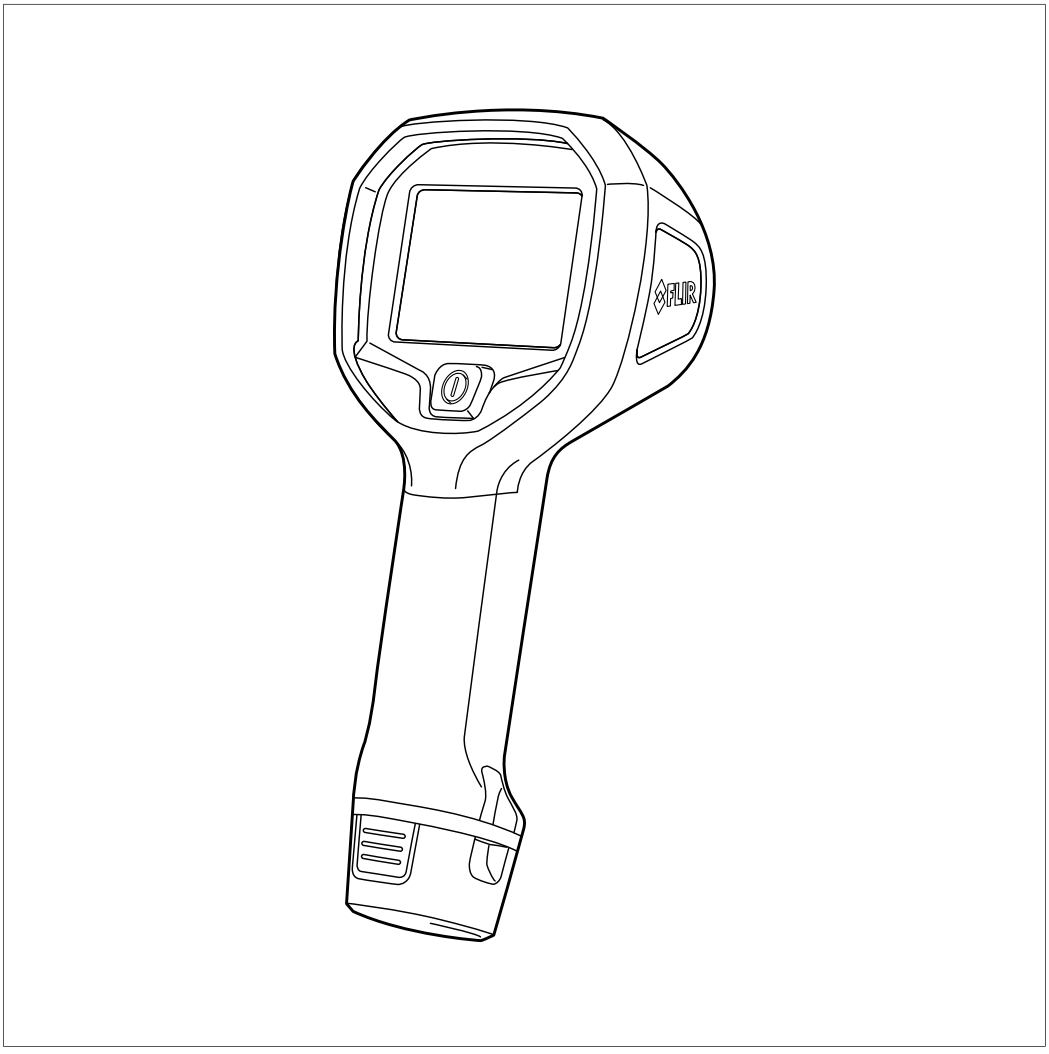
User's manual
FLIR Kx series



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。

User's manual
FLIR Kx series

Table of contents

1 Legal disclaimer

1.1 Legal disclaimer

All products manufactured by FLIR Systems are warranted against defective materials and workmanship for a period of one (1) year from the delivery date of the original purchase, provided such products have been under normal storage, use and service, and in accordance with FLIR Systems instruction.

Uncooled handheld infrared cameras manufactured by FLIR Systems are warranted against defective materials and workmanship for a period of two (2) years from the delivery date of the original purchase, provided such products have been under normal storage, use and service, and in accordance with FLIR Systems instruction, and provided that the camera has been registered within 60 days of original purchase.

Detectors for uncooled handheld infrared cameras manufactured by FLIR Systems are warranted against defective materials and workmanship for a period of ten (10) years from the delivery date of the original purchase, provided such products have been under normal storage, use and service, and in accordance with FLIR Systems instruction, and provided that the camera has been registered within 60 days of original purchase.

Products which are not manufactured by FLIR Systems but included in systems delivered by FLIR Systems to the original purchaser, carry the warranty, if any, of the particular supplier only. FLIR Systems has no responsibility whatsoever for such products.

The warranty extends only to the original purchaser and is not transferable. It is not applicable to any product which has been subjected to misuse, neglect, accident or abnormal conditions of operation. Expendable parts are excluded from the warranty.

In the case of a defect in a product covered by this warranty the product must not be further used in order to prevent additional damage. The purchaser shall promptly report any defect to FLIR Systems or this warranty will not apply.

FLIR Systems will, at its option, repair or replace any such defective product free of charge if, upon inspection, it proves to be defective in material or workmanship and provided that it is returned to FLIR Systems within the said one-year period.

FLIR Systems has no other obligation or liability for defects than those set forth above.

No other warranty is expressed or implied. FLIR Systems specifically disclaims the implied warranties of merchantability and fitness for a particular purpose.

FLIR Systems shall not be liable for any direct, indirect, special, incidental or consequential loss or damage, whether based on contract, tort or any other legal theory.

This warranty shall be governed by Swedish law.

Any dispute, controversy or claim arising out of or in connection with this warranty, shall be finally settled by arbitration in accordance with the Rules of the Arbitration Institute of the Stockholm Chamber of Commerce. The place of arbitration shall be Stockholm. The language to be used in the arbitral proceedings shall be English.

1.2 Usage statistics

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

1.3 Changes to registry

The registry entry HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\Lsa\LmCompatibilityLevel will be automatically changed to level 2 if the FLIR Camera Monitor service detects a FLIR camera connected to the computer with a USB cable. The modification will only be executed if the camera device implements a remote network service that supports network logons.

1.4 U.S. Government Regulations

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

1.5 Copyright

1.6 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.

1.7 Patents

One or several of the following patents and/or design patents may apply to the products and/or features. Additional pending patents and/or pending design patents may also apply.

000279476-0001; 000439161; 000499579-0001; 000653423; 000726344; 000859020; 001106306-0001; 001707738; 001707746; 001707787; 001776519; 001954074; 002021543; 002058180; 002249953; 002531178; 0600574-8; 1144833; 1182246; 1182620; 1285345; 1299699; 1325808; 1336775; 1391114; 1402918; 1404291; 1411581; 1415075; 1421497; 1458284; 1678485; 1732314; 2106017; 2107799; 2381417; 3006596; 3006597; 466540; 483782; 484155; 4889913; 5177595; 60122153.2; 602004011681.5-08; 6707044; 68657; 7034300; 7110035; 7154093; 7157705; 7237946; 7312822; 7332716; 7336823; 7544944; 7667198; 7809258 B2; 7826736; 8,153,971; 8,823,803; 8,853,631; 8018649 B2; 8212210 B2; 8289372; 8354639 B2; 8384783; 8520970; 8565547; 8595689; 8599262; 8654239; 8680468; 8803093; D540838; D549758; D579475; D584755; D599,392; D615,113; D664,580; D664,581; D665,004; D665,440; D677298; D710,424 S; D718801; DI6702302-9; DI6903617-9; DI7002221-6; DI7002891-5; DI7002892-3; DI7005799-0; DM/057692; DM/061609; EP 2115696 B1; EP2315433; SE 0700240-5; US 8340414 B2; ZL 201330267619.5; ZL01823221.3; ZL01823226.4; ZL02331553.9; ZL02331554.7; ZL200480034894.0; ZL200530120994.2; ZL200610088759.5; ZL200630130114.4; ZL200730151141.4; ZL200730339504.7; ZL200820105768.8; ZL200830128581.2; ZL200880105236.4; ZL200880105769.2; ZL200930190061.9; ZL201030176127.1; ZL201030176130.3; ZL201030176157.2; ZL201030595931.3; ZL201130442354.9; ZL201230471744.3; ZL201230620731.8.

