

## ECE 528 – Understanding Power Quality

<https://webpages.uidaho.edu/ECE/power/ECE528>

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### Lecture 29

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## Today...

- Power quality instruments and analyzers
- Data files and software
- Safety

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## Your turn to evaluate the course

### University of Idaho Vanc

Personal Information **Students** Faculty & Advisors

Search  Go

#### Students

Registration

Degree Audit & Transcript

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Graduation Application Status

Instructor / Course Evaluation

Online evaluations are available for the course on VandalWeb: Closes on May 7

## Power Quality instruments and analyzers: What does your instructor use?

Note, this is not a recommendation or testimonial

- DMMs
  - Fluke 87V, 189, 289
  - An assortment of current probes
- Current clamp meters
  - AEMC 512
  - Fluke 360
- Oscilloscopes
  - Fluke 190-204 (4-channel, 200MHz)
- Ground Impedance tester
  - AEMC 6417
- 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 15-degree lens (for overhead connections from the ground)

## Some less common tools:

- UV camera
  - Corona
  - Arcing connections
- Radio Frequency Interference tools
  - Receiver – Radar Engineers 243
  - Parabolic dish w/ultrasonic mic
  - Flir Ultrasonic Imager
  - Assorted antennas
- Sound meter
  - TSI Quest SP-DL-2
- Stray and contact voltage tools
  - An assortment of long leads, shunt resistors, copper plates, and probes
  - SVM-10 Stray voltage recorder (Power Monitors Inc.)

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## Other tools

- Tape measures and range finder
- Hair dryer and other test loads
- Screwdrivers and wrenches
- Electrical tape in different colors
- “Sharpie” markers
- Meter seals
- Meter bypass blades
- Extra-long meter leads (~200’)
- Flashlight
- Camera
- Voltage “pen”
- Spare fasteners

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## Remember the Power Quality Equation

$$\text{Electrical Disturbance} + \text{Path} + \text{Vulnerable Equipment} = \text{Power Quality Problem}$$

- Recorders can tell us about:
  - Disturbances – type, magnitude, duration, affected phases
  - Equipment – did it trip? Did it respond to the disturbance? Is it the source of the disturbance?
  - Exactly when things happen at different locations.
  - Multiple recorders – capture event at different locations

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## Deciding what to record and where - Reasons to record:

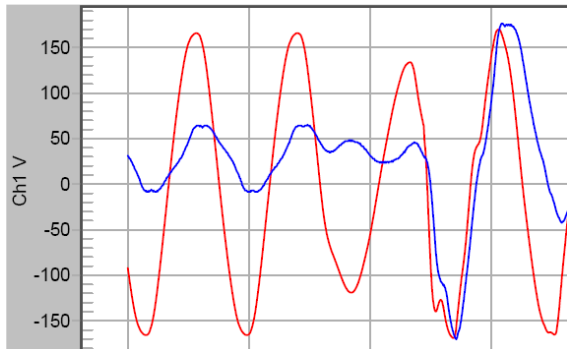
- Characterize system performance
  - Determine typical voltages, THD, harmonic content, daily energy profile, etc. – compare system to models
    - Remember IEEE Std. 1250 and EN 60150
  - Quantify sags, interruptions and outages
  - Collect “pre-change” data to help analyze system modifications
  - Identify pre-failure symptoms

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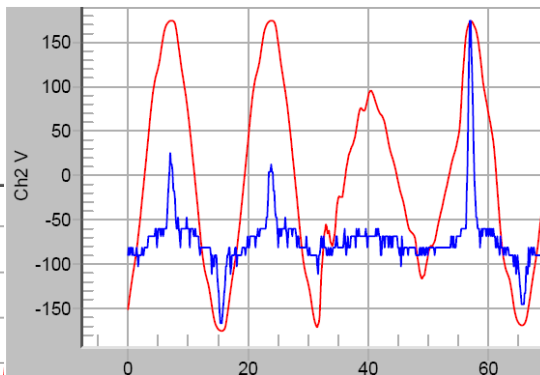
## Identifying pre-failure symptoms or other conditions requiring attention

Known tap-changer malfunction



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Recently recorded event

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## Reasons to record:

- Characterizing specific problems
  - Monitoring in specific locations to determine if equipment problems correlate with electrical system disturbances
  - Monitoring during the operation of suspect devices under controlled conditions
  - Monitoring in multiple locations to determine the extent of some condition or disturbance

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## Reasons to record:

- Facility or site surveys
  - May involve multiple problems
  - Extended monitoring or deliberate testing to quantify equipment vulnerability – what causes a trip?
  - Monitors at the PCC can help determine if an event is internal or external to a facility
  - This can reduce troubleshooting time following process trips
  - Multiple recorders may be required

