

ThermaCAM™ PM575/595

Operator's Manual



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1 General information

1.1 *Warranty*

All products manufactured by FLIR Systems AB 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's instruction.

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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 or this warranty will not apply.

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

FLIR 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.

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This manual must not, in whole or part, be copied, photocopied, reproduced, translated or transmitted to any electronic medium or machine readable form without prior consent, in writing, from FLIR Systems AB.

1.3 *Quality Assurance*

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

FLIR Systems AB 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.

All functions described in this manual are not available in both camera models.

2 Introduction

2.1 *System overview*

The ThermaCAM™ PM575/595 infrared condition monitoring system consists of an IR-camera with a built-in 24° lens, a removable battery pack and a range of accessories. The IR-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.

The ThermaCAM™ PM575/595 camera is dust- and splash-proof and shock- and vibration-tested for use in the most demanding field conditions. It is a handheld, truly portable camera, which is lightweight and operates for more than 1.5 hours on one battery pack. A high-resolution colour image is provided in real-time either in the integral viewfinder or on an external monitor.

The camera is very easy to use and is operated by using a few buttons which are conveniently placed on the camera, allowing fingertip control of major functions. A built-in menu system also gives easy access to an advanced, simple-to-use camera software for increased functionality.

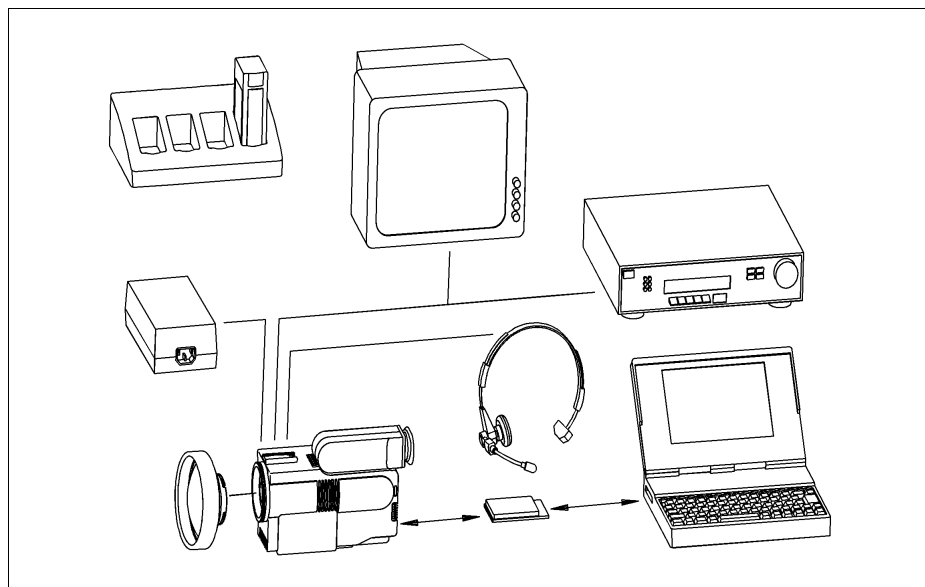
To document the object under inspection it is possible to capture and store images onto a removable PC-card. It is also possible to store, together with every image, voice comments and/or text comments, including information such as the object's ID data, field conditions etc. This is achieved by making use of the headset connected to the camera.

The images can be analysed either in the field by using the real-time measurement functions built into the camera, or in a PC by using the *AGEMA™ Report* software.

The PC-card is moved from the camera to the PC. In the PC the images cannot only be viewed and analysed, but the voice comment can also be played back. *AGEMA™ Report* makes it very easy to create complete survey reports (containing numerous IR images, photos, tables etc.) from the inspections.

2.2 *Unpacking and assembly*

On receipt of your ThermaCAM™ PM575/595 remove each component from the carrying case and inspect them all against the delivery note.



- PC software, AGEMA™ Report.
- High temperature options.
- Remote control handle.
- Camera handle.

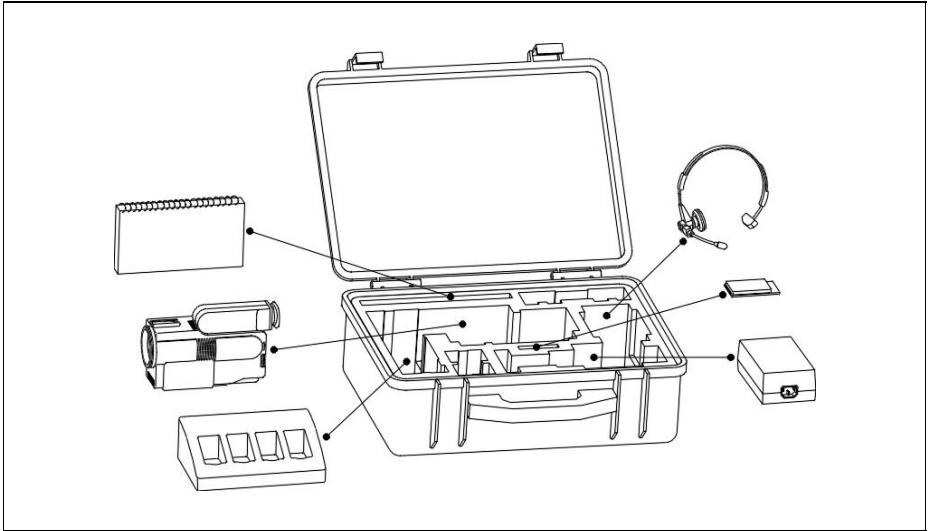


Figure 2.2 How to pack the ThermaCAM™ PM575/595 in the transport case.

3 Controls and connections

3.1 Direct access buttons

The camera is controlled by pressing the direct access buttons and/or using the joystick control.

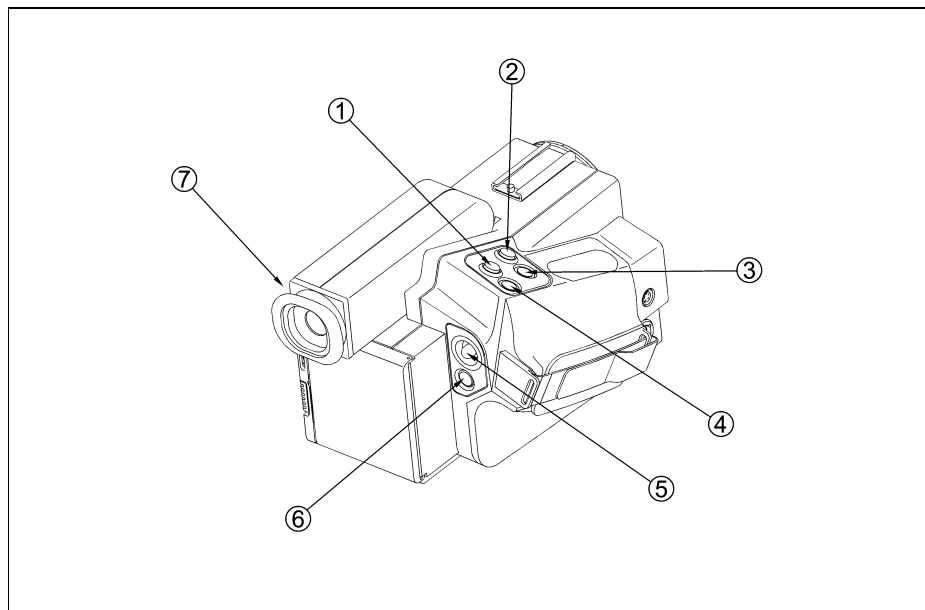


Figure 3.1 Direct access buttons

The ↵ (*enter*) button [1] brings up the menu system of the camera in the viewfinder. Make your selection in the menu by using the joystick control. You accept the menu choice and quit the menu mode by pressing the ↵ button. The ↵ button also means *Accept* or *Confirm*.

Press the *A (auto)* button [2] to get the best image in the viewfinder automatically. When this button is pressed an automatic calibration is also performed.

Press the *S (save)* button [3] shortly to switch between a frozen image and a live image. To store the image to the PC-card press the *S* button for more than 1 sec.

The *C (clear)* button [4] is used when you need to skip a menu selection without making any changes and leave the menu mode. The *C* button also means *Escape* or *Don't accept*.

The joystick [5] has various functions. At the start up of the camera the joystick is in the default mode controlling focus (up/down) and zoom (left/right). In the menu mode you use the joystick to select the appropriate function and to increase or decrease various parameter settings.

The green (on/off) button [6] is used to switch the power of the camera on and off. Press the button to switch the camera on. Keep down the button for more than 2 seconds to switch the camera off.

The focus of the viewfinder [7] can be adjusted by turning the adjustment ring either clockwise or counter-clockwise.

For further information on the direct access buttons, see “User interface” on page 14.

3.2 Connections

There are three connectors on the camera:

- *12 VDC connector*: For connection to the power cable from battery belt or power supply. This connector also provides S-VHS signals (or on some camera models 14-bit digital signals) and remote control signals when the optional 5 metres (16.4 ft) extension cable is used.
- *Headset connector*: For connection to a headset to make voice comments to stored images.
- *Video connector*: For connection to large monitors or standard VHS-video equipment for viewing or recording.

[1] Video connector

[2] 12 VDC connector

[3] Headset connector

(Overleaf)

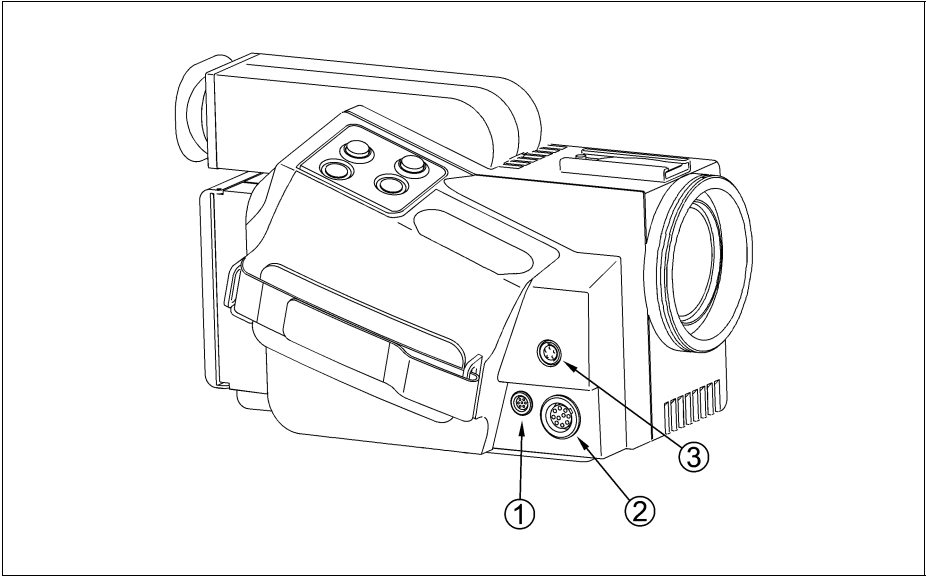


Figure 3.2 Camera connectors.

