General Power Quality

Power Quality University

We are glad you are here, its almost time to *"Sharpen the Saw"*.

While you are waiting, subscribe to our Podcast channel, The Power Grid.



Providing an educational environment for training, testing, and evaluation of today's power quality and data center solutions and equipment.

P3 leads Customer Education through Power Quality University (PQU):

- Highly Qualified, Expert Instructors
- Practical, Relevant Topics
- Continuing Education Credits (CEU's)

Upcoming Events

Harmonic Correction – Thursday, October 15 – 12 PM – 1 PM CDT.
Power Factor Correction – November 6, – 9 AM – 11 AM CDT.

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General Power Quality

Presented by

Agenda

Introductions to P3

Host Karah Butac
Presenter Brian Branigan

Program

- Power Quality Related Definitions
- Surge Protection
- Power Factor / Harmonics
- UPS

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General Power Quality



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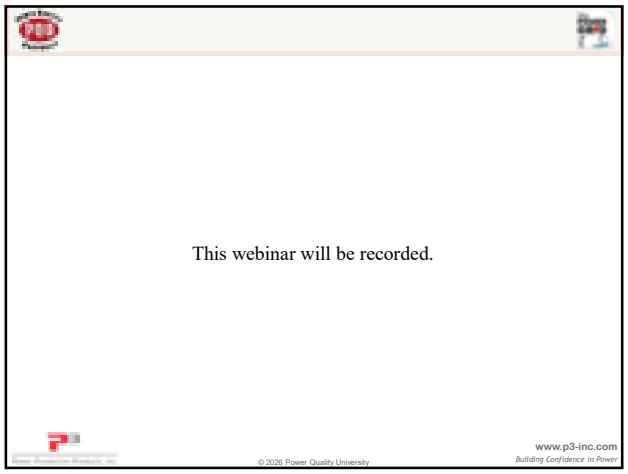

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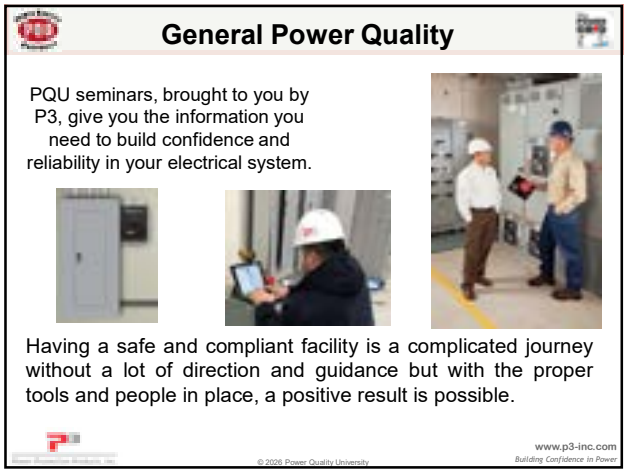

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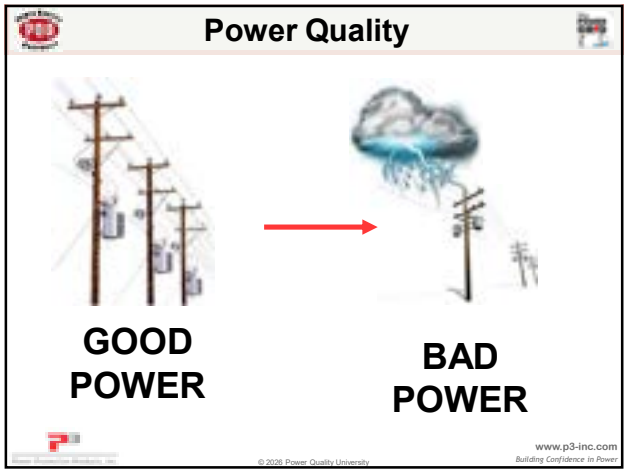

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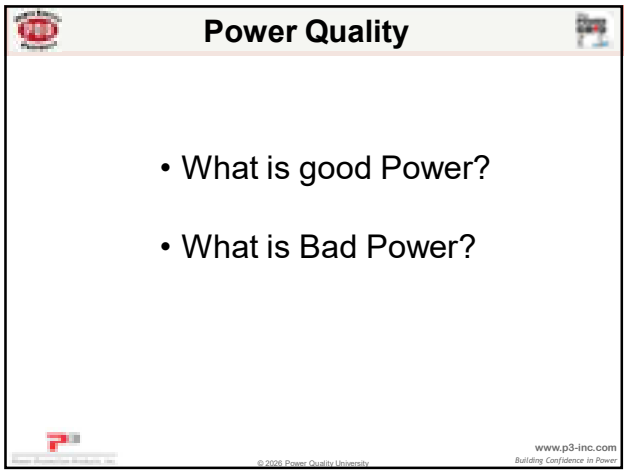

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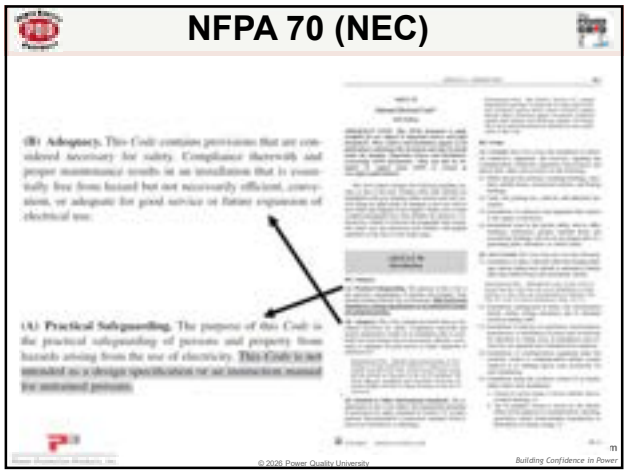

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Power Quality

IEEE Std 1100

IEEE Recommended Practice for Powering and Grounding Electronic Equipment

IEEE Std 142

IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems

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Power Quality

What is good Power?

- IEEE is the most often quoted "Source" for definitions of Power
- IEEE stands for "Institute of Electrical and Electronic Engineers"
- IEEE defines Good Power as:

Clean, pure power exhibits constant voltage and frequency, perfect sinusoidal waveshapes, and is free of harmonics, noise, and transients.

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Power Quality

What is Bad Power?

IEEE defines Bad Power as:

Power that includes voltage variations, voltage swells, voltage sags, over-voltages and under-voltages, harmonics, transients, traveling waves, and power failures.

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The Power Quality BIG 8

Over-voltages

Under-voltages

Sags

Swells

Harmonics

Noise

Transients

Grounding

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The Power Quality BIG 8

Sags	**IEEE-1100**
Swells	**IEEE-1100**
Over-voltages	**IEEE-1100**
Under-voltages	**IEEE-1100**
Harmonics	**IEEE-519 and IEEE-1100**
Noise	**IEEE-1100**
Transients	**IEEE-C62.41 and IEEE 1100**
Grounding	**IEEE-142 and IEEE 1100**

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Voltage Sag

IEEE-1100-2.2.67:

A… reduction in the ac voltage, at the power frequency, for durations from a 0.5 cycle to 1 Min.

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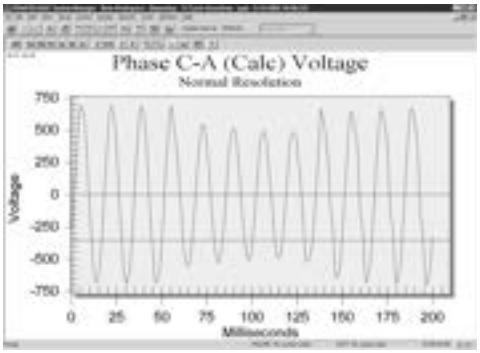
Voltage Sag



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Voltage Swell

IEEE 1100-2.2.78:

An increase in… voltage or current at the power frequency for durations from 0.5 cycle to 1.0 min.

