

ECE 528 – Understanding Power Quality

<http://www.ece.uidaho.edu/ee/power/ECE528/>

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Today...

- HW7 and Final Questions?
- Safety
- Power quality instruments and analyzers
 - Handheld meters
 - Handheld Power Quality Analyzers
 - Monitors and recorders
 - Advantages and disadvantages of different features
 - Permanent recorders
 - Deciding what to record and where

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Safety

- Why is safety even more important in power quality work?
 - Power quality work requires the equipment to be energized while measurements are made
 - An electrical problem with the equipment may exist and may be causing the symptoms you are there to investigate
- Qualified Person (2014 NEC)
 - “One who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved.”*
 - Specific safety practices and requirements are outside the scope of this class

Safety

- The hazards
 - Electrical Shock
 - Results from contact allowing current flow through the body
 - May result in fibrillation
 - Burns
 - contact – current
 - Flash – radiant
 - Impact
 - Blast energy and shrapnel

Safety

- FR – Fire Resistant Clothing
 - Designed to absorb heat energy and not sustain flame
 - Rated in calories/cm²
- PPE – Personal Protective Equipment
(Gloves, safety glasses, ear plugs, face shield, hard hat, hood, boots)
 - Insulation from contact
 - Reduced exposure to arc energy
 - Some protection from shrapnel and other blast effects

Copper expands about 67,000 times its original volume when it vaporizes

Arc temperature can be about 35,000 deg-F at arc

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Choosing instruments and analyzers

- What do you need to know?
 - Basic electrical parameters
 - RMS voltage and/or current
 - Single-phase or three-phase
 - Waveforms of voltage and/or current
 - Waveforms of transient events – frequency?
 - Calculated parameters
 - Power
 - Imbalance
 - Harmonics / Voltage distortion

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Choosing instruments and analyzers

- How much do you want (or need) to know?
 - Spot measurements
 - Logging at specific intervals
 - Triggered events
 - Customizable triggers? – different parameters, magnitudes
 - Continuous recording
 - Memory issues – how long before data is lost
 - Usually, continuous monitoring (not recording) with periodic logging and triggering is used

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Basic instruments DMM: Digital Multimeter

- Single-phase, single parameter instrument
- True RMS
- May include built-in current clamp, or use external clamps
- May measure other parameters
 - Frequency
 - Capacitance
 - Resistance
 - Crest Factor
- Some models may have recording capability



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Picture from Fluke Inc.

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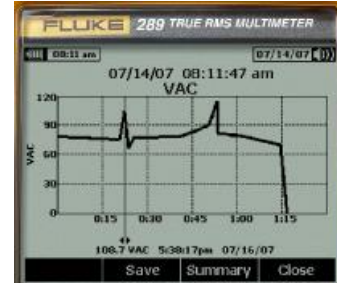
DMMs: More advanced functions



On-screen menus and help



Recording



Plotting of recorded data

Data can be downloaded to a computer for analysis and reporting

Pictures from Fluke Inc.

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The next step up: Handheld power quality analyzers

- Measures voltage and current simultaneously
 - Necessary for power values (W , VA , VAR , PF , etc.)
- Additional functions
 - Sags, swells
 - Transients
 - Inrush current
 - Harmonics - THD, individual harmonic magnitudes, etc.
 - Basic oscilloscope functions
- Some triggering and recording capabilities
- Will save data for analysis and reporting

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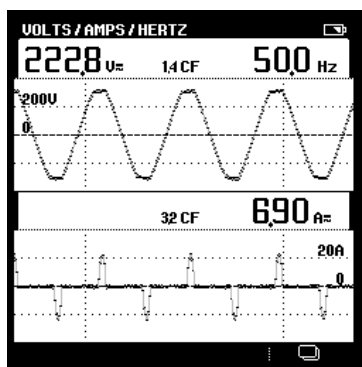
Handheld power quality analyzers

- Single-phase (2-channel)
 - (1 voltage and 1 current channel)
- Three-phase (8-channel)
 - (4 voltage and 4 current channels)
 - Adds automatic calculation of three phase parameters
 - Voltage imbalance, three-phase power, etc.
 - Connections become important
 - On-screen connection diagrams are helpful

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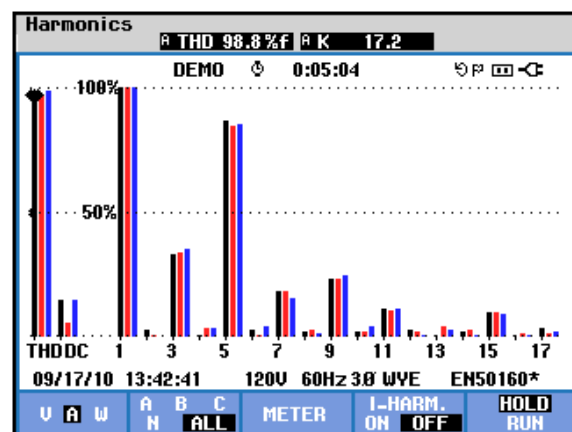
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Handheld power quality analyzers Some function examples



RMS voltage and current with waveforms

Pictures from Fluke Inc.