4 Getting started

4.1 *Adjusting and connecting system components*

4.1.1 Lenses

The camera is equipped with a built-in 24° lens, but optional lenses can also be fitted.

- [1] To mount the lens push the lens carefully into the bayonet of the camera, aligning the white dots on the camera bayonet and the lens. Turn the lens 45° clockwise to lock the lens.
- [2] To release the lens turn it 45° counter-clockwise and remove the lens.
- [3] The lens type is recognised by the camera and the correct calibration is automatically used.

4.1.2 PC-card

The recorded images with voice and text comments are stored on a removable PC-card.

- [1] To insert the PC-card open the hatch by pressing the release button on the back of the camera downwards. Insert the disk with the connector side (i.e. the bottom side of the disk) to the right and the connectors facing the camera.
- [2] To remove the PC-card open the hatch and press the eject button.

After the PC-card has been inserted, the camera software will check that it hasn't got any errors. This will be indicated in the viewfinder by the words *Checking disk*.

4.1.3 Battery

- [1] To insert the battery pack open the hatch by pressing the release button downwards on the back of the camera. Insert the battery with the connectors facing the camera and with its convex side facing downwards.
- [2] To remove the battery open the hatch and press the battery release button below the battery.

See also "Battery system" on page 42.

4.1.4 Shoulder strap

- [1] To fit the shoulder strap to the camera, pull back the safety clasp at the end of the shoulder strap by pressing the release button.

- [2] Pass the thin straps through the slots on the left and right back side of the camera. Insert the wire hook through the holes at the end of the straps. Lock the mechanism by pulling forward the safety clasp.
- [3] Adjust the length of the shoulder strap so that the camera rests comfortably on the chest.

4.1.5 Headset

- [1] Connect the headset to the headset connector of the camera.
- [2] Place the headset on your head with the plastic support above your ear on the opposite side of the headphone.
- [3] Adjust the position of the microphone to about 2–3 cm from your mouth.

The headset can be used with the headphone either to the left or to the right. On the cable there is also a clip to fasten the cable to the operator.

4.2 First time operation

4.2.1 To get an image

- [1] Insert the battery into the battery compartment on the back of the camera.
- [2] Remove the lens cover from the camera.
- [3] Press the green on/off button to start the camera. After approx. 15 seconds an image with the FLIR logotype will appear and will be displayed until the camera controls are ready for use.
- [4] Adjust the viewfinder focus to obtain the best display focus for your eyes.
- [5] Point the camera at a warm object to be viewed, like a face or a hand.
- [6] Press the *A* button to activate the auto-adjust function to achieve in a good image in the viewfinder.
- [7] Adjust the focus of the camera by moving the joystick up/down.

4.2.2 To set a new language

If the camera is set to the wrong language, press the \downarrow button to display the menu system.

- [1] Go to *Local adapt...* in the *Set-up* menu (*Setup®Local adapt...*). Press \downarrow which makes the *Setup – Local adaptations* panel appear.
- [2] Choose Language (*Setup®Local adapt...®Language*) and select the desired language by moving the joystick to the right or left. When the correct language is shown press \downarrow to set the language.

4.2.3 To measure a temperature

- [1] Press the \downarrow button to display the menu system.
- [2] Go to the *Spot* function in the menu tree by moving the joystick to the left or the right. The *Spot* function is located in the *Analysis* menu. Press the \downarrow button when *Spot* is highlighted. The spot meter crosshair will now appear in the image and the measured temperature will be shown in the upper right corner of the display. If the multiple spots option is selected in the setup menu (*Setup@Analysis@Multiple spots@On*), the *Analysis* menu will display *Spot 1*, *Spot 2* and *Spot 3* instead of *Spot*.
- [3] To move the spot meter crosshair on the screen the function has to be highlighted in the *Analysis* menu. It can then be moved with the joystick. When the spot is correctly located, press \downarrow to go back to the normal function of the joystick (i.e. controlling focus and zoom). To be able to move the spot meter after the joystick has resumed its normal function, it has to be highlighted and confirmed in the *Analysis* menu again.

4.2.4 To save an image

- [1] Press the *A* button and focus the image.
- [2] Press the *S* button to freeze the image.
- [3] To save, hold down the *S* button for one second or until the filename (e.g. *E123232*) of the image appears.

Press the *S* button briefly to go to live mode.

4.2.5 To add a voice comment to an image

- [1] Connect the headset to the headset connector and place it on your head. See also "Connections" on page 7.
- [2] Press the *A* button and focus the image.
- [3] Freeze the image by pressing the *S* button for a short while. \downarrow
- [4] Press the \downarrow to get the menu system and go to *Voice comment...* in the *File* menu by using the joystick. Select *Voice comment...* by pressing \downarrow . This will make the control panel for voice comments appear.
- [5] Hold down the *S* button while recording. The length of the comment is indicated by * signs in the control bar.
- [6] Playback in the headphone indicates that the recording is working.
- [7] When the voice recording is complete press the \downarrow button to save both the image and the voice comment.
- [8] To listen to the comment keep down the *A* button.

4.2.6 To add text comments to an image


This function is only possible if a file containing user-defined text comments is stored on the PC-card. These text comments can be created and edited in

AGEMA™ Report PC software. See the software *Operator's Manual* for further information on creating and editing text comments.

- [1] Press the *A* button and focus the image.
- [2] Freeze the image by pressing the *S* button for a short while.
- [3] Select *Text comment...* in the *File* menu. This brings up a maximum of four consecutive multiple-choice panels.
- [4] Move the joystick up/down to choose the desired text comment. Move the joystick left/right to go to the next text comment panel, or to return to a previous one.
- [5] Press ↵ to save the complete text comment in the last panel.

The suffix *T* after the image file name indicates that a text comment is attached to the file.

4.2.7 To recall a stored image and listen to a voice comment

N.B. – The symbol  after an image filename denotes that a voice comment is attached to the image file.

- [1] Press the ↵ button to display the menu system.
- [2] Go to the *Open* function in the *File* menu by moving the joystick to the left or the right. Press the ↵ button when *Open* is highlighted. A control bar for opening files will now appear at the bottom of the screen.
- [3] To choose the image you would like to open move the joystick up and down. If the image is in another directory go to the directory selection box by moving the joystick to the right. When the desired image file name appears, press ↵ to select the image.
- [4] To listen to the voice message go to the *Voice comment...* function in the *File* menu. Press the ↵ button when *Voice comment...* is highlighted. A dialog panel for Voice comment... will now appear on the right side of the screen.
- [5] To play back and listen to the message keep down the *A* button. To remove the Voice comment... dialog panel, press the *C* button.
- [6] To get back to live mode again, press the *S* button.

4.2.8 To recall a previously stored image and view text comments

N.B. – The letter *T* after an image filename indicates that text comments are attached to the image file.

- [1] Press the ↵ button to display the menu system.
- [2] Go to the *Open* function in the *File* menu by moving the joystick to the left or the right. Press the ↵ button when *Open* is highlighted. A control bar for opening files will now appear at the bottom of the screen.
- [3] To choose the image you would like to open move the joystick up and down. If the image is in another directory go to the directory selection box by moving

the joystick to the right. When the desired image file name appears, press ↵ to select the image.

If *Text comments: None* is selected in the *Setup – Image* dialog box (*Setup→Image→Text comments→None*):

[4] Select *Text comment...* in the *File* menu when the image is shown. A dialog box will appear and the current text comments are displayed at the bottom of the screen, above the data fields.

If *Text comments: Value only* or *Text comments: Value and label* is presently selected in the *Setup – Image* dialog box (*Setup→Image*):

[5] The current text comments are displayed at the bottom of the screen – above the data fields – when the image is opened.

5 Operation

5.1 User interface

The most important functions can be accessed with the buttons described below.

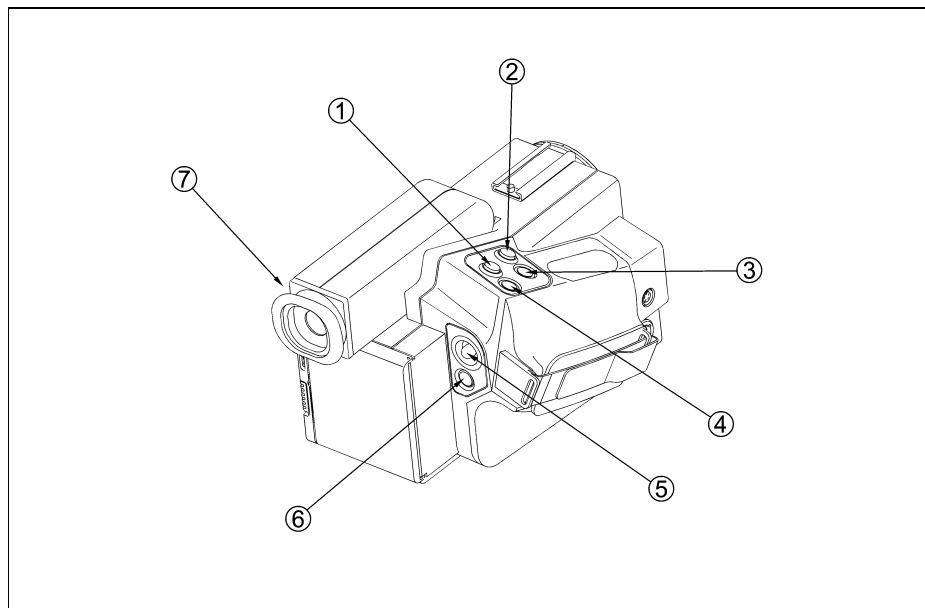


Figure 5.1 User interface.

Enter button [1] – This button (marked ↵) has different functions depending on which mode the camera is in i.e. normal (focus/zoom) mode or menu mode. However, the ↵ button always means continue, confirm or exit.

Pressing ↵ in normal mode will bring up the menu system and put the camera in menu mode.

