

TECHNICAL SPECIFICATION

**Industrial process control devices – Thermographic cameras –
Part 1: Metrological characterization**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2020 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

TECHNICAL SPECIFICATION

Industrial process control devices – Thermographic cameras – Part 1: Metrological characterization

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 17.200, 25.040.40

ISBN 978-2-8322-7969-4

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	6
INTRODUCTION.....	8
1 Scope.....	9
2 Normative references	9
3 Terms and definitions	9
4 Symbols	14
5 Abbreviated terms	14
6 Determination of technical data	15
6.1 General.....	15
6.2 Measuring temperature range	15
6.2.1 General	15
6.2.2 Required parameters	16
6.2.3 Examples of indications	16
6.2.4 Test condition, method and procedure for measuring temperature range	16
6.3 Noise equivalent temperature difference (<i>NETD</i>)	16
6.3.1 General	16
6.3.2 Required parameters	16
6.3.3 Examples of indications	16
6.3.4 Test condition, method and procedure for noise equivalent temperature difference	17
6.4 Measuring distance (<i>d</i>).....	18
6.4.1 General	18
6.4.2 Required parameters	18
6.4.3 Examples of indications	18
6.4.4 Test condition, method and procedure for measuring distance	18
6.5 Field of view (<i>FOV</i>)	18
6.5.1 General	18
6.5.2 Required parameters	19
6.5.3 Examples of indications	19
6.5.4 Test condition, method and procedure for field of view	19
6.6 Number of image elements	19
6.7 Detector format used (number of detector elements used)	19
6.8 Instantaneous field of view (<i>IFOV</i>)	20
6.8.1 General	20
6.8.2 Required parameters	20
6.8.3 Example of indications	20
6.8.4 Test condition, method and procedure for instantaneous field of view	20
6.9 Slit response function (<i>SRF</i>)	20
6.9.1 General	20
6.9.2 Required parameters	21
6.9.3 Examples of indications	21
6.9.4 Test condition, method and procedure for slit response function	21
6.10 Minimum field of view for temperature measurement (<i>MFOV_T</i>).....	22
6.10.1 General	22
6.10.2 Required parameters	23
6.10.3 Example of indications	23

6.10.4	Test condition, method and procedure for minimum field of view for temperature measurement	23
6.11	Spectral range	24
6.11.1	General	24
6.11.2	Examples of indications	24
6.11.3	Test condition, method and procedure for spectral range	24
6.12	Emissivity setting	24
6.12.1	General	24
6.12.2	Examples of indications	24
6.12.3	Test condition, method and procedure for emissivity setting	24
6.13	Influence of the internal instrument temperature	24
6.13.1	General	24
6.13.2	Required parameters	25
6.13.3	Examples of indications	25
6.13.4	Test condition, method and procedure for influence of the internal instrument temperature	25
6.14	Influence of the humidity	26
6.14.1	General	26
6.14.2	Required parameters	26
6.14.3	Example of indications	26
6.14.4	Test condition, method and procedure for influence of the humidity	26
6.15	Long-term stability	26
6.15.1	General	26
6.15.2	Required parameters	26
6.15.3	Example of indication	26
6.15.4	Test condition, method and procedure for long-term stability	27
6.16	Short-term stability	27
6.16.1	General	27
6.16.2	Required parameters	27
6.16.3	Example of indication	28
6.16.4	Test condition, method and procedure for short-term stability	28
6.17	Repeatability	28
6.17.1	General	28
6.17.2	Required parameters	28
6.17.3	Example of indication	29
6.17.4	Test condition, method and procedure for repeatability	29
6.18	Interchangeability (spread of production)	29
6.18.1	General	29
6.18.2	Required parameters	29
6.18.3	Example of indication	30
6.18.4	Test condition, method and procedure for interchangeability (spread of production)	30
6.19	Response time	30
6.19.1	General	30
6.19.2	Required parameters	34
6.19.3	Example of indication	34
6.19.4	Test condition, method and procedure for response time	34
6.20	Exposure time	35
6.20.1	General	35
6.20.2	Required parameters	36

