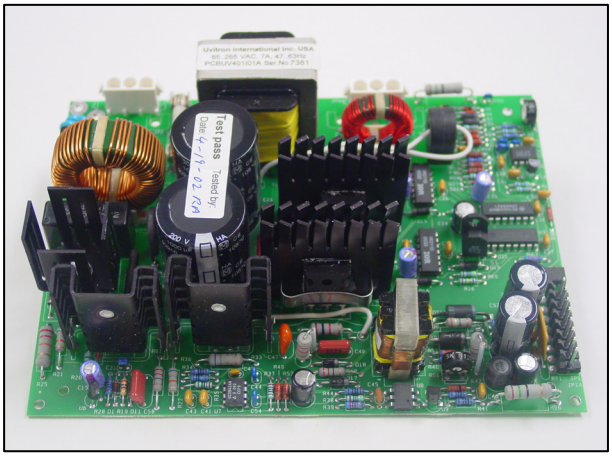
UV Power-Plus Solid-state Lamp Drivers



The *UV Power-Plus* technology utilized in all Uvitron light curing systems represents a major technical advancement over traditional transformer type curing ballasts. The *Power-Plus* lamp drivers are solid-state switch mode power supplies, which sense lamp voltage and current to control lamp power. This solid-state circuitry is small, lightweight and more efficient than transformer curing systems. The power delivered to the lamp is also much tighter regulated, resulting in a more repeatable curing process, and longer lamp life.

Transformer Ballasts

Many curing systems on the market today, use large, heavy 50 or 60 cycle iron transformers to supply power and limit startup current to UV emitting arc lamps. These types of units are relatively easy to design and build, but they are very large and heavy. Transformer based systems also regulate lamp power (and intensity) very poorly in response to variations in line and lamp voltages. This results in inconsistent curing, and temperature changes that shorten lamp life.

Intensity Variations Due to Changes in Line Voltage

The chart below (Fig. 1) shows how the UVA output intensity of a popular transformer type system from another major manufacturer varies as a function of line voltage (as compared to a Uvitron flood curing system). The transformer ballasted system has a greater than 51% percent variation in intensity over a normal input voltage range. Dips and droops of AC line voltage are transferred to the lamp output, and show up as similar variations in lamp intensity (see Fig. 2). These types of variations can cause product yield problems, and result in significant production waste.

In comparison, the UV Power-Plus equipped system is well regulated. The input storage capacitors and power regulation of the Uvitron systems also make it possible to operate during brownouts and line cycle dropouts, which cause transformer ballasted lamps to extinguish.