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.
- IF YOU DO NOT AGREE TO THIS END USER LICENSE AGREEMENT (“EULA”), DO NOT USE THE DEVICE OR COPY THE SOFTWARE. INSTEAD, PROMPTLY CONTACT FLIR Systems AB FOR INSTRUCTIONS ON RETURN OF THE UNUSED DEVICE(S) FOR A REFUND. **ANY USE OF THE SOFTWARE, INCLUDING BUT NOT LIMITED TO USE ON THE DEVICE, WILL CONSTITUTE YOUR AGREEMENT TO THIS EULA (OR RATIFICATION OF ANY PREVIOUS CONSENT).**
- **GRANT OF SOFTWARE LICENSE.** This EULA grants you the following license:
  - You may use the SOFTWARE only on the DEVICE.
  - **NOT FAULT TOLERANT.** THE SOFTWARE IS NOT FAULT TOLERANT. FLIR Systems AB HAS INDEPENDENTLY DETERMINED HOW TO USE THE SOFTWARE IN THE DEVICE, AND MS HAS RELIED UPON FLIR Systems AB TO CONDUCT SUFFICIENT TESTING TO DETERMINE THAT THE SOFTWARE IS SUITABLE FOR SUCH USE.
  - **NO WARRANTIES FOR THE SOFTWARE.** THE SOFTWARE is provided “AS IS” and with all faults. THE ENTIRE RISK AS TO SATISFACTORY QUALITY, PERFORMANCE, ACCURACY, AND EFFORT (INCLUDING LACK OF NEGLIGENCE) IS WITH YOU. ALSO, THERE IS NO WARRANTY AGAINST INTERFERENCE WITH YOUR ENJOYMENT OF THE SOFTWARE OR AGAINST INFRINGEMENT. **IF YOU HAVE RECEIVED ANY WARRANTIES REGARDING THE DEVICE OR THE SOFTWARE, THOSE WARRANTIES DO NOT ORIGINATE FROM, AND ARE NOT BINDING ON, MS.**
  - No Liability for Certain Damages. **EXCEPT AS PROHIBITED BY LAW, MS SHALL HAVE NO LIABILITY FOR ANY INDIRECT, SPECIAL, CONSEQUENTIAL OR INCIDENTAL DAMAGES ARISING FROM OR IN CONNECTION WITH THE USE OR PERFORMANCE OF THE SOFTWARE. THIS LIMITATION SHALL APPLY EVEN IF ANY REMEDY FAILS OF ITS ESSENTIAL PURPOSE. IN NO EVENT SHALL MS BE LIABLE FOR ANY AMOUNT IN EXCESS OF U.S. TWO HUNDRED FIFTY DOLLARS (U.S.$250.00).**
  - **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: Cameras with one or more batteries.

Do not disassemble or do a modification to the battery. The battery contains safety and protection devices which, if damage occurs, can cause the battery to become hot, or cause an explosion or an ignition.

WARNING

Applicability: Cameras with one or more batteries.

If there is a leak from the battery and you get the fluid in your eyes, do not rub your eyes. Flush well with water and immediately get medical care. The battery fluid can cause injury to your eyes if you do not do this.

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

Applicability: Cameras with one or more batteries.

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

CAUTION

Applicability: Cameras with one or more batteries.

Do not connect the positive terminal and the negative terminal of the battery to each other with a metal object (such as wire). Damage to the batteries can occur.

CAUTION

Applicability: Cameras with one or more batteries.

Do not get water or salt water on the battery, or permit the battery to become wet. Damage to the batteries can occur.

CAUTION

Applicability: Cameras with one or more batteries.

Do not make holes in the battery with objects. Damage to the battery can occur.

CAUTION

Applicability: Cameras with one or more batteries.

Do not hit the battery with a hammer. Damage to the battery can occur.

CAUTION

Applicability: Cameras with one or more batteries.

Do not put your foot on the battery, hit it or cause shocks to it. Damage to the battery can occur.

CAUTION

Applicability: Cameras with one or more batteries.

Do not put the batteries in or near a fire, or into direct sunlight. When the battery becomes hot, the built-in safety equipment becomes energized and can stop the battery charging procedure. If the battery becomes hot, damage can occur to the safety equipment and this can cause more heat, damage or ignition of the battery.

CAUTION

Applicability: Cameras with one or more batteries.

Do not put the battery on a fire or increase the temperature of the battery with heat. Damage to the battery and injury to persons can occur.

CAUTION

Applicability: Cameras with one or more batteries.

Do not put the battery on or near fires, stoves, or other high-temperature locations. Damage to the battery and injury to persons can occur.

CAUTION

Applicability: Cameras with one or more batteries.

Do not solder directly onto the battery. Damage to the battery can occur.

CAUTION

Applicability: Cameras with one or more batteries.

Do not use the battery if, when you use, charge, or put the battery in storage, there is an unusual smell from the battery, the battery feels hot, changes color, changes shape, or is in an unusual condition. Speak with your sales office if one or more of these problems occurs. Damage to the battery and injury to persons 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.

Only use a specified battery for the camera. Damage to the camera and 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), unless other information is specified in the user documentation or technical data. 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 -15°C to +50°C (+5°F to +122°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

Applicability: Cameras with one or more batteries.

When the battery is worn, apply insulation to the terminals with adhesive tape or equivalent materials before you discard it. Damage to the battery and injury to persons can occur if you do not do this.

CAUTION

Applicability: Cameras with one or more batteries.

Remove any water or moisture on the battery before you install it. Damage to the battery can occur if you do not do this.

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.

CAUTION

Do not change the standard fire-fighting procedures when you use a FLIR K series camera. The FLIR K series camera is not a replacement technology.

CAUTION

Do not use the FLIR K series camera without the correct training. If the persons that operate the camera do not have the correct training, an incorrect analysis of the infrared images can occur. Thus, incorrect decisions during the firefighting can be made.

The training must include:

- How a thermal camera operates and its limits
- How to interpret an image
- How to work safely with the camera.

3 Notice to user

3.1 User-to-user forums

Exchange ideas, problems, and infrared solutions with fellow thermographers around the world in our user-to-user forums. To go to the forums, visit:

http://www.infraredtraining.com/community/boards/

3.2 Disposal of electronic waste

As with most electronic products, this equipment must be disposed of in an environmentally friendly way, and in accordance with existing regulations for electronic waste.

Please contact your FLIR Systems representative for more details.

3.3 Training

To read about infrared training, visit:

- http://www.infraredtraining.com
- http://www.irtraining.com
- http://www.irtraining.eu

3.4 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 and notifications, go to the Download tab at:

http://support.flir.com

It only takes a few minutes to register online. 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.

3.5 Important note about this manual

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

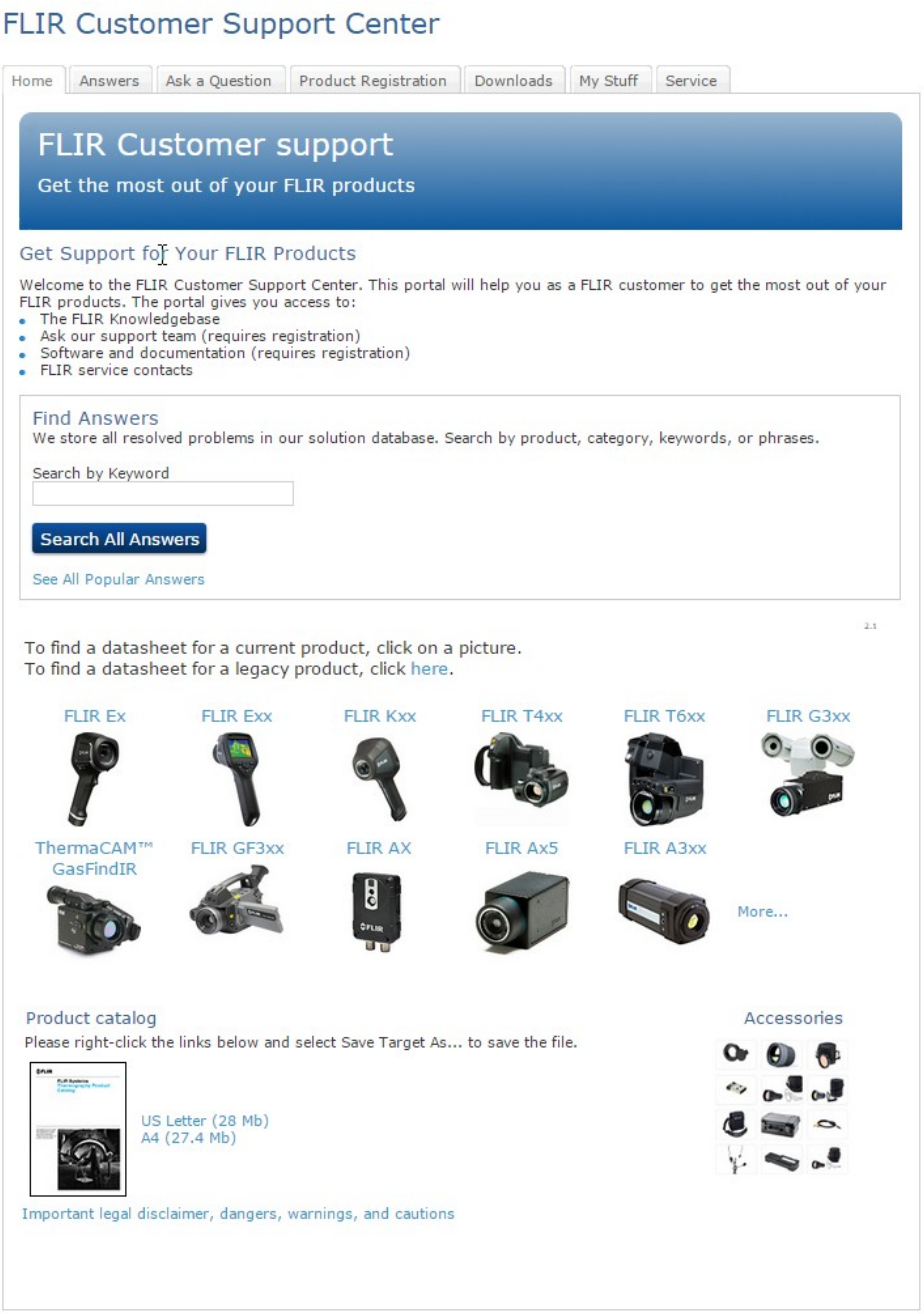
This means that this manual may contain descriptions and explanations that do not apply to your particular camera model.

