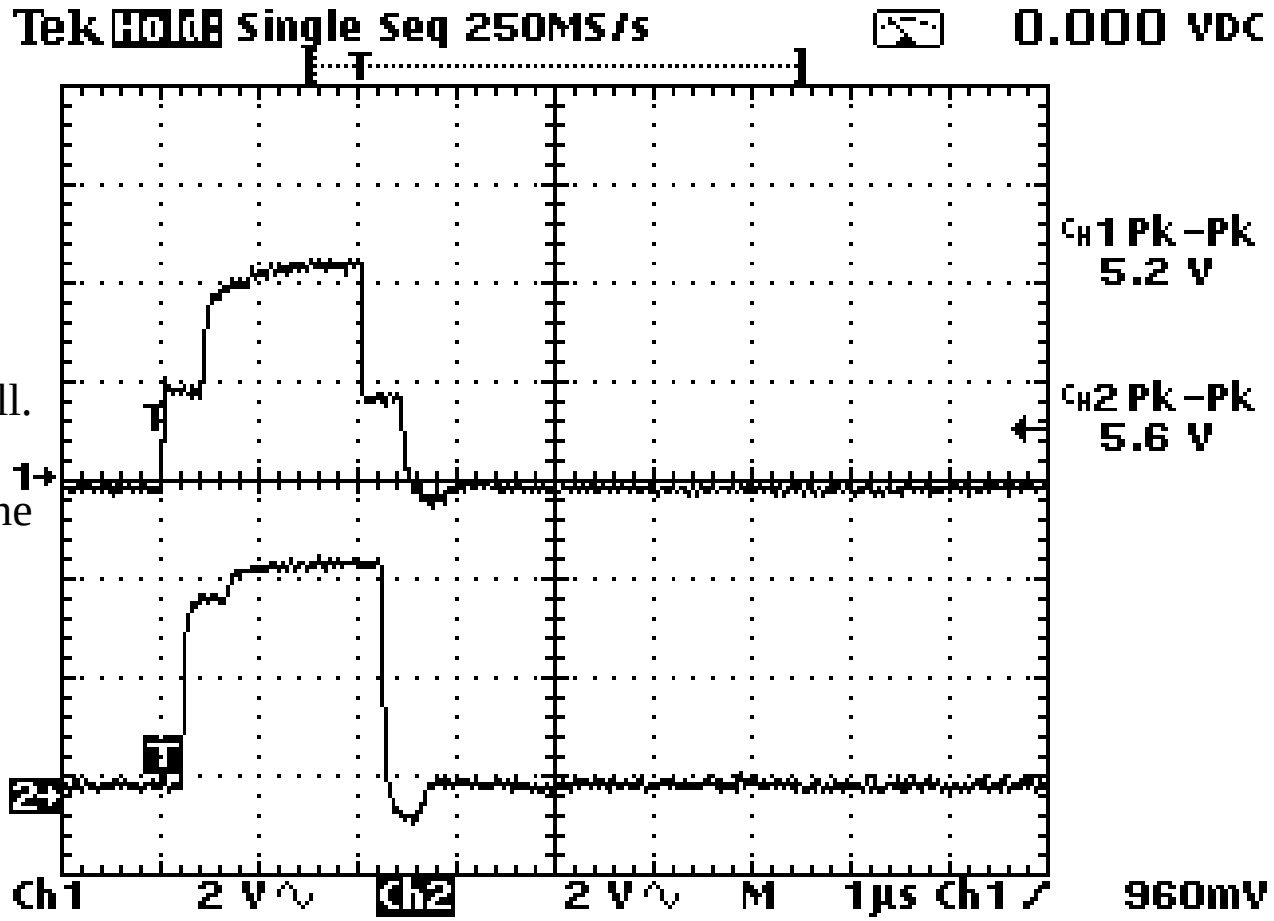
NO resistor at scope

Typical Scope

I REMOVED the resistor at the scope.

