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Non-destructive testing — Infrared thermography —

Part 1: Characteristics of system and equipment

Essais non destructifs — Thermographie infrarouge —

Partie 1: Caractéristiques du système et des équipements

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Foreword

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This document was prepared by Technical Committee ISO/TC 135, *Non-destructive testing*, Subcommittee SC 8, *Thermographic testing*.

A list of all parts in the ISO 18251 series can be found on the ISO website.

Introduction

The industrial applications of infrared thermographic testing in non-destructive testing (NDT) are growing, along with a remarkable improvement in thermographic technologies. The effectiveness of any application of infrared thermographic testing depends upon proper and correct usage of the system and equipment. The purpose of this document is to provide the characterization description of system and equipment for infrared thermography in the field of industrial NDT. The development of this document resolves the lack of International Standards on infrared equipment and systems. The main interested parties who will benefit from this document are manufacturers and users of such equipment and systems.

Non-destructive testing — Infrared thermography —

Part 1:
Characteristics of system and equipment

1 Scope

This document describes the main components, and their characteristics, constituting an infrared (IR) imaging system and related equipment used in non-destructive testing (NDT). It also aims to assist the user in the selection of an appropriate system for a particular measurement task.

The following items are specified:

— objective lens;

— detector;

— image processor;

— display;

— thermal stimulation source;

— accessories.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 10878, *Non-destructive testing — Infrared thermography — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 10878 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

4 IR system setup

Figure 1 represents an imaging arrangement including the IR system. The lens focuses an image of the object on the detector. The array of pixels in the detector produces electrical signals dependent on infrared radiation intensity. The electrical signals are processed to produce an image that is shown on a display and available for storage or further processing.

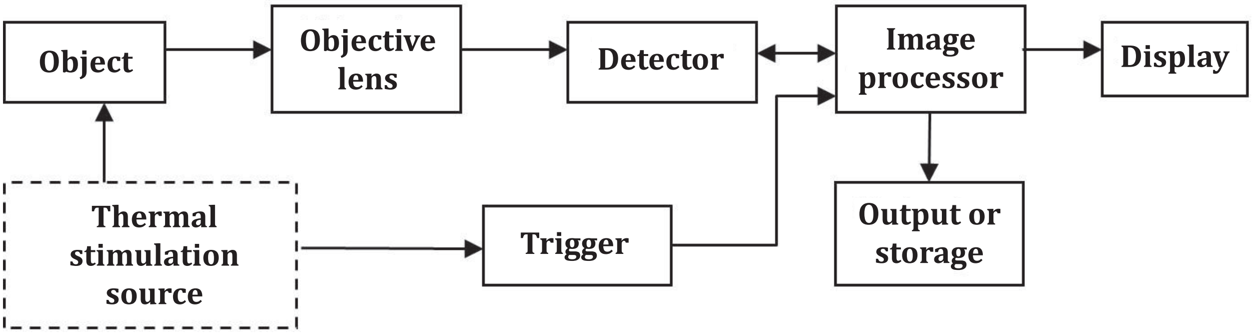

Figure 1 — IR system setup

5 Objective lens

5.1 General

The objective lens of an optical system is the element, or combination of elements, that focuses radiant energy from the object and forms the primary image.

Interchangeable lenses are used to reach a desired spatial resolution of the investigated object, or object detail.

5.2 Spectral response

IR-cameras are adapted to the transmission properties of the atmosphere for infrared radiation (atmospheric windows):

— Short Wave, SW: wavelength between approx. 0,8 µm and 2 µm;

— Mid Wave, MW: wavelength between approx. 3 µm and 5 µm;

— Long Wave, LW: wavelength between approx. 8 µm and 14 µm.

The spectral response of the IR-camera depends on the used detector. The transmission of the objective lens system should be adapted to the spectral response of the detector. The detector is selected according to the test problem.

5.3 Focal length (mm)

The focal length is the distance between optical centre of the lens and the focal plane point of the detector. The image of an observed object differs according to the focal length of the lens. A long focal length results in a smaller field of view and a larger image on the focal plane; this can be useful for increasing the working distance or visualizing fine details of an object.

5.4 Aperture f-number

The aperture defines the opening through which the rays come to a focus on the focal plane array. The effective size of the lens aperture affects the amount of radiant energy that passes through a lens. It is usually specified as an f-number, the ratio of the focal length to the effective aperture diameter. It strongly influences the sensitivity of the infrared detector. A larger aperture, a lower f-number, allows more radiant energy to reach the detector, increasing sensitivity of the system. These are “fast” apertures like f/1.1 or f/2. A smaller aperture, a higher f-number, allows less light that gets in. These are “slow” apertures like f/3 or f/4.5.

The lens aperture diameter needs to be greater than the detector diagonal to ensure that most of the radiant energy hitting the detector comes through the lens rather than from the internal parts of the system enclosure.

Detector aperture and lens aperture have to be carefully matched. It is beneficial to keep the lens system slightly faster than the detector in order to improve the ratio of rays accumulated by the lens system to the rays incoming from lens housing and other internal components.

5.5 Interchangeable object lenses

Interchangeable object lenses are used to adapt the camera system to special geometric requirements of measurement tasks (image section, required minimal resolution). There are typically standard object lenses, e.g. wide angle and telephoto lenses as well as accessory lenses for the measurement of large or small objects. For improved accuracy, each object lens shall be calibrated together with the camera.

6 Detector

6.1 General

The detector represents the core of the infrared camera since it senses infrared radiation and converts it to a usable electrical signal. Several characteristics affect the performance of the detector system. The type, number and arrangement of detector elements affect the sensitivity, thermal resolution, response time and spectral response of the imaging system.

6.2 Detector types

There are many different kinds of detectors available in infrared equipment, such as microbolometer, photoelectric, pyroelectric or quantum sensor, etc. These detectors are classified as two types: thermal detectors and quantum detectors. Thermal detectors, e.g. microbolometers or pyroelectric detectors, work at room temperature. Quantum detectors, e.g. photoelectric detectors or QWIP detectors, have to be cooled down to very low temperatures to reduce thermal noise. Quantum detectors have a higher sensitivity and they are easily compatible with higher frame modes of image acquisition.

6.3 Detector arrays

Infrared detectors can be single, linear arrays or two-dimensional arrays. Single element detectors require a scanning system to direct radiation from successive parts of the image at the detector in an organized two-dimensional scan that can be decoded into an image. Linear arrays can be used for producing images of moving objects, such as production lines. Two-dimensional detector arrays [focal plane array (FPA)] are capable of recording images without scanning.

6.4 Scanning systems

Mechanical scanning is achieved by moving mirrors, prisms, or polygons. Scanning cameras inherently provide homogeneous images without electronic correction mechanisms. However, the frame rate is limited due to the scanning. They are therefore less suitable to capture fast processes than FPA-cameras.

6.5 Working wavelength range

The working wavelength range depends on the detectors' material, objective lens and encapsulating window. For testing, it is selected according to the test condition and test object.