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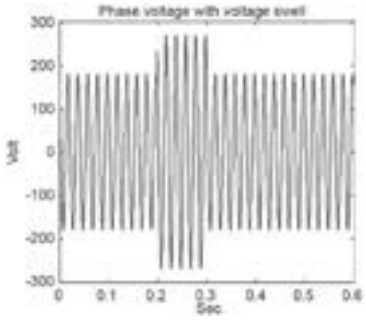
Voltage Swell



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Over-voltages

IEEE-1100-2.2.56:

Increase in the ac voltage, at the power frequency, for a period of time greater than 1 min.

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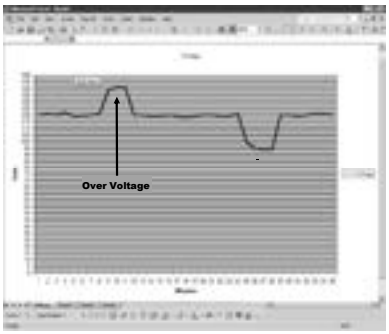
Over-voltages



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Under-voltages

IEEE 1100-2.2.56:

Decrease in the ac voltage, at the power frequency, for a period of time greater than 1 min.

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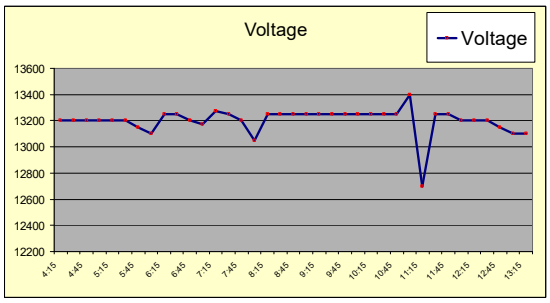
Under-voltages



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Utility Standards

Utility standards are defined by the various *State Utility Boards.* Most require the utility must adhere to this standard:

1. Voltage limits as stated by IEEE/ANSI C84.1

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Utility Standards

IEEE/ANSI C84.1

Standard Voltage	Voltage Range A	Voltage Range B
120	114-126	110-127
120/240	114/228-126/252	110/220-127/254
208Y/120	197Y/114-218Y/126	191Y/110-220Y/127
480Y/277	456Y/263-504Y/291	440Y/254-508Y/293
13200Y	12870Y-13860Y	12504Y-13970Y

"Electrical supply systems shall be so designed and operated that most service voltages will be within the limits for range A"

"When…Range B… voltages occur, corrective measures shall be undertaken within a reasonable time to improve voltages to meet Range A requirements."

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Transient

IEEE-1100-2.2.83:

A sub-cycle disturbance in the ac waveform that is evidenced by a sharp, brief discontinuity of the waveform. May be of either polarity and may be additive to, or subtractive from, the nominal waveform.

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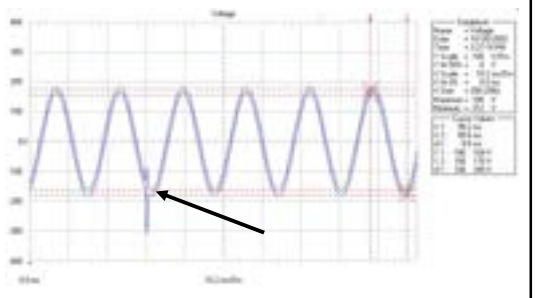
Transient



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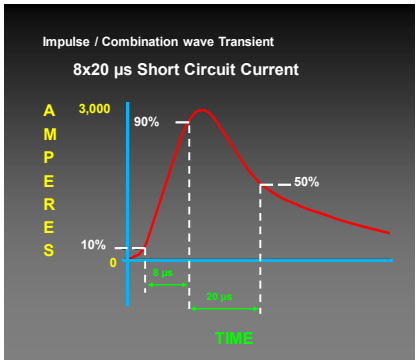
Transient



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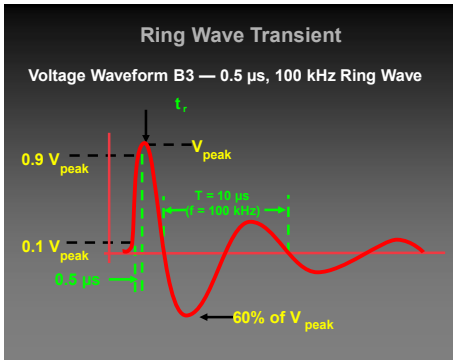
Transient



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Noise

IEEE 1100-2.2.49:

Unwanted electrical signals that produce undesirable effects in the circuits of the control- systems in which they occur.

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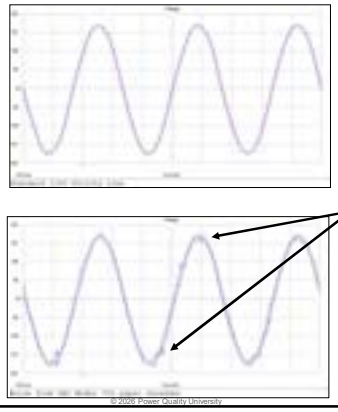
Noise, Waveform Capture



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Harmonics

A harmonic is the term used for current flow on your facilities power system at frequencies other than 60Hertz.

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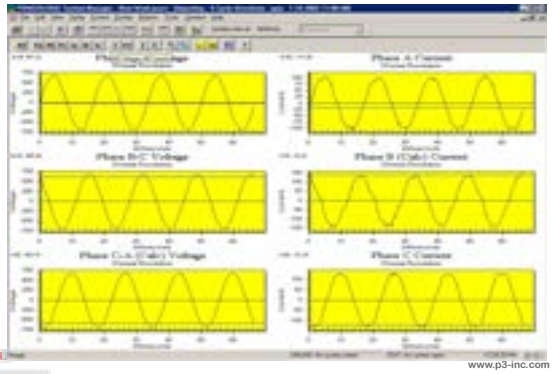
Harmonics

Low Harmonic Waveform



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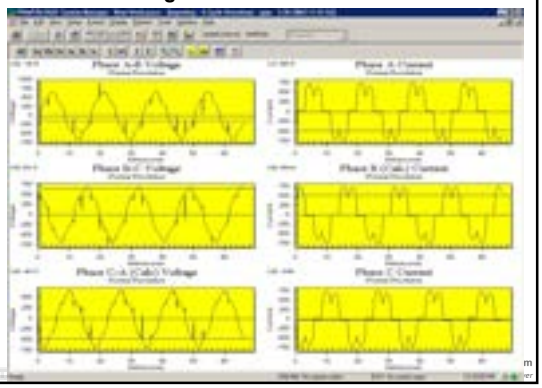
Harmonics

High Harmonic Waveform



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Harmonic Problems

- Electrical and Electronic damage.
- Overheating and less efficient transformers
- Control System errors due to Electrical noise caused by harmonics.
- Blown Fuses for no APPARENT reason.
- Nuisance tripping of Circuit Breakers.

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Harmonic Frequencies

Typical Harmonic frequencies that cause problems:

3 x 60 = 180HZ
5 x 60 = 300HZ
7 x 60 = 420HZ
11 x 60 = 660HZ
13 x 60 = 780HZ

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Grounding for Power Quality

NEC 250.53 states that ground resistance should be less than 25 ohms.

Is this true?

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Grounding for Power Quality

No!

**NEC 250.53 states "A single electrode shall be supplemented by an additional electrode…
If a single electrode has a resistance to earth of 25 ohms or less the supplemental electrode shall not be required".**

Is this good enough?

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Why Grounding for "Power Quality"?

IEEE 142

IEEE 142-5.1
The grounding of sensitive electronic equipment, such as computers, programmable logic controllers, process plants, distributed control systems, and similar electronic equipment, has been found to be one of the important items in achieving useful operation from these systems.

The low operating voltage of computers and other sensitive electronic equipment makes them susceptible to random voltages far below levels that are perceptible to humans and that have no effect on electrical power equipment.

Certainly the voltages injected into the earth by lightning strokes even within several thousand feet, unless suitable neutralization is accomplished, can cause malfunction and can possibly damage the equipment.