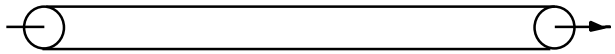
The upper trace 1 is a 2 microsecond (µsec) impulse from the test unit. The lower trace 2 is what was recorded at the scope.

Note that the distortion and magnitude changes are relatively small. Note the "loading" of the test set by impedance reflections.



Experiment E

What happens if I use 50 ohm coaxial cable?
(100 foot)



50 ohm coaxial cable

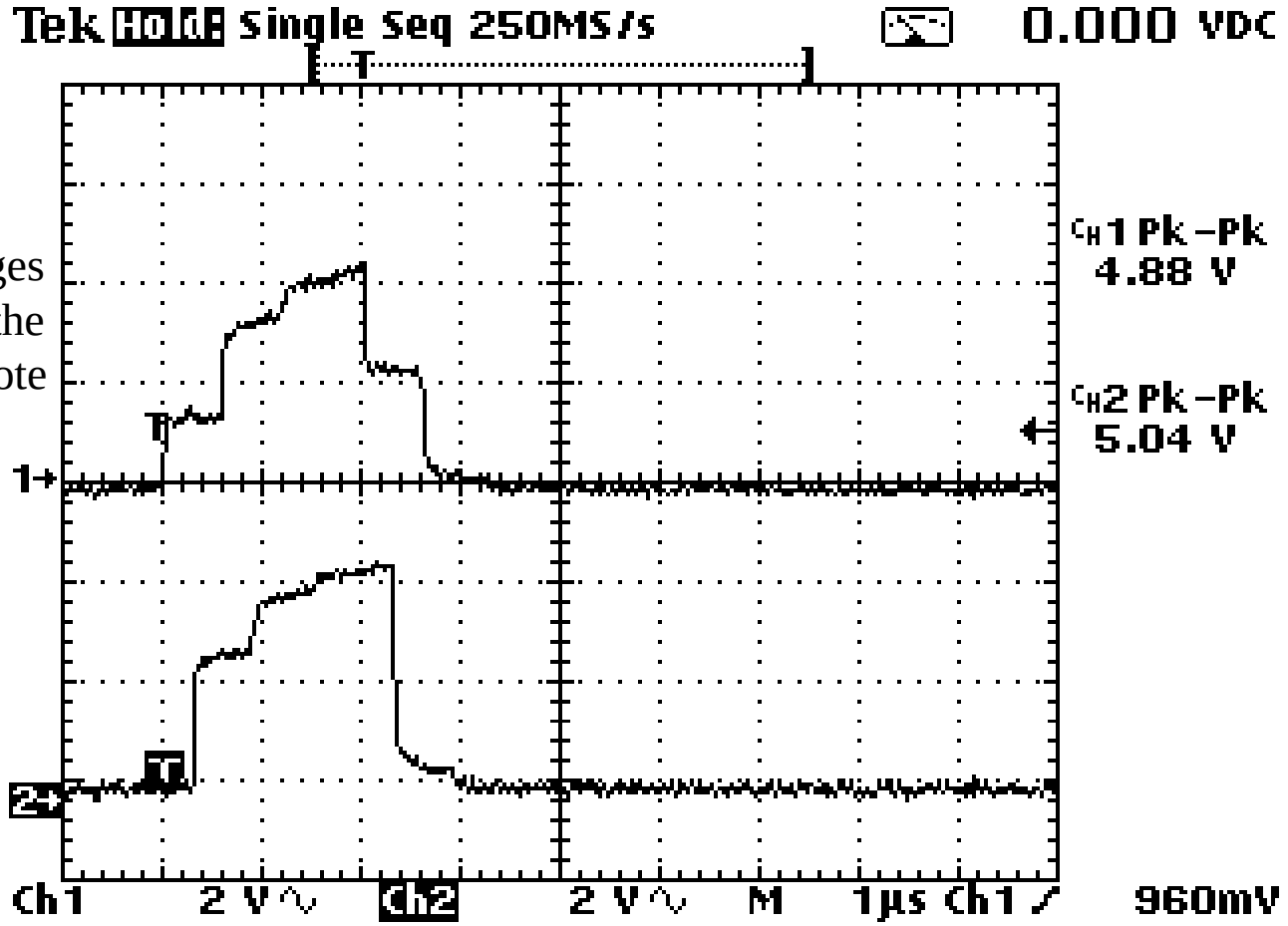
Mr. Pulsar
at cow contact
Rs=102 ohms