Pressing ↵ in menu mode:

- Activates the selected function or command in the menus.
- Confirms and leaves the selected choices.

Auto-adjust button [2] – Press the button (marked A) to set the best image. The camera will automatically adjust the viewed temperature span and level and will also adjust the palette for best contrast in all parts of the image. If the image is in live mode a calibration is performed automatically. The exact function of the auto

adjust button when pressed can be changed in the *Setup* menu (*Setup*→*Image*→*Auto-adjust*).

If the *A* button is not pressed within a few minutes, the camera will automatically perform this calibration.

Save button [3] – Press the button (marked *S*) briefly to switch between frozen and live images. A frozen image is indicated by the word *Frozen* in the status area.

An image is saved by pressing the button for about one second until the filename for the saved image appears in the status area, e.g. *Saving G0101-00*. If there is no PC-card inserted in the camera, the message *No disk* will appear.

Clear button [4] – This button (marked *C*) clears, quits or cancels without changing anything. In menu mode it normally removes the menu system, putting the camera in normal mode. In normal (focus/zoom) mode it activates a special feature

N.B. – While the *C* button is held down the level and span can be adjusted with the joystick:

- *Joystick left/right*: Decreases/increases span
- *Joystick down/up*: Decreases/increases level.

Joystick [5] – The joystick can be moved in four directions left, right, up and down. Functionality in menu mode:

- Change menu items and item values.

Functionality in measurement function mode:

- Moving or resizing measurement functions on the screen , i.e. *Spot*, *Area*, *Profile* and *Isotherm*.

Functionality in normal mode:

- *Joystick left/right*: Zooming out/in.
- *Joystick down/up*: Focusing near/far

Green (on/off) button [6] – Press the button to switch the camera on. Keep down the button for more than two seconds to switch the camera off.

Viewfinder [7] – See “System overview” on page 3.

5.2 Menu objects

The menu system includes a number of different menu objects. This section describes these objects.

N.B. – The screens on the following pages do not *necessarily* show possible combinations of menu objects that can be displayed at the same time. They are only meant to show the operator the different types of menu objects.

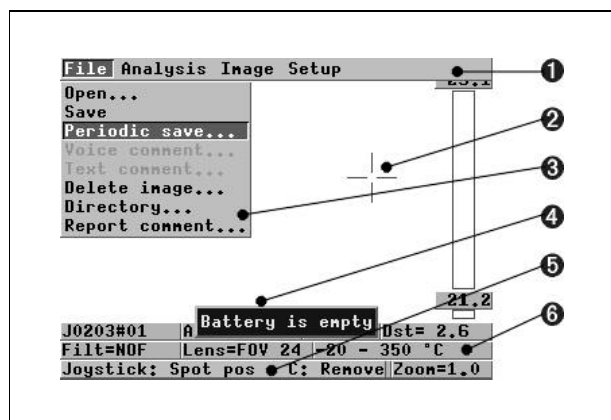


Figure 5.2 Menu objects – example 1.

- [1] Menu area with pull-down menus
- [2] Spot meter crosshair
- [3] Pull-down menu
- [4] Critical info (e.g. *Battery is empty*)
- [5] Joystick control
- [6] Data presentation – one to three lines (one to five if the text comments option is enabled).

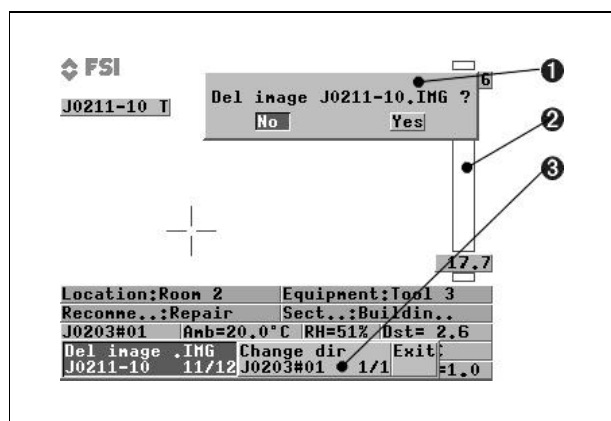


Figure 5.3 Menu objects – example 2 (explanations overleaf).

- [1] Status text (e.g. *Frozen* or *Saving*)
- [2] Dialog box (e.g. *Setup – Analysis*)
- [3] Control box

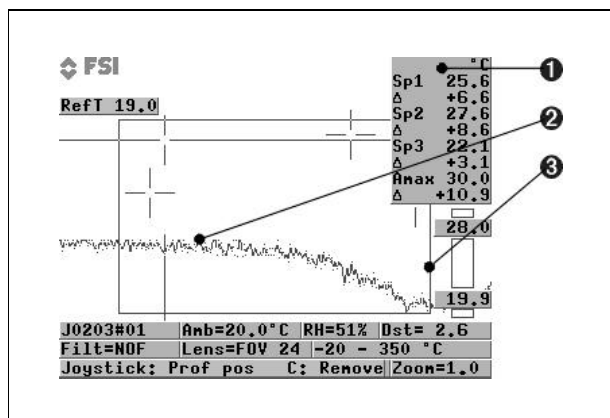


Figure 5.4 Menu objects – example 3.

- [1] Result table (i.e. measurement presentation area)
- [2] Profile
- [3] Area

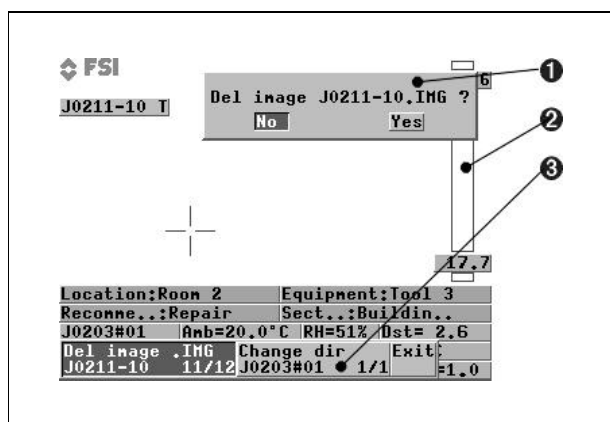


Figure 5.5 Menu objects – example 4.

- [1] Confirm box
- [2] Temperature scale
- [3] Selection box (e.g. *Del image* or *Change dir*)

5.3 Menu area

The menu area is reached by pressing the \downarrow button which activates the menu system. Moving the joystick left/right brings out the different pull-down menus. Selecting an item in a pull-down menu is made by moving the joystick up/down. The selected item is highlighted. Some of the functions might be marked grey, indicating that they cannot be activated under the current conditions. For example, this is the case for the *Open* or *Save* commands if there is no PC-card disk inserted.

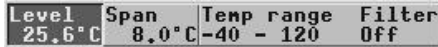
Actions when \downarrow is pressed:

- If the selected pull-down menu item has three dots at the end (e.g. *Open...*) a menu dialog will show up on the screen.
- If not, the selected menu item (e.g. *Save*) will be executed and the menu area will be removed.

Pressing the *C* button will remove the pull down menu area and restore the normal function for the joystick, i.e. focus/zoom.

5.3.1 Control box

Some selections in the menu area result in showing a control box in the bottom left-hand corner of the screen.



Level	Span	Temp range	Filter
25.6°C	8.0°C	-40 - 120	Off

Figure 5.6 Control box.

The control box is a horizontal table with different selection possibilities. The upper line contains the selection headings and the lower line the value/alternative for each selection.

Joystick functions:

- *Left/right*: Change item.
- *Up/down*: Change value/alternative.

The selected item is marked white/dark grey. Pressing the \downarrow button saves changes and removes the control box. Pressing the *C* button will remove the control box, cancel the changes and put the camera in normal mode, i.e. focus/zoom function for the joystick.

5.3.2 Dialog boxes

Some selections in the menu area result in showing a dialog box on the screen.

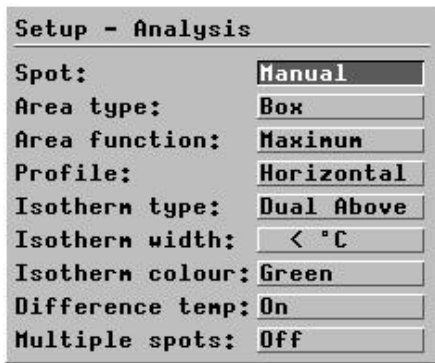


Figure 5.7 Dialog box.

A dialog box contains either one or several horizontal selection items or one vertical selection item (see figure above).

Joystick function, horizontal dialog box

- *Up/down*: Change item.
- *Left/right*: Change value/alternative.

Joystick function, vertical dialog box

- *Up/down*: Change item value/alternative.

The selected item is marked white/dark grey. Pressing the \downarrow button results in a function dependent action (see “Menu functions” on page 6).

Pressing the C button will normally remove the dialog box, cancel the changes and put the camera in normal mode, i.e. focus/zoom function for the joystick.

5.3.3 Confirm boxes

Some selections (pressing \downarrow or C) result in a confirm box appearing on the screen.



Figure 5.8 Confirm box.

Joystick function:

- *Left/right*: Change item (e.g. Yes or No)

The selected item is marked white/dark grey. Pressing the \downarrow button normally confirms the action (removing the dialog and confirm box) and puts the camera back in normal mode, i.e. focus/zoom. Pressing the C button removes the confirm box without any other action.

5.3.4 Result table

When a measurement function is active it is displayed in a result table in the upper right-hand corner of the screen. The first line contains the selected temperature unit (see *Local adapt...*, “Setup menu” on page 35), i.e. *degrees Celsius* (°C) or *degrees Fahrenheit* (°F). The consecutive lines contain one or more measurement functions, e.g. *Sp1*, *Amin*, *Amax*, *Aavg*, *Cur* or *Iso* and the corresponding values. If the isotherm is activated together with another measurement function, the *Iso* value is located under the measurement function, e.g. *Spot 1*. If *Diff temp* (see “Setup menu” on page 35) is activated, the temperature difference between two defined measurement functions is displayed. If the reference temperature is activated (*Analysis*→*Ref temp*), it is displayed in the bottom line of the result table.

If one or two functions are selected, each of these functions' Δ -values are displayed in the result table. The Δ -value is calculated as the difference between the function's temperature and the reference temperature. If three or more functions are selected, the Δ -value is only calculated for the last chosen, or last adjusted, measurement function. The reference temperature can be set to either of the different functions that are active by confirming that particular function in the *Analysis* menu and then confirming *Ref temp* in the same menu.