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Earth Reference

IEEE 142-4.1.2 Recommended Acceptable Values

- The most elaborate grounding system may not perform satisfactorily unless the connection of the system to earth is adequate for the particular installation.
- With reference to power quality, the earth connection is one of the most important parts of the whole grounding system.
- **The connection to earth of the electrode system… should be… 1-5 ohms for commercial and industrial services.**

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Earth Reference After Installation

IEEE 142-4.4.1 Need for Measurement
Many indeterminate factors exists in any formula for the calculation of the resistance to earth. Total reliance should not be placed on the calculated results. For example, the soil resistivity varies inversely with the soil temperature and directly with the moisture content and may vary with the depth. The only certain way to determine the resistance is to measure it after the system has been completed.

IEEE 142-4.4.3 Periodic Testing
Tests should be made periodically after the original installation and test so that it can be determined whether the resistance is remaining constant or is increasing. If later tests show that the resistance is increasing to an undesirable value, steps should be taken to reduce the resistance…

Don't bury it and forget it!

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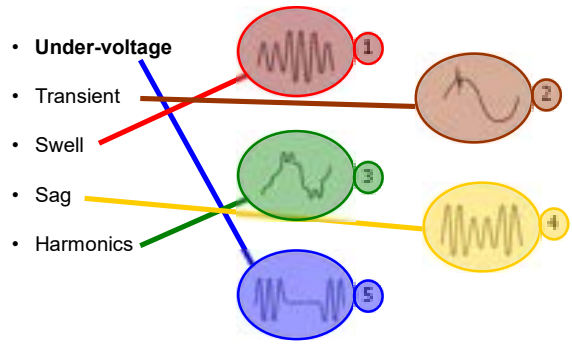
Power Quality Events

- **Under-voltage**
- Transient
- Swell
- Sag
- Harmonics



Know the problem BEFORE installing Power Quality Equipment

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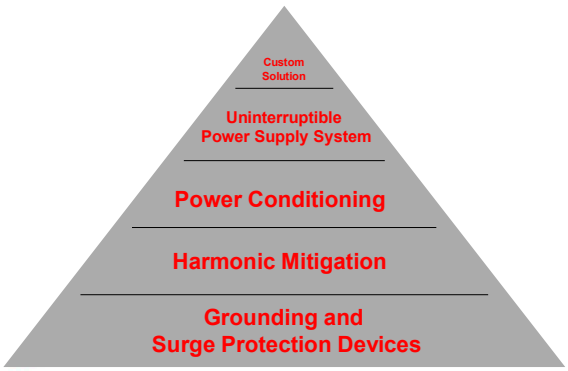
The Power Quality Pyramid



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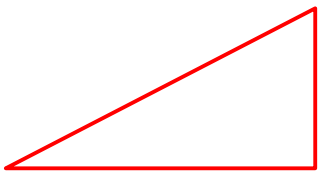
Power Factor



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Power Factor

- What is Power Factor?
- What is a good Power Factor?
- What is a Bad Power Factor?
- What problems are caused by a bad Power Factor?
- How to correct for a bad Power Factor.

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What is Power Factor?

- Power Factor is the ratio of Active Power to Total Power

$$\frac{\text{Active Power}}{\text{Total Power}} = \text{Power Factor}$$

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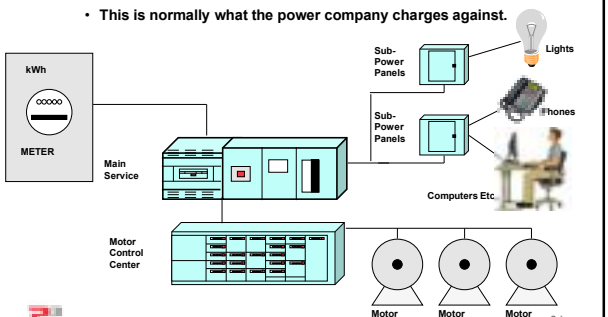
Active Power

- Active power is what we normally see as the electricity used in our facility.
- Measured in kW (Kilowatts).
- This is normally what the power company charges against.



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Total Power

- Total power is what our equipment needs to be sized for in our facility.
- Measured in KVA (Kilo-voltamps).
- The power company may charge extra money (penalties) for a large KVA.
- The large KVA is usually stated in Power Factor.

Total Power is a combination of Active Power and something called Reactive Power.

$$\frac{\text{Active Power}}{\text{Total Power}} = \text{Power Factor}$$

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Reactive Power

Measured in Kvar

- Reactive Power takes into consideration the energy needed to build all the magnetic fields in a facility.
- Your facilities equipment must be sized large enough to handle the extra energy needed to produce these magnetic fields.
- Magnetic fields are produced in ALL current carrying equipment in a facility. This includes Switchboards, Panelboards, Busway, wiring, all equipment, and especially MOTORS and TRANSFORMERS. Motors and Transformers have thousands of feet of wire, which add greatly to a facilities Reactive Power

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Magnetic Fields

Produced in your Facility

- In a AC (Alternating Current) system, current flow changes direction 60 times every second. This is called 60 Hertz (Hz).
- Each time the current changes direction a magnetic field is developed around ALL current carrying parts of a circuit.
- This includes all the wire in your facility, all motors and all transformers.

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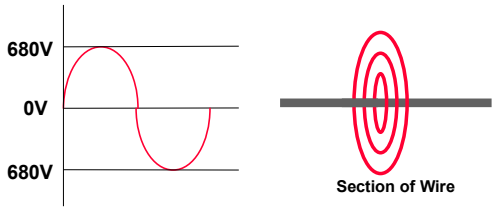
Magnetic Fields

Produced around Wire



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Reactive Power

- The energy needed to produce this Magnetic Field is real.
- You don't see it on your energy bill because the power is given back to the circuit in each quarter cycle.
- The extra current flow is there. Therefore, you and your power company must size equipment large enough to handle the extra energy needed to produce these magnetic fields.
- This is why many Power Companies add an extra charge (penalty) to facilities with a large amount of reactive power.

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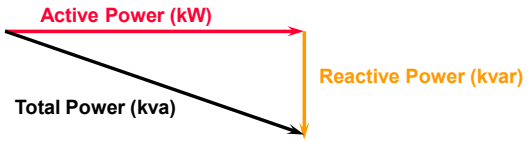
Power Factor

Remember…
Total Power is a combination of
Active Power and Reactive Power.

This is how they combine:



Active Power $(kW)^2$ + Reactive Power $(kvar)^2$ = Total Power $(kva)^2$

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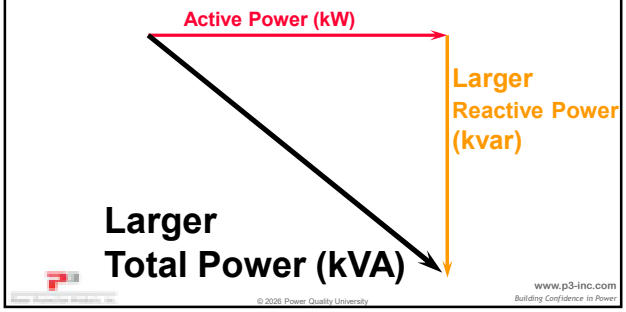
Power Factor

As Reactive Power increases Active Power stays the same however Total Power increases greatly.