3.6 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

For customer help, visit:

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 (for example, 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:

- 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 stories.
- Technical datasheets.
- Product catalogs.

5 Important information about FLIR Kx series service

- Contact the service department before shipping the camera. Many problems can be resolved on the phone—if so, the camera does not need to be shipped.
- The camera must be thoroughly cleaned, decontaminated and disinfected before shipping to our service department. No hazardous residues are allowed on cameras. Such residues include—but are not limited to—chemical fire-extinguishing compounds, radioactivity, biohazardous materials, and residues from chemical fires.
- FLIR Systems reserves the right to charge the full cost for the decontamination and disinfection of contaminated cameras that are shipped to our service department.

6 Introduction

Thank you for choosing a FLIR Kx series camera from FLIR Systems.

The FLIR Kx series is a robust and reliable infrared camera series designed to perform under extremely severe conditions. The FLIR Kx series camera has an intuitive interface with a design that makes it easy to control even with a gloved hand.

Main features:

- **Robust and reliable**. The FLIR Kx series is designed to meet tough operating conditions. It can withstand a drop from 2 m (6.5′) onto a concrete floor, is water resistant to IP67, and is fully operational up to 55°C (135°F).
- **Innovative**. The FLIR Kx series utilizes our patented technology MSX, where a thermal sensor is combined with a visual camera sensor to give detailed image information in many user situations.
- **Easy-to-use**. The FLIR Kx series is easily used in a gloved professional hand. An intuitive and simple user interface allows you to focus on the job. The FLIR Kx series can be controlled by just one large button on top of the unit.

7 Quick start guide

Follow this procedure:

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

   NOTE

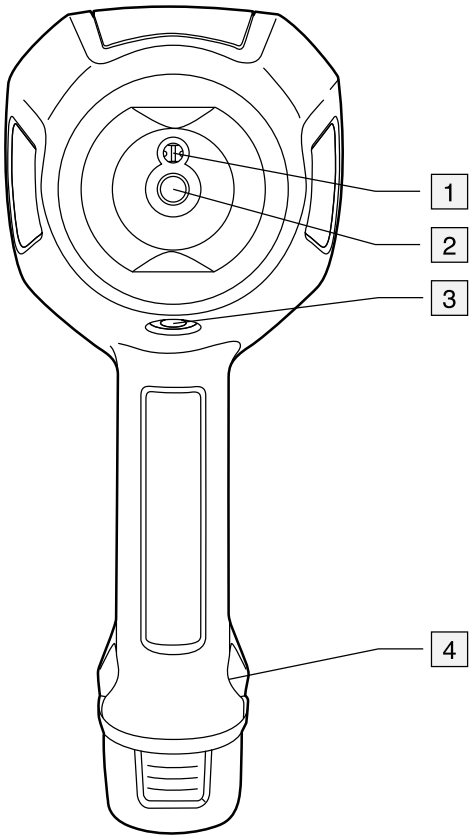
   Charging the camera using a USB cable connected to a computer takes *considerably* longer than using the FLIR power supply or the FLIR stand-alone battery charger.

2. Push the on/off button to turn on the camera.
3. Aim the camera toward the object of interest.

8 Camera parts

8.1 View from the front

8.1.1 Figure

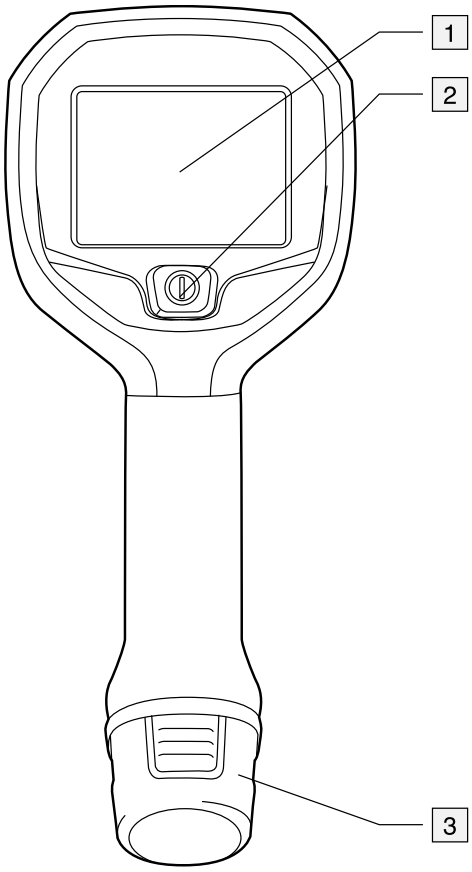


8.1.2 Explanation

1. Digital camera lens.
2. Infrared lens.
3. Tripod mount.
4. Attachment point for lanyard strap.

8.2 View from the rear

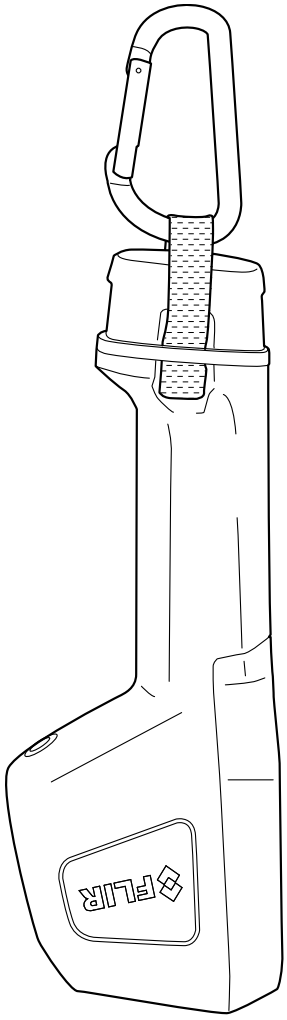
8.2.1 Figure



8.2.2 Explanation

1. Camera screen.
2. On/off button. This button has three functions:
   - Push the on/off button to turn on the camera.
   - Push and hold the on/off button for more than 3 seconds but less than 10 seconds to put the camera into the standby mode. The camera then automatically turns off after 6 hours.
   - Push and hold the on/off button for more than 10 seconds to turn off the camera.
3. Battery.

8.3 Lanyard strap



9 Screen elements

9.1 Figure

9.2 Explanation

1. Low-sensitivity range indicator.
2. Overheating indicator. The indicator provides a visual warning to the user that the thermal imager is about to shut down due to internal overheating.
3. Temperature scale.
4. Digital readout of the temperature at the position of the spotmeter.
5. Battery status indicator.
6. Camera mode indicator (e.g. *fire mode*).
7. Spotmeter.

NOTE

The icons are displayed in green or blue, depending on the selected camera mode.

- The green icon color indicates that the camera is in a mode where it automatically switches between the high-sensitivity range and the low-sensitivity range, depending on the temperature of objects in the field of view.
- The blue icon color indicates that the camera is in a mode where the temperature range is locked to the high-sensitivity range.

10 Operation

10.1 Charging the battery

10.1.1 Charging the battery using the FLIR power supply

Follow this procedure:

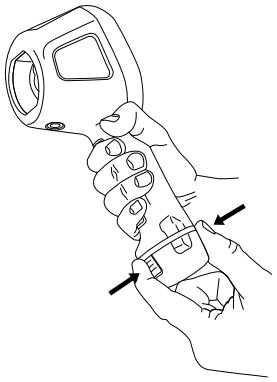
1. Connect the power supply to a wall outlet.
2. Connect the power supply cable to the USB connector on the camera. To access the USB connector, see section 10.3 *Accessing the connector bay*, page 16.

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

10.1.2 Charging the battery using the FLIR stand-alone battery charger.

Follow this procedure:

1. Connect the stand-alone battery charger to a wall outlet.
2. Remove the battery from the camera.



3. Put the battery into the stand-alone battery charger.

NOTE
• The charging time for a fully depleted battery is 2 hours. • The battery is being charged when the blue LED is flashing. • The battery is fully charged when the blue LED is continuous.

10.1.3 Charging the battery using a USB cable

Follow this procedure:

1. Connect the camera to a computer using a USB cable. To access the USB connector, see section 10.3 *Accessing the connector bay*, page 16.

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 or the FLIR stand-alone battery charger.

10.2 Turning on and turning off the camera

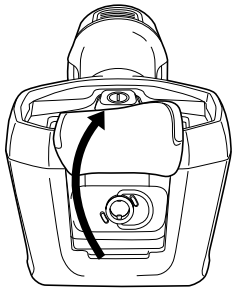
- Push the on/off button to turn on the camera.
- Push and hold the on/off button for more than 3 seconds but less than 10 seconds to put the camera into the standby mode. The camera then automatically turns off after 6 hours.
- Push and hold the on/off button for more than 10 seconds to turn off the camera.

