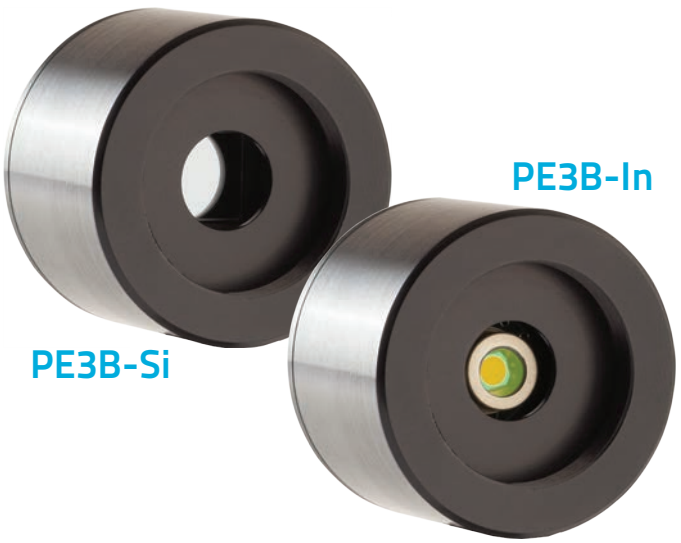
APPLICATION NOTE

CALIBRATION UNCERTAINTY OF PHOTO DETECTORS



The objective of this application note is to inform Gentec Electro-Optics' distributors and clients about two aspects of photodetectors that are believed to cause some confusion and raise questions. At first, a clarification will be made about the variation of calibration of uncertainty over the wavelength spectrum for the PH-B, PH and PE-B photodetectors series. The second aspect that will be clarified is the unique wavelength uncertainty specified for models PE3B-Si and PE3B-In.

ASPECTS TO BE CLARIFIED

1 Power and energy photodetectors uncertainty variation

For the PH-B, PH and PE-B series of photodetectors, one can notice that there are significant variations regarding the calibration uncertainty over the wavelength spectrum. For example, the values we have for the PH100-Si model are the following:

PH100-Si Uncertainty	320-399 nm : ±6.5% 400-899 nm : ±2.5% 900-999 nm : ±3.5% 1000-1049 nm : ±5% 1050-1100 nm : ±7%

There are a few parameters explaining the differences in uncertainty that can be observed in this table. For the 320-399 range of wavelength, since photodetectors are calibrated with NIST traceable gold standards as references, their uncertainties are primarily related to those of the standards, which are variable over the wavelength spectrum and somewhat higher for this specific wavelength range. Moreover, the combination of photo sensitivity variations over the spectrum (Figure 1) and spectrophotometer spectral light emission variations (lower emission for UV wavelengths) is resulting in a greater impact of the noise and thus a larger uncertainty for this range of wavelength. In other words, it is not possible to compensate for the low photo sensitivity and reduce the impact of the noise by increasing the emitted intensity at these wavelengths. This is also the reason why filters cannot be calibrated below 400 nm for OD1 and 630 nm for OD2.

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For the 1000-1049 and 1050-1100 ranges of wavelength, which are associated with regions of the curve that have a steep slope, there is a larger uncertainty because of the rapid variations in photosensitivity for a few nm of wavelength. NIST gold standards uncertainties also increase significantly in these wavelength ranges. These contributions are the parameters that have the biggest impact on uncertainty. Thus, the range of wavelength associated with the highest value of instant slope (first derivative of curve) will have the largest uncertainty of the spectrum.
In this wavelength range, the photodiodes are more responsive to temperature variation. Indeed, by taking a look at the table of uncertainty, it is possible to see that the range of wavelength that fit this condition is 1050 nm to 1100 nm and that it is the one that has the largest value for uncertainty (7%). Additionally, there are spatial uniformity considerations when using a silicon sensor at these wavelengths.

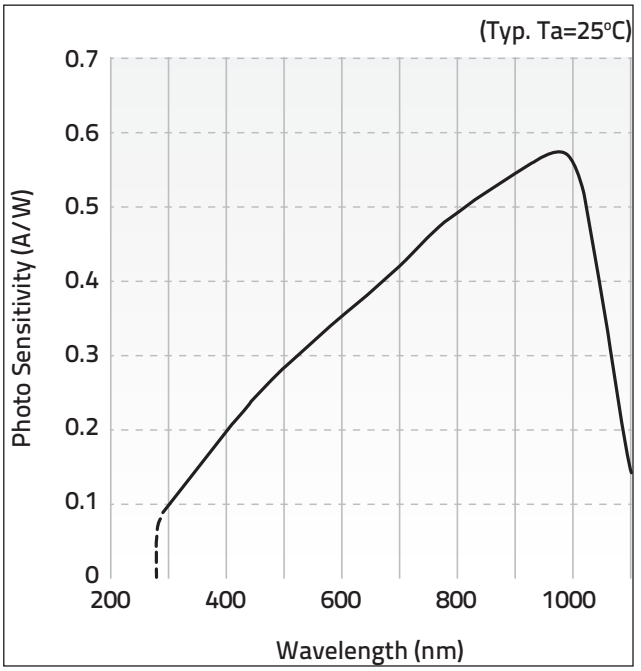

FIGURE 1: PH100-Si typical spectral response

2 Unique wavelength uncertainty for specific models PE3B-Si and PE3B-In

As it is possible to notice either in our company's product guide or website, the extremely low energy detectors PE3B-Si and PE3B-In from PE-B series have a calibration uncertainty (4% for both) that is given for a single wavelength only, unlike other photodetectors. This wavelength is 634 nm for the PE3B-Si model and 1310 nm for the PE3B-In model. After a NIST (National Institute of Standards and Technology) traceable calibration at these wavelengths, detectors absorption on a certain range of wavelength, which later determines the uncertainty, is evaluated with the use of a spectrophotometer. However, the geometric configuration of spectrophotometers is limiting the measurement of absorption for the two models mentioned above because these models have an effective aperture that is smaller than the diameter of the beam produced by the spectrophotometers. Therefore, the uncertainty for the two models is only NIST traceable at the calibration wavelengths for the PE3B-Si and PE3B-In models. Both models have typical spectral curves to make measurement at other wavelengths, but they are not traceable to a standard.

CONCLUSION

Gentec Electro-Optics wants his distributors and clients to keep in mind the following elements:

- The variation of uncertainty for different wavelength ranges for the PH-B, PH and PE-B series can be directly attributed to parameters like the uncertainty of NIST traceable gold standards, spectral photosensitivity, spectrophotometer emission as well as the shape of the spectral response curve.
- The PE3B-Si and PE3B-In models have a unique wavelength uncertainty because of geometrical limitations of the spectrophotometers.

If you have questions about the calibration and/or spectral response of our Photo Detectors please contact us at info@gentec-eo.com.