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Calibration Specification for Thermal Imagers

热像仪校准规范

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1 Scope

This Specification is applicable to the calibration of thermal imagers with temperature measurement function in the range of -20°C ~ 2000°C.

2 Normative References

This Specification quoted the following references:

JJF 1001-1998 General Terms in Metrology and Their Definitions

JJG 1007-2007 Temperature Metrological Terms and Their Definitions

GB/T 19870-2005 Industrial Inspecting Thermal Imagers

JJF 1059-1999 Evaluation and Expression of Uncertainty in Measurement

When using this Specification, pay attention to adopting the current effective editions of the above normative references.

3 Terms and Metrological Unit

3.1 Terms

3.1.1 The terms and definitions given in GB/T 19870-2005 *Industrial Inspecting Thermal Imagers* are applicable to this Specification.

3.1.2 Error of indication

The error of indication for the thermal imager refers to the difference between the temperature indication of the thermal imager and the agreed true value of the measured blackbody radiation source temperature.

3.2 Metrological unit

The temperature unit is Celsius (°C) or Kelvin (K).

The temperature of the blackbody radiation source is usually measured by a contact thermometer or a radiation thermometer, such as a platinum resistance thermometer or a thermocouple (with corresponding electrical measuring equipment).

6.2.3 The external display displaying the measurement results of the thermal imager shall meet the requirements for the measurement signal output index of the calibrated thermal imager (for example, the external display required by the calibrated thermal imager).

6.2.4 Instrument holder required for thermal imager calibration.

7 Calibration Items and Methods

7.1 Calibration items

7.1.1 Appearance

The thermal imager's housing, mechanical adjustment parts, exposed optical components, keys, electrical connections, etc. shall not have defects that affect the measurement function of the thermal imager.

The camera shall be marked with the manufacturer (or trademark), model, and number, etc.

7.1.2 Display

There shall be no defects in the display effect of the thermal imager that affect normal use.

7.1.3 Error of indication

Calibrate the error of indication for the thermal imager under laboratory environmental conditions.

7.1.4 Temperature measurement consistency

The thermal imager shall be tested for temperature measurement consistency under laboratory environmental temperature and humidity conditions.

7.2 Calibration methods

7.2.1 Appearance

Take manual and visual inspection, the appearance of the calibrated thermal imager must meet the requirements of 7.1.1.

7.2.2 Display

Take manual and visual inspection, the display device of the calibrated thermal imager must meet the requirements of 7.1.2.

7.2.3 Error of indication

7.2.3.1 Selection of calibration temperature point.

The selection of the calibration temperature point is the upper and lower limits of the range and the middle value of the range. For thermal imager with multiple ranges, in the temperature range where the ranges overlap, different ranges shall be chosen to calibrate. At the same time, the calibration temperature can be set according to user requirements.

7.2.3.2 Clean the exposed optical components of the thermal imager according to the instructions of the it.

7.2.3.3 Install optical elements such as additional optical lenses or attenuators according to user requirements.

7.2.3.4 Determine the measurement distance according to the requirements of the user or the focusing range of the thermal imager, the optical resolution and the target diameter of the blackbody radiation source. Adjust the position of the thermal imager, make the thermal imager aim at the target center of the blackbody radiation source in the axial direction of the blackbody radiation source, and make the measured object clearly imaged.

7.2.3.5 According to the instruction manual of the thermal imager, turn on the thermal imager for a certain period of time before measurement (if required by the calibrated thermal imager).

7.2.3.6 According to the instruction manual of the thermal imager, enter the range and calibration condition data, such as the ambient temperature, ambient humidity, and measurement distance parameters. During calibration, the emissivity parameter of the calibrated thermal imager is set to be 1 or equal to the emissivity of the blackbody radiation source.

7.2.3.7 Before performing the calibration on the error of indication, other operations that have an impact on the measurement results, such as clearing, etc. (if required by the calibrated thermal imager) shall be completed, as required by the instruction manual of the thermal imager.