10.3 Accessing the connector bay

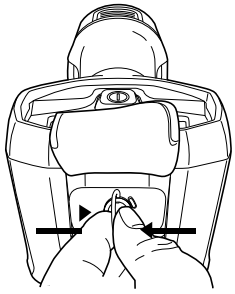
10.3.1 Procedure

Follow this procedure:

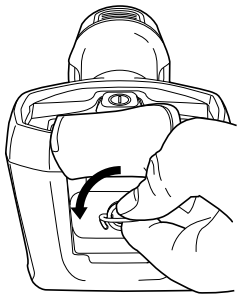
1. Fold up the rubber cover at the top of the camera.



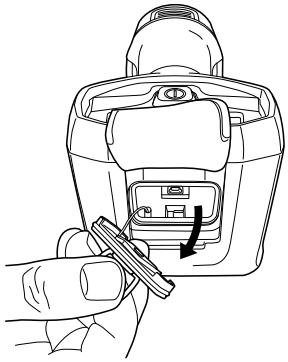
2. Hold the metal ring firmly.



3. Turn the ring about 90° counter-clockwise.



4. Pull out the plastic insert.



⚠ **CAUTION**
The plastic insert has an O-ring seal. Do not damage the O-ring seal.

10.4 Changing temperature unit

10.4.1 General

The camera displays temperatures in °C or °F. You change the temperature unit with a switch, located in the connector bay.

10.4.2 Procedure

Follow this procedure:

1. To access the temperature unit switch, see section 10.3 *Accessing the connector bay*, page 16.
2. Set the temperature unit switch to the desired position.

10.5 Changing settings (in FLIR Tools)

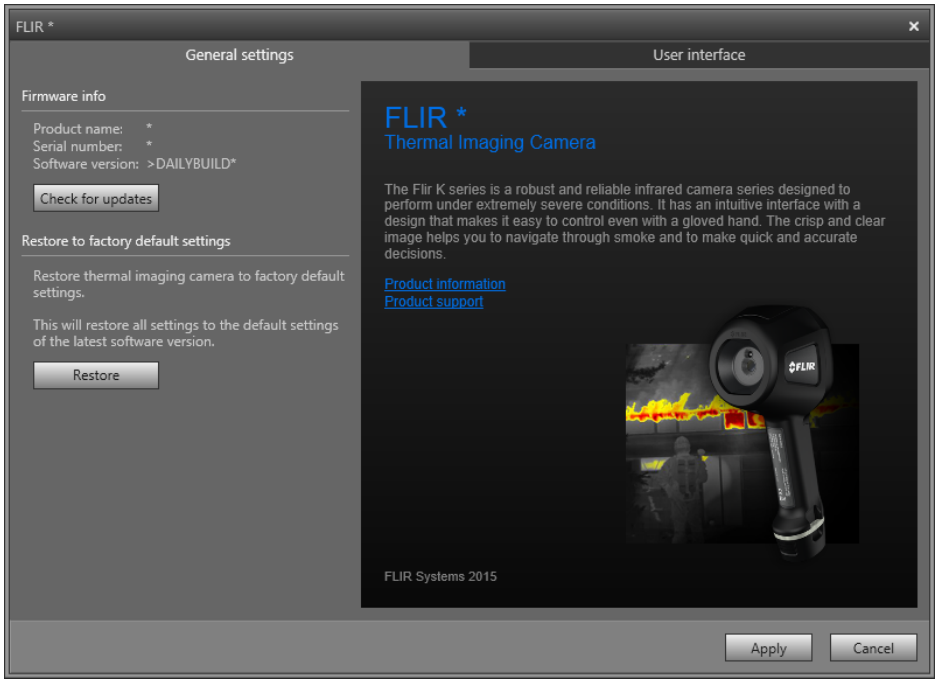
10.5.1 General

By connecting the camera to FLIR Tools, you get access to a variety of settings in the camera.

A download card for FLIR Tools is included in the transport case. Connect the camera to the computer using the USB cable. To access the USB connector, see section 10.3 *Accessing the connector bay*, page 16.

10.5.2 The General settings tab

10.5.2.1 Figure



10.5.2.2 Explanation

Firmware info area: To check whether a newer version of the camera firmware exists, click *Check for updates*, and follow the on-screen instructions.

Restore to factory default area: To restore all camera settings to the factory defaults, click *Restore*.

10.5.3 The User interface tab

10.5.3.1 Figure

10.5.3.2 Explanation

Camera modes area: To define which camera modes to enable in the camera, select the camera mode. For more information on each camera mode, see section 10.5.4.2 *Explanation of the different camera modes*, page 19.

Add custom boot image area: To specify your own unique image to appear during start-up, click *Browse*, and navigate to the image file. This is useful for, for example, identifying your fire department's cameras. By incorporating your fire department's logo, and a unique identity number in the image, you can keep track of your cameras.

10.5.4 Camera modes

10.5.4.1 General

The FLIR Kx series features seven different camera modes:

1. Basic mode.
2. Black and white firefighting mode.
3. Fire mode.
4. Search and rescue mode.
5. Heat detection mode.
6. Cold detection mode.
7. Building analysis mode.

Each mode is optimized for a certain type of firefighting application. The modes also differ in the following ways:

- Modes with green icons (1–3 in the list): The camera switches between the high-sensitivity range (–20 to +150°C (–4 to +302°F)) and the low-sensitivity range (0 to +500° C (+32 to +932°F)) automatically when an object with a temperature above 150°C (302°F), covering more than 2% of the image, enters the field of view of the camera.
- Modes with blue icons (4–7 in the list): The temperature range is locked to the high-sensitivity range (–20 to +150°C (–4 to +302°F)). This is useful if you need to maintain the best possible image for objects with a temperature below 150°C (302°F), even if

there are objects with a temperature above 150°C (302°F) in the field of view of the camera.

10.5.4.2 Explanation of the different camera modes

10.5.4.2.1 Basic mode

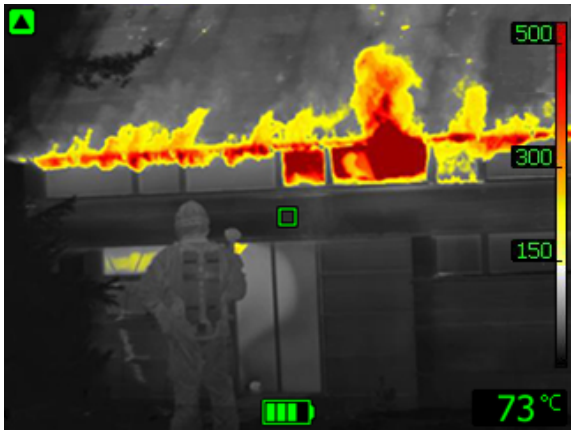


Figure 10.1 Basic mode.

The Basic mode is the default mode of the camera. It is a multipurpose mode for the initial fire attack with life rescuing operation and control of the fire. The camera automatically switches between the high-sensitivity range and the low-sensitivity range, to maintain an optimal infrared image while at the same time maintaining a safe and consistent heat colorization of the fire scene.

- Automatic range.
- Colorization of heat: +150 to +500°C (+302 to +932°F).
- High-sensitivity range: –20 to +150°C (–4 to +302°F).
- Low-sensitivity range: 0 to +500°C (+32 to +932°F).

10.5.4.2.2 Black and white firefighting mode

Figure 10.2 Black and white firefighting mode.

The *black and white firefighting mode* is a standardized firefighting mode based on the Basic mode. It is a multipurpose mode for the initial fire intervention that includes life rescuing operations and control of the fire. It is specifically designed for fire services that do not want to use the heat colorization feature.

The camera automatically switches between the high-sensitivity range and the low-sensitivity range, to maintain an optimal infrared image.

- Automatic range.

- High-sensitivity range: –20 to +150°C (–4 to +302°F).
- Low-sensitivity range: 0 to +500°C (+32 to +932°F).

10.5.4.2.3 Fire mode

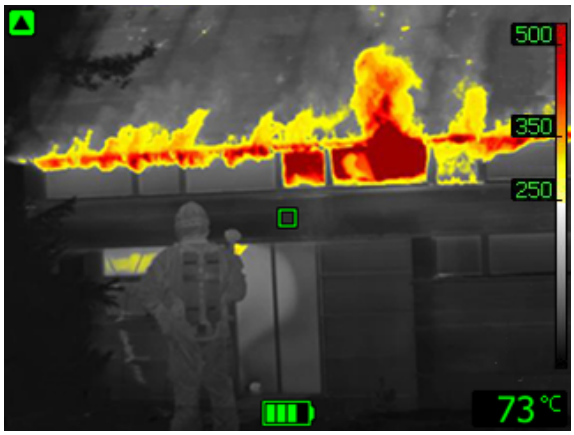


Figure 10.3 Fire mode.

The *fire mode* is similar to the Basic mode, but with a higher-temperature starting point for the heat colorization. It is suitable for fire scenes with higher background temperatures, where there are already a lot of open flames and a high background temperature. The camera automatically switches between the high-sensitivity range and the low-sensitivity range, to maintain an optimal infrared image while at the same time maintaining a safe and consistent heat colorization.

