



Power Quality University



We are glad you are here, its almost time to “Learn about Surge Protection Devices.”

While you are waiting, subscribe to our Podcast channel, The Powe





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](#)

CANCELLED Generated Docking Stations Friday, August 7

Sag Ride Through - Thursday, August 20, 12 PM – 1 PM

www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University



Power Protection Products, Inc.

1



Surge Protection Devices



Presented by



www.powerqualityuniversity.com

Agenda

Introductions to P3
Speakers & Hosts

Speaker: Brian Branigan
Host: Amy Strong
Karah Butac

Program

- Transient Environment Introduction
- Surge Protection Units Comparison
- New NEC Code Update Discussion
- Proper Applications
- See Installation Examples
- Actual Test Results and Specs

www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University



Power Protection Products, Inc.

2





Core Values

Blaze The Trail
Do the Right Thing
Be Humble and Honest
Create a Positive Influence

www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University



Power Protection Products, Inc.

3



P3 is the industry's trusted and respected advisor for critical power, cooling and energy solutions.



www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University



Power Protection Products, Inc.

4






INDUSTRIAL POWER SOLUTIONS

Power Quality Specialists with expertise in your Power Quality needs.

Industrial Power Quality, doesn't just happen. It takes technical expertise, investment in products and facility coordination to achieve the desired levels of Power Quality. With experience in both new construction and retrofit installations, P3 can help you select and install the correct products.



We provide Industrial Power Quality Solutions

Surge Protection Devices

Harmonic Mitigating Transformers

Power Factor Correcting Capacitors

www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University


Power Protection Products, Inc.

5




Power Quality Monitoring

System analysis and evaluation of power quality issues to provide solution recommendations for the best possible performance from your existing power system.

The ability to quickly identify and remedy power quality problems will lengthen the life of electrical equipment and improve power system availability.



Our engineering technicians will help you understand your unique facility power system.

www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University


Power Protection Products, Inc.

6



Surge Product Technology and NEC Code (Agenda)

- Applications
- Understanding Transients
 - What are they, symptoms, and more..
- Surge Protection Applications
 - Typical Installation
- Market Approach and NEC Code

www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University



Power Protection Products, Inc.

7



Common SPD Applications

Characteristics:

- Facilities PTX 300, PTX 160
- Cell Sites PTX 160
- Security Cameras XT 50
- Security Lighting PTX 1P101
- Other Sites PTX 160

www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University



Power Protection Products, Inc.

8



POWER QUALITY
LP TIME SERIES
UNIVERSITY

What is a Surge Voltage Transient

The POWER GRID

Definition:

A high rising voltage condition on one or more phases lasting 2 milliseconds or less

Characteristics:

- Duration - 50ns to 2ms
- Rise time - 10ns to 100µs
- Frequency - 20Hz to 20MHz (ringing transients)
- Voltage - up to 20kV

Time	Symbol	Number in 1 second
1 second		1
1 millisecond	ms	1,000
1 microsecond	µs	1,000,000
1 nanosecond	ns	1,000,000,000

www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University

P3
Power Protection Products, Inc.

9

POWER QUALITY
LP TIME SERIES
UNIVERSITY

Types of Transients

The POWER GRID

• Impulse Waveform

• Ring Waveform

www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University

P3
Power Protection Products, Inc.

10



80%
of surges are
INTERNALLY
generated

20%
come from
EXTERNAL
SOURCES

Where Do Voltage Transient Come From?

- **20%** of surges are caused externally by:
 - Lightning
 - Utility Switching
- **80%** are caused internally by:
 - Load Switching
 - Short Circuits
 - Capacitor Switching
 - Variable Speed Drives
 - Imaging Equipment
 - Arc Welders
 - Light Dimmers

www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University


Power Protection Products, Inc.