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Remember

- Power Factor is the ratio of Active Power to Total Power .
- When Reactive Power is large Total Power increases.
- With the formula below we now see that when Total Power increases the Power Factor decreases.

$$\frac{\text{Active Power}}{\text{Total Power}} = \text{Power Factor}$$

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Power Factor

$$\frac{\text{Active Power}}{\text{Total Power}} = \text{Power Factor}$$

- When Total Power increases the Power Factor decreases.

$$\frac{1000\ kW}{1050\ kVA} \quad .95 \text{ Power Factor}$$

$$\frac{1000\ kW}{1500\ kVA} = .6 \text{ Power Factor}$$

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Power Factor

$$\frac{1000\ kW}{1050\ kVA} = .95 \text{ Power Factor}$$

- **.95 to 1 is considered a good power factor.**

$$\frac{1000\ kW}{1500\ kVA} = .6 \text{ Power Factor}$$

- **Anything less than .9 can be considered a bad Power Factor.**
- **Your Power Company may charge you or you may have internal problems in your facility with Power Factors less than .9.**

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Power Factor

- **The best way solve a low Power Factor problem is to install Power Factor Correction Capacitors.**
- **These Power Factor Correction Capacitors capture the energy from the collapsing magnetic field and give the energy back on the next Quarter cycle.**

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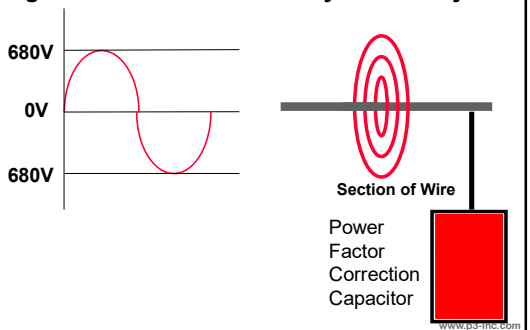
Power Factor

Power Factor Capacitor Storage of Magnetic Fields Produced in your Facility



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Gaining Capacity

with Power Factor Capacitors

$\frac{1000\ kW}{1500\ kVA}$ = .6 Power Factor

If we increase Power Factor, what happens to KVA?

$\frac{1000\ kW}{1050\ kVA}$ = .95 Power Factor

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Gaining Capacity

with Power Factor Capacitors

1500 kVA on a 480 3 phase system is **1800 AMPS**

1050 kVA on a 480 3 phase system is **1200 AMPS**

Could we use this gain of 600 amps?

Absolutely!

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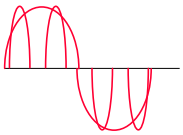
Harmonics



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What is a Harmonic?

A harmonic is the term used for current flow on your facilities power system at frequencies other than 60Hertz.

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What exactly is a Harmonic?

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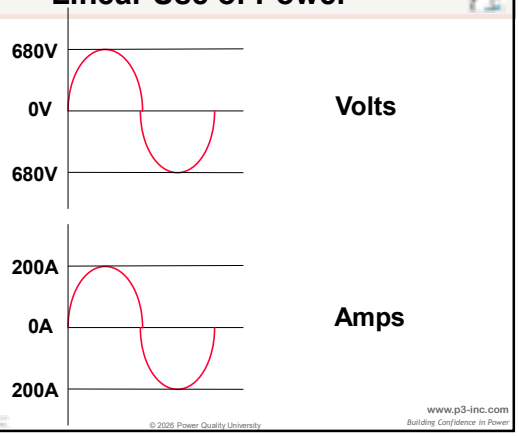
Linear Use of Power



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Linear Use of Power

Equipment that uses power in a
Linear Fashion



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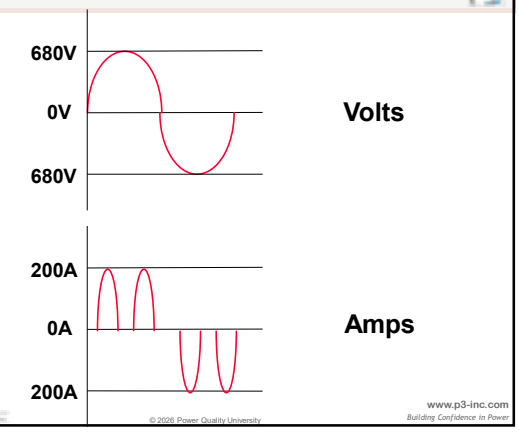
Non-Linear Use of Power



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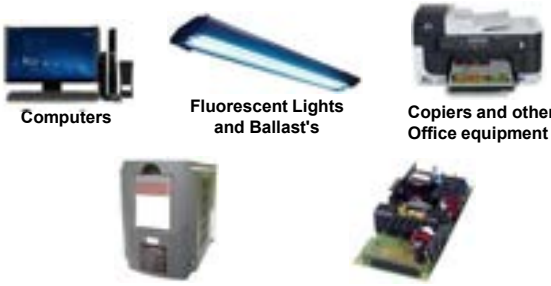
Non-Linear Use of Power

Equipment that uses power in a
NON-linear fashion



Computers

Fluorescent Lights and Ballast's

Copiers and other Office equipment

Variable Frequency Drives

All equipment that uses an AC to DC power supply

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Harmonic Problems

Typical Non-Linear frequencies that cause problems:

3 x 60 = 180HZ
5 x 60 = 300HZ
7 x 60 = 420HZ
11 x 60 = 660HZ
13 x 60 = 780HZ

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Harmonic Problems

Why does Non-Linear current flow cause problems In my facility?

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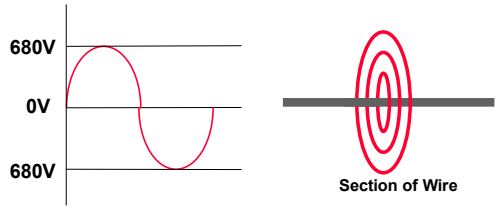
Magnetic Fields

Produced around Wire



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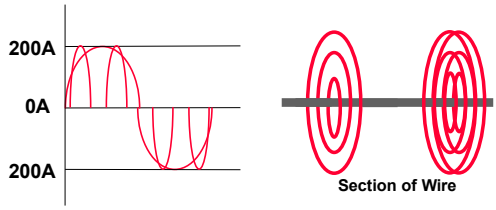
Combination

of Linear & Non-Linear Power



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Harmonic Problems

- Electrical and Electronic damage.
- Overheating and less efficient transformers
- Control System errors due to Electrical noise caused by harmonics.
- Blown Fuses for no APPARENT reason.
- Nuisance tripping of Circuit Breakers.

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Harmonic Problems

IEEE 519- Current

Maximum Harmonic Current Distortion

I_{SC} / I_L	TDD
1-20	5%
20-50	8%
50-100	12%
100-1000	15%
1000+	20%

I_{SC}=Maximum short circuit current
I_L= Maximum demand load
TDD= Total Demand Distortion

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Current Harmonics

Example:

Typical Office Building
1200A 208Y/120 service
30K AIC

The Maximum IEEE Harmonic distortion is:

30,000 AIC / 960 = 31

31 on the IEEE chart is 8%

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Harmonic Problems

IEEE 519 -Voltage

Maximum Harmonic Voltage Distortion

Voltage	THD
69kV and below	5%

THD=Total Harmonic Distortion

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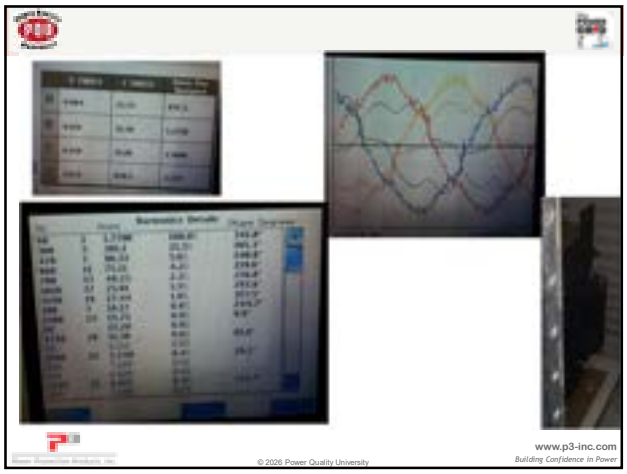

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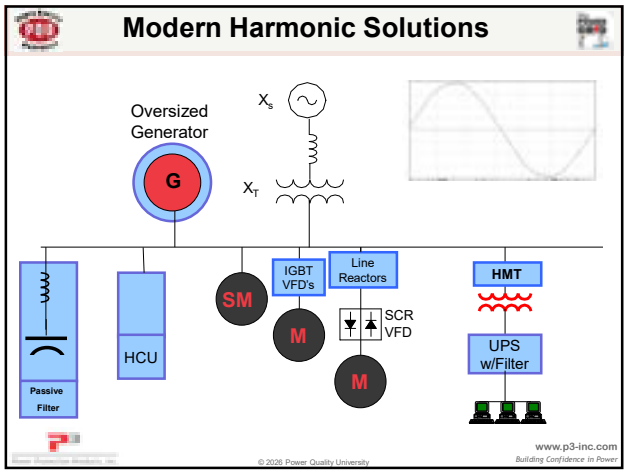