- Automatic range.
- Colorization of heat: +250 to +500°C (+ 482 to +932°F).
- High-sensitivity range: –20 to +150°C (–4 to +302°F).
- Low-sensitivity range: 0 to +500°C (+32 to +932°F).

10.5.4.2.4 Search and rescue mode

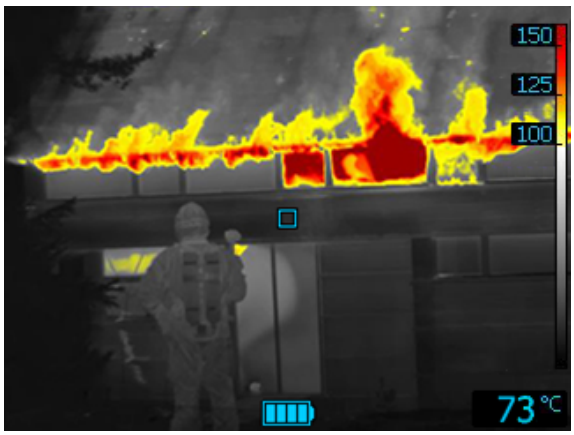


Figure 10.4 Search and rescue mode.

The *search and rescue mode* is optimized for maintaining high contrast in the infrared image while searching for people in landscapes, buildings, or traffic accident scenes.

- High-sensitivity range only.
- Colorization of heat: +100 to +150°C (+212 to +302°F).
- High-sensitivity range: –20 to +150°C (–4 to +302°F).

10.5.4.2.5 Heat detection mode

Figure 10.5 Heat detection mode.

The *heat detection mode* is optimized for searching hotspots during overhaul after the fire is out—typically to ensure that there is no remaining hidden fire. This mode can also be used to find thermal patterns (e.g., signs of people in car seats after accidents), to ensure that everyone has been found. This mode can also be used to search for people in water and open landscapes.

- High-sensitivity range only.
- Colorization of heat: the 20% highest temperatures in the scene.
- High-sensitivity range: –20 to +150°C (–4 to +302°F).

10.5.4.2.6 Cold detection mode

Figure 10.6 Cold detection mode.

The *cold detection mode* is optimized for searching coldspots in a fire situation—typically to find drafts and air flows that may provide oxygen fuel for the fire.

- High-sensitivity range only.
- Colorization of cold: the 20% lowest temperatures in the scene.
- High-sensitivity range: –20 to +150°C (–4 to +302°F).

10.5.4.2.7 Building analysis mode

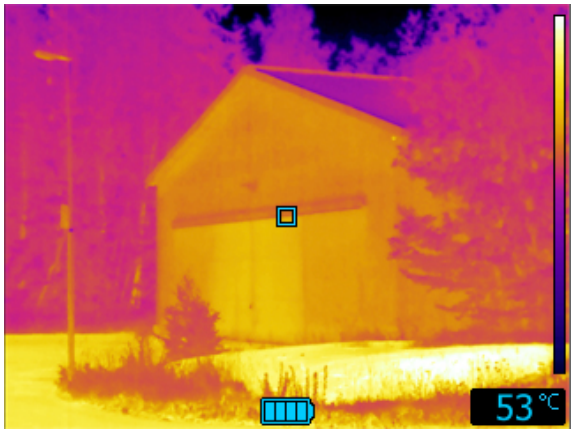


Figure 10.7 Building analysis mode.

The *building analysis mode* is suitable for the analysis of buildings and the detection of building-related anomalies. The thermal image can provide information on structural, mechanical, plumbing, and electrical constructions as well as an indication of moisture, wetness, and air infiltration.

In this mode, the camera uses an iron color palette to display the different temperatures, where black, blue, and purple are for the coldest areas, followed by red, orange, and yellow for the mid-range and going to white for the hottest parts. The temperature scale is automatically adjusted to the thermal content of the image.

10.6 Updating the camera

10.6.1 General

To take advantage of the latest FLIR camera firmware, it is important that you keep your camera updated. You update your camera using FLIR Tools, see section 10.5 *Changing settings (in FLIR Tools)*, page 17.

11 Technical data

11.1 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.

11.2 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.

11.3 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.

11.4 FLIR K2

P/N: 73701-0101
Rev.: 28866

General description
The FLIR K2 is a robust and reliable infrared camera designed to perform under extremely severe conditions. The FLIR K2 has an intuitive interface with a design that makes it easy to control even with a gloved hand.
Benefits:
• Robust and reliable: The FLIR K2 is designed to meet tough operating conditions. It can withstand a drop from 2 m (6.5 ft.) onto a concrete floor, is water resistant to IP67, and is fully operational up to 55°C (135°F), and operational up to +85°C (+185°F) for 15 minutes, +150°C (+302°F) for 10 minutes, and +260°C (+500°F) for 3 minutes. • Innovative: The FLIR K2 utilizes our patented technology MSX, where a thermal sensor is combined with a visual camera sensor to give detailed image information in many user situations. • Easy-to-use: Easily used in a gloved professional hand. An intuitive and simple user interface allows you to focus on the job. The FLIR K2 can be controlled by just one large button on top of the unit.
Typical applications:
• Heat detection. • Search and rescue. • Final extinction. • Back-up camera. • Scanning camera. • Fire attack.

Imaging and optical data	
IR resolution	160 × 120 pixels
Thermal sensitivity/NETD	< 100 mK @ +30°C (+86°F)
Field of view (FOV)	47° × 35°
Depth of field	0.1 m (0.33 ft.), infinity
Focal length	1.9 mm (0.075 in.)
Spatial resolution (IFOV)	6.22 mrad
F-number	1.1
Image frequency	9 Hz
Focus	Fixed

Detector data	
Detector type	Focal plane array, uncooled microbolometer
Spectral range	7.5–13 µm
Pitch	12 µm

Visual camera	
Built-in digital camera	640 × 480 pixels
Digital camera, FOV	73° × 61°, adapts to the IR lens
Sensitivity	Minimum 10 lux

Image presentation	
Display	3 in. LCD, 320 × 240 pixels, backlit
Auto range	Auto, non-selectable

Image presentation modes	
Image modes	• TI Basic fire-fighting mode (default) • Black-and-white fire-fighting mode • Fire mode • Search-and-rescue mode • Heat detection mode **NOTE** The image mode can only be changed using FLIR Tools.
Multi Spectral Dynamic Imaging (MSX)	Yes

Measurement	
Object temperature range	• –20°C to +150°C (–4°F to +302°F) • 0°C to +500°C (+32°F to +932°F)
Accuracy	±4°C (±7.2°F) or ±4% for ambient temperatures of 10–35°C (50–95°F)

Measurement analysis	
Spotmeter	1
Automatic hot detection	Heat detection mode (the hottest 20% of the of scene is colorized)
Isotherm	Yes

USB	
USB	USB Micro-B

Compatibility	
Compatible with FLIR software	FLIR Tools

Data communication interfaces	
Interfaces	Update from PC devices

Power system	
Battery type	Li ion
Battery voltage	3.6 V
Battery capacity	2.6 Ah at 20–25°C (68–77°F)
Battery operating time	Approximately 4 hours at +25°C (+77°F) ambient temperature and typical use
Charging system	Battery is charged inside the camera or in a dedicated charger
Charging time	2.5 h to 90% capacity, charging status indicated by LEDs
Charging temperature	0–45°C (32–113°F)
Power management	Automatic shutdown and sleep mode
Start-up time from sleep mode	10 seconds
Start-up time	30 seconds

Environmental data	
Operating temperature range	• –10°C to +55°C (+14°F to +131°F): infinity • +85°C (+185°F): 15 minutes • +150°C (+302°F): 10 minutes • +260°C (+500°F): 3 minutes
Storage temperature range	–40°C to +70°C (–40°F to +158°F)

Environmental data	
Humidity (operating and storage)	IEC 60068-2-30, 24 hours, 95% relative humidity, 25–40°C (77–104°F), 2 cycles
Relative humidity	95% relative humidity, 25–40°C (77–104°F), non-condensing
EMC	• EN 61000-6-2:2005 (immunity) • EN 61000-6-3:2011 (emission) • FCC 47 CFR Part 15 B (emission)
Magnetic fields	EN 61 000-4-8, test level 5 for continuous field (severe industrial environment)
Encapsulation	IP 67 (IEC 60529)
Corrosion	ASTM B117, salt spray, 5% saline solution in 48 hours and +35°C
Shock	25 g (IEC 60068-2-27)
Vibration	2 g (IEC 60068-2-6)
Drop	2 m (6.6 ft.) on concrete floor (IEC 60068-2-31)
Safety (power supply)	CE/EN/UL/CSA/PSE 60950-1