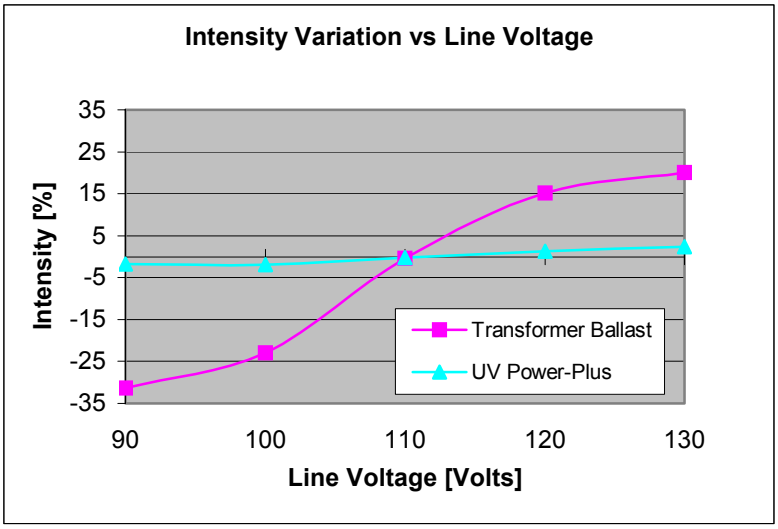


Fig. 1, Comparison of intensity variation caused by changes in input voltage

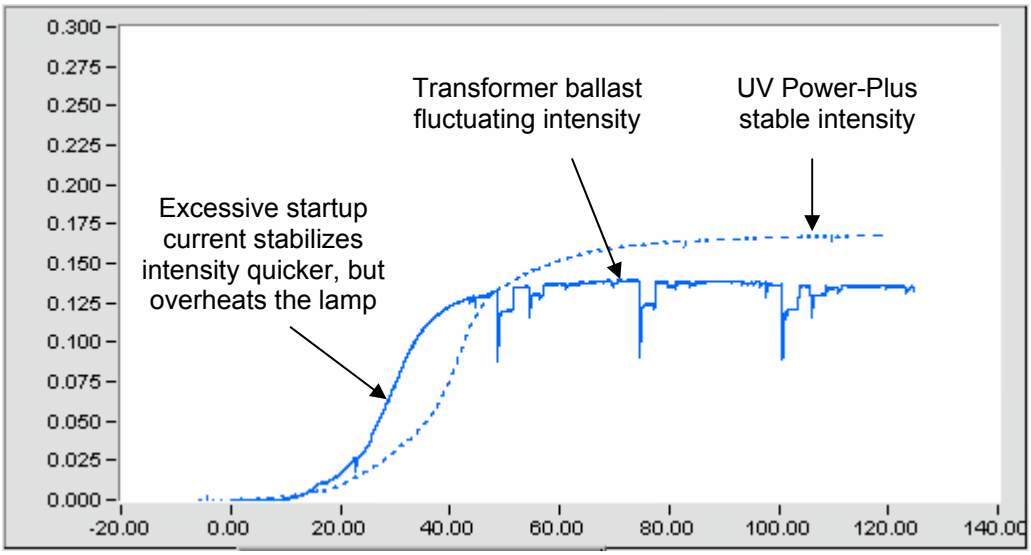


Fig. 2, Startup intensity comparison during line voltage fluctuations encountered at a typical industrial site.

Intensity Variations Due to Changes in Lamp Voltage

The output intensity of a curing system can be regulated by insuring a fixed amount of power is delivered to the arc lamp. Lamp power is defined as follows:

Lamp power = lamp voltage x lamp current

Therefore, if the product of lamp voltage and current is held constant, curing system output intensity will be constant. Transformer type curing systems typically attempt to maintain stable intensity by regulating only lamp current. It is assumed that that since an arc lamp's voltage drop is relatively constant, that if its current is held constant, lamp power will be well regulated.

There are several problems with making this type of design assumption. First of all, arc lamps do not have a constant voltage drop. Lamp voltages vary several volts as a function of current, temperature, and age. Voltage drop also varies significantly from lamp to lamp. All of these voltage changes will cause significant lamp power (and intensity) variations to occur when only regulating lamp current. Additionally (as has been demonstrated), transformer ballasts do not regulate current very well. The result of operating with such quasi-regulated current and varying lamp voltage is *unregulated* lamp intensity.

The UV Power-Plus circuitry solves these problems simply by sensing lamp voltage, and adjusting the current appropriately to maintain constant power to the lamp under all conditions.

Output Wave Shape

Medium pressure mercury and metal halide lamps used in flood curing systems are typically powered with alternating current (AC). This continuously reversing current equalizes the temperature and erosion of both lamp electrodes, which increases lamp life.

Transformer ballasts deliver a distorted sinusoidal wave-shaped current to the arc lamp. This relatively slow changing AC current causes similar shaped variations (or flicker) to appear in the output intensity of the lamp (see fig. 3 below).

In contrast, the UV Power-Plus systems employ high speed switching to rapidly reverse the lamp current over a very short period of time. The result is lamp light emission that is practically constant and equivalent to that of DC current (where no reversing occurs at all). Because of this flicker-free constant intensity, the Power-Plus system is able to deliver higher average light output for the same RMS lamp current (compared with transformer type systems). Higher intensity translates into faster curing, with less heating of lamp electrodes (increasing life).