Typical Scope

I ADDED a 500 ohm resistor at the scope.

The upper trace 1 is a 2 microsecond (µsec) impulse from the test unit. The lower trace 2 is what was recorded at the scope.

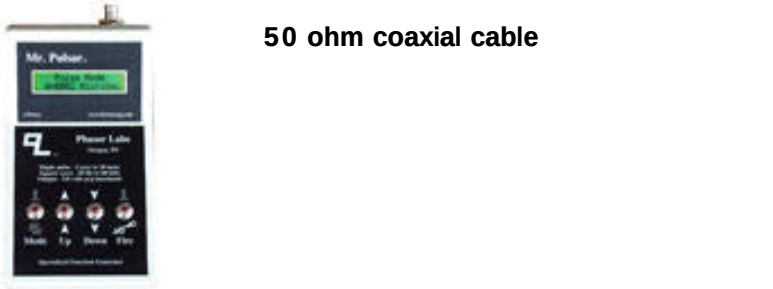
Note that the distortion and magnitude changes are greater than the single wires. Note the “loading” of the test set by impedance reflections.



Experiment F

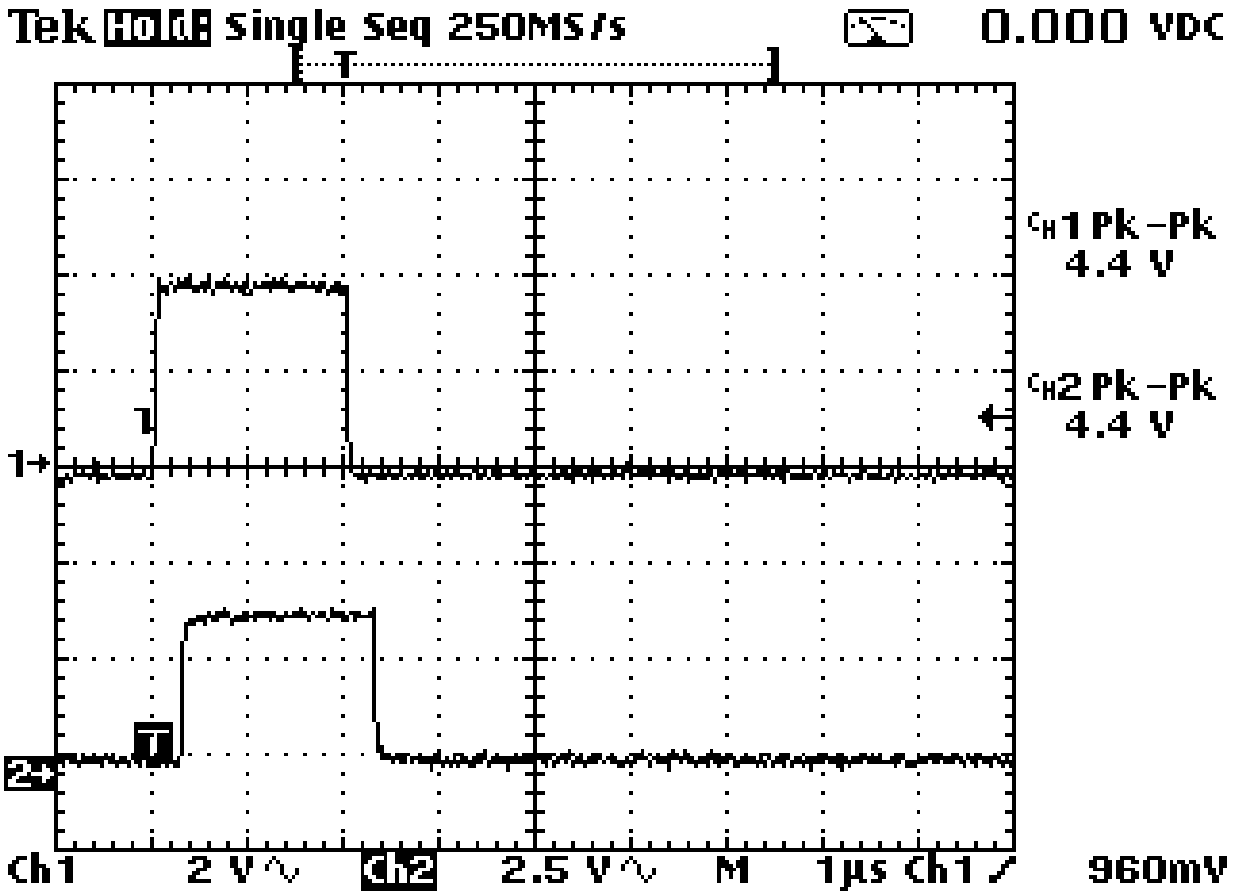
What happens if I use 50 ohm coaxial cable?
(100 foot)