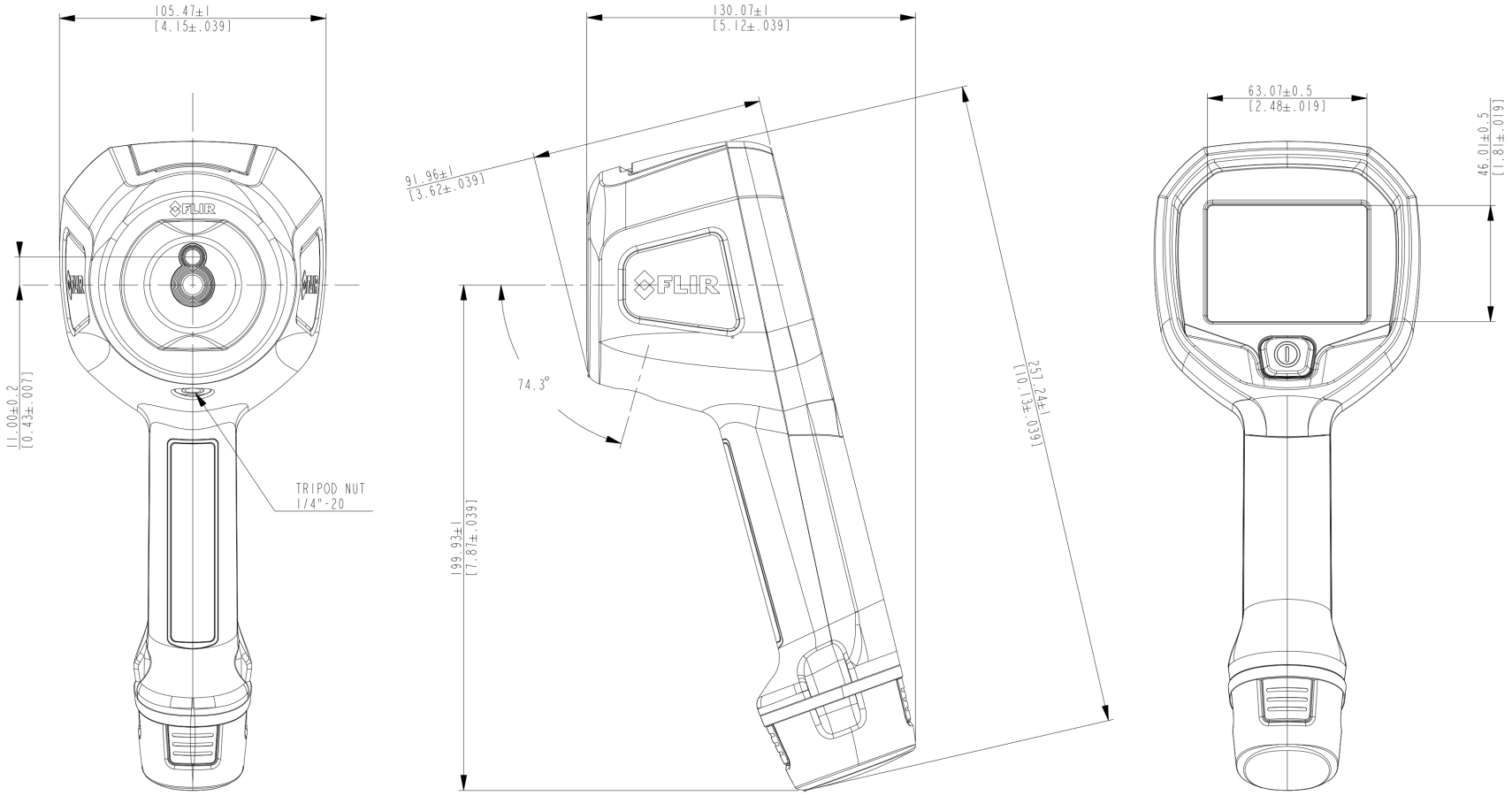
Physical data	
Camera weight, incl. battery	0.7 kg (1.54 lb.)
Battery weight	0.119 kg (0.26 lb.)
Camera size (L × W × H)	250 mm × 105 mm × 90 mm (9.8 in. × 4.1 in. × 3.5 in.)
Tripod mounting	UNC ¼″-20
Material	• PPSU • Silicon rubber • Aluminium, cast • Flame-resistant magnesium alloy

Shipping information	
List of contents	• Infrared camera • Battery (×2) • Battery charger • Lanyard strap • Power supply • Printed documentation • USB cable • User documentation CD-ROM
Packaging, weight	TBD
Packaging, size	TBD
EAN-13	4743254002050
UPC-12	845188011345
Country of origin	China

Supplies & accessories:

- T198532; Car charger
- T198533; USB cable Std A <-> Micro B
- T127722ACC; Retractable lanyard
- T199127; Li-Ion Battery pack 3.6 V 2.6 Ah
- T199128; Battery charger, incl. power supply with multi plugs
- T199130; Lanyard strap

12 Mechanical drawings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TRIPOD NUT
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[.433±.008]
130.07±1
[5.12±.039]
91.96±1
[3.62±.039]
74.3°
199.93±1
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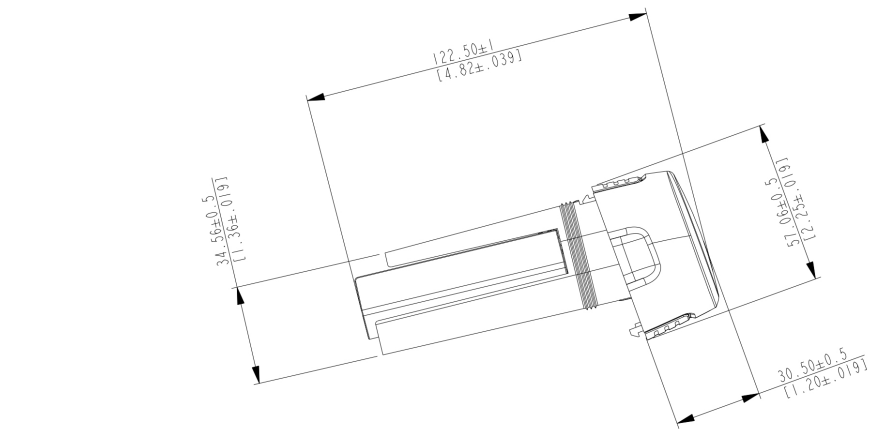
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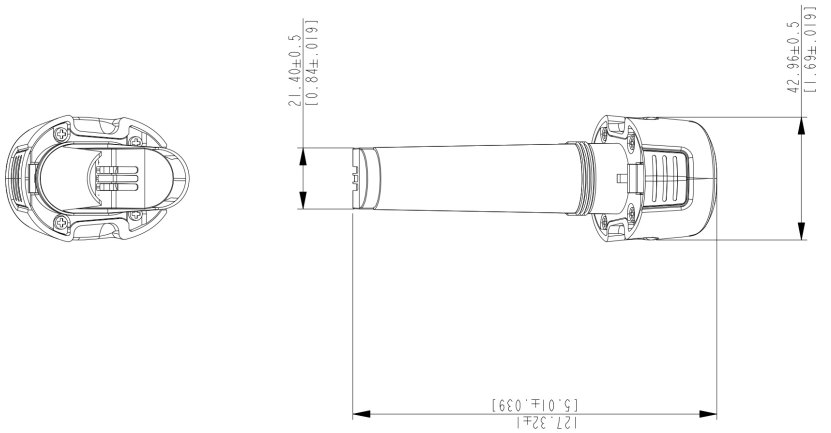
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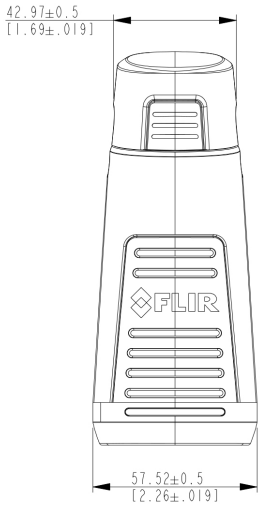
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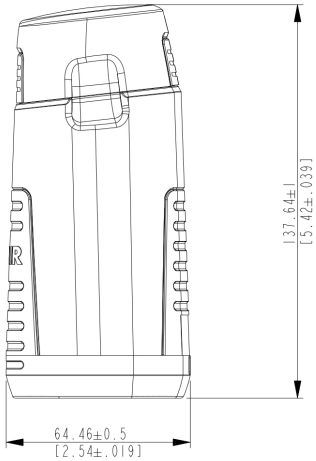
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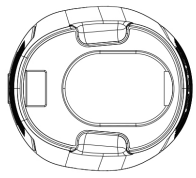

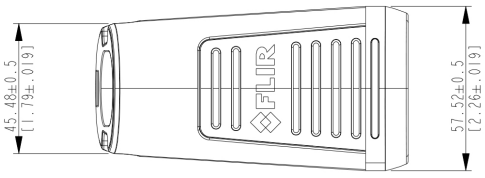
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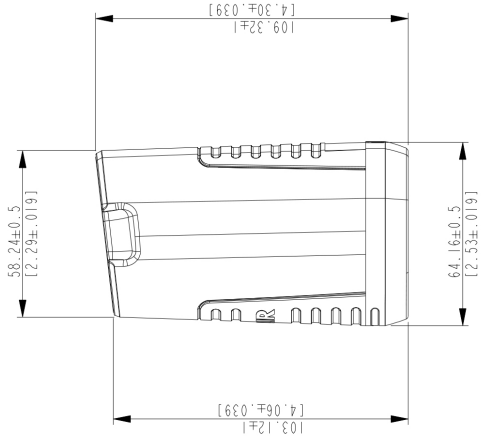
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13 Cleaning the camera

