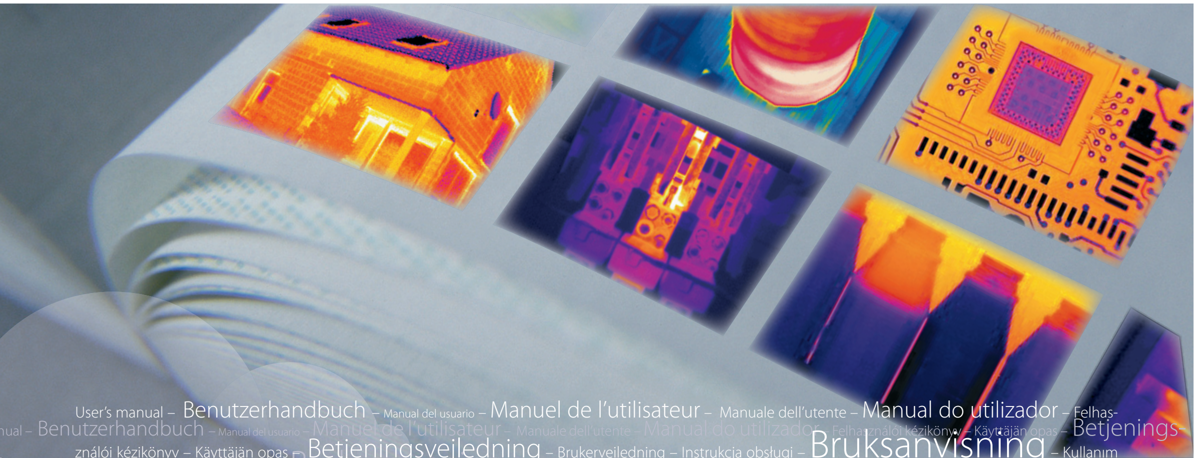
User's manual



FLIR A320
FLIR A325

Publ. No.	T559007
Revision	a277
Language	English (EN)
Issue date	April 21, 2008

User's manual

Publ. No. T559007 Rev. a277 – ENGLISH (EN) – April 21, 2008

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.

All products not manufactured by FLIR Systems included in systems delivered by FLIR Systems to the original purchaser carry the warranty, if any, of the particular supplier only and 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.

Copyright

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 described in this manual without prior notice.

Patents

This product is protected by patents, design patents, patents pending, or design patents pending.

One or several of the following patents, design patents, patents pending, or design patents pending apply to the products and/or features described in this manual:

Designation	Status	Reg. No.
China	Application	00809178.1
China	Application	01823221.3
China	Application	01823226.4
China	Design Patent	235308
China	Design Patent	ZL02331553.9
China	Design Patent	ZL02331554.7
China	Pending	200530018812.0
EPC	Patent	1188086
EPO	Application	01930377.5
EPO	Application	01934715.2
EPO	Application	27282912
EU	Design Patent	000279476-0001
France	Patent	1188086

Designation	Status	Reg. No.
Germany	Patent	60004227.8
Great Britain	Design Patent	106017
Great Britain	Design Patent	3006596
Great Britain	Design Patent	3006597
Great Britain	Patent	1188086
International	Design Patent	DM/057692
International	Design Patent	DM/061609
Japan	Application	2000-620406
Japan	Application	2002-588123
Japan	Application	2002-588070
Japan	Design Patent	1144833
Japan	Design Patent	1182246
Japan	Design Patent	1182620
Japan	Pending	2005-020460
PCT	Application	PCT/SE01/00983
PCT	Application	PCT/SE01/00984
PCT	Application	PCT/SE02/00857
PCT	Application	PCT/SE03/00307
PCT	Application	PCT/SE/00/00739
Sweden	Application	0302837-0
Sweden	Design Patent	68657
Sweden	Design Patent	75530
Sweden	Patent	518836
Sweden	Patent	522971
Sweden	Patent	524024
U.S.	Application	09/576266
U.S.	Application	10/476,760
U.S.	Design Patent	466540
U.S.	Design Patent	483782
U.S.	Design Patent	484155
U.S.	Patent	5,386,117
U.S.	Patent	5,637,871
U.S.	Patent	5,756,999
U.S.	Patent	6,028,309
U.S.	Patent	6,707,044
U.S.	Patent	6,812,465
U.S.	Patent	7,034,300

Designation	Status	Reg. No.
U.S.	Pending	29/233,400

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/.

Table of contents

1 Warnings & Cautions

WARNING

- This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instruction manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.
- (Applies only to cameras with laser pointer:) Do not look directly into the laser beam. The laser beam can cause eye irritation.
- Applies only to cameras with battery:
  - Do not disassemble or do a modification to the battery. The battery contains safety and protection devices which, if they become damaged, can cause the battery to become hot, or cause an explosion or an ignition.
  - If there is a leak from the battery and the fluid gets into 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.
  - 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.
  - Only use the correct equipment to discharge 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 and injury to persons.
- 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

- Do not point the infrared camera (with or without the lens cover) at intensive energy sources, for example devices that emit 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.
- Do not use the camera in a temperature higher than +50°C (+122°F), unless specified otherwise in the technical data section. High temperatures can cause damage to the camera.
- (Applies only to cameras with laser pointer:) Protect the laser pointer with the protective cap when you do not operate the laser pointer.
- Applies only to cameras with battery:
  - Do not attach the batteries directly to a car’s cigarette lighter socket.
  - Do not connect the positive terminal and the negative terminal of the battery to each other with a metal object (such as wire).
  - Do not get water or salt water on the battery, or permit the battery to get wet.
  - Do not make holes in the battery with objects. Do not hit the battery with a hammer. Do not step on the battery, or apply strong impacts or shocks to it.

- 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 process. If the battery becomes hot, damage can occur to the safety equipment and this can cause more heat, damage or ignition of the battery.
- Do not put the battery on a fire or increase the temperature of the battery with heat.
- Do not put the battery on or near fires, stoves, or other high-temperature locations.
- Do not solder directly onto the battery.
- Do not use the battery if, when you use, charge, or store the battery, there is an unusual smell from the battery, the battery feels hot, changes color, changes shape, or is in an unusual condition. Contact your sales office if one or more of these problems occurs.
- Only use a specified battery charger when you charge the battery.
- The temperature range through which you can charge the battery is ±0°C to +45°C (+32°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.
- The temperature range through which you can discharge the battery is −15°C to +50°C (+5°F to +122°F). Use of the battery out of this temperature range can decrease the performance or the life cycle of the battery.
- When the battery is worn, apply insulation to the terminals with adhesive tape or similar materials before you discard it.

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

2 Notice to user

Typographical conventions

This manual uses the following typographical conventions:

- **Semibold** is used for menu names, menu commands and labels, and buttons in dialog boxes.
- *Italic* is used for important information.
- `Monospace` is used for code samples.
- UPPER CASE is used for names on keys and buttons.

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/

PC software updates

FLIR Systems regularly issues PC software updates and service releases on the support pages of the company website:

http://www.flirthermography.com

To find the latest updates and service releases, make that sure you select **USA** in the **Select country** box in the top right corner of the page.

Calibration

(This notice only applies to cameras with measurement capabilities.)

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.

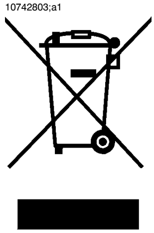
Accuracy

(This notice only applies to cameras with measurement capabilities.)

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

Disposal of electronic waste

10742803;a1



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.

Training

To read about infrared training, visit:

http://www.infraredtraining.com

2

INTENTIONALLY LEFT BLANK

3 Customer help

General

For customer help, visit:

http://flir.custhelp.com

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:

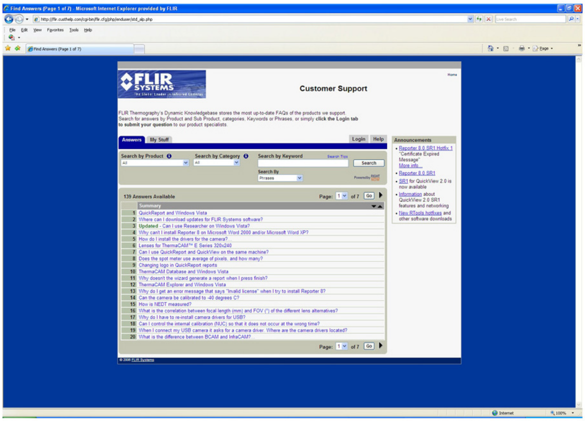
- The camera model
- The camera serial number
- The communication protocol, or method, between the camera and your PC (for example, Ethernet, USB™, or FireWire™)
- Operating system on your PC
- Microsoft® Office version
- Full name, publication number, and revision number of the manual

On the customer help site you will also be able to download program updates for your camera.

Figure

This figure shows the welcome page of FLIR Systems customer help site:

10776203;a1



INTENTIONALLY LEFT BLANK

4 Important note about this manual

General

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.

NOTE

FLIR Systems reserves the right to discontinue models, parts or accessories, and other items, or to change specifications at any time without prior notice.

INTENTIONALLY LEFT BLANK

5 Welcome!

10771503;a1

Twenty-four hours a day, seven days a week, and 365 days a year, the new FLIR A Series infrared camera gives you complete peace of mind that all is well. It keeps watch on your production site, with its infrared eye trained to notice anything that is amiss. It will spot an anomaly before it becomes a serious, costly and potentially life-threatening failure. And as soon as it does, an built-in alarm is triggered, and the camera will even send you an e-mail to alert you to the problem.

5.1 FLIR A320

Note: FLIR A320 was previously named ThermoVision™ A320.

5.1.1 Enhance work safety, avoid breakdowns, minimize production loss

We know where the risk areas are in our production process. We also know which assets are the most critical to production continuity. The difficulty is that we never know exactly where or when a problem might occur. And the gray areas don't stop there. It's not always possible to see a problem with the naked eye or to quantify its severity.

For certain industries this ability is vital. In oil and gas production and power generation or distribution there is a fundamental need to prevent and detect fires fast and automatically. Similarly, the integrity of critical vessels and infrastructure has to be monitored to avoid costly downtime and to ensure on-site safety.

The new and compact FLIR A320 from FLIR Systems meets all these needs with ease. This latest-generation fixed thermal camera can be installed discretely and almost anywhere to monitor your business. It will keep an infrared eye on your production process, safeguard plant and assets, and measure temperature differences so that the criticality of the situation may be assessed.

This advanced infrared camera will allow you to see problems before they become costly failures, preventing downtime and enhancing worker safety.

5.1.2 Unsurpassed functionality

The FLIR A320 infrared camera breaks new ground on many fronts, and comes with an impressive array of key features. For example, Power over Ethernet™ – an industry first – MPEG-4 streamed video, built-in and extensive analysis functionality, and automatic messaging via e-mail.

5.1.3 Extensive, built-in analysis functionality

There are a number of other significant 'firsts' for the FLIR A320. It is, for example, the first ever fixed mount thermal imaging camera with the ability to send analysis results, infrared images, and radiometric data via e-mail both on schedule or when triggered by an alarm. Another ground-breaking feature is the option of image masking functionality, enabling you to pre-select only the area of interest that you want to analyze.

5.1.4 Multi camera software

As with all FLIR Systems' cameras, the FLIR A320 comes with advanced and dedicated software that meets the analysis needs of a wide range of applications. IP Config Utility and IR Monitor – which supports up to nine cameras running simultaneously –

allow the production of an image within minutes of installation. In combination with the built-in analysis and alarm function, this software is the perfect tool for your set-up.

For those requiring a degree of low level programming, the AXXX Control & Image Interfaces are included. An optional Systems Development Kit (SDK) for Visual Studio users and a LabVIEW® toolkit are also available, enabling the functionality of the FLIR A320 to be optimized for specific needs.

5.1.5 Who will benefit from this technology?

The FLIR A320 is ideal for any industry where fire prevention, effective asset management, and fixed mount predictive maintenance are important. Typical users and applications are:

Oil and gas

Oil refineries and exploration, petrochemical plant, and natural gas processing, transport, and storage.

- Fire prevention in storage areas.
- Refractory lining monitoring.
- Flare detection.
- Process quality control.

Power distribution and generation

- Fire prevention in coal piles.
- Fire prevention in wood storage areas.
- Fire prevention in waste storage areas.
- Sub-station monitoring.
- Critical equipment monitoring.

5.1.6 Easy integration

Customer feedback has played an important role in the design of this camera, and a key request has been to make it quick and easy to integrate into other monitoring and control systems. As a result, the FLIR A320 has an open TCP/IP protocol for set-up and control. The choice of fast Ethernet™ opens the door for the use of a host of off-the-shelf industrial accessories . Standard Ethernet™ cables allow remote operation over a distance of up to 100 m/328 ft., and the use of standard converters and fiber optic cable allows this distance to be extended tenfold.

5.1.7 Live images

The camera provides excellent images, with a 320 × 240 pixel resolution from an in-house developed detector. The use of MPEG-4 allows you to view live images at 30 Hz with an image resolution of 640 × 480 pixel. All communication to and from the camera is via the Ethernet™ connection, which can also supply the power.

5.1.8 Affordable

In spite of the impressive feature set and simplicity of installation, the new addition to the FLIR Systems A Series comes at a favorable cost. This unit is easily affordable and enables a short return on investment.

5.1.9 Training

FLIR Systems cooperates closely with ITC, the Infrared Training Centre, an independent, ISO certified, worldwide training facility. The ITC offers infrared training as well as specialized instruction in many application areas.

5.2 FLIR A325 (for automation applications)

Note: FLIR A325 was previously named ThermoVision™ A320G.

5.2.1 Keeping a constant infrared eye on production quality

Production engineers and technicians are faced by demands for higher production output at a constant quality and at lower cost.

The new FLIR A325 infrared camera is designed to meet this challenge and to secure consistent production quality levels. It keeps a constant infrared eye on your production process and alerts you to any quality issue that may impair output and interrupt your value chain.

5.2.2 New models, more features, more ease-of-use

The FLIR A325 version is the first thermal camera to be GigE Vision™ and GenICam™ compatible, a feature that significantly cuts down on integration time. Until now, this capability has only been available for visual cameras. The camera is fully controlled from a PC, and come with a choice of software for easy configuration and monitoring.

The A-Series package is designed to get you up and running quickly and efficiently, allowing you to receive high speed, real time images of your productivity hotspots.

5.2.3 Save time, save cost, increase efficiency

Problems can occur at any time. In most cases, it will not be possible to see the problem with the naked eye or to quickly spot potentially harmful temperature variations. For many applications, such as the production of parts and components for the automotive or electronics industry, these data are critical.

While machine vision can see a production problem, it cannot detect thermal irregularities. Infrared imaging provides much more information for production specialists and decision makers. Indeed, for non-contact precision temperature measurement there is nothing to equal infrared. It adds a new dimension to machine vision, and is the perfect solution for applications involving non-contact precision temperature measurement and non-destructive testing.

The compact FLIR A325 is a new generation of thermal camera for fixed installations.

This advanced infrared camera gives you a sixth sense, allowing you to monitor what you can't see, providing quality assurance in the fastest and easiest way possible. It can be installed almost anywhere to monitor the efficiency of your production process by detecting and measuring temperature differences.

5.2.4 Who will benefit from this technology?

The FLIR A325 is a perfect instrument for industries which rely on permanent monitoring and non-contact precision temperature measurement.

Automotive

Cars and commercial vehicles, engine manufacturing, and subcontractors serving the industry.

- Soldering and welding.
- Car seat heating.
- Verification of window defrosting, heating, and air conditioning functions.
- Casting of plastic or metallic parts.
- Quality checking of laminated parts such as dashboards.
- Quality checking of leather upholstery.
- Friction control of tyres.

Electronics

Electronics design, PCB and component manufacture, and electronics assembly.

- PCB testing, validation, and verification.
- Fault tracing in board assemblies.
- Power electronics design.

This is just a selection of current applications for which the FLIR A325 can improve quality control. However, its scope and potential extends to many other industries and applications. FLIR Systems has considerable experience in fixed mount camera applications, and would be happy to assist you in finding a solution to your critical application problem.

5.2.5 Choice of software

In common with all FLIR Systems' cameras, the new A Series cameras come with the necessary software to get you started. IP Config Utility and IR Monitor allow the production of an image within minutes of installation. For those requiring a degree of low level programming, an AXXX control and image interface is included. An optional Systems Development Kit (SDK) for Visual Studio users and a LabVIEW® toolkit are also available, enabling the functionality of the camera to be optimized for specific needs.

5.2.6 Unsurpassed functionality

Customer feedback has played an important role in the design of this camera. A key request has been to make it accessible to current industry standard protocols.

The FLIR A325 infrared camera breaks new ground on many fronts, and comes with an impressive array of key features. Owing to its Gigabit Ethernet™ interface, this model provides an impressive 60 Hz high speed frame rate. Its software allows it to work within multi-camera installations, and includes simultaneous access to all the networked cameras.

5.2.7 Easy integration and standard compliance

The ability to follow standards and provide easy integration has been perfected in this new A Series camera. Evidence of this is clear, as the FLIR A325 is the first thermal camera ever to be compatible with GigE Vision™ and to support the GenICam™ protocol, making installation simple and quick. The GenICam™ compliance brings the additional benefit of compatibility with third party software such as IMAQ Vision and Common Vision Blox, etc.

5.2.8 Live images

The camera provides excellent live images with a 320 × 240 pixel resolution from an in-house developed detector. The Gigabit Ethernet™ interface ensures that even over long distances a high speed frame rate is achieved (up to 60 Hz of the full 16-bit image). This is an important factor, as many applications call for advanced image analysis and manipulation.

5.2.9 Easy operation – plug and play

Owing to its GigE Vision™ control protocol the FLIR A325 is very simple to use. Just install the software, connect the camera to the PC and start producing high quality, real-time radiometric images – plug and play at its very best.

5.2.10 Affordable

In spite of its impressive feature set and simplicity of installation, the new addition to the FLIR Systems A Series comes at a favorable cost. This unit is easily affordable and enables a short return on investment.

5.2.11 Training

FLIR Systems closely cooperates with ITC, the Infrared Training Centre, an independent, ISO certified, worldwide training facility. The ITC offers infrared training as well as specialized instruction in many application areas.

5.3 FLIR A325 (for R&D applications)

Note: FLIR A325 was previously named ThermoVision™ A320G.

5.3.1 Speed up your design cycle with infrared

The new FLIR A series infrared camera is designed to keep the thermal efficiency of your development project in constant check. It prevents design faults in the making, ensures quality and cuts time-to-market.

The new FLIR A325 has several time-saving features. It is the first thermal camera to comply with the GigE Vision™ camera communication protocol that allows fast image transfer with Gigabit Ethernet™, featuring GenICam™ standard compliance, which substantially eases system integration and configuration.

Until now, this compatibility has only been available for visual cameras.

This model is fully controlled from a PC, and comes with a choice of utility and measurement software to assist your set-up.

The A Series package is designed to get you up and running quickly and efficiently, allowing you to receive high speed, real time images of your research and development projects.

5.3.2 Perfect your design Improve your process

In the design process it is rarely possible to see a thermal problem with the naked eye or to measure temperatures over surfaces accurately.

Often, theoretical calculations and simulations do not give a satisfactory result without practical tests. And these are time consuming, requiring the precise connection of multiple thermocouples to prove the design. Infrared analysis speeds up the development process and makes it more efficient. It shows the complete picture, so that nothing is left to chance.

An infrared camera gives you a sixth sense, allowing you to measure, monitor, and analyze what you can’t see, providing data and evidence in the fastest and easiest way possible. It is the perfect tool for verifying and validating design to ensure that the product fulfills specifications. Infrared also adds another dimension to non-destructive testing.

The compact FLIR A325 is a new generation thermal camera for fixed installations from FLIR Systems. It can be installed almost anywhere to monitor your development process, detecting, measuring, and alerting you to any unwanted temperature difference.

5.3.3 Unsurpassed functionality

Customer feedback has played an important role in the design of this camera, and a key request has been to make it quick and easy to integrate via standard protocols.

The FLIR A325 infrared camera breaks new ground on many fronts, and comes with an impressive array of key features. Owing to its Gigabit Ethernet™ interface, this model provides an impressive 60 Hz high speed frame rate. The camera is available as a full package that includes the advanced FLIR Researcher software, allowing acquisition of images at 60 Hz and post-analyses.

5.3.4 Choice of software

In common with all FLIR Systems' cameras the new FLIR A325 come with the necessary software to get you started. IP Config Utility and IR Monitor allow the production of an image within minutes of installation. For those requiring a degree of low level programming, the AXXX Control & Image Interfaces are included.

For research and development applications, the advanced FLIR Researcher™ software is recommended. FLIR Researcher™ has been developed for use in scientific environments where detailed thermal analysis of dynamic events is required. It offers powerful tools for fast and extensive analysis. An optional Systems Development Kit (SDK) for Visual Studio users and a LabVIEW® toolkit are also available, enabling the functionality of the camera to be optimized for specific needs.

5.3.5 Who will benefit from this technology?

The FLIR A325 is perfect for tasks which require advanced monitoring and detection methods in the industrial or academic world.

Automotive

Cars and commercial vehicles, engine manufacture and subcontractors serving the industry.

- Soldering and welding.
- Verification of car seat heating.
- Verification of window defrosting, air conditioning, and heating.
- Casting of plastic or metallic parts.
- Quality checking of laminated parts, e.g. dashboards.
- Quality check of leather upholstery.
- Friction control of tyres.

Electronics

Electronics design, PCB and component manufacture, and electronics assembly.

- PCB testing, validation, and verification.
- Fault tracing in board assemblies.

- Power electronics design.

This is just an introduction to the applications for which the FLIR A325 can improve the design process. However, its scope and potential extends to many other industries and applications. FLIR Systems has considerable experience in applying this technology, and would be happy to assist you in finding a solution to your critical application problem.

5.3.6 Easy integration and standard compliance

The ability to follow standards and provide easy integration has been perfected in this new camera. Evidence of this is clear, as the FLIR A325 is the first thermal camera ever to be compatible with GigE Vision™ and to support the GenICam™ protocol, making installation simple and quick. The GenICam™ compliance brings the additional benefit of compatibility with third party software such as IMAQ Vision and Common Vision Blox.

5.3.7 Easy operation – plug and play

Owing to its GigE Vision™ control protocol, the FLIR A325 is very simple to use. Just install the software, connect the camera to the PC and start producing high quality, real-time radiometric images – plug and play at its very best.

5.3.8 Live images

The camera provides excellent live images with a 320 × 240 pixel resolution from an in-house developed detector.

The Gigabit Ethernet™ interface ensures that even over long distances a high speed frame rate is achieved (up to 60 Hz for the full 16-bit image). This is an important factor, as many applications call for advanced image analysis and manipulation.

5.3.9 Affordable

In spite of its impressive feature set and simplicity of installation, the new addition to the FLIR A Series comes at a favorable cost. This unit is easily affordable and enables a short return on investment.

5.3.10 Training

FLIR Systems cooperates closely with ITC, the Infrared Training Centre, an independent, ISO certified, worldwide training facility. The ITC offers infrared training as well as specialized instruction in many application areas.

6 Key features

FLIR A320

(**Note**: FLIR A320 was previously named ThermoVision™ A320.)

- 100 MB Ethernet™ (100 m/328 ft. CAT-6 Ethernet™ cable).
- Streaming of MPEG-4 image.
- PoE (Power over Ethernet™).
- Open and well described TCP/IP protocol for control and set-up.
- Extensive analysis functionality built-in.
- Extensive alarm functionality, as function of analysis and more.
- Messaging capabilities, scheduled or on alarm (e-mail (SMTP), file sending (FTP)).
- Synchronization through SNTP.
- 16-bit 320 × 240 images semi-real time. Signal and temperature linear.
- Built in web server with admin and user access rights.
- Composite video output.
- General purpose I/O.
- Multi-camera utility software included.
- Compatible with FLIR Systems FLIR Researcher, FLIR SDK, and FLIR LabVIEW® Toolkit.
- Additional lenses as optional extras.

FLIR A325

(**Note**: FLIR A325 was previously named ThermoVision™ A320G.)

- GigE Vision™ compliant.
- GenICam™ compliant.
- Uses standard CAT-6 Ethernet™ cables (100 m/328 ft.).
- Image flow control.
- 16-bit 320 × 240 images 60 Hz. Signal and temperature linear.
- Complies with any software that supports GenICam™, which includes National Instruments IMAQ Vision and Stemmer Common Vision Blox.
- Support within FLIR Systems' own software FLIR Researcher, FLIR SDK, FLIR LabVIEW® Toolkit for full radiometric images and analysis.
- Additional lenses as optional extras.

INTENTIONALLY LEFT BLANK

7 Typical applications

FLIR A320

(**Note**: FLIR A320 was previously named ThermoVision™ A320.)

- Safety applications with temperature alarms (multi-camera applications).
- Critical vessel monitoring.
- Power utility asset management.
- Low-end industrial control (multi-camera installations are possible).
- Fire prevention in storage areas.
- Refractory lining monitoring.
- Flare detection.
- Process quality control.
- Fire prevention on coal piles.
- Fire prevention in wood storage areas.
- Fire prevention in waste storage areas.
- Sub-station monitoring.
- Critical equipment monitoring.

FLIR A325

(**Note**: FLIR A325 was previously named ThermoVision™ A320G.)

- Any high-end infrared machine vision application that needs temperature measurements.
- Slag detection.
- Food processing.
- Electronics testing.
- Power resistor testing.
- Automotive.
- R&D.
- Soldering and welding.
- Car seat heating.
- Verification of window defrosting, heating, air conditioning functions.
- Casting of plastic or metallic parts.
- Quality checking of laminated parts such as dashboards.
- Quality checking of leather upholstery.
- Friction control of tyres.
- PCB testing, validation and verification.
- Fault tracing in board assemblies.
- Power electronics design.

INTENTIONALLY LEFT BLANK

8 Packing list

General

The number of parts and accessories included depends on the camera model and/or customer configuration.

Contents

Item	Part number
6-pole screw terminal	-
Documentation CD-ROM (including reference manuals in multiple languages)	T197031
Ethernet™ cable CAT-6, 2 m/6.6 ft. **Note:** Only CAT-6 Ethernet™ cables should be used with this camera.	T950004
FLIR A320 or A325 infrared camera	Model-dependent
FLIR System Tools & Utilities CD-ROM, including the following applications: ■ IP Config Utility ■ IR Monitor ■ AXXX Control & Image Interfaces	T197030
Power cable, pigtailed, 2 m/6.6 ft.	1910586
Power cord	One of the following: ■ EU: 1910400 ■ USA: 1910401 ■ UK: 1910402 ■ Australia: 1910464
Power supply, 110–220 VAC	1910585
Printed Getting Started Guide	T559000

NOTE

FLIR Systems reserves the right to discontinue models, parts or accessories, and other items, or to change specifications at any time without prior notice.

