Designation: E2758 – 22

Standard Guide for Selection and Use of Infrared Thermometers[1]

This standard is issued under the fixed designation E2758; 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 (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide covers electronic instruments intended for measurement of temperature by detecting intensity of thermal radiation exchanged between the subject of measurement and the sensor.

1.2 The devices covered by this guide are referred to as IR thermometers.

1.3 The IR thermometers covered in this guide are instruments that are intended to measure temperatures below 2700 °C and measure a narrow to wide band of thermal radiation in the infrared region.

1.4 This guide covers best practice in using IR thermometers. It addresses concerns that will help the user make better measurements. It also provides graphical tables to help determine the accuracy of measurements.

1.5 Details on the design and construction of IR thermometers are not covered in this guide.

1.6 This guide addresses general information on emissivity and how to deal with emissivity when making measurements with an IR thermometer.

1.7 This guide contains basic information on the classification of different types of IR thermometers.

1.8 The values of quantities stated in SI units are to be regarded as the standard. The values of quantities in parentheses are not in SI and are optional.

1.9 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.10 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E1256 Test Methods for Radiation Thermometers (Single Waveband Type)

E1862 Practice for Measuring and Compensating for Reflected Temperature Using Infrared Imaging Radiometers

E1897 Practice for Measuring and Compensating for Transmittance of an Attenuating Medium Using Infrared Imaging Radiometers

E1933 Practice for Measuring and Compensating for Emissivity Using Infrared Imaging Radiometers

2.2 *IEC Standards:*[3]

IEC 62492-1 TS Industrial Process Control Devices—Radiation Thermometers—Part 1: Technical Data for Radiation Thermometers

2.3 *BIPM Standards:*

JCGM 200:2012 International Vocabulary of Metrology—Basic and General Concepts and Associated Terms (VIM)

3. Terminology

3.1 *Definitions:*

3.1.1 *absolute zero, n*—a temperature of 0 K (–273.15 °C).

3.1.2 *atmospheric attenuation, n*—a ratio showing how much thermal radiation in a given spectral range is absorbed or scattered in air over a given distance.

3.1.3 *atmospheric transmission, n*—a ratio showing how well thermal radiation in a given spectral range at a given distance travels through a certain distance of air.

3.1.4 *attenuating medium, n*—a semi-transparent solid, liquid or gas, such as a window, filter, external optics, or an atmosphere that reduces thermal radiation, or combinations thereof.

3.1.5 *background radiation*—see *reflected radiation*.

[1] This guide is under the jurisdiction of ASTM Committee E20 on Temperature Measurement and is the direct responsibility of Subcommittee E20.02 on Radiation Thermometry.

Current edition approved Oct. 1, 2022. Published November 2022. Originally approved in 1910. Last previous edition approved in 2021 as E2758 – 15A (2021). DOI:10.1520/E2758-22.

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

[3] Available from International Electrotechnical Commission (IEC), 3, rue de Varembé, 1st floor, P.O. Box 131, CH-1211, Geneva 20, Switzerland, https://www.iec.ch.

3.1.6 *blackbody, n*—the perfect or ideal source of thermal radiant power having a spectral distribution described by Planck's Law.

3.1.7 *blackbody simulator, n*—a device with an emissivity close to unity that can be heated or cooled to a stable temperature.

3.1.8 *calibration adjustment, n*—the correction to an IR thermometer based on its calibration.

3.1.9 *celestial radiation, n*—flux coming from the sky.

3.1.10 *center wavelength, n*—the simple average of the lower and upper spectral range limits.

3.1.11 *contact thermometer, n*—an instrument that is adapted for measuring temperature by means of thermal conductance by determining the temperature at the moment when negligible thermal energy flows between the thermometer and the object of measurement.

3.1.12 *dew point, n*—the temperature at which water vapor condenses into liquid water.

3.1.13 *diffuse reflector, n*—a surface that produces a diffuse image of a reflected source.

