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White Paper on Power Quality Implications of Self-ballasted Lamps in Residences

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Power Quality Implications of Self-ballasted Lamps in Residences

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Overview

The presence of high-reliability, low-cost electronic products continues to grow in the market. From a power systems perspective, these products can represent non-linear loads. They include entertainment devices, such as televisions, DVD players, and audio equipment; information technology devices, such as PCs, printers, and fax machines; variable speed motor drives for heating, ventilation, and air conditioning (HVAC); white goods appliances; food preparation and cooking products, such as microwaves and cooktops; and lighting products, which include electronic ballasts, self-ballasted compact fluorescent lamps (CFLs), light-emitting diode (LED) lamps, and other power conversion devices that operate a variety of lamps.

This proliferation is a direct result of the availability of low-cost switch-mode devices and control circuitry and the benefits such technology can bring to end-users, including:

a. lower operating costs
b. energy cost savings
c. short economic paybacks, often under two years
d. more features, improved performance
e. size and weight reduction
f. improved form factors
g. reduction of fossil fuel generation of electricity, causing less pollution

From a utilities perspective, the proliferation of such products results in increased growth of non-linear loads. Products with non-linear loads are not new, but we have entered a period where growth continues in all major end-use segments: residential, commercial, and industrial. This growth has led to increased concern by some utilities about the effects on power quality from such loads. As a result, these utilities are expending more effort to instrument their service areas so they can monitor THD(V) in an attempt to correlate end-user and system disturbances with the increase of such loads in these service areas.

At the highest levels, utilities are concerned with distortion to the voltage waveform they supply to their customers, but they are also concerned with the effects of non-linear loads on their distribution infrastructure, which can include capital equipment and added heating losses within the systems. Some are concerned with disturbances that might occur in customers' premises since those customers might attempt to fix the blame for local interaction problems on the power quality as supplied by the utility.

This white paper does not go into detail on the fundamentals of the above issues. There are many papers that address this subject from a utility perspective. This white paper seeks to put into perspective the subject of self-ballasted lamps and explain why the effects presented by these lamps, from a power quality perspective, are not as severe as has sometimes been postulated.

1 Scope

This white paper provides information about self-ballasted lamps and the implications these lamps present from a power quality perspective. It focuses on the use of self-ballasted lamps in residences and on residential power quality. Self-ballasted lamps have dedicated ballasts or drivers that are part of the lamp itself, which allows the lamp to be used in some sockets that originally were meant for incandescent lamps. The ballast or driver intercepts the electrical current before it enters the light source itself, and it cannot be removed from the base. Some CFLs and some LED lamps are examples of self-ballasted lamps.

Utilities are often internally conflicted on the issue of residential power quality. Engineering departments tend to be conservative since they are entrusted with the reliability of the system. Accordingly, they also tend to be risk-averse regarding power quality issues, even when the loads are small and experience indicates that problems have yet to occur with products, such as non–power-factor (PF) corrected self-ballasted lamps (also called normal power factor, but the terms low power factor and non–power-factor corrected will be used interchangeably in this document). This white paper presents information from work started in the late 1990s using CFLs in aggregate and with other loads, including LEDs, to try to better understand why non–power-factor corrected CFL and more recent LED usage posed no problems during the introduction of self-ballasted lamps into the residential marketplace. We hope this paper will help justify why utilities should not hesitate to support and endorse the use of self-ballasted lamps, even those without power factor correction.

2 Benefits of Self-ballasted Lamps

A brief review of self-ballasted lamp benefits is helpful in setting the stage. Self-ballasted lamps use less than 25% of the power that would be consumed by traditional incandescent lamps with equivalent light output. End users and energy advocacy groups realize the savings this can represent in energy costs and preserving natural resources. Such performance provides benefits for utilities that are often looking for ways to reduce the connected load or strategies that can help slow the overall demand increase. Thus, the sometimes-conflicted utility dilemma. One department might want to promote low-cost, non–PF corrected self-ballasted lamps, while another cautions against the possible detrimental effects to system power quality.

Since the technology used is fluorescent or LED, which has a much longer life than incandescent technology, self-ballasted lamps easily achieve rated lifetimes greater than 10 times longer in use. This feature alone often convinces the end-user to try self-ballasted lamps in high-usage applications, despite their higher initial cost.

Since non–PF corrected self-ballasted lamps draw approximately 25% or less current than their incandescent counterparts, self-ballasted loads reduce current losses that occur throughout the distribution infrastructure both on the utility side and within the user's premises.

3 Power Quality Aspects of Self-ballasted Lamps

3.1 Background

This section provides a review of the power quality aspects of non–PF corrected self-ballasted lamps. This white paper concentrates on this category since these self-ballasted lamps are lowest in cost and represent the best opportunity for consumer acceptance. Energy efficiency and energy savings related to power usage lead to a reduction of up to 25% savings compared with the equivalent incandescent lamp. That leads to reduced distribution power (I^2R) losses through the electrical infrastructure. The power factor is lower than for an incandescent lamp: typically 0.5 for low- or non–PF corrected types. Some power-factor corrected models have a power factor that ranges from 0.8 through greater than 0.9. Total harmonic distortion (THD) and harmonic currents are greater than an incandescent lamp; THD(I) for