GE Consumer & Industrial
Electrical Distribution

Ballast Survival Testing When Exposed To Commonly Found Transient Voltages

imagination at work

1 OVERVIEW

1.1 This white paper was developed to review the effects of exposing energy efficient commercial and industrial lighting ballasts to transient surges. The test purpose was not to determine if a single ballast company or product was more resistant to transient surges when compared to another, but instead focused on the overall susceptibility for failures caused by transient surges as an overall industry.

1.2 Transients have become a common power quality issue. They may be generated from outside the facility by lightning or irregular power generator switching. Variable speed motors, compressors, refrigerators, digital controllers, switching power supplies in computers and laser scanners, can also generate transients from within the facility itself. The surges outlined below are derived from the IEEE C62.41 Surge Protection Standard for Low Voltage AC Power Circuits. The test was completed to determine if TVSS would provide protection against these surges and thus extend the ballast life.

1.3 The testing was applied in three parts, with each segment representing a different level of transient risk to a typical lighting system.

1.3.1 The initial test was the IEEE C62 B3 Ring Wave test to simulate real world transient activity on a lighting system in a large building that would be seen over a 5-year period. This waveform is small enough to be generated both from sources found inside and outside of any facility.

1.3.2 If the Unit Under Test (UUT) showed no degradation in performance then the test will proceed with an IEEE B3/C1 Surge test. This reflects stronger surges that are statistically possible for more then 70% of North America within a 5-year period.

1.3.3 If the lighting ballasts showed no degradation to its life during the B3/C1 tests, a C3 Surge Test was applied and its effects analyzed.

1.4 By analyzing Flash Density data and statistical numbers on transient activity studied by IEEE C.62, the magnitude of the transient surge and the number of repetitions were developed. With this yearly data, an extrapolated number of transient surges and expected magnitude was developed that could be statistically justified for a product over a 5 year period.

1.5 Tests were conducted on an unprotected lighting assembly to characterize the effects of transients on a lighting system (ballast). This assembly included 100 feet of 12 AWG wire connected to the ballast and lighting system to better emulate an actual lighting system. Note that shorter power wiring distances in the field present an even higher transient voltage level risk to the ballasts.

1.6 Testing was then repeated on new samples after installing a GE TVSS to protect the lighting system from transient surges.

2 TEST OUTLINE

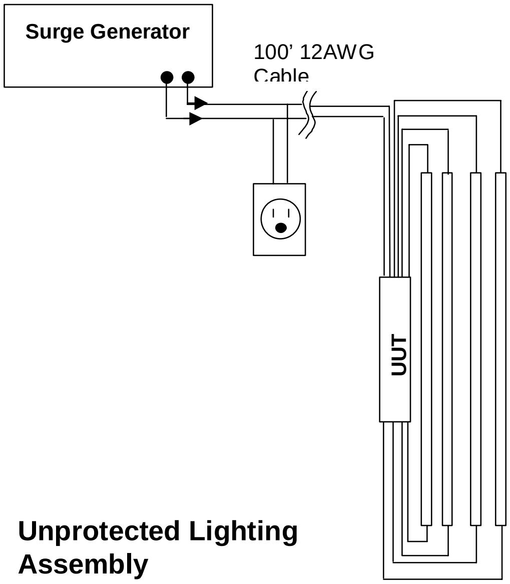
A total of 9 different ballast models were selected from four different manufacturing companies that are recognized leaders in supplying lighting ballast.

All surges were conducted Line to Neutral.

Each ballast under test was connected to the surge generator through 100 feet of 12 AWG cable with an outlet connected in parallel. This was to simulate a true installation behind a distribution panel as described in IEEE 62.41 (see Fig. Below).

The UUT was powered for all surge tests except the C3 surge waveform.

Degradation of the UUT was defined as a deviation of 20% of either the input current into the ballast assembly or the output frequency of the ballast. It was monitored for any indication of failure.