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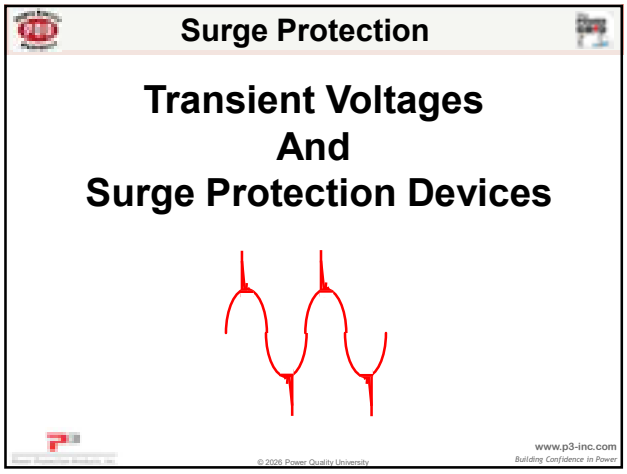

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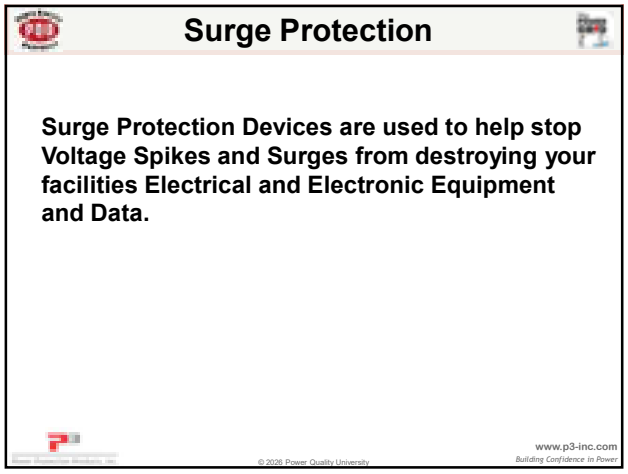

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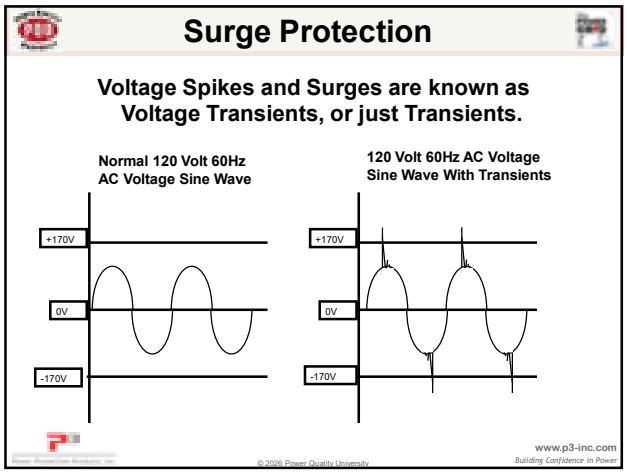

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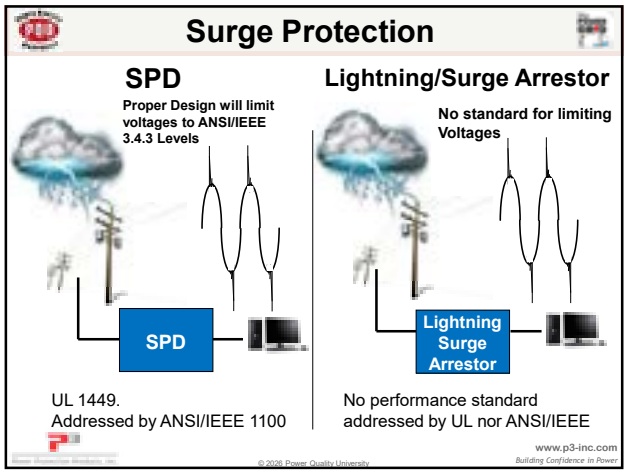

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What causes these Transients?

Motors







Fluorescent Lights & Ballasts



Copiers & other office equipment



Welders & other industrial equipment



Motors

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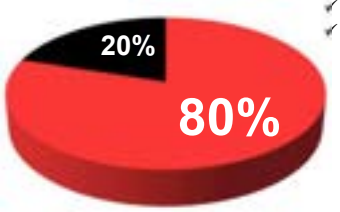
Surge Protection

Transients come from two sources

- External to your Facility:
  - ✓ Lightning
  - ✓ Power Grid Problems



- Internal in your Facility:
  - ✓ Motors
  - ✓ Ballasts
  - ✓ Office Equipment
  - ✓ Industrial Equipment

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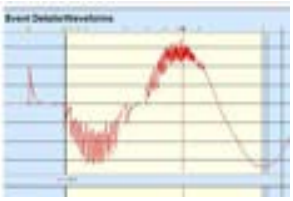
Transients

Generated by Switching 2x4, 4 bulb fixture





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IEEE Example Transients

Generated by Capacitor Switching





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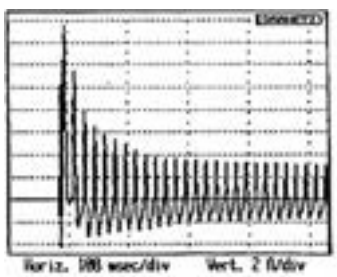
IEEE Example Transients

Generated by Energizing a Transformer





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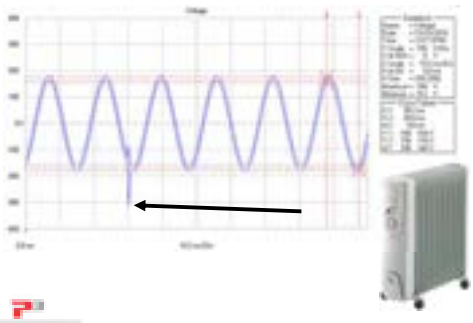
Transient caused by

Switching a 120 volt 1500 Watt plug in Heater



Actual P³ Power Quality Study

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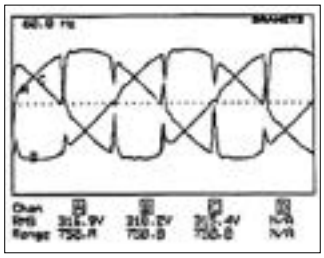
IEEE Example Transients

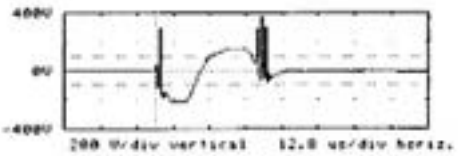
Caused by Harmonics





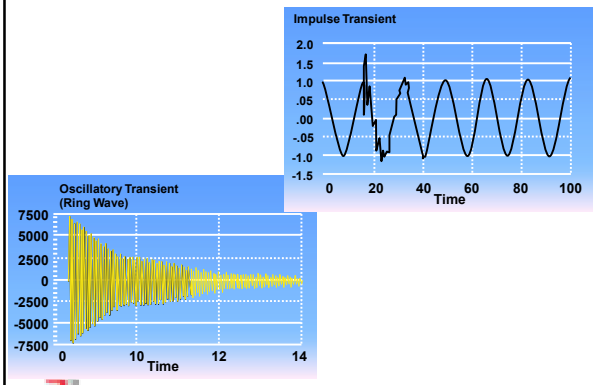
IEEE Example Transients

Caused by Motor Switching

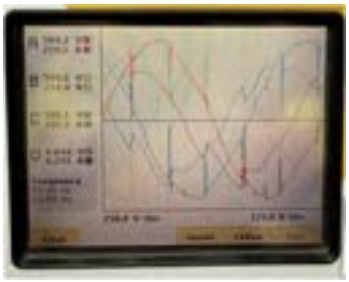




Transients





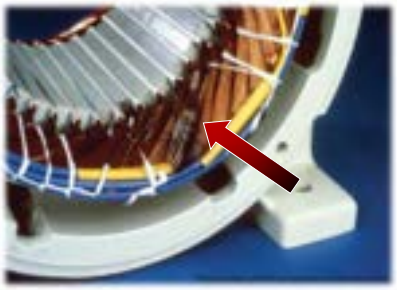


Transients

Some Problems caused by Transients in your Facility:

- Premature Equipment failure
- Long term cumulative equipment damage
- Power loss
- Data losses and system resets
- Catastrophic equipment failure
- Immediate operation shutdown
- Expensive equipment repair and replacement costs

Problems with Equipment



- **Motor Windings**
- **Premature or complete motor failure**

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Problems with Equipment



Contact Failure from lightning strike

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Problems with Equipment



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Problems with Equipment

Light Emitting Diode Lighting



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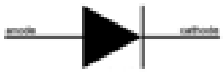
What's a Diode?