I ADDED a 50 ohm resistor at the scope.



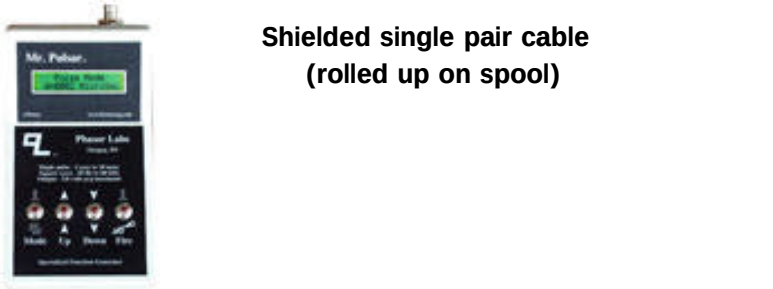
The upper trace 1 is a 2 microsecond (µsec) impulse from the test unit.
The lower trace 2 is what was recorded at the scope.

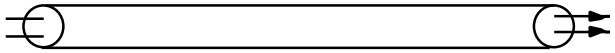
Note that the minimum change in duration and magnitude occurs. There is some reduction in magnitude.



Experiment G

WhatWhat happens if I use shielded cable with a twisted pair? (100 foot)





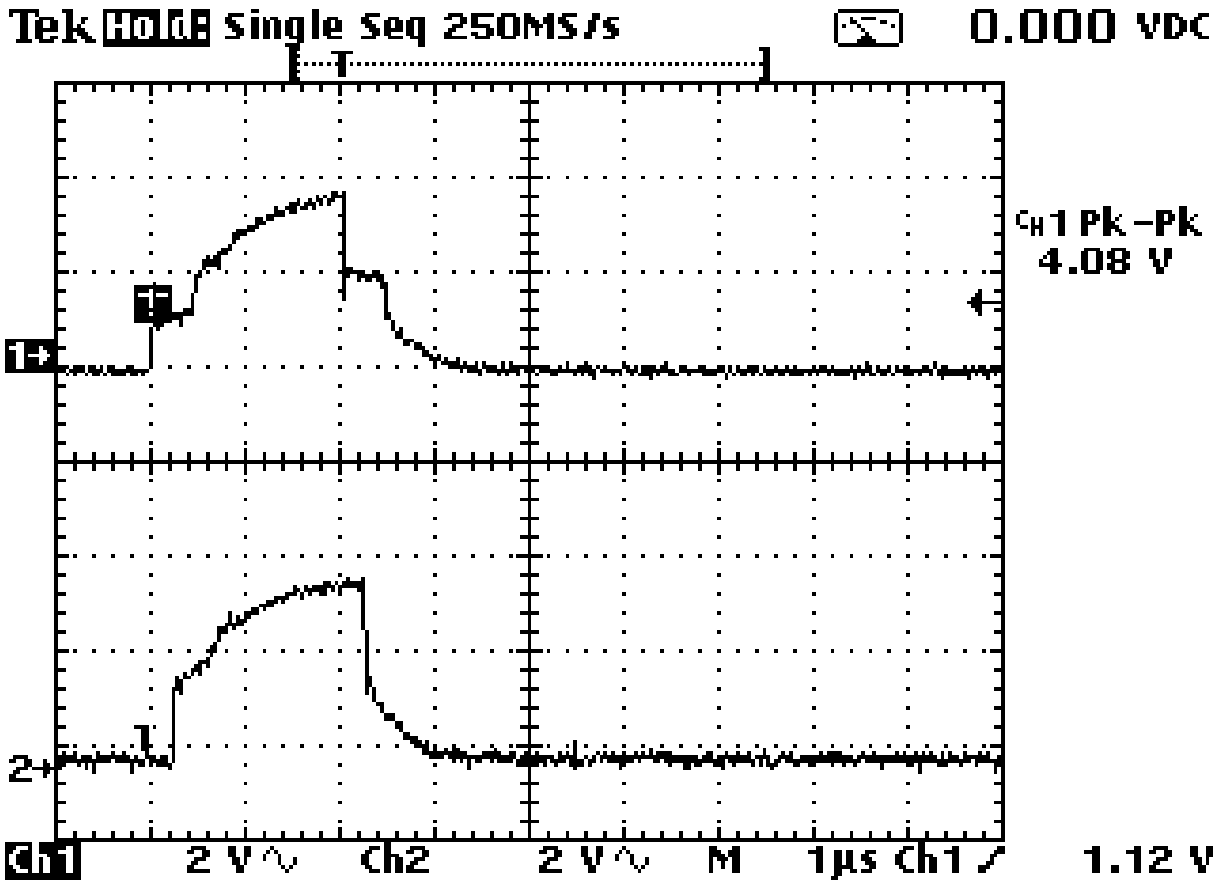
Shielded single pair cable
(rolled up on spool)

Typical Scope

I ADDED a 500 ohm resistor at the scope.

The upper trace 1 is a 2 microsecond (µsec) impulse from the test unit.
The lower trace 2 is what was recorded at the scope.

Note the "loading" of the test set by impedance reflections. Still pretty good!



Now… the rest of the story

What is it that NONE of the above test lead connections can prevent…that is what can provide a false reading at the scope or meter?

Magnetic pickup

Sheilded conductors, unless enclosed in steel conduit, are suseptable to induced voltages from nearby magnetic fields. The shielded conductors do attenuate electric fields.

What are some sources of magnetic fields on the farm?…..

Magnetic Fields...

A large current surge through a branch circuit or secondary service conductor.

Local storms create magnetic and electric fields.

Adjacent to ballasts or transformer windings.

Cow ID systems…… Any more????????

But… you say ...

I only measure for 60 Hertz steady state…

Why not use the best techniques possible, even if it is not required at this time.

How about checking for fencer/trainer pulses??

If you do not have the proper connection lead wire...

To measure short duration impulses simply move your scope to the cow contact point and use short leads from the scope.

Check with and without the 500 ohm resistor.

Be sure to disconnect the other wire connections to the cow contact point. Why??

To be continued……..

See Part 2 to follow….

Keep an eye on:

www.phasorlabs.com