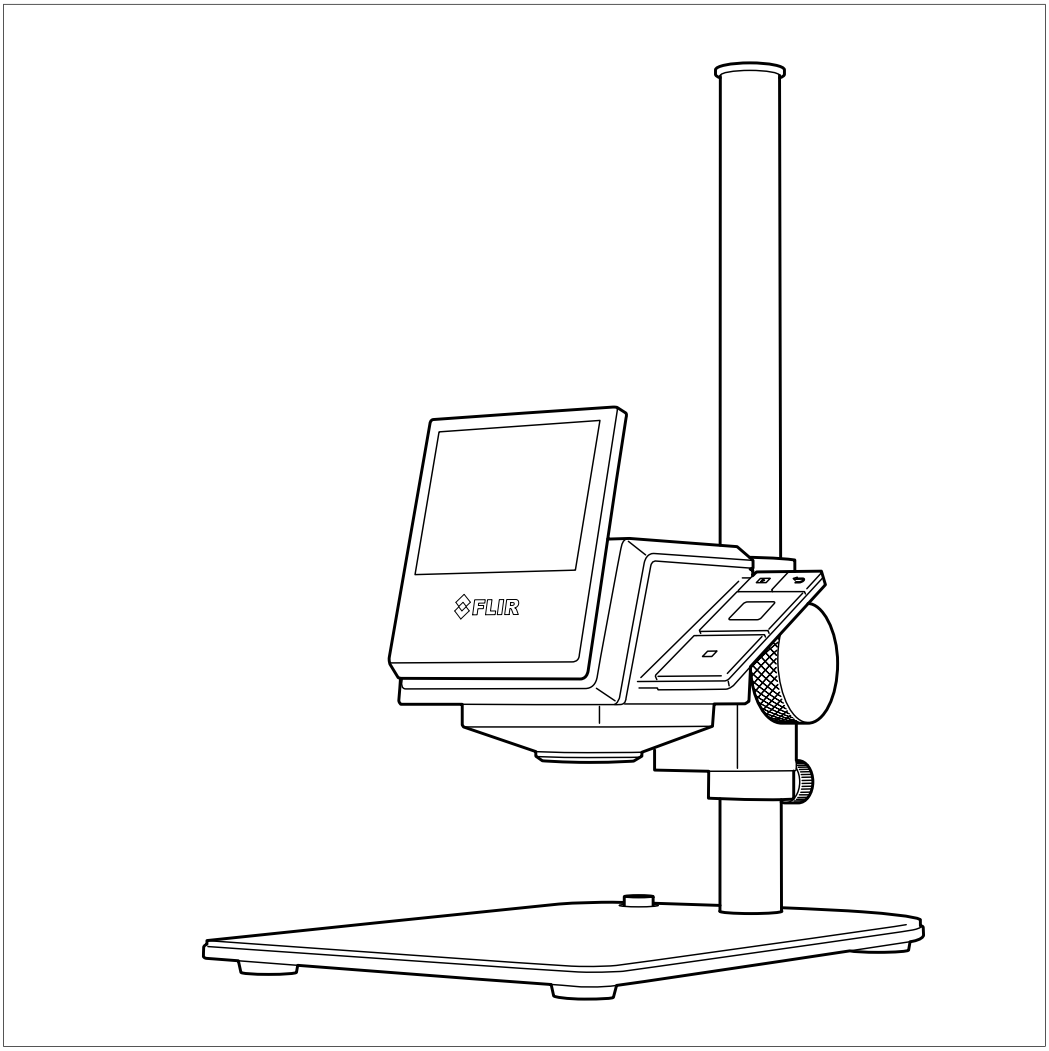
User's manual
FLIR ETS3xx series



Important note
Before operating the device, you must read, understand, and follow all instructions, warnings, cautions, and legal disclaimers.

Důležitá poznámka
Před použitím zařízení si přečtěte veškeré pokyny, upozornění, varování a vyvázání se ze záruky, ujistěte se, že jim rozumíte, a řiďte se jimi.

Vigtig meddelelse
Før du betjener enheden, skal du du læse, forstå og følge alle anvisninger, advarsler, sikkerhedsforanstaltninger og ansvarsfraskrivelser.

Wichtiger Hinweis
Bevor Sie das Gerät in Betrieb nehmen, lesen, verstehen und befolgen Sie unbedingt alle Anweisungen, Warnungen, Vorsichtshinweise und Haftungsausschlüsse

Σημαντική σημείωση
Πριν από τη λειτουργία της συσκευής, πρέπει να διαβάσετε, να κατανοήσετε και να ακολουθήσετε όλες τις οδηγίες, προειδοποιήσεις, προφυλάξεις και νομικές αποποιήσεις.

Nota importante
Antes de usar el dispositivo, debe leer, comprender y seguir toda la información sobre instrucciones, advertencias, precauciones y renuncias de responsabilidad.

Tärkeä huomautus
Ennen laitteen käyttämistä on luettava ja ymmärrettävä kaikki ohjeet, vakavat varoitukset, varoitukset ja lakitiedotteet sekä noudatettava niitä.

Remarque importante
Avant d'utiliser l'appareil, vous devez lire, comprendre et suivre l'ensemble des instructions, avertissements, mises en garde et clauses légales de non-responsabilité.

Fontos megjegyzés
Az eszköz használata előtt figyelmesen olvassa el és tartsa be az összes utasítást, figyelmeztetést, óvintézkedést és jogi nyilatkozatot.

Nota importante
Prima di utilizzare il dispositivo, è importante leggere, capire e seguire tutte le istruzioni, avvertenze, precauzioni ed esclusioni di responsabilità legali.

重要な注意
デバイスをご使用になる前に、あらゆる指示、警告、注意事項、および免責条項をお読み頂き、その内容を理解して従ってください。

중요한 참고 사항
장치를 작동하기 전에 반드시 다음의 사용 설명서와 경고, 주의사항, 법적 책임제한을 읽고 이해하며 따라야 합니다.

Viktig
Før du bruker enheten, må du lese, forstå og følge instruksjoner, advarsler og informasjon om ansvarsfraskrivelse.

Belangrijke opmerking
Zorg ervoor dat u, voordat u het apparaat gaat gebruiken, alle instructies, waarschuwingen en juridische informatie hebt doorgelezen en begrepen, en dat u deze opvolgt en in acht neemt.

Ważna uwaga
Przed rozpoczęciem korzystania z urządzenia należy koniecznie zapoznać się z wszystkimi instrukcjami, ostrzeżeniami, przestrogami i uwagami prawnymi. Należy zawsze postępować zgodnie z zaleceniami tam zawartymi.

Nota importante
Antes de utilizar o dispositivo, deverá proceder à leitura e compreensão de todos os avisos, precauções, instruções e isenções de responsabilidade legal e assegurar-se do seu cumprimento.

Важное примечание
До того, как пользоваться устройством, вам необходимо прочитать и понять все предупреждения, предостережения и юридические ограничения ответственности и следовать им.

Viktig information
Innan du använder enheten måste du läsa, förstå och följa alla anvisningar, varningar, försiktighetsåtgärder och ansvarsfriskrivningar.

Önemli not
Cihazı çalıştırmadan önce tüm talimatları, uyarıları, ikazları ve yasal açıklamaları okumalı, anlamalı ve bunlara uymalısınız.

重要注意事项
在操作设备之前，您必须阅读、理解并遵循所有说明、警告、注意事项和法律免责声明。

重要注意事項
操作裝置之前，您務必閱讀、了解並遵循所有說明、警告、注意事項與法律免責聲明。

Table of contents

1 Disclaimers

1.1 Legal disclaimer

For warranty terms, refer to https://www.flir.com/warranty.

1.2 U.S. Government Regulations

This product may be subject to U.S. Export Regulations. Send any inquiries to exportquestions@flir.com.

1.3 Patents

This product is protected by patents, design patents, patents pending, or design patents pending. Refer to the FLIR Systems' patent registry:

https://www.flir.com/patentnotices

1.4 Quality assurance

The Quality Management System under which these products are developed and manufactured has been certified in accordance with the ISO 9001 standard.

FLIR Systems is committed to a policy of continuous development; therefore we reserve the right to make changes and improvements on any of the products without prior notice.

1.5 Usage statistics

FLIR Systems reserves the right to gather anonymous usage statistics to help maintain and improve the quality of our software and services.

1.6 Copyright

1.7 EULA Terms

Qt4 Core and Qt4 GUI, Copyright ©2013 Nokia Corporation and FLIR Systems AB. This Qt library is a free software; you can redistribute it and/or modify it under the terms of the GNU Lesser General Public License as published by the Free Software Foundation; either version 2.1 of the License, or (at your option) any later version. This library is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU Lesser General Public License, http://www.gnu.org/licenses/lgpl-2.1.html. The source code for the libraries Qt4 Core and Qt4 GUI may be requested from FLIR Systems AB.

1.8 EULA Terms

- You have acquired a device ("INFRARED CAMERA") that includes software licensed by FLIR Systems AB from Microsoft Licensing, GP or its affiliates ("MS"). Those installed software products of MS origin, as well as associated media, printed materials, and "online" or electronic documentation ("SOFTWARE") are protected by international intellectual property laws and treaties. The SOFTWARE is licensed, not sold. All rights reserved.
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  - **Limitations on Reverse Engineering, Decompilation, and Disassembly.** You may not reverse engineer, decompile, or disassemble the SOFTWARE, except and only to the extent that such activity is expressly permitted by applicable law notwithstanding this limitation.
  - **SOFTWARE TRANSFER ALLOWED BUT WITH RESTRICTIONS.** You may permanently transfer rights under this EULA only as part of a permanent sale or transfer of the Device, and only if the recipient agrees to this EULA. If the SOFTWARE is an upgrade, any transfer must also include all prior versions of the SOFTWARE.
  - **EXPORT RESTRICTIONS.** You acknowledge that SOFTWARE is subject to U.S. export jurisdiction. You agree to comply with all applicable international and national laws that apply to the SOFTWARE, including the U.S. Export Administration Regulations, as well as end-user, end-use and destination restrictions issued by U.S. and other governments. For additional information see http://www.microsoft.com/exporting/.

2 Safety information

WARNING

Applicability: Class B digital devices.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

WARNING

Applicability: Digital devices subject to 15.19/RSS-210.

NOTICE: This device complies with Part 15 of the FCC Rules and with RSS-210 of Industry Canada. Operation is subject to the following two conditions:

1. this device may not cause harmful interference, and
2. this device must accept any interference received, including interference that may cause undesired operation.

WARNING

Applicability: Digital devices subject to 15.21.

NOTICE: Changes or modifications made to this equipment not expressly approved by FLIR Systems may void the FCC authorization to operate this equipment.

WARNING

Applicability: Digital devices subject to 2.1091/2.1093/KDB 447498/RSS-102.

Radiofrequency radiation exposure Information: The radiated output power of the device is far below the FCC radio frequency exposure limits. Nevertheless, the device should be used in such a manner that the potential for human contact during normal operation is minimized.

WARNING

Applicability: Cameras with one or more batteries.

Do not continue to charge the battery if it does not become charged in the specified charging time. If you continue to charge the battery, it can become hot and cause an explosion or ignition. Injury to persons can occur.

