

## Oscilloscope Basics

Todd Montevideo  
Director – System Protection and  
Control  
Wisconsin Public Service Corporation

## Purpose of Today

Purpose of this training is to help you to set up the scope properly to take meaningful measurements.

Best way to get good at using an oscilloscope is to practice taking measurements and refer to the manual.

## Purpose of this Discussion

- Explain the Basic Components of an Oscilloscope
- Explain the How Specific Settings Impact the Measurements

## Outline

- Oscilloscope Safety
- Oscilloscope Block Diagram
- Oscilloscope Specifications/Probe Specifications
- Oscilloscope Setting (What do they mean?)

## What is an Oscilloscope

- Device that can display a parameter that varies over time
  - Voltages
  - Currents
  - Pressures
  - Temperatures
  - Anything that can be measured and converted to a voltage

## Focus Today

- Measurements of Voltages
  - Steady State Measurements
    - Voltage Distortion
    - Repetitive Events
  - Transients
    - Fencers/Trainers
    - Voltage Changes Due to Faults
    - Motor Starts
    - Other Transients

## Focus Today

- Oscilloscopes Can Also Measure or Display
  - Radio Signals
  - TV Signals
  - EMI from Lighting
  - EMI from Malfunctioning Equipment

## Safety

- All Electrical Instruments Have Their Limitations (Including Oscilloscopes)
  - Know the limits of your instrument
  - Know the system you are taking measurements on

## Safety

- Scope Input

### Safety



Designed to Installation Category III per IEC 1010, CSA C22.2 (including approval), and UL1244 (including approval) for 600V measurements on industrial power distributions systems.

MAX. Input voltage on .....300V rms, 600V rms with  
INPUT A or INPUT B 10:1 probe

## Safety

- Scope Probes

### Passive Probe 10:1 (PM8918)

Attenuation: x10

Useful Bandwidth: 100 MHz

Input resistance: 10 MΩ

Input capacitance: 15 pF

Cable length: 1.5m

Max. signal Voltage: 600V rms

Max. surge Voltage: 6 kV

Max. Voltage to Ground: 600V rms

Double insulated per IEC1010-1 for 600V.



## Safety

### BNC Connectors

- Supplied Probes Typically Insulated



- BNC to Banana Connectors  
(May not be insulated)



## Oscilloscope Current Probes

### Specifications


Nominal current range	10 A 100 A 1000 A
Continuous current range	0.1 A - 10 A 0.1 A - 100 A 1 A - 1000 A
Maximum Non-Destructive Current	2000 A
Lowest measurable current	0.1
Basic Accuracy	1% + 1 A (48-65 Hz) (% reading + floorspec)
Useable frequency	5 Hz - 100 kHz
Output level(s)	100 mv/A 10 mv/A 1 mv/A



### Safety Specifications

Safety	CAT III, 600 V CAT IV, 300 V
Maximum voltage	600 V AC


### Safety



Specifications	
Nominal current range	400A
Continuous current range	1 A - 400 A
Maximum Non-Destructive Current	1000 A
Lowest measurable current	1 A
Basic accuracy	2% + 0.06 A (45-400 Hz) (% reading + floorspec)
Useable frequency	5 Hz - 20 kHz
Output level(s)	1 mA/A

