



# Standard Test Method for Measuring Steady-State Primary Photocurrent<sup>1</sup>

This standard is issued under the fixed designation F448; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the U.S. Department of Defense.*

## 1. Scope

1.1 This test method covers the measurement of steady-state primary photocurrent,  $I_{pp}$ , generated in semiconductor devices when these devices are exposed to ionizing radiation. These procedures are intended for the measurement of photocurrents greater than  $10^{-9}$  A·s/Gy(Si or Ge), in cases for which the relaxation time of the device being measured is less than 25 % of the pulse width of the ionizing source. The validity of these procedures for ionizing dose rates as great as  $10^8$  Gy(Si or Ge)/s has been established. The procedures may be used for measurements at dose rates as great as  $10^{10}$  Gy(Si or Ge)/s; however, extra care must be taken. Above  $10^8$  Gy/s, the package response may dominate the device response for any device. Additional precautions are also required when measuring photocurrents of  $10^{-9}$  A·s/Gy(Si or Ge) or lower.

1.2 Setup, calibration, and test circuit evaluation procedures are also included in this test method.

1.3 Because of the variability between device types and in the requirements of different applications, the dose rate range over which any specific test is to be conducted is not given in this test method but must be specified separately.

1.4 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

**E668 Practice for Application of Thermoluminescence-Dosimetry (TLD) Systems for Determining Absorbed Dose in Radiation-Hardness Testing of Electronic Devices**  
**F526 Test Method for Using Calorimeters for Total Dose Measurements in Pulsed Linear Accelerator or Flash X-ray Machines**

## 3. Terminology

### 3.1 Definitions:

3.1.1 *fall time, n*—the time required for a signal pulse to drop from 90 to 10 % of its steady-state value.

3.1.2 *photocurrent relaxation time, n*—the time required for the radiation induced photocurrent to decrease to  $1/e$  (0.368) of its initial value. The relaxation time depends upon the recombination-controlled photocurrent decay in the media, which is often a semiconductor. The relaxation time can depend upon the temperature and the strength of the irradiation/illumination.

3.1.3 *primary photocurrent, n*—the flow of excess charge carriers across a  $p$ - $n$  junction due to ionizing radiation creating electron-hole pairs throughout the device. The charges associated with this current are only those produced in the junction depletion region and in the bulk semiconductor material approximately one diffusion length on either side of the depletion region (or to the end of the semiconductor material, whichever is shorter).

3.1.4 *pulse width, n*—the time a pulse-amplitude remains above 50 % of its maximum value.

3.1.5 *rise time, n*—the time required for a signal pulse to rise from 10 to 90 % of its steady-state value.

## 4. Summary of Test Method

4.1 In this test method, the test device is irradiated in the primary electron beam of a linear accelerator. Both the irradiation pulse and junction current (**Fig. 1**) are displayed and

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.