WARNING

Applicability: Cameras with one or more batteries.

Only use the correct equipment to remove the electrical power from the battery. If you do not use the correct equipment, you can decrease the performance or the life cycle of the battery. If you do not use the correct equipment, an incorrect flow of current to the battery can occur. This can cause the battery to become hot, or cause an explosion. Injury to persons can occur.

WARNING

Make sure that you read all applicable MSDS (Material Safety Data Sheets) and warning labels on containers before you use a liquid. The liquids can be dangerous. Injury to persons can occur.

CAUTION

Do not point the infrared camera (with or without the lens cover) at strong energy sources, for example, devices that cause laser radiation, or the sun. This can have an unwanted effect on the accuracy of the camera. It can also cause damage to the detector in the camera.

CAUTION

Do not use the camera in temperatures more than 50°C (122°F), unless other information is specified in the user documentation or technical data. High temperatures can cause damage to the camera.

CAUTION

Do not attach the camera unit directly to a car's cigarette lighter socket, unless FLIR Systems supplies a specific adapter to connect the camera unit to a cigarette lighter socket. Damage to the camera unit can occur.

CAUTION

Applicability: Cameras with one or more batteries.

Only use a specified battery charger when you charge the battery. Damage to the battery can occur if you do not do this.

CAUTION

Applicability: Cameras with one or more batteries.

The temperature range through which you can charge the battery is ±0°C to +45°C (+32°F to +113°F), except for the Korean market where the approved range is +10°C to + 45°C (+50°F to +113°F). If you charge the battery at temperatures out of this range, it can cause the battery to become hot or to break. It can also decrease the performance or the life cycle of the battery.

CAUTION

Applicability: Cameras with one or more batteries.

The temperature range through which you can remove the electrical power from the battery is +10°C to +40°C (+50°F to +104°F), unless other information is specified in the user documentation or technical data. If you operate the battery out of this temperature range, it can decrease the performance or the life cycle of the battery.

CAUTION

Do not apply solvents or equivalent liquids to the camera, the cables, or other items. Damage to the battery and injury to persons can occur.

CAUTION

Be careful when you clean the infrared lens. The lens has an anti-reflective coating which is easily damaged. Damage to the infrared lens can occur.

CAUTION

Do not use too much force to clean the infrared lens. This can cause damage to the anti-reflective coating.

Note The encapsulation rating is only applicable when all the openings on the camera are sealed with their correct covers, hatches, or caps. This includes the compartments for data storage, batteries, and connectors.

3 Notice to user

3.1 Calibration

We recommend that you send in the camera for calibration once a year. Contact your local sales office for instructions on where to send the camera.

3.2 Accuracy

For very accurate results, we recommend that you wait 5 minutes after you have started the camera before measuring a temperature.

3.3 Disposal of electronic waste

Electrical and electronic equipment (EEE) contains materials, components and substances that may be hazardous and present a risk to human health and the environment when waste electrical and electronic equipment (WEEE) is not handled correctly.

Equipment marked with the below crossed-out wheeled bin is electrical and electronic equipment. The crossed-out wheeled bin symbol indicates that waste electrical and electronic equipment should not be discarded together with unseparated household waste, but must be collected separately.

For this purpose all local authorities have established collection schemes under which residents can dispose waste electrical and electronic equipment at a recycling centre or other collection points, or WEEE will be collected directly from households. More detailed information is available from the technical administration of the relevant local authority.

3.4 Training

For training resources and courses, go to https://www.flir.com/support-center/training.

3.5 Documentation updates

Our manuals are updated several times per year, and we also issue product-critical notifications of changes on a regular basis.

To access the latest manuals, translations of manuals, and notifications, go to the Download tab at:

http://support.flir.com

In the download area you will also find the latest releases of manuals for our other products, as well as manuals for our historical and obsolete products.

3.6 Important note about this manual

FLIR Systems issues generic manuals that cover several cameras within a model line.

This means that this manual may contain descriptions and explanations that do not apply to your particular camera model.

3.7 Note about authoritative versions

The authoritative version of this publication is English. In the event of divergences due to translation errors, the English text has precedence. Any late changes are first implemented in English.

4 Customer help

4.1 General

Do not hesitate to contact our Customer Support Center if you experience problems or have any questions.

For customer help, go to http://support.flir.com.

4.2 Submitting a question

To submit a question to the customer help team, you must be a registered user. It only takes a few minutes to register online. If you only want to search the knowledgebase for existing questions and answers, you do not need to be a registered user.

When you want to submit a question, make sure that you have the following information to hand:

- The camera model.
- The camera serial number.
- The communication protocol, or method, between the camera and your device (e.g., SD card reader, HDMI, Ethernet, USB, or FireWire).
- Device type (PC/Mac/iPhone/iPad/Android device, etc.).
- Version of any programs from FLIR Systems.
- Full name, publication number, and revision number of the manual.

4.3 Downloads

On the customer help site you can also download the following, when applicable for the product:

- Firmware updates for your infrared camera.
- Program updates for your PC/Mac software.
- Freeware and evaluation versions of PC/Mac software.
- User documentation for current, obsolete, and historical products.
- Mechanical drawings (in *.dxf and *.pdf format).
- CAD data models (in *.stp format).
- Application examples.
- Technical datasheets.

5 Introduction

5.1 General description

The FLIR ETS3xx is FLIR's first electronic test bench camera, designed for a quick temperature check of PCB boards and electronic devices. The FLIR ETS3xx is sensitive enough to detect subtle temperature difference with an accuracy of ±3°C (±5.4°F), so you can quickly find hot spots and potential points of failure. The 320 × 240 pixel infrared detector offers more than 76 000 points of temperature measurement, eliminating the guesswork of legacy measurement tools. Designed specifically for bench-top work, the battery-powered FLIR ETS3xx connects to your PC for immediate analysis and sharing of thermal data.

5.2 Benefits

- Reduces test times: Quickly identify hot spots, thermal gradients, and potential points of failure.
- Improves product design: Know where and when to add fans and heatsinks, and ensure products are operating within specification for their maximum lifetime.
- Saves money: Improve rapid prototyping and reduce product development cycles.
- Optimizes lab time: Battery powered and hands-free, and offers complete measurement and analysis in the camera.

5.3 Key features

- >76 000 points of non-contact temperature measurement at the push of a button.
- 320 × 240 pixel detector provides crisp thermal imagery.
- Time versus temperature measurement with FLIR Thermal Studio.
- Small-component measurement, down to 170 µm per pixel spot size.
- Lens offers a 45° thermal view of the target for the quick detection of hot spots.
- Records radiometric imagery in standard JPEG format for easy sharing.
- ±3% accuracy promotes quality assurance and factory acceptance of PCBs.
- Quickly mounts on the supplied stand for immediate use.
- Crisp 3 in. LCD display provides immediate thermal feedback.
- World-class software provided for advanced measurement corrections/capabilities.

6 Quick start guide

6.1 Procedure

Follow this procedure:

1. Charge the battery. You can do this in different ways:
   - Charge the battery using the FLIR power supply.
   - Charge the battery using a USB cable connected to a computer.

     Note Charging the camera using a USB cable connected to a computer takes *considerably* longer than using the FLIR power supply or the FLIR stand-alone battery charger.
2. Connect a ground cord to the ground stud on the ESD mat of the camera stand.
3. Push the On/off button to turn on the camera.
4. Adjust the position of the camera unit.
5. Push the Save button to save an image.

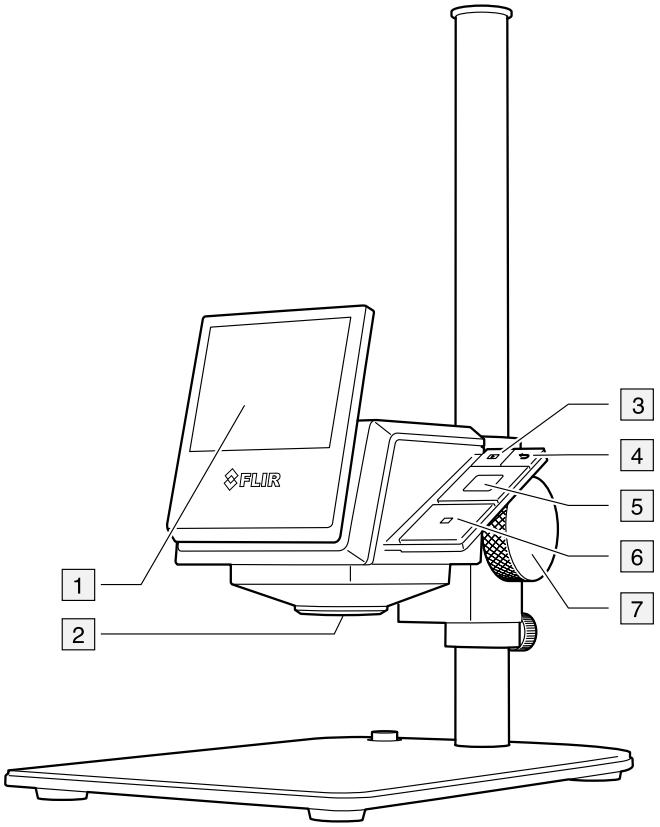
(Optional steps)

6. Go to the following website to download FLIR Thermal Studio[1]
   http://support.flir.com/thermalstudio
7. Install FLIR Thermal Studio on your computer.
8. Start FLIR Thermal Studio.
9. Connect the camera to your computer, using the USB cable.
10. Import the images into FLIR Thermal Studio.

1. For online documentation about FLIR Thermal Studio, go to http://support.flir.com/resources/5sfn/.

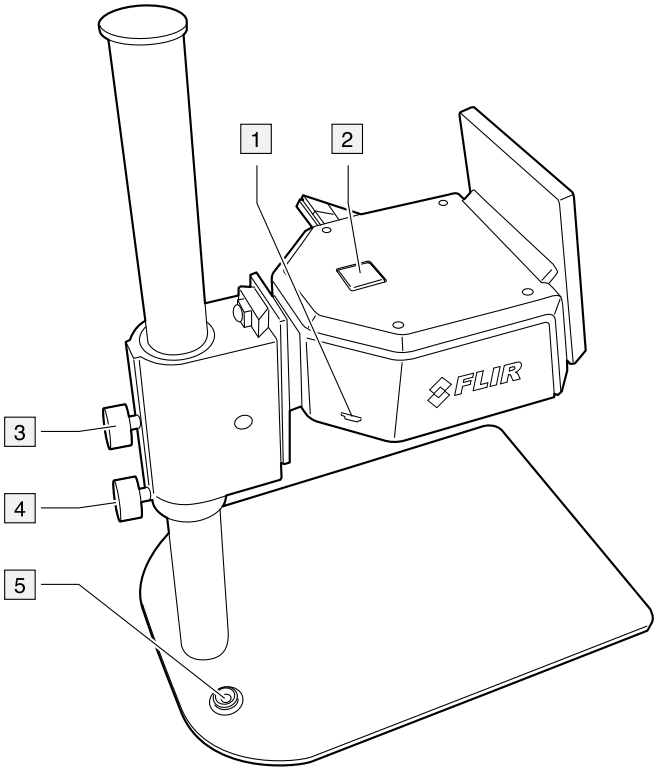
7 Description

7.1 View from the front



1. LCD display.
2. Infrared camera lens.
3. Archive button.
   - Push to open the image archive.
4. Back/Cancel button.
   - Push to go back into the menu system.
   - Push to cancel a choice.
5. Navigation pad.
   - Push left/right or up/down to navigate in menus, submenus, and dialog boxes.
   - Push the center to confirm.
6. Save button.
   - Push to save an image.
7. Fine-adjustment knob.