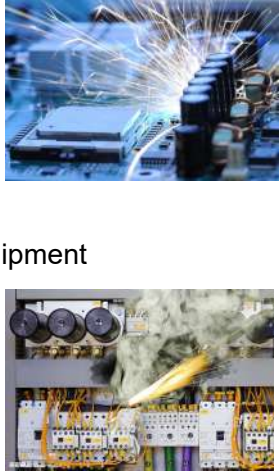
11



Symptoms of Surge Activity



- Equipment damage
- Insulation breakdown on electrical conductors
- Premature aging of electrical and electronic equipment
- Process interruption
- Data loss and data transfer rate reduction



www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University


Power Protection Products, Inc.

12



Disruptive Damage



- Damage caused by transients that lock-up systems, create malfunction and can corrupt local files

Communication Error

PLC1 Error Code received

Screen No. : 0
Received Code No. : 4 0 3 1

Retry

www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University


 Power Protection Products, Inc.

13

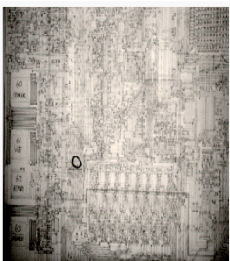


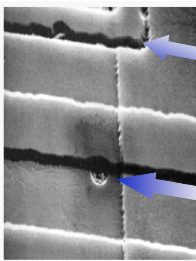
Disruptive Damage



(Premature Aging)

Are you familiar with the subtle damage?





Cumulative

Failure

- Cumulative activity does not cause immediate failure. Cumulative activity is lower magnitude activity with more numerous instances of occurrence. Repeated exposure leads to premature failures.

www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University

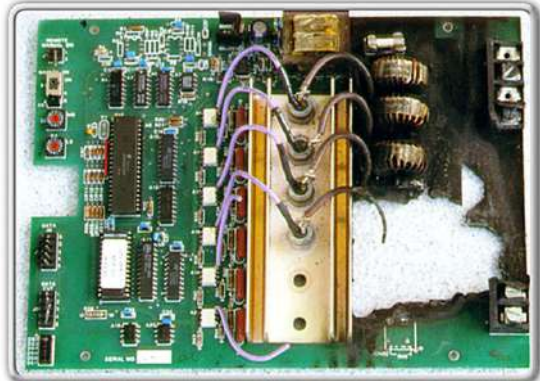

 Power Protection Products, Inc.

14



Disruptive Damage





- Catastrophic damage to equipment can occur because of a high energy transient voltage event

www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University


 Power Protection Products, Inc.

15



NEMA Surge Damage Survey



Below are interesting facts documented in the 2014 Surge Damage Survey conducted by NEMA with maintenance and facility managers regarding surge activity over the prior three year period:

- **75%** of respondents experienced one or more incidents of surge damage in the past three years.
- **41%** of respondent reported catastrophic damage due to a surge event
- **48%** of respondents reported lost production ranging between \$5,000 and \$50,000.
- **61%** of respondents reported equipment damage of \$10,000 or less but **16%** of respondents experienced equipment damage exceeding \$150,000
- **38%** experienced computer lock up as a result of a surge event





www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University


 Power Protection Products, Inc.

16



SPDs Act As “Pressure Relief Valves”



- The ideal SPD shunts harmful surge current to **ground** under a surge condition and appears as a high impedance under normal operating conditions
- The SPD is a **self-sacrificing** device – bearing the brunt of harmful surge currents



Did you know?
Overcurrent devices do not provide protection from surges

www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University

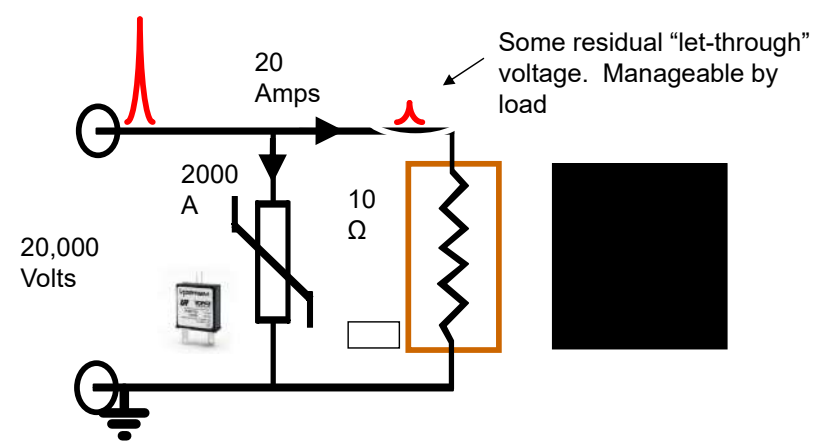

 Power Protection Products, Inc.