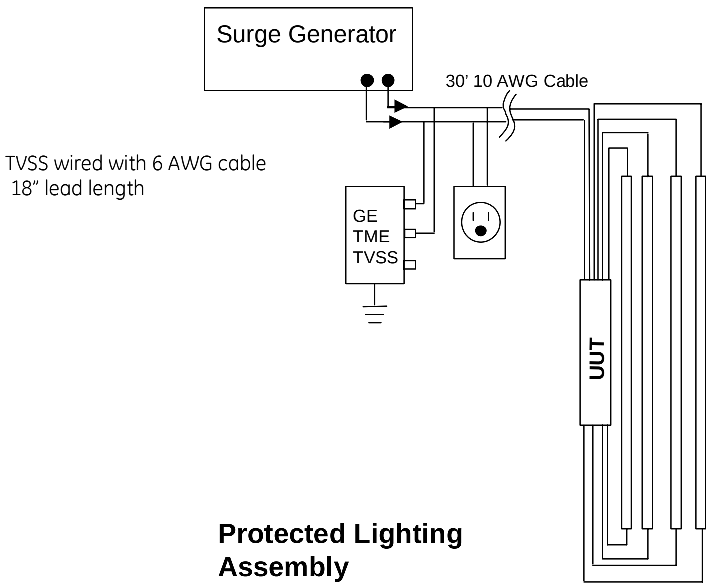


Surge Testing of an Unprotected Assembly with 100 feet of 12 AWG power cable was as follows:

1. Conducted IEEE C62 B3 Ring Wave Surge; 6 kV 500 Amp 100kHz; 500 Hits
2. If the ballast did not sustain any damage from the B3 surge, conducted a 6kV, 3kA, 8x20µs Surge (IEEE B3/C1), 5 Hits.
3. If the ballast did not sustain any damage, conducted an IEEE C3 Surge (20 kV, 10 kA, 8x20µs), 1 Hit

Surge Testing of a Protected Assembly was repeated as outlined above for the unprotected ballast assembly.

The protected assembly under test was connected as shown below:



3 Results

Type of Surge	Number of surges	Nine Ballast Test Results	Percent Passed	Comments
100 foot Lead – No GE TVSS installed				
Ring Wave Surge; 500 Amp 100kHz;	**500**	**3 - Pass** **6 - Fail**	**33%**	**Samples typically failed between 1 and 25 surges.**
6kV, 3kA, 8x20us	**5**	**3 - Fail**	**0%**	**All ballasts failed after 1 hit**
20 kV, 10 kA, 8x20us	**1**	**-**	**0%**	**No ballast passed previous test to be tested**
100 foot Lead – With GE TVSS installed				
Ring Wave Surge; 500 Amp 100kHz;	**500**	**9 - Pass**	**100%**	**No sign of degradation or failure**
6kV, 3kA, 8x20us	**5**	**9 – Pass**	**100%**	**No sign of degradation or failure**
20 kV, 10 kA, 8x20us	**1**	**9 –Pass**	**100%**	**No sign of degradation or failure**

4 Conclusions

The test data showed that energy efficient ballast have an overall sensitivity to transient surges and poor power quality events that were generated both inside and outside of a facility.

The test also clearly demonstrated the value of adding over voltage protection provided by a GE Transient Voltage Surge Suppression product. In the past, the industry has acknowledged the benefits and value of surge protection devices to protect sensitive electronic and computer based products. This test expands that field by demonstrating the need to include any solid-state lighting ballast used in retail, commercial or industrial applications.

It is widely accepted that the quality of power supplied to both Commercial and Industrial facilities is expected to continue to decline as increased usage outpaces the industry ability to supply that power. Internally generated noise and high-speed voltage transients are coming from computers, laser devices, solid-state switching power supplies and variable speed motors.

Historically, many electrical products were not as susceptible to poor power quality, because they used analog based designs (i.e. transformers, capacitors). However, with the growth of solid-state circuitry being designed into everything from lighting ballast to smart appliances, it has also increased our sensitivity to poor power quality. This sensitivity is having a costly effect to the end user of that power.

While the replacement cost for the actual ballast component is not a large amount to the end-user, it is the overall cost of the act of replacement of that single ballast that must be considered. When the cost of Electrical Contractors ($38 -75/hr avg [1]), lost revenues due to dark spots in the buildings, and lower safety to customers and their personnel leading to higher liability are considered, the total replacement costs of the lighting ballast dramatically increases. While each customer should self evaluate their true cost, one major retail leader has indicated that their average multiple ballast replacement cost is actually $1800 per replacement event.

Based on this test, the installation of GE TVSS products clearly protected sensitive lighting ballast from transient surges. This protection increases ballast life, which can significantly lower yearly building maintenance costs.

1. Wage rates are based on experience levels and regional non-overtime data released by International Brotherhood of Electrical Workers & National Electrical Contractors Association, because of the dynamics of pay rates, rate numbers should only be used as an example and not used for planning purposes.