Surge Ratings

Introduction

This document attempts to clarify the surge ratings of several Novaris power line and signal line surge protectors.

Surge rating (also referred to as maximum surge current capacity, surge withstand, maximum surge handling, etc.) is a specification that is often misunderstood. Most people would think that a surge protector rated at 200kA should be able to survive a 200kA surge. This sounds logical enough, however it is actually entirely unreasonable.

The largest surge current specified in both the British Standard BS6651 and the American Standard IEEE C62.41 is only 10kA. This figure has been reached through years of research and field measurements. The largest surge current specified in any lightning protection standard anywhere in the world is only 70kA (Australian Standard AS1768).

So, if lightning protection standards committees from around the world agree that a surge greater than 70kA will never occur, why are some surge protectors rated at 200kA? This is a straightforward question, and deserves an equally straightforward answer. The answer is that surge protectors rated at 200kA are not designed to withstand 200kA surges, but instead are designed withstand many surges of less than 70kA. To understand this concept an understanding of the surge protection components must first be gained.

Metal Oxide Varistors

The most common surge protection component is the metal oxide varistor (MOV). It is used in almost all power line surge protectors and also in many signal line protectors. They have proved to be a highly reliable and effective surge protection component over many years now.

Each surge that a MOV experiences causes a small amount of degradation. The amount of degradation depends on the diameter of the MOV and the magnitude of the surge. For example a 40mm strap MOV can withstand at least[1]:

- 1 x 40kA surge
- 10 x 15kA surges
- 100 x 5kA surges

[1] Information from the EPCOS SIOV Metal Oxide Varistor Data Book 2001

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- 1,000 x 2kA surges
- 10,000 x 500A surges
- 100,000 x 200A surges

Therefore, in order to achieve a long working life out of a MOV-based surge protector it should have a surge rating much greater than the magnitude of the surges it is expected to experience.

Over many years Novaris have been formulating, testing and revising a "recommended MOV surge rating guide" to assist customers in selecting a surge rating that will achieve a long working life for their applications. It is shown in Figure 1 below. The guide takes into account the area that the surge protector is to be installed in (Categories defined according to AS1768), the average number of thunder days experienced at the site per year, and whether the power cables coming into the site are underground or overhead. Novaris customers have found this guide to be very useful and have reported longer working lives from their surge protectors than they had previously experienced.

Area:	Area 1	Area 2	Area 3		Area 4	
Category:	Cat A	Cat B	Cat C		Cat C – High	
Thunder days			<30	≥30	<30	≥30
Underground	8kA	16kA	40kA	80kA	120kA	160kA
Overhead	8kA	16kA	80kA	120kA	160kA	200kA

Figure 1 Novaris Recommended MOV Surge Ratings

Gas Discharge Tubes

Gas discharge tubes (GDTs) are widely used in signal line protectors. They are typically rated at 5kA, 10kA or 20kA. They suffer far less degradation due to surges than MOVs and subsequently can withstand many thousands of surges below or up to their surge rating.

Silicon Avalanche Diodes

Silicon avalanche diodes (SADs) are also widely used in signal line protectors. Typically they have very low surge ratings – about 100A. Therefore, they are generally used in the third stage of protection so that they do not experience large surges. SADs suffer very little degradation due to surges and subsequently can withstand many thousands of surges below their surge rating.

Specified Surge Ratings

As with all surge protection manufacturers, Novaris determine the surge rating of a surge protector by adding the surge ratings of the individual components as specified by the manufacturer of the components. However, something that does vary from manufacturer to manufacturer is the way in which this is done.

Surge Rating Per Mode or Surge Rating Per Two Conductors

A mode is any combination of two conductors. For example, in a single-phase power system there are three modes: L-N, L-E & N-E. The surge rating of a particular mode may be defined as the sum of the surge ratings of the components that conduct when a surge is applied to that mode.

This is Novaris's preferred method of specifying surge ratings.

Example: The surge diverter in Figure 2 has a surge rating of 40kA per mode.