Special signs:

- Undefined temperature
- < Temperature below range
- > Temperature above range
- * Uncalibrated, i.e. the temperature is outside calibrated range

	°C
Sp1	25.6
Δ	+6.6
Sp2	27.6
Δ	+8.6
Sp3	22.1
Δ	+3.1
Amax	30.0
Δ	+10.9

Figure 5.8 Result table – an example.

5.3.5 Data presentation

The data presentation is displayed on the first, second and/or third bottom lines of the screen. If text comments are attached to an image file, they are displayed

above these three lines. In *Setup→Image→Data field*, data presentation can be selected on four different levels, *None*, *Normal*, *Reduced* or *Extended*. The background can be set either to *Solid* or *Transparent*. See “Setup menu” on page 35, for detailed information.


5.3.6 Temperature scale

The temperature scale is displayed on the right-hand side of the screen. The scale shows how the colours are distributed over the various temperatures in the image with high temperatures at the upper end and low temperatures at the lower end. The small boxes above and below the scale display what colours are used for temperatures outside the scale. See also “Saturation col.” on page 38.

5.3.7 Status area

The status area shows the current action.

Examples:

<i>Checking disk</i>	Msg is displayed when a PC-card ATA disk is inserted.
<i>Frozen</i>	Msg is displayed when the image is frozen.
<i>Saving G0101-01</i>	Msg is displayed during the time an image with the name <i>G0101-01</i> is written to the disk.
<i>Adjusting</i> <i>G0101-01</i> 	Msg is displayed when the camera performs an auto adjustment. The recalled image name and the speaker symbol are displayed if the image contains a voice comment.
<i>G0101-01 T</i>	The recalled image name and the <i>T</i> symbol are displayed if the image contains a text comment.
<i>Zooming in/out</i>	Msg is displayed when zooming.
<i>Focus far/near</i>	Msg is displayed when changing focus.

5.3.8 Joystick control

When a measurement function is chosen and activated by highlighting that function in the *Analysis* menu, the camera shows what measurement function is connected to the joystick. This information is displayed at the bottom of the screen:

Joystick: Spot pos	C: Remove
Joystick: Iso temp	C: Remove
Joystick: Area size	C: Remove
Joystick: Profile pos	C: Remove

To deactivate a measurement function, press *C* when one of the above messages is displayed.

5.3.9 Critical information

Critical camera information is displayed in the centre of the screen.

Typical messages:

<i>Battery low</i>	The battery voltage is under a specified limit and the batteries will be empty within minutes.
<i>Battery empty</i>	The battery voltage has dropped below a minimum. The camera will be switched off within 10 seconds.
<i>Recalibrating camera</i>	Msg is displayed when the camera is changing the temperature range.
<i>Failed checking disk</i>	Msg is displayed if an error occurs during the disk checking procedure. The message will be displayed until the faulty disk is removed.
<i>Unknown PC-card</i>	Msg is displayed if a non-ATA disk is inserted in the camera. The message will be displayed until the disk is removed.
<i>Disk error</i>	Msg is displayed if some kind of error is detected while reading/writing to the PC-card disk.

5.4 File System

The ThermoCAM™ PM575/595 uses the standard PC-card (ATA hard/flash disks), with DOS file system, to record 14 bit-images (*.IMG and/or *.BMP) with voice comments and/or text comments.

5.4.1 Advantages with digital recording

Digital recording using PC-cards offers a number of advantages when storing images with the ThermoCAM™ PM575/595. Images can be stored and recalled later without any loss of accuracy.

5.4.2 File organisation

The camera only creates new inspection/working directories at the root level. Images are saved under an inspection/working directory.

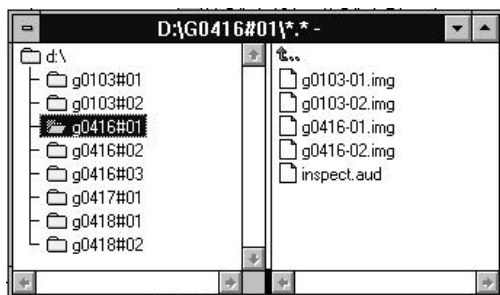


Figure 5.9 File organisation example using Windows™ 3.11 File Manager.

The camera ignores image files located in the root directory. The camera also ignores directories located in an inspection/working directory.

5.4.3 Naming files and directories

When storing an image a name is automatically generated based on either the current date or the current directory according to the selection made in the *Setup®Save options* menu.

Example 1 – Image names based on current date:

When storing an image or creating a new directory the name, based on current date, is generated according to the following standard:

Image name: YMMDDnnn.EXT

Y	=	Last digit in the current year, converted to an equivalent letter (A = 0 to J = 9), e.g. 1996 → G.
MM	=	Current month (01–12)
DD	=	Current day (01–31)
nnn	=	File/directory index. If index [01–99] → -nn, #nn if directory name. If index [100–999] → -nnn.

The current date is 10/01/96 (January 10th, 1996). Two images have already been stored on this date. The next image to be stored is allocated the prefix G0110-03.

G	=	digit 6 in 1996 converted to a letter.
0110	=	January 10th
03	=	File index (i.e. this is the third image generated on January 10th,1996).

No extension is used for directory names. The extension *.IMG is used for image names. The extension is not displayed in the camera.

Example 2 – Image names based on current directory:

Image names can also be based on the current directory that is being used. In that case they are created according to the following standard:

Image name: DIRECnnn.IMG

DIREC	=	First 5 characters of the directory name
nnn	=	File/directory index. If index [01–99] → -nn If index [100–999] → -nnn.

The directory name is *COMPANY*. Two images have already been stored on this date. The next image to be stored is allocated the prefix *COMP*A-03.

5.4.4 Naming files and directories in a PC

When creating directories in a PC there is no restriction on naming the directories. The camera can also read all directories on the root level independently of chosen directory name. It is possible to rename image names created in the camera to any DOS approved name, i.e. the camera can read image files independently of chosen image names. However, the camera can only access files with the extension *.IMG or *.BMP. If the extension for a file is renamed in a PC the camera ignores the file. On the other hand, if a non-*ThermaCAM™ File Format* file has the *.IMG extension, the camera will display the critical info *Bad file format* when recalling the file.

5.5 Menu Functions

The menu system is organised into four main groups *File*, *Analysis*, *Image* and *Setup*. This section describes all menu functions in detail.

5.5.1 File menu

The file menu contains all the functions dealing with the digital image and storage of voice and/or text comments, i.e. *Open...*, *Save*, *Periodic save...*, *Voice comment...*, *Text comment...*, *Delete image...*, *Directory...* and *Report comment...*

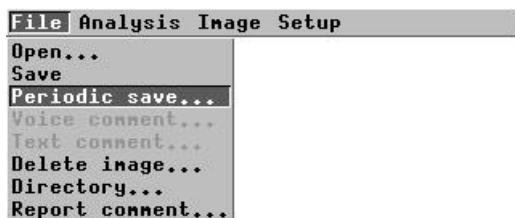


Figure 5.10 File menu.

5.5.1.1 Open...

This function is used to open or recall previously saved images from the disk. The function brings up a control box at the bottom of the screen, showing the name of the image being displayed and the directory in which the image file is stored. To select another image to be displayed, use the joystick up and down to change the selected image from the directory.



Figure 5.11 Open control box.

The index field after the image/directory name contains file order information.

Example:

A file with the name *G0112-12 12/23* represents the 12th image in a directory containing 23 images.

Note that the measurement functions, colour scales and object parameters can be changed since these are saved with the image and will be used when it is recalled.

To change the directory select *Change dir* by moving the joystick to the right. The directories can then be changed by moving the joystick up/down.

5.5.1.2 Save

This function will save the displayed image onto the PC-card disk. Together with the image all the current conditions, like measurement function, colour scale, zoom factor, values of the object parameters etc., will be saved to be used again when the image is recalled. If the save function is activated on a recalled image, a confirmation panel will appear on the screen.



Figure 5.12 Confirmation panel; *Image exist@Create new or Overwrite.*

If *Create new* is selected, the image on the screen will be stored in a new file (with a new, automatically allocated name) on the disk. If *Overwrite* is selected, this will overwrite the recalled image file on the disk.

The same function as choosing *Save* in the *File* menu can be activated by pressing the S button for more than one second.

If *Voice comment* is enabled (see “Save options...” on page 39) the voice dialog will be displayed on the screen. The user can now add a comment to the image (see “To add a voice comment to an image” on page 11, and “Voice comment...” on page 26) or just press ↵ to store the image without a voice comment.

Depending on the settings in *Setup – Save options (Setup@Save options...)*, images can be saved either in *.IMG file format, *.IMG and *.BMP file formats, or only *.BMP file format. Later analysis of saved images (e.g. in the *AGEMA™ Report* PC software) can only be made if the images are saved in *.IMG file format. If *BMP only* or *IMG and BMP* is selected, the operator can choose if the only the IR image or the IR image and the graphics (data fields etc.) shall be saved.

5.5.1.3 Periodic save...

This function will save a number of images, at a certain selectable periodicity, onto the PC-card. Together with the images all the current conditions will be saved.

When activating the function, a periodic save dialog will be displayed on the screen.

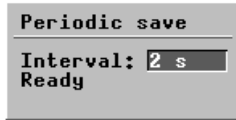


Figure 5.13 Periodic save

The periodicity at which images are saved can be set by using the joystick. The periodicity can be set from 2 seconds up to 24 hours. Select fast for shortest time interval (as fast as possible, i.e. about one image per second).

- Pressing \downarrow will start the recording.
- Pressing \downarrow or C will stop the recording.

Images will be stored as a sequence on the selected directory, image no. 1 under the name *SEQ001*, image no. 2 under *SEQ002* and so on.

If the recording is stopped and then started again the new images will be added at the end of the previous sequence on the same directory.

5.5.1.4 Voice comment...

When pressing the \downarrow button the voice comment dialog will be displayed on the screen.



Figure 5.14 Voice comment dialog box.

Features in the image voice comment function:

- listen to a recorded comment, make a pause, and then continue.
- record a new comment, make a pause, and then continue.
- edit a recorded comment, i.e. listen and/or add a comment at the end of the recorded comment.

- overwriting an existing recording.
- adding comments to an already recorded voice comment.

How to use:

As long as the *S* button is pressed recording will proceed. Playback will proceed as long as the *A* button is pressed.

Normally when the \downarrow button is pressed the image will be stored together with the new comment. The camera will then return to the status prior to the image voice comment session, i.e. a live or recalled image.