8

INTENTIONALLY LEFT BLANK

9 Software installation

General

Before you start using your infrared camera you must install a range of programs from the FLIR System Tools & Utilities CD-ROM.

What gets installed?

A complete installation installs the following programs:

Program	Explanation
Bonjour	Bonjour is a program from Apple that lets you create an instant network of computers and smart devices simply by connecting them. **Note:** You typically don't use this program interactively. *Default installation path:* C:\Program Files\Bonjour
ffdshow	ffdshow is a DirectShow and VFW codec for decoding/encoding many video and audio formats, including DivX and XviD movies using libavcodec, xvid, and other open source libraries with a rich set of postprocessing filters. **Note:** You typically don't use this program interactively. *Default installation path:* C:\Program Files\ffdshow
IP Config Utility	IP Config Utility is a setup and configuration program to detect and find FLIR A320/A325 cameras on a network and automatically assign or manually set IP addresses. *Default installation path:* C:\Program Files\FLIR Systems\FLIR System Tools and Utilities\IP Config Utility
IR Monitor	IR Monitor is a program to control FLIR A320/A325 cameras on a network. The program features are dependent on the camera model, but you typically use IR Monitor to change camera settings, lay out measurement tools on the screen, set up alarms, etc. *Default installation path:* C:\Program Files\FLIR Systems\FLIR System Tools and Utilities\IR Monitor

SEE

- Section 9.1 – System requirements on page 27

- Section 9.2 – Installation on page 28

9.1 System requirements

Operating system	■ Microsoft® Windows® XP Professional, with Service Pack 2 (SP-2) ■ Microsoft® Windows® Vista Ultimate 32-bit

Hardware	■ Personal computer with a 2 GHz 32-bit processor
	■ 1 GB of RAM, or greater
	■ 20 GB of hard disk space
	■ Super VGA (1024 × 768) or higher-resolution monitor
	■ Support for DirectX 9 graphics with:
	  ■ WDDM driver
	  ■ 128 MB of graphics memory (minimum)
	  ■ Pixel Shader 2.0 (in hardware)
	  ■ 32 bits per pixel
	■ DVD-ROM drive
	■ Audio output
	■ Keyboard and Microsoft® mouse, or a compatible pointing device

Software	Microsoft® Internet Explorer 6 or 7
SEE	For specific information about system requirements for the operating systems mentioned above, please visit: http://www.microsoft.com/windows/

9

9.2 Installation

General

Last minute changes and other important information can be found in the **readme** file on the CD-ROM. We recommend that you read this file before you install the programs.

NOTE

- If you experience problems during the installation, please visit our Customer Help by pointing your browser to http://flir.custhelp.com.
- You must be an Adminstrator or a user with Administrative Rights to install the programs.
- A complete installation consists of several subinstallations, of which some are installations from third-party vendors. Do not abort these subinstallations, as they are needed for the complete installation.
- A complete installation can take up to 10 minutes to complete.

Procedure

Follow this procedure:

1	Close down all applications.
2	Insert the FLIR System Tools & Utilities CD-ROM into the CD-ROM drive on the computer. The installation should start automatically. Should the installation not start automatically, start Windows® Explorer and double-click INSTALL.HTM on the CD-ROM.
3	Click Install IP Config Utility and IR Monitor. **Note:** If you are a software developer you will also need to install Install AXXX Control & Image Interfaces. This installations includes Interface Control Document (ICDs), user documentation and C-code examples. We recommend that you read through the documentation.
4	Follow the on-screen instructions.

10 Mechanical installation

10.1 Installation of fixed cameras

Mounting interfaces

The camera unit has been designed to allow it to be mounted in any position. The housing has three mounting interfaces – bottom, left, and right – each with the following threaded holes:

- 2 × M4 metric threaded holes
- 1 × UNC ¼"-20 standard tripod mount.

Notes on permanent mounting

If the camera unit is to be permanently mounted at the application site, certain steps are required.

The camera unit might need to be enclosed in a protective housing and, depending on the ambient conditions (e.g. temperature), the housing may need to be cooled or heated by means of water or air.

In very dusty conditions the installation might also need to have a stream of pressurized air directed at the lens, in order to prevent dust build-up.

Vibrations

When mounting the camera unit in harsh industrial environments, every precaution should be taken securing the unit.

If the environment exposes the unit to severe vibrations, there may be a need to secure the mounting screws by means of Loctite™ or any other industrial brand of thread-locking liquid, as well as to dampen the vibrations by mounting the camera unit on a specially designed base.

Further information

For further information regarding mounting recommendations and environmental enclosures, contact FLIR Systems.

10.2 Mounting and removing lenses

10.2.1 Mounting an additional infrared lens

NOTE

Do not touch the lens surface when you mount an infrared lens. If this happens, clean the lens according to the instructions in section 16.2 – Infrared lens on page 104.

Procedure

Follow this procedure to mount an additional infrared lens:

1	Push the lens release button to unlock the lens ring. The lens ring is made of plastic and holds the plastic lens cap.
2	Rotate the lens ring 30° counter-clockwise (looking at the front of the lens).
3	Carefully pull out the lens ring from the bayonet ring.
4	Correctly position the lens in front of the bayonet ring.
5	Carefully push the lens into position.
6	Rotate the lens 30° clockwise (looking at the front of the lens).

10.2.2 Removing an additional infrared lens

NOTE

- Do not touch the lens surface when you remove an infrared lens. If this happens, clean the lens according to the instructions in section 16.2 – Infrared lens on page 104.
- When you have removed the lens, put the lens caps on the lens immediately, to protect it from dust and fingerprints.

Procedure

Follow this procedure to remove an additional infrared lens:

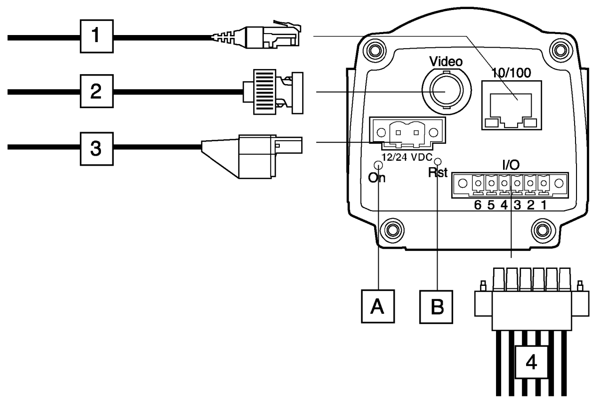
1	Push the lens release button to unlock the lens.
2	Rotate the lens counter-clockwise 30° (looking at the front of the lens).
3	Carefully pull out the lens from the bayonet ring.
4	Correctly position the lens ring in front of the bayonet ring.
5	Carefully push the lens ring into position.
6	Rotate the lens ring 30° clockwise (looking at the front of the lens).

10

11 Connectors, controls and indicators

Figure

10769803;a2



Explanation

This table explains the figure above:

<table>
<tr><td>1</td><td>Network cable with RJ45 connector for Ethernet™ connectivity and PoE™ (PoE™ applies only to FLIR A320 cameras)

Note: Only CAT-6 Ethernet™ cables should be used with this camera

Note: The LEDs indicate the following:
<table><tr><th>Camera</th><th>Left LED</th><th>Right LED</th></tr><tr><td>FLIR A320</td><td>The LED flashes yellow when sending/receiving data</td><td>The LED glows continuously green when a cable is connected (Link Detect)</td></tr><tr><td>FLIR A325 (previously named ThermoVision™ A320G)</td><td>The LED flashes green when sending/ receiving data</td><td>The LED glows continuously green when a cable is connected (Link Detect)</td></tr></table></td></tr>
<tr><td>2</td><td>Video cable with BNC connector for CVBS (composite video) output

Note: Applies only to FLIR A320 cameras.</td></tr>
<tr><td>3</td><td>Power cable for 12–24 VDC power in

Note: The power connector on the camera is polarity protected.</td></tr>
</table>

<table>
<tr><td>4</td><td>Digital I/O ports, opto-isolated (6-pole screw terminal)

Pin configuration:

1 IN 1
2 IN 2
3 OUT 1
4 OUT 2
5 I/O +
6 I/O –

For a schematic overview of the digital I/O ports, see page 110.</td></tr>
<tr><td>A</td><td>Power indicator

Note: The LEDs indicate the following:

<table><tr><th>Type of signal</th><th>Explanation</th></tr><tr><td>The LED glows continously orange</td><td>The camera is starting up</td></tr><tr><td>The LED glows continously red</td><td>An error has been detected. Contact service</td></tr><tr><td>The LED glows continously green</td><td>The camera has started</td></tr><tr><td>The LED flashes 10 times per second</td><td>An error has been detected. Contact service</td></tr></table></td></tr>
<tr><td>B</td><td>Hardware reset button (for a factory default reset)

Use an unbent paper clip or similar tool to press the reset button through the small hole on the back of the camera for 5 seconds, then release the button.</td></tr>
</table>

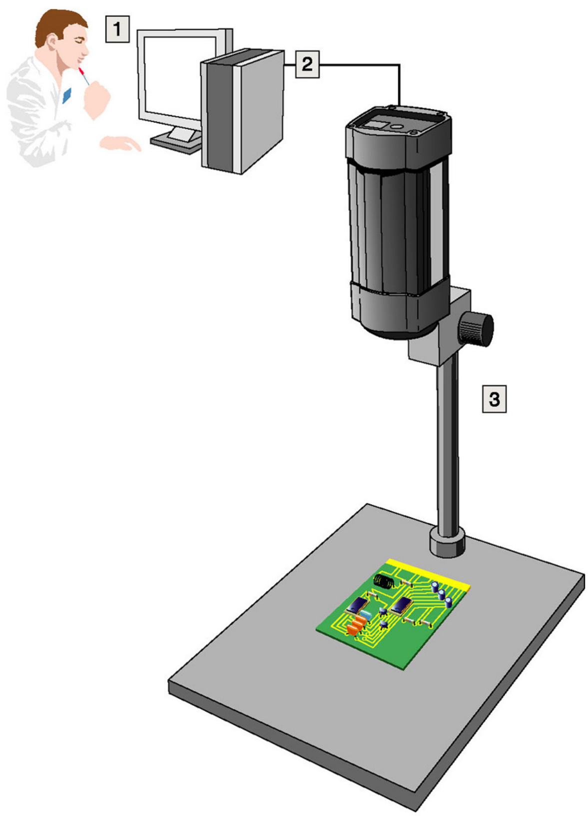
NOTE

Cables for digital I/O ports should be 100 m/328 ft. maximum.

12 Example system overviews

12.1 FLIR A325

Figure 10777303;a2



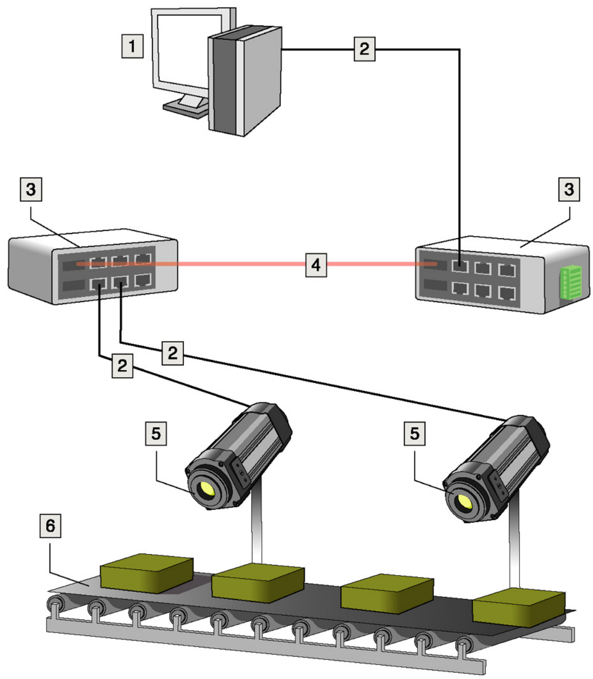
Explanation

This table explains the figure on the previous page:

1	Computer
2	CAT-6 Ethernet™ cable with RJ45 connectors
3	Laboratory set-up with theFLIR A325 camera

Figure

10777403;a2



Explanation

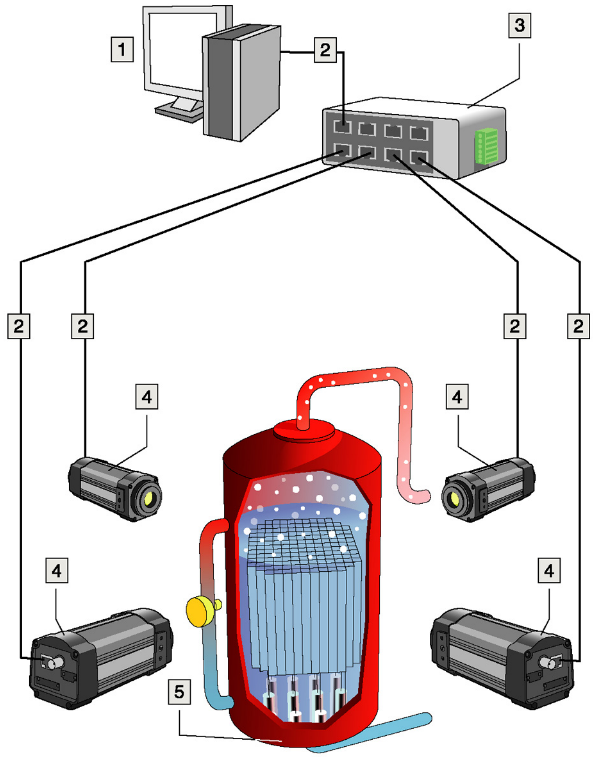
This table explains the figure on the previous page:

1	Computer
2	CAT-6 Ethernet™ cable with RJ45 connectors
3	Industrial Ethernet™ switches with fiber optic ports
4	Fiber optic cable
5	FLIR A325 cameras
6	Industrial process to be monitored, e.g. items on a conveyor belt

12.2 FLIR A320

Figure

10777503;a2



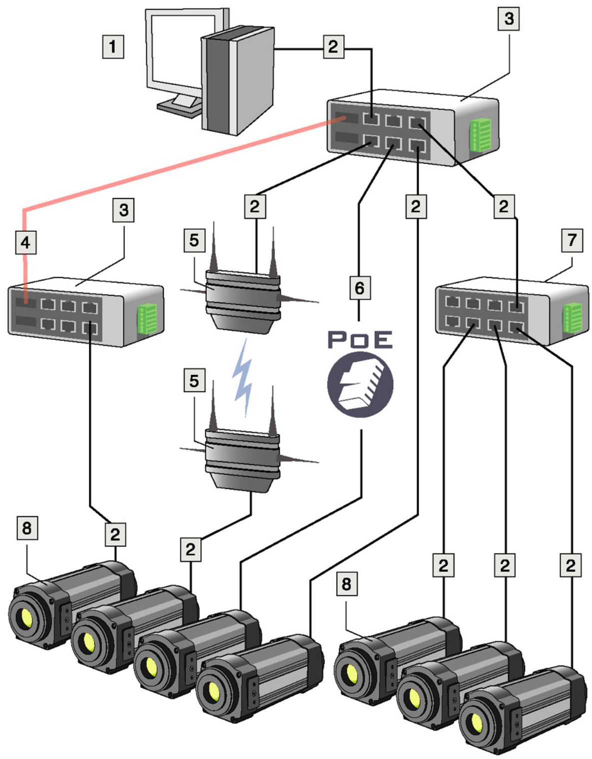
Explanation

This table explains the figure on the previous page:

1	Computer
2	CAT-6 Ethernet™ cable with RJ45 connectors
3	Industrial Ethernet™ switch
4	FLIR A320 cameras
5	Industrial process to be monitored, e.g. a gasifier

Figure

10777603;a2



Explanation

This table explains the figure on the previous page:

1	Computer
2	CAT-6 Ethernet™ cable with RJ45 connectors
3	Industrial Ethernet™ switches with fiber optic ports
4	Fiber optic cable
5	Wireless access points
6	CAT-6 Ethernet™ cable with RJ45 connectors. Powering the camera using PoE (Power over Ethernet™)
7	Industrial Ethernet™ switch
8	FLIR A320 cameras

13 Detecting cameras in a network

General

Before you start working with the cameras, you need to detect which cameras are available in the Ethernet™ network. You may also want to change various settings for the cameras at this stage, but this is not mandatory.

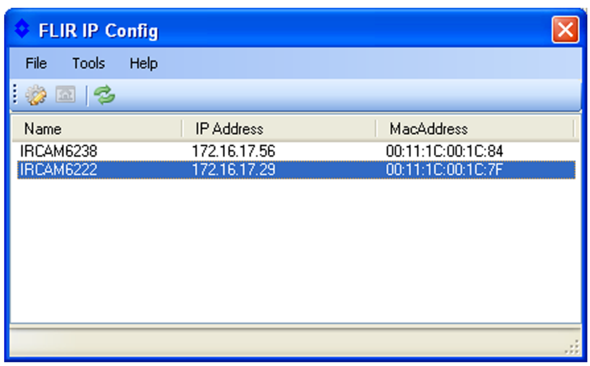
You detect cameras by using the IP Config Utility program, which was installed during the installation of the FLIR System Tools & Utilities program suite. With the IP Config Utility program, you can do one or more of the following:

- Automatically assign or manually set the IP address for a camera.
- Set the subnet mask for a camera.
- Set the default gateway for a camera.
- (Applies only to FLIR A320 cameras.) Go to the camera's web interface. (For procedures related to the user web, refer to section 14.1 – Using the camera's web interface on page 46.)

Figure

This figure shows a typical main screen of the IP Config Utility program.

10771103;a1



13

Procedure

Follow this procedure:

1	On the **Start** menu, click IP Config Utility (Start > Programs > FLIR Systems > FLIR System Tools & Utilities > IP Config Utility).
2	In the list of detected cameras, do one of the following: ■ Right-click one camera and select **Modify**. ■ Select one camera and click  on the toolbar. This will display the **IP address settings** dialog box.
3	In the **IP address settings** dialog box, you can enter new values for one or more of the following parameters: ■ **IP address** ■ **Subnet mask** ■ **Default gateway**
4	Click **OK**.

NOTE

- For complete information on interface elements, refer to section 15 – Alphabetical index of interface elements on page 67.
- A network switch may have the STA (Spanning Tree Algorithm) enabled. The STA blocks all packets from a new connected port for a ‘Forward Delay’ second. This ‘Forward Delay’ is usually between 15 and 45 seconds. A GigE Vision™ device complying with the GigE Vision™ standard states that a device must attempt for only 6 seconds (± 2 seconds) to get its IP Address through DHCP before using LLA (Local Link Address = 169.254.x.x) to get its IP Address. The DHCP process for a GigE Vision™ compliant device may fail if connected to a switch which has STA enabled. To prevent this from happening, the Forward Delay should be set at 4 seconds, or the STA disabled for the switch port.
- **If you change the IP address you need to restart the camera (applies only to the FLIR A325 camera).**

INTENTIONALLY LEFT BLANK

14 Controlling the camera

General

You can control the camera using two different methods:

- Using the camera's web interface. The web interface resides on the camera's internal web server. Applies only to the FLIR A320 camera.
- Using the IR Monitor program, which was installed during the installation of FLIR System Tools & Utilities.

Important difference

One important difference between using the camera's web interface and using IR Monitor is the following:

With the camera's web interface you can only control one camera, but with IR Monitor you can control multiple cameras at the same time.

SEE

- Section 14.1 – Using the camera's web interface on page 46
- Section 14.2 – Using IR Monitor on page 54

14

14.1 Using the camera’s web interface

NOTE

- This section applies only to the FLIR A320 camera.
- The default password for the web interface is IRCAM (case-sensitive).
- You may need to install certain components the first time you go to the camera’s web interface. To do this, click the **Install** button, follow the on-screen instructions, and then reload the page by pressing F5.

When to use the camera’s web interface

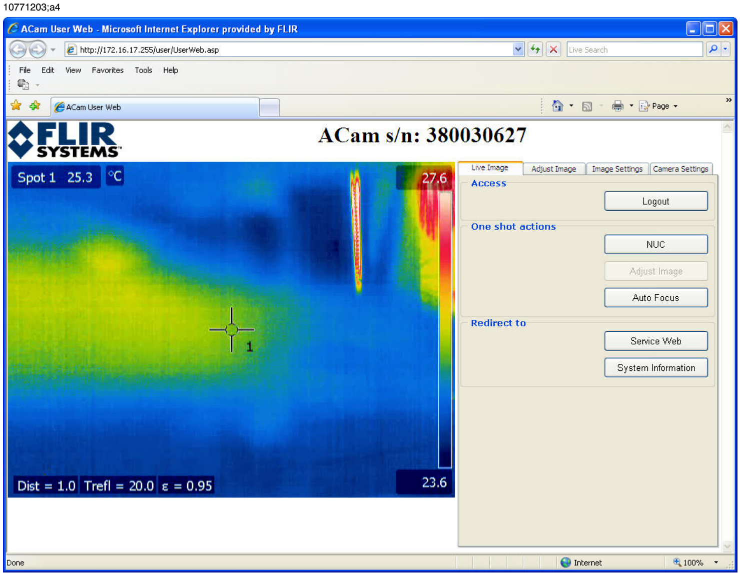
You typically use the camera’s web interface when doing one or more of the following:

- When carrying out image adjustments, such as non-uniformity corrections, adjusting the level and span, changing the frame rate, changing the compression ratio, or changing the color palette.
- When changing regional options, such as units, the date and time format, or the clock synchronization.
- When focusing the camera and using the zoom.
- When looking for technical information on the camera, such as hardware and software versions, and serial numbers.

Figure

This figure shows a typical main window of the camera’s web interface.

10771203;a4



How to access the camera’s web interface

Follow this procedure:

1	On the **Start** menu, click IP Config Utility (Start > Programs > FLIR Systems > FLIR System Tools & Utilities > IP Config Utility).
2	In the list of detected cameras, do one of the following: ■ Right-click one camera and select **Web**. ■ Select one camera and click  on the toolbar. ■ Double-click the camera. This will open the camera’s web interface in your web browser.

14.1.1 Typical procedures related to the camera's web interface

General

This section describes a number of typical procedures related to the camera's web interface.

For detailed information on all interface elements – menus, buttons, list boxes, etc. – refer to section 15 – Alphabetical index of interface elements on page 67.

SEE

- Section 14.1.1.1 – Adjusting and autofocusing the camera on page 49
- Section 14.1.1.2 – Change settings related to images on page 50
- Section 14.1.1.3 – Adjusting images on page 51
- Section 14.1.1.4 – Changing settings related to the camera on page 52
- Section 14.1.1.5 – Manage passwords, testing I/O ports, and restarting the camera on page 53

14.1.1.1 *Adjusting and autofocusing the camera*

General

You adjust and autofocus the camera on the **Live image** tab. On this tab you can also get technical information on the camera. You will typically need this technical information when contacting customer support, or our service departments.

Procedure

Follow this procedure:

1	Click the **Live image** tab.
2	In the right pane, do one or more of the following: ■ To perform a non-uniformity correction, click **NUC** ■ To autofocus the camera, click **Autofocus** ■ To find technical information about the camera, click **System Information**.

SEE

For complete information on interface elements, refer to section 15 – Alphabetical index of interface elements on page 67.

14.1.1.2 *Change settings related to images*

General

You adjust images on the **Image Settings** tab.

Procedure

Follow this procedure:

1	Click the **Image Settings** tab.
2	In the right pane, do one or more of the following: ■ To up- or downsample the video stream resolution, select a new size in the **Size in pixels** list box ■ To change the frame rate, select a new frame rate in the **Frame rate** list box ■ To change the compression ratio of the MPEG-4 video, select a new compression ratio in the **Compression quality** list box ■ To turn on/turn off the overlay graphics, select or clear the **Overlay** check box ■ To change the color palette used for the infrared image, select a new color palette in the **Palette** list box.

SEE

For complete information on interface elements, refer to section 15 – Alphabetical index of interface elements on page 67.

14.1.1.3 Adjusting images

General

You control many image properties on the **Adjust Image** tab.

Procedure

Follow this procedure:

1	Click **Adjust Image** tab.
2	In the right pane, do one or more of the following: ■ To change the adjustment method used for adjusting images, select a method (**Auto color distr.**, **Manual, latch to**) and a corresponding value ■ To change the level and span, type a value in the appropriate text box or use the sliders ■ To change the object temperature range, select a new temperature range in the **Temperature range** list box ■ To focus the camera, click the appropriate focus buttons ■ To select a different object temperature range, select a temperature range in the list box ■ To zoom in on images, click the appriopriate zoom buttons.

SEE

For complete information on interface elements, refer to section 15 – Alphabetical index of interface elements on page 67.

14.1.1.4 Changing settings related to the camera

General

You configure the camera on the **Settings** subtab of the **Camera Settings** tab.

Procedure

Follow this procedure:

1	Click the **Camera Settings** tab, then click the **Settings** subtab.

2	In the right pane, do one or more of the following:
	■ To change the language, select a new language in the **Language** list box
	■ To change the temperature and distance units, select the corresponding list box and select a new unit
	■ To change the date and time format, select the corresponding list box and select a new format
	■ To set the time, do one of the following:
	  ■ Click **Set client time** and make the appropriate settings
	  ■ Select the **Sync to source** check box and enter a time sync URL in the text box.

SEE

For complete information on interface elements, refer to section 15 – Alphabetical index of interface elements on page 67.

14.1.1.5 Manage passwords, testing I/O ports, and restarting the camera

General

You change the password, test I/O ports, and restart the camera on the **Test** subtab of the **Camera Settings** tab.

Procedure

Follow this procedure:

1	Click the **Camera Settings** tab, then click the **Test** subtab.

2	In the right pane, do one or more of the following:
	■ Manage the password
	■ Restart the camera
	■ Enable/disable automatic NUC (non-uniformity correction)
	■ To test digital I/O ports, do one or more of the following:
	  ■ To test a *digital in* port, connect the external device and note the displayed color – red indicates a low digital in signal, while green indicates a high digital in signal.
	  ■ To test a *digital out* port, connect the external device and set the type of digital out signal that you want to send (**Off**, **Low**, **High**).

NOTE

- The default password for the web interface is IRCAM (case-sensitive).
- If you change the password, the new password must be at least six characters long.

SEE

For complete information on interface elements, refer to section 15 – Alphabetical index of interface elements on page 67.

14.2 Using IR Monitor

NOTE

- The majority of the functions and features in IR Monitor apply only to FLIR A320 camera.
- The first time you start IR Monitor you will need to make an active selection to use ffdshow to view images in IR Monitor. The recommendation is to select Use ffdshow (always) in the dialog box that is displayed.
- In order to view Axis camera images in IR Monitor, a specific Axis component must be installed on the computer, the *Axis Media Control*. There are two ways to obtain that component – either through the Axis camera interface or by downloading it from the Axis home page on the Internet (http://www.axis.com).
- In Windows® Vista, problems with displaying the image stream may occur. This problem is related to Group Policy. Please contact your IT department for support on this issue.