7.2 View from the rear



1. USB connector.
2. On/off button.
   - Push the On/off button to turn on the camera.
   - Push and hold the On/off button for less than 5 seconds to put the camera into standby mode. The camera then automatically turns off after 48 hours.
   - Push and hold the On/off button for more than 10 seconds to turn off the camera.
3. Stand mount knob.
4. Supporting ring knob.
5. Ground stud.

7.3 USB connector

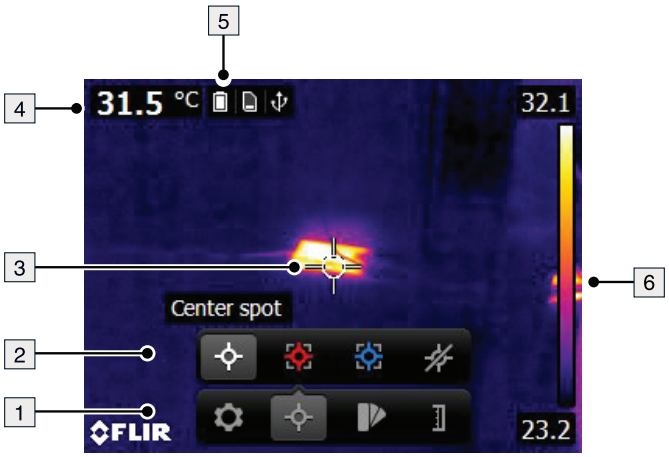
The purpose of this USB connector is the following:

- Charging the battery using the FLIR power supply.
- Charging the battery using a USB cable connected to a computer.

  Note Charging the camera using a USB cable connected to a computer takes *considerably* longer than using the FLIR power supply.
- Moving images from the camera to a computer for further analysis in FLIR Thermal Studio.

  Note Install FLIR Thermal Studio on your computer before you move the images.

7.4 Screen elements



1. Main menu toolbar.
2. Submenu toolbar.
3. Spotmeter.
4. Result table.
5. Status icons.
6. Temperature scale.

8 Handling the camera unit

8.1 Charging the battery

⚠ WARNING
Make sure that you install the socket-outlet near the equipment and that it is easy to get access to.

8.1.1 Charging the battery using the FLIR power supply

Follow this procedure:

1. Connect the power supply to a mains socket.
2. Connect the power supply cable to the USB connector on the camera unit.
3. It is good practice to disconnect the power supply from the mains socket when the battery is fully charged.

Note The charging time for a fully depleted battery is 2 hours.

8.1.2 Charging the battery using a USB cable connected to a computer

Follow this procedure:

1. Connect the camera unit to a computer using a USB cable.

Note

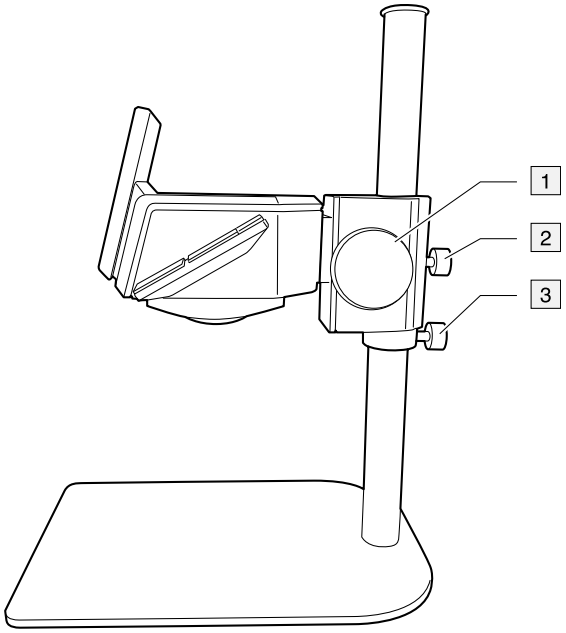
- To charge the camera, the computer must be turned on.
- Charging the camera using a USB cable connected to a computer takes *considerably* longer than using the FLIR power supply.

8.2 Turning on and turning off the camera

- Push the On/off button to turn on the camera.
- Push and hold the On/off button for less than 5 seconds to put the camera in standby mode. The camera then automatically turns off after 48 hours.
- Push and hold the On/off button for more than 10 seconds to turn off the camera.

8.3 Adjusting the position of the camera unit

Note Do not touch the lens surface. If this happens, clean the lens according to the instructions in 13.2 *Infrared lens*, page 32.



1. Fine-adjustment knob.
2. Stand mount knob.
3. Supporting ring knob.

Follow this procedure:

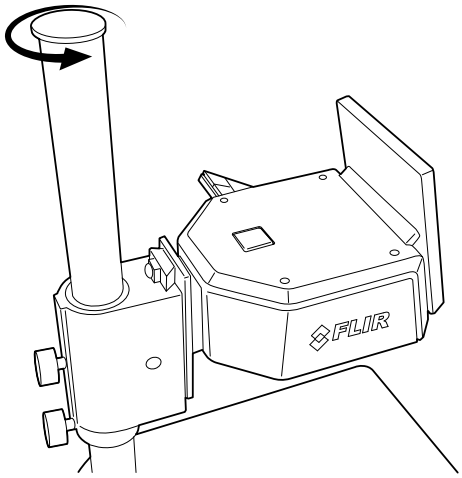
1. For fine adjustments, turn the fine-adjustment knob.
2. For coarse adjustments, do the following:
    2.1. Loosen the stand mount knob and move the stand mount to the desired position. Tighten the stand mount knob.
    2.2. Loosen the supporting ring knob and move the supporting ring near the stand mount. Tighten the supporting ring knob.

8.4 Removing the stand mount from the camera unit

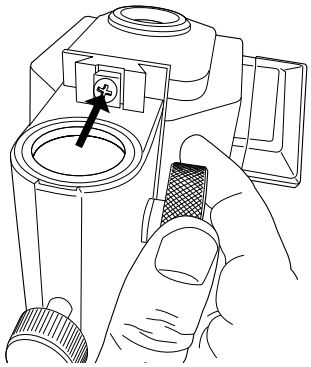
Note Do not touch the lens surface. If this happens, clean the lens according to the instructions in 13.2 *Infrared lens*, page 32.

Follow this procedure:

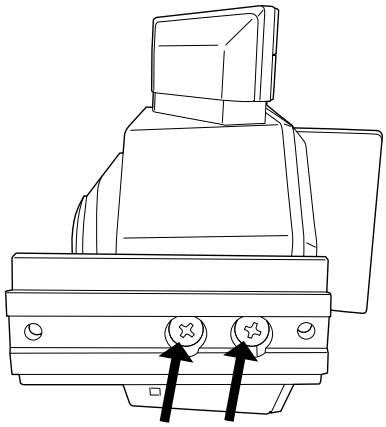
1. Turn and remove the top of the stand.



2. Loosen the stand mount knob and remove the camera unit from the stand.
3. Turn the fine-adjustment knob counter-clockwise until you can see a screw. Remove the screw.



4. Turn the fine-adjustment knob clockwise until you can see a screw on the other side. Remove the screw.
5. Remove the stand mount from the camera unit.
6. Remove the two screws that hold the bracket to the camera unit.



7. Remove the two screws that hold the bracket to the camera unit.
8. Remove the bracket from the camera unit.

9 Operation

9.1 Saving an image

You can save multiple images to the internal camera memory. Approximately 1500 images can be saved to the internal camera memory.

The naming convention for images is *FLIRxxxx.jpg*, where *xxxx* is a unique counter.

Follow this procedure:

1. To save an image, push the Save button.

9.2 Recalling an image

When you save an image, it is stored in the internal camera memory. To display the image again, you can recall it from the internal camera memory.

Follow this procedure:

1. Push the Archive button.
2. Push the navigation pad left/right or up/down to select the image you want to view.
3. Push the center of the navigation pad. This displays the selected image.
4. Do one or more of the following:
   - To view the image in full screen, display image information, or delete the image, push the center of the navigation pad. This displays a toolbar.
   - To view the previous/next image, push the navigation pad left/right.
5. To return to live mode, push the Back button repeatedly or push the Archive button.

9.3 Deleting an image

You can delete one or more images from the internal camera memory.

Follow this procedure:

1. Push the Archive button.
2. Push the navigation pad left/right or up/down to select the image you want to delete.
3. Push the center of the navigation pad. This displays the selected image.
4. Push the center of the navigation pad. This displays a toolbar.
5. On the toolbar, select *Delete*  . This displays a dialog box where you can choose to delete the image or to cancel the delete action.

9.4 Deleting all images

You can delete all images from the internal camera memory.

Follow this procedure:

1. Push the center of the navigation pad. This displays a toolbar.
2. On the toolbar, select *Settings*  . This displays a dialog box.
3. In the dialog box, select *Device settings*. This displays a dialog box.
4. In the dialog box, select *Reset options*. This displays a dialog box.
5. In the dialog box, select *Delete all saved images*. This displays a dialog box where you can choose to permanently delete all the saved images or to cancel the delete action.

9.5 Measuring a temperature using a spotmeter

You can measure a temperature using a spotmeter. This will display the temperature at the position of the spotmeter on the screen.

Follow this procedure:

1. Push the center of the navigation pad. This displays a toolbar.
2. On the toolbar, select *Measurement* . This displays a toolbar.
3. On the toolbar, select *Center spot* .
   The temperature at the position of the spotmeter will now be displayed in the top left corner of the screen.

9.6 Measuring the hottest temperature within an area

You can measure the hottest temperature within an area. This displays a moving spotmeter that indicates the hottest temperature.

Follow this procedure:

1. Push the center of the navigation pad. This displays a toolbar.
2. On the toolbar, select *Measurement* . This displays a toolbar.
3. On the toolbar, select *Hot spot* .

9.7 Measuring the coldest temperature within an area

You can measure the coldest temperature within an area. This displays a moving spotmeter that indicates the coldest temperature.

Follow this procedure:

1. Push the center of the navigation pad. This displays a toolbar.
2. On the toolbar, select *Measurement* . This displays a toolbar.
3. On the toolbar, select *Cold spot* .

9.8 Hiding measurement tools

Follow this procedure:

1. Push the center of the navigation pad. This displays a toolbar.
2. On the toolbar, select *Measurement* . This displays a toolbar.
3. On the toolbar, select *No measurements* .

9.9 Changing the color palette

You can change the color palette that the camera uses to display different temperatures. A different palette can make it easier to analyze an image.

