

Ballasts Survival Testing When Exposed to ANSI/IEEE Category B Transient Voltages

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 installation locations 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 surge protection 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 switching 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 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 100 kHz ring wave, 2.5 kV (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 82.11 standard, there are times when the internal protection that comes with the ballast may not be sufficient. Those facilities in areas that experience high lightning or utility switching activity should consider the installation of a voltage surge suppresser at the lighting distribution center or breaker box.
- 1.6 Flash Density data is studied by ANSI/IEEE and summarized in C.62.41. The surge crest levels and annual frequency of transient voltages are developed based on field case studies. With this yearly data, an extrapolated number of transient surges were chosen for the 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.

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- 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 possible for more than 70% of North America at IEEE category B locations.
- 1.8 The initial tests were conducted on an unprotected lighting assembly to characterize the effects of transients on the lighting system 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 shorter power wiring distances in practice 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.

2 TEST OUTLINE

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

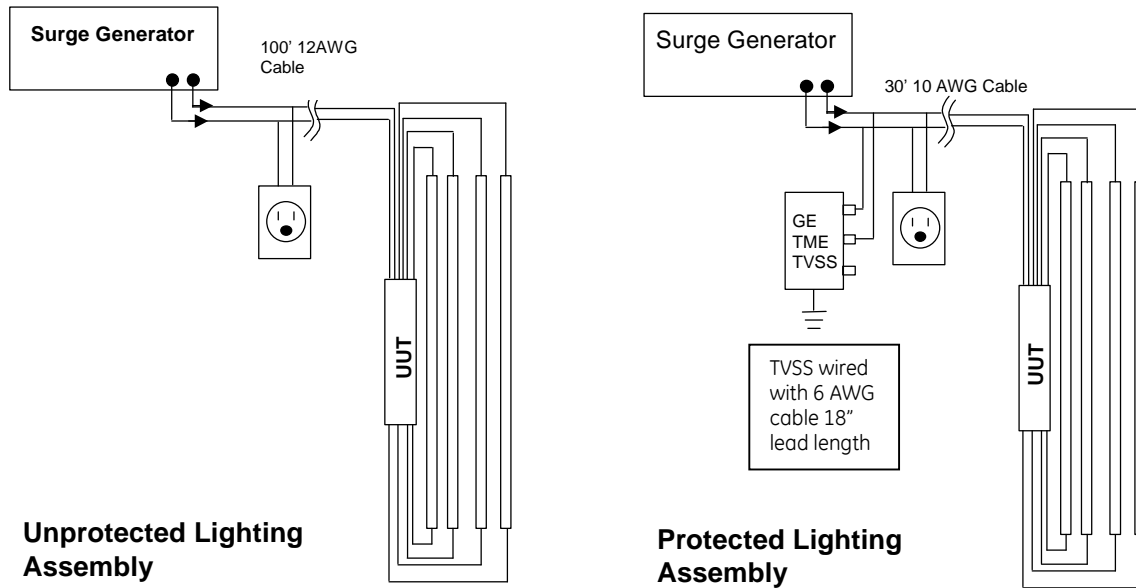
All surges were applied between the Line and Neutral conductors of the simulated electrical lighting system.

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 true 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 ballast assembly or the output frequency of the ballast. Units were also monitored for any other indications of failure.

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Following is the test plan as used in the lab:

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

1. Conduct IEEE C62 B3 Ring Wave Surge; 6 kV, 500 Amp, 100kHz; 500 Hits
2. If the ballast does not sustain any damage from the B3 surge (in # 1 above), conduct a 6kV, 3kA, 8x20 μ s Surge (IEEE B3/C1), 5 Hits.

Surge testing of a protected assembly will be repeated as outlined above for the unprotected ballast assembly.

The protected assembly under test should be as shown above.

3 Results

Type of Surge	Number of surges	Test Results	Percent of Failures	Comments
100' foot Lead – No GE TVSS installed				
Ring Wave Surge; 500 Amp 100kHz;	500	6 units Failed 3 units Passed	67%	Samples typically failed between 1 and 25 surges.
6kV, 3kA, 8x20µs	5	9 units Failed	100%	All ballasts tested failed after 1 hit
100' foot Lead – With GE TVSS installed				
Ring Wave Surge; 500 Amp 100kHz;	500	9 units Passed	0%	No sign of degradation or failure
6kV, 3kA, 8x20µs	5	9 units Passed	0%	No sign of degradation or failure

4 Conclusions

The testing revealed that electronic 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.

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

In past years, many electrical products 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 ballast component is not generally significant to the end-user, it is the overall cost that must be considered. When the cost of electrical contractors (\$38 -75/hr avg ¹), lost revenues due to dark spots in commercial/retail stores and lower safety to customers and personnel is considered, the total replacement costs of a lighting ballast can increase dramatically.

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

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.