When to use IR Monitor

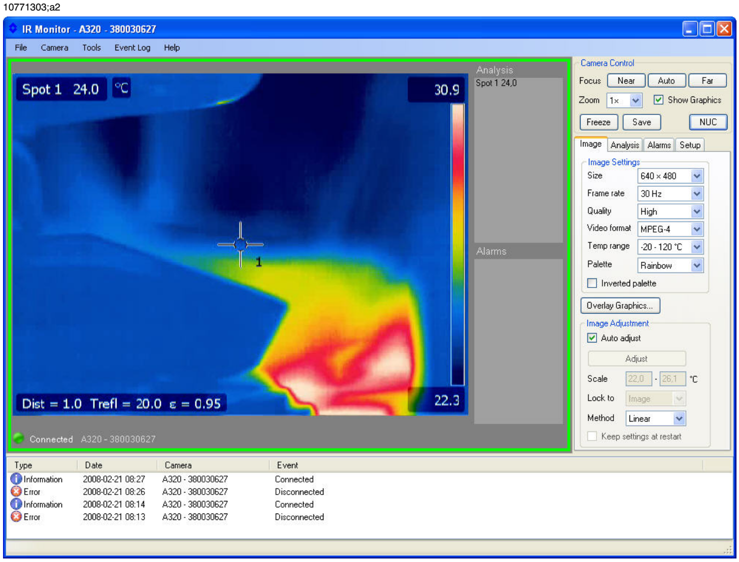
You typically use IR Monitor when doing one or more of the following:

- When laying out and moving analysis tools on the infrared image.
- When setting up alarms.
- When changing object parameters.
- When laying out or editing grid overlays on the infrared image.

Figure

This figure shows a typical main window of IR Monitor.

10771303;a2



How to start IR Monitor

To start IR Monitor, click IR Monitor on the **Start** menu (Start > Programs > FLIR Systems > FLIR System Tools & Utilities > IR Monitor).

14.2.1 Typical procedures related to IR Monitor

General

This section describes a number of typical procedures related to IR Monitor.

For detailed information on all interface elements – menus, menu commands, command buttons, list boxes, etc. – refer to section 15 – Alphabetical index of interface elements on page 67.

SEE

- Section 14.2.1.1 – Connecting to one or more cameras on page 56
- Section 14.2.1.2 – Changing object parameters on page 57
- Section 14.2.1.3 – Changing settings related to infrared images on page 58
- Section 14.2.1.4 – Laying out analysis tools on page 59
- Section 14.2.1.5 – Working with measurement masks on page 60
- Section 14.2.1.6 – Moving and resizing analysis tools on page 61
- Section 14.2.1.7 – Setting up a difference calculation on page 62
- Section 14.2.1.8 – Setting up an alarm on page 63

14.2.1.1 Connecting to one or more cameras

General

In IR Monitor, you can display live images from one or more cameras on a network at the same time. To do this you connect the camera/cameras to IR Monitor using a **Select camera** dialog box.

Procedure

Follow this procedure:

1	On the **Camera** menu, select **Connect**. This will display a **Select camera** dialog box.
	In the right pane of the dialog box, create a camera grid by using the **Rows** and **Columns** list boxes.
2	In the left pane of the **Select camera** dialog box, select the camera/cameras you want to connect to IR Monitor.
3	Drag-and-drop the selected camera/cameras into the camera grid that you created.
4	Click **View cameras in grid** to close the dialog box and go back to the main window of IR Monitor. You will now see live images from the camera/cameras you have selected.

SEE

For complete information on interface elements, refer to section 15 – Alphabetical index of interface elements on page 67.

14.2.1.2 *Changing object parameters*

General

For accurate measurements, you must set the object parameters. This procedure describes how to change the parameters.

Procedure

Follow this procedure:

1	Click the **Setup** tab.
2	To enter new values, type the desired values in the appropriate text boxes.

NOTE

- If you have connected several cameras to IR Monitor you must activate the corresponding camera window before changing settings. To do this, click the window.
- You can copy one camera's object parameters to the camera that is currently displayed. To do this, click **Copy to** and select a camera.

SEE

For complete information on interface elements, refer to section 15 – Alphabetical index of interface elements on page 67.

14.2.1.3 Changing settings related to infrared images

General

You change settings related to the the infrared images on the **Image** tab.

Procedure

Follow this procedure:

1	Click the **Image** tab.

2	Do one of the following:
	▪ To change an image setting, select a new value in the appropriate list box
	▪ To adjust the image, do one of the following:
	  ▪ Select **Auto adjust** to make the camera automatically adjust the image
	  ▪ Clear **Auto adjust**, enter values for the scale limits and adjustment method, and click **Adjust**.

NOTE

- You can also change these settings using the camera's web interface.
- If you have connected several cameras to IR Monitor you must activate the corresponding camera window before changing settings. To do this, click the window.

SEE

For complete information on interface elements, refer to section 15 – Alphabetical index of interface elements on page 67.

14.2.1.4 Laying out analysis tools

General

You lay out analysis tools using the functions on the **Analysis** tab.

Procedure

Follow this procedure:

1	Click the **Analysis** tab.
2	In the list, select an analysis tool, e.g. an area.
3	Click **Edit**.
4	In the dialog box that is displayed, make the appropriate changes and then click **OK** or **Apply**.

NOTE

If you have connected several cameras to IR Monitor you must activate the corresponding camera window before changing settings. To do this, click the window.

SEE

For complete information on interface elements, refer to section 15 – Alphabetical index of interface elements on page 67.

14

14.2.1.5 Working with measurement masks

General

A measurement mask is a manually created free-form area within a fixed measurement area that can be used when working with alarms.

For example, if you create a rectangular area but only want an alarm to trigger if conditions are met in a smaller, irregularly shaped area inside the rectangular area, use a measurement mask to achieve this.

Procedure

Follow this procedure:

1	Click the **Analysis** tab.
2	Create a measurement area and make it active, according to section 14.2.1.4 – Laying out analysis tools on page 59.
3	Select the **Use Measurement Mask** check box.
4	Click **Measurement Mask**. This will display the **Measurement Mask** dialog box.
5	In the **Measurement Mask** dialog box, select a pen size in pixels and use the cursor to paint a free-form area within the measurement area that you previously created.
6	To leave the dialog box and apply the mask to the selected camera, click **OK**.

NOTE

- If you have connected several cameras to IR Monitor, you must activate the corresponding camera window before changing settings. To do this, click the window.

SEE

For complete information on interface elements, refer to section 15 – Alphabetical index of interface elements on page 67.

14.2.1.6 Moving and resizing analysis tools

General

You move and resize analysis tools using the functions on the **Analysis** tab.

Procedure

Follow this procedure:

1	Click the **Analysis** tab.
2	In the list box, select an analysis tool.
3	Click **Edit**.
4	In the dialog box that is displayed, make the appropriate changes and then click **OK** or **Apply**.

NOTE

If you have connected several cameras to IR Monitor you must activate the corresponding camera window before changing settings. To do this, click the window.

SEE

For complete information on interface elements, refer to section 15 – Alphabetical index of interface elements on page 67.

14.2.1.7 Setting up a difference calculation

General

You set up difference calculations using the functions on the **Analysis** tab. A difference calculation returns the result of the subtraction between two different measurement results.

Setting up a difference calculation assumes that at least two previous analysis tools have been laid out. These analysis tools must be either two spotmeters, or one spotmeter and one area.

Procedure

Follow this procedure:

1	Click the **Analysis** tab.
2	In the list box, select **Diff**.
3	Click **Edit**. This will display the **Edit** dialog box.
4	In the **Function 1** list box, select the first analysis tool to be used in the subtraction.
5	In the **Result 1** list box, select the result type that you want to use for the first analysis tool.
6	In the **Function 2** list box, select the second analysis tool to be used in the subtraction.
7	In the **Result 2** list box, select the result type that you want to use for the second analysis tool.
8	Click **OK** or **Apply**.

NOTE

If you have connected several cameras to IR Monitor you must activate the corresponding camera window before changing settings. To do this, click the window.

SEE

For complete information on interface elements, refer to section 15 – Alphabetical index of interface elements on page 67.

14.2.1.8 Setting up an alarm

General

You set up alarms on the **Alarm** tab.

An alarm can be triggered by several different sources, such as a measurement result in the image, a digital input, or an internal temperature sensor.

When an alarm is triggered, the camera can carry out one or more tasks. For example, it can e-mail the image frame for which the alarm was triggered to a mail recipient, send the image to an FTP site, or save the image to memory. The camera can also further trigger a variety of external devices, using the digital output.

Setting an alarm based on the measurement result

Follow this procedure:

1	Click the **Alarm** tab.
2	In the list box, select an alarm.
3	Click **Edit**.
4	Click the **Measurement** tab.
5	In the **Function** list box, select the analysis tool that you want to use to trigger the alarm. The analysis tool must be one that you created in section 14.2.1.4 – Laying out analysis tools on page 59.
6	In the **Result type** list box, select the type of analysis result that you want to use to trigger the alarm.
7	In the **Alarm type** list box, the type of alarm (**Above**, **Below**, **Match**).
8	In the **Value** text box, enter the temperature level that will be used as the trigger limit.
9	In the **Threshold time** text box, enter the duration that must be matched or exceeded in order for the alarm to be triggered. Duration identifies the amount of time that has to pass before an alarm is triggered. This can be used as a powerful tool to avoid false alarms.
10	In the **Hysteresis** text box, enter the hysteresis value. Hysteresis is the interval within which the temperature value is allowed to vary without causing a change in the trigger. If the threshold is set above, for example, 30.00°C and the hysteresis is set at 2.00°C, the trigger goes high when the temperature rises above 30.00°C and stays high until the temperature sinks below 28.00°C. In contrast, if the threshold is set below 30.00°C, and the same hysteresis value is kept, the trigger goes high if the temperature sinks below 30.00°C and stays high until the temperature rises above 32.00°C.
11	Under **Alarm actions**, decide what actions the camera will take when an alarm is triggered.
12	Click **Activate alarm**.

13	Click **OK** to leave the dialog box.

NOTE If you have connected several cameras to IR Monitor you must activate the corresponding camera window before changing settings. To do this, click the window.

SEE For complete information on interface elements, refer to section 15 – Alphabetical index of interface elements on page 67.

Setting an alarm based on the digital input

Follow this procedure:

1	Click the **Alarm** tab.
2	In the list box, select an alarm.
3	Click **Edit**.
4	Click the **Digital input alarm** tab.
5	In the **Input** list box, select the digital input I/O port to use.
6	Under **Actions**, decide what actions the camera will take when an alarm is triggered.
7	Click **Activate alarm**.
8	Click **OK** to leave the dialog box.

NOTE

If you have connected several cameras to IR Monitor you must activate the corresponding camera window before changing settings. To do this, click the window.

SEE

For complete information on interface elements, refer to section 15 – Alphabetical index of interface elements on page 67.

Setting an alarm based on internal temperature sensor

Follow this procedure:

1	Click the **Alarm** tab.
2	In the list box, select an alarm.
3	Click **Edit**.
4	Do one of the following: ■ To trigger the alarm above a set temperature, select the **Condition above** check box ■ To trigger the alarm below a set temperature, clear the **Condition above** check box.
5	In the **Duration** text box, enter the duration that must be matched or exceeded in order for the alarm to be triggered. The minimum duration identifies the amount of time that has to pass before an alarm is triggered. This can be used as a powerful tool to avoid false alarms.
6	In the **Hysteresis** text box, enter a temperature value for hysteresis. Hysteresis is the interval within which the temperature value is allowed to vary without causing a change in the trigger. If the threshold is set above, for example, 30.00°C and the hysteresis is set at 2.00°C, the trigger goes high when the temperature rises above 30.00°C and stays high until the temperature sinks below 28.00°C. In contrast, if the threshold is set below 30.00°C, and the same hysteresis value is kept, the trigger goes high if the temperature sinks below 30.00°C and stays high until the temperature rises above 32.00°C.
7	In the **Value** text box, enter a temperature level above or below which the alarm will be triggered.
8	Under **Actions**, decide what actions the camera will take when an alarm is triggered.
9	Click **Activate alarm**.
10	Click **OK** to leave the dialog box.

NOTE

If you have connected several cameras to IR Monitor you must activate the corresponding camera window before changing settings. To do this, click the window.

SEE

For complete information on interface elements, refer to section 15 – Alphabetical index of interface elements on page 67.

14

15 Alphabetical index of interface elements

General

This section provides an alphabetical list of menu names, menu commands, buttons, and list boxes, with explanations and comments.

SEE

- Section 15.1 – IR Monitor on page 68
- Section 15.2 – IP Config Utility on page 90
- Section 15.3 – Camera web interface on page 92

15.1 IR Monitor

15.1.1 Explanation of interface elements (in alphabetical order)

10776903;a2

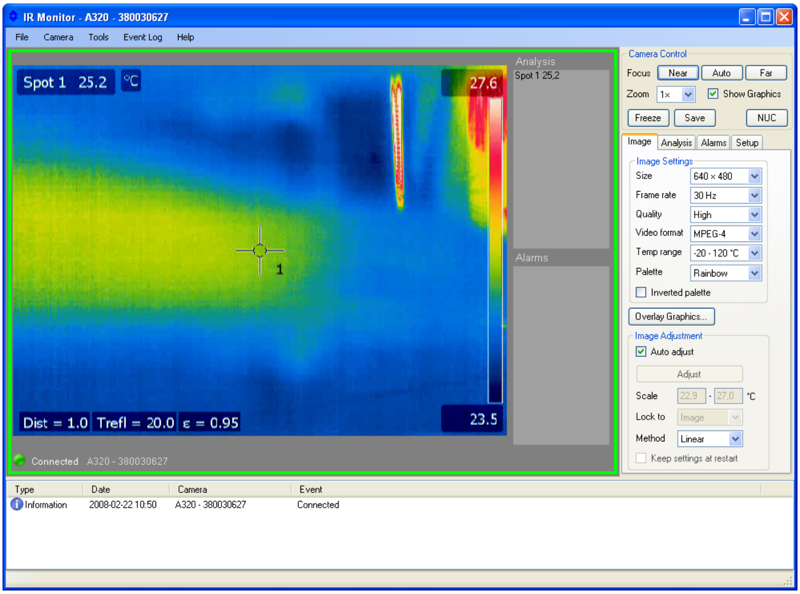


Figure 15.1 Image tab

10777003;a2

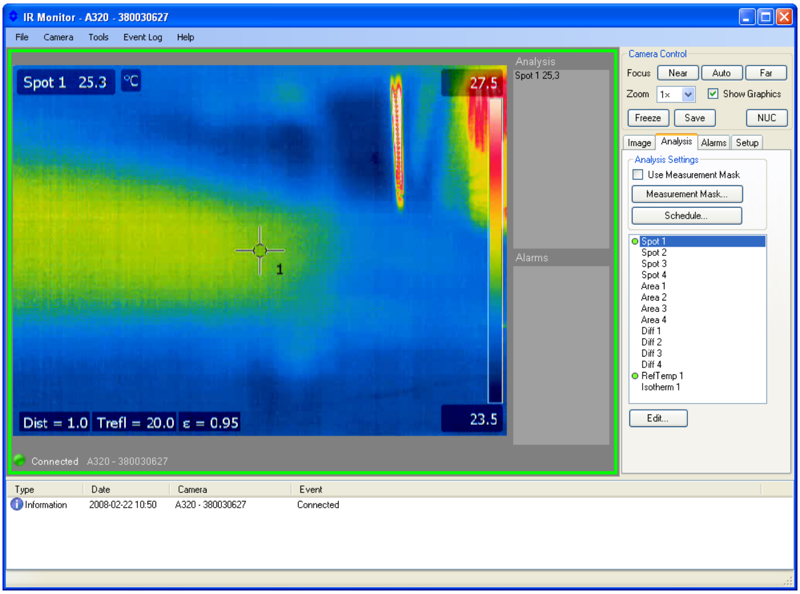


Figure 15.2 Analysis tab

10777103;a2

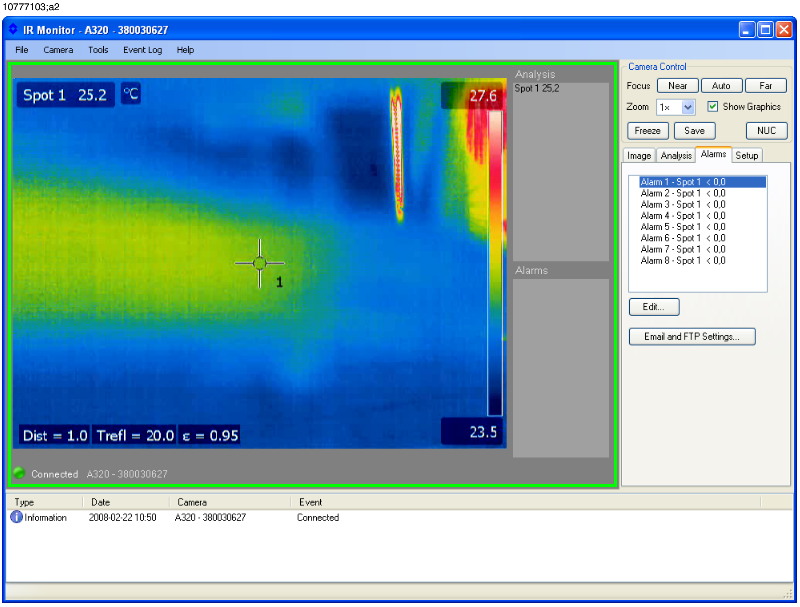


Figure 15.3 Alarms tab

10777203;a2

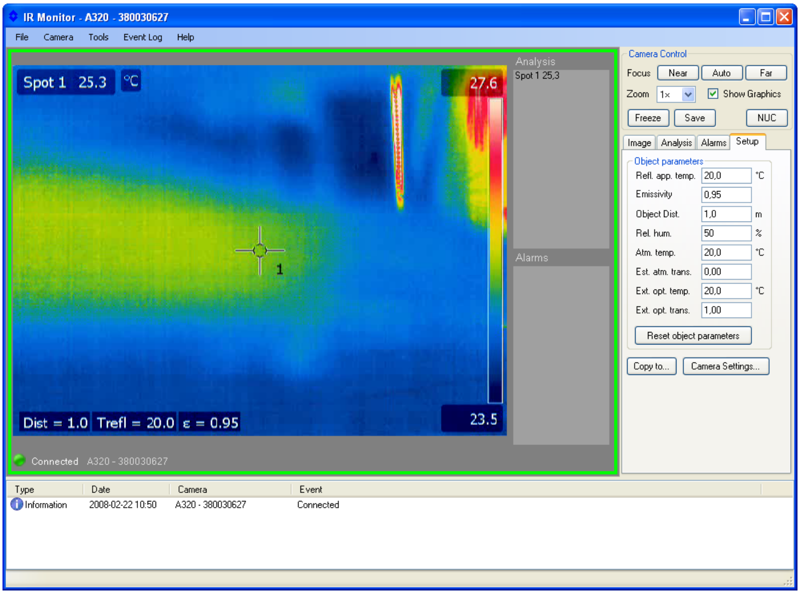


Figure 15.4 Setup tab

Figure 15.5 Explanation of the figures above

About IR Monitor	*Context:* **Help** menu *Element type:* Menu command *Action:* On clicking, displays a dialog box with version and copyright information about IR Monitor.
Adjust	*Context:* **Image** tab *Element type:* Command button *Action:* On clicking, adjusts the camera according to the adjacent settings.
Alarms	*Element type:* Tab name *Action:* On clicking, returns the **Alarms** tab.
Analysis	*Element type:* Tab name *Action:* On clicking, returns the **Analysis** tab.
Atm. temp.	*Context:* **Setup** tab *Element type:* Label *Action:* None, refers to the adjacent text box. *Comment:* The temperature of the air between the camera and the object of interest.

Auto	*Context:* **Camera control** group *Element type:* Command button *Action:* On clicking, performs an autofocus sequence.
Auto adjust	*Context:* **Image** tab *Element type:* Check box *Action:* On selection, autoadjusts the camera for the best contrast and brightness.
Camera	*Context:* Menu bar *Element type:* Menu name *Action:* On clicking, returns the **Camera** menu.
Camera control	*Element type:* Group name *Action:* None, refers to the adjacent buttons.
Camera Settings	*Context:* **Setup** tab *Element type:* Command button *Action:* On clicking, returns a dialog box in which the user can change regional settings for the camera.
Clear all events	*Context:* **Event log** menu *Element type:* Menu command *Action:* On clicking, clears the event log.
Connect	*Context:* **Camera** menu *Element type:* Menu command *Action:* On clicking, returns the **Select camera** dialog box. *Comment:* In the **Select camera** dialog box, camera/cameras to be connected to IR Monitor can be specified.
Copy to	*Context:* **Setup** tab *Element type:* Command button *Action:* On clicking, returns a dialog box in which the user can select a camera to which the current object parameters should be copied.
Edit	*Context:* **Alarms** tab. *Element type:* Command button *Action:* On clicking, displays an edit dialog box for the selected alarm. *Comment:* For more information, see section 15.1.1.1 – Explanation of the edit dialog box for alarms on page 78.

Edit	*Context:* **Analysis** tab. *Element type:* Command button *Action:* On clicking, displays an edit dialog box for the selected analysis tool. *Comment:* For more information, see section 15.1.1.4 – Explanation of the Edit dialog boxes for analysis tools on page 85.
E-mail and FTP settings	*Context:* **Alarms** tab. *Element type:* Command button *Action:* On clicking, displays a dialog box where e-mail and FTP settings for the alarms can be set. *Comment:* For more information, see section 15.1.1.2 – Explanation of the E-mail and FTP settings dialog box on page 83.
Emissivity	*Context:* **Setup** tab *Element type:* Label *Action:* None, refers to the adjacent text box. *Comment:* Refers to how much radiation an object emits, compared with the radiation of a theoretical reference object at the same temperature (called a 'blackbody'). The opposite of emissivity is reflectivity. The emissivity determines how much of the radiation originates from the object as opposed to being reflected by it.
Event log	*Context:* Menu bar *Element type:* Menu name *Action:* On clicking, returns the **Event log** menu.
Exit	*Context:* **File** menu *Element type:* Menu command *Action:* On clicking, exits the application.
Ext. atm. trans.	*Context:* **Setup** tab *Element type:* Label *Action:* None, refers to the adjacent text box. *Comment:* Not entered by the user, calculated from other object parameters.
Ext. opt. temp.	*Context:* **Setup** tab *Element type:* Label *Action:* None, refers to the adjacent text box. *Comment:* The temperature of any protective windows, etc. that are set up between the camera and the object of interest. If no protective window or protective shield is used, this value is irrelevant.

Ext. opt. trans.	*Context:* **Setup** tab *Element type:* Label *Action:* None, refers to the adjacent text box. *Comment:* The optical transmission of any protective windows, etc. that are set up between the camera and the object of interest.
Far	*Context:* **Camera control** group *Element type:* Command button *Action:* On clicking, sets the camera focus for distant objects.
File	*Context:* Menu bar *Element type:* Menu name *Action:* On clicking, returns the **File** menu.
Focus	*Context:* **Camera control** group *Element type:* Label *Action:* None, refers to the adjacent buttons.
Frame rate	*Context:* **Image** tab *Element type:* Label *Action:* None, refers to the adjacent list box. *Applicable values:* 0.1, 1, 9, 30 Hz (A320); 3.75, 7.5, 9, 15, 30 Hz (A325) *Comment:* Refers to the frame rate of the video stream.
Freeze	*Context:* **Camera control** group *Element type:* Command button *Action:* On clicking, freezes the image.
Image	*Element type:* Tab name *Action:* On clicking, returns the **Image** tab.
Image Adjustment	*Context:* **Image** tab *Element type:* Group name *Action:* None, refers to the adjacent controls.
Image Settings	*Context:* **Image** tab *Element type:* Group name *Action:* None, refers to the adjacent controls.
Inverted Palette	*Context:* **Image** tab *Element type:* Check box *Action:* When selected, inverts the currently selected palette.

Keep settings at restart	*Context:* **Image** tab *Element type:* Check box *Action:* On selection, the settings are kept and used when restarting the camera.
Lock application	*Context:* **Tools** menu *Element type:* Menu command *Action:* On clicking, returns the **Lock application** dialog box. *Comment:* In the **Lock application** dialog box, a password can be set to password protect the application.
Lock to	*Context:* **Image** tab *Element type:* Label *Action:* None, refers to the adjacent text box. *Applicable values:* Image, Temperature *Comment:* Refers to whether the temperature scale should be locked to the image or to the temperature.
Manual as Adobe PDF file	*Context:* **Help** menu *Element type:* Menu command *Action:* On clicking, returns the manual as an Adobe® PDF file.
Manual as HTML Help	*Context:* **Help** menu *Element type:* Menu command *Action:* On clicking, returns the manual as a HTML Help file.
Measurement Mask	*Context:* **Analysis** tab *Element type:* Command button *Action:* On clicking, returns the **Measurement Mask** dialog box. *Comment:* For more information, see section 14.2.1.5 – Working with measurement masks on page 60
Measurement Mask	*Context:* **Tools** menu *Element type:* Menu command *Action:* On clicking, returns the **Measurement Mask** dialog box. *Comment:* For more information, see section 14.2.1.5 – Working with measurement masks on page 60.

Method	*Context:* **Image** tab *Element type:* Label *Action:* None, refers to the adjacent list box. *Applicable values:* Histogram, Linear *Comment:* Refers to algorithms used for image adjustments. The most suitable algorithm for a certain imaging situation depends on many different factors, such as the target temperature and emissivity, reflected apparent temperature, and the distance to the target. The user will need to test different algorithms in order to find the one that suits the imaging situation the best.
Near	*Context:* **Camera control** group *Element type:* Command button *Action:* On clicking, sets the camera focus for near objects.
NUC	*Context:* **Camera control** group *Element type:* Command button *Action:* On clicking, performs a non-uniformity correction. *Comment:* The NUC (non-uniformity correction) function performs an internal calibration to correct for image non-uniformities that arise due to the slightly different offset characteristics occurring from detector to detector within the array.
Object dist.	*Context:* **Setup** tab *Element type:* Label *Action:* None, refers to the adjacent text box. *Comment:* The distance between the camera and the object of interest.
Object parameters	*Context:* **Setup** tab *Element type:* Group name *Action:* None, refers to the adjacent controls.
Open user settings	*Context:* **File** menu *Element type:* Menu command *Action:* On clicking, returns an **Open** dialog box. *Comment:* Using the **Open** dialog box, the user settings files (*.config file extension) can be loaded.

