



Standard Test Methods for Measuring Contrast of a Linear Polarizer ¹

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1. Scope

1.1 These test methods describe measurement of polarizer contrast. A distinction is made between contrast, which is an intrinsic polarizer property, and extinction, which is a comparison between two polarizers.

1.2 These test methods are applicable to polarizers that operate in a transmissive mode at near-normal incidence. Angular or translative offset of the transmitted beam is acceptable if the entire transmitted beam power can be measured.

1.3 The polarizer size or aperture is not limited by the test methods, but the operator must appreciate that the contrast will be an average over the beam spot on the polarizer. Contrast measured at one location on the aperture does not necessarily apply to the entire aperture.

1.4 These test methods are limited to wavelengths for which the tester can provide a collimated beam, and correctly measure changes in the transmitted beam power. The contrast obtained at one wavelength does not necessarily apply at any other wavelength.

1.5 The maximum contrast obtained by these test methods is limited by the dynamic range of the source-detector combination.

1.6 *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.* For hazard statement, see Section 7.

2. Referenced Documents

- 2.1 *ANSI Standard:*
Z136.1 Safe Use of Lasers ²

3. Terminology

3.1 Definitions:

3.1.1 *contrast*: $C = t_1/t_2$ —the ratio of maximum transmission through a polarizer (t_1) to minimum transmission (t_2) when the polarizer is rotated in a light beam of infinite contrast. Contrast is an intrinsic property of a polarizer.

3.1.1.1 *Discussion*— Contrast can also be used to describe the degree of linear polarization of a light beam. In that case it is the ratio of linearly polarized light power in the maximum direction (P_1) to the minimum (P_2). $C_L = P_1/P_2$ and $P_{\text{tot}} = P_1 + P_2$. An unpolarized or circularly polarized light beam has $C_L = 1$. A completely linearly polarized light beam has $C = \infty$.

3.1.2 *extinction*, X —the ratio of maximum to minimum transmission of light through a pair of polarizers that are rotated with respect to each other.³ X is an average between the two measured polarizers and is not necessarily applicable to either polarizer taken alone.

3.1.2.1 *Discussion*— If the two polarizers have the same contrast, then $X = t_1/2t_2 = (1/2)C$. Extinction can be measured with unpolarized or polarized light. The inverse of X is sometimes referred to as extinction ratio. The distinction is self-evident since X varies from 1 to ∞ and $1/X$ varies from 1 to zero.

3.1.3 *leakage transmission*, t_2 —the ratio of minimum transmitted light power for a polarizer rotated in a light beam of infinite contrast, to the total light beam power without the polarizer.

$$t_2 = P_{\text{min}} / P_{\text{tot}} \quad (1)$$

3.1.4 *transmission*, t_1 —the ratio of maximum transmitted light power for a polarizer rotated in a light beam of infinite contrast, to the total light beam power without the polarizer.

$$t_1 = P_{\text{max}} / P_{\text{tot}} \quad (2)$$

4. Summary of Test Methods

4.1 Three test methods are described in this standard. The first method is a direct contrast measurement that requires a linearly polarized light source with high C_L . The second method is a comparison with a linearly polarized light source with known C_L . The third method is an indirect contrast measurement that can use an unpolarized or polarized light source of unknown C_L .

4.1.1 *Direct Contrast Measurement*—This is the preferred method for measuring C of a single polarizer. This method can be used if $C_L \gg C$ for the polarizer to be tested. It is a simple, expedient, and accurate test method if a highly linear polarized light beam is available at the required wavelength. The source will normally be a polarized laser beam in combination with a

¹ These test methods are under the jurisdiction of ASTM Committee F01 on Electronics and is the direct responsibility of Subcommittee F01.06 on Silicon Materials and Process Control.

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² Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

³ Bennett, J. M., and Bennett, H. E., "Polarization," Section 10 of the *Handbook of Optics*, W. G. Driscoll and W. Vaughan, Eds., McGraw-Hill, 1978.