13.1 Camera housing, cables, and other items

13.1.1 Liquids

Use one of these liquids:

- Warm water
- A weak detergent solution

13.1.2 Equipment

A soft cloth

13.1.3 Procedure

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

13.2.1 Liquids

Use one of these liquids:

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

13.2.2 Equipment

Cotton wool

13.2.3 Procedure

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

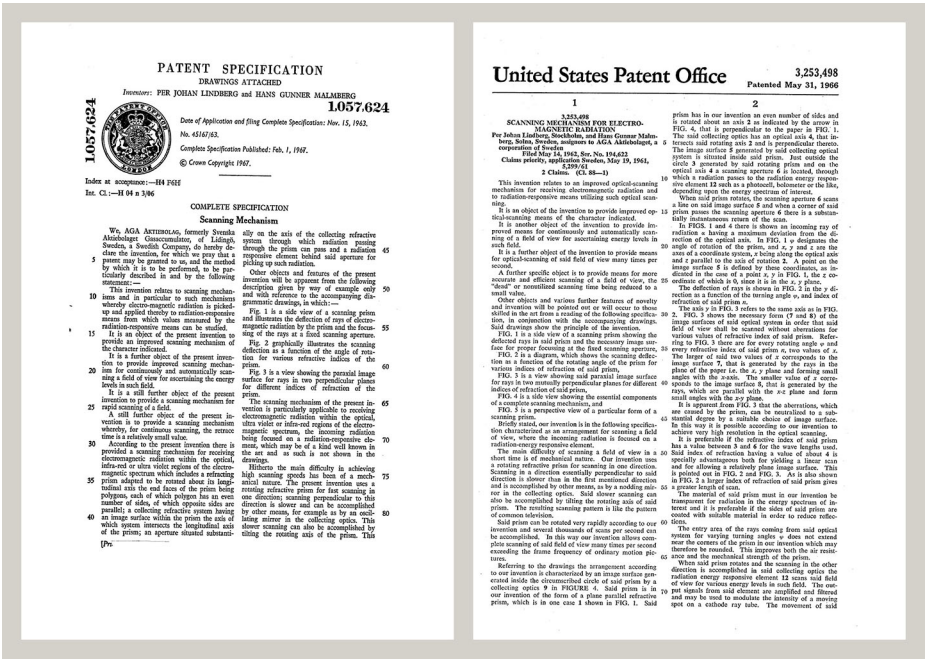
- Be careful when you clean the infrared lens. The lens has a delicate anti-reflective coating.
- Do not clean the infrared lens too vigorously. This can damage the anti-reflective coating.

14 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 in sensor technologies:

- Extech Instruments (2007)
- Ifara Tecnologías (2008)
- Salvador Imaging (2009)
- OmniTech Partners (2009)
- Directed Perception (2009)
- Raymarine (2010)
- ICx Technologies (2010)
- TackTick Marine Digital Instruments (2011)
- Aerius Photonics (2011)
- Lorex Technology (2012)
- Traficon (2012)
- MARSS (2013)
- DigitalOptics micro-optics business (2013)



PATENT SPECIFICATION

DRAWINGS ATTACHED

Inventors: PER JOHAN LINDBERG and HANS GUNNER MALMBERG

1.057.624

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

We, AGA AKTIEBOLAG, formerly Svenska Aktiebolaget Gasaccumulator, of Lidingö, Sweden, a Swedish Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to scanning mechanisms and in particular to such mechanisms whereby electro-magnetic radiation is picked-up and applied thereby to radiation-responsive means from which values measured by the radiation-responsive means can be studied.

It is an object of the present invention to provide an improved scanning mechanism of the character indicated.

It is a further object of the present invention to provide improved scanning mechanism for continuously and automatically scanning a field of view for ascertaining the energy levels in such field.

It is a still further object of the present invention to provide a scanning mechanism for rapid scanning of a field.

A still further object of the present invention is to provide a scanning mechanism whereby, for continuous scanning, the retrace time is a relatively small value.

According to the present invention there is provided a scanning mechanism for receiving electromagnetic radiation within the optical, infra-red or ultra violet regions of the electromagnetic spectrum which includes a refracting prism adapted to be rotated about its longitudinal axis the end faces of the prism being polygons, each of which polygon has an even number of sides, of which opposite sides are parallel; a collecting refractive system having an image surface within the prism the axis of which system intersects the longitudinal axis of the prism; an aperture situated substantially on the axis of the collecting refractive system through which radiation passing through the prism can pass and a radiation responsive element behind said aperture for picking up such radiation.

Other objects and features of the present invention will be apparent from the following description given by way of example only and with reference to the accompanying diagrammatic drawings, in which:—

Fig. 1 is a side view of a scanning prism and illustrates the deflection of rays of electromagnetic radiation by the prism and the focussing of the rays at a fixed scanning aperture.

Fig. 2 graphically illustrates the scanning deflection as a function of the angle of rotation for various refractive indices of the prism.

Fig. 3 is a view showing the parraxial image surface for rays in two perpendicular planes for different indices of refraction of the prism.

The scanning mechanism of the present invention is particularly applicable to receiving electromagnetic radiation within the optical, ultra violet or infra-red regions of the electromagnetic spectrum, the incoming radiation being focused on a radiation-responsive element, which may be of a kind well known in the art and as such is not shown in the drawings.

Hitherto the main difficulty in achieving high scanning speeds has been of a mechanical nature. The present invention uses a rotating refractive prism for fast scanning in one direction; scanning perpendicular to this direction is slower and can be accomplished by other means, for example as by an oscillating mirror in the collecting optics. This slower scanning can also be accomplished by tilting the rotating axis of the prism. This

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SCANNING MECHANISM FOR ELECTROMAGNETIC RADIATION

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2 Claims. (Cl. 88—1)

This invention relates to an improved optical-scanning mechanism for receiving electromagnetic radiation and to radiation-responsive means utilizing such optical scanning.

It is an object of the invention to provide improved optical-scanning means of the character indicated.

It is another object of the invention to provide improved means for continuously and automatically scanning out a field of view for ascertaining energy levels in such field.

It is a further object of the invention to provide means for optical-scanning of said field of view many times per second.

A further specific object is to provide means for more accurate and efficient scanning of a field of view, the "dead" or nonutilized scanning time being reduced to a small value.

Other objects and various further features of novelty and invention will be pointed out or will occur to those skilled in the art from a reading of the following specification, in conjunction with the accompanying drawings. Said drawings show the principle of the invention.

FIG. 1 is a side view of a scanning prism showing the deflected rays in said prism and the necessary image surface for proper focussing of the fixed scanning aperture.

FIG. 2 is a diagram, which shows the scanning deflection as a function of the rotating angle of the prism for various indices of refraction of said prism,

FIG. 3 is a view showing said parraxial image surface for rays in two mutually perpendicular planes for different indices of refraction of said prism,

FIG. 4 is a side view showing the essential components of a complete scanning mechanism, and

FIG. 5 is a perspective view of a particular form of a scanning prism.

Briefly stated, our invention is in the following specification characterized as an arrangement for scanning a field of view, where the incoming radiation is focused on a radiation-responsive element.

The main difficulty of scanning a field of view in a short time is of mechanical nature. Our invention uses a rotating refractive prism for scanning in one direction. Scanning in a direction substantially perpendicular to said direction is slower than in the first mentioned direction and is accomplished by other means, as by a nodding mirror in the collecting optics. Said slower scanning can also be accomplished by tilting the rotating axis of said prism. The resulting scanning pattern is like the pattern of common television.

Said prism can be rotated very rapidly according to our invention and several thousands of scans per second can be accomplished. In this way our invention allows complete scanning of said field of view many times per second exceeding the frame frequency of ordinary motion pictures.

Referring to the drawings the arrangement according to our invention is characterized by an image surface generated inside the circumscribed circle of said prism by a collecting optics 9 in FIGURE 4. Said prism is in our invention of the form of a plane parallel refractive prism, which is in one case 1 shown in FIG. 1. Said prism has in our invention an even number of sides and is rotated about an axis 2 as indicated by the arrow in FIG. 4, that is perpendicular to the paper in FIG. 1. The said collecting optics has an optical axis 4, that intersects said rotating axis 2 and is perpendicular thereto. The image surface 5 generated by said collecting optical system is situated inside said prism. Just outside the circle 3 generated by said rotating prism and on the optical axis 4 a scanning aperture 6 is located, through which a radiation passes to the radiation energy responsive element 12 such as a photocell, bolometer or the like, depending upon the energy spectrum of interest.

When said prism rotates, the scanning aperture 6 scans a line on said image surface 5 and when a corner of said prism passes the scanning aperture 6 there is a substantially instantaneous return of the scan.

In FIGS. 1 and 4 there is shown an incoming ray of radiation a having a maximum deviation from the direction of the optical axis. In FIG. 1 α designates the angle of rotation of the prism, and x, y and z are the axes of a coordinate system, z being along the optical axis and z parallel to the axis of rotation 2. A point on the image surface 5 is defined by these coordinates, as indicated in the case of a point x, y in FIG. 1, the z coordinate of which is 0, since it is in the x, y plane.