Options	*Context:* **Tools** menu *Element type:* Menu command *Action:* On clicking, returns the **Options** dialog box. *Comment:* In the **Options** dialog box, the language, date and time format, measurement and temperature units, and alarm sound files can be set.
Overlay Graphics	*Context:* **Image** tab *Element type:* Command button *Action:* On clicking, returns the **Overlay Graphics** dialog box. *Comment:* In the **Overlay Graphics** dialog box, the user can select which parameters will be displayed on the screen when overlay graphics are enabled.
Palette	*Context:* **Image** tab *Element type:* Label *Action:* None, refers to the adjacent list box. *Comment:* Refers to the color palette used for the infrared images.
Quality	*Context:* **Image** tab *Element type:* Label *Action:* None, refers to the adjacent list box. *Applicable values:* High, Medium, Low *Comment:* Refers to the compression of the video stream.
Refl. app. temp.	*Context:* **Setup** tab *Element type:* Label *Action:* None, refers to the adjacent text box. *Comment:* Refers to when compensating for the radiation from the surroundings reflected by the object into the camera. This property of the object is called reflectivity.
Rel. humidity	*Context:* **Setup** tab *Element type:* Label *Action:* None, refers to the adjacent text box. *Comment:* The relative humidity of the air between the camera and the object of interest.
Reset object parameters	*Context:* **Setup** tab *Element type:* Command button *Action:* On clicking, resets all object parameters to default values. *Comment:* The optical transmission of any protective windows, etc., that are set up between the camera and the object of interest.

Save	*Context:* **Camera control** group *Element type:* Command button *Action:* On clicking, saves the image to memory.
Save as	*Context:* **Event log** menu *Element type:* Menu command *Action:* On clicking, displays a dialog box where the current event log can be saved as a text file (*.txt).
Save user settings as	*Context:* **File** menu *Element type:* Menu command *Action:* On clicking, returns a **Save As** dialog box. *Comment:* Using the **Save As** dialog box, current user settings files (*.config file extension) can be saved.
Scale	*Context:* **Image** tab *Element type:* Label *Action:* None, refers to the adjacent text boxes. *Comment:* High and low scale limit values to be entered into the text box. This value will be used as a basis for adjustments.
Schedule	*Context:* **Analysis** tab *Element type:* Command button *Action:* On clicking, returns the **Schedule** dialog box. *Comment:* For more information, see section 15.1.1.3 – Explanation of the Schedule dialog box on page 83
Setup	*Element type:* Tab name *Action:* On clicking, returns the **Setup** tab.
Size	*Context:* **Image** tab *Element type:* Label *Action:* None, refers to the adjacent list box. *Applicable values:* 160 × 120, 320 × 240, 640 × 480 *Comment:* Refers to up- and downsampling of the video stream.
Temp. range	*Context:* **Image** tab *Element type:* Label *Action:* None, refers to the adjacent list box. *Comment:* Refers to the object temperature range to be used.
Tools	*Context:* Menu bar *Element type:* Menu name *Action:* On clicking, returns the **Tools** menu.

Use Measurement Mask	*Context:* **Analysis** tab *Element type:* Check box *Action:* On clicking, sets the camera to use a previously set up measurement mask.
Video format	*Context:* **Image** tab *Element type:* Label *Action:* None, refers to the adjacent list box. *Applicable values:* MPEG-4, Signal *Comment:* Refers to the format of the video stream.

15.1.1.1 Explanation of the edit dialog box for alarms

T630201;a1

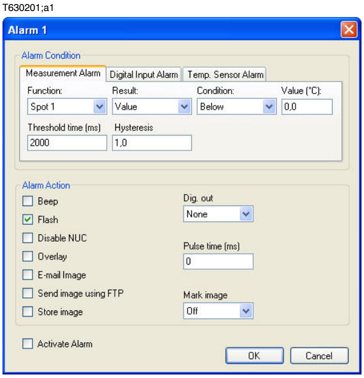


Figure 15.6 Edit dialog box for alarms: The Measurement Alarm tab

T630207;a1

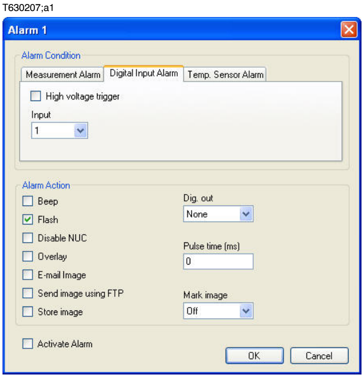


Figure 15.7 Edit dialog box for alarms: The Digital Input Alarm tab

T630208;a1

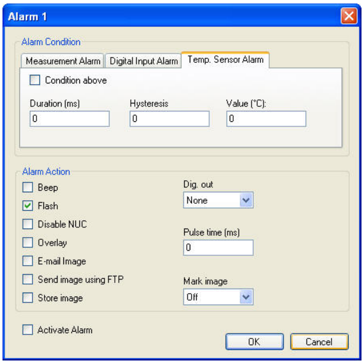


Figure 15.8 Edit dialog box for alarms: The Temp. Sensor Alarm tab

Figure 15.9 Explanation of the figures above

Activate alarm	*Element type:* Check box *Action:* On selection, activates the alarm.
Alarm actions	*Context:* All tabs *Element type:* Group name *Action:* None, refers to the adjacent controls.
Alarm condition	*Element type:* Group name *Action:* None, refers to the adjacent controls.
Apply	*Context:* **Alarms** tab *Element type:* Command button *Action:* On clicking, updates using the previously changed settings.
Beep	*Context:* All tabs *Element type:* Check box *Action:* On selection, sets off an audio signal when an alarm is triggered.
Condition above	*Context:* **Temp. sensor alarm** tab *Element type:* Check box *Action:* When selected, the alarm triggers at a temperature above the set temperature. When cleared, the alarm triggers at a temperature below the set temperature.

Dig. out	*Context:* All tabs *Element type:* Label *Action:* None, refers to the adjacent list box. *Applicable values:* 0, 1, 2 *Comment:* Refers to the digital output I/O port.
Disable NUC	*Context:* All tabs *Element type:* Check box *Action:* On selection, disables the automatic NUC (non-uniformity correction) when an alarm is triggered.
Duration ms	*Context:* **Temp. sensor alarm** tab *Element type:* Label *Action:* None, refers to the adjacent text box. *Comment:* Identifies the amount of time that has to pass before an alarm is triggered. This can be used as a powerful tool to avoid false alarms.
E-mail image	*Context:* All tabs *Element type:* Check box *Action:* On selection, e-mails the image frame to a mail recipient when an alarm is triggered.
Flash	*Context:* All tabs *Element type:* Check box *Action:* On selection, displays a visible signal when an alarm is triggered.
Function	*Context:* Edit dialog box for alarms *Element type:* Label *Action:* None, refers to the adjacent list box. *Comment:* Refers to which type of analysis tool will be used to trigger an alarm. *Applicable values:* Spot, Box, Diff., Ref. temp., Isotherm
High voltage trigger	*Context:* **Digital input alarm** tab *Element type:* Check box *Action:* When selected, the camera is set to react to a high digital-in signal. When cleared, the camera is set to react to a low digital-in signal.

Hysteresis	*Context:* **Measurement alarm** tab, **Temp. sensor alarm** tab *Element type:* Label *Action:* None, refers to the adjacent text box. *Comment:* Hysteresis is the interval within which the temperature value is allowed to vary without causing a change in the trigger. If the threshold is set above, for example, 30.00°C and the hysteresis is set at 2.00°C, the trigger goes high when the temperature rises above 30.00°C and stays high until the temperature sinks below 28.00°C. In contrast, if the threshold is set below 30.00°C, and the same hysteresis value is kept, the trigger goes high if the temperature sinks below 30.00°C and stays high until the temperature rises above 32.00°C.
Input	*Context:* **Digital input alarm** tab *Element type:* Label *Action:* None, refers to the adjacent list box. *Applicable values:* 1, 2 *Comment:* Refers to the digital input I/O port.
Mark image	*Context:* All tabs *Element type:* Label *Action:* None, refers to the adjacent list box. *Applicable values:* Start, Stop, Tag
Measurement alarm	*Element type:* Tab name *Action:* On clicking, returns the **Measurement alarm** tab.
Overlay	*Context:* All tabs *Element type:* Check box *Action:* When selected, the graphical overlay is enabled when an alarm is triggered.
Pulse time	*Context:* All tabs *Element type:* Label *Action:* None, refers to the adjacent text box. *Comment:* Pulse time to be entered into text box. *Note:* Negative integers are not allowed.

Result	*Context:* **Measurement alarm** tab *Element type:* Label *Action:* None, refers to the adjacent list box. *Comment:* Refers to which type of result from an analysis tool will be used to trigger an alarm. *Applicable values:* Average, Iso coverage, Max., Min., Median, Std. Dev., Value
Send image using FTP	*Context:* All tabs *Element type:* Check box *Action:* On selection, sends an image to a predefined FTP site when an alarm is triggered.
Store image	*Context:* All tabs *Element type:* Check box *Action:* On selection, saves the image frame memory when an alarm is triggered.
Threshold time	*Context:* **Measurement alarm** tab *Element type:* Label *Action:* None, refers to the adjacent text box. *Comment:* Identifies the amount of time that has to pass before an alarm is triggered. This can be used as a powerful tool to avoid false alarms. *Note:* Default value is 2,000 ms.
Value	*Context:* **Measurement alarm** tab *Element type:* Label *Action:* None, refers to the adjacent text box. *Comment:* The temperature limit for the trigger condition to be entered into the adjacent text box.

15.1.1.2 *Explanation of the* E-mail and FTP settings *dialog box*

T630259;a1

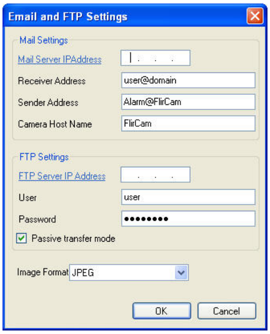


Figure 15.10 **E-mail and FTP settings** dialog box

For an explanation of this dialog box, see the corresponding descriptions in section 15.1.1.3 – Explanation of the Schedule dialog box on page 83.

15.1.1.3 *Explanation of the* Schedule *dialog box*

T630260;a1

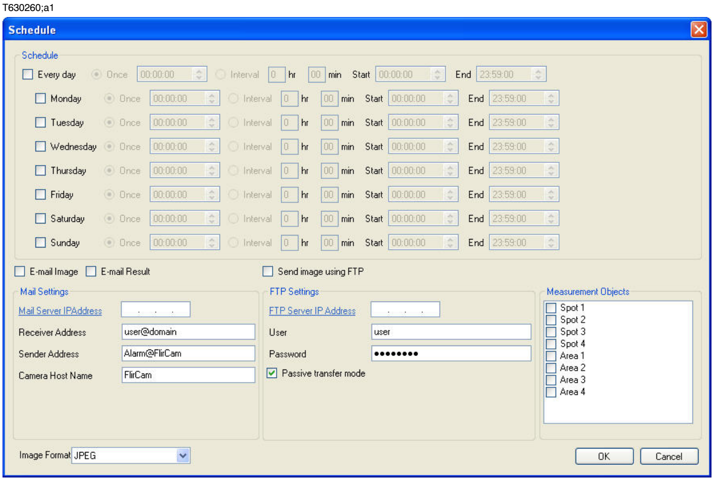


Figure 15.11 **Schedule** dialog box

Figure 15.12 Explanation of the figures above

E-mail image	*Context:* **Schedule** dialog box *Element type:* Check box *Action:* On selection, e-mails the image when an alarm is triggered.

E-mail result	*Context:* **Schedule** dialog box *Element type:* Check box *Action:* On selection, e-mails the result when an alarm is triggered.
FTP server IP address	*Context:* **Schedule** dialog box *Element type:* Label *Action:* Refers to the adjacent text box. *Comment:* The FTP server IP address to be entered into the text box.
FTP settings	*Context:* **Schedule** dialog box *Element type:* Group name *Action:* None, refers to the adjacent text boxes.
Image format	*Context:* **Schedule** dialog box *Element type:* Group name *Action:* None, refers to the adjacent list box. *Comment:* Specifies the image format to be used when sending images.
Mail server IP address	*Context:* **Schedule** dialog box *Element type:* Label *Action:* Refers to the adjacent text box. *Comment:* The mail server IP address to be entered into the text box.
Mail settings	*Context:* **Schedule** dialog box *Element type:* Group name *Action:* None, refers to the adjacent text boxes.
Measurement objects	*Context:* **Schedule** dialog box *Element type:* Group name *Action:* None, refers to the adjacent check boxes. *Comment:* One or more check boxes to be selected to specify which measurement result will be sent by e-mail or FTP.
Passive transfer mode	*Context:* **Schedule** dialog box *Element type:* Check box *Action:* On selection, uses the passive transfer mode when sending an image using FTP. With passive transfers the client asks the server for data and the server specifies how the transfer will be done. The server chooses a port and then tells the client to connect to that port and receive the data.

Password	*Context:* **Schedule** dialog box *Element type:* Label *Action:* Refers to the adjacent text box. *Comment:* The password to be entered into the text box.
Receiver address	*Context:* **Schedule** dialog box *Element type:* Label *Action:* Refers to the adjacent text box. *Comment:* The receiver address to be entered into the text box.
Schedule	*Context:* **Schedule** dialog box *Element type:* Group name *Action:* None, refers to the adjacent day and time controls.
Sender address	*Context:* **Schedule** dialog box *Element type:* Label *Action:* Refers to the adjacent text box. *Comment:* The sender address to be entered into the text box.
Send image using FTP	*Context:* **Schedule** dialog box *Element type:* Check box *Action:* On selection, sends the image using FTP when an alarm is triggered.
User	*Context:* **Schedule** dialog box *Element type:* Label *Action:* Refers to the adjacent text box. *Comment:* The user name to be entered into the text box.

15.1.1.4 *Explanation of the Edit dialog boxes for analysis tools*

T630254;a1

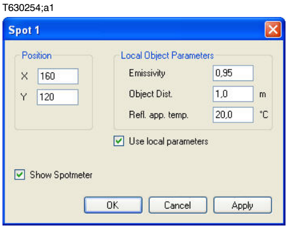


Figure 15.13 Edit dialog box for analysis tools: The Spot dialog box

T630255;a1

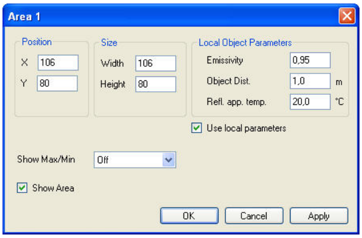


Figure 15.14 Edit dialog box for analysis tools: The Area dialog box

T630256;a1

Figure 15.15 Edit dialog box for analysis tools: The Diff dialog box

T630257;a1

Figure 15.16 Edit dialog box for analysis tools: The Ref. temp. dialog box

T630258;a1

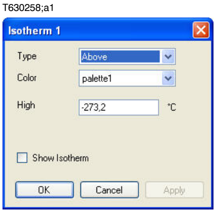


Figure 15.17 Edit dialog box for analysis tools: The Isotherm dialog box

Figure 15.18 Explanation of the figures above

Color	*Context:* Edit dialog box for analysis tools *Element type:* Label *Action:* None, refers to the adjacent list box. *Applicable values:* Various, depends on the camera configuration. *Comment:* Refers to the isotherm color.

Emissivity	*Context:* Edit dialog box for analysis tools *Element type:* Label *Action:* None, refers to the adjacent text box. *Comment:* Refers to how much radiation an object emits, compared with the radiation of a theoretical reference object at the same temperature (called a ‘blackbody’). The opposite of emissivity is reflectivity. The emissivity determines how much of the radiation originates from the object as opposed to being reflected by it.
Function	*Context:* Edit dialog box for analysis tools *Element type:* Label *Action:* None, refers to the adjacent list box. *Applicable values:* Spot, Box, Ref. Temp, Isotherm *Comment:* Refers to which analysis tool will be used in a difference calculation.
Height	*Context:* Edit dialog box for analysis tools *Element type:* Label *Action:* None, refers to the adjacent text box. *Comment:* Denotes the height of the analysis tool (e.g. an area).
High	*Context:* Edit dialog box for analysis tools *Element type:* Label *Action:* None, refers to the adjacent text box. *Comment:* The higher temperature limit to be used for the isotherm to be entered into the text box.
Local object parameters	*Context:* Edit dialog box for analysis tools *Element type:* Group name *Action:* None, refers to the adjacent controls.
Low	*Context:* Edit dialog box for analysis tools *Element type:* Label *Action:* None, refers to the adjacent text box. *Comment:* The lower temperature limit to be used for the isotherm to be entered into the text box.
Object dist.	*Context:* Edit dialog box for analysis tools *Element type:* Label *Action:* None, refers to the adjacent text box. *Comment:* The distance between the camera and the object of interest.

Position	*Context:* Edit dialog box for analysis tools *Element type:* Group name *Action:* None, refers to the adjacent controls.
Reference temperature	*Context:* Edit dialog box for analysis tools *Element type:* Label *Action:* None, refers to the adjacent text box. *Comment:* Refers to the reference temperature.
Refl. app. temp.	*Context:* Edit dialog box for analysis tools *Element type:* Label *Action:* None, refers to the adjacent text box. *Comment:* Refers to when compensating for the radiation from the surroundings reflected by the object into the camera. This property of the object is called reflectivity.
Result	*Context:* Edit dialog box for analysis tools *Element type:* Label *Action:* None, refers to the adjacent list box. *Applicable values:* Average, Iso coverage, Max., Min., Median, Std. Dev., Value *Comment:* Refers to which type of result from an analysis tool will be used for the difference calculation.
Show area	*Context:* Edit dialog box for analysis tools *Element type:* Check box *Action:* On selection, activates the analysis tool.
Show diff	*Context:* Edit dialog box for analysis tools *Element type:* Check box *Action:* On selection, activates the analysis tool.
Show isotherm	*Context:* Edit dialog box for analysis tools *Element type:* Check box *Action:* On selection, activates the analysis tool.
Show Max./Min.	*Context:* Edit dialog box for analysis tools *Element type:* Label *Action:* None, refers to the adjacent list box. *Applicable values:* Off, Max., Min., Both *Comment:* Refers to which temperature result will be displayed (e.g. in an area).

Show spotmeter	*Context:* Edit dialog box for analysis tools *Element type:* Check box *Action:* On selection, activates the analysis tool.
Size	*Context:* Edit dialog box for analysis tools *Element type:* Group name *Action:* None, refers to the adjacent controls.
Type	*Context:* Edit dialog box for analysis tools *Element type:* Label *Action:* None, refers to the adjacent list box. *Applicable values:* Above, Below, Interval *Comment:* Refers to the isotherm type.
Use local parameters	*Context:* Edit dialog box for analysis tools *Element type:* Check box *Action:* On selection, lets the camera use the locally set parameters instead of the globally set parameters.
Value	*Context:* Edit dialog box for analysis tools *Element type:* Label *Action:* None, refers to the adjacent text box. *Comment:* The reference temperature to be entered into text box.
Width	*Context:* Edit dialog box for analysis tools *Element type:* Label *Action:* None, refers to the adjacent text box. *Comment:* Denotes the width of the analysis tool (e.g. an area).
X	*Context:* Edit dialog box for analysis tools *Element type:* Label *Action:* None, refers to the adjacent text box. *Comment:* Denotes the X position for the analysis tool.
Y	*Context:* Edit dialog box for analysis tools *Element type:* Label *Action:* None, refers to the adjacent text box. *Comment:* Denotes the Y position for the analysis tool.

15.2 IP Config Utility

15.2.1 Explanation of interface elements (in alphabetical order)

10776803;a1

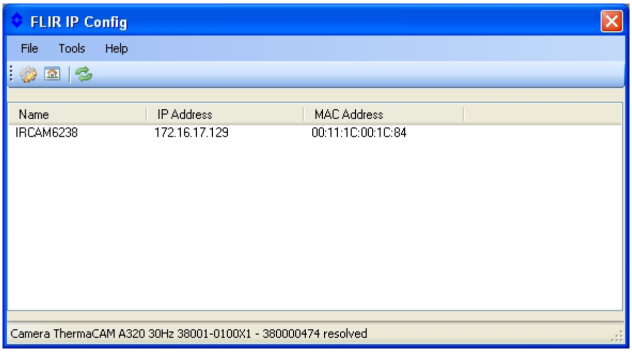


Figure 15.19 Main window

Figure 15.20 Explanation of the figure above

	*Context:* Toolbar *Element type:* Toolbar button *Action:* On clicking, returns the **IP address settings** dialog box. *Comment:* In this dialog box, the IP address, the subnet mask, and the default gateway can be changed.
	*Context:* Toolbar *Element type:* Toolbar button *Action:* On clicking, returns the camera's web interface.
	*Context:* Toolbar *Element type:* Toolbar button *Action:* On clicking, refreshes the camera list.
Exit	*Context:* **File** menu *Element type:* Menu command *Action:* On clicking, exits the application.
File	*Context:* Menu bar *Element type:* Menu name *Action:* On clicking, returns the **File** menu.
Help	*Context:* Menu bar *Element type:* Menu name *Action:* On clicking, returns the **Help** menu.

Manual as Adobe PDF file	*Context:* **Help** menu *Element type:* Menu command *Action:* On clicking, returns the manual as an Adobe® PDF file.
Manual as HTML Help	*Context:* **Help** menu *Element type:* Menu command *Action:* On clicking, returns the manual as an HTML Help file.
Modify	*Context:* Right-click menu *Element type:* Menu command *Action:* On clicking, returns the **FLIR IP Config Camera Settings** dialog box. *Comment:* In this dialog box, the IP address, the subnet mask, and the default gateway can be changed.
Options	*Context:* **Tools** menu *Element type:* Menu command *Action:* On clicking, returns the **FLIR IP Config Settings** dialog box. *Comment:* In this dialog box, the language of the application can be changed.
Refresh	*Context:* Right-click menu *Element type:* Menu command *Action:* On clicking, refreshes the camera list.
Tools	*Context:* Menu bar *Element type:* Menu name *Action:* On clicking, returns the **Tools** menu.
Web	*Context:* Right-click menu *Element type:* Menu command *Action:* On clicking, returns the camera's web interface.

