Electronic Measurements Safety

Commitment to Safety Innovation
Special Postdoc Unit
(CSI-SPU)

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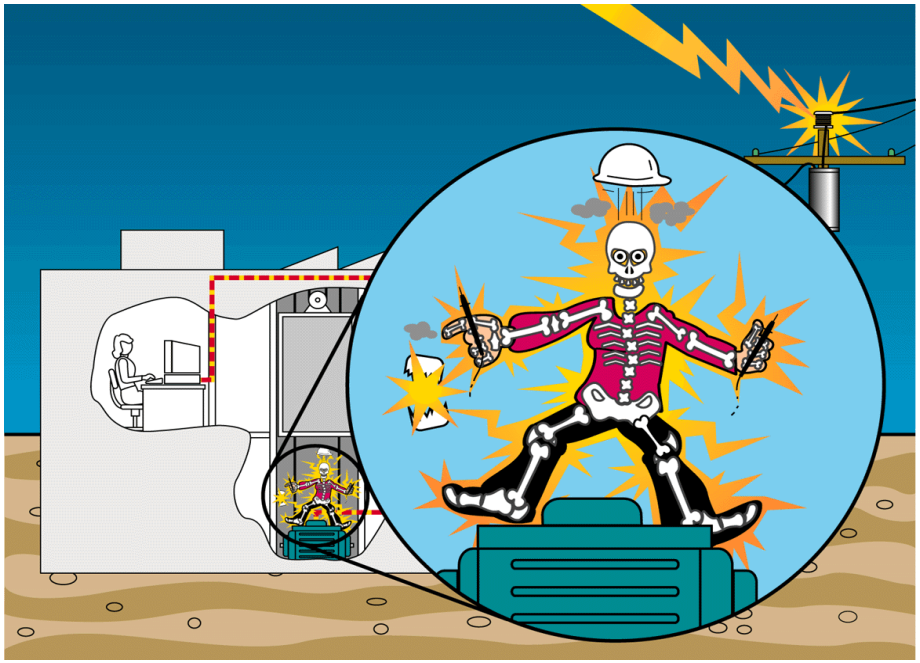
Introduction

- Measurement tools safety
  - Digital MultiMeter (DMM)
  - Oscilloscpe
- Common sources of danger
  - Circuit grounding
  - Voltage source combination
  - Temporary circuits
- Current limits



Measurement tools safety - DMM

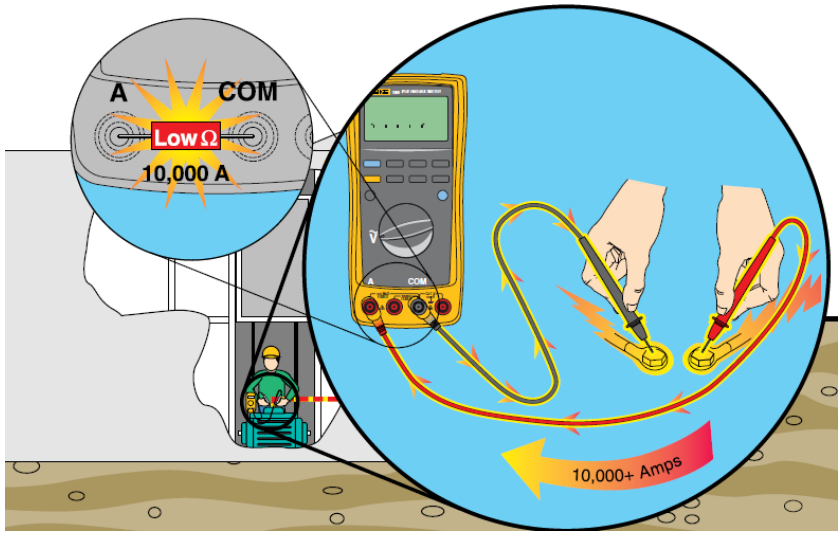
- What electrical power can do to a DMM???

How not to save time...

This DMM had a hot date with 13.8 kV…

- Now, guess what electrical power can do to you!!!

