A NEMA Lighting Systems Division Document

Interaction of Infrared Controls And Electronic Compact Fluorescent Lamps

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Introduction

The use of infrared radiation (IR) for the transmission of audio, video, data, and control signals is rapidly growing. Applications using infrared transmissions include TV, VCR, and cable remote controls, wireless LAN networks, video-conferencing, computer peripherals, medical equipment, and personnel locating monitors. Also, because of increased energy awareness and economic benefits, compact fluorescent lamps are being used in growing numbers in homes and commercial office buildings. Therefore, representatives from the Lamp Section of the National Electrical Manufacturers Association (NEMA) and the Consumer Electronics Group of the Electronics Industries Association (EIA) have been working together through a joint task force. This task force met specifically to define the possible interactions between compact fluorescent lamps and remote controls typically used in home entertainment devices, such as TVs and VCRs.

The committee reviewed various known potential interference situations, such as the interactions between compact fluorescent lamps in hotel rooms and cable converter boxes. At times these interactions reportedly resulted in random channel changing and volume increases or decreases. Reports of inoperative TVs and remote controls with locked-out keypads and reduced operating ranges arose from utility rebate programs. After an investigation of these phenomena, the task force made an association with them and the proximity of compact fluorescent lamps and IR receivers.

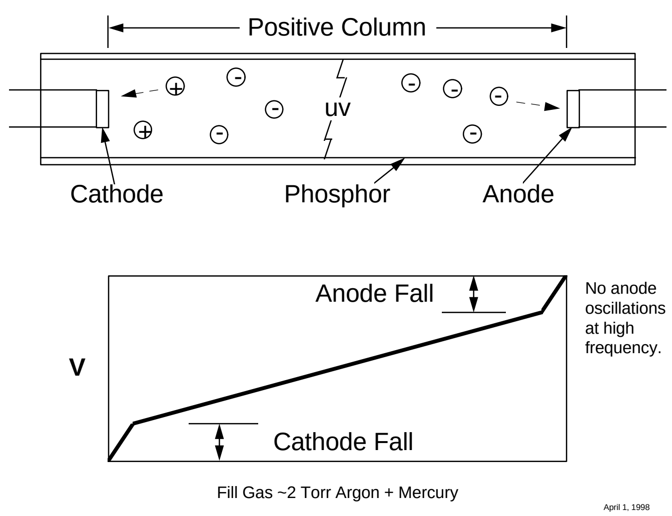
Thus, NEMA and EIA addressed the issue and proposed industry solutions. These solutions ranged from simple things like *moving* a table lamp containing a compact fluorescent lamp to more complicated things. The more complicated solutions included things, such as separating the operating frequency ranges of compact fluorescent lamps and remote controls or improving receiver circuitry. To accomplish the latter two, some manufacturers altered the design of established products.

Potential Sources of Interference

Present electronic compact fluorescent lamp circuits drive the lamp current at frequencies between 20,000 and 100,000 Hertz (one Hertz equals one cycle per second, abbreviated as Hz). This is the excitation frequency. In addition to visible light, the lamp also emits a small amount of IR and ultra-violet (UV) radiation. The infrared radiation is emitted at wavelengths between 800 and 1200 nanometers (one nanometer equals 0.000000001 meters or 10^{-9} meters, abbreviated as nm). These wavelengths fall within the sensitivity band, or range, of IR receivers used for TV, cable boxes, VCRs, etc.

Within compact fluorescent lamps, two major sources account for the IR emissions, (1) spectral lines from the inert gas fill, nearly always argon near both electrodes when each serves as a cathode, and (2) mercury lines from the main discharge or positive column. See Figure 1. The main discharge, or positive column, is contained within the phosphor coated lamp walls and between the electrodes. During the first five minutes of lamp operation, or start-up, the IR emissions from the inert gas fill in the 800 to 850 nm band dominate. After five to ten minutes of operation, during steady state operation, the 1014 nm mercury line emission becomes roughly equivalent to the total rare gas emission..

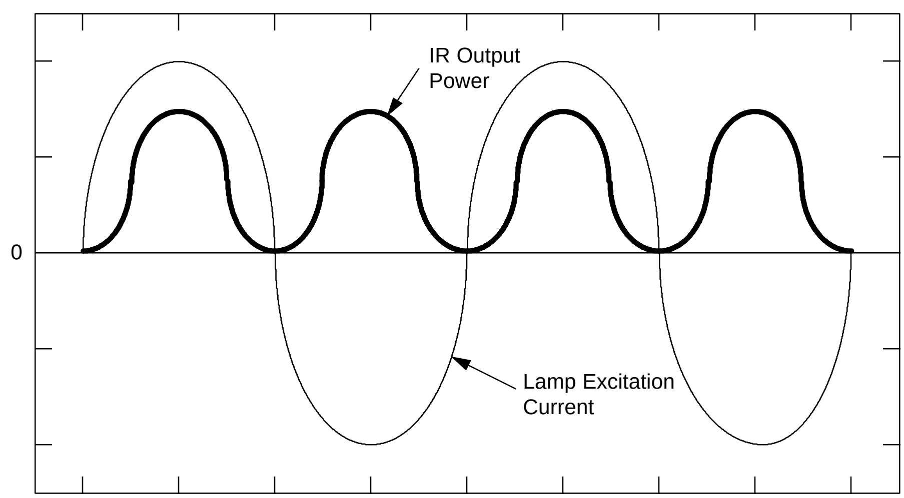
Figure 1. Lamp Discharge Physics



The task force made two observations with regard to the infrared radiation from a typical compact fluorescent lamp. First, the region near each of the two electrodes in a compact fluorescent lamp emits infrared radiation once every cycle of the drive waveform. Thus, the emission from the region near both electrodes, viewed from a distance, appears at the lamp excitation frequency.

