

# NTC-Based Inrush Current Limiters

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## The **Ametherm** Advantage

*Protecting your circuits through technological innovation - accurately and economically*

# What is Inrush Current?

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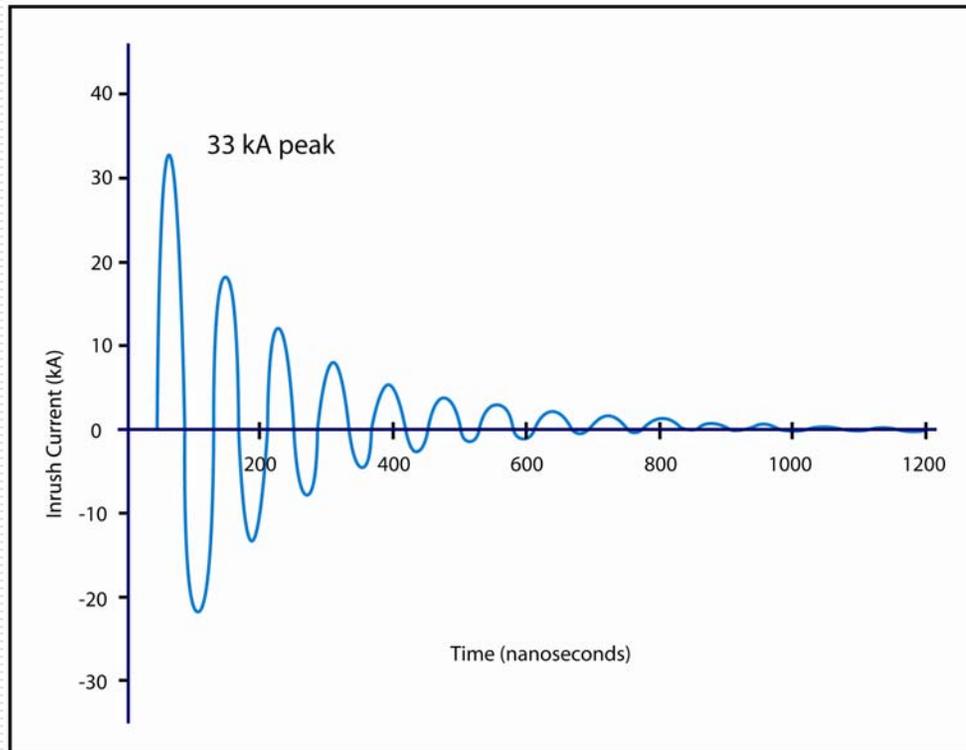
When you first turn on an electrical device, the maximum, instantaneous input current drawn by the electrical device is called the **Inrush Current**. This current is also called **input surge current**. It is basically the charging current of the capacitance inside the equipment.

Example:

- Incandescent light bulbs – draw large currents until their filaments warm up
- AC electric motors - draw several times their normal full loads current when first energized
- Power converters – draw high inrush current relative to their steady currents

# What is Inrush Current?

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Inrush current is the maximum, instantaneous input current drawn by an electrical device, when the device is turned on.

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# Why Do You Need to Limit Inrush Current?

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Inrush current can damage components when any equipment is turned on.

If steps are not taken to minimize this inrush current, it can damage power devices and reduce equipment life.

## How Do You Limit Inrush Current?

Here are two ways to limit inrush current:

- Using NTC Thermistor-based inrush current limiters
  - Using various forms of active circuits - including triacs, power resistors, and thyristors
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# About NTC Thermistors

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- ❑ Thermistors are electronic components that are used for temperature sensing, or to detect changes in the temperature of an object
- ❑ Thermistors can detect very small changes in temperature through the manifestation of a big change in resistance (i.e., a nonlinear characteristics).
- ❑ Thermistors are also tough, reliable and easy to use.
- ❑ A **Negative Temperature Coefficient** or an **NTC Thermistor** is capable of lowering its resistance when there is an increase in the temperature of a measuring object.
- ❑ NTC Thermistor exhibits nonlinear behavior. For example, if the temperature of a measuring object increases because of some internal heating the resistance of a working (engaged for this purpose) NTC Thermistor decreases nonlinearly to indicate this increase in temperature.

