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
  - 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 INPUT A or INPUT B: 300V rms, 600V rms with 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: 8 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

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Safety Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal current range</td>
<td>CAT IE 600 V</td>
</tr>
<tr>
<td>Continuous current range</td>
<td>CAT IV, 300 V</td>
</tr>
<tr>
<td>Minimum non-destructive current</td>
<td>600 V AC</td>
</tr>
<tr>
<td>Basic accuracy</td>
<td>CAT I, CAT II</td>
</tr>
<tr>
<td>Usable frequency</td>
<td>CAT III, CAT IV</td>
</tr>
<tr>
<td>Output levels</td>
<td>CAT III, CAT IV</td>
</tr>
<tr>
<td>Max. 10 mV/A</td>
<td>Max. 10 mV/A</td>
</tr>
<tr>
<td>Max. 10 mV/A</td>
<td>Max. 10 mV/A</td>
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<tr>
<td>Max. 10 mV/A</td>
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</tr>
</tbody>
</table>
Safety

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

Safety

Often Electrically Connected

Oscilloscope Block Diagram

Safety Questions?

Oscilloscope Block Diagram

Filter – Determines the bandwidth of the Oscilloscope i.e. 100MHz Scope (3db loss at 100 MHz)

Maximum frequency that can be accurately measured

Oscilloscope Block Diagram

AC/DC Coupling – AC Coupling Blocks the DC Component COUPLING AC/DC/GND SETTING
Oscilloscope Block Diagram

**Voltage Input** -> **Amplifier/Filter**

Amplifier – Scales the voltage input to the scope, will determine the resolution (quality) of the data.

VOLTAGE RANGE SETTING, PROBE 1:1, 1:10

**Sample/Hold & A/D Conversion** – Real Time Sampling Rate (i.e. 1 Giga Samples /Second), Sample Resolution (8 bit A/D = 256 discrete values)

**Analog to Digital** -> **Memory**

Memory – Stores the waveform data

**Processor**

Processor – Decides what information will be stored. Also determines the Horizontal Range (Seconds/Div)

TRIGGER SETTINGS / TIME DELAY / GLITCH DETECT / ENVELOPE / PROBE SCALING 1:1, 1:10

**Display**

Displays your waveform, sample information, measurements, grid

**Processor** – Post signal processing, measuring, rescaling (to a degree, you can't get what you don't have), sends the appropriate data to the display
Oscilloscope Specifications

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandwidth</td>
<td>Phase 199C: 200 MHz</td>
</tr>
<tr>
<td></td>
<td>Phase 199C: 100 MHz</td>
</tr>
<tr>
<td></td>
<td>Phase 192C: 60 MHz</td>
</tr>
<tr>
<td>Real-time sample rate</td>
<td>Phase 199C: 2 GHz</td>
</tr>
<tr>
<td></td>
<td>Phase 199C: 1 GHz</td>
</tr>
<tr>
<td></td>
<td>Phase 192C: 500 MHz</td>
</tr>
<tr>
<td>Inputs and digitizers</td>
<td>2 plus external/DARM</td>
</tr>
<tr>
<td></td>
<td>inputs</td>
</tr>
<tr>
<td>Independently floating</td>
<td>up to 1000 V between</td>
</tr>
<tr>
<td></td>
<td>inputs, references, and</td>
</tr>
<tr>
<td></td>
<td>grounds</td>
</tr>
<tr>
<td>Timebase range</td>
<td>1 ns - 2 microsec</td>
</tr>
<tr>
<td></td>
<td>0 ns - 2 microsec (10 G)</td>
</tr>
<tr>
<td>Input sensitivity</td>
<td>1900 Models: 20 kV/100 V/</td>
</tr>
<tr>
<td>Trigger types</td>
<td>1900: Connect and View™,</td>
</tr>
<tr>
<td></td>
<td>Fast Rise, Slow Rise,</td>
</tr>
<tr>
<td></td>
<td>Edge, Delay, Video</td>
</tr>
<tr>
<td></td>
<td>Selectable pulse width</td>
</tr>
<tr>
<td></td>
<td>and external</td>
</tr>
<tr>
<td>Glitch capture</td>
<td>50 ns (3 microsec - 1 microsec)</td>
</tr>
</tbody>
</table>

Oscilloscope Specifications

• Probes
  Passive Probe 10:1 (PM8918)
  Attenuation: x10
  Useful Bandwidth: 100 MHz
  Input resistance: 10 MΩ
  Input capacitance: 15 pF
  Cable length: 1.5 m
  Max. signal Voltage: 600 V rms
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  Max. Voltage to Ground: 600 V rms
  Double insulated per IEC 1010-1 for 600 V.

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 div x 1 volt/div) = 6.5 volts

Fencer Waveform

Scope Setting – Time Range (Horizontal Axis)

• How long does it last
• 50 microSec/div

(6 div x 50 microSec/div) = 300 microSec (0.3 mS)

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)

**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?