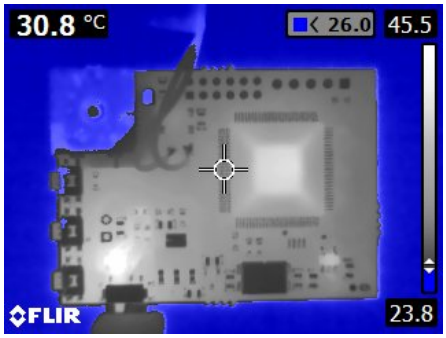
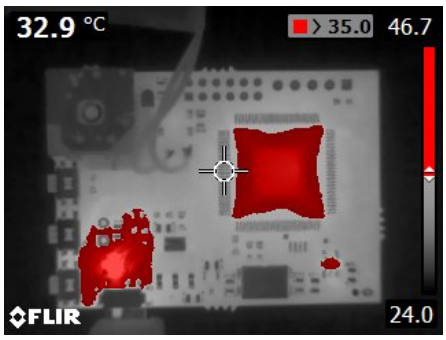
Follow this procedure:

1. Push the center of the navigation pad. This displays a toolbar.
2. On the toolbar, select *Color* . This displays a toolbar.
3. On the toolbar, select a new color palette.

9.10 Working with color alarms

By using color alarms (isotherms), anomalies can easily be discovered in an infrared image. The isotherm command applies a contrasting color to all pixels with a temperature above or below the specified temperature level.

This table explains the different color alarms (isotherms).

Color alarm	Image
Below alarm	
Above alarm	

Follow this procedure:

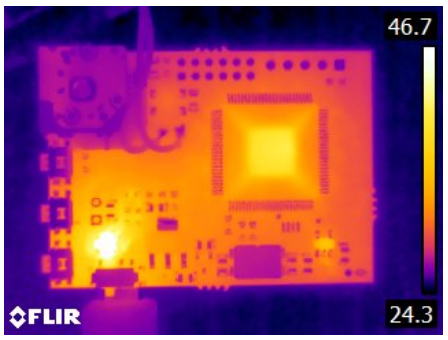
1. Push the center of the navigation pad. This displays a toolbar.
2. On the toolbar, select *Color* . This displays a toolbar.
3. On the toolbar, select the type of alarm:
   - *Below alarm* .
   - *Above alarm* .
4. Push the center of the navigation pad. The threshold temperature is displayed at the top of the screen.
5. To change the threshold temperature, push the navigation pad up/down.

9.11 Changing the temperature scale mode

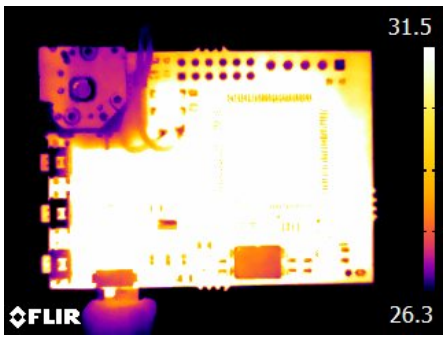
The camera can, depending on the camera model, operate in different temperature scale modes:

- *Auto* mode: In this mode, the camera is continuously auto-adjusted for the best image brightness and contrast.
- *Manual* mode: This mode allows manual adjustments of the temperature span and the temperature level.

Here are two infrared images of a PCB board. To make it easier to analyze the temperature variations in the component in the upper left corner, the temperature scale in the right image has been changed to values close to the temperature of the component.



Automatic



Manual

Follow this procedure:

1. Push the center of the navigation pad. This displays a toolbar.
2. On the toolbar, select *Temperature scale*. This displays a toolbar.
3. On the toolbar, select one of the following:
   - *Auto*.
   - *Manual*.
4. To change the temperature span and the temperature level in *Manual* mode, do the following:
   - Push the navigation pad left/right to select (highlight) the maximum and/or minimum temperature.
   - Push the navigation pad up/down to change the value of the highlighted temperature.

9.12 Setting the emissivity as a surface property

To measure temperatures accurately, the camera must know what kind of surface you are measuring. You can choose between the following surface properties:

- *Matt*.
- *Semi-matt*.
- *Semi-glossy*.

Follow this procedure:

1. Push the center of the navigation pad. This displays a toolbar.
2. On the toolbar, select *Settings*. This displays a dialog box.
3. In the dialog box, select *Measurement parameters*. This displays a dialog box.
4. In the dialog box, select *Emissivity*. This displays a dialog box.
5. In the dialog box, select one of the following:
   - *Matt*.
   - *Semi-matt*.
   - *Semi-glossy*.

For more information about emissivity, see section 14 *Thermographic measurement techniques*, page 33.

9.13 Setting the emissivity as a custom material

Instead of specifying a surface property as matt, semi-matt or semi-glossy, you can specify a custom material from a list of materials.

Follow this procedure:

1. Push the center of the navigation pad. This displays a toolbar.
2. On the toolbar, select *Settings* . This displays a dialog box.
3. In the dialog box, select *Measurement parameters*. This displays a dialog box.
4. In the dialog box, select *Emissivity*. This displays a dialog box.
5. In the dialog box, select *Custom material*. This displays a list of materials with known emissivities.
6. In the list, select the material.

For more information about emissivity, see section 14 *Thermographic measurement techniques*, page 33.

9.14 Changing the emissivity as a custom value

For very precise measurements, you may need to set the emissivity, instead of selecting a surface property or a custom material. You also need to understand how emissivity and reflectivity affect measurements, rather than just simply selecting a surface property.

Emissivity is a property that indicates how much radiation originates from an object as opposed to being reflected by it. A lower value indicates that a larger proportion is being reflected, while a high value indicates that a lower proportion is being reflected.

Polished stainless steel, for example, has an emissivity of 0.14, while a structured PVC floor typically has an emissivity of 0.93.

For more information about emissivity, see section 14 *Thermographic measurement techniques*, page 33.

Follow this procedure:

1. Push the center of the navigation pad. This displays a toolbar.
2. On the toolbar, select *Settings* . This displays a dialog box.
3. In the dialog box, select *Measurement parameters*. This displays a dialog box.
4. In the dialog box, select *Emissivity*. This displays a dialog box.
5. In the dialog box, select *Custom value*. This displays a dialog box where you can set a custom value.

9.15 Changing the reflected apparent temperature

This parameter is used to compensate for the radiation reflected by the object. If the emissivity is low and the object temperature significantly different from that of the reflected temperature, it will be important to set and compensate for the reflected apparent temperature correctly.

Follow this procedure:

1. Push the center of the navigation pad. This displays a toolbar.
2. On the toolbar, select *Settings* . This displays a dialog box.
3. In the dialog box, select *Measurement parameters*. This displays a dialog box.
4. In the dialog box, select *Reflected apparent temperature*. This displays a dialog box where you can set a value.

For more information about reflected apparent temperature, see section 14 *Thermographic measurement techniques*, page 33.

9.16 Performing a non-uniformity correction (NUC)

When the thermal camera displays *Calibrating...* it is performing what in thermography is called a ”non-uniformity correction” (NUC). An NUC is *an image correction carried out by the camera software to compensate for different sensitivities of detector elements and other optical and geometrical disturbances*[2]. For more information, see section 15 *About calibration*, page 38.

An NUC is performed automatically, for example at start-up or when the environment temperature changes.

You can also perform an NUC manually. This is useful when you have to perform a critical measurement with as little image disturbance as possible.

Follow this procedure:

1. To perform a manual NUC, push and hold down the Archive button for more than 2 seconds.

9.17 Changing the settings

You can change a variety of settings for the camera.

The *Settings* menu includes the following:

- *Measurement parameters*.
- *Device settings*.

Follow this procedure:

1. Push the center of the navigation pad. This displays a toolbar.
2. On the toolbar, select *Settings*  . This displays a dialog box.
3. In the dialog box, select the setting that you want to change and use the navigation pad to display additional dialog boxes.

9.17.1 *Measurement parameters*

- *Emissivity*: Default value: 0.95.
- *Reflected temperature*: Default value: 20°C (69°F).
- *Distance*: Default value: 1.0 m (3.3 ft.).

Note During normal operation there is typically no need to change the default measurement parameters. For very accurate measurements, you may need to set the *Emissivity* and/or the *Reflected temperature*. For more information, see sections 9.12 *Setting the emissivity as a surface property*, 9.13 *Setting the emissivity as a custom material*, 9.14 *Changing the emissivity as a custom value*, and 9.15 *Changing the reflected apparent temperature*.

9.17.2 *Device settings*

- *Language, time & units*:
  - *Language*.
  - *Temperature unit*.
  - *Distance unit*.
  - *Date & time*.
  - *Date & time format*.
- *Reset options*:
  - *Reset default camera mode*.

2. Definition from the European standard EN 16714-3:2016, Non-destructive Testing—Thermographic Testing—Part 3: Terms and Definitions.

  - *Reset device settings to factory default*.
  - *Delete all saved images*.
- *Auto power off*.
- *Display intensity.*
- *Camera information*: This menu command displays various items of information about the camera, such as the model, serial number, and software version.

9.18 Updating the camera

To take advantage of our latest camera firmware, it is important that you keep your camera updated. Download firmware updates from our Customer Support Center at http://support.flir.com.

10 Technical data

10.1 Online field-of-view calculator

Please visit http://support.flir.com and click the photo of the camera series for field-of-view tables for all lens–camera combinations.

10.2 Note about technical data

FLIR Systems reserves the right to change specifications at any time without prior notice. Please check http://support.flir.com for latest changes.

10.3 Note about authoritative versions

The authoritative version of this publication is English. In the event of divergences due to translation errors, the English text has precedence. Any late changes are first implemented in English.

10.4 FLIR ETS320

P/N: 63950-1001
Rev.: 84743

General description
The FLIR ETS320 is FLIR's first electronic test bench camera, designed for a quick temperature check of PCB boards and electronic devices. The FLIR ETS320 is sensitive enough to detect subtle temperature difference with an accuracy of ±3°C (5.4°F), so you can quickly find hot spots and potential points of failure. The 320 × 240 pixel infrared detector offers more than 76 000 points of temperature measurement, eliminating the guesswork of legacy measurement tools. Designed specifically for bench-top work, the battery-powered FLIR ETS 320 connects to your PC for immediate analysis and sharing of thermal data.
Benefits: • Reduces test times: Quickly identify hot spots, thermal gradients, and potential points of failure. • Improves product design: Know where and when to add fans and heatsinks, and ensure products are operating within specification for their maximum lifetime. • Saves money: Improve rapid prototyping and reduce product development cycles. • Optimizes lab time: Battery powered and hands-free, and offers complete measurement and analysis in the camera.
Key features: • >76 000 points of non-contact temperature measurement at the push of a button. • 320 × 240 pixel detector provides crisp thermal imagery. • Time versus temperature measurement with FLIR Thermal Studio. • Small-component measurement, down to 170 µm per pixel spot size. • Lens offers a 45° thermal view of the target for the quick detection of hot spots. • Records radiometric imagery in standard JPEG format for easier sharing. • ±3% accuracy promotes quality assurance and factory acceptance of PCBs. • Quickly mounts on the supplied stand for immediate use. • Crisp 3 in. LCD display provides immediate thermal feedback. • World-class software provided for advanced measurement corrections/capabilities.