17



Voltage Event with Surge Protection





www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University

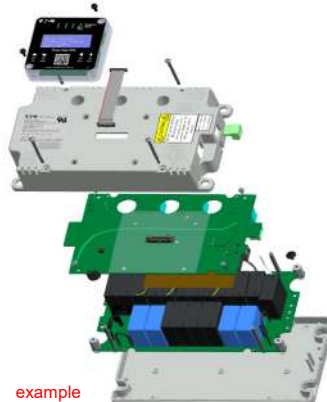

 Power Protection Products, Inc.

18



Surge kA Ratings Explained





example

- The peak surge current is a predictor of how long an SPD will last in each environment
 - The higher the kA rating, the longer the life of the MOV
- Similar to the tread on a tire
 - The thicker the tread, the longer the tire will last



www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University


 Power Protection Products, Inc.

19



Connector Lead Length



- Absolutely Critical!**
- Transients occur quickly-<.000028 sec.**
- Each foot of conductor adds
≈ 100V to 200V on the
let through voltage**
- Need short, straight, lead lengths**



www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University


 Power Protection Products, Inc.

20



Example



- Customer asked, "Why am I having surge damage even though I have an SPD?"
- Note: Not Eaton Product or installation



20 feet of conductor

www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University


 Power Protection Products, Inc.

