How Surge Gards™ can improve power supplies

Surge Gards™ devices are NTC thermistors made from a specially formulated metal-oxide ceramic material which has the characteristic of sharply decreasing electrical resistance with increase in temperature. If current flows through these devices they self-heat and the resistance falls. Thus, they are used in equipment where there is a need to limit a surge of current when power is first applied.

They have many applications in the electronics industry from power supplies to lighting; the one described here is typical and shows step by step the way Surge Gard™ are specified for a power supply.

The advantages of limiting the surge current are:

- Lower rated and therefore a cheaper on/off switch can be used
- A lower rated, lower cost rectifier bridge may be used
- A standard fuse can be used
- A reduction of power sag noise

The main reason for fitting a Surge Gard™ in a power supply is to protect the diode rectifier bridge while the input capacitor is charging. (This is almost a short circuit in its uncharged state.) The Surge Gard™ in the circuit (figure 1) will offer a high resistance at first but will quickly self-heat (one to two seconds) and its resistance will drop to a relatively low resistance, thus protecting the bridge while the capacitor charges.

This article used a 75W power supply with a universal input, whose maximum input current is 1.2 amps at 90 volts. This parameter is Imax.

The Surge Gard™ must provide maximum current protection when the power supply is switched on when the capacitor is totally discharged. The input rectifier bridge should be selected to be able to pass at least two to three times the effective peak input current during the first half cycle of AC power.

If in this example we choose a 1N5406 rated at 3 amps continuous and 200 amps over one cycle, a Surge Gard™ that limits the inrush current to less than 100A at the maximum input voltage of 265V has to be chosen. Therefore the cold resistance R25 is a minimum of 265/100 = 2.65Ω.

Of the available models, the SG37 and SG230 will meet these criteria.

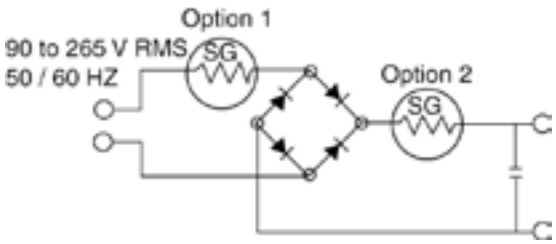
The selection of the best device for the application does not stop here, as there are four more things to be taken into consideration.

If the 'Surge Gard™' is to operate at high ambient temperatures, the 'cold resistance' specified at 25˚C is affected. If the maximum operating temperature is 50˚C, the resistance at that temperature can be determined. The resistance value at 25˚C of the SG37 and SG230 is 25Ω and 20Ω respectively. To determine the value at 50˚C these resistances must be multiplied by 0.464 (see the table on the next page).

In some cases, this drop in cold resistance at higher temperatures could mean that there is insufficient resistance to limit the inrush current adequately.

Each 'Surge Gard™ has a limit to the amount of surge energy J_{max} that it can tolerate. Each 'Surge Gard™' has an energy rating in joules. The energy rating of the circuit is given by the equation $E = ½CV^2$.

Figure 1 – 'Surge Gard™' in the circuit



If the capacitor in this circuit is 470 µF, then the energy is 16.5 joules. The SG specification shows us that the energy rating of the SG37 is 15 joules and the rating for the SG230 is 31 joules so the SG230 is the better choice.

The voltage drop across the device when hot can be calculated using the 'Surge Gard™' Resistance Curve (see figure 2). By using this chart the multiplying factor M can be found. The running current Iop is 1.2 A. I_{max} for the SG230 is 1.75 amps, I_{op}/I_{max} = 0.7 so (from figure 2) M is about 1.5.

To determine the hot resistance of the device, this figure should be multiplied by the resistance at maximum current RI_{max} figure. So the hot resistance is approximately 1.5 x 0.6 = 0.9Ω. So the voltage drop is approximately 1V.

