





## XPerts in Power - Module 2

### Input Protection AC & DC

Stephen Dodson

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### Module Content

- Why do we need input protection?
- Inrush current
- Fuses - sizing & characteristics
- Circuit breakers - types, sizing & characteristics
- Input transient protection
- Reverse polarity protection



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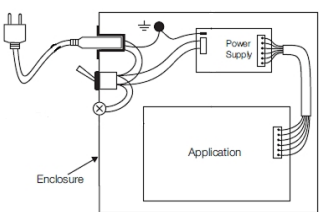
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### Why do we need input protection?





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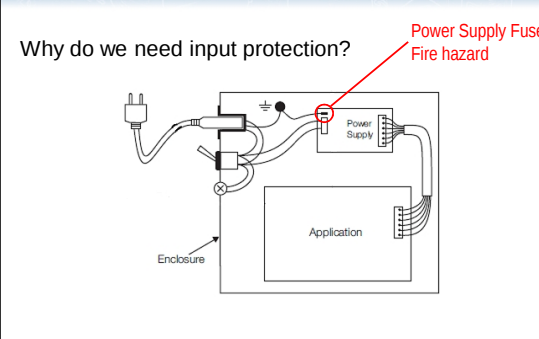
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Why do we need input protection?



Power Supply Fuse  
Fire hazard

Enclosure

Power Supply

Application

XP Power

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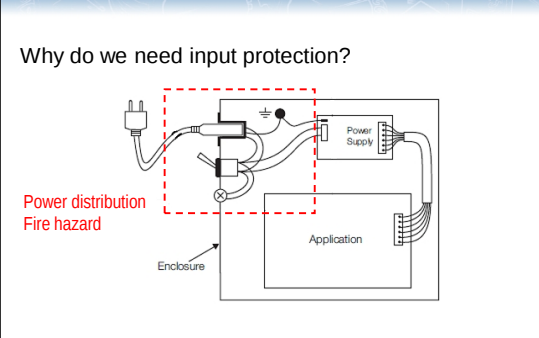
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Why do we need input protection?



Power distribution  
Fire hazard

Enclosure

Power Supply

Application

XP Power

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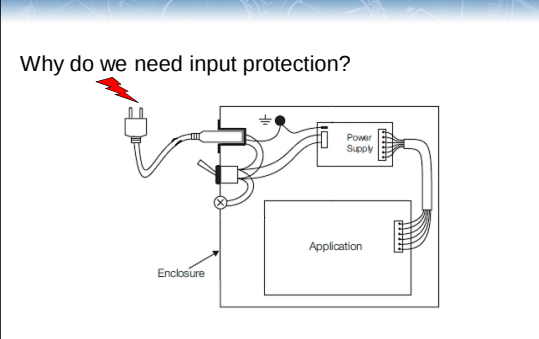
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Why do we need input protection?



Power distribution  
Fire hazard

Enclosure

Power Supply

Application

XP Power

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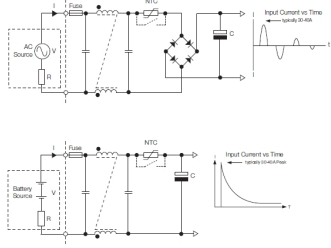
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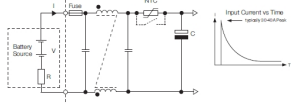
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### Inrush Current



The top diagram shows a circuit with an AC source, a resistor R, a fuse, an NTC thermistor, and a load. A graph of Input Current vs Time shows a high initial peak (labeled 'lumpy 10 kHz') that decays over time.



The bottom diagram shows a similar circuit but with a battery source. The graph of Input Current vs Time shows a smooth exponential decay curve.

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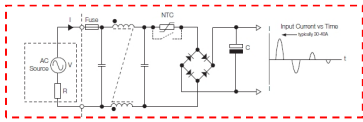
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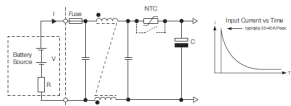
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### Inrush Current



The top diagram, which includes the AC source circuit and its graph, is enclosed in a red dashed box.



The bottom diagram shows the battery source circuit and its graph.

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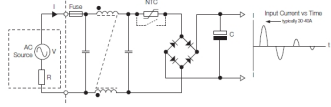
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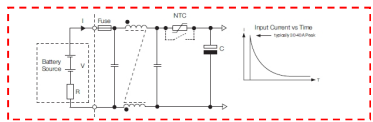
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### Inrush Current



The top diagram shows the AC source circuit and its graph.



The bottom diagram, which includes the battery source circuit and its graph, is enclosed in a red dashed box.

