

# OPTRONIC LABORATORIES CALIBRATION OF PHOTODETECTORS

## INTRODUCTION

Detector spectral response measurements over the wavelength range of 200 nm to 1800 nm are based directly on standard detectors supplied to Optronic Laboratories by NIST (*National Institute of Standards and Technology*). All measurements made beyond 1800 nm are referenced to a heavily blackened thermal detector, which covers the entire 1.0  $\mu\text{m}$  to 30  $\mu\text{m}$  wavelength range. All primary detectors are calibrated in a uniform, semi-collimated beam, which irradiates the central portion of the detector's active area.

## INSTRUMENTATION

A typical configuration for spectral response measurements consists of Optronic Laboratories's OL 750D Double Monochromator Automated Spectroradiometric Measurement System supplemented with the:

- 1 OL 740-20D/UV UV-Visible Dual Source Attachment
- 2 OL 740-20D/IR Visible-IR Dual Source Attachment
- 3 OL 750-10C Mirror Collimating Optics Module
- 4 OL 410-200 Precision Lamp Sources
- 5 OL 46D Deuterium Lamp Precision Current Source
- 6 OL 750-425 Detector Spectral Response Software Package

Appropriate gratings and blocking filters supplement the above equipment.

## MEASUREMENT PROCEDURE

Optronic Laboratories has set up a series of calibrated UV-enhanced silicon detectors for the 200 nm to 1100 nm wavelength region and TE cooled germanium detectors for use over the range of 800 nm to 1800 nm. These detectors have been compared directly to the NIST calibrated detectors. All IR detector spectral response calibrations (*with the exception of the Ge and InGaAs detectors*) are based on a standard thermal detector. NPL (*National Physical Laboratory*) performed the relative spectral response curve for the standard thermal detector from 1.0  $\mu\text{m}$  to 20  $\mu\text{m}$ . The relative spectral response of the thermal detector from 20  $\mu\text{m}$  to 30  $\mu\text{m}$  was determined from a knowledge of the spectral reflectance of the blackened receiver and independently verified by comparison to a blackened, conical-shaped,

thermopile detector. The absolute response of the thermal detector was determined by comparison to a NIST-traceable silicon detector at a wavelength of 1.0  $\mu\text{m}$ . Accordingly, the absolute spectral response of the OL thermal detector was determined from a knowledge of the relative spectral response over the wavelength range of 1.0  $\mu\text{m}$  to 30  $\mu\text{m}$  and the absolute response at 1.0  $\mu\text{m}$ .

## UNCERTAINTY (K = 2)

The uncertainty in the calibration of the NIST supplied standard silicon photodiodes and the estimated transfer uncertainty to the Optronic Laboratories's Standard Detector varies as follows:

WAVELENGTH RANGE (nm)	NIST UNCERTAINTY <sup>1/</sup> (%)	TRANSFER UNCERTAINTY (%)
200	± 4.6	± 1.5
205 to 215	± 3.2 to 3.8	± 1.0 to ± 1.5
220 to 355	± 0.75 to 2.0	± 0.75 to 1.5
360 to 375	± 0.72 to 0.88	± 0.5
380 to 400	± 0.46 to 0.68	± 0.5
405 to 450	± 0.24 to 0.42	± 0.5
455 to 950	± 0.20 to 0.22	± 0.5
955 to 1020	± 0.42 to 1.0	± 0.5 to 1.0
1025 to 1040	± 1.2 to 1.7	± 0.5 to 1.0
1045 to 1070	± 1.8 to 2.6	± 0.5 to 1.0
1075 to 1100	± 2.8 to 3.4	± 1.0 to 1.5

The uncertainty in the NIST1/ calibrated germanium detector varies from ± 0.44% to ± 4.2%, and the estimated transfer uncertainty to the Optronic Laboratories's Standard Detectors is ± 1.0%.

The estimated transfer uncertainty in the relative spectral response of the pyroelectric detectors supplied by Optronic Laboratories varies with wavelength as follows:

WAVELENGTH RANGE ( $\mu\text{m}$ )	TRANSFER UNCERTAINTY (%)
1.0 to 2.5	$\pm 1.0$
2.5 to 5.0	$\pm 1.5$
5.0 to 15	$\pm 2.0$
15 to 20	$\pm 2.5$
20 to 30	$\pm 4.0$

The estimated uncertainty in the absolute spectral response of the pyroelectric detector at 1.0  $\mu\text{m}$  is  $\pm 1\%$  to 2%.

<sup>v</sup> Relative expanded uncertainty at  $k=2$ .

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As part of our policy of continuous product improvement, we reserve the right to change specifications at any time.