

Electronic Lighting Ballast Survival Testing



1 Overview

- 1.1 This study was conducted to review the effects of exposing energy efficient lighting systems to transient surges that can occur at typical installations within a facility.
- 1.2 Testing was performed with primary focus on the overall susceptibility of electronic lighting ballasts to premature failures caused by exposure to Category B surges in high exposure locations. Subsequent testing was performed to determine if adding transient voltage surge suppression (TVSS) could improve ballast surge immunity. The testing was not to determine if a single ballast manufacturer's brand or product was more resistant to surges than another. Nor was the test program to evaluate any ballast for immunity to other common power quality problems such as voltage sags, swells or harmonics.
- 1.3 Transients are a common power quality issue and may be generated from outside the facility by lightning or utility power switching. They can also be generated from within the facility by variable speed motors, compressors, refrigerators, digital controllers and switch mode power supplies in computers and laser scanners. The surges outlined in the testing plan were derived from the ANSI/IEEE C62.41 Surge Protection Standard for Low Voltage AC Power Circuits. The lighting system test setup was simulated for Category B locations where energy efficient lighting systems are normally installed within commercial and industrial facilities.
- 1.4 The standard for high frequency fluorescent lamp ballast, ANSI/IEEE C82.11 Rev. 2002 states, "Electronic High Frequency ballast are more susceptible to line transients than the line frequency magnetic ballasts. Therefore, transient protection shall be included. The requirement for this transient protection is in ANSI/IEEE C62.41, Class A operation. The line transient test shall consist of seven strikes of a 100kHz ring wave, 2.5kV (higher values may be used as appropriate) level, for both common mode and differential mode."
- 1.5 Although many ballast manufacturers comply with the voluntary requirements of the ANSI/IEEE C82.11 standard, there are times when the standard internal protection provided with the ballast may not be sufficient. Facilities in areas that experience high lightning or utility switching activity should consider the installation of a TVSS at the lighting distribution center or breaker box.
- 1.6 Flash Density data is studied by ANSI/IEEE and summarized in C62.41. Surge crest levels and annual frequency of transient voltage data is developed based on field case studies. With this yearly data, an extrapolated number of transient surges were chosen for the electronic ballast exposure testing. The test plan was based on surges that could statistically occur over a 5 year period within facilities at IEEE C62.41 Category B locations.
- 1.7 The test was applied in two parts, with each segment representing a different type of transient risk.
 - 1.7.1 The initial ANSI/IEEE C62.41 B3 Ring Wave test was performed to simulate exposure to oscillatory transients that could occur in IEEE defined high exposure environments at Category B Locations.
 - 1.7.2 If the electronic ballast showed no degradation in performance, the test would proceed to a second testing phase. This test was an IEEE C1/B3 impulsive type wave shape that reflects a stronger surge, statistically found in more than 70% of North America at IEEE category B locations.
- 1.8 The initial tests were conducted on an unprotected lighting assembly (see Figure 1) to characterize the effects of transients on the lighting system electronic ballast. This assembly included 100 feet of 12 AWG wire to emulate a practical wiring distance between the electrical distribution panel and the lighting system. It is important to note that power wiring distances shorter than 100' will present an even greater exposure risk to unprotected ballasts.
- 1.9 Testing was then repeated on previously untested ballast samples after installing a GE TVSS to protect the lighting system (See Figure 2).