- The diode is an electronic semiconductor (PN junction)
- It is the basis of design for Transistors
- Highly susceptible to Transients
- Must be protected by a SPD



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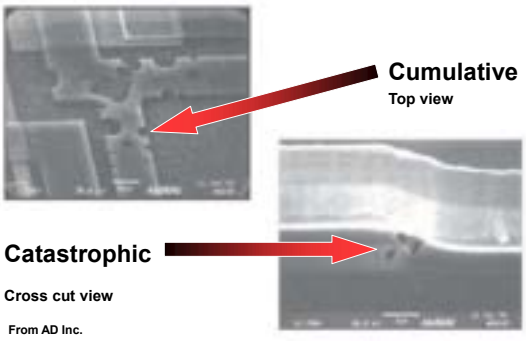
Electron Microscopic Photo



Cumulative
Top view

Catastrophic

Cross cut view

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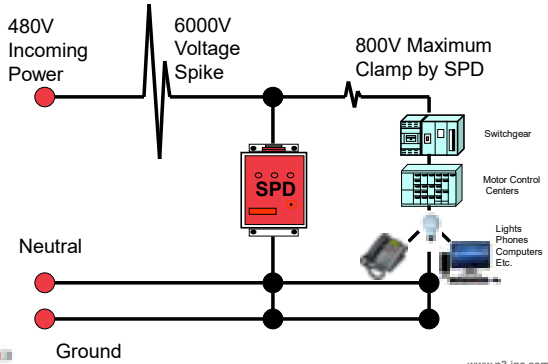
The Protection Circuit



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Surge Protection

The SPD unit is designed to:

- Protect equipment from damage

Therefore, the SPD unit must:

- Sense transients quickly- <1 nanosecond
- Limit the let- through voltage- IEEE 3.4.3
- Inform user if not functioning- Alarms
- Not interrupt Normal Service- while doing its job

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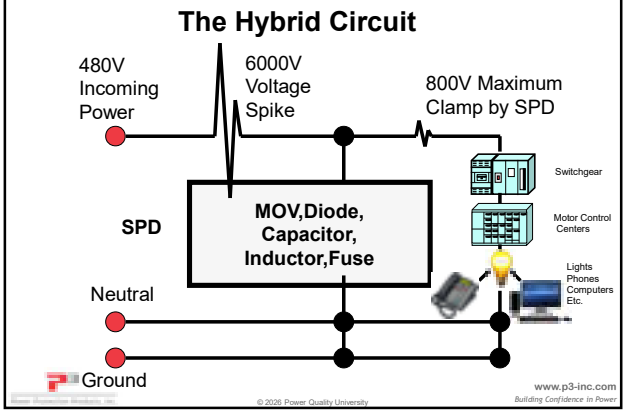
How do SPD's work?



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NEC Code and SPD

NFPA 70 NEC REQUIREMENTS for SPD's

695.15	Fire Pump Controllers
700.8	Emergency Systems
708.20	Critical Operations
670.6	Safety Interlocks
620.51(E)	Emergency Systems Loads
645.18	Data Centers
694.7(D)	Wind Electric Systems
230.67	Dwelling Units

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NEC Code and SPD

700.8 Surge Protection. A listed SPD shall be installed in or on all emergency systems switchboards and panelboards.

700.2 Emergency Systems are: Those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any governmental agency having jurisdiction. These systems are intended to automatically supply illumination, power, or both,... illumination is required for safe exiting... such as hotels, theaters, sports arenas, health care facilities, and similar institutions... ventilation, fire detection and alarm systems, elevators, fire pumps, public safety communications systems, industrial processes where current interruption would produce serious life safety or health hazards, and similar functions.



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NEC Code and SPD

620.51 (E) Surge Protection. Where **any of the disconnecting means** in 620.51 has been designated as supplying an emergency system load, surge protection shall be provided.

620.51 Loads are: 1. Elevators Without Generator Field Control. 2.Elevators with Generator Field Control. 3.Escalators and Moving Walks. 4.Platform Lifts and Stairway Chairlifts.



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NEC Code and SPD

670.6 Surge Protection. Industrial machinery with safety interlock circuits shall have surge protection installed.

Note: it says "shall have", not "should have" surge protection installed. "Industrial machinery with safety interlock circuits shall have surge protection installed". The concern is failure of safety interlocks on machinery poising safety risk to operators that may not be aware of disabled safety mechanisms.



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NEC Code and SPD

695.15 Surge Protection. A listed surge protection device shall be installed in or on the fire pump controller.



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NEC Code and SPD

708.20 Surge Protection Devices. Surge protection devices shall be provided at all facility distribution voltage levels… in Critical Operations Power Systems (COPS)

708.2 Critical Operations Power Systems (COPS). Power systems for facilities or parts of facilities that require continuous operation for the reasons of public safety, emergency management, national security, or business continuity.



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NEC Code and SPD

645.18 Surge Protection for Critical Operations Data Systems. Surge protection shall be provided for critical operations data Systems.

645.2 Critical Operations Data System. An information technology equipment system that requires continuous operation for reasons of public safety, emergency management, national security, or business continuity.



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NEC Code and SPD

694.7(D) Surge Protective Devices (SPD). A surge protective device shall be installed between a wind electric system and any loads served by the premises electrical system.



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2020 NEC – 230.67(A) – Residential Dwellings Requirement

- Surge protection is now required for all dwelling unit services. Article **230.67(A)** requires a Type 1 or Type 2 surge protective device (SPD) to be installed for dwelling unit services.
- The SPD may be integral to or adjacent to the electrical service. Additionally, an SPD will be required when an existing service is replaced. This applies to all dwellings – single occupancy (home) or multiple dwelling (apartments)





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NEC Code & SPD

230.67 Surge Protection NEW in 2023

230.67(A) Surge-Protective Device.
All services supplying dwelling units shall be provided with a surge-protective device (SPD).

- Ensure the new service equipment and feeder equipment surge requirements are not missed on projects.
  Surge now required for services supplying:
  - **Dwelling units**
  - **Dormitory units**
  - **Guest rooms and suites of hotels/motels**
  - **Areas of nursing homes and limited-care facilities used exclusively as patient sleeping rooms**
- Specify the correct SPD: (E) **Nominal discharge current rating (In) of not less than 10kA**



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The Current UL1449

UL Testing Procedure
Pick a Type: 1 or 2
Pick a Test: 3,5,10,20 kA
Pick overcurrent device (if any)
Test: at 6,000v and 3,000 amps
Record Result (let-through voltage)
Test: 15 times at 1 minute apart at desired test
Test: again at 6,000v and 3,000 amps
Record Result (let-through voltage)

Must not deviate by more than 10%
Assign to a grouping by VPR results (IE 700-800)

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409.70 – Industrial Control Panels

409.70: "Safety circuits for personnel protection that are subject to damage from surge events shall have surge protection installed within or immediately adjacent to the control panel."