3.1.14 *distance ratio, n*—the ratio of the measuring distance to the diameter of the field-of-view, when the target is in focus.[4]

3.1.15 *electromagnetic radiation, n*—physically occurring radiant flux classified according to wavelength or frequency.

3.1.16 *emissivity (ε), n*—the emissivity of a surface is the ratio between the radiation emitted from this surface and the radiation from a blackbody at the same temperature.

3.1.16.1 *Discussion*—The emissivity describes a thermophysical material characteristic, which in addition to the chemical composition of the material may also be dependent on the surface structure (rough, smooth), the emission direction as well as on the observed wavelength and the temperature of the measured object.[4]

3.1.17 *emissivity setting, n*—an adjustment on an IR thermometer to compensate for an emissivity of non-unity.

3.1.17.1 *Discussion*—In most measuring situations a radiation thermometer is used on a surface with an emissivity significantly lower than one. For this purpose most thermometers have the possibility of adjusting the emissivity setting. The temperature reading is then automatically corrected.[4]

3.1.18 *emissivity tables, n*—a list of objects and their measured emissivity for a particular IR thermometer.

3.1.19 *field-of-view (FOV), n*—a usually circular, flat surface of a measured object from which the radiation thermometer receives radiation.[4]

3.1.20 *frost point, n*—the temperature at which water vapor condenses into solid water or ice.

3.1.21 *infrared (IR), adj*—referring to electromagnetic radiation with a wavelength from approximately 0.7 µm to 30 µm.

3.1.22 *infrared reflector, n*—a material with a reflectance in the infrared region as close as possible to unity.

3.1.23 *infrared sensing device, n*—one of a wide class of instruments used to display or record (or both) information related to the thermal radiation received from any object surfaces viewed by the instrument.

3.1.24 *infrared (IR) thermometer, n*—optoelectronic instrument adapted for noncontact measurement of temperature of a subject by utilizing thermal radiation exchange between the subject and the sensor.

3.1.24.1 *Discussion*—IR thermometers are a subset of radiation thermometers. Most manufacturers use the term IR thermometer for handheld radiation thermometers. In general, these devices are wideband and use a thermopile detector.

3.1.25 *IR thermometry, n*—the use of IR thermometers to determine temperature by measuring thermal radiation.

3.1.26 *irradiance (E), n*—the radiant flux (power) per unit area incident on a given surface in units of W/m^2.

3.1.27 *limit of error, n*—the extreme value of measurement error of an infrared thermometer reading, relative to reference temperature standards, as permitted by a specification.

3.1.27.1 *Discussion*—Manufacturers sometimes use the term accuracy in their specifications to represent limit of error.

3.1.27.2 *Discussion*—A manufacturer's accuracy specification may apply only to well defined conditions.

3.1.28 *low-temperature, adj*—for radiation and IR thermometry, referring to any temperature below 660 °C.

3.1.29 *measurement uncertainty (accuracy), n*—nonnegative parameter, characterizing the dispersion of the values that could reasonably be attributed to the measurement of the quantity values being attributed to a measurand, based on the information used.[4,5]

3.1.30 *measuring distance, n*—distance or distance range between the radiation thermometer and the target (measured object) for which the radiation thermometer is designed.[4]

3.1.31 *measuring temperature range, n*—temperature range for which the radiation thermometer is designed.[4]

3.1.32 *noise equivalent temperature difference (NETD), n*—parameter which indicates the contribution of the measurement uncertainty in °C, which is due to instrument noise.[4]

3.1.33 *opaque, adj*—referring to the property of a material whose transmittance is zero for a given spectral range.

3.1.34 *operating temperature range and air humidity range, n*—the permissible temperature range and humidity range within which the radiation thermometer may be operated. For this temperature range and humidity range the specifications are valid.[4]

3.1.34.1 *Discussion*—This is the range of ambient temperature and humidity the instrument may operate within and be expected to meet its specification. It may be thought of as the ambient operating temperature range and the ambient operating humidity range.

[4] See IEC 62492-1.

[5] See BIPM JCGM 200:2012.