TECH NOTE

LRS-9400 Series External Photodiode Array Calibration

OVERVIEW

The LRS-9400 Series Laser Reliability and Burn-In Test Systems support external optical power monitoring through the use of removable photodiode arrays that attach to the device fixtures. The arrays incorporate either Si or InGaAs detectors and are temperature controlled for high stability.

ARRAY CALIBRATION

Photodiode arrays are calibrated using a single point calibration and a nominal responsivity curve to provide a calibration accuracy of ±10% over the specified wavelength range of the array. The responsivity of each photodiode is individually measured at a single wavelength and power during system calibration at the factory. During operation, this calibration responsivity and a table of nominal responsivity vs wavelength are then used to calculate the measured optical power at other wavelengths.

Nominal photodiode responsivity vs wavelength was determined in ILX Lightwave's Optical Calibration Laboratory by measuring the responsivity vs wavelength for batches of Si and InGaAs photodiodes, and then calculating the average responsivity vs wavelength for each batch. The normalized average responsivities for the Si and InGaAs photodiode arrays are shown in Figure 1.

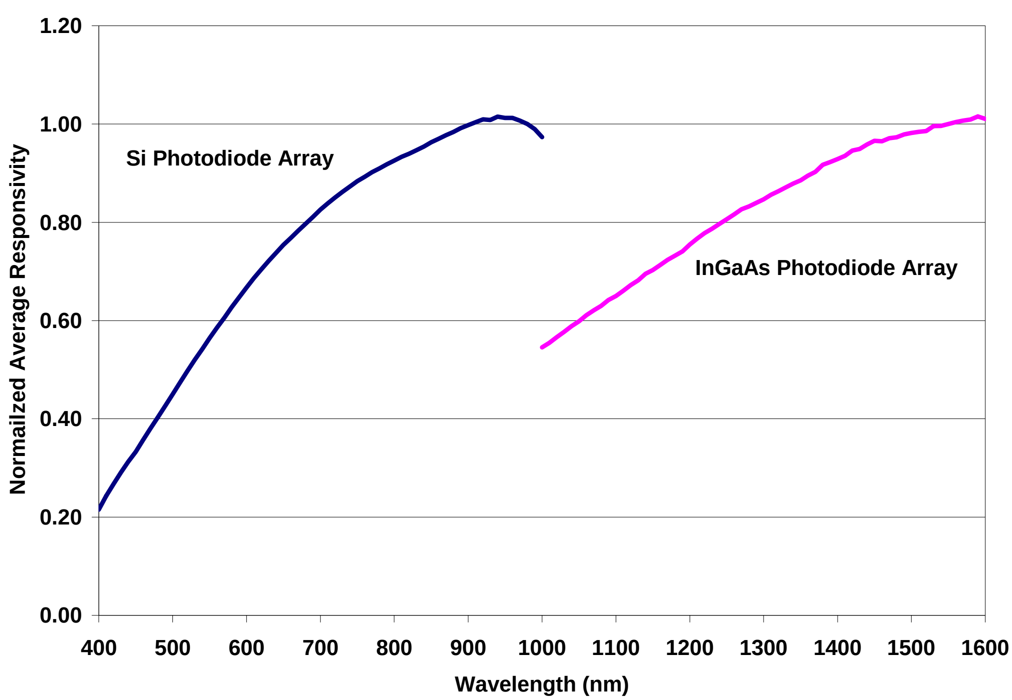

FIGURE 1 – Normalized Average Responsivity vs Wavelength

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Single point calibrations of individual photodiodes are performed using a stable fiber optic source at 980nm and 1550nm for the Si and InGaAs arrays respectively, and an OMM-6810B optical power meter and measurement head. The output power of the fiber optic source is measured with the OMM-6810B. This output is then injected into the individual photodiodes in the array and photodiode current is measured using a calibrated LRS-9400 Series control-measure electronics module.

The calibration responsivity for each photodiode channel is calculated as:

$$R_{cal} = XDI_{cal} / P_{cal}$$

Where R_{cal} is the calibration responsivity, XDI_{cal} is the photodiode current at the calibration wavelength and power, and P_{cal} is the optical power injected into the photodiode at the time of calibration.

During use, the LRS-9400 Series control-measure electronics module calculates external optical power as:

$$XDP = XDI / (R_{cal} * [R_{nom}(\lambda) / R_{nom}(\lambda_{cal})] * F_{user})$$

Where XDP is the calculated optical power, XDI is the measured photocurrent, $R_{nom}(\lambda)$ is the nominal photodiode responsivity at the measurement wavelength, $R_{nom}(\lambda_{cal})$ is the nominal photodiode responsivity at the calibration wavelength, and F_{user} is an optional user calibration factor.

ARRAY FULL SCALE SETTINGS

Full scale optical power measurement ranges are factory set by adjusting gain resistors located on the photodetector arrays. Gains are set to provide a 2000 μA output with a full scale optical power input at the calibration wavelength. For example, a 10 mW Si photodiode array will output 2000 μA when 10 mW of optical power is input at 980 nm. The available full scale optical input power will generally be greater at other wavelengths since the responsivity of the photodetectors varies with wavelength.

For example, from Figure 1 it can be seen that the normalized responsivity of the Si array is 0.78 at 670 nm. The maximum optical input power at this wavelength for a “10 mW” array is therefore, 10 mW / 0.78 = 12.8 mW. In general, full scale optical input power may be calculated using the following equation:

$$\text{Full Scale Optical Input Power} = \text{Array Full Scale Setting} / R_{nom}(\lambda)$$

In this equation, $R_{nom}(\lambda)$ is the normalized average responsivity obtained from the graph in Figure 1 and λ is the wavelength of the lasers under test.