- Industrial Control Panels are defined in Article 100 Industrial Control Panels as:
  1) Power circuit components only, such as motor controllers, overload relays, fused disconnect switches, and circuit breakers:
  2) Control circuit components only, such as push buttons, pilot lights, selector switches, timers, switches and control relays;
  3) A combination of power and control circuit components.
- "Safety circuits for personnel protection" is an extremely vast interpretation. Industrial panels with indicating lights is considered a safety circuit to the safe operation of the equipment. Therefore, virtually all industrial panels need protection.





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Surge Protection

The latest UL 1449 Specification

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The New UL1449 Specification

- SPD Type
- NRTL listing mark
- Peak surge current per phase (not required)
- Short circuit current rating
- Nominal Discharge Current Rating
- System voltages
- System frequency
- Voltage Protection Rating



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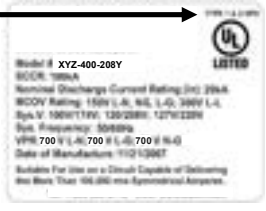
The New UL1449 Specification

- **SPD Type**
- NRTL listing mark
- Peak surge current per phase (not required)
- Short circuit current rating
- Nominal Discharge Current Rating
- System voltages
- System frequency
- Voltage Protection Rating



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UL 1449 – SPD Type

- The SPD type refers to the location where the SPD can be used:
  - Type 1: before the service disconnect overcurrent device
  - Type 2: after service disconnect overcurrent device
  - Type 3: at least 10m (30 ft) of conductor between service disconnect overcurrent device and SPD
  - Type 4: component SPD (must be tested to the appropriate installation location where it will be installed)

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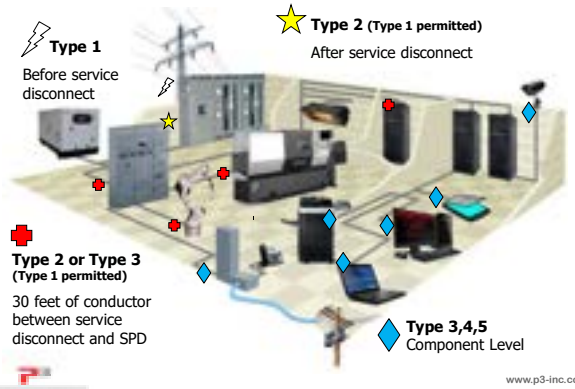
Locations for SPD Types



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Conventional Industry Standard

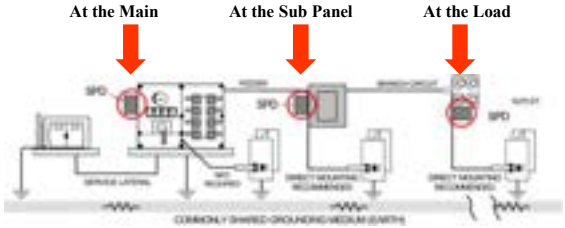

Figure 8-25 – Typical locations of power distribution surge protective devices

8.6.4 Premise electrical system surge protection

In addition to surge protective devices installed in the service entrance equipment, it is recommended that additional surge protective devices… be applied to downstream electrical switchboards and panelboards, and panelboards on the secondary of separately derived systems if they support communications, information technology equipment, signaling, television, or other form of electronic load equipment (see Figure 8-25).

From ANSI/IEEE 1100

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The New UL1449 Specification

- SPD Type
- **NRTL listing mark**
- Peak surge current per phase (not required)
- Short circuit current rating
- Nominal Discharge Current Rating
- System voltages
- System frequency
- Voltage Protection Rating



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Nationally Recognized Testing

Laboratory Mark - NRTL

- Other laboratories besides Underwriters Laboratories can test and list devices to be compliant with any standard, including UL 1449
- An SPD tested by another NRTL can be "Compliant to UL 1449" but will be "Listed" by the NRTL – e.g. "ETL Listed", "CSA Listed"

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The New UL1449 Specification

- SPD Type
- NRTL listing mark
- **Peak surge current per phase (not required)**
- Short circuit current rating
- Nominal Discharge Current Rating
- System voltages
- System frequency
- Voltage Protection Rating



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What "Peak Surge" do you need?

Application Size Chart



Use Industry Standards

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The New UL1449 Specification

- SPD Type
- NRTL listing mark
- Peak surge current per phase (not required)
- **Short circuit current rating**
- Nominal Discharge Current Rating
- System voltages
- System frequency
- Voltage Protection Rating
  - **Measure of how much current the electrical utility can supply during a fault condition**



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The New UL1449 Specification

- SPD Type
- NRTL listing mark
- Peak surge current per phase (not required)
- Short circuit current rating
- **Nominal Discharge Current Rating**
- System voltages
- System frequency
- Voltage Protection Rating



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Nominal Discharge Current - I_n

- Manufacturer chooses a current they want to test with:
  - Type 1: 10kA or 20kA
  - Type 2: 3kA, 5kA, 10kA or 20kA
- Complete SPD is tested along with any required overcurrent devices (fuse or breaker)
- Measured let through voltage for a 6000V 3000A surge is recorded
- SPD is subjected to 15 surges at chosen current one minute apart with rated voltage applied between surges
- **Measured let through voltage for a 6000V and 3000A surge is recorded again – let through voltage must not deviate more than 10% from original voltage (this is brand new!)**

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The New UL1449 Specification

- SPD Type
- NRTL listing mark
- Peak surge current per phase (not required)
- Short circuit current rating
- Nominal Discharge Current Rating
- **System voltages**
- System frequency
- Voltage Protection Rating



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The New UL1449 Specification

- SPD Type
- NRTL listing mark
- Peak surge current per phase (not required)
- Short circuit current rating
- Nominal Discharge Current Rating
- System voltages
- **System frequency**
- Voltage Protection Rating



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The New UL1449 Specification

- SPD Type
- NRTL listing mark
- Peak surge current per phase (not required)
- Short circuit current rating
- Nominal Discharge Current Rating
- System voltages
- System frequency
- **Voltage Protection Rating**



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Voltage Protection Rating "VPR"

Voltage Protection Rating is assigned to an SPD model by the NRTL from a table based on the average of the measured limiting voltage from **3** impulses of a 6000V/3000A Transient

Measured Limiting Voltage	Voltage Protection Rating
330 or less	330
331 - 400	400
401 - 500	500
501 - 600	600
601 - 700	700
701 - 800	800
801 - 900	900
901 - 1000	1000
1001 - 1200	1200
1201 - 1500	1500
1501 - 1800	1800
1801 - 2000	2000
2001 - 2500	2500
2501 - 3000	3000
3001 - 4000	4000
4001 - 5000	5000
5001 - 6000	6000

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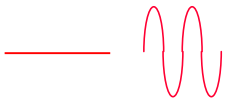
UPS Systems



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UPS Systems

An Uninterruptible Power Supply system is a device that provides power to your facilities equipment when the normal power provider cannot.

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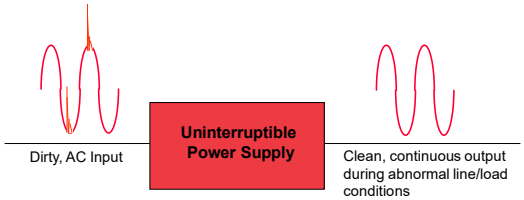
Purpose of a UPS

- Originally to provide back-up power during power fail conditions
- Expanded application to cover line and load power quality issues



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UPS Systems

IEEE 1100
Section 7 tells us:

The correct UPS System can solve 7 of the 8 power problems that cause failure or malfunction of equipment in your facilities.

