TECHNICAL NOTE

LINEARITY WITH POWER OF GENTEC-EO'S THERMAL LASER POWER DETECTORS

This short technical note briefly describes the concept linearity with power for a laser power detector and explains how and why Gentec-EO power measurements are linear with power. The linearity of Gentec-EO's power detectors was evaluated by the National Institute of Standards and Technology (NIST) and the measured coefficient is taken into account during Gentec-EO's calibration processes and by Gentec-EO monitors during measurements.

THE CONCEPT OF LINEARITY WITH POWER

A laser power detector has a linear response if its output signal is proportional to the input power, all over the detector's operation range. Example: For a UP55G-500F-H12 from Gentec-EO existing in a perfect world, this is a unique sensitivity in mV/W, all the way from a few hundreds of mW to 500 W. A detector with a non-linear response, on the other hand, would exhibit a gradually decreasing or gradually increasing sensitivity as input power rises up. If this non-linearity is significant, measurements can be underestimated or overestimated, depending on how the sensitivity behaves with average power. For almost every laser power measurement application, it is important to have linear power detectors.

GENTEC-EO'S RIGOR

At Gentec-EO, since thermal power detectors are most of the time calibrated at a single power level near the mid-range, it is mandatory for the company to develop and maintain a technology that has a linear response with power. To make sure this is the case, Gentec-EO has sent its own Gold power detectors to laser specialists at the National Institute of Standards and Technology (NIST) to have a complete set of sensitivity measurements as a function of laser power. The Gold detectors were compared to NIST standard calorimeters at a laser wavelength of 1064 nm using a continuous wave (CW) Nd:YAG laser. The laser beam had a nominal diameter of 38 mm and was centered on the detectors' absorbing surfaces. The results show an outstanding linearity in all cases. The table below shows the results obtained with a UP55G-500F-H12 detector across its entire operation range. As one can see, the slight variation in sensitivity (0.8 %) between 1 W and 453 W is well within the uncertainty of the measurement process (1.2 %).

TABLE 1: LINEARITY OF GENTEC-EO'S UP55G-500F-H12 EVALUATED BY NIST

NOMINAL AVERAGE INPUT POWER (W)	CALIBRATION FACTOR (µV/W)	SENSITIVITY VARIATION (%)	EXPANDED UNCERTAINTY (K=2) (%)
1	63.22	0.40	1.20
51	63.16	0.30	1.20
101	63.11	0.22	1.20
151	63.05	0.13	1.20
201	63.00	0.05	1.20
251	62.94	-0.05	1.20
301	62.89	-0.13	1.20
352	62.83	-0.22	1.20
402	62.78	-0.30	1.20
453	62.72	-0.40	1.20

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Even if it is very small, the measured non-linearity coefficient is taken into account during the calibration process of each Gentec-EO detector. It is used by Gentec-EO monitors in order to have the most accurate sensitivity with NIST traceable corrections for each level of power. Additionally, even if the non-linearity was proven to be negligible and well within NIST's calibration uncertainty (±1.2%), Gentec-EO considers this parameter in its total uncertainty calculation and uses the ±1.2% in its type B error calculation.

THINGS TO REMEMBER:

- Linearity with power is important when making measurements over a broad range of powers.
- All Gentec-EO thermal power detectors have the inherent advantage of being almost perfectly linear with power.
- The measured non-linearity coefficient is very small and is taken into account during detectors calibration processes.
- Gentec-EO monitors use NIST traceable corrections for each level of power.
- The uncertainty of the linearity measurements is taken into account into the total calibration uncertainty calculations.

We hope this technical information will prove useful! Should you have more questions, please contact your local Gentec-EO representative at info@gentec-eo.com.