Imaging and optical data	
IR resolution	320 × 240 pixels
Thermal sensitivity/NETD	<0.06°C (0.11°F)/<60 mK
Field of view (FOV)	45° × 34°
Fixed focus distance	70 mm ± 10 mm (2.8 in. ±0.4 in.)
Spatial resolution (IFOV)	2.6 mrad
F-number	1.5
Image frequency	9 Hz

Detector data	
Detector type	Focal plane array (FPA), uncooled microbolometer
Spectral range	7.5–13 µm

Image presentation	
Display	3.0 in. 320 × 240 color LCD
Image adjustment	Automatic/manual

Measurement	
Object temperature range	–20°C to +250°C (–4°F to +482°F)
Accuracy	±3°C (±5.4°F) or ±3% of reading, whichever greatest, for ambient temperature 10°C (50°F) to 35°C (95°F) and object temperature above +0°C (+32°F)

Measurement analysis	
Spotmeter	Center spot
Area	Box with maximum/minimum
Emissivity correction	Variable from 0.1 to 1.0
Emissivity table	Emissivity table of predefined materials
Reflected apparent temperature correction	Automatic, based on input of reflected temperature

Set-up	
Color palettes	Black and white, iron, and rainbow
Set-up commands	Local adaptation of units, language, date and time formats

Video streaming	
Radiometric IR video streaming	Full dynamic to PC (FLIR Thermal Studio) using USB
Non-radiometric IR video streaming	Uncompressed colorized video using USB

Storage of images	
File formats	Standard JPEG, 14-bit measurement data included

Data communication interfaces	
Interfaces	USB Micro: Data transfer to and from PC and Mac devices

Power system	
Battery type	Rechargeable Li ion battery
Battery voltage	3.7 V
Battery operating time	Approximately 4 hours at 25°C (77°F) ambient temperature and typical use
Charging system	Battery is charged inside the unit
Charging time	2.5 hours to 90% capacity
Power management	Automatic shut-down
AC operation	AC adapter, 90–260 V AC input, 5 V DC output to camera
Battery documents	For documents like MSDS and UN38.3 test reports/summaries, see: https://support.flir.com/resources/msds

Environmental data	
Operating temperature range	10–40°C (50–104°F)
Storage temperature range	–40 to +70°C (–40 to +158°F)
Humidity (operating and storage)	IEC 60068-2-30/24 h 95% relative humidity
Encapsulation	IP 40 (IEC 60529)

Directives and regulations	
Directives and regulations	• Battery Directive 2006/66/EC • EMC Directive 2014/30/EU • FCC 47 CFR Part 15 Class B Subpart B • REACH Regulation EC 1907/2006 • RoHS2 Directive 2011/65/EC • WEEE Directive 2012/19/EC
Declaration of conformity	See: https://support.flir.com/resources/DoC

Physical data	
System weight, incl. battery	1.8 kg (4.0 lb.)
System size (L × W × H)	220 × 150 × 300 mm (8.7 × 5.9 × 11.8 in.)
Color	Black and gray

Shipping information	
Packaging, type	Cardboard box
List of contents	• Infrared camera unit • USB cable • Power supply • FLIR Thermal Studio Standard, 1 Year Subscription • Printed documentation
Packaging, weight	2.9 kg (6.4 lb.)
Packaging, size (L × W × H)	290 × 170 × 378 mm (11.4 × 6.7 × 14.9 in.)
EAN-13	4743254002913
UPC-12	845188014186
Country of origin	Designed & Engineered by FLIR Systems, Sweden. Assembled in Taiwan.

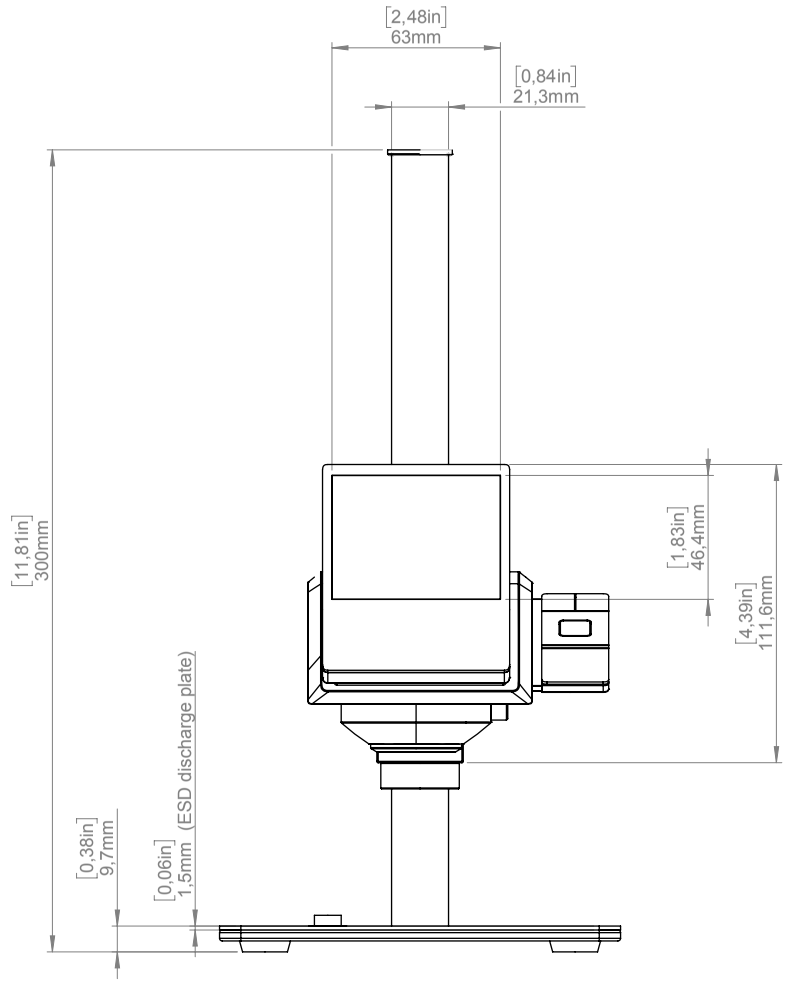
Supplies & accessories:

- T300243; FLIR Thermal Studio Pro, 1 Year Subscription
- T300083; FLIR Thermal Studio Pro, Perpetual license
- T300341; FLIR Thermal Studio Standard, 1 Year Subscription
- T300258; FLIR Thermal Studio Standard, Perpetual license
- 4232535; FLIR Research Studio, Professional Edition - 1 Year Subscription (online activation)
- 4232556; FLIR Research Studio, Professional Edition - Perpetual License (online activation)
- 4232590; FLIR Research Studio, Professional Edition - Perpetual License (USB dongle)
- 4220499; FLIR Research Studio, Standard Edition - 1 Year Subscription (online activation)
- 4220500; FLIR Research Studio, Standard Edition - Perpetual License (online activation)
- 4220646; FLIR Research Studio, Standard Edition - Perpetual License (USB dongle)
- 4232591; FLIR ResearchIR to Research Studio, Professional Edition - 1 Year License Upgrade

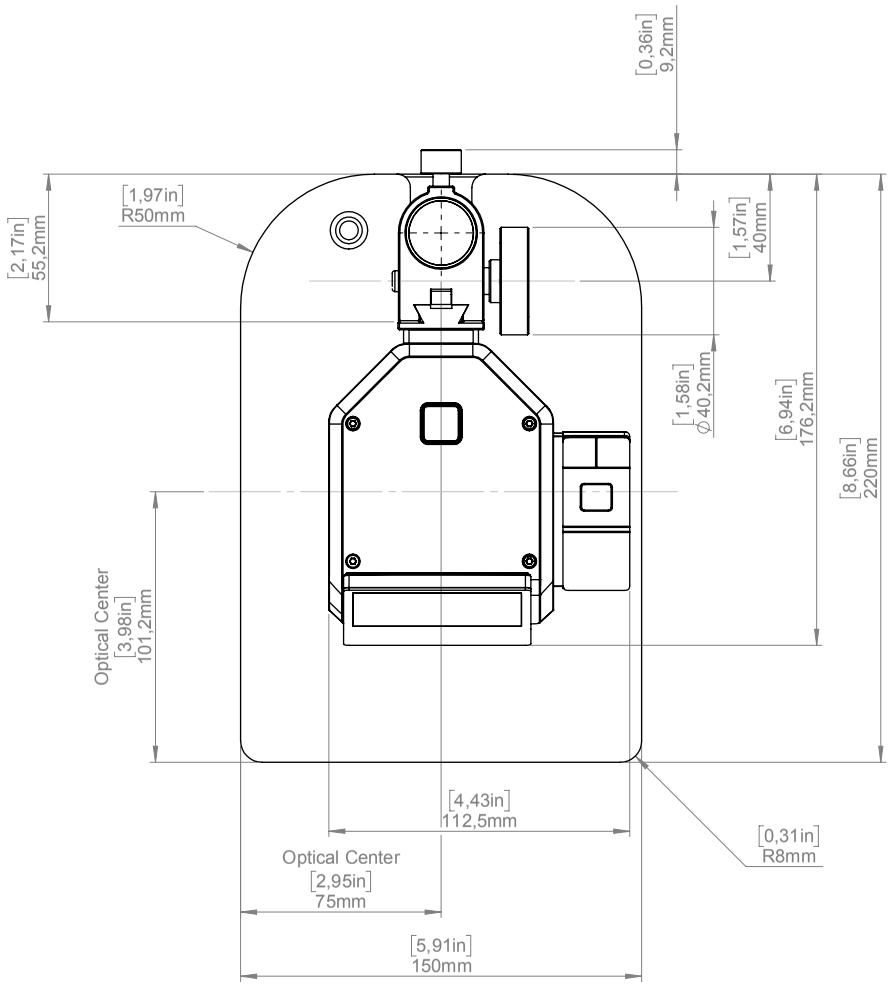
11 Mechanical drawings

[See next page]