15.3 Camera web interface

15.3.1 Explanation of interface elements (in alphabetical order)

10776303;a2

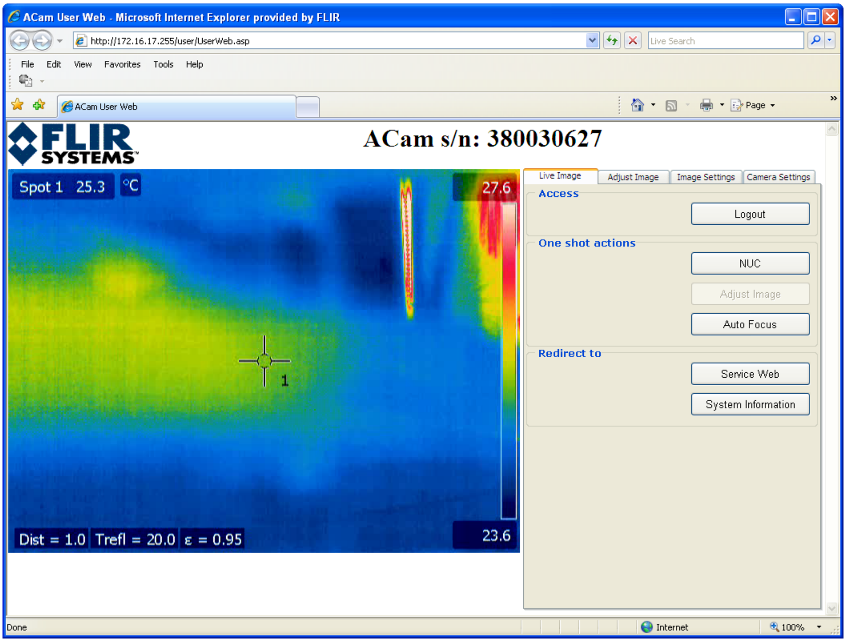


Figure 15.21 Live image tab

10776403;a2

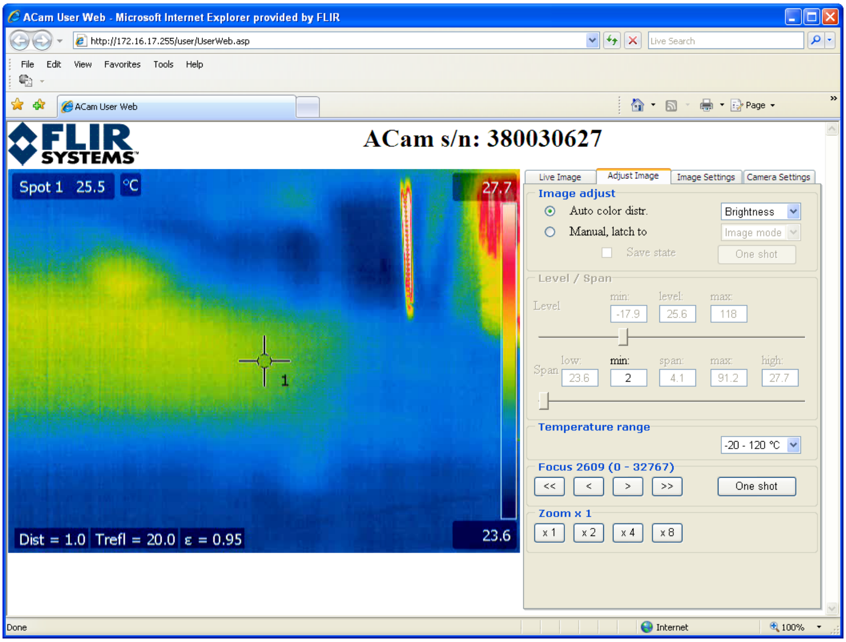


Figure 15.22 Adjust Image tab

10776503;a2

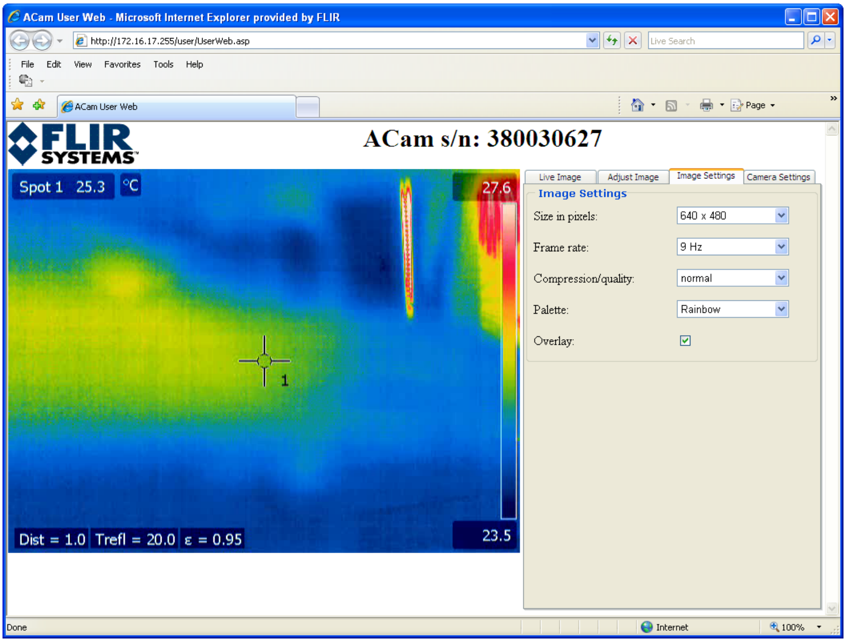


Figure 15.23 Image Settings tab

10776603;a2

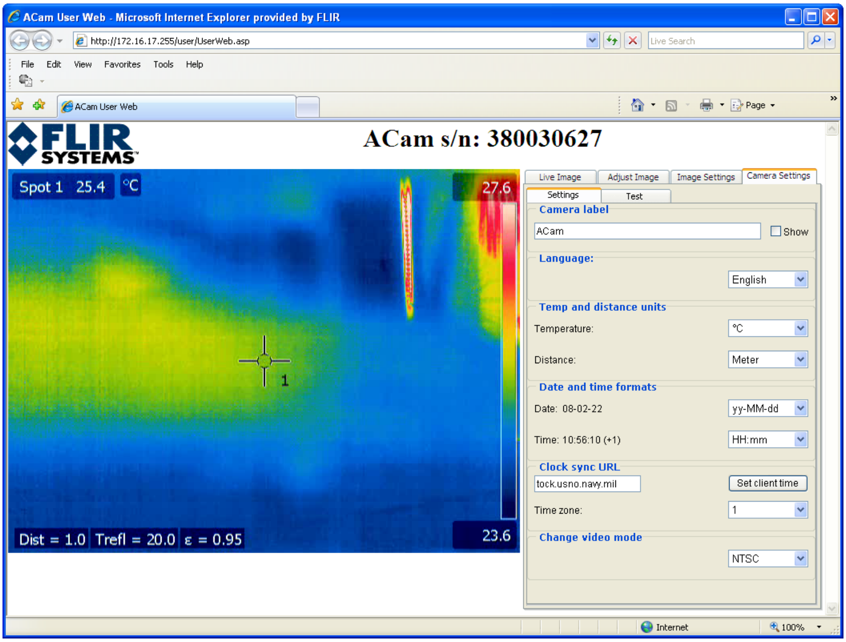


Figure 15.24 Camera Settings tab, subtab **Settings**

10776703;a2

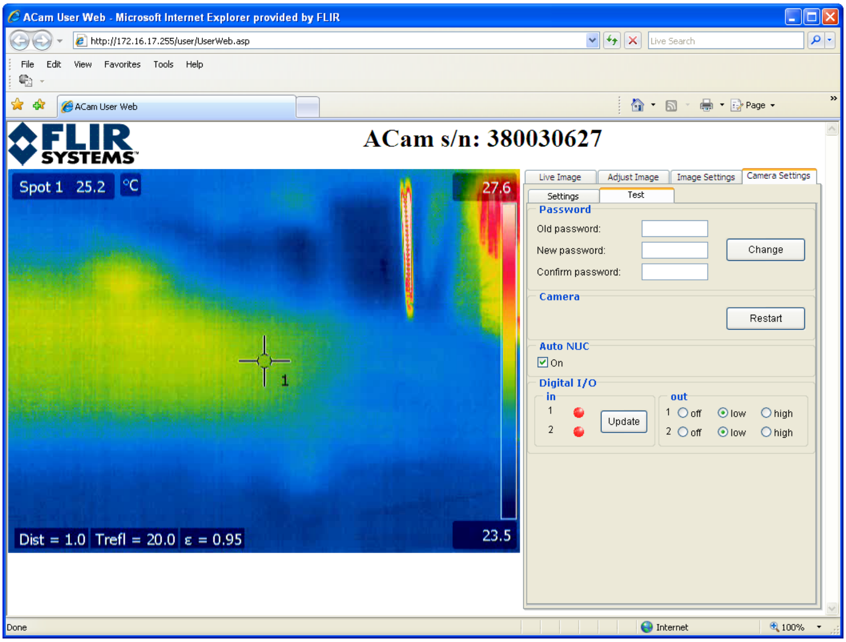


Figure 15.25 **Camera Settings** tab, subtab **Test**

Figure 15.26 Explanation of the figures above

×1	*Context:* **Adjust Image** tab *Element type:* Command button *Action:* On clicking, sets the zoom to ×1.
×2	*Context:* **Adjust Image** tab *Element type:* Command button *Action:* On clicking, sets the zoom to ×2.
×4	*Context:* **Adjust Image** tab *Element type:* Command button *Action:* On clicking, sets the zoom to ×4.
×8	*Context:* **Adjust Image** tab *Element type:* Command button *Action:* On clicking, sets the zoom to ×8.
<	*Context:* **Adjust Image** tab *Element type:* Command button *Action:* On clicking, starts a focusing sequence with small focusing steps.

<<	*Context:* **Adjust Image** tab *Element type:* Command button *Action:* On clicking, starts a focusing sequence with large focusing steps.
>	*Context:* **Adjust Image** tab *Element type:* Command button *Action:* On clicking, starts a focusing sequence with small focusing steps.
>>	*Context:* **Adjust Image** tab *Element type:* Command button *Action:* On clicking, starts a focusing sequence with large focusing steps.
Adjust Image	*Context:* **Live image** tab *Element type:* Command button *Action:* On clicking, performs an adjustment sequence. *Comment:* Adjusts the camera for the best contrast and brightness.
Adjust Image	*Element type:* Tab name *Action:* On clicking, returns the **Adjust Image** tab
Auto color distr.	*Context:* **Adjust Image** tab *Element type:* Option button *Action:* On selection, activates the adjacent list box. *Applicable values:* Brightness, Histogram *Comment:* Refers to algorithms used for image adjustments. The most suitable algorithm for a certain imaging situation depends on many different factors, such as the target temperature and emissivity, reflected apparent temperature, and the distance to the target. The user will need to test different algorithms in order to find the one that suits the imaging situation the best.
Autofocus	*Context:* **Live image** tab *Element type:* Command button *Action:* On clicking, performs an autofocus sequence.
Camera Settings	*Element type:* Tab name *Action:* On clicking, returns the **Camera status** tab
Change video mode	*Context:* **Camera Settings** tab *Element type:* Label *Action:* None, refers to the adjacent list box. *Applicable values:* PAL, NTSC

Clock sync. URL	*Context:* **Camera Settings** tab *Element type:* Group name *Action:* None, refers to the adjacent controls.
Compression quality	*Context:* **Image Settings** tab *Element type:* Label *Action:* None, refers to the adjacent list box. *Applicable values:* High, Medium, Low *Comment:* Refers to the compression of the video stream.
Date	*Context:* **Camera Settings** tab *Element type:* Label *Action:* None, refers to the adjacent list box. *Applicable values:* yyyy-MM-dd, yy-MM-dd, dd/MM/yy, dd/MM/yyyy, MM/dd/yy, MM/dd/yyyy
Date and time formats	*Context:* **Camera Settings** tab *Element type:* Group name *Action:* None, refers to the adjacent controls.
Distance	*Context:* **Camera Settings** tab *Element type:* Label *Action:* None, refers to the adjacent list box. *Applicable values:* Meter, Feet
Focus	*Context:* **Adjust Image** tab *Element type:* Group name *Action:* None, refers to the adjacent controls.
Frame rate	*Context:* **Image Settings** tab *Element type:* Label *Action:* None, refers to the adjacent list box. *Applicable values:* 0.1, 1, 9, 30 *Comment:* Refers to the frame rate of the video stream.
Image adjust	*Context:* **Adjust Image** tab *Element type:* Group name *Action:* None, refers to the adjacent controls.
Image Settings	*Element type:* Tab name *Action:* On clicking, returns the **Image Settings** tab

Language	*Context:* **Camera Settings** tab *Element type:* Label *Action:* None, refers to the adjacent list box. *Applicable values:* English
Level/Span	*Context:* **Adjust Image** tab *Element type:* Group name *Action:* None, refers to the adjacent controls. *Comment:* The level command can be regarded as the *brightness*, while the span command can be regarded as the *contrast*. Controls are provided to change the level and span either by entering numerical values or by using the slider.
Live image	*Element type:* Tab name *Action:* On clicking, returns the **Live image** tab
Login	*Context:* **Live image** tab *Element type:* Command button *Action:* On clicking, logs in the user. *Comment:* Login required to access certain security-controlled web pages on the web interface.
Logout	*Context:* **Live image** tab *Element type:* Command button *Action:* On clicking, logs out from security-controlled web pages.
Manual, latch to	*Context:* **Adjust Image** tab *Element type:* Option button *Action:* On selection, activates the adjacent list box *Applicable values:* Image mode, Temp. mode *Comment:* Refers to whether the temperature scale should be locked to the image or to the temperature.
NUC	*Context:* **Live image** tab *Element type:* Command button *Action:* On clicking, performs a NUC. *Comment:* The NUC (non-uniformity correction) function performs an internal calibration to correct for image non-uniformities that arise due to the slightly different offset characteristics occurring from detector to detector within the array.
One shot	*Context:* **Adjust Image** tab *Element type:* Command button *Action:* On clicking, performs a one-shot auto-adjustment sequence.

One shot	*Context:* **Adjust Image** tab *Element type:* Command button *Action:* On clicking, starts an autofocus sequence.
Overlay	*Context:* **Image Settings** tab *Element type:* Check box *Action:* On selection, activates the graphical overlay on the infrared image.
Palette	*Context:* **Image Settings** tab *Element type:* Label *Action:* None, refers to the adjacent list box. *Applicable values:* Black & white, Iron, Rainbow *Comment:* Refers to the color palette used for the infrared images.
Restart	*Context:* **Test** subtab on the **Camera Settings** tab *Element type:* Command button *Action:* On clicking, restarts the camera.
Save state	*Context:* **Adjust Image** tab *Element type:* Check box *Action:* On selection, saves the current setting.
Save state	*Context:* ***Camera Settings*** tab *Element type:* Check box *Action:* On selection, saves the current setting.
Service web	*Context:* **Live image** tab *Element type:* Command button *Action:* On clicking, redirects the user to the service web. *Comment:* Service web pages may be password protected.
Size in pixels	*Context:* **Image Settings** tab *Element type:* Label *Action:* None, refers to the adjacent list box. *Applicable values:* 160 × 120, 320 × 240, 640 × 480 *Comment:* Refers to up- and downsampling of the video stream.
Sync to source	*Context:* **Camera Settings** tab *Element type:* Check box *Action:* On selection, synchronizes the time to the time sync server at the URL in the adjacent text box.

System Information	*Context:* **Live image** tab *Element type:* Command button *Action:* On clicking, redirects the user to a web page displaying system information about the camera. *Comment:* Service web pages may be password protected.
Temp. and distance units	*Context:* **Camera Settings** tab *Element type:* Group name *Action:* None, refers to the adjacent controls.
Temperature	*Context:* **Camera Settings** tab *Element type:* Label *Action:* None, refers to the adjacent list box. *Applicable values:* °C, °F
Temperature range	*Context:* ***Adjust Image*** tab *Element type:* Group name *Action:* None, refers to the adjacent controls *Comment:* Appropriate object temperature range to be selected in the list box.
Time	*Context:* **Camera Settings** tab *Element type:* Label *Action:* None, refers to the adjacent list box. *Applicable values:* hh:MM, h:mm tt
Time zone	*Context:* **Camera Settings** tab *Element type:* Label *Action:* None, refers to the adjacent list box. *Applicable values:* –12 to +13 hrs
URL	*Context:* **Camera Settings** tab *Element type:* Text box *Action:* No action *Comment*: Time sync server URL in the adjacent text box.
Zoom	*Context:* **Adjust Image** tab *Element type:* Group name *Action:* None, refers to the adjacent controls.

INTENTIONALLY LEFT BLANK

16 Cleaning the camera

16.1 Camera housing, cables, and other items

Liquids

Use one of these liquids:

- Warm water
- A weak detergent solution

Equipment

A soft cloth

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.

16

16.2 Infrared lens

Liquids

Use one of these liquids:

- 96% isopropyl alcohol.
- A commercial lens cleaning liquid with more than 30% isopropyl alcohol.

Equipment

Cotton wool

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.

17 Technical data

Disclaimer

FLIR Systems reserves the right to discontinue models, parts or accessories, and other items, or to change specifications at any time without prior notice.

Imaging and optical data (built-in lens)

Field of view (FOV)	25° × 18.8°
Close focus limit	0.4 m (1.31 ft.)
Focal length	18 mm (0.7 in.)
Spatial resolution (IFOV)	1.36 mrad
Lens identification	Automatic
F-number	1.3
Thermal sensitivity/NETD	70 mK @ +30°C (+86°F)
Image frequency	■ 9 Hz (FLIR A320, FLIR A325) ■ 30 Hz (FLIR A320) ■ 60 Hz (FLIR A325)
Focus	Automatic or manual (built in motor)
Electronic zoom	1–8× continuous, interpolating zooming on images (subject to camera model)

Detector data

Detector type	Focal plane array (FPA), uncooled microbolometer
Spectral range	7.5–13 µm
Resolution	320 × 240 pixels
Detector pitch	25 µm
Detector time constant	Typically 12 ms

Measurement

Object temperature range	■ –20°C to +120°C (–4°F to +248°F) ■ 0°C to +350°C (+32°F to +662°F) ■ Optional +250°C to +1200°C (+482°F to +2192°F)
Accuracy	±2°C (±3.6°F) or ±2% of reading

Measurement analysis

Atmospheric transmission correction	Automatic, based on inputs for distance, atmospheric temperature, and relative humidity
Optics transmission correction	Automatic, based on signals from internal sensors
Measurement corrections	Global and individual object parameters (subject to camera model)
Emissivity correction	Variable from 0.01 to 1.0
Reflected apparent temperature correction	Automatic, based on input of reflected temperature
External optics/windows correction	Automatic, based on input of optics/window transmission and temperature

Image storage

Image storage type	Built-in memory for image storage (FLIR A320)
File formats	■ FFF ■ FFF JPEG ■ PNG ■ PNG JPEG ■ JPEG
Compatibility	Subject to camera model. One of the following: ■ FLIR Researcher 2.9 ■ FLIR Researcher 2.9, FLIR Reporter 8 and FLIR QuickReport compatible

Ethernet™

Ethernet™, purpose	Subject to camera model. One of the following: ■ Control, result, and image ■ Control and image
Ethernet™, type	Subject to camera model. One of the following: ■ 100 Mbps ■ Gigabit Ethernet™
Ethernet™, standard	IEEE 802.3
Ethernet™, connector type	RJ-45
Ethernet™, cable	CAT-6 cable standard accessory
Ethernet™, communication	Subject to camera model. One of the following: ■ TCP/IP socket-based FLIR proprietary ■ TCP/IP socket-based FLIR proprietary and GenICam™ protocol

Publ. No. T559007 Rev. a277 – ENGLISH (EN) – April 21, 2008

Ethernet™, video streaming	MPEG-4, ISO/IEC 14496-1 MPEG-4 ASP@L5 (subject to camera model)
Ethernet™, power	Power over Ethernet™, PoE IEEE 802.3af class 0 (subject to camera model)
Ethernet™, image streaming	16-bit 320 × 240 pixels: ■ Signal linear ■ Temperature linear ■ Radiometric ■ GigE Vision™ and GenICam™ compatible (subject to camera model)
Ethernet™, protocols	■ TCP ■ UDP ■ SNTP ■ RTSP ■ RTP ■ HTTP ■ ICMP ■ IGMP ■ FTP ■ SMTP ■ SMB (CIFS) ■ DHCP ■ MDNS (Bonjour) ■ uPnP

Digital input/output

Digital input, purpose	Subject to camera model. One of the following: ■ Image tag (start/stop/general), input external device (programmatically read) (FLIR A320) ■ Image tag (start, stop, general), image flow control (stream on/off), input external device (programmatically read) (FLIR A325) ■ Alarm
Digital input	2 opto-isolated, 10–30 VDC
Digital output, purpose	Subject to camera model. One of the following: ■ As function of ALARM. Output to ext. device (programmatically set) (FLIR A320) ■ Output to ext. device (programmatically set) (FLIR A325)
Digital output	2 opto-isolated, 10–30 VDC, max. 100 mA
Digital I/O, isolation voltage	500 VRMS
Digital I/O, supply voltage	12/24 VDC, max 200 mA

Digital I/O, connector type	6-pole jackable screw terminal

Note: Cables for digital I/O ports should be 100 m/328 ft. maximum.

Pin configuration for I/O connector

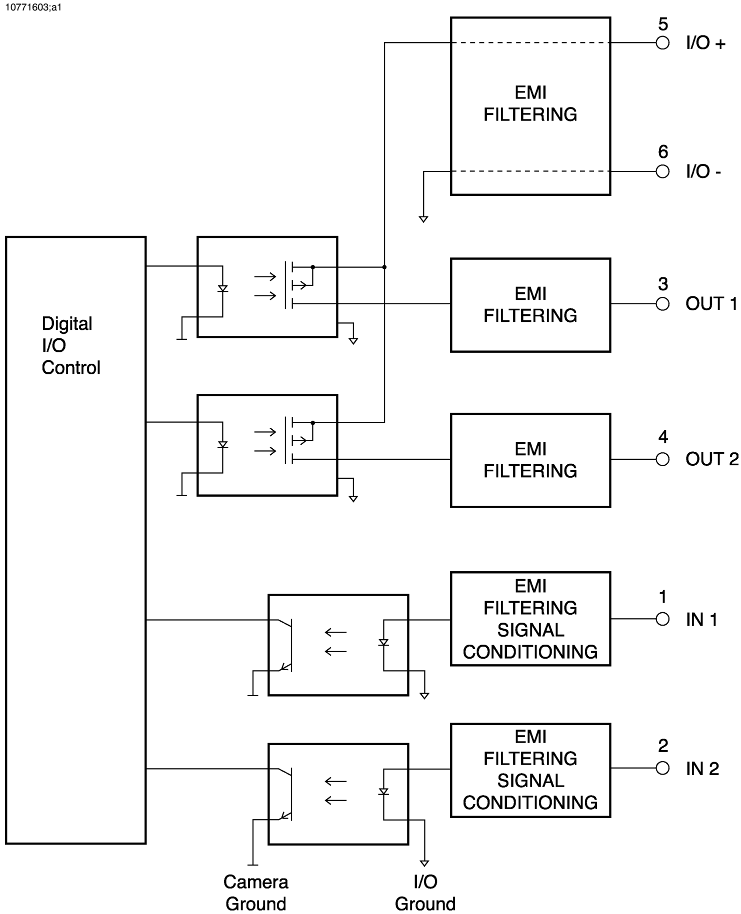
Pin	Configuration
1	IN 1
2	IN 2
3	OUT 1
4	OUT 2
5	I/O +
6	I/O –

For a schematic overview of the digital I/O ports, see page 110.

17

Schematic overview of the digital I/O ports

10771603;a1



Composite video

Video, purpose	Composite video output, PAL and NTSC compatible (subject to camera model)
Video, standard	CVBS (ITU-R-BT.470 PAL/SMPTE 170M NTSC) (subject to camera model)
Video, connector type	Standard BNC connector (subject to camera model)

Power system

External power operation	12/24 VDC, 24 W absolute max.
External power, connector type	2-pole jackable screw terminal
Voltage	Allowed range 10–30 VDC

Environmental data

Operating temperature range	−15°C to +50°C (+5°F to +122°F)
Storage temperature range	−40°C to +70°C (−40°F to +158°F)
Humidity (operating and storage)	IEC 60068-2-30/24 h 95% relative humidity +25°C to +40°C (+77°F to +104°F)
EMC	EN 61000-6-2:2001 (Immunity), EN 61000-6-3:2001 (Emission), FCC 47 CFR Part 15 Class B (Emission)
Encapsulation	IP 40 (IEC 60529)
Bump	25*g* (IEC 60068-2-29)
Vibration	2*g* (IEC 60068-2-6)

17

Physical data

Weight	0.7 kg (1.54 lb.)
Camera size (L × W × H)	170 × 70 × 70 mm (6.7 × 2.8 × 2.8 in.)
Tripod mounting	UNC ¼"-20 (on three sides)
Base mounting	2 × M4 thread mounting holes (on three sides)
Housing material	Aluminum

External infrared lenses (optional)

30 mm/15° lens, Field of view (FOV)	15° x 11.3°
30 mm/15° lens, Close focus limit	1.2 m (3.93 ft.)
30 mm/15° lens, Focal length	30.38 mm (1.196 in.)
30 mm/15° lens, Spatial resolution (IFOV)	0.82 mrad
30 mm/15° lens, F-number	1.3
30 mm/15° lens, Size (Length × Diameter)	24.3 × 58 mm (0.96 × 2.28 in.)
30 mm/15° lens, Camera size (L × W × H)	121.1 × 201.0 × 125.0 mm (4.76 × 7.91 × 4.92 in.), with 15° lens pointing forward
30 mm/15° lens, Weight	0.092 kg (0.203 lb.), incliuding two lens caps
10 mm/45° lens, Field of view (FOV)	44.9° x 33.7°
10 mm/45° lens, Close focus limit	0.2 m (0.66 ft.)
10 mm/45° lens, Focal length	9.66 mm (0.380 in.)
10 mm/45° lens, Spatial resolution (IFOV)	2.45 mrad
10 mm/45° lens, F-number	1.3
10 mm/45° lens, Size (Length × Diameter)	38.4 × 47 mm (1.51 × 1.85 in.)
10 mm/45° lens, Camera size (L × W × H)	135.2 × 201.0 × 125.0 mm (5.32 × 7.91 × 4.92 in.), with 45° lens pointing forward

10 mm/45° lens, Weight	0.105 kg (0.231 lb.), incl. two lens caps

Field of view and distance, 30 mm/15° lens lens

10771403;a1

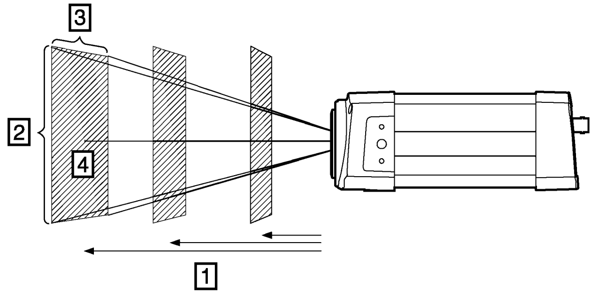


Figure 17.1 Relationship between the field of view and distance. **1:** Distance to target; **2:** VFOV = vertical field of view; **3:** HFOV = horizontal field of view, **4:** IFOV = instantaneous field of view (size of one detector element).

This table gives examples of the field of view of a 30 mm/15° lens for different target distances:

10762803;a1

Focal length: 30.38 mm									
Resolution: 320 x 240 pixels									
Field of view in degrees: 15.0									
D --->			**2.00**	**5.00**	**10.00**	**25.00**	**50.00**	**100.00**	**m**
HFOV			0.53	1.32	2.63	6.58	13.17	26.33	**m**
VFOV			0.39	0.99	1.97	4.94	9.87	19.75	**m**
IFOV			1.65	4.11	8.23	20.57	41.15	82.29	**mm**
D --->			**6.56**	**16.39**	**32.79**	**81.97**	**163.93**	**327.87**	**ft.**
HFOV			1.73	4.32	8.63	21.58	43.17	86.34	**ft.**
VFOV			1.30	3.24	6.48	16.19	32.38	64.75	**ft.**
IFOV			0.06	0.16	0.32	0.81	1.62	3.24	**in.**
Legend:									
D = Distance to target in meters & feet									
HFOV = Horizontal field of view in meters & feet									
VFOV = Vertical field of view in meters & feet									
IFOV = Instantaneous field of view (size of one detector element) in millimeters & inches									

Field of view and distance, 18 mm/25° lens lens (built-in)

10771403;a1

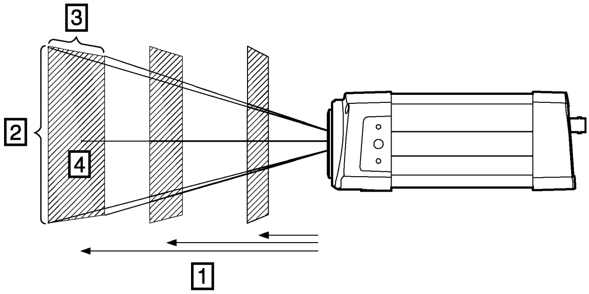


Figure 17.2 Relationship between the field of view and distance. **1:** Distance to target; **2:** VFOV = vertical field of view; **3:** HFOV = horizontal field of view, **4:** IFOV = instantaneous field of view (size of one detector element).

This table gives examples of the field of view of a 18 mm/25° lens for different target distances:

10762903;a1

Focal length: 18.04 mm									
Resolution: 320 x 240 pixels									
Field of view in degrees: 25.0									
D --->	**0.50**	**1.00**	**2.00**	**5.00**	**10.00**	**25.00**	**50.00**	**100.00**	**m**
HFOV	0.22	0.44	0.89	2.22	4.43	11.09	22.17	44.35	**m**
VFOV	0.17	0.33	0.67	1.66	3.33	8.31	16.63	33.26	**m**
IFOV	0.69	1.39	2.77	6.93	13.86	34.65	69.29	138.58	**mm**
D --->	**1.64**	**3.28**	**6.56**	**16.39**	**32.79**	**81.97**	**163.93**	**327.87**	**ft.**
HFOV	0.73	1.45	2.91	7.27	14.54	36.35	72.70	145.40	**ft.**
VFOV	0.55	1.09	2.18	5.45	10.90	27.26	54.52	109.05	**ft.**
IFOV	0.03	0.05	0.11	0.27	0.55	1.36	2.73	5.46	**in.**
Legend:									
D = Distance to target in meters & feet									
HFOV = Horizontal field of view in meters & feet									
VFOV = Vertical field of view in meters & feet									
IFOV = Instantaneous field of view (size of one detector element) in millimeters & inches									

Field of view & distance, 10 mm/45° lens lens

10771403;a1

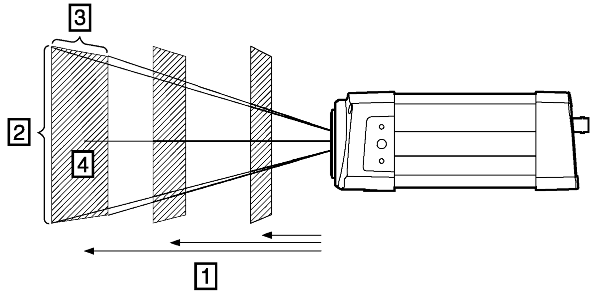


Figure 17.3 Relationship between the field of view and distance. **1:** Distance to target; **2:** VFOV = vertical field of view; **3:** HFOV = horizontal field of view, **4:** IFOV = instantaneous field of view (size of one detector element).

