

Measuring UV LEDs with Standard Equipment

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Introduction

Why do measuring devices not always provide the reading we are told we should see?

The simple reason is that UV LEDs create light in variables. That's why you need different measuring equipment.

Most UV-led diode manufacturers measure die output in an integrating sphere.

The process involves placing a single die in an integrating sphere (*see diagram 1*) and then measuring the light that is radiated onto a known area of the circumference.

The result is then factored back up to the total sphere surface to give the total radiation, and then calculated back to the array size to provide the irradiance/cm²

The process is usually carried out in 1nm bands and accumulated to create the total UV output.



Diagram 1: example of a typical integrating sphere

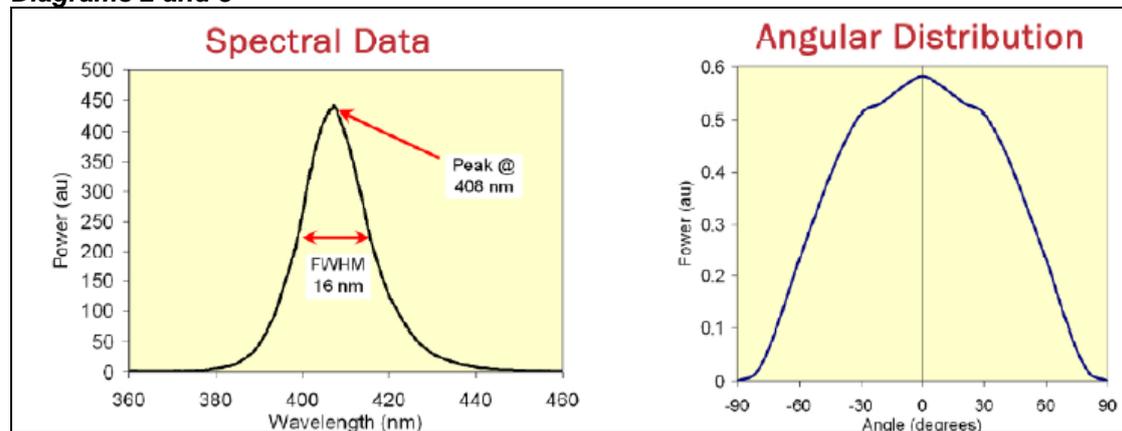
Measuring LEDs

Whilst LED's are targeted at a specific wavelength, light is given off at wavelengths either side of the nominal value.

Integration Technology LEDs have a width of 16nm at half intensity.

Let's take a look (see *diagram 2 and 3*) at a typical example for a 405nm LED (it would be similar for 395 nm etc).

Diagrams 2 and 3



Intensity vs frequency

Non focused light source

If an LED has a peak value of $450\text{mW}/\text{cm}^2$ at 405nm at 8nm either side of the peak (397nm and 413nm), the intensity is $225\text{mW}/\text{cm}^2$.

The actual peak occurs at a value which must fall within the "bin" selection width for the wavelength. The tighter the bin width (i.e. the smaller the tolerance) the more expensive the dies become.

Integration Technology uses a wavelength tolerance of **$\pm 5\text{nm}$** .

A looser bin selection results in a cheaper die selection, but since this process cannot be guaranteed, a wider bin selection does not then mean a wider width of wavelengths: it simply means less control over the wave length.

A randomly selected range of dies between 380nm and 420nm means precisely that: all of the dies could be 380nm , all 420nm , or some variation between these.

The solution

The most common device for measuring UV power/ intensity is the [EIT Power Puck](#) or EIT Power Map, a new joint development between ITL and EIT Inc.

A full-service contract electronic manufacturing services firm, EIT serves the instrument market through the design, production, and distribution of equipment that measures and tracks process control information in UV applications. EIT radiometers and on-line monitoring equipment provide UV users with the widest choice of instruments on the market.

The Power Puck device is fitted with 4 sensor heads for UVV, UVA, UVB and UVC. Each of these sensors has a response curve, none of which is ideal for measuring UV LED's in the $380\text{-}400\text{nm}$ range.

Diagram 4

The UVA aligned measuring head has the following response curve.