Front View



Top View

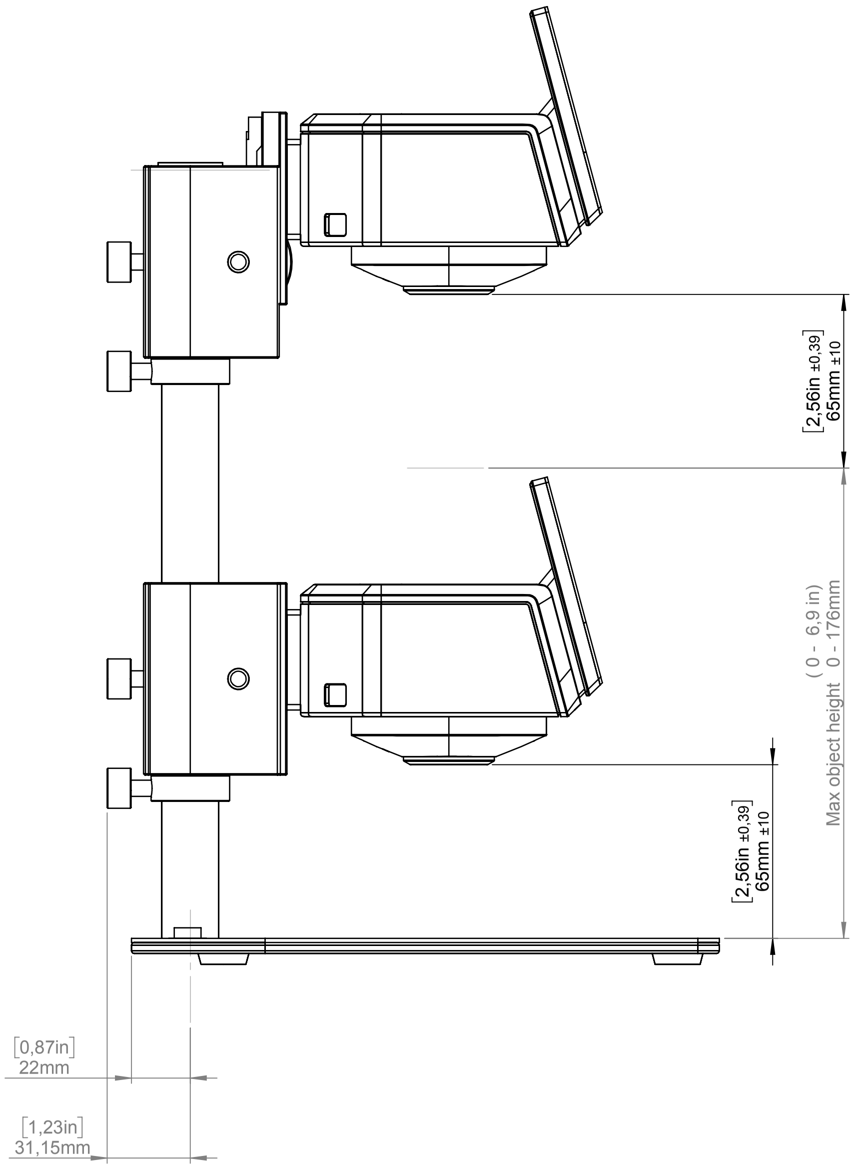


Modified	Check	Drawn by
2017-03-01	TMHA	R&D Instruments

Denomination

Basic Dimension ETS 320

Size	Sheet
A3	1(4)
Scale 1:2	
Drawing No. T130266	Rev A

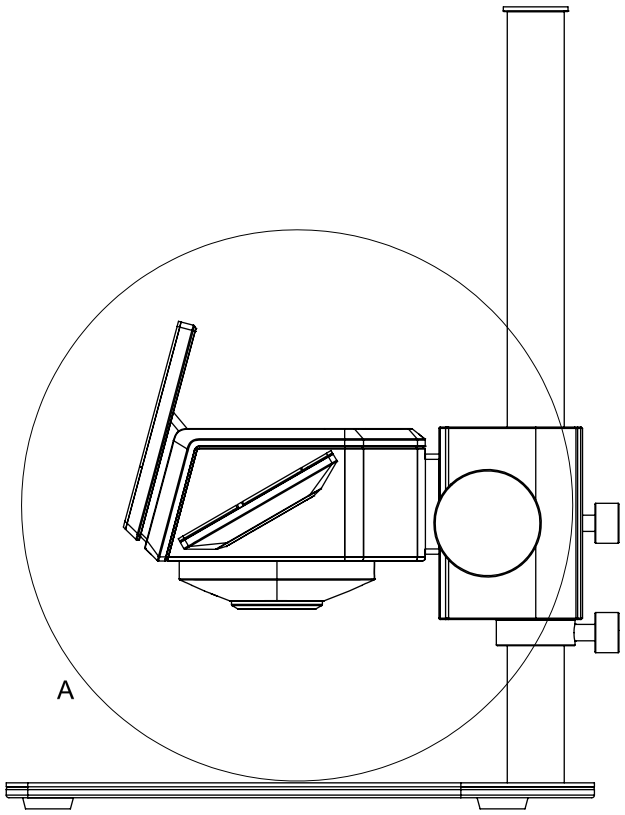


Modified	Check	Drawn by
2017-03-01	TMHA	R&D Instruments

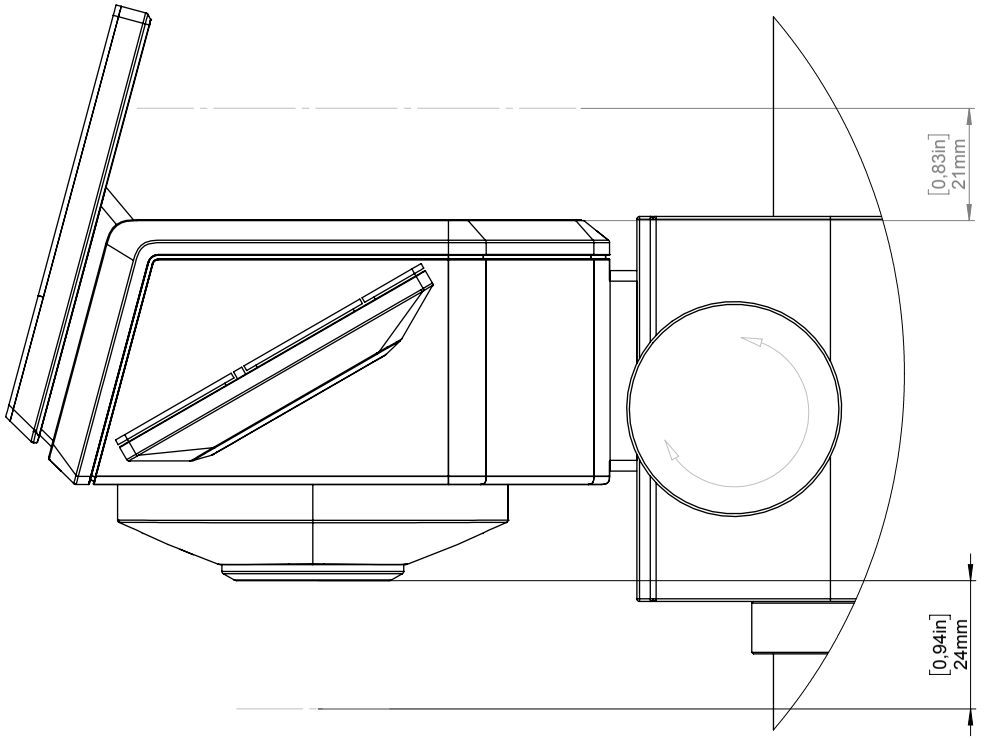
Denomination: Basic Dimension ETS 320

Size: A3
Scale: 1:2
Sheet: 2(4)
Drawing No.: T130266
Rev: A

FLIR



DETAIL A
SCALE 1 : 1



Total adjustment length (locked): 45mm (1,77 in)

Modified	Check	Drawn by
2017-03-01	TMHA	R&D Instruments

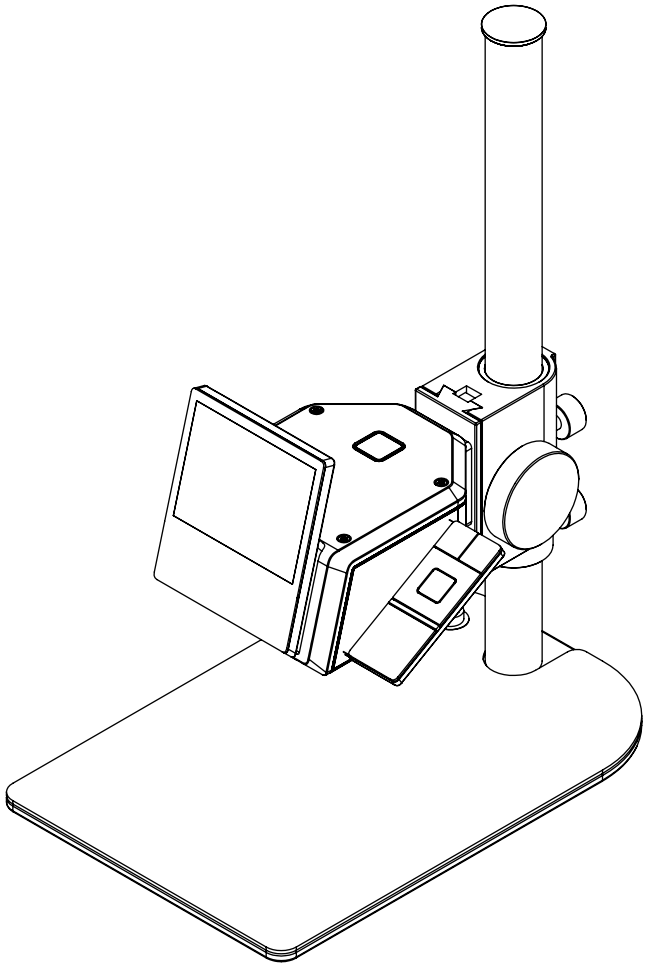
Denomination

Basic Dimension ETS 320

Size	Sheet
A3	3(4)

Scale 1:2

Drawing No.	Rev
T130266	A



Modified	Check	Drawn by
2017-03-01	TMHA	R&D Instruments

Denomination

Basic Dimension ETS 320

Size	Sheet
A3	4(4)

Scale	Drawing No.	Rev
1:2	T130266	A

12 CE Declaration of conformity

The full text of the Declaration of conformity is available at the following internet address: http://support.flir.com/resources/f73v.

13 Cleaning the camera

13.1 Camera housing, cables, and other items

Use one of these liquids:

- Warm water
- A weak detergent solution

Equipment:

- A soft cloth

Follow this procedure:

1. Soak the cloth in the liquid.
2. Twist the cloth to remove excess liquid.
3. Clean the part with the cloth.

CAUTION

Do not apply solvents or similar liquids to the camera, the cables, or other items. This can cause damage.

13.2 Infrared lens

Use one of these liquids:

- A commercial lens cleaning liquid with more than 30% isopropyl alcohol.
- 96% ethyl alcohol (C_2H_5OH).

Equipment:

- Cotton wool

CAUTION

If you use a lens cleaning cloth it must be dry. Do not use a lens cleaning cloth with the liquids that are listed above. These liquids can cause material on the lens cleaning cloth to become loose. This material can have an unwanted effect on the surface of the lens.

Follow this procedure:

1. Soak the cotton wool in the liquid.
2. Twist the cotton wool to remove excess liquid.
3. Clean the lens one time only and discard the cotton wool.

WARNING

Make sure that you read all applicable MSDS (Material Safety Data Sheets) and warning labels on containers before you use a liquid: the liquids can be dangerous.

CAUTION

- Be careful when you clean the infrared lens. The lens has a delicate anti-reflective coating.
- Do not clean the infrared lens too vigorously. This can damage the anti-reflective coating.

14 Thermographic measurement techniques

14.1 Introduction

An infrared camera measures and images the emitted infrared radiation from an object. The fact that radiation is a function of object surface temperature makes it possible for the camera to calculate and display this temperature.

However, the radiation measured by the camera does not only depend on the temperature of the object but is also a function of the emissivity. Radiation also originates from the surroundings and is reflected in the object. The radiation from the object and the reflected radiation will also be influenced by the absorption of the atmosphere.

To measure temperature accurately, it is therefore necessary to compensate for the effects of a number of different radiation sources. This is done on-line automatically by the camera. The following object parameters must, however, be supplied for the camera:

- The emissivity of the object
- The reflected apparent temperature
- The distance between the object and the camera
- The relative humidity
- Temperature of the atmosphere

14.2 Emissivity

The most important object parameter to set correctly is the emissivity which, in short, is a measure of how much radiation is emitted from the object, compared to that from a perfect blackbody of the same temperature.