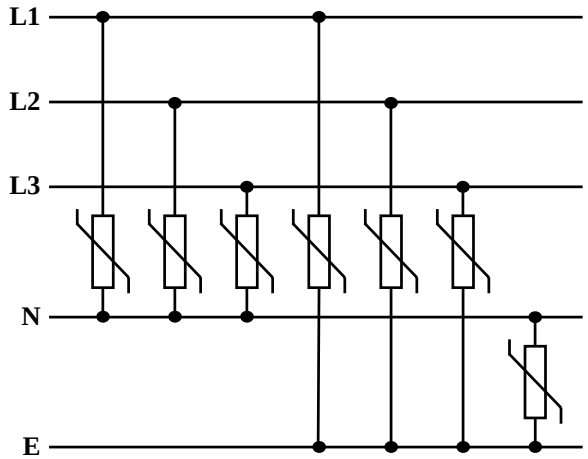

Figure 2 Schematic of three-phase all-mode surge diverter (40kA MOVs)

Surge Rating Per Phase

Surge rating per phase may be defined as the sum of the surge ratings of the components connected to a particular phase. For example, in a three-phase power line protector the surge rating for Phase 3 would be equal to the sum of the surge ratings of all of the components connected from Phase 3 to Neutral and Phase 3 to Earth.

Example: The surge diverter in Figure 2 has a surge rating of 80kA per phase.

Total Surge Rating to Earth

The total surge rating to earth may be defined as the sum of the surge ratings of all of the components connected to earth. For example, in a three-phase power line protector the total surge rating to earth would be equal to the sum of the

surge ratings of all of the components connected from Phase 1 to Earth, Phase 2 to Earth, Phase 3 to Earth and Neutral to Earth.

Example: The surge diverter in Figure 2 has a surge rating of 160kA total to earth.

Total Surge Aggregate Rating

The total surge rating may be defined as the sum of the surge ratings of all of the components within the surge protector.

Example: The surge diverter in Figure 2 has a 280kA total surge aggregate.

Novaris Surge Tests Laboratory

Novaris have a dedicated surge test laboratory, one of the best equipped in the Asia-Pacific region. It has four surge generators, all compliant with IEC 61000-4-5:1995 "Electromagnetic compatibility (EMC), Part 4: Testing and measurement techniques, Section 5: Surge immunity test". This Standard defines tolerances for the magnitudes and waveshapes of the various standard surge test waveforms.

1. 20kA 8/20µs, 10kV 1.2/50µs combination wave surge generator
2. 3kA 8/20µs, 6kV 1.2/50µs combination wave surge generator
3. 6kV 0.5µs 100kHz ring wave surge generator
4. 5kV 10/700µs 100kHz ring wave surge generator

Together these surge generators are capable of producing all of the relevant standard surge test waveforms with the sole exception of the 70kA 8/20µs waveform specified in AS1768 for Category C – High Exposure locations.

Novaris Surge Tests

Surge Protectors with Surge Ratings ≤ 20kA

All Novaris surge protectors with surge ratings ≤ 20kA are tested to their surge rating in Novaris's surge test laboratory.

Surge Protectors with Surge Ratings > 20kA

All Novaris surge protectors with surge ratings exceeding 20kA are based on one particular component: 40mm strap MOVs. These components have a manufacturer's single shot 8/20µs surge rating of 40kA.

The reason why Novaris base their surge protectors on 40kA MOVs (and not smaller MOVs like many manufacturers) is due to the problems associated with current sharing between MOVs. It is widely documented that MOVs connected in parallel do not share current perfectly evenly. 40kA MOVs can withstand multiple Category C surges[2] individually. This means that Novaris surge protectors (with ratings ≥40kA) do not rely on current sharing whatsoever. It is this fact that makes Novaris surge protectors extremely reliable.

In order to complete the full range of surge waveform tests on their surge protectors Novaris had 70kA 8/20µs surge tests performed independently by EJ Bondarenko & Associates at the Telstra Research Laboratories High Voltage Laboratory. The 40kA MOVs were tested both individually and in a parallel arrangement as they are used in some Novaris surge protectors. Also a 160kA rated **MultiMOV** surge diverter was tested.

The following is a summary of some of the findings of these tests:

1. The component manufacturer's 40kA rating is extremely conservative. One 40kA MOV withstood ten 40kA surges without failure.

2. Four 40kA MOVs in parallel withstood seventeen 70kA surges before the first MOV failed. The final MOV failed after a total of thirty 70kA surges.

3. Four MOVs in parallel shared current within 10% of each other.

Summary

All Novaris surge protectors are tested to their surge rating, or up to 20kA if their surge rating exceeds this. All Novaris surge protectors with surge ratings exceeding 20kA are based on 40kA MOVs, which have been tested to 70kA and have proved to be highly effective.

Novaris's surge testing procedure is very thorough, ensuring that Novaris surge protectors will perform as specified in the real world.

[2] 10kA for BS6651 and IEEE C62.41. 20kA for AS1768

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