This table gives examples of the field of view of a 10 mm/45° lens for different target distances:

10763003;a1

Focal length: 9.66 mm									
Resolution: 320 x 240 pixels									
Field of view in degrees: 44.9									
D --->	**0.50**	**1.00**	**2.00**	**5.00**	**10.00**	**25.00**	**50.00**	**100.00**	**m**
HFOV	0.41	0.83	1.66	4.14	8.28	20.70	41.41	82.82	**m**
VFOV	0.31	0.62	1.24	3.11	6.21	15.53	31.06	62.11	**m**
IFOV	1.29	2.59	5.18	12.94	25.88	64.70	129.40	258.80	**mm**
D --->	**1.64**	**3.28**	**6.56**	**16.39**	**32.79**	**81.97**	**163.93**	**327.87**	**ft.**
HFOV	1.36	2.72	5.43	13.58	27.15	67.88	135.76	271.53	**ft.**
VFOV	1.02	2.04	4.07	10.18	20.36	50.91	101.82	203.65	**ft.**
IFOV	0.05	0.10	0.20	0.51	1.02	2.55	5.09	10.19	**in.**
Legend:									
D = Distance to target in meters & feet									
HFOV = Horizontal field of view in meters & feet									
VFOV = Vertical field of view in meters & feet									
IFOV = Instantaneous field of view (size of one detector element) in millimeters & inches									

Optional accessories

Camera accessories	■ Tele lens 15° × 11°, close focus 1.2 m/3.9 ft. ■ Wide angle lens 45° × 34°, close focus 0.2 m/0.7 ft. ■ Hard case ■ FLIR SDK ■ FLIR LabVIEW® Toolkit ■ FLIR Researcher Professional 2.9

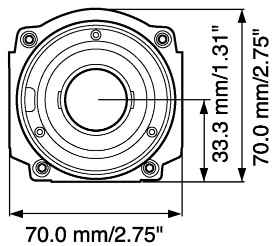
INTENTIONALLY LEFT BLANK

18 Dimensions

18.1 Camera dimensions (front)

Figure

10770303;a1

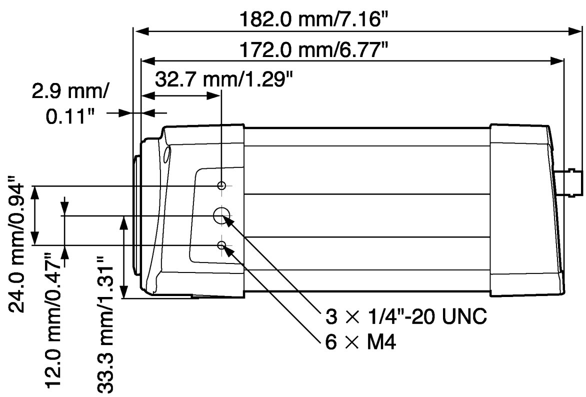


18

18.2 Camera dimensions (side)

Figure

10770403;a1

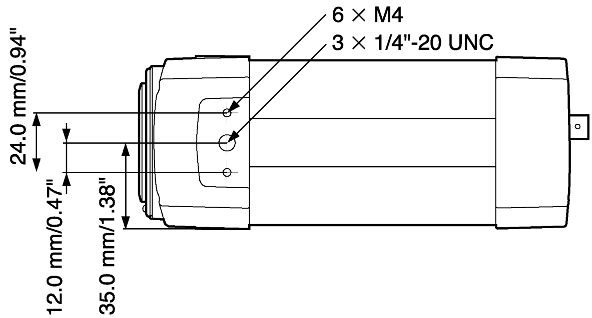


NOTE BNC connector on rear panel applies only to FLIR A320 cameras.

18.3 Camera dimensions (bottom)

Figure

10770503;a1



NOTE

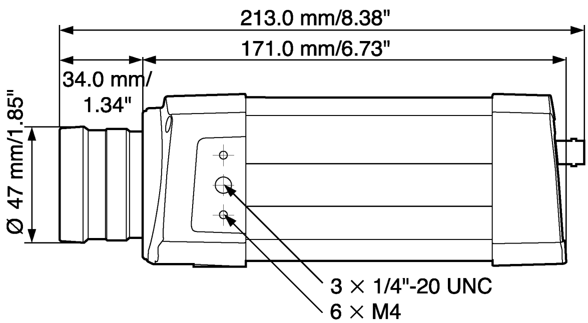
BNC connector on rear panel applies only to FLIR A320 cameras.

18

18.4 Camera dimensions (with 10 mm/45° lens)

Figure

10770603;a1

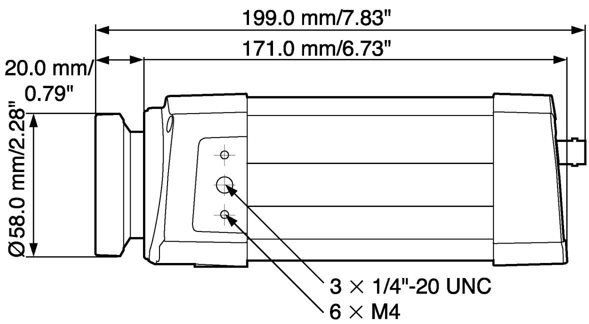


NOTE BNC connector on rear panel applies only to FLIR A320 cameras.

18.5 Camera dimensions (with 30 mm/15° lens)

Figure

10770703;a1



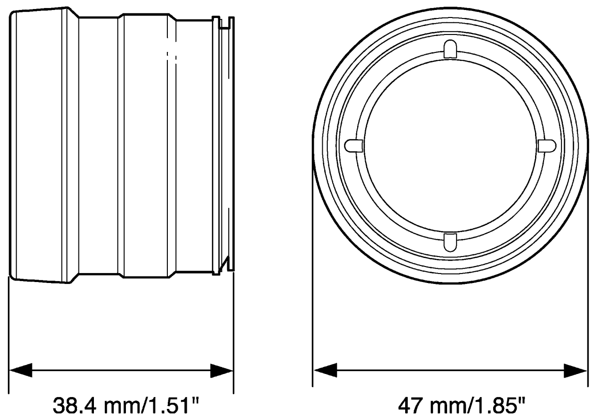
NOTE

BNC connector on rear panel applies only to FLIR A320 cameras.

18.6 Infrared lens (10 mm/45°)

Figure

10762403;a1

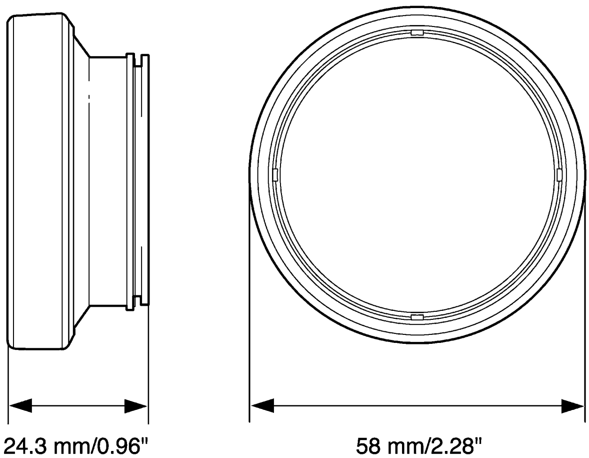


18

18.7 Infrared lens (30 mm/15°)

Figure

10762503;a1



INTENTIONALLY LEFT BLANK

19 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 four major companies with outstanding achievements in infrared technology since 1965—the Swedish AGEMA Infrared Systems (formerly AGA Infrared Systems), and the three United States companies Indigo Systems, FSI, and Inframetrics.

10722703;a1

Figure 19.1 LEFT: Thermovision® Model 661 from 1969. 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. **RIGHT:** InfraCAM from 2006. Weight: 0.55 kg (1.21 lb.), including the battery

The company has sold more than 40,000 infrared cameras worldwide for applications such as predictive maintenance, R & D, non-destructive testing, process control and automation, and machine vision, among many others.

FLIR Systems has three manufacturing plants in the United States (Portland, OR, Boston, MA, Santa Barbara, CA) and one in Sweden (Stockholm). Direct sales offices in Belgium, Brazil, China, France, Germany, Great Britain, Hong Kong, Italy, Japan, 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.

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.

19.1 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.

19.2 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.

19.3 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.

19.4 A few images from our facilities

10401303;a1

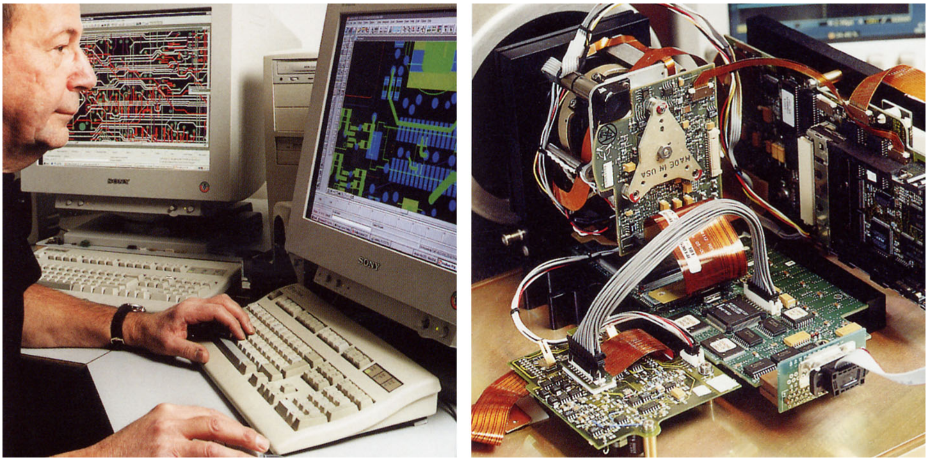


Figure 19.2 LEFT: Development of system electronics; **RIGHT:** Testing of an FPA detector

10401403;a1

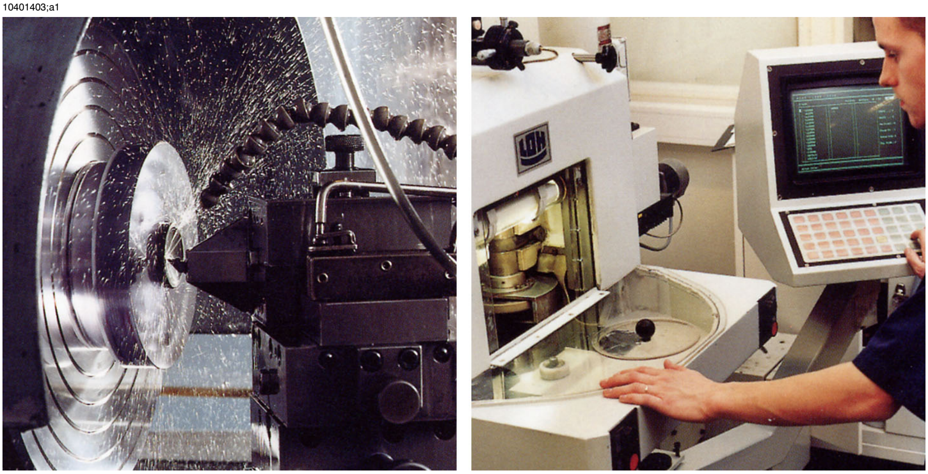


Figure 19.3 LEFT: Diamond turning machine; **RIGHT:** Lens polishing

19

10401503;a1

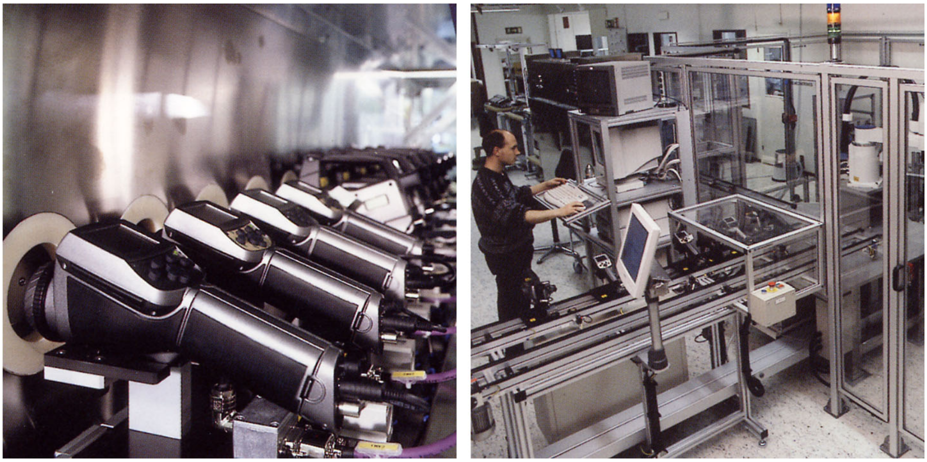


Figure 19.4 LEFT: Testing of infrared cameras in the climatic chamber; **RIGHT:** Robot used for camera testing and calibration

20 Glossary

Term or expression	Explanation
absorption (absorption factor)	The amount of radiation absorbed by an object relative to the received radiation. A number between 0 and 1.
ambient	Objects and gases that emit radiation towards the object being measured.
atmosphere	The gases between the object being measured and the camera, normally air.
autoadjust	A function making a camera perform an internal image correction.
autopalette	The IR image is shown with an uneven spread of colors, displaying cold objects as well as hot ones at the same time.
blackbody	Totally non-reflective object. All its radiation is due to its own temperature.
blackbody radiator	An IR radiating equipment with blackbody properties used to calibrate IR cameras.
calculated atmospheric transmission	A transmission value computed from the temperature, the relative humidity of air and the distance to the object.
cavity radiator	A bottle shaped radiator with an absorbing inside, viewed through the bottleneck.
color temperature	The temperature for which the color of a blackbody matches a specific color.
conduction	The process that makes heat spread into a material.
continuous adjust	A function that adjusts the image. The function works all the time, continuously adjusting brightness and contrast according to the image content.
convection	The process that makes hot air or liquid rise.
difference temperature	A value which is the result of a subtraction between two temperature values.
dual isotherm	An isotherm with two color bands, instead of one.
emissivity (emissivity factor)	The amount of radiation coming from an object, compared to that of a blackbody. A number between 0 and 1.
emittance	Amount of energy emitted from an object per unit of time and area (W/m^2)

Term or expression	Explanation
estimated atmospheric transmission	A transmission value, supplied by a user, replacing a calculated one
external optics	Extra lenses, filters, heat shields etc. that can be put between the camera and the object being measured.
filter	A material transparent only to some of the infrared wavelengths.
FOV	Field of view: The horizontal angle that can be viewed through an IR lens.
FPA	Focal plane array: A type of IR detector.
graybody	An object that emits a fixed fraction of the amount of energy of a blackbody for each wavelength.
IFOV	Instantaneous field of view: A measure of the geometrical resolution of an IR camera.
image correction (internal or external)	A way of compensating for sensitivity differences in various parts of live images and also of stabilizing the camera.
infrared	Non-visible radiation, having a wavelength from about 2–13 μm.
IR	infrared
isotherm	A function highlighting those parts of an image that fall above, below or between one or more temperature intervals.
isothermal cavity	A bottle-shaped radiator with a uniform temperature viewed through the bottleneck.
Laser LocatIR	An electrically powered light source on the camera that emits laser radiation in a thin, concentrated beam to point at certain parts of the object in front of the camera.
laser pointer	An electrically powered light source on the camera that emits laser radiation in a thin, concentrated beam to point at certain parts of the object in front of the camera.
level	The center value of the temperature scale, usually expressed as a signal value.
manual adjust	A way to adjust the image by manually changing certain parameters.
NETD	Noise equivalent temperature difference. A measure of the image noise level of an IR camera.
noise	Undesired small disturbance in the infrared image
object parameters	A set of values describing the circumstances under which the measurement of an object was made, and the object itself (such as emissivity, ambient temperature, distance etc.)

Term or expression	Explanation
object signal	A non-calibrated value related to the amount of radiation received by the camera from the object.
palette	The set of colors used to display an IR image.
pixel	Stands for *picture element*. One single spot in an image.
radiance	Amount of energy emitted from an object per unit of time, area and angle ($W/m^2/sr$)
radiant power	Amount of energy emitted from an object per unit of time (W)
radiation	The process by which electromagnetic energy, is emitted by an object or a gas.
radiator	A piece of IR radiating equipment.
range	The current overall temperature measurement limitation of an IR camera. Cameras can have several ranges. Expressed as two blackbody temperatures that limit the current calibration.
reference temperature	A temperature which the ordinary measured values can be compared with.
reflection	The amount of radiation reflected by an object relative to the received radiation. A number between 0 and 1.
relative humidity	Percentage of water in the air, relative to what is physically possible. Air temperature dependent.
saturation color	The areas that contain temperatures outside the present level/span settings are colored with the saturation colors. The saturation colors contain an ‘overflow’ color and an ‘underflow’ color. There is also a third red saturation color that marks everything saturated by the detector indicating that the range should probably be changed.
span	The interval of the temperature scale, usually expressed as a signal value.
spectral (radiant) emittance	Amount of energy emitted from an object per unit of time, area and wavelength ($W/m^2/\mu m$)
temperature range	The current overall temperature measurement limitation of an IR camera. Cameras can have several ranges. Expressed as two blackbody temperatures that limit the current calibration.
temperature scale	The way in which an IR image currently is displayed. Expressed as two temperature values limiting the colors.
thermogram	infrared image

Term or expression	Explanation
transmission (or transmittance) factor	Gases and materials can be more or less transparent. Transmission is the amount of IR radiation passing through them. A number between 0 and 1.
transparent isotherm	An isotherm showing a linear spread of colors, instead of covering the highlighted parts of the image.
visual	Refers to the video mode of a IR camera, as opposed to the normal, thermographic mode. When a camera is in video mode it captures ordinary video images, while thermographic images are captured when the camera is in IR mode.

21 Thermographic measurement techniques

21.1 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

21.2 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.

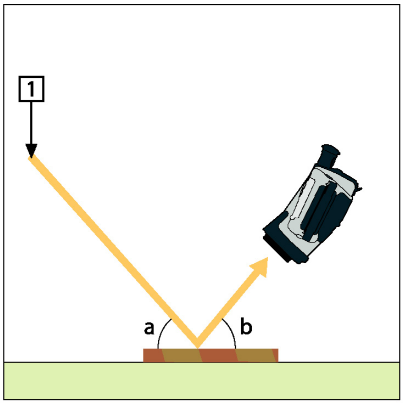
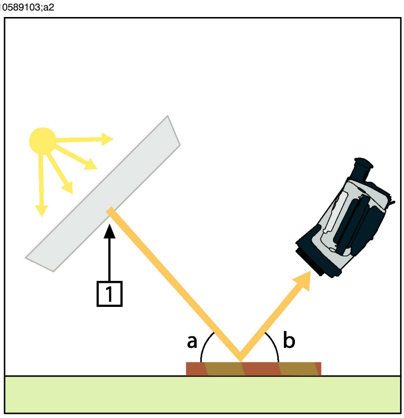
21.2.1 Finding the emissivity of a sample

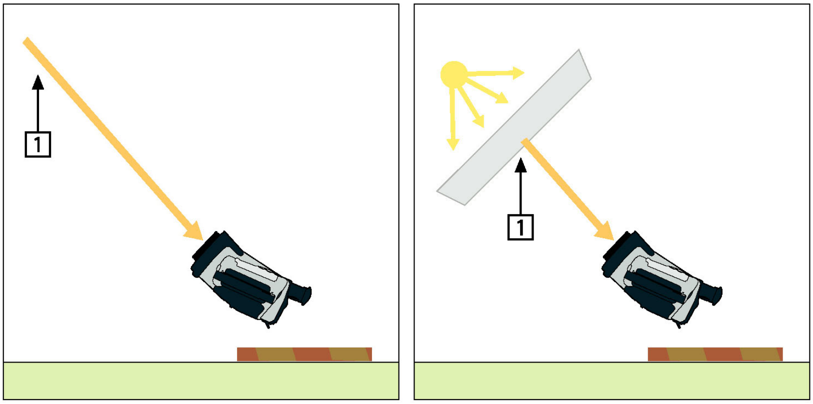
21.2.1.1 Step 1: Determining reflected apparent temperature

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

21.2.1.1.1 Method 1: Direct method

21

1	Look for possible reflection sources, considering that the incident angle = reflection angle (a = b). 10588903;a1  **Figure 21.1** 1 = Reflection source
2	If the reflection source is a spot source, modify the source by obstructing it using a piece if cardboard. 10589103;a2  **Figure 21.2** 1 = Reflection source

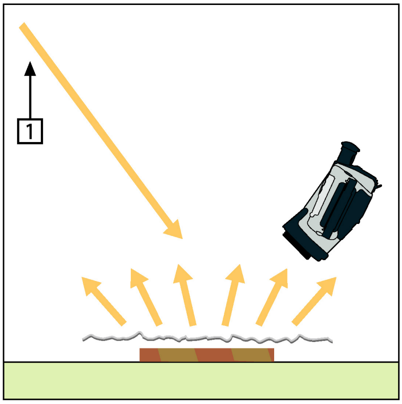
3	Measure the radiation intensity (= apparent temperature) from the reflecting source using the following settings: ■ Emissivity: 1.0 ■ D_{obj}: 0 You can measure the radiation intensity using one of the following two methods: 10589003;a2  **Figure 21.3** 1 = Reflection source

Note: Using a thermocouple to measure reflected apparent temperature is not recommended for two important reasons:

- A thermocouple does not measure radiation intensity
- A thermocouple requires a very good thermal contact to the surface, usually by gluing and covering the sensor by a thermal isolator.

21.2.1.1.2 Method 2: Reflector method

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. 10727003;a2  **Figure 21.4** Measuring the apparent temperature of the aluminum foil

21.2.1.2 Step 2: Determining the emissivity

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.

21.3 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.

21.4 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 athmosphere between the object and the camera.
- That radiation from the atmosphere itself is detected by the camera.

21.5 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%.

21.6 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 transmission – *i.e.* the transmission of any external lenses or windows used in front of the camera

INTENTIONALLY LEFT BLANK

22 History of infrared technology

Less than 200 years ago 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.

10398703;a1

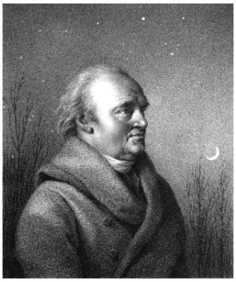


Figure 22.1 Sir William Herschel (1738–1822)

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 that 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 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.

10398903;a1

Figure 22.2 Marsilio Landriani (1746–1815)

Moving the thermometer into the dark region beyond the red end of the spectrum, Herschel confirmed that the heating effect 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 restricted 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 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 century, until the art of synthetic crystal growing was mastered in the 1930s.

10399103;a1

Figure 22.3 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 3 meters (10 ft.) 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. John Herschel also managed to obtain a primitive record of the thermal image on paper, which he called a 'thermograph.'

10399003;a2

Figure 22.4 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 (1311 ft.).

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 was possible to store liquefied gases for entire days. The common 'thermos flask', 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 world 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 based around the extremely sensitive photon detector. During this period, military secrecy prevented disclosure of the status of infrared-imaging technology. This secrecy only began to be lifted in the middle of the 1950s, and viable thermal-imaging devices finally began to be available to civilian science and industry.

23 Theory of thermography

23.1 Introduction

The subjects of infrared radiation and the related technique of thermography are still new to many who will use an infrared camera. In this section the theory behind thermography will be given.

23.2 The electromagnetic spectrum

The electromagnetic spectrum is divided arbitrarily into a number of wavelength regions, called *bands*, distinguished by the methods used to produce and detect the radiation. There is no fundamental difference between radiation in the different bands of the electromagnetic spectrum. They are all governed by the same laws and the only differences are those due to differences in wavelength.

10067803;a1

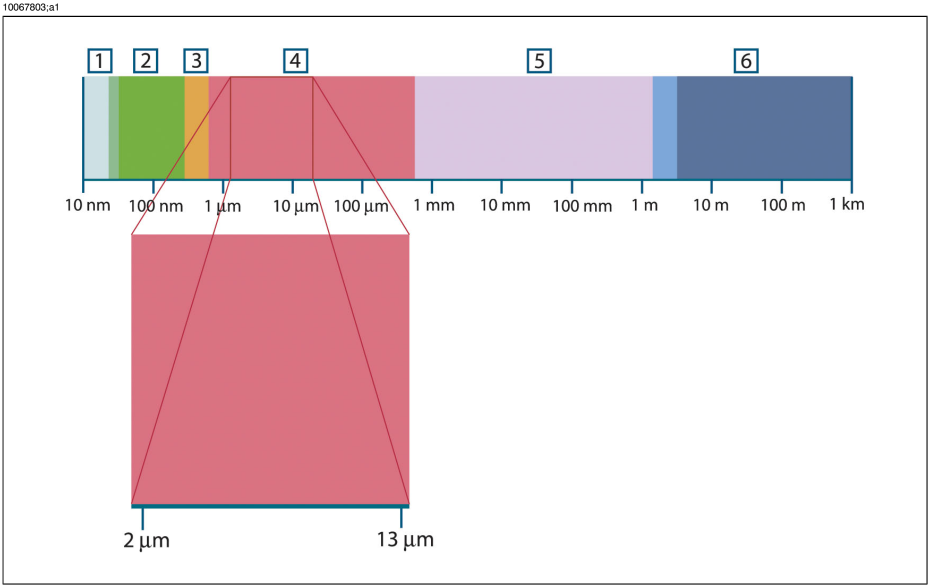


Figure 23.1 The electromagnetic spectrum. **1:** X-ray; **2:** UV; **3:** Visible; **4:** IR; **5:** Microwaves; **6:** Radiowaves.

Thermography makes use of the infrared spectral band. At the short-wavelength end the boundary lies at the limit of visual perception, in the deep red. At the long-wavelength end it merges with the microwave radio wavelengths, in the millimeter range.

The infrared band is often further subdivided into four smaller bands, the boundaries of which are also arbitrarily chosen. They include: the *near infrared* (0.75–3 µm), the *middle infrared* (3–6 µm), the *far infrared* (6–15 µm) and the *extreme infrared* (15–100 µm). Although the wavelengths are given in µm (micrometers), other units are often still used to measure wavelength in this spectral region, *e.g.* nanometer (nm) and Ångström (Å).

The relationships between the different wavelength measurements is:

$$10\ 000\ \text{Å} = 1\ 000\ \text{nm} = 1\ \mu = 1\ \mu\text{m}$$

23.3 Blackbody radiation

A blackbody is defined as an object which absorbs all radiation that impinges on it at any wavelength. The apparent misnomer *black* relating to an object emitting radiation is explained by Kirchhoff's Law (after *Gustav Robert Kirchhoff*, 1824–1887), which states that a body capable of absorbing all radiation at any wavelength is equally capable in the emission of radiation.

