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# Non-destructive testing — Thermographic testing

## Part 3: Terms and definitions

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**National foreword**

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A list of organizations represented on this committee can be obtained on request to its secretary.

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# Non-destructive testing - Thermographic testing - Part 3: Terms and definitions

Essais non destructifs - Analyses thermographiques - Partie 3: Termes et définitions

Zerstörungsfreie Prüfung - Thermografische Prüfung - Teil 3: Begriffe

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## European foreword

This document (EN 16714-3:2016) has been prepared by Technical Committee CEN/TC 138 “Non-destructive testing”, the secretariat of which is held by AFNOR.

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EN 16714, *Non-destructive testing — Thermographic testing* consists of the following parts:

— *Part 1*: *General principles*

— *Part 2*: *Equipment*

— *Part 3*: *Terms and definitions*

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# 1 Scope

This European Standard establishes terms and definitions for thermographic testing.

# 2 Terms and definitions

**2.1**
**absorptance**
$\alpha$
ratio of absorbed radiant power to the incident radiant power

Note 1 to entry: Absorptance may vary with wavelength, temperature and angle.

**2.2**
**active thermography**
thermographic procedure in which an artificial or natural source of energy is used to produce a non-stationary heat flux for the purpose of testing

**2.3**
**anti-reflectance coating**
coating of infrared or optical elements (lenses, protective windows) to increase the transmission of certain wavelength ranges by minimizing or suppressing reflections at interfaces

**2.4**
**atmospheric temperature**
$T_{atm}$
temperature of the atmosphere between camera and measured object

**2.5**
**atmospheric attenuation**
reduction of flux densities of electromagnetic radiation on the path through the atmosphere

Note 1 to entry: The atmosphere between object and camera attenuates IR radiation. Besides absorption of radiation by gases, e.g. water vapour ($H_2O$) and carbon dioxide ($CO_2$), radiation is attenuated by scattering (dust, fog, rain, snow, etc.).

**2.6**
**comparative thermography**
thermographic procedure that evaluates temperature differences or phase differences or differences of secondary parameters

**2.7**
**chromatic aberration**
wavelength dependent aberration of lens

Note 1 to entry: Due to dispersion (wavelength dependent index of refraction), different spectral parts are imaged in different image planes. This aberration is increasing with the spectral bandwidth of captured radiation.

**2.8**
**close-up lens**
additional lens which is placed in front of an existing IR lens to decrease the minimum distance between camera and object

Note 1 to entry: Close-up lenses are an inexpensive alternative to macro lenses to adapt the field of view of a camera or lens to visualize small objects.

**2.9**
**data analysis**
application of algorithms and calculations in order to increase the contrast of indications of recorded data

**2.10**
**differential temperature**
temperature difference between two temperature values recorded at different positions and/or at different times

Note 1 to entry: Temperature differences are used, e.g. for subtracting the temperature of an undisturbed area or for subtracting the zero image (thermogram before heating) from a data sequence.

**2.11**
**diffraction limit**
limit of spatial resolution due to diffraction of optical systems

Note 1 to entry: Diffraction at diaphragms, lens holders, etc. physically limits the spatial resolution of IR cameras. The limit can be estimated with the Rayleigh criterion. Diffraction depends on the wavelength of radiation as well as shape and dimension of beam-narrowing components.

**2.12**
**emissivity**
***ε***
ratio of the power radiated by real bodies to the power that is radiated by a black-body at the same temperature

Note 1 to entry: The emissivity can depend on the wavelength, the angle of emission, the body temperature and other factors. In this general case the ratio of the spectral radiance of a real body and a black-body is called spectral directional emissivity. In thermography practice, only the emissivity within the spectral sensitivity range of the IR camera is relevant. It is used for correcting temperature measurements carried out with the IR camera (settings of IR cameras for temperature measurements).

**2.13**
**extension ring**
ring that is placed between the camera and the lens to increase the distance between image plane and lens (increase of magnification)

**2.14**
**external heating source**
heating source which is used for external heating in active thermography for introducing a non-stationary heat transfer into the object under test

Note 1 to entry: As external heating source, e.g. flash lamps, halogen lamps, lasers, inductive coils, ultrasonic sonotrodes can be used.

**2.15**
**field of view**
**FOV**
image section that is captured by an IR camera

Note 1 to entry: The field of view depends amongst others on the focal length of the lens.

**2.16**
**fill factor**
ratio of the sum of all single detector areas to the total area of the detector array

Note 1 to entry: The fill factor is an important parameter to describe the properties of detector arrays. Arrays with high fill factors produce homogenous images. However, high fill factors are also prone to crosstalk of neighbouring detector elements.

**2.17**
**fixed pattern noise**
influence of different sensitivities of single detectors and readout circuit in FPA cameras

**2.18**
**focal plane array**
**FPA**
detector consisting of a one- or two-dimensional array of single detectors

**2.19**
**frame rate**
number of thermograms (frames) of a specific resolution per second, which are recorded with the IR camera

**2.20**
**image averaging**
averaging of consecutive images (thermograms, frames) to improve the thermal resolution of IR cameras

Note 1 to entry: Image averaging improves the signal-to-noise ratio (SNR). Image averaging improves the thermal resolution of IR cameras at the expense of temporal resolution. To avoid blurred images, image averaging should only be used for slowly moving cameras or slowly changing temperature distributions.