MOUNTING SURGE GARDS

Surge gards may get hot in operation. Use the following guidelines when mounting for best results.

- Do not place on the PCB near temperature sensitive components.
- Use a high temperature solder on the PCB.
- If equipped, use a ceramic spacer to stand off the surge gard from the PCB or contact us for pre-formed devices.
- Keep away from wiring looms.

How Surge Gards™ can improve power supplies (continued)

One final consideration is the I_{max} versus the ambient temperature. A derating curve is given in Figure 3. It shows that I_{max} reduces to zero at 150˚C. Note that if the maximum operating temperature is 100˚C, then the 'Surge Gard™' should only be used at only 58.8 per cent of its rated maximum current.

To summarise, there are five steps to take to select the correct 'Surge Gard™' for a power supply:

1. Calculate the maximum continuous current (I_{max})
2. Calculate the resistance needed to limit the surge current at 25˚C
3. Select a 'Surge Gard™' that is specified to handle the required energy of the circuit
4. Calculate the 'Surge Gard™' resistance at the operating current, using the M curve
5. Consider if derating is required for operating temperatures over 65˚C

Temperature (˚C)	R-T Curve (RT/R25)
-20	5.69
-10	3.68
0	2.45
10	1.68
20	1.18
25	1.00
30	0.854
40	0.628
50	0.464
60	0.350
70	0.267
80	0.208
90	0.163
100	0.130
110	0.105
120	0.0852
130	0.0700
140	0.0579
150	0.0483

Figure 2 – 'Surge Gard™' Resistance Curve

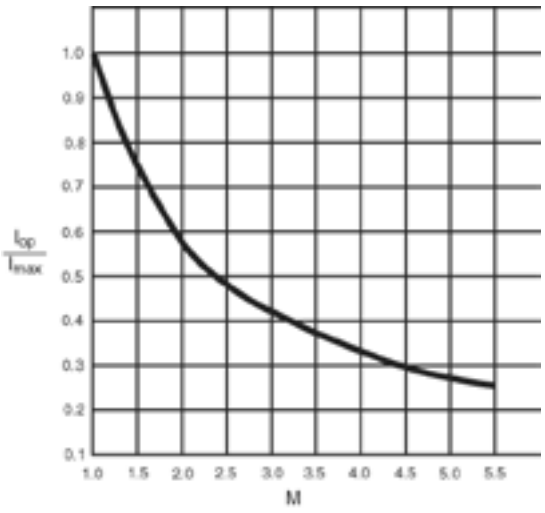
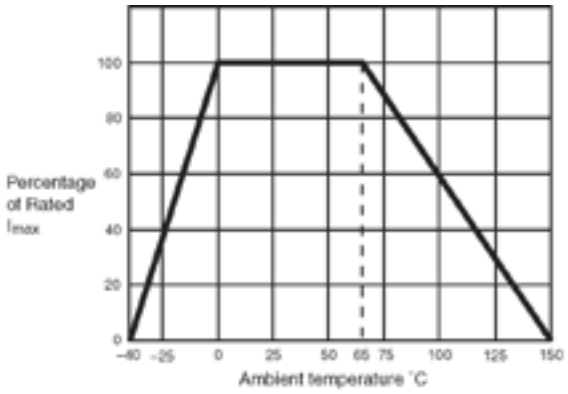


Figure 3 – Derating Curve



DESIGNING FOR SAFETY APPROVAL

'Surge Gards™' are CSA approved (contract no. 204620, report no. 1087594). Most of our customers satisfy safety authorities by careful mounting and protection of the device in the circuit. The following guidelines should be followed.

1. The 'Surge Gard™' body should not touch other components on the PCB.
2. A fuse rated at the maximum current rating of the device (allowing for any derating that may be needed for ambient temperatures in excess of 65˚C) or lower than the maximum current rating of the device should be used.

   These devices are widely used by many power supply and other equipment manufacturers who have no trouble in getting approval for their equipment when following the above guidelines.