10398803;a1

Figure 23.2 Gustav Robert Kirchhoff (1824–1887)

The construction of a blackbody source is, in principle, very simple. The radiation characteristics of an aperture in an isotherm cavity made of an opaque absorbing material represents almost exactly the properties of a blackbody. A practical application of the principle to the construction of a perfect absorber of radiation consists of a box that is light tight except for an aperture in one of the sides. Any radiation which then enters the hole is scattered and absorbed by repeated reflections so only an infinitesimal fraction can possibly escape. The blackness which is obtained at the aperture is nearly equal to a blackbody and almost perfect for all wavelengths.

By providing such an isothermal cavity with a suitable heater it becomes what is termed a *cavity radiator*. An isothermal cavity heated to a uniform temperature generates blackbody radiation, the characteristics of which are determined solely by the temperature of the cavity. Such cavity radiators are commonly used as sources of radiation in temperature reference standards in the laboratory for calibrating thermographic instruments, such as a FLIR Systems camera for example.

If the temperature of blackbody radiation increases to more than 525°C (977°F), the source begins to be visible so that it appears to the eye no longer black. This is the incipient red heat temperature of the radiator, which then becomes orange or yellow as the temperature increases further. In fact, the definition of the so-called *color temperature* of an object is the temperature to which a blackbody would have to be heated to have the same appearance.

Now consider three expressions that describe the radiation emitted from a blackbody.

23.3.1 Planck's law

10399203;a1

Figure 23.3 Max Planck (1858–1947)

Max Planck (1858–1947) was able to describe the spectral distribution of the radiation from a blackbody by means of the following formula:

$$W_{\lambda b} = \frac{2\pi hc^2}{\lambda^5 \left(e^{hc/\lambda kT} - 1\right)} \times 10^{-6} [Watt / m^2, \mu m]$$

where:

$W_{\lambda b}$	Blackbody spectral radiant emittance at wavelength λ.
c	Velocity of light = 3×10^8 m/s
h	Planck's constant = 6.6×10^{-34} Joule sec.
k	Boltzmann's constant = 1.4×10^{-23} Joule/K.
T	Absolute temperature (K) of a blackbody.
λ	Wavelength (μm).

23

➲ The factor 10^{-6} is used since spectral emittance in the curves is expressed in Watt/m², µm.

Planck's formula, when plotted graphically for various temperatures, produces a family of curves. Following any particular Planck curve, the spectral emittance is zero at λ = 0, then increases rapidly to a maximum at a wavelength λ_{max} and after passing it approaches zero again at very long wavelengths. The higher the temperature, the shorter the wavelength at which maximum occurs.

10327103;a4

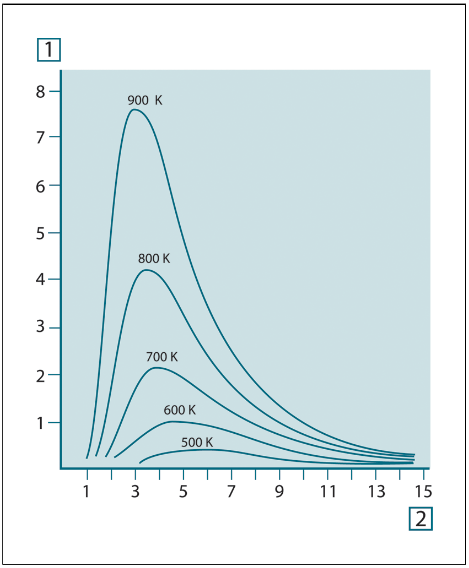


Figure 23.4 Blackbody spectral radiant emittance according to Planck's law, plotted for various absolute temperatures. **1:** Spectral radiant emittance (W/cm² × 10³(µm)); **2:** Wavelength (µm)

23.3.2 Wien's displacement law

By differentiating Planck's formula with respect to λ, and finding the maximum, we have:

$$\lambda_{\max} = \frac{2898}{T}[\mu m]$$

This is Wien's formula (after *Wilhelm Wien*, 1864–1928), which expresses mathematically the common observation that colors vary from red to orange or yellow as the temperature of a thermal radiator increases. The wavelength of the color is the same as the wavelength calculated for λ_{max}. A good approximation of the value of λ_{max} for a given blackbody temperature is obtained by applying the rule-of-thumb 3 000/T µm. Thus, a very hot star such as Sirius (11 000 K), emitting bluish-white light, radiates with the peak of spectral radiant emittance occurring within the invisible ultraviolet spectrum, at wavelength 0.27 µm.

10399403;a1

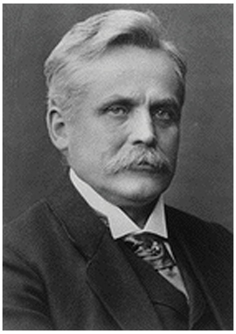


Figure 23.5 Wilhelm Wien (1864–1928)

The sun (approx. 6 000 K) emits yellow light, peaking at about 0.5 µm in the middle of the visible light spectrum.

At room temperature (300 K) the peak of radiant emittance lies at 9.7 µm, in the far infrared, while at the temperature of liquid nitrogen (77 K) the maximum of the almost insignificant amount of radiant emittance occurs at 38 µm, in the extreme infrared wavelengths.

10327203;a4

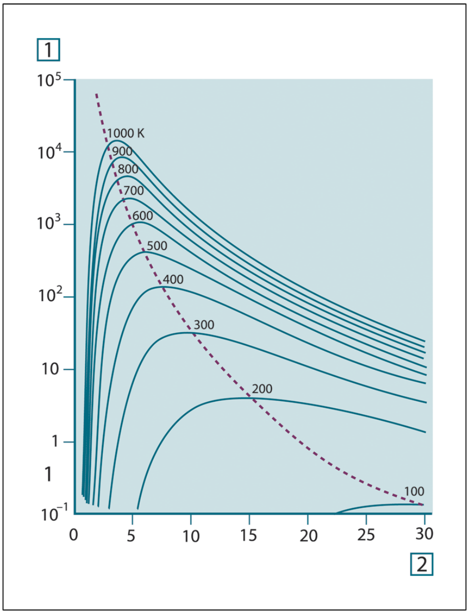


Figure 23.6 Planckian curves plotted on semi-log scales from 100 K to 1000 K. The dotted line represents the locus of maximum radiant emittance at each temperature as described by Wien's displacement law. **1:** Spectral radiant emittance (W/cm^2 (µm)); **2:** Wavelength (µm).

23.3.3 Stefan-Boltzmann's law

By integrating Planck's formula from $\lambda = 0$ to $\lambda = \infty$, we obtain the total radiant emittance (W_b) of a blackbody:

$$W_b = \sigma T^4 \text{ [Watt/m}^2\text{]}$$

This is the Stefan-Boltzmann formula (after *Josef Stefan*, 1835–1893, and *Ludwig Boltzmann*, 1844–1906), which states that the total emissive power of a blackbody is proportional to the fourth power of its absolute temperature. Graphically, W_b represents the area below the Planck curve for a particular temperature. It can be shown that the radiant emittance in the interval $\lambda = 0$ to λ_{max} is only 25% of the total, which represents about the amount of the sun's radiation which lies inside the visible light spectrum.

10399303;a1

Figure 23.7 Josef Stefan (1835–1893), and Ludwig Boltzmann (1844–1906)

Using the Stefan-Boltzmann formula to calculate the power radiated by the human body, at a temperature of 300 K and an external surface area of approx. 2 m^2, we obtain 1 kW. This power loss could not be sustained if it were not for the compensating absorption of radiation from surrounding surfaces, at room temperatures which do not vary too drastically from the temperature of the body – or, of course, the addition of clothing.

23.3.4 Non-blackbody emitters

So far, only blackbody radiators and blackbody radiation have been discussed. However, real objects almost never comply with these laws over an extended wavelength region – although they may approach the blackbody behavior in certain spectral intervals. For example, a certain type of white paint may appear perfectly *white* in the visible light spectrum, but becomes distinctly *gray* at about 2 µm, and beyond 3 µm it is almost *black*.

There are three processes which can occur that prevent a real object from acting like a blackbody: a fraction of the incident radiation α may be absorbed, a fraction ρ may be reflected, and a fraction τ may be transmitted. Since all of these factors are more or less wavelength dependent, the subscript λ is used to imply the spectral dependence of their definitions. Thus:

- The spectral absorptance α_λ= the ratio of the spectral radiant power absorbed by an object to that incident upon it.
- The spectral reflectance ρ_λ = the ratio of the spectral radiant power reflected by an object to that incident upon it.
- The spectral transmittance τ_λ = the ratio of the spectral radiant power transmitted through an object to that incident upon it.

The sum of these three factors must always add up to the whole at any wavelength, so we have the relation:

$$\alpha_\lambda + \rho_\lambda + \tau_\lambda = 1$$

23

For opaque materials τ_λ = 0 and the relation simplifies to:

$$\alpha_\lambda + \rho_\lambda = 1$$

Another factor, called the emissivity, is required to describe the fraction ε of the radiant emittance of a blackbody produced by an object at a specific temperature. Thus, we have the definition:

The spectral emissivity ε_λ= the ratio of the spectral radiant power from an object to that from a blackbody at the same temperature and wavelength.

Expressed mathematically, this can be written as the ratio of the spectral emittance of the object to that of a blackbody as follows:

$$\varepsilon_\lambda = \frac{W_{\lambda o}}{W_{\lambda b}}$$

Generally speaking, there are three types of radiation source, distinguished by the ways in which the spectral emittance of each varies with wavelength.

- A blackbody, for which ε_λ = ε = 1
- A graybody, for which ε_λ = ε = constant less than 1
- A selective radiator, for which ε varies with wavelength

According to Kirchhoff's law, for any material the spectral emissivity and spectral absorptance of a body are equal at any specified temperature and wavelength. That is:

$$\varepsilon_\lambda = \alpha_\lambda$$

From this we obtain, for an opaque material (since $\alpha_\lambda + \rho_\lambda = 1$):

$$\varepsilon_\lambda + \rho_\lambda = 1$$

For highly polished materials ε_λ approaches zero, so that for a perfectly reflecting material (*i.e.* a perfect mirror) we have:

$$\rho_\lambda = 1$$

For a graybody radiator, the Stefan-Boltzmann formula becomes:

$$W = \varepsilon\sigma T^4 \text{ [Watt/m}^2\text{]}$$

This states that the total emissive power of a graybody is the same as a blackbody at the same temperature reduced in proportion to the value of ε from the graybody.

10401203;a2

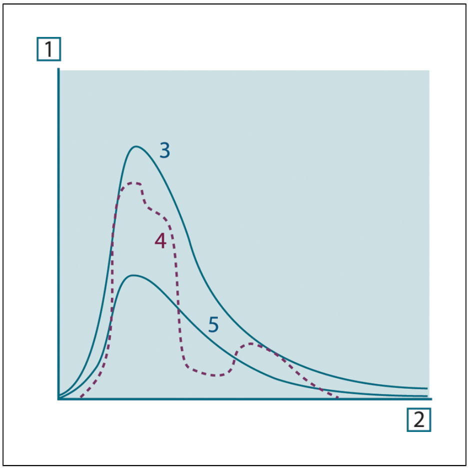


Figure 23.8 Spectral radiant emittance of three types of radiators. **1:** Spectral radiant emittance; **2:** Wavelength; **3:** Blackbody; **4:** Selective radiator; **5:** Graybody.

10327303;a4

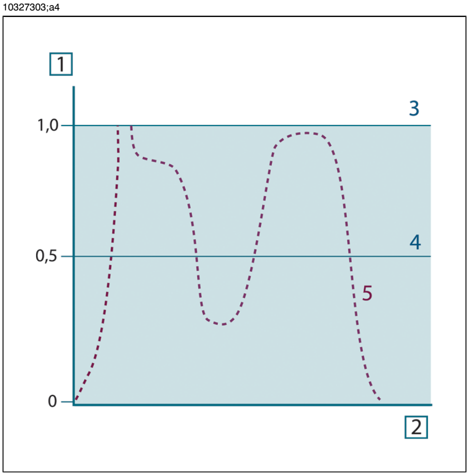


Figure 23.9 Spectral emissivity of three types of radiators. **1:** Spectral emissivity; **2:** Wavelength; **3:** Blackbody; **4:** Graybody; **5:** Selective radiator.

23.4 Infrared semi-transparent materials

Consider now a non-metallic, semi-transparent body – let us say, in the form of a thick flat plate of plastic material. When the plate is heated, radiation generated within its volume must work its way toward the surfaces through the material in which it is partially absorbed. Moreover, when it arrives at the surface, some of it is reflected back into the interior. The back-reflected radiation is again partially absorbed, but some of it arrives at the other surface, through which most of it escapes; part of it is reflected back again. Although the progressive reflections become weaker and weaker they must all be added up when the total emittance of the plate is sought. When the resulting geometrical series is summed, the effective emissivity of a semi-transparent plate is obtained as:

$$\varepsilon_\lambda = \frac{(1-\rho_\lambda)(1-\tau_\lambda)}{1-\rho_\lambda\tau_\lambda}$$

When the plate becomes opaque this formula is reduced to the single formula:

$$\varepsilon_\lambda = 1-\rho_\lambda$$

This last relation is a particularly convenient one, because it is often easier to measure reflectance than to measure emissivity directly.

24 The measurement formula

As already mentioned, when viewing an object, the camera receives radiation not only from the object itself. It also collects radiation from the surroundings reflected via the object surface. Both these radiation contributions become attenuated to some extent by the atmosphere in the measurement path. To this comes a third radiation contribution from the atmosphere itself.

This description of the measurement situation, as illustrated in the figure below, is so far a fairly true description of the real conditions. What has been neglected could for instance be sun light scattering in the atmosphere or stray radiation from intense radiation sources outside the field of view. Such disturbances are difficult to quantify, however, in most cases they are fortunately small enough to be neglected. In case they are not negligible, the measurement configuration is likely to be such that the risk for disturbance is obvious, at least to a trained operator. It is then his responsibility to modify the measurement situation to avoid the disturbance e.g. by changing the viewing direction, shielding off intense radiation sources etc.

Accepting the description above, we can use the figure below to derive a formula for the calculation of the object temperature from the calibrated camera output.

10400503;a1

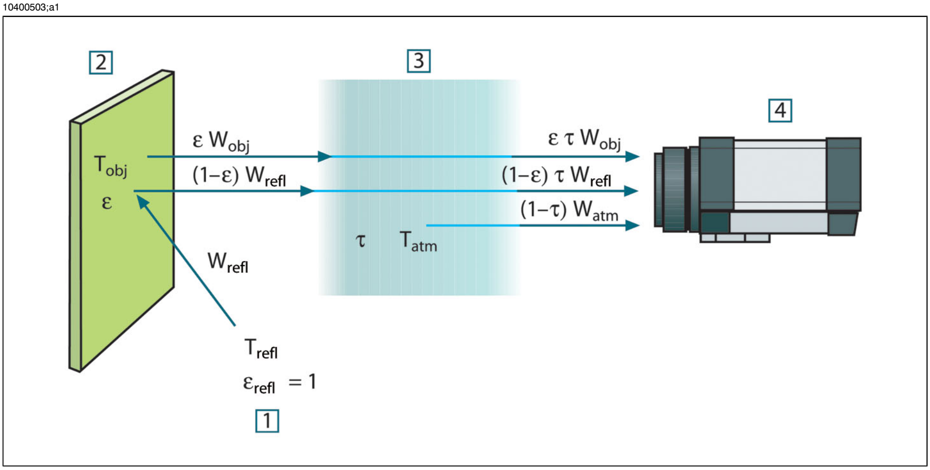


Figure 24.1 A schematic representation of the general thermographic measurement situation. **1:** Surroundings; **2:** Object; **3:** Atmosphere; **4:** Camera

Assume that the received radiation power W from a blackbody source of temperature T_{source} on short distance generates a camera output signal U_{source} that is proportional to the power input (power linear camera). We can then write (Equation 1):

$$U_{source} = CW(T_{source})$$

or, with simplified notation:

$$U_{source} = CW_{source}$$

where C is a constant.

Should the source be a graybody with emittance ε, the received radiation would consequently be εW_{source}.

We are now ready to write the three collected radiation power terms:

1 – Emission from the object = $\varepsilon\tau W_{obj}$, where ε is the emittance of the object and τ is the transmittance of the atmosphere. The object temperature is T_{obj}.

2 – Reflected emission from ambient sources = $(1 - \varepsilon)\tau W_{refl}$, where (1 – ε) is the reflectance of the object. The ambient sources have the temperature T_{refl}.

It has here been assumed that the temperature T_{refl} is the same for all emitting surfaces within the halfsphere seen from a point on the object surface. This is of course sometimes a simplification of the true situation. It is, however, a necessary simplification in order to derive a workable formula, and T_{refl} can – at least theoretically – be given a value that represents an efficient temperature of a complex surrounding.

Note also that we have assumed that the emittance for the surroundings = 1. This is correct in accordance with Kirchhoff's law: All radiation impinging on the surrounding surfaces will eventually be absorbed by the same surfaces. Thus the emittance = 1. (Note though that the latest discussion requires the complete sphere around the object to be considered.)

3 – Emission from the atmosphere = $(1 - \tau)\tau W_{atm}$, where (1 – τ) is the emittance of the atmosphere. The temperature of the atmosphere is T_{atm}.

The total received radiation power can now be written (Equation 2):

$$W_{tot} = \varepsilon\tau W_{obj} + (1-\varepsilon)\tau W_{refl} + (1-\tau)W_{atm}$$

We multiply each term by the constant C of Equation 1 and replace the CW products by the corresponding U according to the same equation, and get (Equation 3):

$$U_{tot} = \varepsilon\tau U_{obj} + (1-\varepsilon)\tau U_{refl} + (1-\tau)U_{atm}$$

Solve Equation 3 for U_{obj} (Equation 4):

$$U_{obj} = \frac{1}{\varepsilon\tau}U_{tot} - \frac{1-\varepsilon}{\varepsilon}U_{refl} - \frac{1-\tau}{\varepsilon\tau}U_{atm}$$

This is the general measurement formula used in all the FLIR Systems thermographic equipment. The voltages of the formula are:

Figure 24.2 Voltages

U_{obj}	Calculated camera output voltage for a blackbody of temperature T_{obj} i.e. a voltage that can be directly converted into true requested object temperature.
U_{tot}	Measured camera output voltage for the actual case.
U_{refl}	Theoretical camera output voltage for a blackbody of temperature T_{refl} according to the calibration.
U_{atm}	Theoretical camera output voltage for a blackbody of temperature T_{atm} according to the calibration.

The operator has to supply a number of parameter values for the calculation:

- the object emittance ε,
- the relative humidity,
- T_{atm}
- object distance (D_{obj})
- the (effective) temperature of the object surroundings, or the reflected ambient temperature T_{refl}, and
- the temperature of the atmosphere T_{atm}

This task could sometimes be a heavy burden for the operator since there are normally no easy ways to find accurate values of emittance and atmospheric transmittance for the actual case. The two temperatures are normally less of a problem provided the surroundings do not contain large and intense radiation sources.

A natural question in this connection is: How important is it to know the right values of these parameters? It could though be of interest to get a feeling for this problem already here by looking into some different measurement cases and compare the relative magnitudes of the three radiation terms. This will give indications about when it is important to use correct values of which parameters.

The figures below illustrates the relative magnitudes of the three radiation contributions for three different object temperatures, two emittances, and two spectral ranges: SW and LW. Remaining parameters have the following fixed values:

- τ = 0.88
- T_{refl} = +20°C (+68°F)
- T_{atm} = +20°C (+68°F)

24

It is obvious that measurement of low object temperatures are more critical than measuring high temperatures since the ‘disturbing’ radiation sources are relatively much stronger in the first case. Should also the object emittance be low, the situation would be still more difficult.

We have finally to answer a question about the importance of being allowed to use the calibration curve above the highest calibration point, what we call extrapolation. Imagine that we in a certain case measure U_{tot} = 4.5 volts. The highest calibration point for the camera was in the order of 4.1 volts, a value unknown to the operator. Thus, even if the object happened to be a blackbody, i.e. $U_{obj} = U_{tot}$, we are actually performing extrapolation of the calibration curve when converting 4.5 volts into temperature.

Let us now assume that the object is not black, it has an emittance of 0.75, and the transmittance is 0.92. We also assume that the two second terms of Equation 4 amount to 0.5 volts together. Computation of U_{obj} by means of Equation 4 then results in U_{obj} = 4.5 / 0.75 / 0.92 – 0.5 = 6.0. This is a rather extreme extrapolation, particularly when considering that the video amplifier might limit the output to 5 volts! Note, though, that the application of the calibration curve is a theoretical procedure where no electronic or other limitations exist. We trust that if there had been no signal limitations in the camera, and if it had been calibrated far beyond 5 volts, the resulting curve would have been very much the same as our real curve extrapolated beyond 4.1 volts, provided the calibration algorithm is based on radiation physics, like the FLIR Systems algorithm. Of course there must be a limit to such extrapolations.

10400603;a2

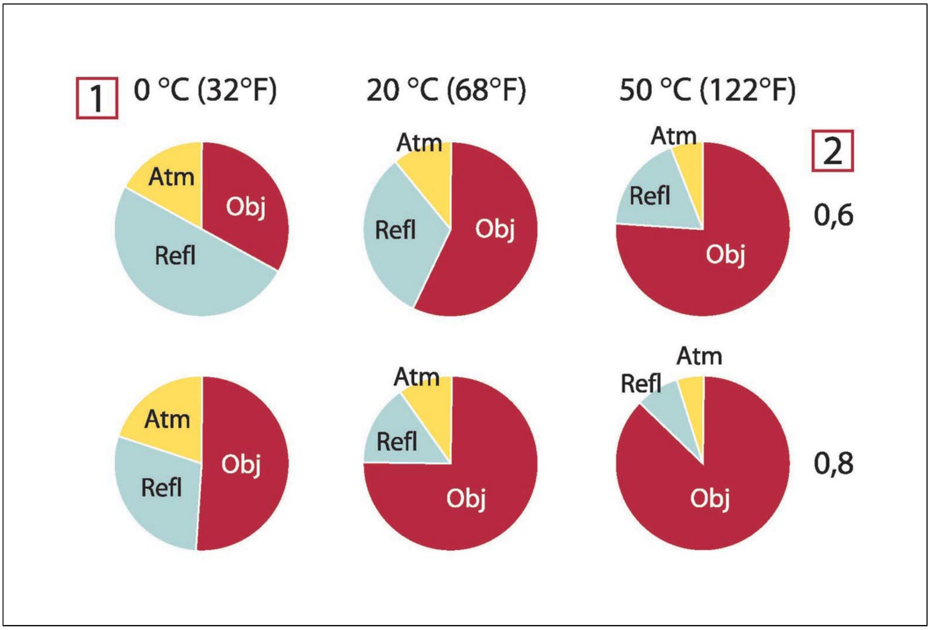


Figure 24.3 Relative magnitudes of radiation sources under varying measurement conditions (SW camera). **1:** Object temperature; **2:** Emittance; **Obj:** Object radiation; **Refl:** Reflected radiation; **Atm:** atmosphere radiation. Fixed parameters: $\tau = 0.88$; $T_{refl} = 20°C$ (+68°F); $T_{atm} = 20°C$ (+68°F).

24

10400703;a2

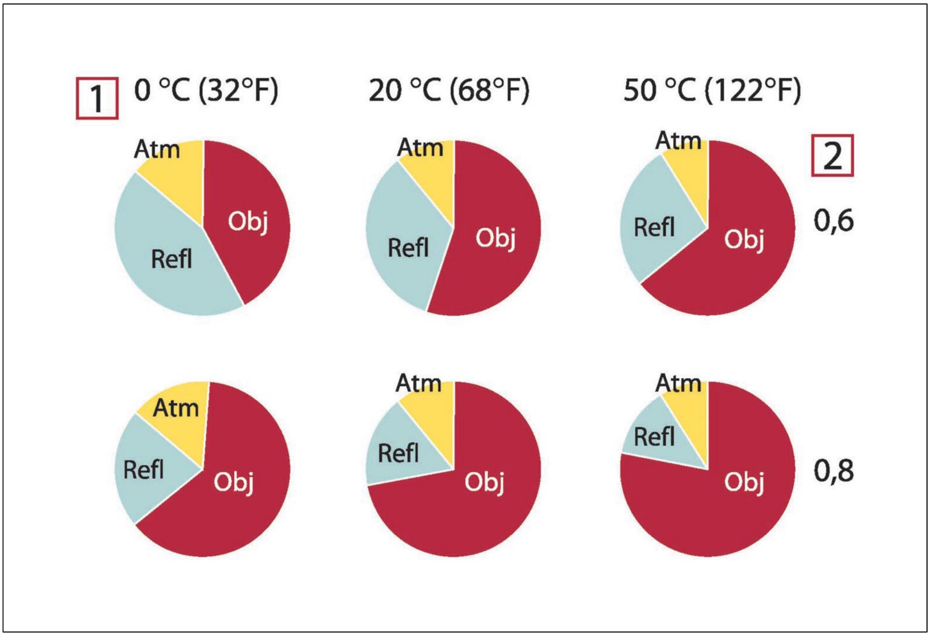


Figure 24.4 Relative magnitudes of radiation sources under varying measurement conditions (LW camera). **1:** Object temperature; **2:** Emittance; **Obj:** Object radiation; **Refl:** Reflected radiation; **Atm:** atmosphere radiation. Fixed parameters: τ = 0.88; T_{refl} = 20°C (+68°F); T_{atm} = 20°C (+68°F).

25 Emissivity tables

This section presents a compilation of emissivity data from the infrared literature and measurements made by FLIR Systems.

25.1 References

1	Mikaél A. Bramson: *Infrared Radiation, A Handbook for Applications*, Plenum press, N.Y.
2	William L. Wolfe, George J. Zissis: *The Infrared Handbook*, Office of Naval Research, Department of Navy, Washington, D.C.
3	Madding, R. P.: *Thermographic Instruments and systems*. Madison, Wisconsin: University of Wisconsin – Extension, Department of Engineering and Applied Science.
4	William L. Wolfe: *Handbook of Military Infrared Technology*, Office of Naval Research, Department of Navy, Washington, D.C.
5	Jones, Smith, Probert: *External thermography of buildings...,* Proc. of the Society of Photo-Optical Instrumentation Engineers, vol.110, Industrial and Civil Applications of Infrared Technology, June 1977 London.
6	Paljak, Pettersson: *Thermography of Buildings*, Swedish Building Research Institute, Stockholm 1972.
7	Vlcek, J: *Determination of emissivity with imaging radiometers and some emissivities at* $\lambda = 5$ *µm.* Photogrammetric Engineering and Remote Sensing.
8	Kern: *Evaluation of infrared emission of clouds and ground as measured by weather satellites*, Defence Documentation Center, AD 617 417.
9	Öhman, Claes: *Emittansmätningar med AGEMA E-Box*. Teknisk rapport, AGEMA 1999. (Emittance measurements using AGEMA E-Box. Technical report, AGEMA 1999.)