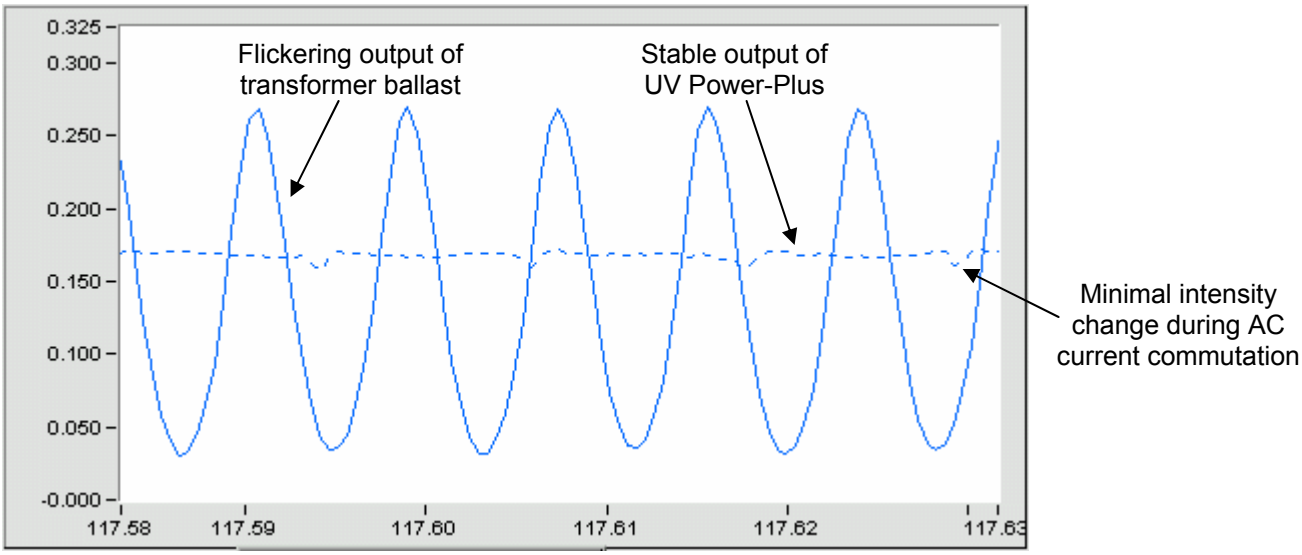


Fig. 3, Output intensity wave shape comparison

Input Voltage & Frequency

Transformer ballasts are typically designed to operate with either 120VAC, 60 Hz input (as used in USA), or for various other voltage inputs at 50 Hz (as used in other countries). Because the transformers must be powered with the line input voltage and frequency for which they were designed, systems utilizing them cannot be used easily in other countries. This makes stocking of several unit configurations (or models) necessary, which increases price and lead-time. Some manufactures require setting of voltage select switches or jumpers to adapt their units for various line voltages. If the setting is not adjusted properly, the unit can be damaged, requiring it to be returned to the factory.

Uvitron UV Power-Plus equipped systems feature auto-ranging AC input circuitry, which eliminates the need for multiple AC line input models and voltage select switches. The auto-ranging circuits allow operation with input frequencies from 45 to 400 Hertz, and voltages from 85 to 265 Volts AC, making these systems compatible with utility power sources worldwide. Uvitron systems are therefore truly portable for applications where operation in more than one country may be required.

Lamp Intensity Control

The current control capabilities of the UV Power-Plus circuitry also allows for modulation of lamp current to various amplitudes. This permits the operator to tune lamp intensity to particular adhesives characteristics, or substrate temperature requirements.