21





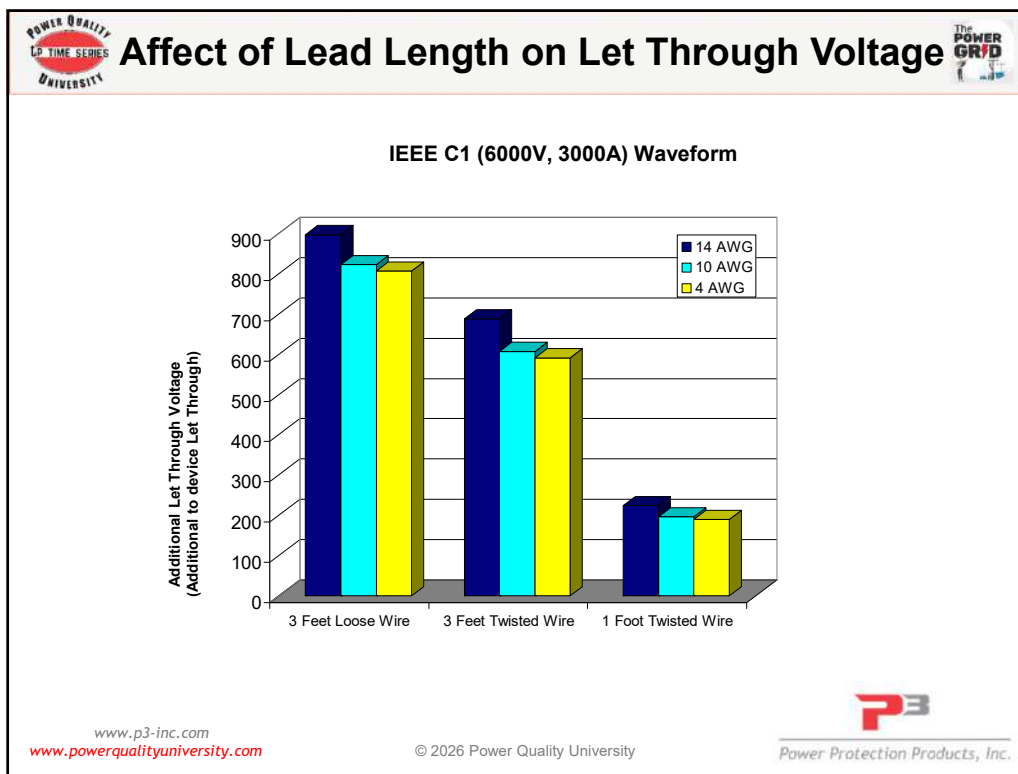


www.p3-inc.com
www.powerqualityuniversity.com

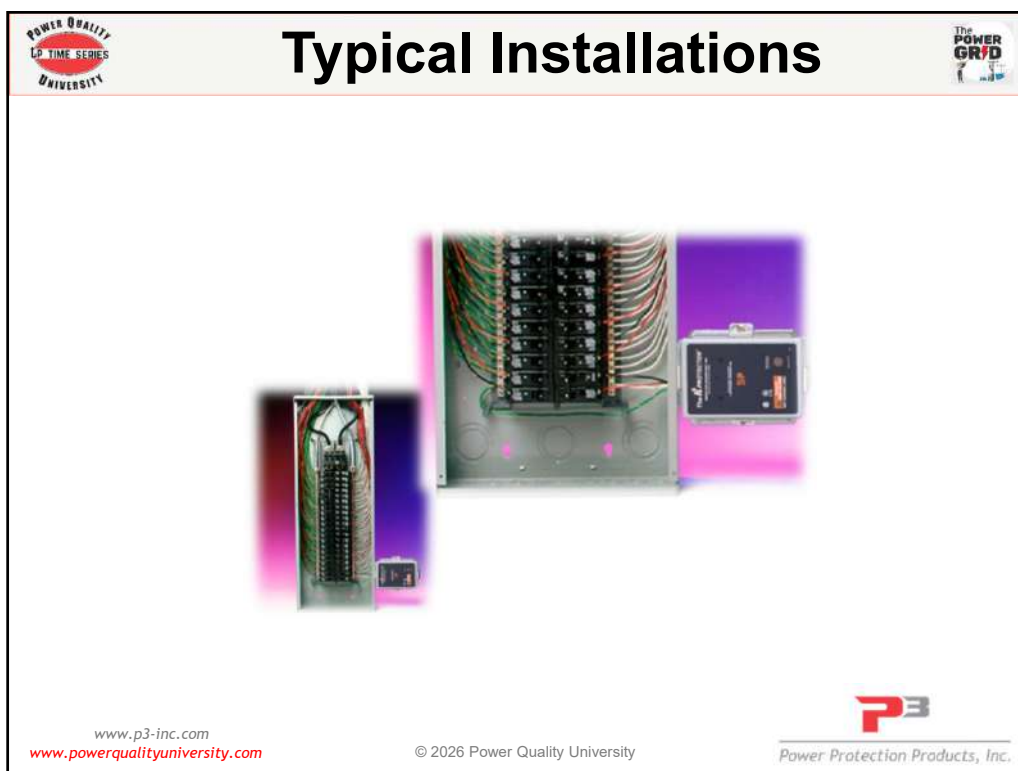
© 2026 Power Quality University


 Power Protection Products, Inc.

22



23



24

Typical Installations

www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University

Power Protection Products, Inc.

25

Performance/Application

Independent tests confirm better performance with integrated SPDs

Good

Better

Best

Side mount
Good let-through voltage if leads are short

Wired connection through a breaker
Better than side mount

Direct bus connected
Up to 46% better let-through compared to side mount.
Eliminates #1 Field Issue with Surge – Installation Errors.