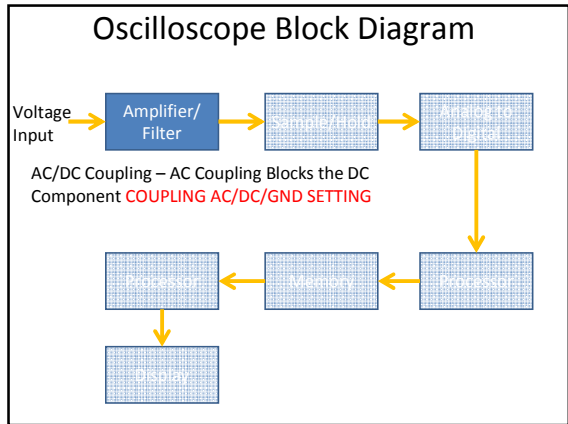
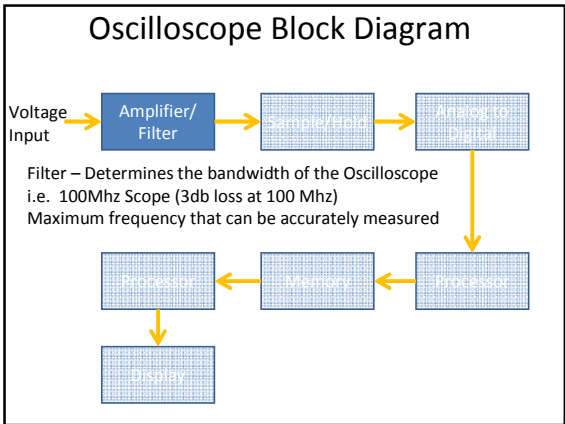
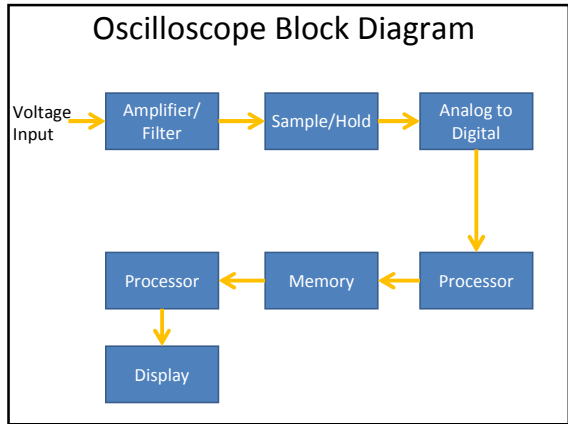
**Do Not Connect these to an Oscilloscope!  
Oscilloscopes Have Voltage Inputs Not Current**