The default selection in the confirmation panel is *No*. If *No* is selected and the operator press \downarrow , dialog boxes will be removed and no storing will occur. If *Yes* is selected the old comment will be overwritten.

5.5.1.4.1 Voice comment info panel

This function will display a user-defined ASCII text file on the screen when selecting Voice comment.

The function is enabled by selecting *Voice comment*. An ASCII text file named *VOICECMT.TXT* must be located in the working/inspection directory or in the root directory. If the file is placed in the root directory this function will be enabled independent of the selected working/inspection directory.

The camera displays the first 15 character in each line. A maximum of 9 lines is displayed. The first line is selected as the heading.

How to use:

- [1] Prepare an inspection by creating an inspection directory on the PC-card. Edit a parameter label list (ASCII-text only) and save it on this directory under the name *VOICECMT.TXT* on the PC-card. The directory can be created in the *AGEMA™ Report* PC-software.
- [2] During the inspection, the parameter label list will show up in the viewfinder every time you are going to add a voice comment to an image.
- [3] Make voice comments to all parameters according to the label list.

If the item parameters in the *AGEMA™ Report* PC software are arranged in the same way as the parameter label list, it will now be very easy to input the voice comments made into the item parameters when making the inspection report.

5.5.1.5 Text comment...

This function allows the operator to add text comments to an image, or a series of images. Using the function is only possible if a file containing user-defined text

comments is stored on the PC-card (*.tcf). These text comments can be created and edited in AGEMA™ *Report PC* software. See the software *Operator's Manual* for further information on creating and editing text comments.

To add a text comment to an image, choose *Text comments* in the *File* menu. A dialog box with multiple choices of text comments appears on the screen. The choice in each dialog box is confirmed by highlighting the comment and pressing ↵. This also brings up the next dialog box. Even though only one choice can be made in a maximum of four different dialog boxes, the number of dialog boxes may exceed that number. Pressing ↵ in the last dialog box confirms the complete text comment. Pressing S in any particular dialog box saves that comment and cancels the following dialog boxes.

N.B. – Text comments can only be made if *IMG only* or *IMG and BMP* is selected in the *Setup – Save options* dialog box (*Analysis@Save options*). If *BMP only* is selected, no text comments can be made.

If the option *Label & value* or *Value* is chosen in the *Setup@Image@Text comments* menu, the text comments appear above the data presentation field at the bottom of the screen. The suffix *T* is also added to the saved image, to indicate that a text comment is attached to the file.

5.5.1.6 Delete image...

This function is used to delete previously saved images from the disk. The function brings up a control bar showing the name of the image being displayed and the directory in which it is stored. To select another image to be deleted move the joystick up and down to change the selected image from the directory.



Figure 5.15 Delete Image control bar.

- To change the directory move the joystick to the right. The different directories can then be selected by moving the joystick up or down.
- To delete an image, select *Del Image* and press ↵. The image will be deleted after confirming *Yes* and pressing ↵ in the confirmation dialog box.

If the directory is empty it is possible to delete the directory. The dialog box item *Del Image* is changed to *Del Dir*. Deleting the directory is made in the same way as deleting an image (see above).

5.5.1.7 Directory...

This function is used to change the working/inspection directory. To change directory move the joystick up or down until the selected directory is highlighted. By pressing the \downarrow button, the selection is made and the dialog box is removed.



Figure 5.16 Change directory dialog box.

To create a new directory select the last item in the directory list, *Create new*, and press the \downarrow button. If you select *Yes* in the confirmation panel an automatically named directory is created on your disk. This new directory is now your working directory.

5.5.1.8 Report comment...

This function is used to store a general report comment within an inspection directory. The comment will be stored in a separate file under the present inspection directory. The handling is similar to the *Voice comment...* function (see “Voice comment...” on page 26).

5.5.1.8.1 Report comment info panel

The *Report comment...* function will display a user-defined ASCII text file on the screen and is enabled by selecting *Report comment* (*File*→*Report comment*). An ASCII text file named *REPORCMT.TXT* must be located in the working/inspection directory or in the root directory. If the file is placed in the root directory this function will be enabled independent of the selected working/inspection directory.

The camera displays the first 15 characters in each line. A maximum of 9 lines are displayed. The first line is selected as the heading.

See also “Voice comment info panel” on page 27.

5.5.2 Analysis menu

In the analysis menu the desired measurement function can be activated. Isotherm can always be active along with one or more of the other functions, i.e. *Area*, *Spot* or *Profile*. If the multiple spots option is selected, the *Analysis* menu shows three different spot meters, *Spot 1*, *Spot 2* and *Spot 3*. The result of a measurement function is presented in the result table located in the top right-hand corner of the screen. The operator can also select *Remove all* to de-activate all measurement functions.

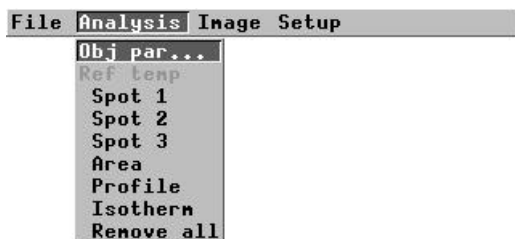


Figure 5.17 Analysis menu.

An asterisk (*) in front of the menu item (-s) indicates that the measurement function is active. More measurement functions than one can be active at the same time, e.g. three spotmeters and one isotherm. In that case the one that is selected is indicated with the # sign. By pressing the C button when the joystick text is displayed (e.g. *Joystick: Spot pos C: Remove*) the measurement function will be disabled.

In order to move or resize a function's measuring point on the screen – e.g. a crosshair or area – the operator has to confirm this function by highlighting it in the *Analysis* menu. The measuring point can then be moved with the joystick.

5.5.2.1 Obj par...

This function is used to set the object parameters *Emiss*, (emissivity factor), *Dist* (distance), *Tamb* (ambient temperature), *RelHum* (relative humidity) and reference temperature *RefT* manually. The function brings up a control box showing the different parameters. The parameters are chosen by moving the joystick left/right and set by moving the joystick up/down.

If the PC-card contains a user-defined table of materials with known emissivities, this table is brought up by default when trying to set the emissivity manually. In that case the emissivity can only be chosen from the table. If no PC-card is inserted, any emissivity can be set by moving the joystick up/down. This user-defined table

of known emissivities can be created and edited in the *AGEMA™ Report* PC software. See the software *Operator's Manual* for further information.

N.B. – The emissivity file can be stored at root level or at directory level. However, the camera software prioritizes files that are stored at directory level and the directory has to be selected in order to store the emissivity file in the camera memory. If the camera software does not find an emissivity file at directory level, it searches for similar files at root level and saves those instead.

The object parameters are described in “Theory of thermography” on page 51.

5.5.2.2 Ref temp

Activating this command by pressing Δ will set the *Ref temp* equal to the momentary temperature of the active measurement function. In the result table, the symbol Δ will indicate the difference between the measurement function's temperature and the reference temperature. If the camera is set to single-spot mode, the isotherm value will always be used as the reference temperature. If it is set to multi-spot mode, the reference temperature can be set to any one of the active measurement functions by highlighting that particular function and then selecting *Ref temp*. It is also possible to set the *Ref temp* manually. See “Obj par...” on page 30

N.B. – To enable the *Ref temp* function, see “Setup menu” on page 35

Example:

Point the *Area* function (with *Maximum* option enabled, *Setup*→*Analysis*→*Area function*→*Maximum*) at a good phase of a power breaker and activate the *Ref temp* command. This will set the reference temperature to the hottest temperature of the good phase. Point the same area function at the faulty phase and read the increase in difference in temperature as the difference temperature (Δ) under the *Area max* function.

5.5.2.3 Spot

A maximum of three independently measuring spot meters can be activated. Each spot meter can be positioned anywhere on the screen by confirming that particular spot meter in the *Analysis* menu and then moving it with the joystick.

The multiple spots option is selected in the *Setup*→*Analysis*→*Multiple spots*→*On* menu.

The spot meter function measures the temperature of the crosshair and displays the value in the result table. In the *Setup*→*Analysis*→*Spot* menu the spotmeter mode can be selected. In the *Manual* mode the position of the crosshair is controlled by the joystick. When the required spot position has been set press the Δ

button to resume the normal function of the joystick, i.e. focus/zoom. To move the crosshair next time, it is necessary to confirm *Spot* (or *Spot 1, 2 or 3*) in the *Analysis* menu.

In *Maximum* (or *Minimum*) mode four corners of a box are displayed on the screen when the spotmeter function is activated. The size of the box can be controlled by using the joystick. When the desired box size has been set press the \downarrow button to resume the normal function of the joystick. To change the size of the box next time, it is necessary to confirm *Spot* again (or *Spot 1* if *Maximum* or *Minimum* is selected in the *Setup – Analysis* dialog box; *Setup*→*Analysis*).

The crosshair will now continuously move to the part of the image within the box where it hits the maximum (or minimum) temperature.

5.5.2.4 Area

The area function measures either the maximum, minimum or average temperature within a rectangular or circular area around the centre of the image. The result is indicated by the *Amin*, *Amax* or *Aavg* text in the result table. To resize the rectangle, confirm *Area* in the *Analysis* menu. The size of the area can then be controlled by the movement of the joystick in the following way while the text *Joystick: Area size C: Remove* is shown at the bottom of the screen. To change the size of the area next time, it is necessary to confirm *Area* in the *Analysis* menu again.

- *Joystick Up:* Increases the rectangle height or circle radius.
- *Joystick Down:* Decreases the rectangle height or circle radius.
- *Joystick Left:* Decreases the rectangle width or circle radius.
- *Joystick Right:* Increases the rectangle width or circle radius.

Once the required area size has been set, press the \downarrow button to resume the normal function of the joystick, i.e. focus/zoom.

The *Area* type (i.e. *Box* or *Circle*) and the *Area* function (i.e. *Amin*, *Amax* or *Aavg*) are selected in the *Setup*→*Analysis*→*Area type* and *Setup*→*Analysis*→*Area function* menu (see “Setup menu” on page 35).

5.5.2.5 Profile

The profile function shows a horizontal or vertical temperature graph, depending on the *Setup*→*Analysis*→*Profile* setting (see “Setup menu” on page 35), marked by the profile line. The temperature of the cursor is indicated by the *Cur* text in the result table. To move the cursor and the line along which the measuring takes place, confirm *Profile* in the *Analysis* menu. The position of the cursor can then be controlled by the movement of the joystick while the text *Joystick: Prof pos C: Remove* is shown in the bottom left-hand corner of the viewfinder. Once the

required profile position has been set, press the \downarrow button to resume the normal function of the joystick, i.e. focus/zoom. To change the position of the cursor and line next time, it is necessary to confirm *Profile* again.