**2.21**
**infrared (IR) camera**
optical device including lens, filters, FPA and internal data processing for collecting and imaging the infrared radiation emitted by an object under test and which is measuring the radiation flux and/or the temperature

Note 1 to entry: Only the wavelength interval of infrared radiation transmitted by the lens and filters and where the FPA is sensitive is detected.

**2.22**
**IR-imager**
**IR-viewer**
infrared camera for visualizing infrared radiation without measurement functionalities

**2.23**
**instantaneous field of view**
**IFOV**
image section of a single detector element of IR camera

Note 1 to entry: The instantaneous field of view specifies the spatial resolution of IR cameras. It is strictly applicable only to scanning cameras with one single detector element. The spatial resolution for measurement of focal plane array can be determined by the slit response function (SRF).

**2.24**
**integration time**
time during which the incoming infrared radiation is accumulated (integrated) on the detectors of the FPA

Note 1 to entry: The longer the integration time, the more light is collected. A long integration time applied to objects with high temperature may saturate the detectors.

Note 2 to entry: The shortest integration time is usually limited by the speed of the detector.

**2.25**
**long-wave infrared**
**LWIR**
wavelength range between 8,0 µm and 14,0 µm

**2.26**
**measurement field of view**
**MFOV**
smallest target spot size on which an infrared camera can fulfil measurement, expressed in terms of angular subtense

Note 1 to entry: The slit response function (SRF) test and the hole response function (HRF) test are typical methods used to measure MFOV.

**2.27**
**mid-wave infrared**
**MWIR**
wavelength range between 2,0 µm and 5,0 µm

**2.28**
**minimum resolvable temperature difference**
**MRTD**
measure of the ability of an infrared imaging system and the human observer to recognize periodic bar targets on a display

**2.29**
**modulation (of heat source)**
procedure in which amplitude, phase and/or frequency of the periodic or impulse excitation function of a heat source is modified

**2.30**
**noise equivalent temperature difference**
**NETD**
temperature difference of a black-body radiator that corresponds to the signal-to-noise ratio of 1 that is caused by a temporal noise

Note 1 to entry: The noise equivalent temperature difference is measured in kelvin for a given object temperature at a certain integration time.

**2.31**
**non-uniformity correction**
**NUC**
image correction carried out by the camera software to compensate for different sensitivities of detector elements and other optical and geometrical disturbances

**2.32**
**passive thermography**
thermographic procedure in which no external heating source is used for the purpose of testing, only heat flow due to intrinsic heat of the object under test is used

**2.33**
**phase angle**
phase angle between a thermal signal at the surface of the object and the excitation signal of an external heating source at a frequency f

Note 1 to entry: The phase angle is measured in degree or in rad. In general, the phase angle is composed of a physical part which is given by the phase angle between temperature at the surface of the object and the heat flux density of an external heating source at the heating location due to the heat conduction transfer processes and an instrumental part which is given by the phase angle between the excitation signal of an external heating source and its heat flux density

**2.34**
**qualitative thermography**
thermography in which the radiation flux or the temperature or the phase angle or secondary parameters derived there from are not determined

**2.35**
**quantitative thermography**
thermography in which the radiation flux, the temperature, the phase angle or secondary parameters derived there from are determined

**2.36**
**quantum detector**
semiconductor detector that absorbs IR radiation by producing electron-hole pairs (photoelectric effect) thereby altering electrical conductivity or generating photovoltage or photocurrent

**2.37**
**quantum well infrared photon detector**
**QWIP detector**
special type of infrared detector which uses the effect of photoexcitation of electrons (holes) between the base and the first excitation levels in the conduction (valence) band of so-called quantum wells

**2.38**
**reflectance**
$\rho$
ratio of reflected radiant power to incident radiant power

**2.39**
**reflected apparent temperature**
$T_{refl}$
apparent temperature of the environment that is reflected by the target into the IR camera and it is measured on a diffuse reflector placed in the same plane as the target

Note 1 to entry: Neglecting the reflected apparent temperature, or setting a wrong value, may (in presence of low emissivity surfaces) lead to considerable errors in the estimation of the target temperature.

**2.40**
**short-wave infrared**
**SWIR**
wavelength range between 0,8 µm and 2,0 µm

**2.41**
**spectral absorptance**
$\alpha_\lambda$
absorptance at a specific wavelength

**2.42**
**spectral emissivity**
$\varepsilon_\lambda$
emissivity at a specific wavelength

**2.43**
**spectral reflectance**
$\rho_\lambda$
reflectance at a specific wavelength

**2.44**
**spectral transmittance**
$\tau_\lambda$
transmittance at a specific wavelength

**2.45**
**spherical aberration**
aberration caused by the geometry of the lens

Note 1 to entry: Spherical lenses do not exactly refract abaxial beams into either a focal point or a focal plane.

**2.46**
**thermal detector**
detector that provides an electric signal generated by its temperature change under incident infrared radiation

Note 1 to entry: Measurement signals are e.g. changes of electrical resistance (bolometer), thermoelectrical potential (thermocouple), or electrical polarization.

**2.47**
**thermography**
contact-free detection, processing and visual display of the distribution of the thermal radiation originating from an object and recordable with an IR detector system

Note 1 to entry: Infrared thermography (IR thermography) is used as a synonym.

**2.48**
**thermographic testing**
non-destructive testing using thermography

**2.49**
**transmittance**
**$\tau$**
ratio of transmitted radiant power to incident radiant power

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