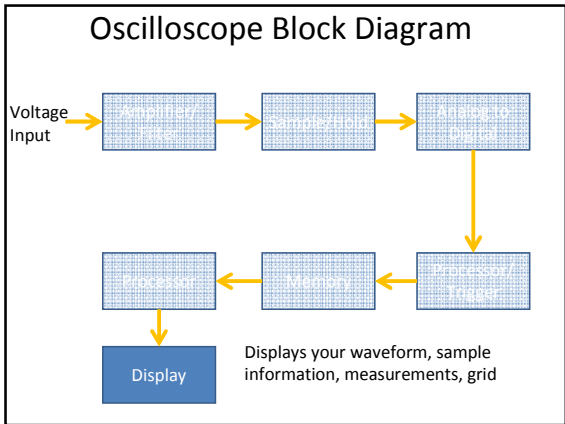
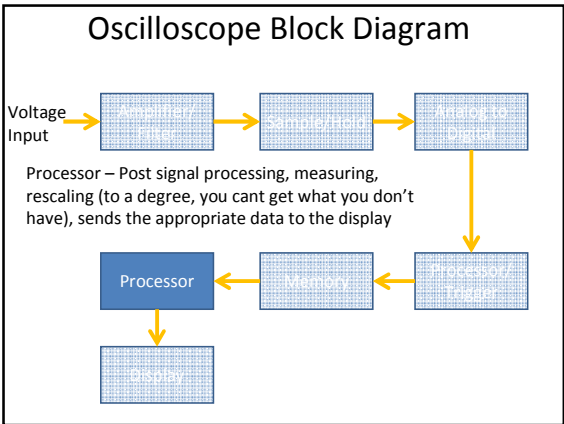
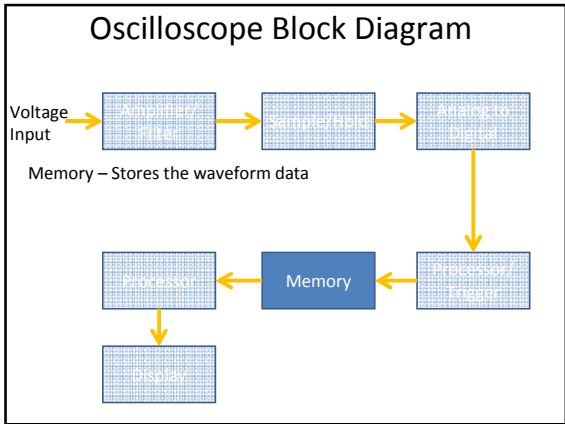
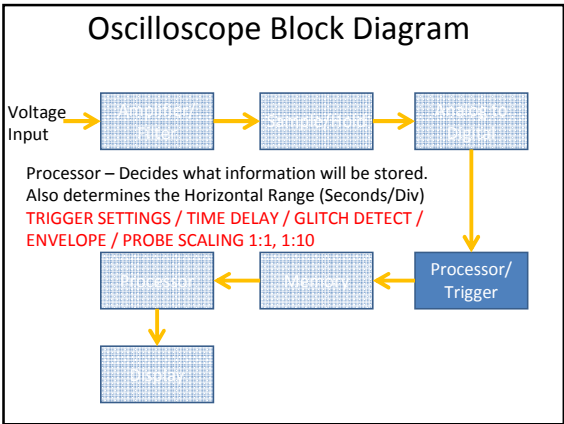
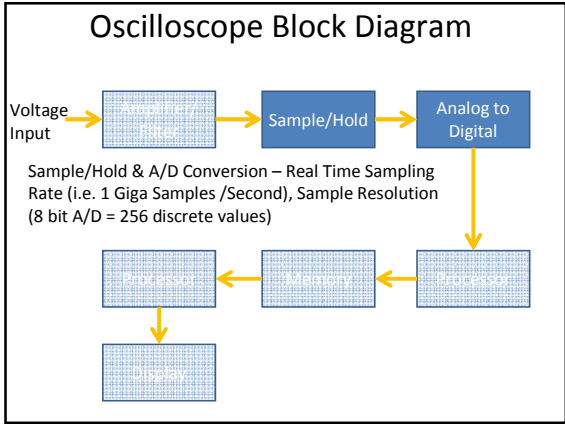
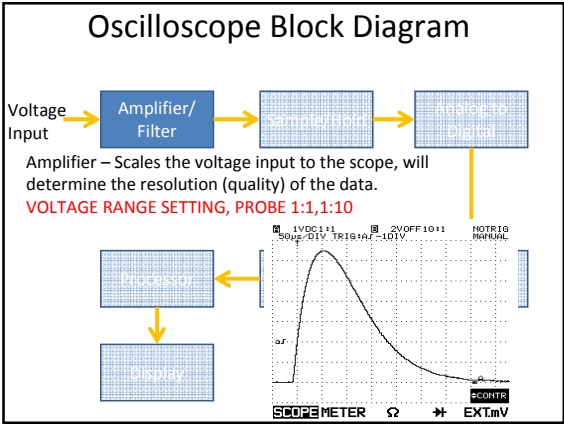
### Safety



**Often Electrically Connected**

Safety Questions?





## Oscilloscope Specifications

Specifications	
Bandwidth	Fluke 199C: 200 MHz Fluke 196C: 100 MHz Fluke 192C: 60 MHz
Real-time sample rate	Fluke 199C: 2.5 GS/s Fluke 196C: 1 GS/s Fluke 192C: 500 MS/s
Inputs and digitizers	2 plus external / DMM input
Independently floating isolated inputs	Up to 1000 V between inputs, references and ground
Timebase range	5 ns - 2 min/div 10 ns - 2 min/div (192B)
Input sensitivity	190C Models: 2 mV-100 V/div
Trigger types	190C Models: Connect-and-View™, Free Run, Single Shot, Edge, Delay, Video, Selectable pulse width and External Dual slope trigger and Event trigger (n-cycle)
Glitch capture	50 ns (5 μs/div - 1 min/div)

## Oscilloscope Specifications

- Probes

- Passive Probe 10:1 (PM8918)**

- Attenuation: x10

- Useful Bandwidth: 100 MHz

- Input resistance: 10 MΩ

- Input capacitance: 15 pF

- Cable length: 1.5m

- Max. signal Voltage: 600V rms

- Max. surge Voltage: 6 kV

- Max. Voltage to Ground: 600V rms

- Double insulated per IEC1010-1 for 600V.