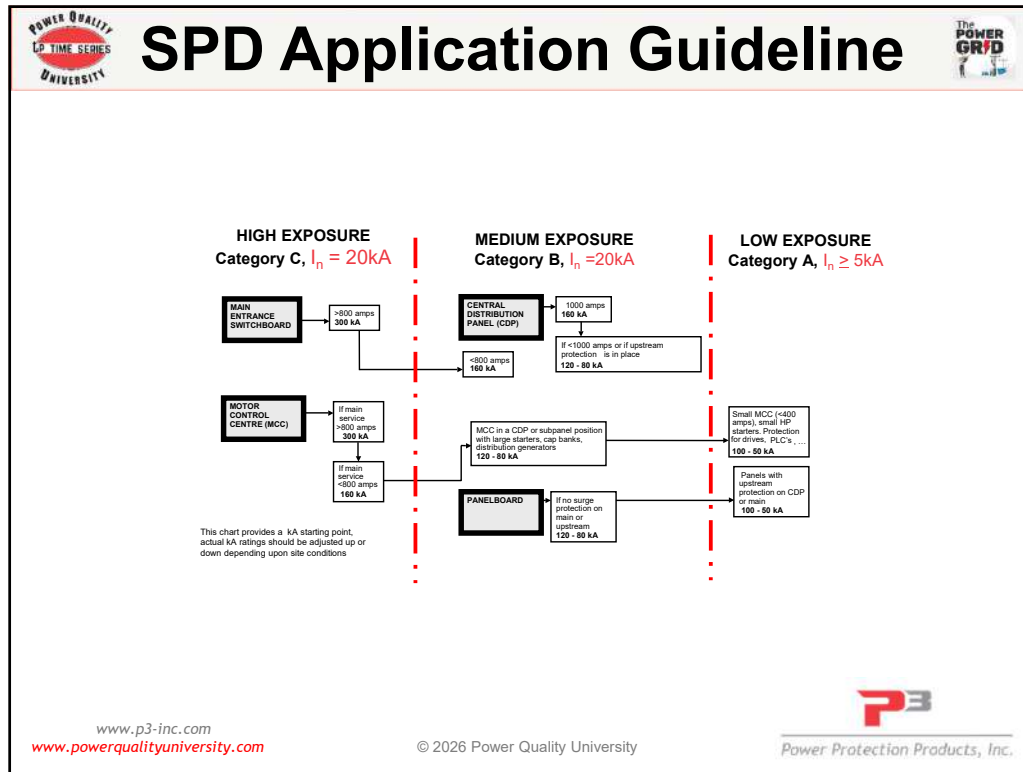
examples

www.p3-inc.com
www.powerqualityuniversity.com

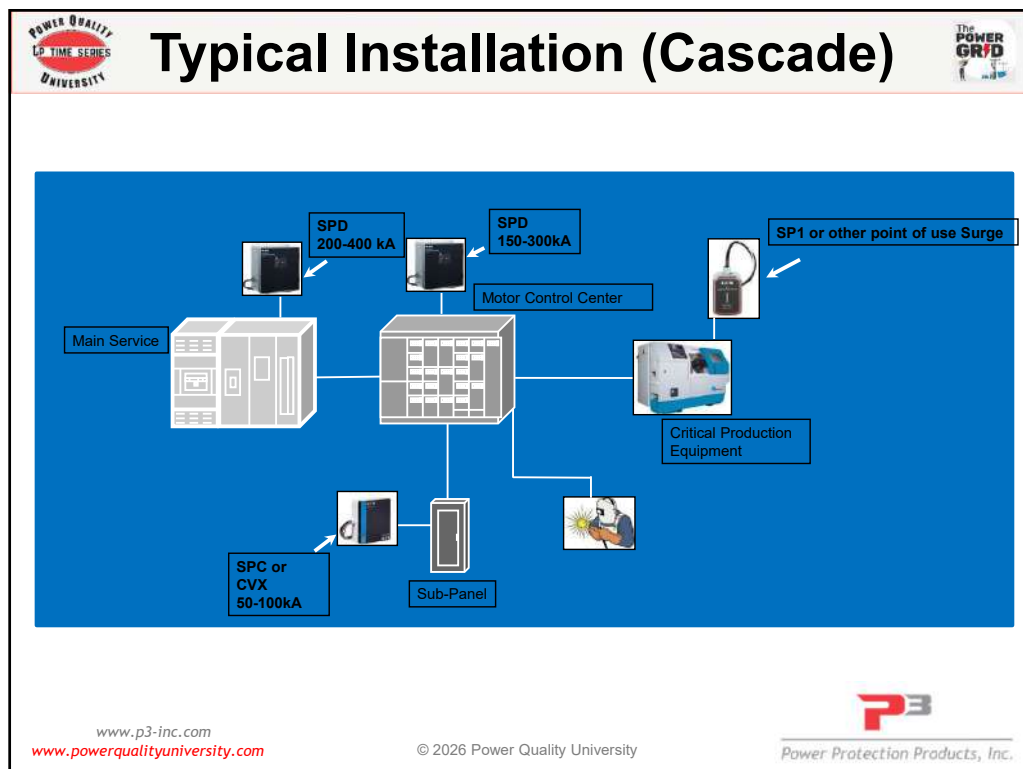
© 2026 Power Quality University

Power Protection Products, Inc.