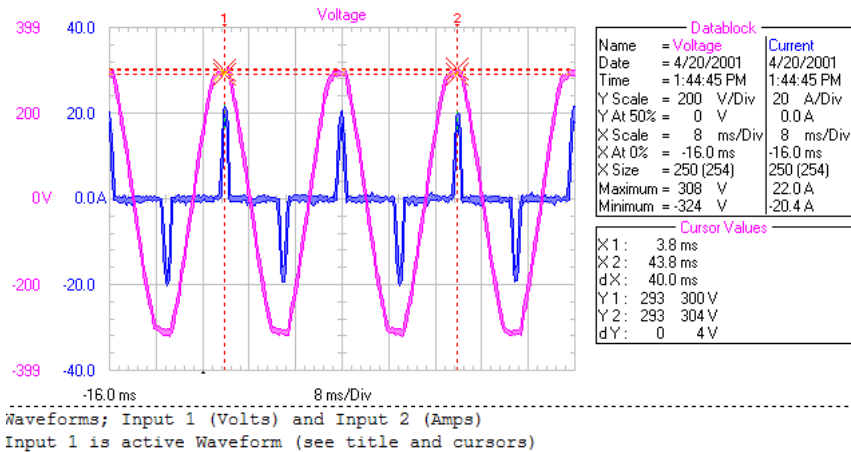


Three-phase harmonic current with THD and K factor

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Handheld power quality analyzers Looking at the data with a computer



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Monitors and recorders - From basic to advanced

- Power Quality Monitoring (from the class text):
 - *The process of gathering, analyzing, and interpreting raw measurement data into useful information.*
- Unconventional power quality monitors
 - Any device or condition that changes in an observable way as a result of some power quality issue can provide useful data
 - Digital clocks, analog clocks, incandescent lights, variable speed drives, computers, UPSs, irrigation control systems, etc., could all be considered to be basic power quality monitors

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Recorder features

- Basic recorder features
 - Logging of RMS voltage or current at specified intervals
 - No triggers – essentially just a digital strip-chart recorder
 - May record minimum and maximum values within an interval, but not specific duration data



Picture from AEMC.com

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Intermediate features

- Simple RMS voltage magnitude triggers
 - Record the time the RMS voltage left the normal bandwidth
- Automatic, internal triggers
 - Reduces installation time
 - Usually voltage triggering only
- Combined voltage channels
 - N-G, A-N, B-N, C-N
- These characteristics usually reduce the time it takes to install the recorder, but may also reduce the operator's options in conducting the investigation



Pictures from powermonitors.com

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Advanced features

- Highly customizable triggers
 - Triggering on multiple parameters
 - Triggering on parameters besides voltage or current
- Fully-independent voltage channels with individual ranges
 - Monitor multiple voltages simultaneously including DC
- On-board display and controls with real-time data display while recording continues
 - Allows the recorder to also serve as a meter or handheld analyzer

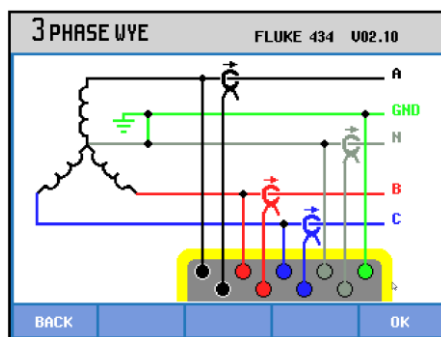


Standard Distortion UserFreq Unbalance Advanced			
Basic	Volts		Amps
Comp Basic	A	120.3	30.07
Power	B	120.3	30.07
Demand	C	120.3	30.07
Energy	D	9.986	10.02
Harmonics	A-B	209.3 *	
Flicker	B-C	209.3 *	
	C-A	206.3 *	

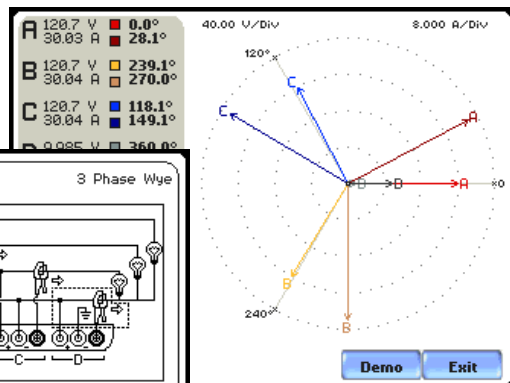
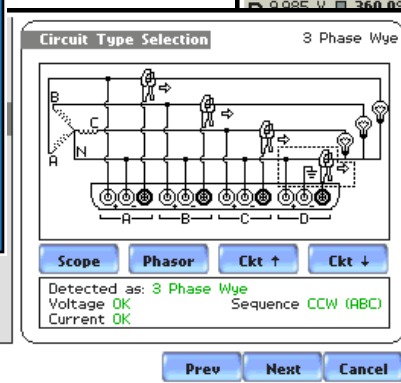
* Derived values

Pictures from dranetz.com

A few other useful features



Connection diagrams



Phasor display

What does your instructor use?

Note, this is not a recommendation or testimonial

- DMMs
 - Fluke 87III, 189, 289
 - An assortment of current probes
- Current clamp meters
 - AEMC 512
 - Fluke 360
- Oscilloscopes
 - Fluke 190-204 (4-channel, 200MHz)
- Ground Impedance tester
 - Fluke 1630
- Handheld PQ Analyzers
 - Fluke 43B, 434
- PQ Recorders
 - Power Monitors Inc. Eagle-440, Socket recorders, Eagle 120, Revolution with cell-modem
 - Dranetz PX5
 - PowerLogic ION 8650 permanent meters at large customers and similar at substations
- Infrared Camera
 - Flir E60 with 15mm lens (for overhead connections from the ground)

Next time...

- Last lecture!
 - Finish PQ recorders
 - Closing remarks