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	Surge Protection Device	Noise Filter	Isolation Transformer	Voltage Regulator	Generator	Stand By Off Line UPS	Line Interactive UPS	True On Line Double Conversion UPS
Over-voltage	N	N	N	N	?	N	Y	Y
Under-voltage	N	N	N	N	?	N	Y	Y
Sag	N	N	N	Y	N	N	N	Y
Swell	N	N	N	Y	N	N	N	Y
Transient	Y	N	?	?	N	N	N	Y
Noise	?	Y	?	Y	N	N	N	Y
Long term outage	N	N	N	N	Y	?	?	?
Frequency variation	N	N	N	N	?	N	?	Y

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UPS Systems

There are three basic types of Uninterruptible Power Supply systems available:

1. **Stand by (Off line)**
2. **Line interactive (Off Line)**
3. **True On line Double Conversion**

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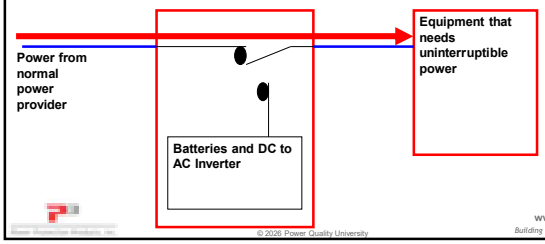
Stand By UPS System

The stand by UPS system (sometimes called Off-line system) operates in the following manor:

While the normal power provider is operational the equipment wired to the UPS system receives power from this normal power provider. When this normal power is lost (blackout) the UPS system activates (turns on) and supplies power to the equipment that needs uninterruptible power until the normal power returns. The way this UPS system creates power is by converting the DC power from batteries to AC via an inverter. The activation (turn on) time for the inverter and internal switch from normal power to inverter power is typically 8-16 milliseconds.



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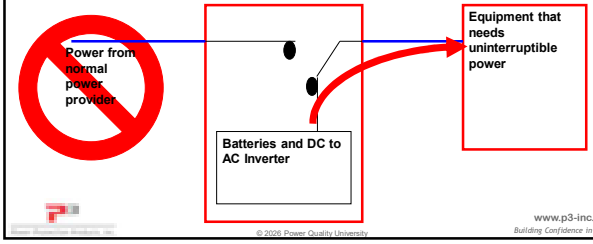

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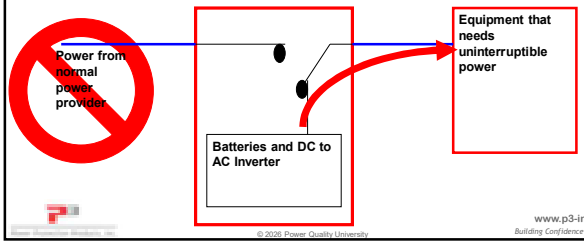

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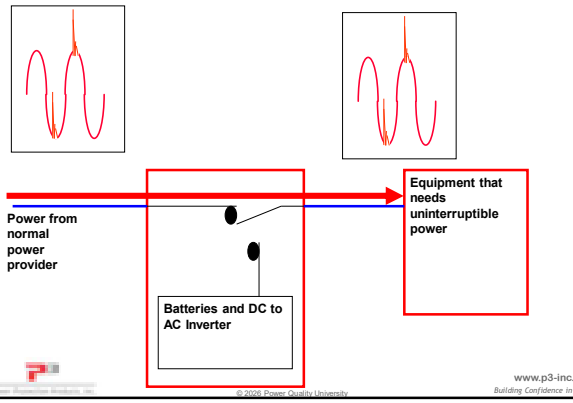
Stand By UPS System



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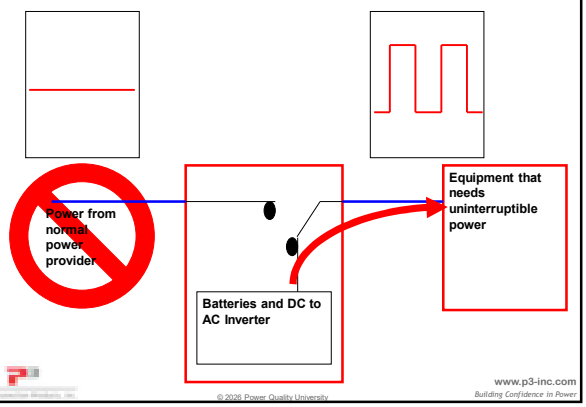
Stand By UPS System



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Stand By (Off Line) UPS System

Benefits:

- Inexpensive
- Small Footprint

Disadvantages:

- Not Designed for Critical Loads
- No Power Conditioning
- Load Exposed to Surges, Sags, and transients
- Not Generator Compatible
- Switching Necessary to go from Utility to battery Power. Discontinuous Power during Switch to Battery
- Less Battery Life (Used more often)
- Poor Maintainability without maintenance Bypass

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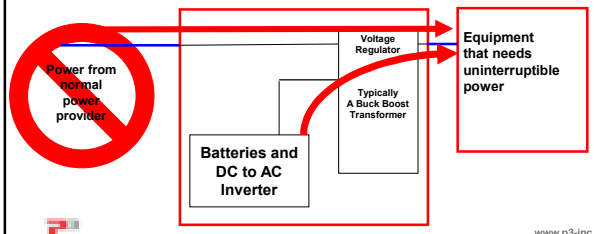
Line Interactive UPS System

Line interactive (Off Line) UPS systems add extra features that give us, at a minimum, two advantages over the Stand By UPS system. One, they usually include some type of voltage regulator between the normal power provider and your equipment that needs uninterruptible power and two, they have activation times around 4-8 milliseconds.



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Line Interactive UPS System

Benefits:

- Less Costly than True on Line Technology
- Some Power conditioning

Disadvantages:

- Not Designed for Critical Loads
- Limited Power Conditioning
- Load Exposed to Surges, Sags, and Transients
- Not always Generator compatible
- Less Battery Life (Used more often)
- Poor Maintainability without a maintenance bypass

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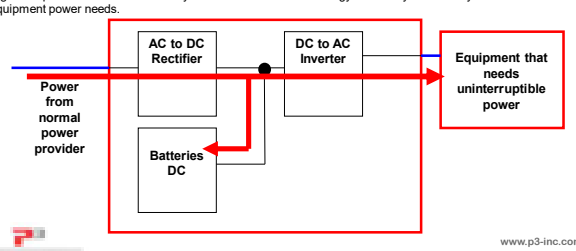
True On Line UPS system

Double Conversion

The On Line UPS is the best option when your equipment cannot loose power for even a split second. With an On Line system power is constant and there is no activation time. The On Line system uses batteries and a DC to AC inverter just like to other two units mentioned above, however, it also uses something called a rectifier. The addition of the rectifier along with the batteries and inverter enable the On Line UPS to give constant power to your equipment that needs uninterruptible power. The inverter that supplies power to your equipment is always on. The inverter gets its power from either the normal power provider (via the rectifier) or the batteries. With power to your equipment being supplied constantly from the inverter you receive clean regulated power at all times. In many cases this On Line technology is the only answer to your sensitive equipment power needs.



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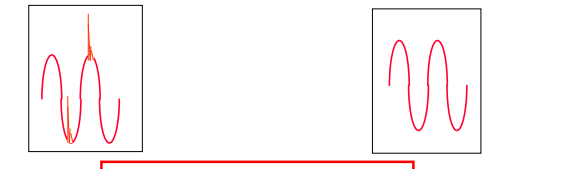
True On Line UPS system

Double Conversion



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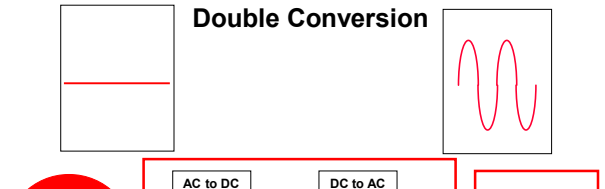
True On Line UPS system

Double Conversion



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True On Line UPS system

Double Conversion

Benefits:

- Designed for Critical Loads
- Superior Power Conditioning
- Isolates Load from Surges, Sags, and Transients
- Generator Compatible
- Extended Battery Times available with Full Time inverter
- Extended Battery Life (Only used during emergencies)
- Easy to Maintain with maintenance Bypass Switch

Disadvantages:

- More Expensive than lessor technologies
- Bigger Footprint

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True On Line UPS system

Double Conversion

The True On Line UPS is the best solution if the Uninterrupted operation of your equipment is critical.

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CHALLENGE ACCEPTED

At the end of long power quality journey is the beginning of solution implementation and obtaining compliance and desired results.



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Power Quality
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877-393-1223

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