XP Power 9

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### Input fuses / circuit breaker - sizing

Input Power = Output Power / Efficiency

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Input Current = (Input Power / Input Voltage) / Power Factor

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Choose fuse or CB rating at least 1.5 x Input Current - Time Lag

**XP Power** 10

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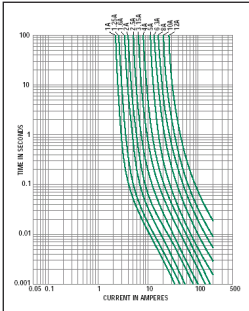
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### Input fuses - characteristics

Series: **215XE**  
Technology: Leaded and Cartridge  
Description: 215 Series - 5x20mm Time Lag Axial Specification

**XP Power** 11

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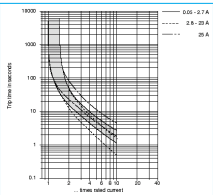
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### Input circuit breakers - thermal types

Typical time-current characteristic at +25°C/+73.4°F



The time-current characteristic curve depends on the ambient temperature prevailing in order to estimate ambient effects. Please multiply the current values by the derating factor shown below. Use derating factor 1.0 for ambient temperature +25°C.

| Ambient temperature °C | Derating factor |
|------------------------|-----------------|
| -40                    | 0.75            |
| -25                    | 0.85            |
| -10                    | 0.95            |
| 0                      | 1.00            |
| +25                    | 1.00            |
| +40                    | 0.95            |
| +55                    | 0.85            |
| +70                    | 0.75            |

**XP Power** 12

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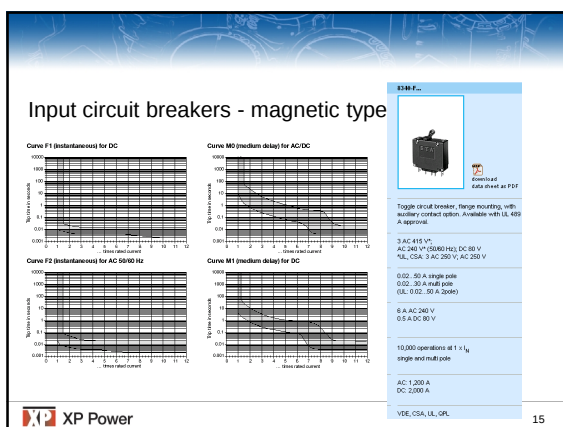
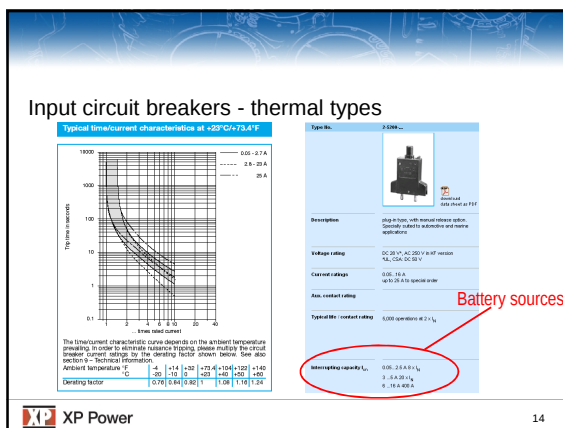
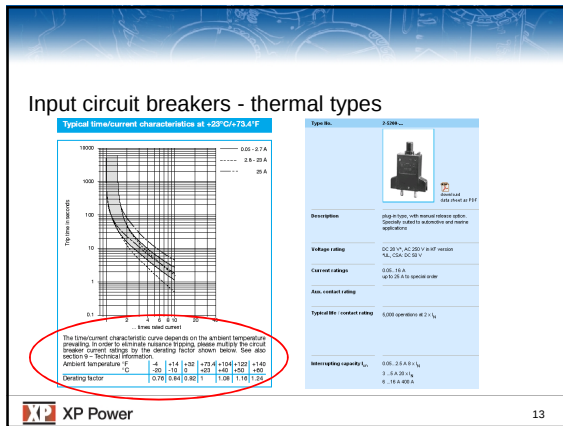
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### Why do we need input protection?

Power Supply Fuse  
Fire hazard

Power distribution  
Fire hazard

Enclosure

Power Supply

Application

XP Power

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### Input transient voltage protection

|                            |                                                                                                         |
|----------------------------|---------------------------------------------------------------------------------------------------------|
| Transorb                   | - Semiconductor device<br>Sharp characteristic<br>Fast response low energy                              |
| MOV "Metal Oxide Varistor" | - Voltage dependant resistor<br>Soft characteristic<br>Medium response high energy                      |
| GDT "Gas Discharge Tube"   | - Gas filled spark gap<br>Clears fuse<br>Slow response very high energy<br>Used in conjunction with MOV |
| Electronic protection      | - Used for vehicle traction applications<br>Linear regulator or open circuit                            |

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### Input transient voltage protection

L O

N O

Fuse

Transorb

NTC

XP Power

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### Input transient voltage protection

XP Power

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### Input transient voltage protection

XP Power

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### Input transient voltage protection

XP Power

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### Input over voltage protection

DC SUPPLY

Electronic Regulator

Transorb

DC/DC CONVERTER

XP Power

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### Reverse polarity protection

DC/DC CONVERTER

Shunt diode/transorb

DC/DC CONVERTER

Series diode

DC/DC CONVERTER

Series MOSFET

XP Power

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### Fuse blowing transients

48V

100-300V

0V (short cct)

Fuse blowing transient

XP Power

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Fuse blowing transients & reverse polarity protection

48V 100-300V  
0V (short cct)  
Fuse blowing transient

Shunt diode/transorb Series diode Series MOSFET

XP Power 25

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Fuse blowing transients & reverse polarity protection

48V 100-300V  
0V (short cct)  
Fuse blowing transient

Shunt diode/transorb Series diode Series MOSFET

XP Power 26

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XP Power

[www.xppower.com](http://www.xppower.com)

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