7.2.3.8 Refer to the instruction manual and place the calibrated thermal imager in the point temperature measurement mode to measure the target center temperature of the blackbody radiation source. Make no less than 4 measurements at each calibration temperature point. During the measurement, record the measured value, $t_{BBi,j}$, of the reference standard of the blackbody radiation source, indication, $t_{i,j}$, of the calibrated

format of calibration certificate.

In addition to the above calibration result information, the calibration certificate or report for calibration results shall also include (but not limited to) the following information:

a) A title, such as "calibration certificate" or "calibration report";

b) Laboratory name and address;

c) Where calibration is performed (if calibration is not performed in a laboratory);

d) The unique identification of the certificate or report (such as the certificate number), the identification of the page number and the total number of pages;

e) The name and address of the calibration-sending organization;

f) The description and clear identification of the calibrated object;

g) The date of the calibration, if it is related to the validity and application of the calibration results, the date of receipt of the calibrated object shall be stated;

h) The sampling procedures shall be explained if they are relevant to the validity and application of the calibration results;

i) Identification of the technical specifications on which the calibration is based, including name and code;

j) A traceability and validity statement of the measurement standards used in this calibration;

k) A description of the calibration environment;

l) Description of the uncertainty for calibration results and their measurement;

m) The signature, title or equivalent identification of the person who issued the calibration certificate or report, and the date of issuing;

n) A statement that the calibration result is valid only for the calibrated object;

o) Statements of calibration certificates or reports may not be reproduced in part without written approval from the laboratory.

9 Recalibration Time-Interval

The time interval for recalibration is determined by the user according to the use situation, and it is recommended to be 1 year. It shall be shortened appropriately when it is used frequently.

At 100°C, the emissivity of the blackbody radiation source is 0.9985 ± 0.0015, take 0.9985 as the reference value, correct the indication of calibrated thermal imager affected by the deviation from 1 of the radiation source emissivity; the radiation temperature uncertainty of the blackbody source radiation caused by uncertainty of 0.0015 of the blackbody source emissivity is 0.1°C, which is evaluated as uniform distribution. The standard uncertainty component caused by the emissivity correction of the blackbody radiation source u_2=0.06°C.

③ Standard uncertainty component, u_3, introduced by reference standard passing

According to the verification certificate, the standard uncertainty component introduced by precision platinum resistance thermometer u_3 = 0.04°C.

④ Standard uncertainty component, u_4, introduced by electrical measurement equipment

Use the digital multimeter, standard resistance and low pyroelectric four-wire transfer switch to measure the resistance of standard thermometer. Take Keithley 2000 as an example, the standard uncertainty component introduced by the electrical measurement equipment u_4 = 0.02°C.

⑤ Uncertainty component, u_5, caused by the temperature difference between the target surface temperature of the radiation source and the measurement point of the standard instrument

The temperature difference between the target surface temperature of the radiation source and the measurement point of the standard instrument is determined by the characteristics of the temperature field of the radiation source. The maximum temperature difference between the target surface temperature of the radiation source and the measurement point of the standard instrument is 0.05°C. Considering the uniform distribution, its standard uncertainty component u_5 = $0.05/\sqrt{3}=0.03$℃.

Then standard uncertainty, u(t_{BBi}), of the input quantity of t_{BBi} is as follows:

$$u(t_{BBi}) = \sqrt{0.06^2 + 0.06^2 + 0.04^2 + 0.02^2 + 0.03^2} = 0.15℃ \qquad (A.3)$$

A.2.1.2 Evaluation of the standard uncertainty, u(t_i), of the input quantity of t_i

① Standard uncertainty component, u_6, introduced by thermal imager measurement repeatability

The maximum difference among the four measurements of the thermal imager repeatability experiment is 1.0°C; and the standard deviation of the average value is u_6=(1.0/C/$\sqrt{4}$°C), where the number of measurements is 4, the range coefficient C = 2.06.

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