Second, the positive column emits radiation during both halves of the high frequency cycle at twice the lamp excitation frequency called the lamp power frequency (Figure 2). The positive column is the major region of the discharge where UV is emitted resulting in the excitation of the phosphor coating on the lamp wall. The excitation of the phosphor coating ultimately causes the emission of visible light from the phosphor. In addition to the IR at the fundamental excitation and power frequencies, the harmonics (or integer multiples) of the excitation frequency or power frequency can also cause an interference if they fall into the carrier frequency range of an IR receiver. There are instances of a compact fluorescent lamp operating at about 19 kHz (1 kHz equals 1,000 Hertz) interfering with IR receivers at 38 kHz and 56 kHz.

Figure 2. Lamp Frequencies



IR Output Power Frequency = 2 X Excitation Frequency

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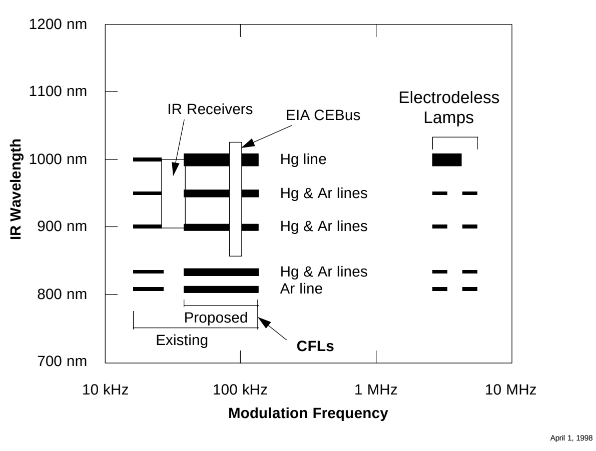
IR receivers generally operate with maximum sensitivities around 930 nm and operate at a carrier frequency between 33 and 40 kHz or from 50 to 60 kHz. The center frequency and the tuning characteristics of the IR receiver determine the particular excitation frequency of a compact fluorescent lamp that is most likely to cause interference. Industry tests of various compact fluorescent lamps and TV receivers indicate that an undesirable interaction can occur shortly after lamp switch-on or during the steady state operation of a lamp.

Why Does Interference Occur?

Compact fluorescent lamps can interact with IR receiving equipment operation when either the lamp excitation frequency or the lamp power frequency is within the carrier frequency band of the receiving equipment. Compact fluorescent lamp excitation frequencies generally range from 20 to 65 kHz, and may even approach 100 kHz. IR remote controls in the United States operate from 33 to 40 kHz and at about 56 kHz. Thus, lamps with excitation frequencies in the range of 20 to 40 kHz are capable of interacting with IR remote controls (Figure 3). Symptoms of compact fluorescent lamp interactions include the total loss of remote control operation, random operation of volume controls, on-off switching, channel scanning, lockout of manual operation, and reduced operating range.

Figure 3. Frequency Mapping of IR Sources and Receivers



What Can Be Done to Reduce Interference?

End-users can do the following things:

1. Move the compact fluorescent lamp out of direct line-of-sight of the IR receiver or move it farther away from the receiver.
2. Shade the lamp.
3. Switch to another lamp model with a different frequency. (The IR interference can only occur when there is a match of the compact fluorescent lamp output IR frequency to that of the IR receiver carrier frequency passband.)
4. Switch to a compact fluorescent lamp with an excitation frequency greater than 40 kHz or use a magnetically ballasted (60 Hz) type of lamp. (Several manufacturers are producing compact fluorescent lamps with frequencies equal to or greater than 40 kHz.)

Elimination of IR interactions between compact fluorescent lamps and remote controls requires cooperation between lamp manufacturers and the electronic equipment industry.

What Does the Future Hold?

Recent technical investigation, performed by lamp manufacturers, has confirmed that the lamp discharge cannot be modulated as effectively at frequencies above 100 kHz. This means that IR systems with higher frequencies of operation will be inherently less susceptible to potential interactions than those that operate at lower frequencies. For example, studies show that the IR modulation of the lamp positive column falls to approximately 10 percent in the 200 to 300 kHz range and has diminished to just several percent by 400 kHz. IR modulation of the rare gas lines modulates more slowly. At 200 to 300 kHz, the emission from near the cathodes is still on the order of 60 percent reaching approximately 10 percent at about 1500 kHz. Nevertheless the percent modulation of the combined emission above 400 kHz is significantly reduced. This explains why some newer IR control schemes that operate in the 400 kHz range have proven to be very immune to potential interactions when contrasted with systems that operate in the region below 100 kHz. This information is applicable to both linear and compact fluorescent lamp lighting systems and will be invaluable to the designer of IR communications systems. Designers of new systems are encouraged to take advantage of this phenomenon by moving their IR frequencies above the 400 kHz region.

Many consumer IR systems, such as commonly employed in the TV and audio industries, utilize the 33 to 40 kHz region for IR carrier frequencies. In the March 1998 meeting of the ANSI fluorescent lamp and ballast standards committees, it was determined that, in future lighting standards, the subject of IR compatibility in the 33 to 40 kHz range will be taken under consideration as a task item. Many CFL high frequency electronic systems have already vacated this frequency range, but this may not be feasible for linear fluorescent high frequency ballasts.