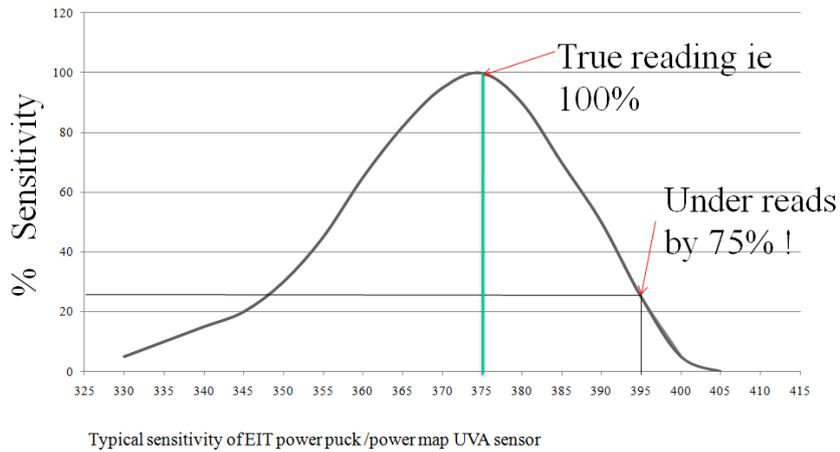
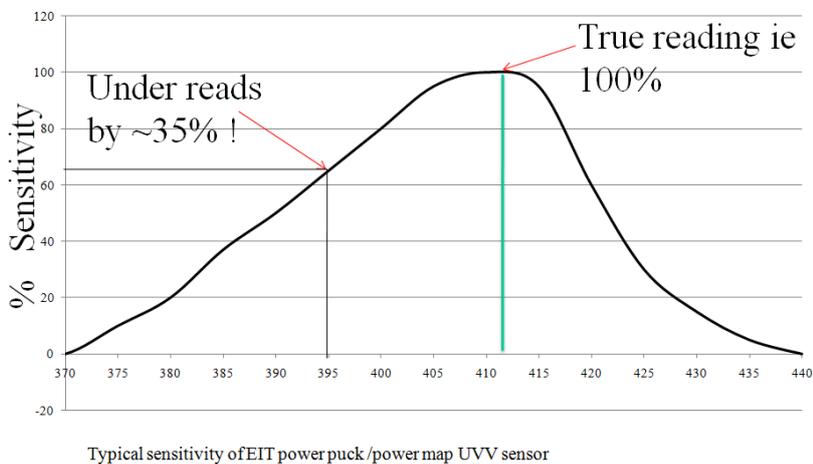


Diagram 5

The UVV aligned measuring head has the following response curve.

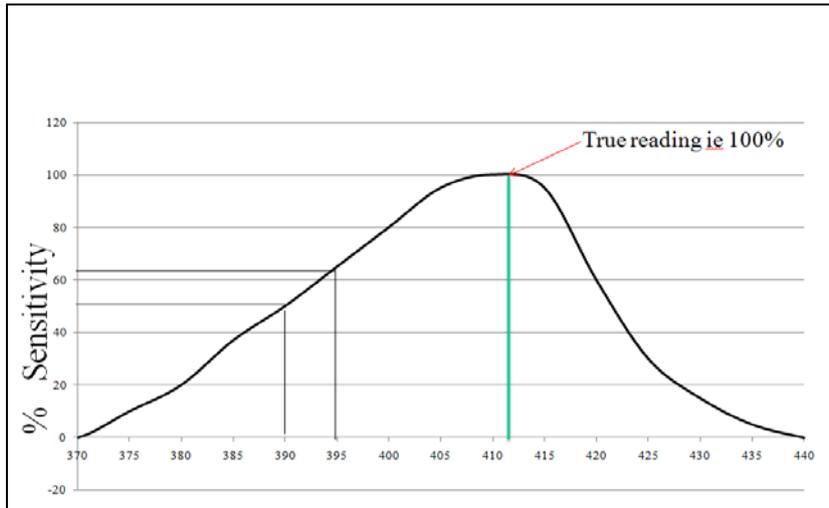


As you can see in *diagrams 4 and 5*, if the device remains constant, and the wavelength is consistent, then it would be possible to “calculate” the actual power from the response curve and know the wavelength.

If the wave length can vary by +/- 5nm, this could induce an error of up to 15%.

Of course, if the wavelength selection of the dies is greater than -/+ 5nm then the error grows in proportion.