26



27



28



NEC Code Requirements



- Beginning 2008 the NEC began requiring surge protection. The first article added was **708.20** regarding Critical Operation Power Systems (COPS).
- NEC states at the beginning of Article 708 that Critical Operation Power Systems are those systems so classed by municipal, state, federal, or other codes by any governmental agency having jurisdiction or by facility engineering documentation establishing the necessity for such a system.
- These systems include but are not limited to power systems, HVAC, fire alarm, security, communications and signaling for designated critical operations areas



www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University


Power Protection Products, Inc.

29



2011 NEC Change – Wind Generation



- In 2011 the NEC began requiring surge protection for wind generation by adding **Article 694.7 (d)**
- This section was slightly updated in 2017 to add the word “wind” and now reads:

“A surge protective device shall be installed between a wind electric system and any loads served by the premises electrical system”



www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University


Power Protection Products, Inc.

30



2014 Emergency Systems



- **Article 700.8** was added covering Emergency Systems. The NEC defines emergency systems in **section 700.1** as:
 - “Those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any governmental agency having jurisdiction.”



www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University


 Power Protection Products, Inc.

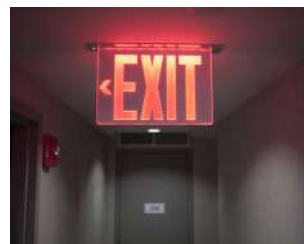
31



2014 Emergency Systems



- According to the NEC, “These systems are intended to automatically supply illumination, power, or both, to designated areas and equipment in the event of failure of the normal supply or in the event of accident to elements of a system intended to supply, distribute, and control power and illumination essential for safety to human life.”



2014 **NFPA** Study found **34.7%** of Smoke Detectors, **33%** of emergency lighting and **18.7%** CO2 Detectors were found to be damaged due to surge activity

www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University


 Power Protection Products, Inc.

32



2017 NEC – 695.15 Fire Pumps



- **695.15** – A listed surge protection device shall be installed in or on the fire pump.
- A study conducted by the NFPA concluded that **12%** of fire pumps tested had damage due to surge activity. Surge can damage motor windings and pump controls leaving critical equipment vulnerable during a critical emergency



www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University



Power Protection Products, Inc.

33



2017 NEC – 645.18 – Critical Data Systems



- Article **645.18** - Surge protection is required for critical operations data systems. The NEC defines these as: "information technology equipment systems that require continuous operation for reasons of public safety, emergency management, national security, or business continuity."
- The NFPA survey conducted found **(48%)** of respondents noted that their facility had experienced unexplained process interruptions.
- More than a third **(38%)** noted the occurrence of lockup of computer or industrial process systems



www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University



Power Protection Products, Inc.

34



2017 NEC – 670: Industrial Machinery



- Article **670.6** addresses industrial equipment with safety interlock circuits. It states that “industrial machinery with safety interlock circuits shall have surge protection installed.”
- The NFPA found that **27%** of safety interlocking mechanism on machinery was defective due to surge activity in the facility




www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University


 Power Protection Products, Inc.

35



**2026 NEC – 230.67(A) –
Residential Dwellings Requirement**



- All services supplying dwelling units **shall** be provided with a surge protective device (SPD). 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)




www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University


 Power Protection Products, Inc.

36



**2026 NEC – 230.67(A) –
Residential Dwellings Requirement**



- 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**





www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University


Power Protection Products, Inc.