5.5.2.6 Isotherm

The isotherm function colours all pixels in the image which have the same temperature as the selected isotherm temperature or temperature interval. The isotherm type, width and colour are selected in the *Setup*→*Analysis*→*Isotherm type*, *Setup*→*Analysis*→*Isotherm width* and *Setup*→*Analysis*→*Isotherm colour* menus, respectively (see “Setup menu” on page 35).

The isotherm temperature is indicated by the text *Iso* in the result table and can be changed by moving the joystick up/down while the text *Joystick: Isotemp C: Remove* is shown. The isotherm width is changed by moving the joystick button left/right. When the required isotherm temperature has been set, press the \downarrow button to resume the normal function of the joystick, i.e. focus/zoom.

N.B. – The choice *Dual above/below* gives two *Iso* values in the result table.

5.5.3 Image menu



Figure 5.18 Image menu.

5.5.3.1 Man adjust...

This function is used to make a manual adjustment of the IR-image. After selecting the function a control panel is presented on the screen. To select an item i.e. *Level*, *Span*, *Range* or *Filter*, move the joystick left/right. To change an item value, move the joystick up/down.



Figure 5.19 Adjustment control panel.

5.5.3.1.1 Level

This function sets the appropriate level of the temperature span displayed in the image. The unit is *degrees Celsius* or *degrees Fahrenheit*.

The whole temperature range is digitized and used for storage. However, normally only a small portion of the whole range is used for viewing. Select what temperature to look at by adjusting level.

The level function can be regarded as the *brightness*.

5.5.3.1.2 Span

This function sets the span of the temperatures displayed in the image. The unit is *degrees Celsius* or *degrees Fahrenheit*.

The whole temperature range is digitized and used for storage. As is the case with level, mentioned above, normally only a small portion of the whole range is used for viewing. Select what temperature range to look at by adjusting span.

The span function can be regarded as the *contrast*.

5.5.3.1.3 Temp range

The camera supports two different temperature ranges. If a high temperature option is installed, the user will get an extra range.

5.5.3.2 Freeze

The function switches the frozen/live status of the image. It has the same effect as pressing the S button.

5.5.3.3 Auto adjust

The camera automatically optimises the parameter (-s) *Level*, *Level & span* or *Auto palette* (see “Man adjust...” on page 33) for best image contrast and brightness. Auto adjust is a one-time procedure which can be repeated if required. It has the same effect as pressing the A button.

5.5.3.3.1 Auto palette

This function distributes the colours in a non-linear way along the temperature scale. The function is useful if the operator wants to capture an image where the relevant information is cluttered in a few parts of the temperature scale.

5.5.3.4 Image only

This function removes all on-screen graphics (e.g. result table, data fields etc). By pressing ↵ or C button the screen is restored.

5.5.4 Setup menu

This menu contains all the functions for changing the camera setup parameters.

The camera is equipped with a non-volatile memory area that holds all setup parameters while the camera is switched off. The active measurement function (e.g. *Spot 1*) and working/inspection directory are also stored in the non-volatile memory. When the camera is switched on, it retains the same settings as those before it was last switched off.

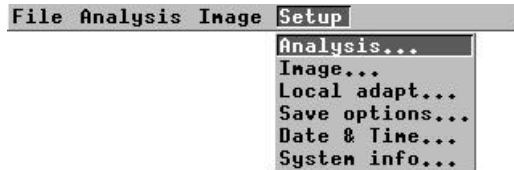


Figure 5.20 Setup menu.

5.5.4.1 Analysis...

The analysis setup defines the parameters used for the measurement functions (see “Analysis menu” on page 30). By pressing \downarrow when *Analysis...* is highlighted in the *Setup* menu, the *Analysis* dialog box is displayed on the screen. By moving the joystick up/down the different dialog box items are selected i.e. *Spot*, *Area type*, *Area function*, *Profile*, *Isotherm type*, *Isotherm width*, *Isotherm colour*, *Difference temp* and *Multiple spots*. By moving the joystick left/right the item parameters will be changed. When the \downarrow button is pressed the parameters are stored and the dialog box is removed. If the clear button is pressed the dialog box is removed without storing any changed parameters.

5.5.4.1.1 Spot

There are three modes for the spotmeter function: *Manual*, *Maximum*, *Minimum*. If *Manual* is selected, the spot meter crosshair can be moved with the joystick to the desired position within the measurement area after having been confirmed in the *Analysis* menu. If *Maximum* or *Minimum* is selected, the spot meter crosshair automatically moves to the point where it hits the highest or lowest temperature within the measurement area.

5.5.4.1.2 Area type

The different area types are *Box* and *Circle*. Choosing either of these creates a box measuring area or a circle measuring area when *Area* is chosen in the *Analysis* menu

5.5.4.1.3 Area function

There are three different area measurement functions for the selected area type. They are *Max*, *Min* and *Average*. See “Area” on page 32.

5.5.4.1.4 Profile

The profile measurement can either be displayed in a *Vertical* or *Horizontal* mode. See “Area” on page 32 for further information.

5.5.4.1.5 Isotherm type

The isotherm types can be either *Interval*, *Above*, *Below*, *Dual Above*, *Dual Below*.

- If *Interval* is chosen, all pixels with a temperature that lies within the set interval will be coloured with the same preset isotherm colour.
- If *Above* is chosen, all pixels with a temperature higher than a set temperature will be coloured with the same preset isotherm colour.
- If *Below* is chosen, all pixels with a temperature lower than a set temperature will be coloured with the same preset isotherm colour.
- If *Dual Above* is chosen all pixels in two consecutive temperature ranges above a set temperature will be coloured with two different preset isotherm colours. Consequently, two different isotherm values will be shown in the result table.
- If *Dual Below* is chosen all pixels in two consecutive temperature ranges below a set temperature will be coloured with two different preset isotherm colours. Consequently, two different isotherm values will be shown in the result table.

N.B. – When the isotherm type is set to *Interval* the isotherm width must be set to more than zero. Otherwise the isotherm will not show up on the screen.

5.5.4.1.6 Isotherm width

The isotherm width can be set within a temperature interval of 0.1–242 °C (or 0.2–436 °F).

5.5.4.1.7 Isotherm colour

The isotherm colour can be selected as either *Green*, *Black*, *White* or *Transparent*. If *Transparent* is chosen, each isotherm colour retains a certain degree of transparency, which can be a useful feature in certain applications.

N.B. – The *Dual above* or *Dual below* isotherm function (*Setup*→*Analysis*) uses its own isotherm colours, independently of the colours that are selected as isotherm colours.

5.5.4.1.8 Difference temp

Difference temperature is an on/off function. If *On* is selected the result table will show the difference between the actual measurement function temperature and the *Ref temp* (see “Analysis...” on page 35).

5.5.4.1.9 Multiple spots

Multiple spot meters is an on/off function. If *On* is selected it is possible to activate a maximum of three spot meters in the *Analysis* menu.

5.5.4.2 **Image...**

The image setup defines the parameters used for the image adjustments (see “Image menu” on page 33). By pressing \downarrow when *Image...* is highlighted in the menu, the *Setup – Image* dialog box is displayed on the screen. By moving the joystick up/down the different dialog box items are selected i.e. *Auto adjust*, *Continuous adj.*, *Colour scale*, *Saturation col.*, *Data field*, *Data background*, *Text comments* and *Scale*. By moving the joystick left/right the item parameters will be changed. When the \downarrow button is pressed the parameters are stored and the dialog box is removed. If the *C* button is pressed the dialog box is removed without storing any changed parameters.

5.5.4.2.1 Auto adjust

The auto adjust function uses either *Level*, *Level and span* or *Auto palette* for adjusting the image for optimal brightness and contrast. See “Image menu” on page 33 for an explanation of these different settings.

5.5.4.2.2 Continuous adjust

This parameter enables you to select either *Level* or *Level and span* for the auto adjust function for achieving optimal brightness and contrast of the image. As the name indicates, the function works all the time, continuously adjusting brightness and contrast according to the image content.

The function can be disabled by selecting *None*.

5.5.4.2.3 Colour scale

There are eight different palette selections: *Grey*, *Grey 10*, *Grey inverted*, *Grey 10 inv*, *Rainbow*, *Rainbow 10*, *Iron* and *Iron 10*. A maximum of three user-defined palettes can be added.

5.5.4.2.4 Saturation col.

Saturation colour is an on/off function. If *On* is selected the areas that contain temperatures outside the present level/span settings are coloured with the saturation colours. The saturation colours contain an »overflow« colour and an »underflow« colour.

There is also a third red saturation colour that marks everything saturated by the detector indicating that the range should probably be changed.

5.5.4.2.5 Data field

This parameter determines the amount of data/information that will be shown on the screen. There are four levels: *Reduced*, *Normal*, *Extended* and *None*.

J0203#01	Amb=20.0 °C	RH=51%	Dst= 2.6
Filt=NOF	Lens=FOV 24	-20 - 350 °C	
11/02/99 03:00:43 PM	e=0.83	Zoom=1.0	

Figure 5.21 Extended data presentation.

In *Reduced* mode, only the lower line is displayed. In *Normal* mode the lower and middle lines are displayed. In *Extended* mode all three lines are displayed.

- The lower line contains information on the date, time, emissivity and zoom factor.
- The middle line contains information on filter setting (optional) and lenses. If no filter is enabled, the text *Filt = NOF* is displayed. If a high temperature filter is enabled, the text *Filt = AP1* is displayed. The lense that is currently being used is indicated as *FOV 12*, *FOV 24* or *FOV 45*, e.g. 12°, 24° and 45° field of view, respectively. In this line the selected temperature range is also displayed, i.e. 35–1000 °C (95–1832 °F) or -40–350 °C (-40–662 °F).
- The upper line contains information on the current directory, ambient temperature, relative humidity and object distance.

5.5.4.2.6 Data background

The background of the data can be selected as *Transparent* or *Solid*. If *Transparent* is selected, the data fields are displayed using the infrared image as a background. If *Solid* is selected, the data fields are displayed against a near-white background.

5.5.4.2.7 Text comments

The text comments option can be selected as *None*, *Value only* and *Label & value*. If *Value only* is selected, the text comments at the bottom of the screen show only the user-defined values that the operator has selected when the text comments were created, e.g. recommendations for repair. If *Label & value* is selected, both

the subject headings and user-defined values are displayed. If *None* is selected, no text comments will be displayed, unless the operator selects *Text comments...* in the *File* menu.

