COSINE DEVELOPMENTS
LEADERS IN LIGHTING TECHNOLOGY

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Lighting Emergency gear – what waveform should we use?

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Many LED luminaires have built-in drivers so emergency gear must either simulate mains or attempt to drive the LED with dc. Lower power LEDs with low power factor are easiest to drive due to their simple circuitry. However, efforts to increase power factors have increased the circuit complexity of newer generation LEDs – this can cause issues with some emergency gear. The best option is to provide a pure sinewave in emergency mode but generating a pure sine wave is relatively expensive compared to generating either dc or a modified sinewave. This paper explains the pitfalls in providing dc or a modified sinewave to drive LEDs in emergency mode.

Modified Sinewave

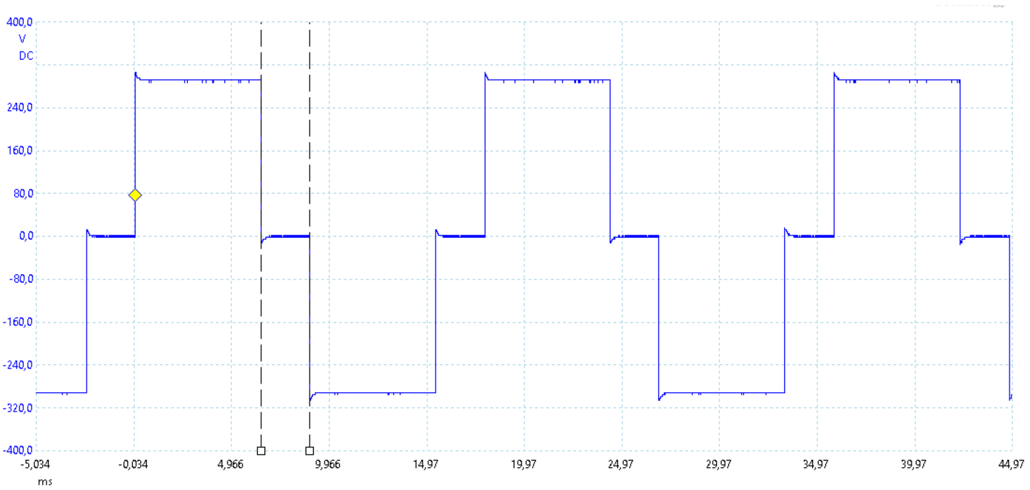

Figure 1 Actual image of modified sinewave

The whole idea behind the use of a simulated sine wave is to "fool" the lighting equipment into working as if it is fed by a pure sine wave (as it was originally designed to receive). By the way the optimum timing for 230 V_{rms}, values of 5 ms high and 5 ms low and peak value of 325 volts is required. This will optimally simulate a sinewave of 230 volts rms value.

$$V_{rms} = \sqrt{\frac{T_{on}}{T_{off}} \times V_{peak}}$$

However,

$$V_{mean} = \frac{T_{on} \times V_{peak}}{T_{off}}$$

Typically, Vrms = 230 V and Vmean =162.5 V. In other words, Vrms and Vmean are incompatible. Note the practical outcome in Figure 1.

It is usually more desirable to get the mean voltage to be 230 V; in other words, for a peak of 325 V we need 7 ms high and 3 ms low (Above waveform shows 6.5 ms high and 2.5 ms low) - which gives an rms value of 271 V which is dangerous for equipment which is rms sensitive. In practise most lighting equipment at least has a full wave rectifier on the mains which means it will not respond to the 271 Vrms but rather just to the peak value of 325 Volts.

Valley Fill Power Factor Correction

One of the simplest forms of power factor correction used in many LED drivers is the Valley Fill method shown in Figure 1. This will typically raise the power factor up to 0.7.

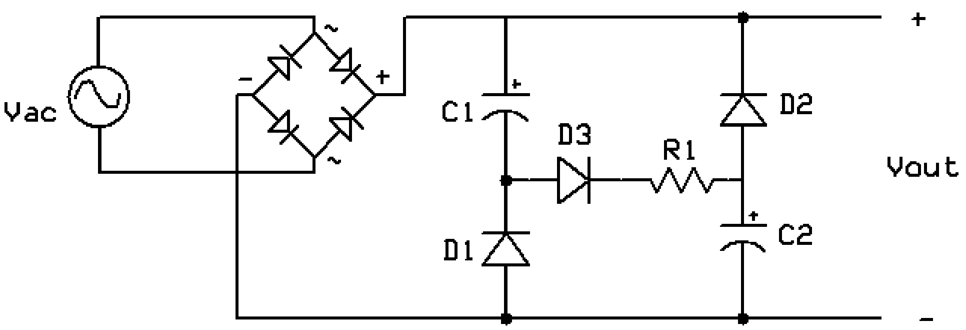

Figure 2 Valley Fill Circuit

It is possible to drive this circuit with pure dc equal to the peak value which the internal rectifier will produce *i.e.* 325 Volts. Driving it with a lower voltage (Vout in the valley fill circuit above) may result in the LED's flashing or switching off thereby providing no emergency lighting.

Active Power Factor Correction

Active power factor correction can raise the power factor to unity. This type of circuitry is becoming more popular to reduce power consumption. The simulated sinewave does not work well in all cases where the input of the product has more circuitry before the rectifier, usually power factor correction. Active power factor correction is required to get input current in-phase with supply voltage, *i.e.* a power factor of 1.

An example of a power system which will not work on a simulated sine wave or dc is active power factor correction shown below in figure 3.

