Line Input Resistors



EMC and ULW Series

TT electronics Welwyn Components, a UK based resistor manufacturer for over 70 years, has developed two series of UL1412 recognised fusible resistors. The EMC and ULW Series are aimed at line (mains) input inrush limiting in power supply applications where UL Approval is necessary.

The selection of a line input resistor for a power supply or battery charger is not a simple task as conflicting factors are involved. On one hand the resistor must be sufficiently robust to survive repeated inrush surges and occasional power line transients. On the other hand, the resistor is often relied on for failsafe flameproof fusing in the event of a short-circuit bridge or capacitor failure, so rapid positive opening with line voltage standoff is called for.

Technology Selection

A common choice of technology is wirewound in the range 10R to 100R. Balancing the conflicting requirements of this application can be a difficult task involving careful selection of the resistance wire alloy and diameter. General purpose wirewound resistors without specified surge performance should be avoided. Even if a sample passes testing in your prototype, there is no guarantee that production lots will have identical winding parameters as there may be flexibility to select from a number of wire options in order to help cope with variable demand without holding excessive wire inventory. TT electronics Welwyn Components has developed the ULW Series with specified surge and fusing performance for precisely this application.

An alternative to wirewound technology is surge resistant metal film. This has the advantage of lower cost and may be employed where surge requirements are at a lower level. It should be noted that it is generally a mistake to use normal or fusible metal film resistors in line input positions as they can fail at very low surge levels. However, a surge resistant type like TT electronics Welwyn Components EMC Series benefits from having little or no trimming applied to the deposited film.



TT electronics Welwyn Components Line Input Resistors

Product	Technology	Energy Capacity (J)
EMC2	Surge resistant metal film	0.1 to 10 (depending on charging duration)
ULW2		1 to 3 (depending on ohmic value)
ULW3	Wirewound	3 to 7 (depending on ohmic value)
ULW5		9 to 12 (depending on ohmic value)

Regardless of the resistor technology chosen, the ideal coating is flameproof silicone cement with UL94-V0 flammability rating. Vitreous enamel types are often too robust to fuse before overheating to a dangerous extent and moulded plastic types can emit copious fumes when overloaded. Furthermore, EMC and ULW Series have multilayer coatings designed to enhance positive opening and avoid excessive loss of coating after fusing.

UL Recognition

Both these series have UL recognition, which is a component status indicating that a sample has been tested and verified by Underwriters Laboratories as suitable for use in a safety critical application. The relevant standard is UL1412 which covers fusing resistors designed to prevent fire by safely breaking a circuit under fault conditions. The main performance features that this ensures are as follows:

- 1. Restricted maximum body temperature enables it to pass a gradual overload test without igniting "cheesecloth" at 13mm spacing.
- 2. Positive opening action ensures that the open circuit resistance after fusing exceeds 100 times original resistance.
- 3. Line voltage fusing is without flame, incandescent fragments, or ignition of cotton material contacting the resistor body.
- 4. Safety-critical aspects of electrical performance have been independently verified by UL Laboratories, and ongoing manufacture is monitored for consistency.

It is clearly easier to obtain and retain UL approval on electrical products if safety critical components are UL recognised. This generally entails using a UL recognised fuse in series with the line input, in addition to an inrush limiting resistor.

Reducing Component Count

EMC and ULW parts perform three circuit protection functions in a single component:

- 1. Providing protection against supply line voltage transients, often in conjunction with a shunt element such as a Varistor or Transient Voltage Suppressor (TVS). This enables the designer to achieve the required level of immunity to conducted lightning induced surges.
- 2. Restricting the peak inrush current at switch-on to levels suitable for the rectifier bridge and consistent with good EMC design.
- Preventing fire by fusing safely under fault conditions such as rectifier or capacitor breakdown.

Typical application in which the input resistor and fuse are replaced by a single part



Stephen Oxley Senior Applications Engineer TT electronics Welwyn Components Ltd