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 Gards™' 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 or two seconds) and its resistance will drop to a relatively low resistance, thus protecting the bridge while the capacitor charges.

This article used a 75-W power supply with a universal input, whose maximum input current is 1.2 amps at 90 volts. This parameter is I_{max} .

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 265 volts has to be chosen. Therefore the cold resistance R_{25} is a minimum of 265/100 = 2.65 Ohms.

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 25 Ohm and 20 Ohm respectively. To determine the value at 50°C these resistances must be multiplied by 0.464 (see the table opposite).

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 energy rating in joules. The energy rating of the circuit is given by the equation $E = ½CV^2$.

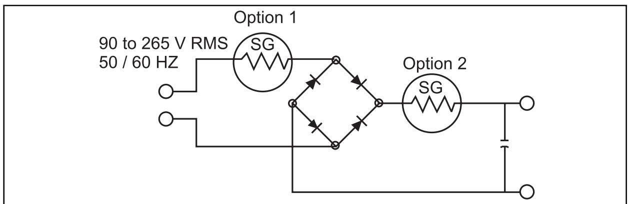

Figure 1 – 'Surge Gard™' in the Circuit

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 the following way: Using the 'Surge Gard™' Resistance Curve.

By using Figure 1. the multiplying factor M can be found. The running current I_{op} is 1.2 A. I_{max} for the SG230 is 1.75 amps, I_{op}/ I_{max} = 0.7 so from Figure 1. 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 = 0.9 Ohm. So the voltage drop is approximately 1 V.

One final consideration is the I_{max} versus the ambient temperature. A derating curve is given in Figure 2. 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% of its rated maximum current.

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

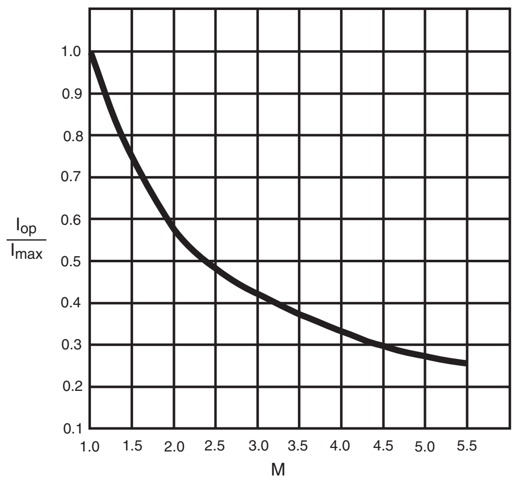

Figure 2 – 'Surge Gard™' Resistance Curve

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By using Figure 2 the multiplying factor M can be found. The running current I_{op} 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.

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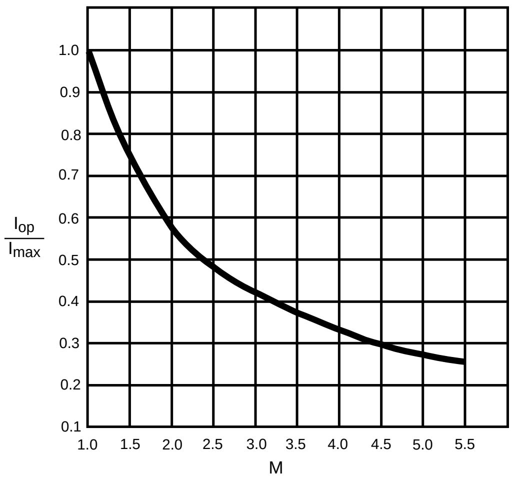
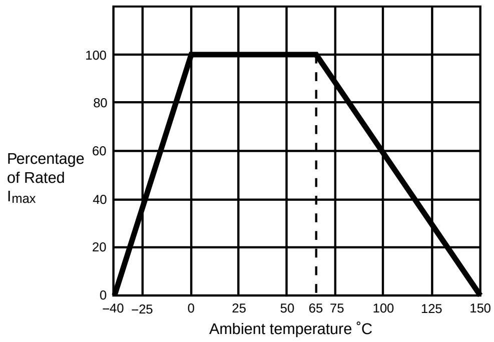


To summarise, there are five steps to take to select the correct 'Surge Gard™' for a power supply:

- Calculate the maximum continuous current (Imax)
- Calculate the resistance needed to limit the surge current at 25°C
- Select a 'Surge Gard™' that is specified to handle the required energy of the circuit
- Calculate the 'Surge Gard™' resistance at the operating current, using the M curve
- Consider if derating is required for operating temperatures over 65°C



