Photodetectors

I. Introduction

EOT Photodetectors are suitable for a variety of pulsewidth measurement and pulse profiling applications. With the exception of the ET-6000, ET series photodetectors use PIN photodiodes and a reverse bias. These photodiodes utilize the photoelectric effect to convert light energy into an electrical current. The reverse bias consists of either 3V lithium cell(s) or a wall plug-in power supply, depending on the amount of bias voltage needed and the intended application of the photodetector. All photodetectors contain their own BNC or SMA output connector. Connecting the photodetector to an oscilloscope and terminating into 50Ω at the oscilloscope is all that is required for operation. Most of EOT's photodetectors can be fitted with FC fiber optic connectors for use with fiber pigtailed light sources.

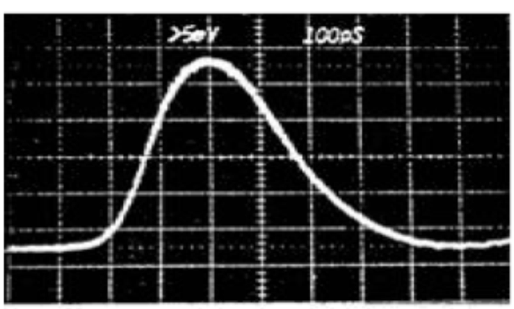
II. Amplified Photodetectors

EOT's Amplified Photodetectors also utilize PIN photodiodes, however, these photodiodes are used in conjunction with high speed transimpedance amplifiers. These transimpedance amplifiers greatly enhance the sensitivity of the photodetectors, allowing light levels as low as 100nW to be measured. Typical gain in EOT's amplified photodetectors is 26dB. It should be noted that EOT's amplified photodetectors are AC coupled and have a low frequency cutoff of 75kHz.

III. Applications

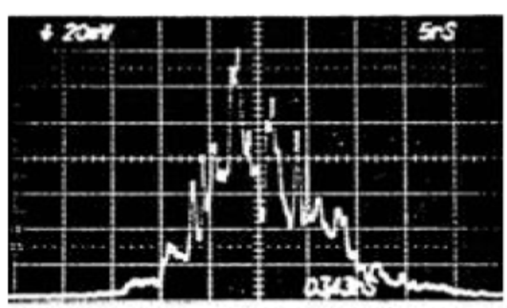
A. Measuring the pulsewidth or viewing the pulse profile of Q-switched lasers.
B. Monitoring the output of mode-locked lasers.
C. Viewing the rapid modulation of diode lasers and externally-modulated CW laser pulses.
D. Beamfinding/alignment of CW and pulsed lasers.
E. Triggering applications using EOT's TTL Photodetectors, which incorporate all of the features of our biased photodetectors, plus an adjustable threshold ultrafast comparator with a TTL output accessible via a second BNC connector.
F. Large area photodetectors can be used as power meters by using Ohm's Law to calculate power levels.

Figures 1 and 2 demonstrate some of the applications for which the ET Series photodetectors are used:



< 100 psec pulse @1064nm viewed with the ET 2000 shows a typical response profile

Figure 1



Mode beating on a 10 nsec Q-Switched Nd:YAG laser viewed with the ET 2000 Oscillosope bandwidth is > 1GHz

Figure 2

IV. Definitions

Responsivity (A/W): The ratio of photocurrent to a corresponding level of incident light. Responsivity varies with wavelength.

Spectral Responsivity: Responsivity plotted as a function of wavelength.

Rise Time (Tr): The time required for the photodetector output level to change from 10% to 90% of the peak output level.

Fall Time (Tf): The time required for the photodetector output level to change from 90% to 10% of the peak output level.

Frequency Response: The electrical output response to a sinewave modulated light input. This is typically measured in dB vs. Hertz.

Cut Off Frequency: The frequency at which the detector output power decreases by 3dB from the output at 100kHz.

Bandwidth: The difference between the high and low cutoff frequencies, measured in Hertz. The bandwidth of the photodetector is approximately related to the rise time (Tr) by:

$$\text{Bandwidth (Hz)} \approx 0.35/Tr$$

Dark Current: The small current which flows when a reverse voltage is applied to a photodiode and no optical input is present.

Junction Capacitance: An effective capacitor is formed at the P-N junction of a photodiode. The junction capacitance is the major factor in determining the speed of a photodiode.

Reverse Breakdown Voltage: The level of reverse voltage which can cause breakdown and deterioration of the detector.

Noise Equivalent Power (NEP): The amount of incident photon energy equivalent to the intrinsic noise level of the device, providing a signal-to-noise ratio of 1.

$$NEP = \frac{\text{Noise Current } (A/\sqrt{Hz})}{\text{Responsivity a } \lambda p \ (A/W)}$$

λp = wavelength of detector's peak responsivity

V. Laser Power Calculations

Using the photodetector's responsivity at a given wavelength and Ohm's Law; V = IR, the output of EOT's photodetectors can be used to calculate the power of the laser incident on the active area of the detector:

For example, if an ET-2030 is producing an output of 20mV, the laser wavelength is 632.8nm and the detector is terminated into 50Ω, the incident power can be derived as follows:

$$I = 0.02V/50\Omega, \text{ or } I = 0.0004A$$

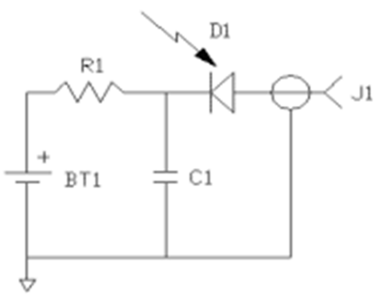
From the responsivity curve contained in the Silicon Photodetector data sheet, the responsivity of the ET-2030 at 632.8nm is 0.4A/W. Therefore:

$$0.0004A \div 0.4A/W = 1mW \text{ of incident power}$$

Note: This is the amount of power incident on the detector, not necessarily the actual power of the beam as not all of the beam may be incident on the detector.

VI. Schematics

A. Schematic of Electrical Circuit for <2GHz Biased Silicon and InGaAs Photodetectors



B. Schematic of Electrical Circuit for >12.5GHz Photodetectors