# NTC-Based Inrush Current Limiters – How Do They Work?

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- ❑ NTC Thermistor based Inrush current limiter is one of the most common design options for protecting circuits in several applications.
- ❑ The resistance of a such surge limiting thermistor decreases as its temperature increases. As the inrush current limiter self-heats, the current begins to flow through it.
- ❑ Its resistance begins to drop and a relatively small current flow charges the capacitors in the power supply. After the capacitors in the power supply become charged, the self heated inrush current limiter offers little resistance in the circuit. So low that the voltage drop is an insignificant factor with respect to the total voltage drop of the circuit.

# Advantages of NTC Thermistor-Based Inrush Current Limiters

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- ❑ **Lower component costs.** Inrush current limiters are typically less expensive than active circuit components.
  - Example: Typical cost of two Thermistors needed for a 300W power supply: \$.80 or less for both thermistors.
- ❑ **Simpler design.** Because inrush current limiter-based surge suppression circuit designs typically involve fewer components, they are less complex than those involving active circuits. In turn, a simpler design reduces the design time.
- ❑ **Greater manufacturing simplicity** and lower reject rates. Fewer components means fewer assembly steps.
- ❑ **Requires significantly less space** on the power supply circuit board. Commonly replaces a power resistor, relay and contactor or triac or thyristor.
- ❑ (NTC- Thermistor based) Inrush current limiter-based surge suppression is **self-protecting** in the failure mode (no component replacement)

# Ametherm NTC Thermistors – Inrush Current Limiters

**Two Series:** SL (Surge Limiter) & MS (MegaSurge) Series.  
Again, SL Series Thermistors are of three types: miniAmp,  
Standard and bigAmp.

Features			
SL Series - miniAmp	SL Series - Standard	SL Series - bigAmp	MS Series
<ul style="list-style-type: none"><li>•Up to 20 Amps</li><li>•2.5 to 220 <math>\Omega</math></li><li>•Up to 20 Joules</li><li>•Short Lead time</li></ul>	<ul style="list-style-type: none"><li>•Up to 20 Amps</li><li>•0.5 to 220 <math>\Omega</math></li><li>•Up to 100 Joules</li><li>•Short Lead time</li></ul>	<ul style="list-style-type: none"><li>•Up to 36 Amps</li><li>•0.2 to 10 <math>\Omega</math></li><li>•Up to 300 Joules</li><li>•Short Lead time</li></ul>	<ul style="list-style-type: none"><li>•Up to 50 Amps</li><li>•0.5 to 220 <math>\Omega</math></li><li>•Up to 960 Joules</li><li>•Short Lead time</li></ul>

# Ametherm NTC Thermistors – Inrush Current Limiters

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Other Features: RoHS Compliant *plus*

		
MegaSurge Series SL Series (miniAmp, Standard, bigAmp)	SL Series (miniAmp, Standard, bigAmp) File No: CA 110861	UL Approval ONLY applies to SL22 Family File No: E209153

# Applications of Inrush Current Limiters

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SL Series	MS (MegaSurge) Series
<ul style="list-style-type: none"><li>•Power Supplies</li><li>•AC Motors and Drives</li><li>•Audio Amplifiers</li><li>•Power Amplifiers</li><li>•UPSs</li><li>•Fire controls</li><li>•HVAC, Industrial Controls</li><li>•Welding Equipment</li><li>•Treadmills</li><li>•X-ray Equipment</li></ul>	<ul style="list-style-type: none"><li>•AC Motors</li><li>•Power Supplies</li><li>•Motor Drives</li><li>•Audio Amplifiers</li><li>•Battery Chargers</li><li>•Frequency Generators</li><li>•Plasma Cutting Tools</li><li>•MRI machines</li><li>•Toroidal Transformers up to 4.0 KVA</li></ul>

# Important Question to Ask

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## Q: How to Select an Inrush Current Limiter?