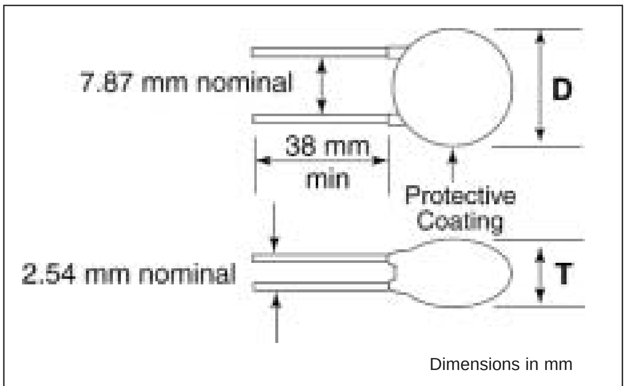
Inrush Current Limiters
‘Surge Gard’TM Series

Surge currents which occur when electrical circuits are switched on can cause serious damage to sensitive electronic components which may exceed their rated values unless the surge is controlled. Damaging surges may be prevented by using Surge-Gard™ inrush current limiters placed in critical parts of the circuit. Surge-Gards™ are a type of power NTC thermistor manufactured from a specially formulated metal oxide ceramic material which is capable of suppressing high inrush current surges. Connected in series with the load, at switch-on, the thermistor limits the current due to its relatively high cold resistance. As a result of current flow the thermistor heats, reducing its resistance value so that once the initial surge has been safely held off the resistance in the circuit is held at a low value to maximise efficiency. They are used in:

- **Power Supplies**
- **Electric Motors**
- **Lighting Circuits**
- **Thermostat Protection**
- **Any Circuit Subject to Switch-on Current Surges**

Surge-Gard™ devices have the following properties:

- **High Hot to Cold Resistance Ratio**
- **Reduced Temperature at Full Load**
- **Extends lamp filament life by up to 6 times**



PART NO.	Imax Max Steady State Current (AMPS)	Resistance (OHM®25°C)	Resistance Tolerance (±%)	RImax Resistance Max Current (OHMS)	Vmax Voltage Rating	Jmax Energy Rating (JOULES)
SG22	0.3	100	10	7.0	120	14
SG15	1.0	5.0	15	0.6	265	20
SG408	1.0	10	20	0.7	265	15
SG37	1.5	25.0	15	0.6	265	15
SG230	1.75	20.0	15	0.6	265	31
SG180	2.0	5.0	15	0.4	265	36
SG240	2.0	40.0	15	0.6	265	20
SG220	3.0	10.0	15	0.2	265	17
SG250	3.0	120	15	0.9	265	36
SG39	4.0	12.0	10	0.22	265	40
SG190	4.0	5.0	15	0.15	265	36
SG210	4.0	7.0	15	0.2	265	50
SG63	4.0	16	25	0.25	265	50
SG42	5.0	10.0	15	0.2	265	44
SG27	6.0	10.0	15	0.15	265	40
SG130	7.0	2.5	15	0.05	265	27
SG200	7.0	5.0	15	0.07	265	40
SG40	8.0	10.0	20	0.1	265	50
SG170	8.0	4.0	15	0.07	265	27
SG140	9.0	2.5	15	0.04	265	27
SG64	10.0	7.0	15	0.08	265	100
SG150	10.0	2.5	15	0.04	265	87
SG26	12.0	5.0	15	0.06	265	100
SG32	14.0	4.0	20	0.05	265	100
SG160	15.0	2.5	15	0.03	265	87
SG110	18.0	2.0	15	0.03	265	80
SG100	20.0	1.0	15	0.015	120	48
SG420	23.0	2.0	25	0.025	265	250
SG260	30.0	0.5	20	0.01	120	31
SG405	30.0	1.0	25	0.015	265	157

PART NO.	“D” (Diameter max over coating) (mm)Max.	“T” (Thickness max over coating) (mm) Max.	“L” Lead Diameter ±0.08 mm
SG22	7.62	7.62	0.81
SG15	15.24	6.35	0.81
SG408	10.79	5.08	0.5
SG37	12.70	7.62	1.02
SG230	12.70	6.35	0.81
SG180	15.24	6.35	0.81
SG240	15.88	6.35	0.81
SG220	11.43	7.62	0.81
SG250	23.50	6.35	1.02
SG39	12.70	8.90	1.02
SG190	15.24	6.35	0.81
SG210	15.24	7.62	1.02
SG63	19.05	6.35	1.02
SG42	12.70	8.90	1.02
SG27	15.24	8.90	1.02
SG130	15.24	6.35	0.81
SG200	15.24	6.35	0.81
SG40	22.86	8.90	1.02
SG170	15.24	6.35	1.02
SG140	15.24	6.35	0.81
SG64	24.13	7.0	1.02
SG150	22.86	6.35	1.02
SG26	22.86	7.0	1.02
SG32	22.86	8.90	1.02
SG160	22.86	7.62	1.02
SG110	22.86	8.90	1.02
SG100	22.86	7.62	1.02
SG420	31.75	7.62	1.02
SG260	31.75	5.08	1.02
SG405	31.75	6.35	1.02

Cropping and Forming

Rhopoint Components can crop or form ‘Surge Gards’™ to your specification. (Subject to minimum quantity)