5.5.4.2.8 Scale

A scale (colour bar) can be selected by setting this parameter *On*. The scale shows how the colours are distributed over the various temperatures in the image with high temperatures at the upper end and low temperatures at the lower end. The small boxes above and below the scale display what colours are used for temperatures outside the scale.

5.5.4.3 **Local adapt...**

By pressing the \downarrow button when *Local adapt...* is highlighted in the *Setup* menu, the *Setup – Local adaptations* dialog box is displayed on the screen. By moving the joystick up/down the different dialog box items are selected, i.e. *Temp unit*, *Dist unit*, *Language*, *Date format* and *Time format*. By moving the joystick left/right the item parameters will be changed. When the \downarrow button is pressed the parameters are stored and the dialog box is removed. If the *C* button is pressed the dialog box is removed without storing any changed parameters.

Temp unit: °C (degrees Celsius) or °F (degrees Fahrenheit).
Distance unit: Meters or feet.
Language: The different languages depend on what modules have been
 downloaded to the camera.
Date format: MM/DD/YY, DD/MM/YY or YY-MM-DD.
Time format: HH:MM:SS, HH:MM:SS PM or HH.MM.SS.

5.5.4.4 **Save options...**

By pressing \downarrow button when *Save options...* is highlighted in the *Setup* menu, the *Setup – Save options* dialog box is displayed on the screen. By moving the joystick up/down the different dialog box items are selected, i.e. *Image storage*, *Prompt comment?*, *Image naming*, *Image file type* and *BMP file content*. By moving the joystick left/right the item parameters will be changed. When the \downarrow button is pressed the parameters are stored and the dialog box is removed. If the clear button *C* is pressed, the dialog box is removed without storing any changed parameters.

5.5.4.4.1 Image storage

If this parameter is selected as *Single* one image will be stored on the disk after pressing the *S* button for an extended period of time. If *Continuous* is selected, images will be stored as fast as possible, for as long as the *S* button is pressed.

5.5.4.4.2 Prompt comment?

If this parameter is selected as *Voice* the *Voice comment* dialog box (see “Voice comment...” on page 26) will show up on the screen every time an image storage operation is made. This function gives the user a chance to add a voice comment to the image before storing the image on disk. If the parameter is selected as *Text*, the text comment dialog box will appear when the operator saves an image. If *Continuous* mode is selected, as in *Image storage* above, this function is ignored.

5.5.4.4.3 Image naming

If *Use date* is selected, the automatic generation of image names will be based on current date. If *Use dir* is selected, the automatic generation of image names will be based on the first five characters of the current inspection directory. See “Naming files and directories” on page 23.

5.5.4.4.4 Image file type

If *IMG only* is selected, this format will apply to all the images that are saved onto the PC-card. If *BMP only* is selected, all images will be saved in the bitmap format. The operator can also select *IMG & BMP* which saves images in both formats. If any IR analysis is to be done to an image after the recording, it has to be saved as *IMG only* or *IMG & BMP*.

5.5.4.4.5 BMP file content

If *BMP only* or *IMG & BMP* is selected above, the operator can choose if the saved images should contain only the infrared data (IR only) or data and graphics (IR & graphics). If *BMP only* is selected, no later analysis can be made to an image.

5.5.4.5 Date & Time...

By pressing the ↓ button when *Date & Time...* is highlighted in the *Setup* menu, the *Setup – Date & Time* dialog box is displayed on the screen. By moving the joystick up/down the different dialog box items are selected, i.e. *Year*, *Month*, *Day*, *Hour* and *Minute*. By moving the joystick left/right the item parameters will be changed. When the ↓ button is pressed the parameters are stored and the dialog box is removed. If the clear button C is pressed the dialog box is removed without storing any changed parameters.

5.5.4.6 System Info...

By pressing the ↓ button when *System Info...* is highlighted in the *Setup* menu, the first *System information panel* is displayed on the screen. By moving the joy-

stick left/right another information panel is selected. There are three different panels. When the ↵ button or the clear button C is pressed the information panels are removed.

6 Battery system

The battery system consists of a removable battery and a fast charger.

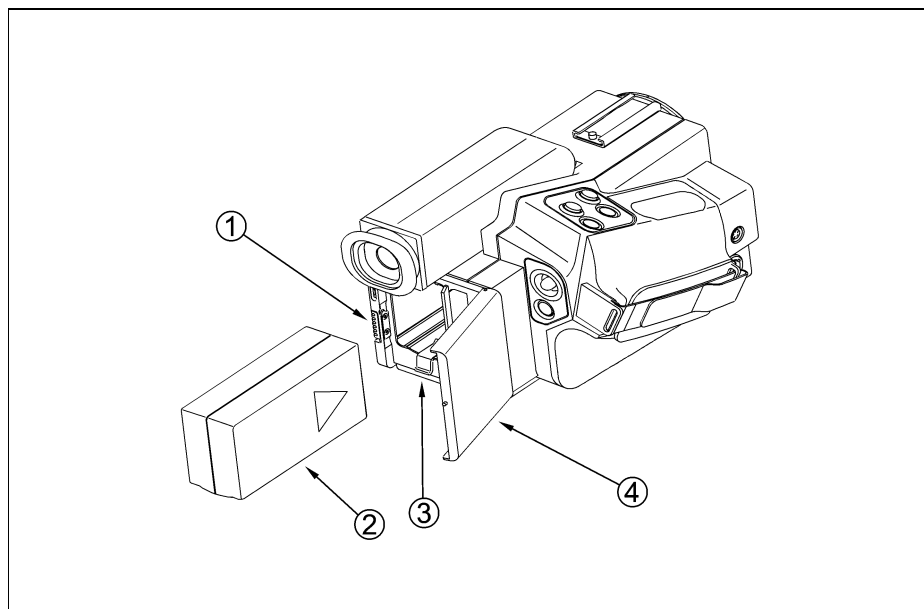


Figure 6.1 Battery & battery compartment.

- [1] Locking mechanism
- [2] Battery
- [3] Release button for battery
- [4] Hatch

6.1 Battery

The removable battery gives an operation time of about 2 hours per battery. When *Battery low* is shown in the camera it is time to change batteries by opening the hatch of the battery compartment on the back of the camera (see figure above). The battery shall be inserted into the battery compartment with its convex side facing downwards and the recessed arrow symbol facing inwards, as shown on the figure. The first battery can now be charged while the camera is running on the second battery.

6.2 Battery charging

Connect the power cable between the power outlet and the back of the charger. The charger automatically switches between voltages and accepts 100–240 VAC/50–60 Hz.

Place the batteries to be charged in the slots of the charger. The batteries will be charged one by one in the order the batteries are inserted into the charger.

The status is indicated by the three sets of LEDs in the following way.

Yellow The battery is waiting to be charged either because another battery is being charged or because the battery is too cold to be charged.

Blinking yellow The battery is currently being charged

Green The battery is charged and ready for use. After appr. one hour the green light will light up while the yellow is still blinking. This indicates that the battery is charged to 90 % capacity and it is ready to be used. After appr. one more hour the yellow LED will stop blinking and the battery is now charged to 100 %.

Blinking red The battery is faulty and cannot be charged.

6.3 Useful notes on the battery system

- There is no risk of overcharging or damaging already charged batteries. If a already charged battery is inserted into the charger the charging will start but be aborted after appr. five minutes when the charger senses that the battery is full.
- If the battery is colder than 15 °C the charging cannot be started until it is heated. This process will be indicated by a yellow light. If the battery is too warm the charging will not start.
- Full capacity from new nickel-metal-hydride (NiMH) batteries is obtained after approx. five discharge cycles.
- Batteries are normally delivered pre-charged.
- The batteries will discharge themselves at the rate of approx. 2 % per day while being stored. It is therefore advisable to charge batteries each time before use.
- Nickel-metal-hydride batteries do not develop the same memory effect as nickel-cadmium batteries (NiCd) sometimes do. It is therefore unnecessary to discharge the batteries completely before charging.

7 Technical specifications

7.1 General specifications

<i>Object temperature measurement range (PM595):</i>	-40–+500 °C (-40–+930 °F), two ranges. Up to +2000 °C (+2700 °F) with high temperature option.
<i>Object temperature measurement range (PM575):</i>	-20–+500 °C (-4–+930 °F), two ranges. Up to +1000 °C (+1832 °F) with high temperature option.
<i>Measurement accuracy:</i>	± 2 %
<i>Thermal sensitivity:</i>	< 0.1 °C
<i>Field of view (F x V):</i>	See “Lens data” on page 48.
<i>Detector type:</i>	<i>Focal Plane Array (FPA)</i> , uncooled microbolometer, 320 x 240 pixels.
<i>Spectral range:</i>	7.5–13 µm, built-in atmospheric filter with cut-on @ 7.5 µm.
<i>Video output:</i>	Standard VHS or S-VHS.
<i>Viewfinder:</i>	Colour LCD (TFT)
<i>PC-card drive:</i>	One slot for <i>Type II</i> or <i>Type III</i> PC-cards. Either <i>FLASH</i> cards or hard disks (<i>ATA</i> -compatible) can be used.

<i>Image storing:</i>	Full dynamics, 14-bit digital storage.
<i>Battery system:</i>	One rechargeable nickel-metal-hydride (NiMH) battery.
<i>Operating time:</i>	Typically 2 hours using one battery.
<i>Environmental temperature range – operation:</i>	-15–+50 °C (+5–+122 °F).
<i>Environmental temperature range – storage:</i>	-40–+70 °C (-40–+158 °F).
<i>Enclosure:</i>	Metal housing, protection IP54 (IEC 529).
<i>Tripod mount:</i>	1/4"-20.
<i>Weight</i>	1.9 kg (4.19 lbs), excluding battery. 2.3 kg (5.07 lbs), including battery.
<i>Size:</i>	220 x 133 x 140 mm (8.66" x 5.24" x 5.5").