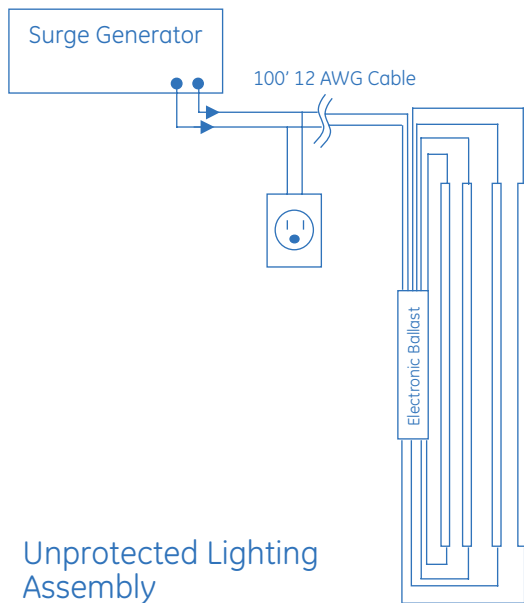


Figure 1

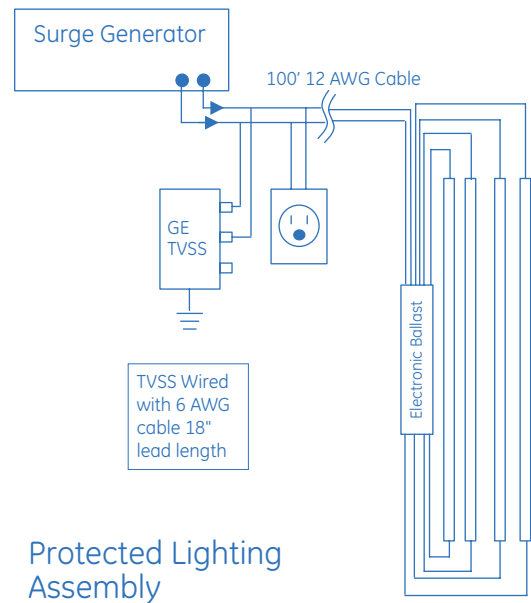


Figure 2

2 Test Outline

A total of nine (9) different electronic lighting ballast models were selected from four industry recognized electronic ballast manufacturers.

All surges were applied between the Line and Neutral conductors of the electrical lighting system under test.

Each lighting system was connected to a surge generator through 100 feet of 12 AWG cable. An outlet was connected in parallel to simulate a typical installation behind a distribution panel to provide a sparkover clearance limit as described in IEEE 62.41.

The system was powered at the nominal rated system voltage for all surge tests.

Degradation was defined as a deviation of 20% of the input current into the electronic ballast assembly or the output frequency of the electronic ballast. The system was also monitored for any other indications of failure.

Following is the test plan as used (see Figure 1):

Surge testing of unprotected assembly with 100 feet of 12 AWG power cable as follows:

1. Conduct IEEE C62 B3 Ring Wave Surge; 6kV, 500 Amp, 100kHz; 500 Hits
2. If the electronic ballast does not sustain any damage from the B3 surge (in # 1 above), conduct a 6kV, 3kA, 8x20µs Surge (IEEE B3/C1), 5 Hits

Surge testing of a protected assembly (see Figure 2) will be repeated as outlined above for the unprotected ballast assembly.

The protected assembly under test should be as shown Figure 2 above.

3 Results

Type of Surge	Number of Surges/Hits	Test Results	Percent Passed	Comments
100' foot lead — No GE TVSS installed				
Ring Wave Surge; 500 Amp, 100kHz	500	6 units Failed 3 units Passed	33%	Samples typically failed between 1 and 25 surges
6kV, 3kA, 8x20µs	5	9 units Failed	0%	All ballasts tested failed after 1 hit
100' foot lead — With GE TVSS installed				
Ring Wave Surge; 500 Amp, 100kHz	500	9 units Passed	100%	No sign of degradation or failure
6kV, 3kA, 8x20µs	5	9 units Passed	100%	No sign of degradation or failure

4 Conclusions

The testing revealed that electronic lighting ballasts have an overall sensitivity to transient surges that can be observed at IEEE Category B Locations. The frequency and severity of these surges are based on factors such as geographic location, seasonal climate changes, lightning activity and nearby electrical distribution switching operations.

This testing also clearly demonstrated the value of adding a TVSS at lighting distribution panels. The electrical power quality industry acknowledges the benefits and value of TVSS devices to protect sensitive electronic and microprocessor-based products. This testing expands that value to also include solid-state devices like lighting ballasts used in commercial or industrial applications.

In past years, many electrical loads were not as susceptible to power quality problems due to analog-based designs (i.e. transformers, capacitors). However, with the growth of solid-state circuitry, sensitivity to poor power quality can have a costly effect on the end-user.

While the replacement cost for the actual electronic ballast may not generally be significant, it is the overall cost to the user that must be considered. When electrician labor costs (electrical contractor rates of \$38-75/hr. avg¹), lost revenues due to non-illuminated areas in commercial/retail stores and lower safety to customers and personnel is considered, the total replacement costs of an electronic ballast can increase dramatically.

Based on the test results, the installation of GE TVSS clearly protected sensitive electronic lighting ballasts against the types of surges that can occur at IEEE Category B Locations. Facilities that are susceptible to these type surges would benefit from the installation of TVSS at the lighting distribution panels as a means to lower the risk of premature electronic ballast failure from possible transient surge exposure.

¹ Wage rates are based on experience levels and regional non-overtime data released by the 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.



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