The deflection of rays is shown in FIG. 2 in the y direction as a function of the turning angle φ, and index of refraction of said prism n.

The axis y in FIG. 2 refers to the same axis as in FIG. 2. FIG. 3 shows the necessary form (7 and 8) of the image surfaces of said optical system in order that said field of view shall be scanned without aberrations for various values of refractive index of said prism. Referring to FIG. 3 there are for every rotating angle φ and every refractive index of said prism n, two values of z. The larger of said two values of z corresponds to the image surface 7, that is generated by the rays in the plane of the paper i.e. the x, y plane and forming small angles with the x-axis. The smaller value of z corresponds to the image surface 8, that is generated by the rays, which are parallel with the x-z plane and form small angles with the x-y plane.

It is apparent from FIG. 3 that the aberrations, which are caused by the prism, can be neutralized to a substantial degree by a suitable choice of image surface. In this way it is possible according to our invention to achieve very high resolution in the optical scanning.

It is preferable if the refractive index of said prism has a value between 3 and 4 for the wave lengths used. Said index of refraction having a value of about 4 is specially advantageous both for yielding a linear scan and for allowing a relatively plane image surface. This is pointed out in FIG. 2 and FIG. 3. As is also shown in FIG. 2 a larger index of refraction of said prism gives a greater length of scan.

The material of said prism must in our invention be transparent for radiation in the energy spectrum of interest and it is preferable if the sides of said prism are coated with suitable material in order to reduce reflection.

The entry area of the rays coming from said optical system for varying turning angles φ does not extend near the corners of said prism in our invention which may therefore be rounded. This improves both the air resistance and the mechanical strength of the prism.

When said prism rotates and the scanning in the other direction is accomplished by the collecting optics the radiation energy responsive element 12 scans said field of view for various energy levels in such field. The output signals from said element are amplified and filtered and may be used to modulate the intensity of a moving spot on a cathode ray tube. The movement of said

Figure 14.1 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.

Figure 14.2 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.

Figure 14.3 2015: FLIR One, an accessory to iPhone and Android mobile phones. Weight: 90 g (3.2 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.

14.1 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.

14.2 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.

14.3 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.

15 History of infrared technology

Before the year 1800, the existence of the infrared portion of the electromagnetic spectrum wasn't even suspected. The original significance of the infrared spectrum, or simply ‘the infrared’ as it is often called, as a form of heat radiation is perhaps less obvious today than it was at the time of its discovery by Herschel in 1800.

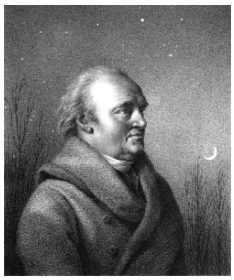

Figure 15.1 Sir William Herschel (1738–1822)

The discovery was made accidentally during the search for a new optical material. Sir William Herschel – Royal Astronomer to King George III of England, and already famous for his discovery of the planet Uranus – was searching for an optical filter material to reduce the brightness of the sun’s image in telescopes during solar observations. While testing different samples of colored glass which gave similar reductions in brightness he was intrigued to find that some of the samples passed very little of the sun’s heat, while others passed so much heat that he risked eye damage after only a few seconds’ observation.

Herschel was soon convinced of the necessity of setting up a systematic experiment, with the objective of finding a single material that would give the desired reduction in brightness as well as the maximum reduction in heat. He began the experiment by actually repeating Newton’s prism experiment, but looking for the heating effect rather than the visual distribution of intensity in the spectrum. He first blackened the bulb of a sensitive mercury-in-glass thermometer with ink, and with this as his radiation detector he proceeded to test the heating effect of the various colors of the spectrum formed on the top of a table by passing sunlight through a glass prism. Other thermometers, placed outside the sun’s rays, served as controls.

As the blackened thermometer was moved slowly along the colors of the spectrum, the temperature readings showed a steady increase from the violet end to the red end. This was not entirely unexpected, since the Italian researcher, Landriani, in a similar experiment in 1777 had observed much the same effect. It was Herschel, however, who was the first to recognize that there must be a point where the heating effect reaches a maximum, and that measurements confined to the visible portion of the spectrum failed to locate this point.

Figure 15.2 Marsilio Landriani (1746–1815)

Moving the thermometer into the dark region beyond the red end of the spectrum, Herschel confirmed that the heating continued to increase. The maximum point, when he found it, lay well beyond the red end – in what is known today as the ‘infrared wavelengths’.

When Herschel revealed his discovery, he referred to this new portion of the electromagnetic spectrum as the ‘thermometrical spectrum’. The radiation itself he sometimes referred to as ‘dark heat’, or simply ‘the invisible rays’. Ironically, and contrary to popular opinion, it wasn't Herschel who originated the term ‘infrared’. The word only began to appear in print around 75 years later, and it is still unclear who should receive credit as the originator.

Herschel’s use of glass in the prism of his original experiment led to some early controversies with his contemporaries about the actual existence of the infrared wavelengths. Different investigators, in attempting to confirm his work, used various types of glass indiscriminately, having different transparencies in the infrared. Through his later experiments, Herschel was aware of the limited transparency of glass to the newly-discovered thermal radiation, and he was forced to conclude that optics for the infrared would probably be doomed to the use of reflective elements exclusively (i.e. plane and curved mirrors). Fortunately, this proved to be true only until 1830, when the Italian investigator, Melloni, made his great discovery that naturally occurring rock salt (NaCl) – which was available in large enough natural crystals to be made into lenses and prisms – is remarkably transparent to the infrared. The result was that rock salt became the principal infrared optical material, and remained so for the next hundred years, until the art of synthetic crystal growing was mastered in the 1930’s.

Figure 15.3 Macedonio Melloni (1798–1854)

Thermometers, as radiation detectors, remained unchallenged until 1829, the year Nobili invented the thermocouple. (Herschel’s own thermometer could be read to 0.2 °C (0.036 °F), and later models were able to be read to 0.05 °C (0.09 °F)). Then a breakthrough occurred; Melloni connected a number of thermocouples in series to form the first thermopile. The new device was at least 40 times as sensitive as the best thermometer of the day for detecting heat radiation – capable of detecting the heat from a person standing three meters away.

The first so-called ‘heat-picture’ became possible in 1840, the result of work by Sir John Herschel, son of the discoverer of the infrared and a famous astronomer in his own right. Based upon the differential evaporation of a thin film of oil when exposed to a heat pattern focused upon it, the thermal image could be seen by reflected light where the interference effects of the oil film made the image visible to the eye. Sir John also managed to obtain a primitive record of the thermal image on paper, which he called a ‘thermograph’.

Figure 15.4 Samuel P. Langley (1834–1906)

The improvement of infrared-detector sensitivity progressed slowly. Another major breakthrough, made by Langley in 1880, was the invention of the bolometer. This consisted of a thin blackened strip of platinum connected in one arm of a Wheatstone bridge circuit upon which the infrared radiation was focused and to which a sensitive galvanometer responded. This instrument is said to have been able to detect the heat from a cow at a distance of 400 meters.

An English scientist, Sir James Dewar, first introduced the use of liquefied gases as cooling agents (such as liquid nitrogen with a temperature of -196 °C (-320.8 °F)) in low temperature research. In 1892 he invented a unique vacuum insulating container in which it is possible to store liquefied gases for entire days. The common ‘thermos bottle’, used for storing hot and cold drinks, is based upon his invention.

Between the years 1900 and 1920, the inventors of the world ‘discovered’ the infrared. Many patents were issued for devices to detect personnel, artillery, aircraft, ships – and even icebergs. The first operating systems, in the modern sense, began to be developed during the 1914–18 war, when both sides had research programs devoted to the military exploitation of the infrared. These programs included experimental systems for enemy intrusion/detection, remote temperature sensing, secure communications, and ‘flying torpedo’ guidance. An infrared search system tested during this period was able to detect an approaching airplane at a distance of 1.5 km (0.94 miles), or a person more than 300 meters (984 ft.) away.

The most sensitive systems up to this time were all based upon variations of the bolometer idea, but the period between the two wars saw the development of two revolutionary new infrared detectors: the image converter and the photon detector. At first, the image converter received the greatest attention by the military, because it enabled an observer for the first time in history to literally ‘see in the dark’. However, the sensitivity of the image converter was limited to the near infrared wavelengths, and the most interesting military targets (i.e. enemy soldiers) had to be illuminated by infrared search beams. Since this involved the risk of giving away the observer’s position to a similarly-equipped enemy observer, it is understandable that military interest in the image converter eventually faded.

The tactical military disadvantages of so-called 'active’ (i.e. search beam-equipped) thermal imaging systems provided impetus following the 1939–45 war for extensive secret military infrared-research programs into the possibilities of developing ‘passive’ (no search beam) systems around the extremely sensitive photon detector. During this period, military secrecy regulations completely prevented disclosure of the status of infrared-imaging technology. This secrecy only began to be lifted in the middle of the 1950’s, and from that time adequate thermal-imaging devices finally began to be available to civilian science and industry.

A note on the technical production of this publication

This publication was produced using XML — the eXtensible Markup Language. For more information about XML, please visit http://www.w3.org/XML/

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