OVERCURRENT PROTECTION

Fuses are current sensitive devices and selected to be the weakest link in the circuit. Circuit protection is provided when the fuse link melts and safely interrupts the over current demand. The key criteria to judge the performance of a fuse is the time versus current characteristic curve. This curve can be used to match the fuse with the anticipated over current load expected in the application.

Types Of Over Current

Short Circuit: A short circuit is a current condition that greatly exceeds the rating of the device. It is caused when a malfunction or accident creates a break in the normal path allowing electricity to flow directly to ground. This shorter current path bypasses the resistance offered by the circuit components connected in the normal current path. In this situation, there is virtually no resistance to impede the current and the current will build to a level where the heat generated can cause insulation or equipment breakdown.

Overload: An overload is an over current that is within the normal current path. Overloads occur when the current exceeds the value for which the equipment or associated wiring is rated. This typically occurs when too many devices are connected to the circuit or when a device connected to the circuit malfunctions. Sustained overloads may slowly cause overheating of the wiring and the components. The circuit protection device must open before these types of overloads cause damage.

Selecting Over Current Protection

During normal conditions, an over current protection device must carry the current without nuisance openings. However, when an overload or short circuit occurs, the device must interrupt the over current and withstand the voltage across the device after arcing. To properly select an over current device, the following items must be carefully considered:

Voltage Rating: Represents the maximum system voltage present in the circuit in which the over current device is installed. The system voltage should not exceed this value for proper operation of the device during an over current event.

Current Rating: This is the ampere value marked on the circuit protection device. It is established by the manufacturer as a value of current which the device can carry, based on a controlled set of test conditions. The current rating of a fuse is typically de-rated by 25% to ensure continuous operation in an ambient temperature of 25˚C and avoid nuisance blowing. Example: A fuse with a current rating of 10A is usually recommended for operation at no more than 7.5A (10A x 0.75) based on an ambient temperature of 25˚C. If the ambient temperature is higher, a re-rating must be calculated as per the section below.

In-rush Characteristics: During the operation of protected equipment, system current can significantly vary. This is particularly evident when motor or other inductive loads in the circuit cause large current surges during start-up or shutdown. A time-delay fuse should be used in applications where in-rush currents are possible.

Re-rating For Ambient Temperature

The current carrying capacity tests of fuses are performed at 25˚C and will be affected by changes in ambient temperature. At higher ambient temperatures, a fuse will respond faster to a given overload. Conversely, at lower ambient temperatures, a fuse will respond slower to a given overload. Selecting the correct fuse for higher or lower ambient temperatures requires the use of an *ambient temperature re-rating chart*. These charts vary by product and manufacturer ie. a slow acting fuse will have a different re-rating curve to a fast acting fuse.

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OVERCURRENT PROTECTION

Example: We need to select the correct fast-acting fuse for a circuit with a normal operating current of 15A and an ambient temperature of 105˚C.

The formula below uses a 105˚C re-rating factor of 0.88 (read from the chart on the right) and the standard 25˚C de-rating factor of 0.75

$$\frac{\text{Normal Operating Current}}{\text{Re-rating x De-rating}} = \frac{15A}{0.88 \times 0.75}$$

The fuse rating we require is: 22.73A at 105˚C.