Normally, object materials and surface treatments exhibit emissivity ranging from approximately 0.1 to 0.95. A highly polished (mirror) surface falls below 0.1, while an oxidized or painted surface has a higher emissivity. Oil-based paint, regardless of color in the visible spectrum, has an emissivity over 0.9 in the infrared. Human skin exhibits an emissivity 0.97 to 0.98.

Non-oxidized metals represent an extreme case of perfect opacity and high reflexivity, which does not vary greatly with wavelength. Consequently, the emissivity of metals is low – only increasing with temperature. For non-metals, emissivity tends to be high, and decreases with temperature.

14.2.1 Finding the emissivity of a sample

14.2.1.1 Step 1: Determining reflected apparent temperature

Use one of the following two methods to determine reflected apparent temperature:

14.2.1.1.1 Method 1: Direct method

Follow this procedure:

1. Look for possible reflection sources, considering that the incident angle = reflection angle (a = b).

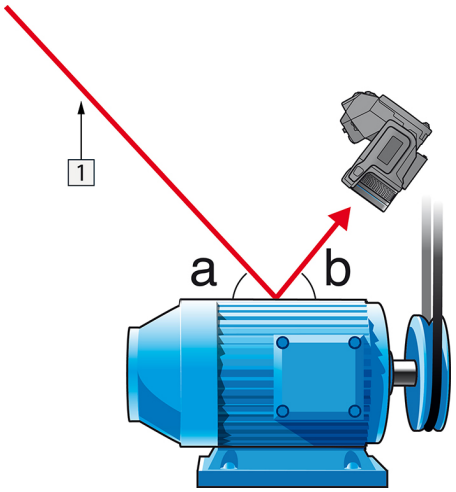


Figure 14.1 1 = Reflection source

2. If the reflection source is a spot source, modify the source by obstructing it using a piece if cardboard.

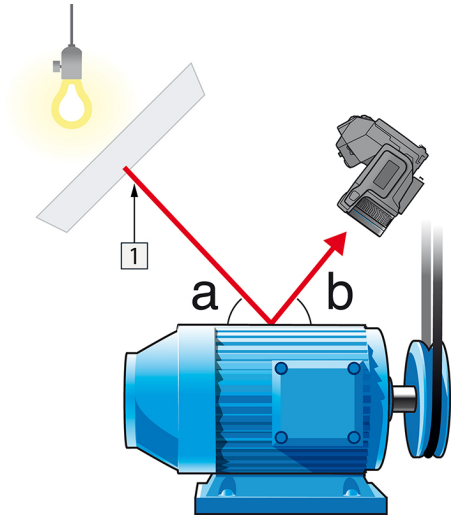


Figure 14.2 1 = Reflection source

3. Measure the radiation intensity (= apparent temperature) from the reflection source using the following settings:
   - Emissivity: 1.0
   - D_{obj}: 0

   You can measure the radiation intensity using one of the following two methods:

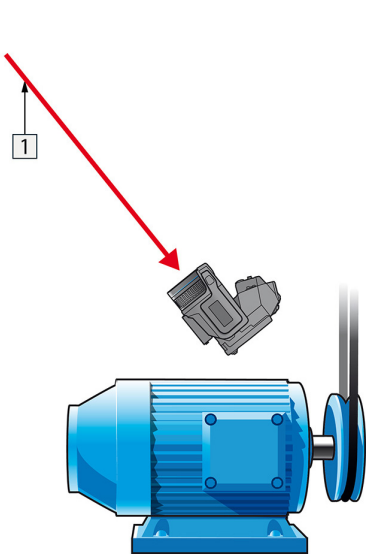


Figure 14.3 1 = Reflection source

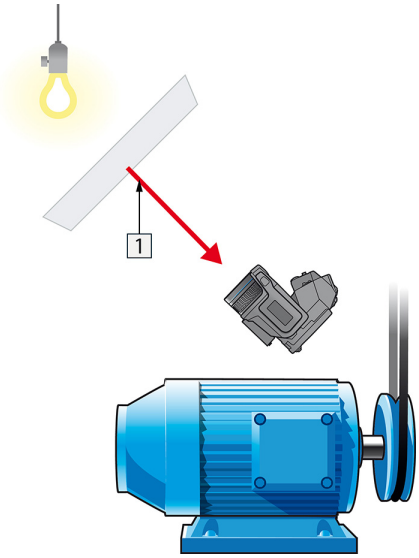


Figure 14.4 1 = Reflection source

You can not use a thermocouple to measure reflected apparent temperature, because a thermocouple measures *temperature*, but apparent temperatrure is *radiation intensity*.

14.2.1.1.2 Method 2: Reflector method

Follow this procedure:

1. Crumble up a large piece of aluminum foil.
2. Uncrumble the aluminum foil and attach it to a piece of cardboard of the same size.
3. Put the piece of cardboard in front of the object you want to measure. Make sure that the side with aluminum foil points to the camera.
4. Set the emissivity to 1.0.

5. Measure the apparent temperature of the aluminum foil and write it down. The foil is considered a perfect reflector, so its apparent temperature equals the reflected apparent temperature from the surroundings.

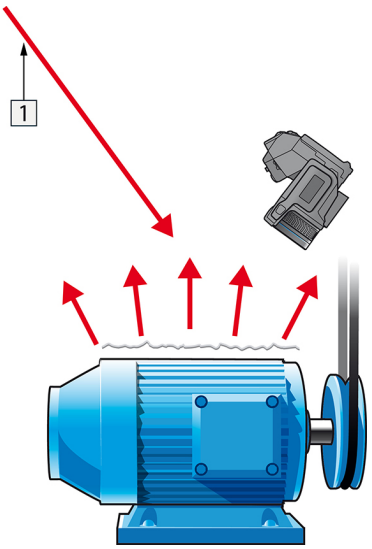


Figure 14.5 Measuring the apparent temperature of the aluminum foil.

14.2.1.2 Step 2: Determining the emissivity

Follow this procedure:

1. Select a place to put the sample.
2. Determine and set reflected apparent temperature according to the previous procedure.
3. Put a piece of electrical tape with known high emissivity on the sample.
4. Heat the sample at least 20 K above room temperature. Heating must be reasonably even.
5. Focus and auto-adjust the camera, and freeze the image.
6. Adjust *Level* and *Span* for best image brightness and contrast.
7. Set emissivity to that of the tape (usually 0.97).
8. Measure the temperature of the tape using one of the following measurement functions:
   - *Isotherm* (helps you to determine both the temperature and how evenly you have heated the sample)
   - *Spot* (simpler)
   - *Box Avg* (good for surfaces with varying emissivity).
9. Write down the temperature.
10. Move your measurement function to the sample surface.
11. Change the emissivity setting until you read the same temperature as your previous measurement.
12. Write down the emissivity.

Note

- Avoid forced convection
- Look for a thermally stable surrounding that will not generate spot reflections
- Use high quality tape that you know is not transparent, and has a high emissivity you are certain of
- This method assumes that the temperature of your tape and the sample surface are the same. If they are not, your emissivity measurement will be wrong.

14.3 Reflected apparent temperature

This parameter is used to compensate for the radiation reflected in the object. If the emissivity is low and the object temperature relatively far from that of the reflected it will be important to set and compensate for the reflected apparent temperature correctly.

14.4 Distance

The distance is the distance between the object and the front lens of the camera. This parameter is used to compensate for the following two facts:

- That radiation from the target is absorbed by the atmosphere between the object and the camera.
- That radiation from the atmosphere itself is detected by the camera.

14.5 Relative humidity

The camera can also compensate for the fact that the transmittance is also dependent on the relative humidity of the atmosphere. To do this set the relative humidity to the correct value. For short distances and normal humidity the relative humidity can normally be left at a default value of 50%.

14.6 Other parameters

In addition, some cameras and analysis programs from FLIR Systems allow you to compensate for the following parameters:

- Atmospheric temperature – *i.e.* the temperature of the atmosphere between the camera and the target
- External optics temperature – *i.e.* the temperature of any external lenses or windows used in front of the camera
- External optics transmittance – *i.e.* the transmission of any external lenses or windows used in front of the camera

15 About calibration

15.1 Introduction

Calibration of a thermal camera is a prerequisite for temperature measurement. The calibration provides the relationship between the input signal and the physical quantity that the user wants to measure. However, despite its widespread and frequent use, the term “calibration” is often misunderstood and misused. Local and national differences as well as translation-related issues create additional confusion.

Unclear terminology can lead to difficulties in communication and erroneous translations, and subsequently to incorrect measurements due to misunderstandings and, in the worst case, even to lawsuits.

15.2 Definition—what is calibration?

The International Bureau of Weights and Measures[3] defines *calibration*[4] in the following way:

an operation that, under specified conditions, in a first step, establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication.

The calibration itself may be expressed in different formats: this can be a statement, calibration function, calibration diagram[5], calibration curve[6], or calibration table.

Often, the first step alone in the above definition is perceived and referred to as being “calibration.” However, this is not (always) sufficient.

Considering the calibration procedure of a thermal camera, the first step establishes the relation between emitted radiation (the quantity value) and the electrical output signal (the indication). This first step of the calibration procedure consists of obtaining a homogeneous (or uniform) response when the camera is placed in front of an extended source of radiation.

As we know the temperature of the reference source emitting the radiation, in the second step the obtained output signal (the indication) can be related to the reference source’s temperature (measurement result). The second step includes drift measurement and compensation.

To be correct, calibration of a thermal camera is, strictly, not expressed through temperature. Thermal cameras are sensitive to infrared radiation: therefore, at first you obtain a radiance correspondence, then a relationship between radiance and temperature. For bolometer cameras used by non-R&D customers, radiance is not expressed: only the temperature is provided.

15.3 Camera calibration at FLIR Systems

Without calibration, an infrared camera would not be able to measure either radiance or temperature. At FLIR Systems, the calibration of uncooled microbolometer cameras with a measurement capability is carried out during both production and service. Cooled cameras with photon detectors are often calibrated by the user with special software. With this type of software, in theory, common handheld uncooled thermal cameras could be calibrated by the user too. However, as this software is not suitable for reporting

3. http://www.bipm.org/en/about-us/ [Retrieved 2017-01-31.]
4. http://jcgm.bipm.org/vim/en/2.39.html [Retrieved 2017-01-31.]
5. http://jcgm.bipm.org/vim/en/4.30.html [Retrieved 2017-01-31.]
6. http://jcgm.bipm.org/vim/en/4.31.html [Retrieved 2017-01-31.]

purposes, most users do not have it. Non-measuring devices that are used for imaging only do not need temperature calibration. Sometimes this is also reflected in camera terminology when talking about infrared or thermal imaging cameras compared with thermography cameras, where the latter are the measuring devices.

The calibration information, no matter if the calibration is done by FLIR Systems or the user, is stored in calibration curves, which are expressed by mathematical functions. As radiation intensity changes with both temperature and the distance between the object and the camera, different curves are generated for different temperature ranges and exchangeable lenses.