25.2 Important note about the emissivity tables

The emissivity values in the table below are recorded using a shortwave (SW) camera. The values should be regarded as recommendations only and used by caution.

25.3 Tables

Figure 25.1 **T:** Total spectrum; **SW:** 2–5 µm; **LW:** 8–14 µm, **LLW:** 6.5–20 µm; **1:** Material; **2:** Specification; **3:** Temperature in °C; **4:** Spectrum; **5:** Emissivity: **6:** Reference

1	2	3	4	5	6
Aluminum	anodized, black, dull	70	LW	0.95	9
Aluminum	anodized, black, dull	70	SW	0.67	9

1	2	3	4	5	6
Aluminum	anodized, light gray, dull	70	LW	0.97	9
Aluminum	anodized, light gray, dull	70	SW	0.61	9
Aluminum	anodized sheet	100	T	0.55	2
Aluminum	as received, plate	100	T	0.09	4
Aluminum	as received, sheet	100	T	0.09	2
Aluminum	cast, blast cleaned	70	LW	0.46	9
Aluminum	cast, blast cleaned	70	SW	0.47	9
Aluminum	dipped in HNO_3, plate	100	T	0.05	4
Aluminum	foil	27	3 μm	0.09	3
Aluminum	foil	27	10 μm	0.04	3
Aluminum	oxidized, strongly	50–500	T	0.2–0.3	1
Aluminum	polished	50–100	T	0.04–0.06	1
Aluminum	polished, sheet	100	T	0.05	2
Aluminum	polished plate	100	T	0.05	4
Aluminum	roughened	27	3 μm	0.28	3
Aluminum	roughened	27	10 μm	0.18	3
Aluminum	rough surface	20–50	T	0.06–0.07	1
Aluminum	sheet, 4 samples differently scratched	70	LW	0.03–0.06	9
Aluminum	sheet, 4 samples differently scratched	70	SW	0.05–0.08	9
Aluminum	vacuum deposited	20	T	0.04	2
Aluminum	weathered, heavily	17	SW	0.83–0.94	5
Aluminum bronze		20	T	0.60	1
Aluminum hydroxide	powder		T	0.28	1
Aluminum oxide	activated, powder		T	0.46	1

1	2	3	4	5	6
Aluminum oxide	pure, powder (alumina)		T	0.16	1
Asbestos	board	20	T	0.96	1
Asbestos	fabric		T	0.78	1
Asbestos	floor tile	35	SW	0.94	7
Asbestos	paper	40–400	T	0.93–0.95	1
Asbestos	powder		T	0.40–0.60	1
Asbestos	slate	20	T	0.96	1
Asphalt paving		4	LLW	0.967	8
Brass	dull, tarnished	20–350	T	0.22	1
Brass	oxidized	70	SW	0.04–0.09	9
Brass	oxidized	70	LW	0.03–0.07	9
Brass	oxidized	100	T	0.61	2
Brass	oxidized at 600°C	200–600	T	0.59–0.61	1
Brass	polished	200	T	0.03	1
Brass	polished, highly	100	T	0.03	2
Brass	rubbed with 80-grit emery	20	T	0.20	2
Brass	sheet, rolled	20	T	0.06	1
Brass	sheet, worked with emery	20	T	0.2	1
Brick	alumina	17	SW	0.68	5
Brick	common	17	SW	0.86–0.81	5
Brick	Dinas silica, glazed, rough	1100	T	0.85	1
Brick	Dinas silica, refractory	1000	T	0.66	1
Brick	Dinas silica, unglazed, rough	1000	T	0.80	1
Brick	firebrick	17	SW	0.68	5
Brick	fireclay	20	T	0.85	1

1	2	3	4	5	6
Brick	fireclay	1000	T	0.75	1
Brick	fireclay	1200	T	0.59	1
Brick	masonry	35	SW	0.94	7
Brick	masonry, plastered	20	T	0.94	1
Brick	red, common	20	T	0.93	2
Brick	red, rough	20	T	0.88–0.93	1
Brick	refractory, corundum	1000	T	0.46	1
Brick	refractory, magnesite	1000–1300	T	0.38	1
Brick	refractory, strongly radiating	500–1000	T	0.8–0.9	1
Brick	refractory, weakly radiating	500–1000	T	0.65–0.75	1
Brick	silica, 95% SiO_2	1230	T	0.66	1
Brick	sillimanite, 33% SiO_2, 64% Al_2O_3	1500	T	0.29	1
Brick	waterproof	17	SW	0.87	5
Bronze	phosphor bronze	70	LW	0.06	9
Bronze	phosphor bronze	70	SW	0.08	9
Bronze	polished	50	T	0.1	1
Bronze	porous, rough	50–150	T	0.55	1
Bronze	powder		T	0.76–0.80	1
Carbon	candle soot	20	T	0.95	2
Carbon	charcoal powder		T	0.96	1
Carbon	graphite, filed surface	20	T	0.98	2
Carbon	graphite powder		T	0.97	1
Carbon	lampblack	20–400	T	0.95–0.97	1
Chipboard	untreated	20	SW	0.90	6

1	2	3	4	5	6
Chromium	polished	50	T	0.10	1
Chromium	polished	500–1000	T	0.28–0.38	1
Clay	fired	70	T	0.91	1
Cloth	black	20	T	0.98	1
Concrete		20	T	0.92	2
Concrete	dry	36	SW	0.95	7
Concrete	rough	17	SW	0.97	5
Concrete	walkway	5	LLW	0.974	8
Copper	commercial, burnished	20	T	0.07	1
Copper	electrolytic, carefully polished	80	T	0.018	1
Copper	electrolytic, polished	–34	T	0.006	4
Copper	molten	1100–1300	T	0.13–0.15	1
Copper	oxidized	50	T	0.6–0.7	1
Copper	oxidized, black	27	T	0.78	4
Copper	oxidized, heavily	20	T	0.78	2
Copper	oxidized to blackness		T	0.88	1
Copper	polished	50–100	T	0.02	1
Copper	polished	100	T	0.03	2
Copper	polished, commercial	27	T	0.03	4
Copper	polished, mechanical	22	T	0.015	4
Copper	pure, carefully prepared surface	22	T	0.008	4
Copper	scraped	27	T	0.07	4
Copper dioxide	powder		T	0.84	1
Copper oxide	red, powder		T	0.70	1

1	2	3	4	5	6
Ebonite			T	0.89	1
Emery	coarse	80	T	0.85	1
Enamel		20	T	0.9	1
Enamel	lacquer	20	T	0.85–0.95	1
Fiber board	hard, untreated	20	SW	0.85	6
Fiber board	masonite	70	LW	0.88	9
Fiber board	masonite	70	SW	0.75	9
Fiber board	particle board	70	LW	0.89	9
Fiber board	particle board	70	SW	0.77	9
Fiber board	porous, untreated	20	SW	0.85	6
Gold	polished	130	T	0.018	1
Gold	polished, carefully	200–600	T	0.02–0.03	1
Gold	polished, highly	100	T	0.02	2
Granite	polished	20	LLW	0.849	8
Granite	rough	21	LLW	0.879	8
Granite	rough, 4 different samples	70	LW	0.77–0.87	9
Granite	rough, 4 different samples	70	SW	0.95–0.97	9
Gypsum		20	T	0.8–0.9	1
Ice: See Water					
Iron, cast	casting	50	T	0.81	1
Iron, cast	ingots	1000	T	0.95	1
Iron, cast	liquid	1300	T	0.28	1
Iron, cast	machined	800–1000	T	0.60–0.70	1
Iron, cast	oxidized	38	T	0.63	4
Iron, cast	oxidized	100	T	0.64	2
Iron, cast	oxidized	260	T	0.66	4
Iron, cast	oxidized	538	T	0.76	4

1	2	3	4	5	6
Iron, cast	oxidized at 600°C	200–600	T	0.64–0.78	1
Iron, cast	polished	38	T	0.21	4
Iron, cast	polished	40	T	0.21	2
Iron, cast	polished	200	T	0.21	1
Iron, cast	unworked	900–1100	T	0.87–0.95	1
Iron and steel	cold rolled	70	LW	0.09	9
Iron and steel	cold rolled	70	SW	0.20	9
Iron and steel	covered with red rust	20	T	0.61–0.85	1
Iron and steel	electrolytic	22	T	0.05	4
Iron and steel	electrolytic	100	T	0.05	4
Iron and steel	electrolytic	260	T	0.07	4
Iron and steel	electrolytic, carefully polished	175–225	T	0.05–0.06	1
Iron and steel	freshly worked with emery	20	T	0.24	1
Iron and steel	ground sheet	950–1100	T	0.55–0.61	1
Iron and steel	heavily rusted sheet	20	T	0.69	2
Iron and steel	hot rolled	20	T	0.77	1
Iron and steel	hot rolled	130	T	0.60	1
Iron and steel	oxidized	100	T	0.74	1
Iron and steel	oxidized	100	T	0.74	4
Iron and steel	oxidized	125–525	T	0.78–0.82	1
Iron and steel	oxidized	200	T	0.79	2
Iron and steel	oxidized	1227	T	0.89	4
Iron and steel	oxidized	200–600	T	0.80	1
Iron and steel	oxidized strongly	50	T	0.88	1
Iron and steel	oxidized strongly	500	T	0.98	1
Iron and steel	polished	100	T	0.07	2

1	2	3	4	5	6
Iron and steel	polished	400–1000	T	0.14–0.38	1
Iron and steel	polished sheet	750–1050	T	0.52–0.56	1
Iron and steel	rolled, freshly	20	T	0.24	1
Iron and steel	rolled sheet	50	T	0.56	1
Iron and steel	rough, plane surface	50	T	0.95–0.98	1
Iron and steel	rusted, heavily	17	SW	0.96	5
Iron and steel	rusted red, sheet	22	T	0.69	4
Iron and steel	rusty, red	20	T	0.69	1
Iron and steel	shiny, etched	150	T	0.16	1
Iron and steel	shiny oxide layer, sheet,	20	T	0.82	1
Iron and steel	wrought, carefully polished	40–250	T	0.28	1
Iron galvanized	heavily oxidized	70	LW	0.85	9
Iron galvanized	heavily oxidized	70	SW	0.64	9
Iron galvanized	sheet	92	T	0.07	4
Iron galvanized	sheet, burnished	30	T	0.23	1
Iron galvanized	sheet, oxidized	20	T	0.28	1
Iron tinned	sheet	24	T	0.064	4
Lacquer	3 colors sprayed on Aluminum	70	LW	0.92–0.94	9
Lacquer	3 colors sprayed on Aluminum	70	SW	0.50–0.53	9
Lacquer	Aluminum on rough surface	20	T	0.4	1
Lacquer	bakelite	80	T	0.83	1
Lacquer	black, dull	40–100	T	0.96–0.98	1
Lacquer	black, matte	100	T	0.97	2
Lacquer	black, shiny, sprayed on iron	20	T	0.87	1

1	2	3	4	5	6
Lacquer	heat–resistant	100	T	0.92	1
Lacquer	white	40–100	T	0.8–0.95	1
Lacquer	white	100	T	0.92	2
Lead	oxidized, gray	20	T	0.28	1
Lead	oxidized, gray	22	T	0.28	4
Lead	oxidized at 200°C	200	T	0.63	1
Lead	shiny	250	T	0.08	1
Lead	unoxidized, polished	100	T	0.05	4
Lead red		100	T	0.93	4
Lead red, powder		100	T	0.93	1
Leather	tanned		T	0.75–0.80	1
Lime			T	0.3–0.4	1
Magnesium		22	T	0.07	4
Magnesium		260	T	0.13	4
Magnesium		538	T	0.18	4
Magnesium	polished	20	T	0.07	2
Magnesium powder			T	0.86	1
Molybdenum		600–1000	T	0.08–0.13	1
Molybdenum		1500–2200	T	0.19–0.26	1
Molybdenum	filament	700–2500	T	0.1–0.3	1
Mortar		17	SW	0.87	5
Mortar	dry	36	SW	0.94	7
Nichrome	rolled	700	T	0.25	1
Nichrome	sandblasted	700	T	0.70	1
Nichrome	wire, clean	50	T	0.65	1
Nichrome	wire, clean	500–1000	T	0.71–0.79	1
Nichrome	wire, oxidized	50–500	T	0.95–0.98	1

1	2	3	4	5	6
Nickel	bright matte	122	T	0.041	4
Nickel	commercially pure, polished	100	T	0.045	1
Nickel	commercially pure, polished	200–400	T	0.07–0.09	1
Nickel	electrolytic	22	T	0.04	4
Nickel	electrolytic	38	T	0.06	4
Nickel	electrolytic	260	T	0.07	4
Nickel	electrolytic	538	T	0.10	4
Nickel	electroplated, polished	20	T	0.05	2
Nickel	electroplated on iron, polished	22	T	0.045	4
Nickel	electroplated on iron, unpolished	20	T	0.11–0.40	1
Nickel	electroplated on iron, unpolished	22	T	0.11	4
Nickel	oxidized	200	T	0.37	2
Nickel	oxidized	227	T	0.37	4
Nickel	oxidized	1227	T	0.85	4
Nickel	oxidized at 600°C	200–600	T	0.37–0.48	1
Nickel	polished	122	T	0.045	4
Nickel	wire	200–1000	T	0.1–0.2	1
Nickel oxide		500–650	T	0.52–0.59	1
Nickel oxide		1000–1250	T	0.75–0.86	1
Oil, lubricating	0.025 mm film	20	T	0.27	2
Oil, lubricating	0.050 mm film	20	T	0.46	2
Oil, lubricating	0.125 mm film	20	T	0.72	2
Oil, lubricating	film on Ni base: Ni base only	20	T	0.05	2
Oil, lubricating	thick coating	20	T	0.82	2

Publ. No. T559007 Rev. a277 – ENGLISH (EN) – April 21, 2008

1	2	3	4	5	6
Paint	8 different colors and qualities	70	LW	0.92–0.94	9
Paint	8 different colors and qualities	70	SW	0.88–0.96	9
Paint	Aluminum, various ages	50–100	T	0.27–0.67	1
Paint	cadmium yellow		T	0.28–0.33	1
Paint	chrome green		T	0.65–0.70	1
Paint	cobalt blue		T	0.7–0.8	1
Paint	oil	17	SW	0.87	5
Paint	oil, black flat	20	SW	0.94	6
Paint	oil, black gloss	20	SW	0.92	6
Paint	oil, gray flat	20	SW	0.97	6
Paint	oil, gray gloss	20	SW	0.96	6
Paint	oil, various colors	100	T	0.92–0.96	1
Paint	oil based, average of 16 colors	100	T	0.94	2
Paint	plastic, black	20	SW	0.95	6
Paint	plastic, white	20	SW	0.84	6
Paper	4 different colors	70	LW	0.92–0.94	9
Paper	4 different colors	70	SW	0.68–0.74	9
Paper	black		T	0.90	1
Paper	black, dull		T	0.94	1
Paper	black, dull	70	LW	0.89	9
Paper	black, dull	70	SW	0.86	9
Paper	blue, dark		T	0.84	1
Paper	coated with black lacquer		T	0.93	1
Paper	green		T	0.85	1
Paper	red		T	0.76	1
Paper	white	20	T	0.7–0.9	1

1	2	3	4	5	6
Paper	white, 3 different glosses	70	LW	0.88–0.90	9
Paper	white, 3 different glosses	70	SW	0.76–0.78	9
Paper	white bond	20	T	0.93	2
Paper	yellow		T	0.72	1
Plaster		17	SW	0.86	5
Plaster	plasterboard, untreated	20	SW	0.90	6
Plaster	rough coat	20	T	0.91	2
Plastic	glass fibre laminate (printed circ. board)	70	LW	0.91	9
Plastic	glass fibre laminate (printed circ. board)	70	SW	0.94	9
Plastic	polyurethane isolation board	70	LW	0.55	9
Plastic	polyurethane isolation board	70	SW	0.29	9
Plastic	PVC, plastic floor, dull, structured	70	LW	0.93	9
Plastic	PVC, plastic floor, dull, structured	70	SW	0.94	9
Platinum		17	T	0.016	4
Platinum		22	T	0.03	4
Platinum		100	T	0.05	4
Platinum		260	T	0.06	4
Platinum		538	T	0.10	4
Platinum		1000–1500	T	0.14–0.18	1
Platinum		1094	T	0.18	4
Platinum	pure, polished	200–600	T	0.05–0.10	1
Platinum	ribbon	900–1100	T	0.12–0.17	1

1	2	3	4	5	6
Platinum	wire	50–200	T	0.06–0.07	1
Platinum	wire	500–1000	T	0.10–0.16	1
Platinum	wire	1400	T	0.18	1
Porcelain	glazed	20	T	0.92	1
Porcelain	white, shiny		T	0.70–0.75	1
Rubber	hard	20	T	0.95	1
Rubber	soft, gray, rough	20	T	0.95	1
Sand			T	0.60	1
Sand		20	T	0.90	2
Sandstone	polished	19	LLW	0.909	8
Sandstone	rough	19	LLW	0.935	8
Silver	polished	100	T	0.03	2
Silver	pure, polished	200–600	T	0.02–0.03	1
Skin	human	32	T	0.98	2
Slag	boiler	0–100	T	0.97–0.93	1
Slag	boiler	200–500	T	0.89–0.78	1
Slag	boiler	600–1200	T	0.76–0.70	1
Slag	boiler	1400–1800	T	0.69–0.67	1
Snow: See Water					
Soil	dry	20	T	0.92	2
Soil	saturated with wa-ter	20	T	0.95	2
Stainless steel	alloy, 8% Ni, 18% Cr	500	T	0.35	1
Stainless steel	rolled	700	T	0.45	1
Stainless steel	sandblasted	700	T	0.70	1
Stainless steel	sheet, polished	70	LW	0.14	9
Stainless steel	sheet, polished	70	SW	0.18	9

1	2	3	4	5	6
Stainless steel	sheet, untreated, somewhat scratched	70	LW	0.28	9
Stainless steel	sheet, untreated, somewhat scratched	70	SW	0.30	9
Stainless steel	type 18-8, buffed	20	T	0.16	2
Stainless steel	type 18-8, oxidized at 800°C	60	T	0.85	2
Stucco	rough, lime	10–90	T	0.91	1
Styrofoam	insulation	37	SW	0.60	7
Tar			T	0.79–0.84	1
Tar	paper	20	T	0.91–0.93	1
Tile	glazed	17	SW	0.94	5
Tin	burnished	20–50	T	0.04–0.06	1
Tin	tin–plated sheet iron	100	T	0.07	2
Titanium	oxidized at 540°C	200	T	0.40	1
Titanium	oxidized at 540°C	500	T	0.50	1
Titanium	oxidized at 540°C	1000	T	0.60	1
Titanium	polished	200	T	0.15	1
Titanium	polished	500	T	0.20	1
Titanium	polished	1000	T	0.36	1
Tungsten		200	T	0.05	1
Tungsten		600–1000	T	0.1–0.16	1
Tungsten		1500–2200	T	0.24–0.31	1
Tungsten	filament	3300	T	0.39	1
Varnish	flat	20	SW	0.93	6
Varnish	on oak parquet floor	70	LW	0.90–0.93	9
Varnish	on oak parquet floor	70	SW	0.90	9

1	2	3	4	5	6
Wallpaper	slight pattern, light gray	20	SW	0.85	6
Wallpaper	slight pattern, red	20	SW	0.90	6
Water	distilled	20	T	0.96	2
Water	frost crystals	–10	T	0.98	2
Water	ice, covered with heavy frost	0	T	0.98	1
Water	ice, smooth	–10	T	0.96	2
Water	ice, smooth	0	T	0.97	1
Water	layer >0.1 mm thick	0–100	T	0.95–0.98	1
Water	snow		T	0.8	1
Water	snow	–10	T	0.85	2
Wood		17	SW	0.98	5
Wood		19	LLW	0.962	8
Wood	ground		T	0.5–0.7	1
Wood	pine, 4 different samples	70	LW	0.81–0.89	9
Wood	pine, 4 different samples	70	SW	0.67–0.75	9
Wood	planed	20	T	0.8–0.9	1
Wood	planed oak	20	T	0.90	2
Wood	planed oak	70	LW	0.88	9
Wood	planed oak	70	SW	0.77	9
Wood	plywood, smooth, dry	36	SW	0.82	7
Wood	plywood, untreat-ed	20	SW	0.83	6
Wood	white, damp	20	T	0.7–0.8	1
Zinc	oxidized at 400°C	400	T	0.11	1
Zinc	oxidized surface	1000–1200	T	0.50–0.60	1

1	2	3	4	5	6
Zinc	polished	200–300	T	0.04–0.05	1
Zinc	sheet	50	T	0.20	1

INTENTIONALLY LEFT BLANK

A note on the technical production of this manual

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

A note on the typeface used in this manual

This manual was typeset using Swiss 721, which is Bitstream's pan-European version of the Helvetica™ typeface. Helvetica™ was designed by Max Miedinger (1910–1980).

The following file identities and file versions were used in the formatting stream output for this manual:

20235103.xml a23
20235203.xml a21
20235303.xml a16
20236703.xml a37
20237103.xml a9
20238703.xml b8
20250403.xml a16
20254903.xml a46
20257003.xml a29
20257103.xml a16
20257303.xml a22
20273903.xml a4
20279803.xml a4
20286103.xml a6
20286203.xml a7
20286303.xml a5
20286403.xml a7
20286503.xml a9
20286603.xml a6
20286703.xml a9
20286803.xml a6
20286903.xml a4
20287003.xml a5
20287103.xml a9
20287203.xml a6
20287303.xml a4
20287303.xml a7
20287403.xml a3
R112.rcp a5
config.xml a5

▪ AUSTRALIA
FLIR Systems
10 Business Park Drive
Nottinghill
Victoria 3168
Australia
Tel: +61-3-9550-2800
Fax: +61-3-9558-9853
Email: info@flir.com.au
Web: www.flirthermography.com

▪ BELGIUM
FLIR Systems
Uitbreidingstraat 60–62
B-2600 Berchem
BELGIUM
Phone: +32 (0)3 287 87 11
Fax: +32 (0)3 287 87 29
E-mail: info@flir.be
Web: www.flirthermography.com

▪ BRAZIL
FLIR Systems
Av. Antonio Bardella, 320
CEP: 18085-852 Sorocaba
São Paulo
BRAZIL
Phone: +55 15 3238 8070
Fax: +55 15 3238 8071
E-mail: paul.verminnen@flir.com.br
E-mail: flir@flir.com.br
Web: www.flirthermography.com

▪ CANADA
FLIR Systems
5230 South Service Road, Suite #125
Burlington, ON. L7L 5K2
CANADA
Phone: 1 800 613 0507 ext. 30
Fax: 905 639 5488
E-mail: IRCanada@flir.com
Web: www.flirthermography.com

▪ CHINA
FLIR Systems
Beijing Representative Office
Rm 203A, Dongwai Diplomatic Office Building
23 Dongzhimenwai Dajie
Beijing 100600
P.R.C.
Phone: +86 10 8532 2304
Fax: +86 10 8532 2460
E-mail: beijing@flir.com.cn
Web: www.flirthermography.com

▪ CHINA
FLIR Systems
Shanghai Representative Office
Room 6311, West Building
Jin Jiang Hotel
59 Maoming Road (South)
Shanghai 200020
P.R.C.
Phone: +86 21 5466 0286
Fax: +86 21 5466 0289
E-mail: shanghai@flir.com.cn
Web: www.flirthermography.com

▪ CHINA
FLIR Systems
Guangzhou Representative Office
1105 Main Tower, Guang Dong
International Hotel
339 Huanshi Dong Road
Guangzhou 510098
P.R.C.
Phone: +86 20 8333 7492
Fax: +86 20 8331 0976
E-mail: guangzhou@flir.com.cn
Web: www.flirthermography.com

▪ FRANCE
FLIR Systems
10 rue Guynemer
92130 Issy les Moulineaux
Cedex
FRANCE
Phone: +33 (0)1 41 33 97 97
Fax: +33 (0)1 47 36 18 32
E-mail: info@flir.fr
Web: www.flirthermography.com

▪ GERMANY
FLIR Systems
Berner Strasse 81
D-60437 Frankfurt am Main
GERMANY
Phone: +49 (0)69 95 00 900
Fax: +49 (0)69 95 00 9040
E-mail: info@flir.de
Web: www.flirthermography.com

▪ GREAT BRITAIN
FLIR Systems
2 Kings Hill Avenue – Kings Hill
West Malling
Kent, ME19 4AQ
UNITED KINGDOM
Phone: +44 (0)1732 220 011
Fax: +44 (0)1732 843 707
E-mail: sales@flir.uk.com
Web: www.flirthermography.com

▪ HONG KONG
FLIR Systems
Room 1613–15, Tower 2
Grand Central Plaza
138 Shatin Rural Committee Rd
Shatin, N.T.
HONG KONG
Phone: +852 27 92 89 55
Fax: +852 27 92 89 52
E-mail: flir@flir.com.hk
Web: www.flirthermography.com

▪ ITALY
FLIR Systems
Via L. Manara, 2
20051 Limbiate (MI)
ITALY
Phone: +39 02 99 45 10 01
Fax: +39 02 99 69 24 08
E-mail: info@flir.it
Web: www.flirthermography.com

▪ JAPAN
FLIR SYSTEMS Japan KK
Nishi-Gotanda Access 8F
3-6-20 Nishi-Gotanda
Shinagawa-Ku
Tokyo 141-0031
JAPAN
Phone: +81 3 6277 5681
Fax: +81 3 6277 5682
E-mail: info@flir.jp
Web: www.flirthermography.com

▪ SWEDEN
FLIR Systems
Worldwide Thermography Center
P.O. Box 3
SE-182 11 Danderyd
SWEDEN
Phone: +46 (0)8 753 25 00
Fax: +46 (0)8 753 23 64
E-mail: sales@flir.se
Web: www.flirthermography.com

▪ USA
FLIR Systems
Corporate headquarters
27700A SW Parkway Avenue
Wilsonville, OR 97070
USA
Phone: +1 503 498 3547
Web: www.flirthermography.com

▪ USA (Primary sales & service contact in USA)
FLIR Systems
USA Thermography Center
16 Esquire Road
North Billerica, MA. 01862
USA
Phone: +1 978 901 8000
Fax: +1 978 901 8887
E-mail: marketing@flir.com
Web: www.flirthermography.com

▪ USA
FLIR Systems
Indigo Operations
70 Castilian Dr.
Goleta, CA 93117-3027
USA
Phone: +1 805 964 9797
Fax: +1 805 685 2711
E-mail: sales@indigosystems.com
Web: www.corebyindigo.com

▪ USA
FLIR Systems
Indigo Operations
IAS Facility
701 John Sims Parkway East
Suite 2B
Niceville, FL 32578
USA
Phone: +1 850 678 4503
Fax: +1 850 678 4992
E-mail: sales@indigosystems.com
Web: www.corebyindigo.com