37



2026 NEC – 620.51(E): Elevators, moving sidewalks, escalators, and more...



- Article **620.51(E)** was added to address emergency system loads, such as elevators, escalators, moving walkways, and chairlifts. These are systems that are a matter of public safety. It states:
 “Where any of the disconnecting means in **620.51** has been designated as supplying an emergency a standby 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.
- The 2014 NFPA sponsored a survey to determine the damaging effects of voltage surges in various applications found **24%** of responders to the survey reporting damage to elevator equipment from surge activity.






www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University


Power Protection Products, Inc.

38



The Current UL1449



Current Edition 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

Contains no serviceable parts.

Model #

SCCR: 1

Nominal Discharge Current Rating (In): **20kA**

MCOV Rating: 150V L-N, NG, L-G; 300V L-L

Sys.V: 100V/174V; 120/208V; 127V/220V

Sys. Frequency: 50/60Hz

VPR: 70 V L-N; 70 V L-G; 70 V N-G

Date of Manufacture: 11/21/2007

Suitable For Use on a Circuit Capable of Delivering Not More Than 100,000 rms Symmetrical Amperes.



www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University


 Power Protection Products, Inc.

39



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)


 Power Protection Products, Inc.

www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University

40



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!)**

www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University


 Power Protection Products, Inc.

41



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, disconnect switches, and circuit breakers;
 - 2) Control circuit components only, such as push buttons, pilot 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, Eaton's interpretation is the virtually all industrial panels need protection.



www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University

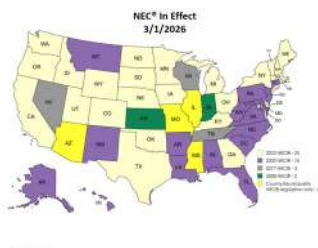

 Power Protection Products, Inc.

42

42

NEC Requirements

- **NEC Code Requirements**
 - 2020 change brings total number of surge requirements to 8.
 - Impossible to construct building without surge protection
 - 2026 Code will have more requirements – trend won't stop!
 - Adoption Map:



What is the Power Xpert SPD

- Advanced monitoring display
 - Tri colored LED indicator lights status per phase
 - Surge magnitude categorization into low, medium and high categories as well as total surge counts
 - Time/date stamped event log
 - % protection remaining per phase





What is the Power Xpert SPD





Tri – colored Indicator lights

Catalog number
Device name
Time
Firmware version

QR code

Input Buttons

- Fully Protected
- Less than 100% protection remaining, unit still providing protection on all modes
- Unit no longer providing protection on all modes, replace unit

www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University



Power Protection Products, Inc.

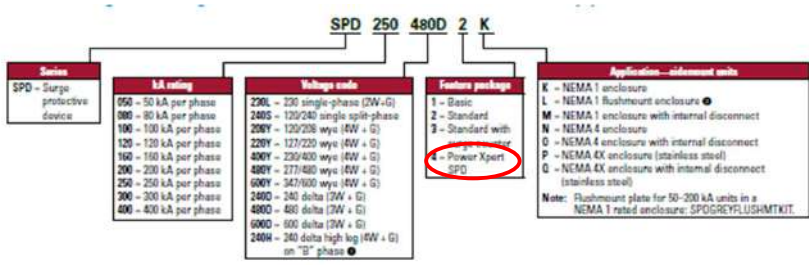
45



What is the Power Xpert SPD



SPD 250 480D 2 K



www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University



Power Protection Products, Inc.

46



Stay Up To Date!



Follow, Like & Share

 Instagram - <https://www.instagram.com/pwrproproducts/>

 Facebook - <https://www.facebook.com/PwrProProducts>

 Twitter - <https://twitter.com/PwrProProducts>

 LinkedIn - <https://www.linkedin.com/company/power-protection-products-inc->



Catch all our new episodes on your favorite platform: <https://lnkd.in/gwDQbVfR>

www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University


Power Protection Products, Inc.

47



Surge Protection Devices



END

Please send completed form to:
PQU@P3-INC.COM
OR
Fill Out Evaluation Online – Link in Chat

*Thank you for attending PQU's
Surge Protection Devices Webinar*

www.p3-inc.com
www.powerqualityuniversity.com

© 2026 Power Quality University


Power Protection Products, Inc.

48