15.4 The differences between a calibration performed by a user and that performed directly at FLIR Systems

First, the reference sources that FLIR Systems uses are themselves calibrated and traceable. This means, at each FLIR Systems site performing calibration, that the sources are controlled by an independent national authority. The camera calibration certificate is confirmation of this. It is proof that not only has the calibration been performed by FLIR Systems but that it has also been carried out using calibrated references. Some users own or have access to accredited reference sources, but they are very few in number.

Second, there is a technical difference. When performing a user calibration, the result is often (but not always) not drift compensated. This means that the values do not take into account a possible change in the camera's output when the camera's internal temperature varies. This yields a larger uncertainty. Drift compensation uses data obtained in climate-controlled chambers. All FLIR Systems cameras are drift compensated when they are first delivered to the customer and when they are recalibrated by FLIR Systems service departments.

15.5 Calibration, verification and adjustment

A common misconception is to confuse *calibration* with *verification* or *adjustment*. Indeed, calibration is a prerequisite for *verification*, which provides confirmation that specified requirements are met. Verification provides objective evidence that a given item fulfills specified requirements. To obtain the verification, defined temperatures (emitted radiation) of calibrated and traceable reference sources are measured. The measurement results, including the deviation, are noted in a table. The verification certificate states that these measurement results meet specified requirements. Sometimes, companies or organizations offer and market this verification certificate as a "calibration certificate."

Proper verification—and by extension calibration and/or recalibration—can only be achieved when a validated protocol is respected. The process is more than placing the camera in front of blackbodies and checking if the camera output (as temperature, for instance) corresponds to the original calibration table. It is often forgotten that a camera is not sensitive to temperature but to radiation. Furthermore, a camera is an *imaging* system, not just a single sensor. Consequently, if the optical configuration allowing the camera to "collect" radiance is poor or misaligned, then the "verification" (or calibration or recalibration) is worthless.

For instance, one has to ensure that the distance between the blackbody and the camera as well as the diameter of the blackbody cavity are chosen so as to reduce stray radiation and the size-of-source effect.

To summarize: a validated protocol must comply with the physical laws for *radiance*, and not only those for temperature.

Calibration is also a prerequisite for *adjustment*, which is the set of operations carried out on a measuring system such that the system provides prescribed indications corresponding to given values of quantities to be measured, typically obtained from measurement standards. Simplified, adjustment is a manipulation that results in instruments that measure correctly within their specifications. In everyday language, the term “calibration” is widely used instead of “adjustment” for measuring devices.

15.6 Non-uniformity correction

When the thermal camera displays ”Calibrating…” it is adjusting for the deviation in response of each individual detector element (pixel). In thermography, this is called a ”non-uniformity correction” (NUC). It is an offset update, and the gain remains unchanged.

The European standard EN 16714-3, Non-destructive Testing—Thermographic Testing —Part 3: Terms and Definitions, defines an NUC as “Image correction carried out by the camera software to compensate for different sensitivities of detector elements and other optical and geometrical disturbances.”

During the NUC (the offset update), a shutter (internal flag) is placed in the optical path, and all the detector elements are exposed to the same amount of radiation originating from the shutter. Therefore, in an ideal situation, they should all give the same output signal. However, each individual element has its own response, so the output is not uniform. This deviation from the ideal result is calculated and used to mathematically perform an image correction, which is essentially a correction of the displayed radiation signal. Some cameras do not have an internal flag. In this case, the offset update must be performed manually using special software and an external uniform source of radiation.

An NUC is performed, for example, at start-up, when changing a measurement range, or when the environment temperature changes. Some cameras also allow the user to trigger it manually. This is useful when you have to perform a critical measurement with as little image disturbance as possible.

15.7 Thermal image adjustment (thermal tuning)

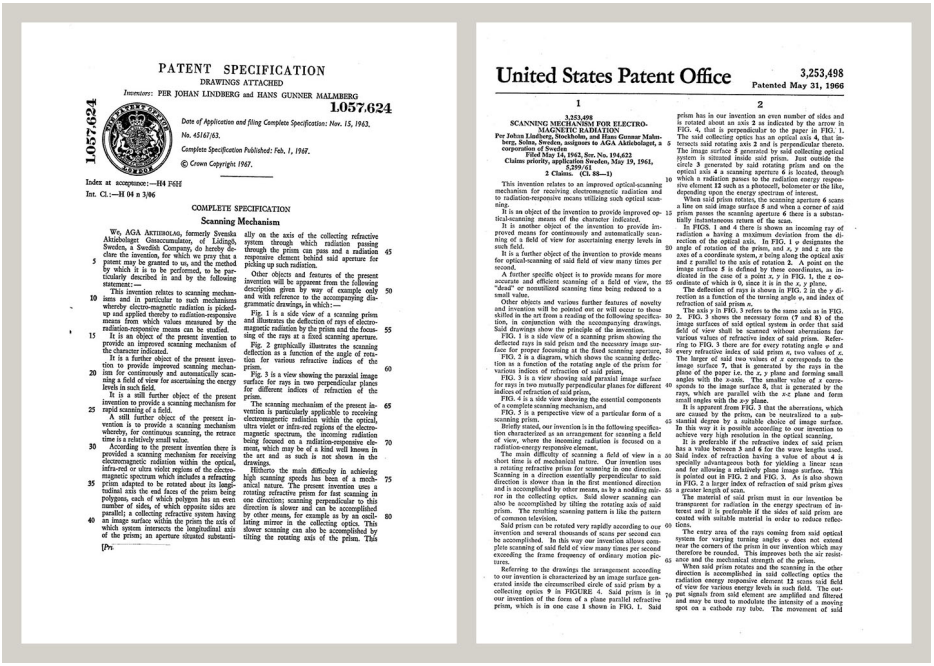
Some people use the term “image calibration” when adjusting the thermal contrast and brightness in the image to enhance specific details. During this operation, the temperature interval is set in such a way that all available colors are used to show only (or mainly) the temperatures in the region of interest. The correct term for this manipulation is “thermal image adjustment” or “thermal tuning”, or, in some languages, “thermal image optimization.” You must be in manual mode to undertake this, otherwise the camera will set the lower and upper limits of the displayed temperature interval automatically to the coldest and hottest temperatures in the scene.

16 About FLIR Systems

FLIR Systems was established in 1978 to pioneer the development of high-performance infrared imaging systems, and is the world leader in the design, manufacture, and marketing of thermal imaging systems for a wide variety of commercial, industrial, and government applications. Today, FLIR Systems embraces five major companies with outstanding achievements in infrared technology since 1958—the Swedish AGEMA Infrared Systems (formerly AGA Infrared Systems), the three United States companies Indigo Systems, FSI, and Inframetrics, and the French company Cedip.

Since 2007, FLIR Systems has acquired several companies with world-leading expertise:

- NEOS (2019)
- Endeavor Robotics (2019)
- Aeryon Labs (2019)
- Seapilot (2018)
- Acyclica (2018)
- Prox Dynamics (2016)
- Point Grey Research (2016)
- DVTEL (2015)
- DigitalOptics micro-optics business (2013)
- MARSS (2013)
- Traficon (2012)
- Aerius Photonics (2011)
- TackTick Marine Digital Instruments (2011)
- ICx Technologies (2010)
- Raymarine (2010)
- Directed Perception (2009)
- OmniTech Partners (2009)
- Salvador Imaging (2009)
- Ifara Tecnologías (2008)
- Extech Instruments (2007)



PATENT SPECIFICATION

DRAWINGS ATTACHED

Inventors: PER JOHAN LINDBERG and HANS GUNNER MALMBERG

1057.624

Date of Application and filing Complete Specification: Nov. 15, 1963.

No. 45167/63.

Complete Specification Published: Feb. 1, 1967.

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Index at acceptance:—H04 F6H

Int. Cl.:—H 04 n 3/06

COMPLETE SPECIFICATION

Scanning Mechanism

United States Patent Office 3,253,498 Patented May 31, 1966

3,253,498

SCANNING MECHANISM FOR ELECTRO-MAGNETIC RADIATION

Per Johan Lindberg, Stockholm, and Hans Gunnar Malmberg, Solna, Sweden, assignors to AGA Aktiebolaget, a corporation of Sweden

Filed May 14, 1962, Ser. No. 194,622

Claim priority, application Sweden, May 19, 1961, 5,299/61

2 Claims. (Cl. 88—1)

Figure 16.1 Patent documents from the early 1960s

FLIR Systems has three manufacturing plants in the United States (Portland, OR, Boston, MA, Santa Barbara, CA) and one in Sweden (Stockholm). Since 2007 there is also a manufacturing plant in Tallinn, Estonia. Direct sales offices in Belgium, Brazil, China,

France, Germany, Great Britain, Hong Kong, Italy, Japan, Korea, Sweden, and the USA —together with a worldwide network of agents and distributors—support our international customer base.

FLIR Systems is at the forefront of innovation in the infrared camera industry. We anticipate market demand by constantly improving our existing cameras and developing new ones. The company has set milestones in product design and development such as the introduction of the first battery-operated portable camera for industrial inspections, and the first uncooled infrared camera, to mention just two innovations.

1969: Thermovision Model 661. The camera weighed approximately 25 kg (55 lb.), the oscilloscope 20 kg (44 lb.), and the tripod 15 kg (33 lb.). The operator also needed a 220 VAC generator set, and a 10 L (2.6 US gallon) jar with liquid nitrogen. To the left of the oscilloscope the Polaroid attachment (6 kg (13 lb.)) can be seen.

2015: FLIR One, an accessory to iPhone and Android mobile phones. Weight: 36 g (1.3 oz.).

FLIR Systems manufactures all vital mechanical and electronic components of the camera systems itself. From detector design and manufacturing, to lenses and system electronics, to final testing and calibration, all production steps are carried out and supervised by our own engineers. The in-depth expertise of these infrared specialists ensures the accuracy and reliability of all vital components that are assembled into your infrared camera.

16.1 More than just an infrared camera

At FLIR Systems we recognize that our job is to go beyond just producing the best infrared camera systems. We are committed to enabling all users of our infrared camera systems to work more productively by providing them with the most powerful camera–software combination. Especially tailored software for predictive maintenance, R & D, and process monitoring is developed in-house. Most software is available in a wide variety of languages.

We support all our infrared cameras with a wide variety of accessories to adapt your equipment to the most demanding infrared applications.

16.2 Sharing our knowledge

Although our cameras are designed to be very user-friendly, there is a lot more to thermography than just knowing how to handle a camera. Therefore, FLIR Systems has founded the Infrared Training Center (ITC), a separate business unit, that provides certified training courses. Attending one of the ITC courses will give you a truly hands-on learning experience.

The staff of the ITC are also there to provide you with any application support you may need in putting infrared theory into practice.

16.3 Supporting our customers

FLIR Systems operates a worldwide service network to keep your camera running at all times. If you discover a problem with your camera, local service centers have all the equipment and expertise to solve it within the shortest possible time. Therefore, there is no need to send your camera to the other side of the world or to talk to someone who does not speak your language.

Website
http://www.flir.com

Customer support
http://support.flir.com

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Publ. No.: T810252
Release: AE
Commit: 85858
Head: 85858
Language: en-US
Modified: 2022-06-21
Formatted: 2022-06-21