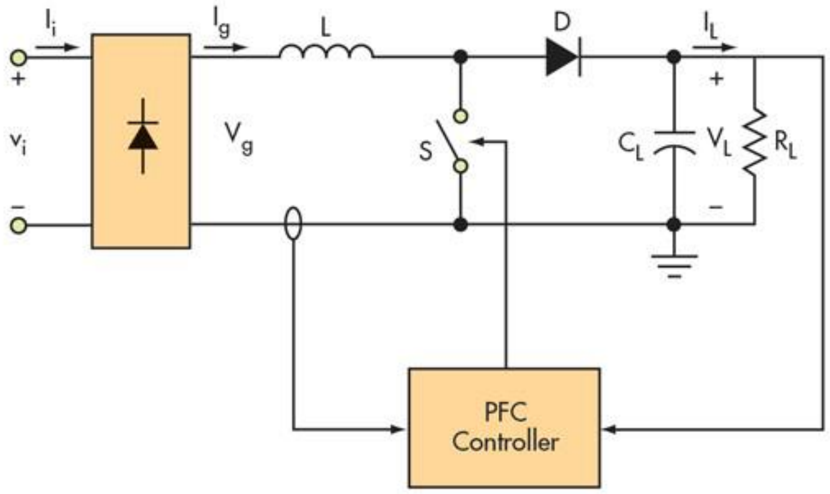

Figure 3 Typical active power factor correction circuit

Pure Sinewave

In this case the only option is to feed it with a pure sinewave (so that the product is unaffected by the difference between the drive from emergency gear and the original mains sinewave.

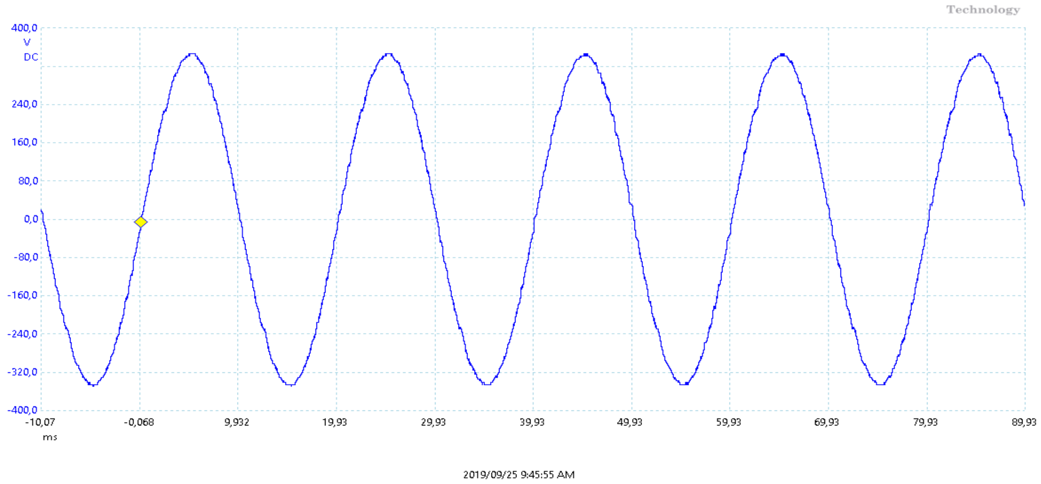

Figure 4 Measured pure sinewave output

Figure 4 shows the output of a Cosine pure sinewave emergency driver. The low distortion waveform can drive any light fitting without any compatibility issues.

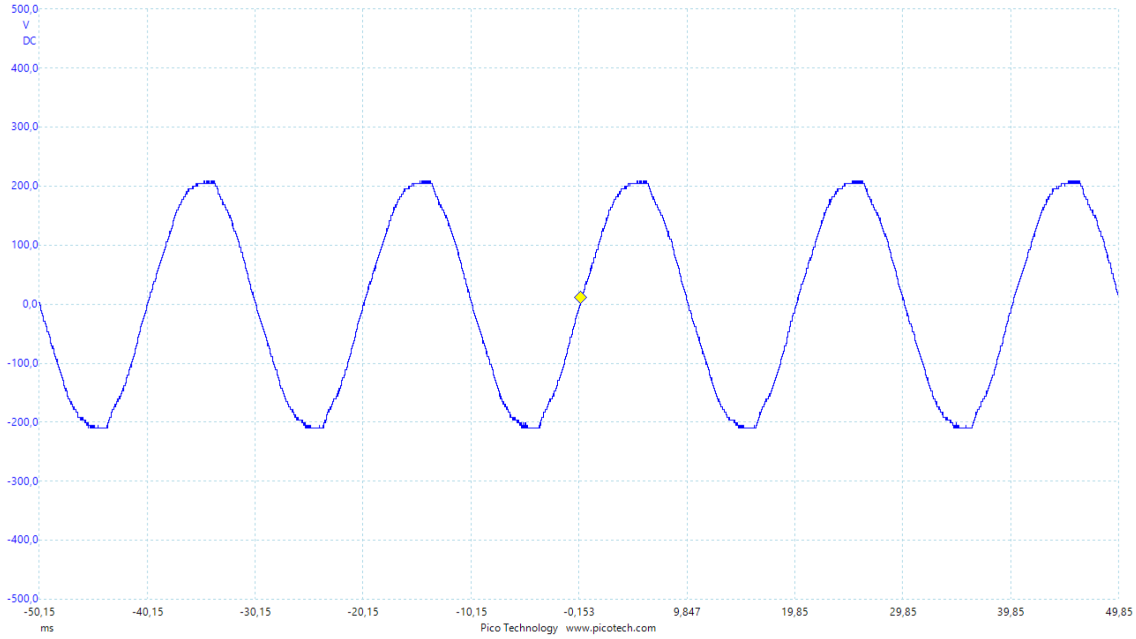

Figure 5 Measured mains supply

Figure 5 shows a measured mains supply. It is clear that the pure sinewave emergency provides a better waveform than the mains supply (at the measurement location).