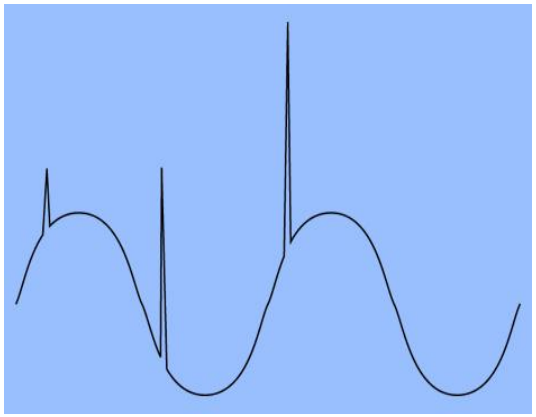
Common DMM hazards



- Measuring voltage with test leads in current jacks
  - Protection:
    - High energy fuses rated to the meter's voltage rating
    - Use meters / testers without current jacks

- Voltage contact while in continuity or resistance
  - Protection:
    - Overload protection in OHMs up to the meter's volt rating

Common DMM hazards



- Arc from transients (lightning, load switching)
  - Protection:
    - Independent certification to meet CAT III-1000 V or CAT IV 600 V
    - Compliance with Argonne's safety standards

- Shock from accidental contact with live components
  - Protection:
    - Test Leads double insulated, recessed / shrouded, finger guards, CAT III – 1000 V. Replace when damaged
    - Power equipment ON AFTER connection

- Using meter or tester above rated voltage
  - Protection:
    - Good karma!!!
    - Never do it

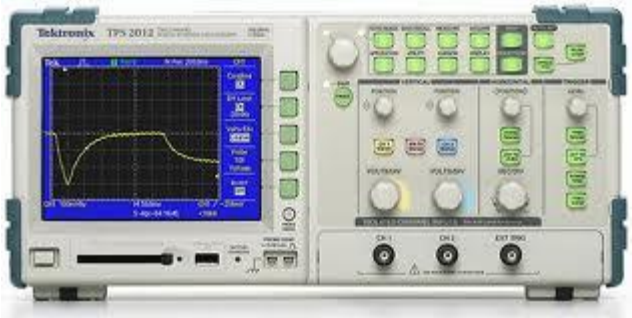
DMM safety takeaways

- Only used approved DMMs
- No meter is safe when improperly used
- Use meters within their rating or even with a safety buffer
- Use replacement fuses approved by the manufacturer

Measurement tools safety - Oscilloscope

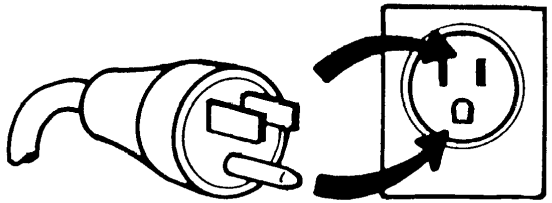
- Oscilloscopes have dangerous levels of voltage inside them

- Some precautions to be followed while using them include:
  - Use an insulated floor material or insulated work surface
  - Keep one hand in your pocket when using a scope probe
  - Remember that ac power may be present in the equipment even when it is turned off
  - Use an isolation transformer whenever the equipment's power plug is two-prong only



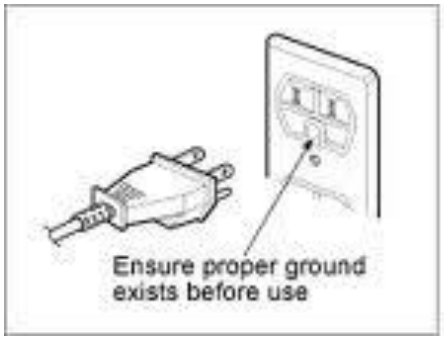
Measurement tools safety - Oscilloscope

- Don’t operate the oscilloscope with the cover removed
- Keep the scope grounded with the 3-wire power plug. Don’t attempt to defeat the third prong or "float" the scope
- Don’t apply excessive voltage to the scope’s input jacks
  - RMS vs. Peak-to-Peak!!!
- Connect the ground clip of a scope probe only to earth ground or isolated common in the equipment under test



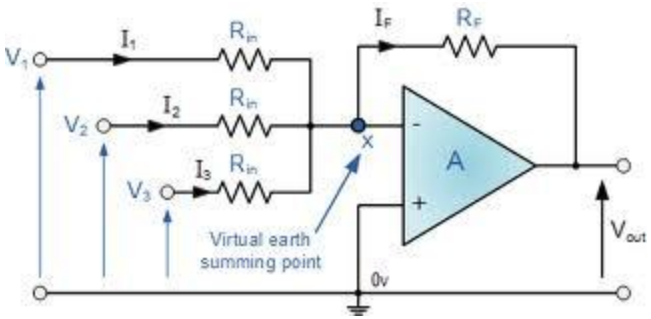
Common sources of danger – Circuit grounding

- "Taping" the ground lead to the lab floor is not grounding
  - Actual observation in Grad. School
- Only equipment with three-prong plugs should be used.
  - The third prong provides a path to ground that helps prevent the buildup of voltages that may result in an electrical shock or spark
  - This does not guarantee that no one will receive a shock, be injured, or be killed
  - It will, however, substantially reduce the possibility of such accidents, especially when used in combination with other safety measures
- You are the "ground" if your circuit does not have one!!!