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## PQ data file formats

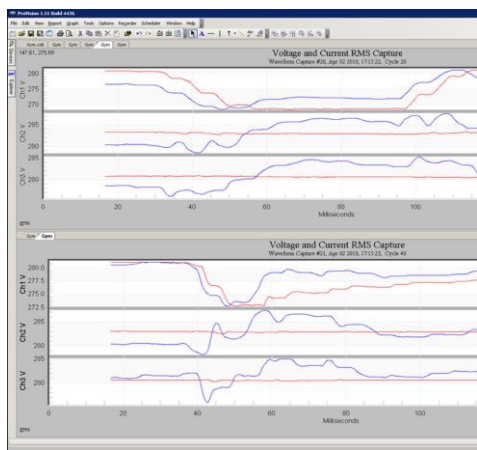
- PQDIF – Power Quality Data Interchange Format
  - defined in IEEE Std. 1159.3
- COMTRADE – Common Format for Transient Data Exchange for power systems – IEEE Std. C37.111
- Manufacturer's proprietary formats

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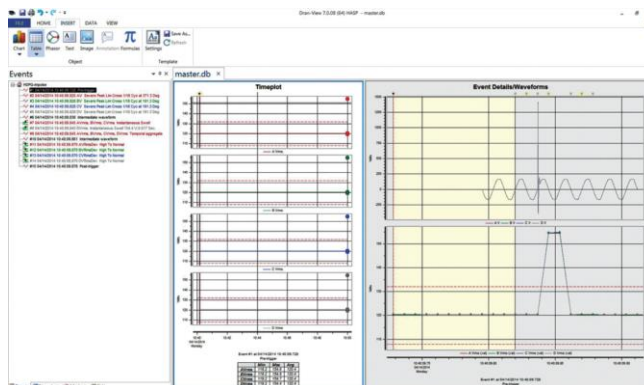
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# Looking at the data – manufacturer’s software



Provision – Power Monitors Inc.



Dranview7 - Dranetz

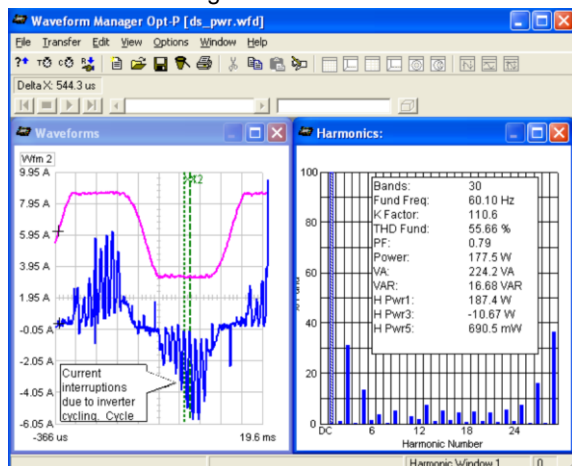
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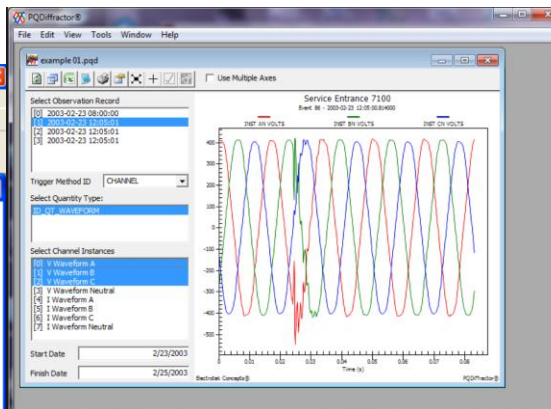
# Looking at the data – independent software

Waveform Manager - Metratek



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PQDiffactor – Electrotek

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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 (2023 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
  - (NFPA 70e – Standard for Electrical Safety in the Workplace)

## 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

- AR/FR – Arc-rated Fire Resistant Clothing
  - Designed to absorb heat energy and not sustain flame
  - Rated in calories/cm<sup>2</sup>
- 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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## Safety

- Appropriate Personal Protective Equipment and Arc-rated/Fire-resistant clothing is location specific.
- Available fault duty, fault clearing time, distance, and enclosure all influence the arc flash/blast energy potential.
- Voltage level
  - Most PQ instruments are only rated for use on systems rated 1000V or less. UL standards include transients.

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## Safety - summary

- Arc flash/blast events are often caused by the worker in the electrical panel.
- When working in electrical equipment, we have a responsibility for our own safety and the safety of those around us.
  - Model safe practices
  - Explain hazards
  - Keep others at a safe distance

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## Coming up...

- The future of power and power quality
- Jobs in power quality
- Engineering work and responsibilities

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