6.20.3	Example of indication	36
6.20.4	Test condition, method and procedure for exposure time	36
6.21	Warm-up time	37
6.21.1	General	37
6.21.2	Required parameters	37
6.21.3	Examples of indication	37
6.21.4	Test condition, method and procedure for warm-up time	37
6.22	Integration time setting range	38
6.22.1	General	38
6.22.2	Required parameters	38
6.22.3	Example of indication	38
6.23	Refresh rate	38
6.23.1	General	38
6.23.2	Example of indication	39
6.23.3	Test condition, method and procedure for refresh rate	39
6.24	Non-uniformity (inhomogeneity of detector responsivity)	39
6.24.1	General	39
6.24.2	Required parameters	39
6.24.3	Example of indication	39
6.24.4	Test condition, method and procedure for non-uniformity	39
6.25	Inhomogeneity equivalent temperature difference (IETD)	40
6.25.1	General	40
6.25.2	Required parameters	40
6.25.3	Examples of indications	40
6.25.4	Test condition, method and procedure for inhomogeneity equivalent temperature difference	40
6.26	Operating temperature range and air humidity range	41
6.26.1	General	41
6.26.2	Example of indication	41
6.26.3	Test condition, method and procedure for operating temperature range and air humidity range	41
6.27	Size-of-source effect (SSE)	41
6.27.1	General	41
6.27.2	Required parameters	41
6.27.3	Examples of indications	42
6.27.4	Test condition, method and procedure for size-of-source effect	42
Annex A (informative)	Change in the indicated temperature caused by a 1 % change in the radiative interchange	43
Bibliography		44
Figure 1	– Schematic measuring setup	15
Figure 2	– Slit response function	21
Figure 3	– Minimum size of a measuring spot for temperature measurement	22
Figure 4	– Synchronous signal acquisition for a quantum detector	31
Figure 5	– Asynchronous signal acquisition for a quantum detector	32
Figure 6	– Asynchronous signal acquisition for a thermal detector (best case)	33
Figure 7	– Asynchronous signal acquisition for a thermal detector (worst case)	34
Figure 8	– Example of the measurement of the warm-up time	38

Table 1 – Symbols	14
Table A.1 – Change in the indicated temperature.....	43

This document is a preview generated by EVS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**INDUSTRIAL PROCESS CONTROL DEVICES –
THERMOGRAPHIC CAMERAS –****Part 1: Metrological characterization****FOREWORD**

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a Technical Specification when

- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical Specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 63144-1, which is a Technical Specification, has been prepared by subcommittee 65B: Measurement and control devices, of IEC technical committee 65: Industrial-process measurement, control and automation.

The text of this Technical Specification is based on the following documents:

Draft TS	Report on voting
65B/1129/DTS	65B/1159/RVDTS

Full information on the voting for the approval of this Technical Specification can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 63144 series, published under the general title *Industrial process control devices – Thermographic cameras*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

Thermographic cameras (also called "thermographic imagers" or "infrared cameras") are being increasingly used for spatially and temporally resolved, non-contact radiation temperature measurement. Tracing the temperature values indicated by these instruments to the International Temperature Scale (ITS-90) is gaining in importance for the comparability of measurements. The precondition for their calibration and metrological application with low uncertainties is to accurately describe and determine the essential metrological data of thermographic cameras. Whereas there are international regulations to determine the technical specifications for radiation thermometers – namely IEC TS 62492-1 and IEC TS 62492-2 – there is a lack of such regulations for thermographic cameras in such a detailed form.

This document is Part 1 of a series of technical specifications for thermographic cameras. It is intended to improve comparability and testability of the essential metrological technical data of thermographic cameras. To this end, unambiguous procedures are laid down for the indication and the determination of this technical data. Future IEC TS 63144-2 is intended to specifically address the absolute calibration procedures and the corresponding uncertainties for thermographic cameras in more depth and detail.

INDUSTRIAL PROCESS CONTROL DEVICES – THERMOGRAPHIC CAMERAS –

Part 1: Metrological characterization

1 Scope

This part of IEC 63144 applies, in the field of metrology, to the statement and testing of technical data in datasheets and instruction manuals for thermographic cameras that are used to measure the temperature of surfaces. This includes, unless otherwise stated, both two-dimensional and one-dimensional (line cameras or line scanners) temperature measuring instruments, independently of the scanning principle (fixed multi-element detector or scanning camera system).

This document describes standard test methods to determine relevant metrological data of thermographic cameras. Manufacturers and sellers can choose relevant data and can state that the data shall be compliant with this Technical Specification.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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>

NOTE The term “uncertainty” used in this document is precisely derived from the above databases and more specifically from ISO/IEC Guide 98-3:2008 [3].

3.1

blackbody radiator

radiator that emits radiation in a very good approximation of Planck's radiation law

Note 1 to entry: A blackbody radiator is a source of thermal radiation with an effective emissivity close to 1.

3.2

coverage factor

numerical factor used as a multiplier of the combined standard uncertainty in order to obtain an expanded uncertainty

Note 1 to entry: Coverage factor, k , is a number larger than one and, typically, in the range from 2 to 3.

3.3

detector format used

number of detector elements (detector pixels) that have actually been used to record the image

Note 1 to entry: The term “pixel”, which is frequently used, will not be used in this document since it can refer both to the detector (detector element) and to the image (image element).