Common sources of danger – Voltage source combination

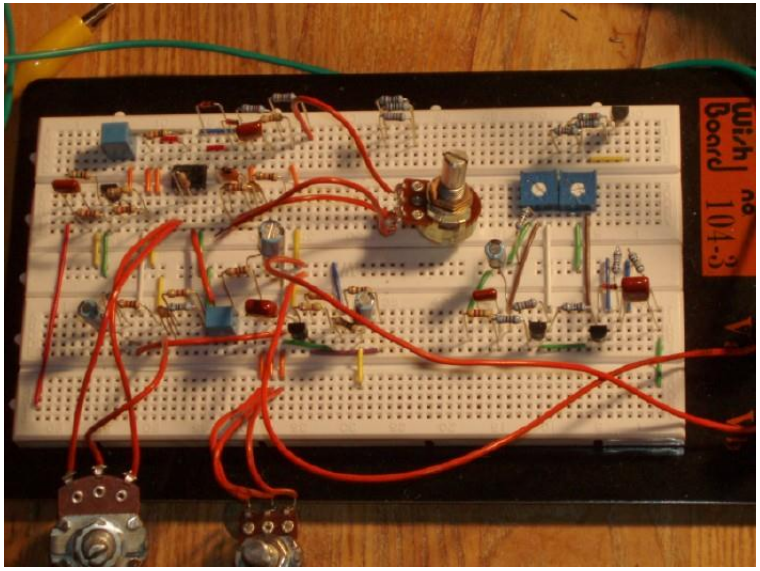
- Never physically add two separate grounded voltage sources together
  - Unlike batteries

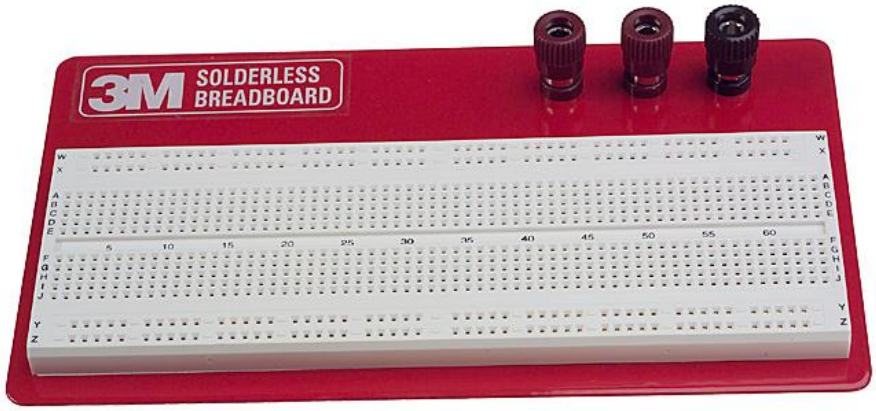


- Use a voltage adder circuit
  - Resistors and OpAmps
  - Resistors and Current PreAmps

Common sources of danger – Temporary circuits

- Avoid whenever possible
- Enclosed box
  - More robust and safe
- If absolutely necessary, use approved solderless breadboards





Current limits

BODILY EFFECT	DIRECT CURRENT (DC)	60 Hz AC	10 kHz AC
Slight sensation felt at hand(s)	Men = 1.0 mA	0.4 mA	7 mA
	Women = 0.6 mA	0.3 mA	5 mA
Threshold of perception	Men = 5.2 mA	1.1 mA	12 mA
	Women = 3.5 mA	0.7 mA	8 mA
Painful, but voluntary muscle control maintained	Men = 62 mA	9 mA	55 mA
	Women = 41 mA	6 mA	37 mA
Painful, unable to let go of wires	Men = 76 mA	16 mA	75 mA
	Women = 51 mA	10.5 mA	50 mA
Severe pain, difficulty breathing	Men = 90 mA	23 mA	94 mA
	Women = 60 mA	15 mA	63 mA
Possible heart fibrillation after 3 seconds	Men = 500 mA	100 mA	
	Women = 500 mA	100 mA	

- “It's not voltage that kills, its current!”
  - The principle that "current kills" is essentially correct
  - However it is the Voltage that leads to current
- Most electrical circuits can provide, under normal conditions, up to 20,000 mA of current flow

Thank You!!!

Q&As???