## Determining Scopemeter Settings

- Consider

- What is the voltage range of the measurement?
  - How fast does the event take place?
  - Does the event repeat?
  - Are you interested in AC, DC or both portions of the signal?
  - Is the shape of the event important?

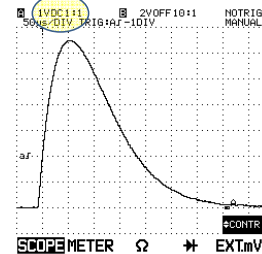
The answers will help you to set up the scope

## Scope Setting – Voltage Range (Vertical Axis)

- Display the waveform as large as possible
- 1 volt dc/division

$$(6.5 \text{ div} \times 1 \text{ volt/div}) = 6.5 \text{ volts}$$

Fencer Waveform

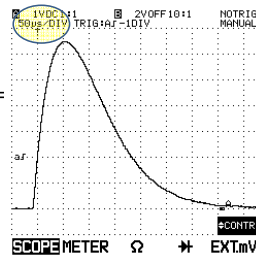


## Scope Setting – Time Range (Horizontal Axis)

- How long does it last
- 50 microSec/div

$$(6 \text{ div} \times 50 \text{ microSec/div}) = 300 \text{ microSec} (0.3 \text{ mS})$$

Fencer Waveform

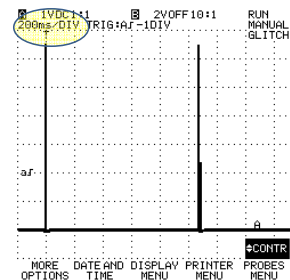


## Scope Setting – Time Range (Horizontal Axis)

- Time between pulses
- 200 mS/div

$$(5.2 \text{ div} \times 200 \text{ mS/div}) = 1040 \text{ mS} (1.04 \text{ Seconds})$$

Fencer Waveform



### Scope Settings - Inputs

- Selects the Input A and/or Input B
  - Each has AC/DC/Gnd Setting
  - The AC setting will block DC (i.e. a 12 volt battery on AC will read 0 volts)

– GND helps you find 0 v

### Scope Settings - Inputs

- Scaling Factor 1:1 probe / 10:1 probe
- Make sure to match up the scaling factor to the probe type (use 1:1 if using a BNC to Banana Adapter)

### Scope Settings – Glitch Detect

Use Glitch Detect when the waveform you are trying to capture is significantly faster than your Time Range (in this case Waveform=0.3 ms, Time Range=200 mS)

### Scope Settings – Trigger Source

#### Trigger A vs. Trigger B

Is the signal being measured the one to trigger on?

Examples: Fencer – yes  
AMR - no

### Scope Settings - Trigger

Adjust Level and Rising vs Falling Edge (voltage level to trigger on)

Rising Edge  
A Input

### Scope Settings – Trigger Time Delay

Adjust how much pre trigger information is shown

## Scope Settings – Trigger Other

- Trace Repeat
  - Single – Scope will trigger and display the waveform then wait for user to press HOLD/RUN
  - Recurrent – Scope will trigger and display the waveform, it will not wait for the user to press HOLD/RUN before triggering again
- Trace Start
  - Free Run – Scope will not wait for a trigger, it will display the waveform after HOLD/RUN is pressed
  - Wait for Trigger – Scope will wait for the trigger after HOLD/RUN is pressed before it captures and displays the waveform

## Settings

### **Use of the Fluke 105B ScopeMeter on the Farm**

**Contains more explanation and detail**

Questions ?