Diagram 6

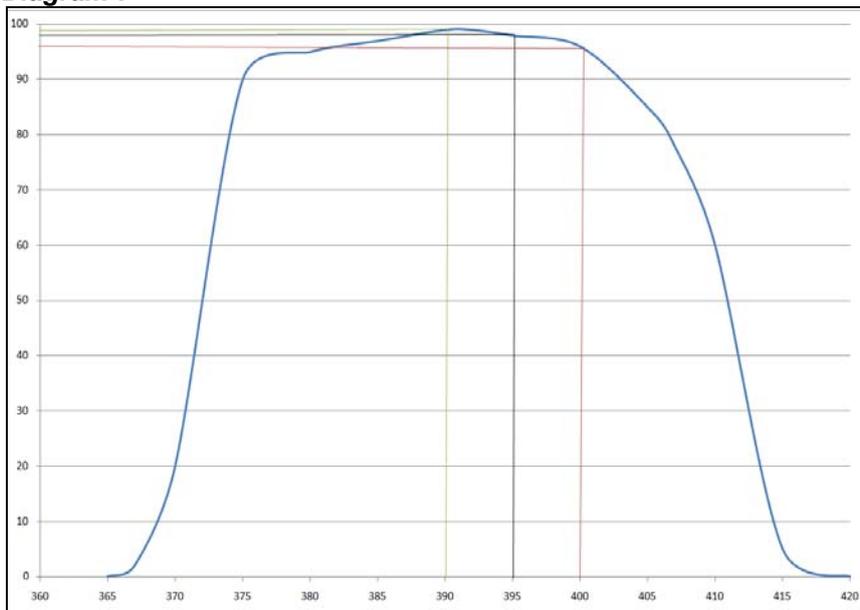


So (in *Diagram 6*), we can calculate based on a factor of .65 (or 1.54)

But if the wavelength changes by 5nm the same die will under read by 15%: or if we are multiplying up, we now need to use a factor of .5 (or 2) to get the actual – e.g. true - output.

EIT are proposing to release a UV LED device later this year which will have a flatter response curve (see *diagram 7*) in the 380- 400nm range, and thereby reduce this error.

Diagram 7



Proposed response curve of the EIT UVA2 device

Additional errors in measuring come from the actual device themselves.

EIT instruments, in common with the industry overall, are accurate to +/-10% (from calibrated value) and repeatable to +/-5%. Although less dramatic, temperature variations of 0.2% /C will also affect readings.

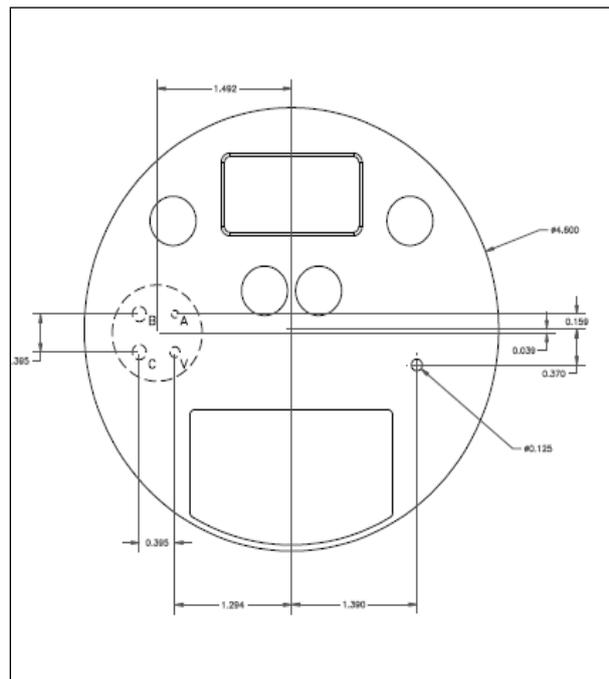
In his summary (*below*) of UV measurement for formulators, Paul Mills of EIT observes:

Radiometer Variations & Limitations

- Users expect the same accuracy as other instruments - current radiometer technology $\pm 10\%$
- Why can't radiometers do better than $\pm 10\%$?
- Optics
 - Filter and detector specifications
 - Spatial response
 - Design
 - Balance between optical stability (minimal solarization) and repeatable electronic signal level
- Electronics
 - Temperature sensitivity
 - Sample rates/Data Collection Speeds
 - Improvements in electronics since early EIT instruments
- Calibration Methodology
- User Induced Errors and Comparisons (Real vs. Perceived)
 - Comparison to other products within EIT family and from other manufacturers

Finally, it is appropriate at this stage also to point out that when using an EIT power puck note that the sensor positions are as in *Diagram 8*.

Diagram 8



Executive Summary:

- The light from an LED is emitted in a Lambda (diverging) profile, therefore intensity drops rapidly with distance – hence the measuring distance is critical.
- LED light appears at a single precise wavelength, in comparison to a much broader emission from an arc/microwave lamp.
- Be aware of the response curve of the proposed measuring equipment.
- Be aware of limitations in regards to repeatability, accuracy and temperature variations of proposed measuring equipment.

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