SYSTEMS DIVISION

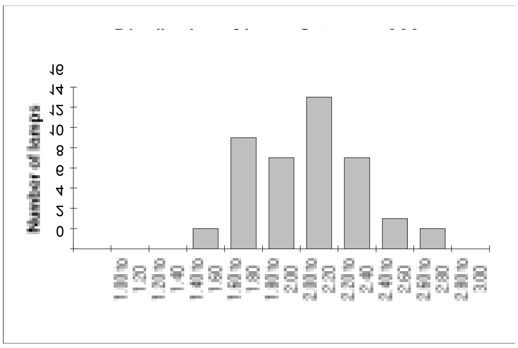
LL07 RANGE

MINIATURE FLUORESCENT BULBS
Application Note 1

MECHANICAL DATA
Dimensions in mm

INTRODUCTION

This application note describes the techniques that can be used to compensate for the natural variation in output intensity of miniature fluorescent bulbs. The output intensity for any 20nm bandwidth can vary by as much as +50% from device to device. A similar figure to LED output intensity tolerance. The major factors, which cause this variation, are differences in the phosphor coating from device to device and tolerances of the anode and cathode geometries. External influences such as ambient temperature will affect the output intensity. Before discussing correction schemes the typical distribution of output intensities is shown for a long wavelength ultra-violet miniature fluorescent device. Similar distributions are obtained for other spectral devices. The output intensities at 366nm of 50 lamps were measured. The distribution is shown below.

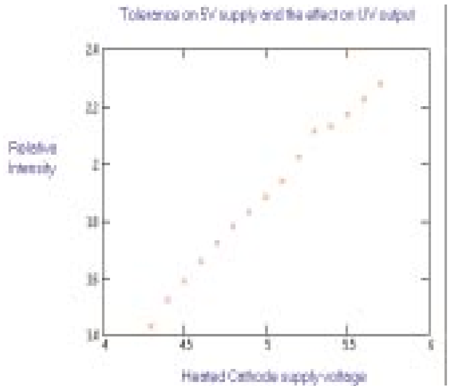


CORRECTION SCHEMES

a) Using the bulb supply voltages

A limited compensation scheme can be devised using the supply voltages of the miniature fluorescent lamp. The lamp requires two power supplies a nominal 5V and a 24V supply. Varying one or both of these voltages will give a first order correction to the lamp output intensity. The correction dynamic range has to be limited to ensure safe operation of the devices.

CONTROL OF MINIATURE FLUORESCENT BULB OUTPUT INTENSITY



For the nominal 5V supply the affect of variations in the supply voltage on output intensity is illustrated below. Care should be taken in interpreting this graph, as the nominal supply voltages are not selected for maximum radiant intensity, but as a compromise to ensure maximum life of the bulb.

The chart shows an almost linear increase in output intensity with increasing cathode voltage. This is to be expected. As the voltage across the cathode increases the self heating and hence the emission of electrons also increases. Consequently, the frequency of collisions with mercury atoms and subsequent UV production also increases. However, increasing the cathode voltage will increase the current flowing through the cathode filament and hence shorten the electrical life of the bulb. If the bulb is operated continuously above 6V the maximum life of the device will reduce from 20000 hours to about 5000 hours.

The 24V supply can also be used to compensate for output variations of the devices. If the power supplies are to be used to control output variations, then this is the desired option. The variation of output intensity with the 24V supply is shown below.

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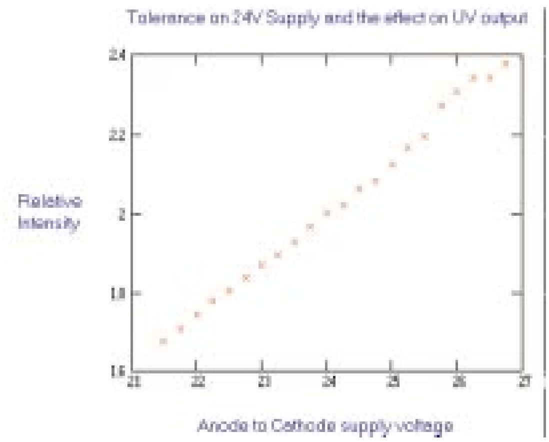


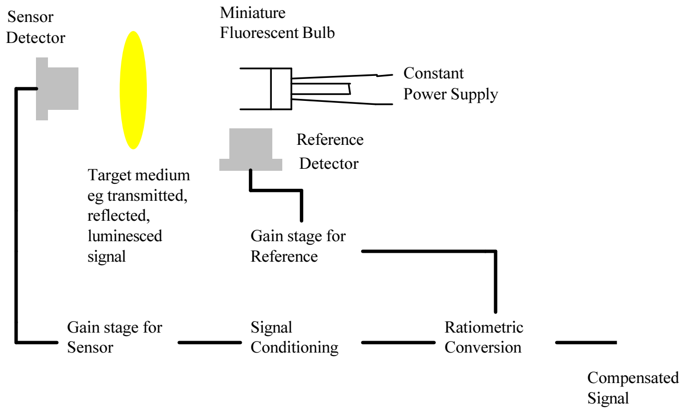
Again, the chart indicates a linear relationship between increasing supply voltage and output. A 10% tolerance on the 24V supply would be acceptable.

However, outside of these limits several other factors have to be considered. If the supply is reduced considerably, then the energy of electrons accelerated from the heated cathode to the anode diminishes and fewer electrons have the required energy to excite orbital electrons of the mercury vapour. These orbital electrons decay to a lower energy level and emit UV photons. Hence, UV emission decreases an undesirable situation. If the voltage falls below 20V the lamp cannot be guarantied to illuminate.

Conversely, if the voltage is increased then the emission of UV will initially increase. However, as the energy of cathode emitted electrons increases orbital electrons of mercury atoms will tend to become ionised (a non-radiant process) rather than excited. At this point UV emission will decrease. Additionally, if the anode to cathode voltage is too large arcing will occur on power up which will over a period of time degrade the phosphor.

b) Ratiometric Compensation

A more elegant approach to the compensation of the output intensity tolerances is the ratiometric technique. A simplified block diagram of the approach is shown below:



The signal from the sensor and reference detector is combined as above to give a ratio i.e. sensor: reference. Then if the bulb output reduces by 50% the ratio will increase by a factor of two, intrinsically compensating for fluctuations in the bulb output.

If several of the above systems are to be used and the response of each system must be identical, the gain of the reference channel can be adjusted. This usually involves the initial use of some calibration medium which is sensed in place of the target medium to be detected. After calibration the inherent compensation of the scheme will ensure close matching between the responses of all systems. This scheme assumes that the response of the target system is directly proportional to the output intensity of the bulb.

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