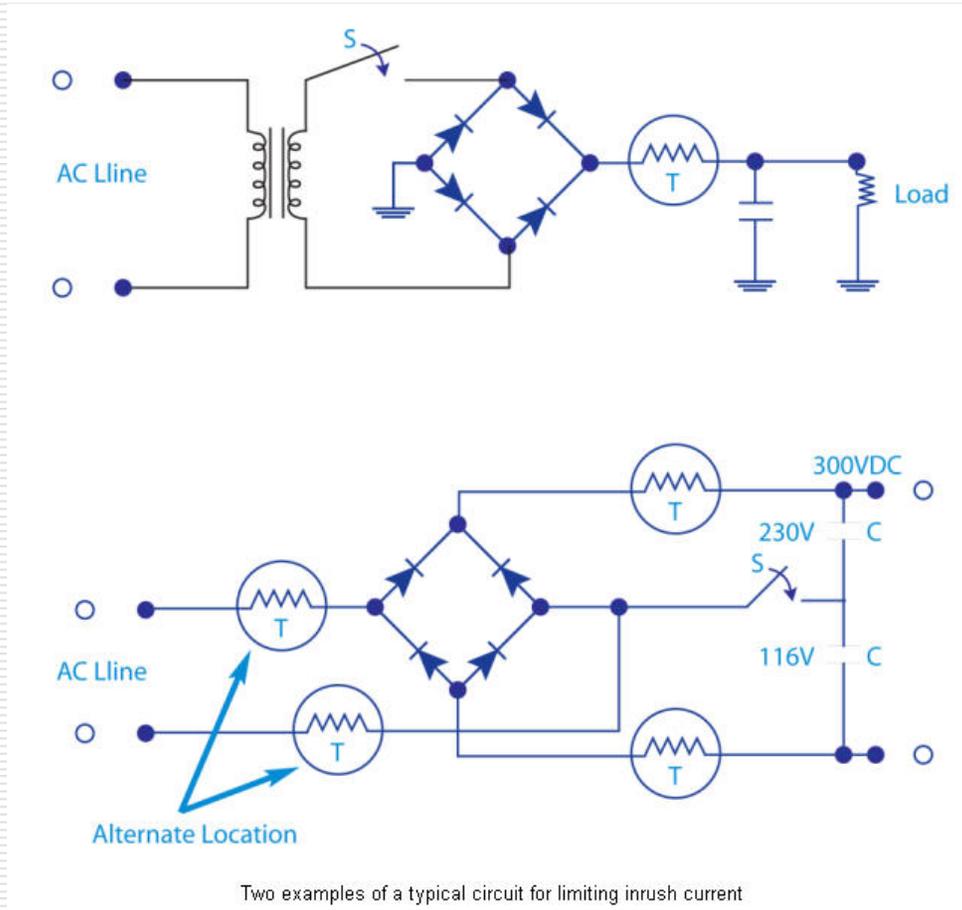
### Follow these steps:

- ❑ Use the maximum allowable surge current and Ohm's Law ( $V/I=R$ ) to determine the least allowable resistance at turn on for your application.
- ❑ Using the formula  $J = .5CV^2$ , determine how much input energy the thermistor will absorb when the device is turned on.
- ❑ Determine the maximum steady state current (SSI) that will flow through the Inrush Current Limiter.

$$\text{SSI} = \text{Output Power}/(\text{Input V} \times \text{Efficiency})$$

- ❑ Select the Inrush Current Limiter that will work for your application.

# Example Circuits Using Inrush Current Limiters



# Cooling down of Inrush Current Limiter

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- **What about the cool down time of an Inrush Current Limiter?**
  - Because inrush current limiters heat after they suppress inrush currents, these devices require a cool-down time after power is removed.
  - This cool-down or "recovery" time allows the resistance of the NTC thermistor to increase sufficiently to provide the required inrush current suppression the next time it is needed.
  - An NTC's cool-down time varies according to the particular device, its mounting method and the ambient temperature.
  - The **cool-down time** required depends on the mass of the part. Typically, **it could be anywhere from 20 seconds to one minute.**

# Summary

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- ❑ Inrush current limiters protect electronic circuits through technological innovation - accurately and economically .
- ❑ Inrush current is the maximum, instantaneous input current drawn by an electrical device when the device is turned on.
- ❑ If steps are not taken to minimize this inrush current, it can damage power devices and reduce equipment life.
- ❑ NTC Thermistor based Inrush current limiter is one of the most common design options
- ❑ Advantages of Ametherm NTC Thermistor-Based Inrush Current Limiters: i) lower component costs, ii) simpler design, iii) greater manufacturing simplicity and iv) less space on the circuit board.
- ❑ Many sophisticated applications in different areas such as consumer electronics, automotive industry, Medical, industrial, Military and aerospace applications need circuit protection via Inrush current limiters
- ❑ **Ametherm provides two Series of Inrush Current Limiters – SL and MS Series – as a solution for circuit protection.**
- ❑ **ISO Certified 9001:2000; RoHS Compliant and Lead-free, SL Series Inrush Current Limiters are CSA approved. NOTE: UL approval is only applicable for SL22 Family.**