The Uvitron systems also feature a Standby power mode, which reduces system temperature, and excessive light radiation when curing is not in progress. This mode saves energy, decreases area temperature rise, and increases system life.
The IntelliRay 400 utilizes this standby mode feature in conjunction with its integrated shutter. During periods when the shutter is closed, all of the lamp's heat is trapped inside the unit's reflector housing. In order to maintain constant lamp temperature and prevent overheating, intensity is decreased to nearly half power. During this hibernation mode, energy consumption is reduced, and ambient temperature rise is minimized. Because the lamp temperature remains constant, the system is capable of very rapid recovery from half to full intensity, providing on-demand curing. Fig. 4 below demonstrates the quick recovery of the IntelliRay 400 output intensity during random time interval shutter cycling.

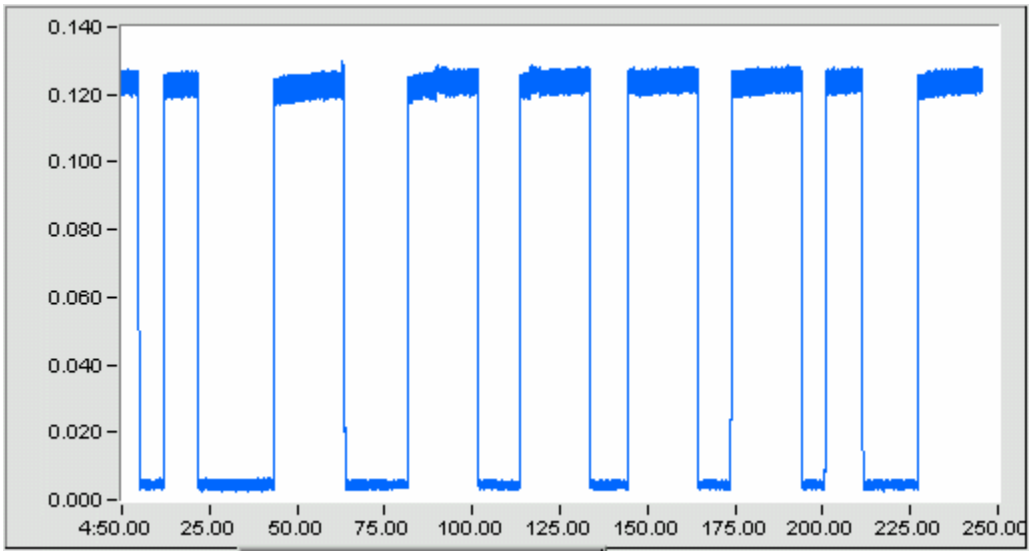


Fig. 4, IntelliRay 400 rapid intensity recovery during shutter cycling

Size and Weight

Due to the state of the art solid-state design of the UV Power-Plus drivers, Uvitron curing systems are the smallest and lightest in the industry. A popular competitor's transformer flood system weighs over 37 pounds, while the Uvitron system of equivalent power weighs only 13 pounds. Uvitron lamp heads are also totally self-contained, and require no heavy power supply box to be externally connected. This makes the Uvitron systems easy to machine or conveyor mount, with no cabling required other than an AC power cord.

Interface Circuitry Allows for Additional Control Features

The UV Power-Plus circuit boards also contain auxiliary 5 Volt and 24 Volt power supplies for powering optional microprocessor controllers, shutters, fans, etc. The boards also contain optically isolated control signals, which allow for convenient interface to internal or customer controllers. The Uvitron IntelliRay 400 takes advantage of this on-board interface circuitry to provide its extended feature set, with minimal change in unit size, weight or cost.

Full Circuit Protection

The UV Power-Plus drivers feature protection from every type of system mishap, insuring high system reliability. System circuit protections include:

- Inrush current limit
- Line voltage surge protection
- Short circuit protection, all outputs: Lamp, 5V, and 24V
- Open circuit voltage protection
- Over temperature protection