7.2 Input & output connectors

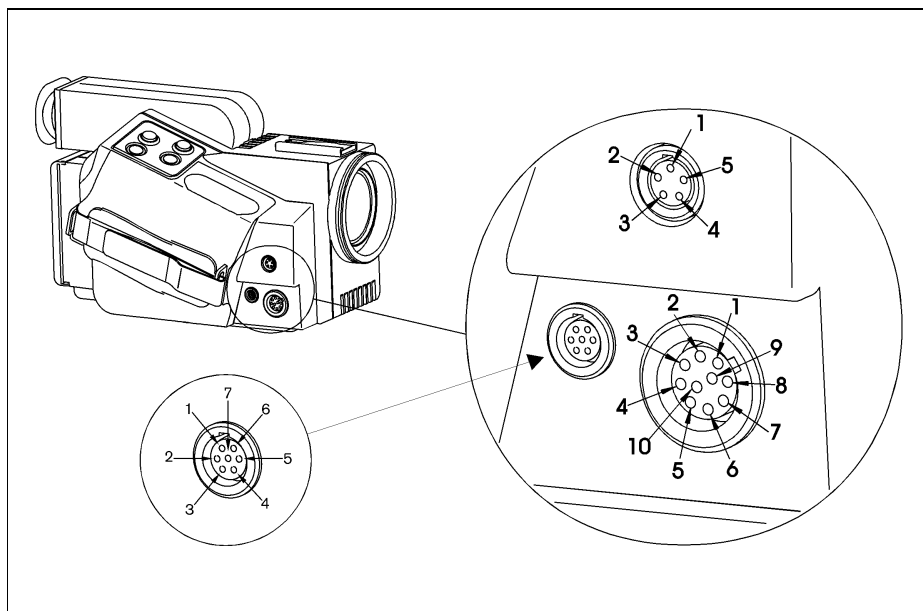


Figure 7.1 Pin configuration.

7.2.1 12 V socket

Pin

- [1] RS-232, TxD (output data)
- [2] RS-232, RxD (input data)
- [3] S-Video Y. (optional 14 bit digital output)
- [4] S-Video C. (optional 14 bit digital output)
- [5] S-Video ground
- [6] Power out 11–16 V
- [7] Power in 11–16 V
- [8] Ground power
- [9] Ground power
- [10] Power in 11–16 V

7.2.2 Headset socket

Pin

- [1] Headphone, +, impedance >350 ohm. Max swing 2.3 Vpp
- [2] Head phone, -
- [3] Microphone, +, electorated type, phantom feed 5 VDC, 1 mA,
max. swing 30 mVpp
- [4] Microphone, -
- [5] N/C

7.2.3 Video socket

Pin

- [1] Composite video
- [2] N/C
- [3] N/C
- [4] N/C
- [5] Power out
- [6] Ground
- [7] Ground

7.2.4 Battery charger

<i>Input:</i>	100–240 VAC, 50 W
<i>Frequency:</i>	50/60 Hz
<i>Output:</i>	11–18 VDC, 1.8 A.
<i>Weight:</i>	0.7 kg (1.55 lbs)
<i>Maximum output:</i>	36 W
<i>Size:</i>	230 x 150 x 72 mm (9.06" 5.90" 2.83")

CE certified.

7.2.5 Power supply (optional)

Input:	100–240 VAC, 1.3 A.
Frequency:	50/60 Hz.
Output:	13.5 VDC.
Weight:	0.7 kg (1.55 lbs)
Maximum output:	55 W
Size:	200 x 96 x 60 mm (7.87" 3.78" 2.36")
Cable length:	1.2 m (4 ft)

CE certified.

UL and CSA approved.

7.3 Lens data

OBJECT DISTANCE	0.3	0.5	2.0	3.0	5.0	10.0	30.0	100.0	(M)
7° HOR FOV IFOV	- -	- -	- -	- -	0.5 1.7	1.2 3.6	3.6 11.3	12.2 38.0	(M) (mm)
12° HOR FOV IFOV	- -	- -	0.4* 1.3	0.6 2.0	1.1 3.5	2.1 6.6	6.3 20.0	21.0 66.0	(M) (mm)
24° HOR FOV IFOV	- -	0.2* 0.7	0.8 2.6	1.3 4.0	2.1 6.6	4.2 13.0	12.0 40.0	42.0 130.0	(M) (mm)
45° HOR FOV IFOV	0.2* 0.8	0.4 1.3	1.7 5.3	2.5 7.8	4.2 13.0	8.3 26.0	25.0 78.0	83.0 260.0	(M) (mm)
80° HOR FOV IFOV	0.6 1.8	0.9 2.9	3.4 10.8	5.1 16.0	8.5 26.5	16.9 52.3	50.4 158.0	169.0 524.0	(M) (mm)

* At close focus.

8 Thermographic measurement techniques

8.1 *Introduction*

The ThermaCAM™ PM575/595 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 ThermaCAM™ PM575/595. The following object parameters must however, be supplied for the camera:

- The emissivity of the object.
- The ambient temperature.
- The distance between the object and the camera.
- The relative humidity.

8.2 *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.

Normally, object materials and surface treatments exhibit emissivities ranging from approximately 0.1 to 0.95. A highly polished (mirror) surface falls below 0.1, while an oxidised or painted surface has much higher emissivity. Oil-based paint, regardless of colour in the visible spectrum, has an emissivity over 0.9 in the infrared. Human skin exhibits an emissivity close to 1.

Non-oxidised metals represent an extreme case of almost perfect opacity and high specular reflectivity, 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.

8.2.1 Finding the emissivity of an object

8.2.1.1 Using a thermocouple

Select a reference point and measure its temperature using a thermocouple. Alter the emissivity until the temperature measured by the ThermaCAM™ PM575/595 agrees with the thermocouple reading. This is the emissivity value of the reference object. However, the temperature of the reference object must not be too close to the ambient temperature for this to work.

8.2.1.2 Using reference emissivity

A tape or paint of a known emissivity should be put onto the object. Measure the temperature of the tape/paint using the camera, setting emissivity to the correct value. Note the temperature. Alter emissivity, until the area with the unknown emissivity adjacent to the tape/paint has the same temperature reading. The emissivity value can now be read. The temperature of the reference object must not be too close to the ambient temperature for this to work either.

8.3 *Ambient temperature*

This parameter is used to compensate for the radiation reflected in the object and the radiation emitted from the atmosphere between the camera and the object.

If the emissivity is low, the distance very long and the object temperature relatively close to that of the ambient it will be important to set and compensate for the ambient temperature correctly.

8.4 *Distance*

The distance is the distance between the object and the front lens of the camera.

This parameter is used to compensate for the fact that radiation is being absorbed between the object and the camera and the fact that transmittance drops with distance.

8.5 *Relative humidity*

The camera can also compensate for the fact that the transmittance is somewhat 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 %.

9 Theory of thermography

9.1 Introduction

The subjects of infrared radiation and the related technique of thermography are still new to many who will use an ThermaCAM™ 500 series camera. In this section the theory behind thermography will be given.

9.2 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.

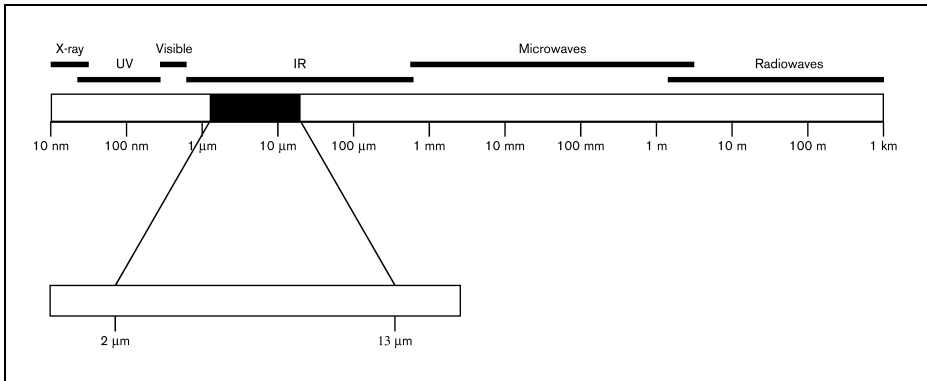


Figure 9.1 The electromagnetic spectrum.

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 millimetre 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 (micrometres), other units are often still used to measure wavelength in this spectral region, e.g. microns (μ), nanometres (nm) and Ångströms (Å).

The relationships between the different wavelength measurements is

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

9.3 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, which states that a body capable of absorbing all radiation at any wavelength is equally capable in the emission of radiation.

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 ThermoCAM™ 500 series camera for example.

If the temperature of blackbody radiation increases to more than 525 °C, 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 »colour 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.

9.3.1 Planck's law

Max Planck was able to describe the spectral distribution of the radiation from a blackbody by means of the following formula:

$$W\lambda_b = \frac{2\pi hc^2}{\lambda^5 (e^{\frac{hc}{\lambda kT}} - 1)} \times 10^{-6} [\text{Watt}/\text{m}^2 \mu\text{m}]$$

where:

$W\lambda_b$ = the blackbody spectral radiant emittance at wavelength λ .

c = the velocity of light = 3×10^8 m/sec.

h = Planck's constant = 6.6×10^{-34} Joule sec.

k = Boltzmann's constant = 1.4×10^{-23} Joule/K.

T = the absolute temperature (K) of a blackbody.

λ = wavelength (m).

N.B. – The factor 10^{-6} is used since spectral emittance in the curves is expressed in $\text{Watt}/\text{m}^2 \mu\text{m}$. If the factor is excluded, the dimension will be $\text{Watt}/\text{m}^2 \text{m}$.

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 $\lambda = 0$, 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.

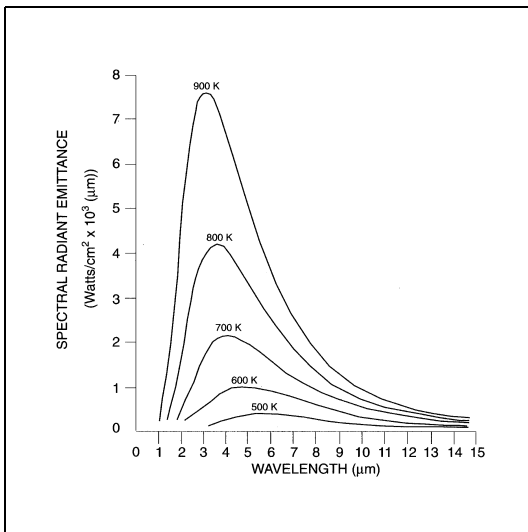


Figure 9.2 Blackbody spectral radiant emittance according to Planck's law, plotted for various absolute temperatures.

9.3.2 Wien's displacement law

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

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

This is Wien's formula, which expresses mathematically the common observation that colours vary from red to orange or yellow as the temperature of a thermal radiator increases. The wavelength of the colour 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 K). 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 .

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.

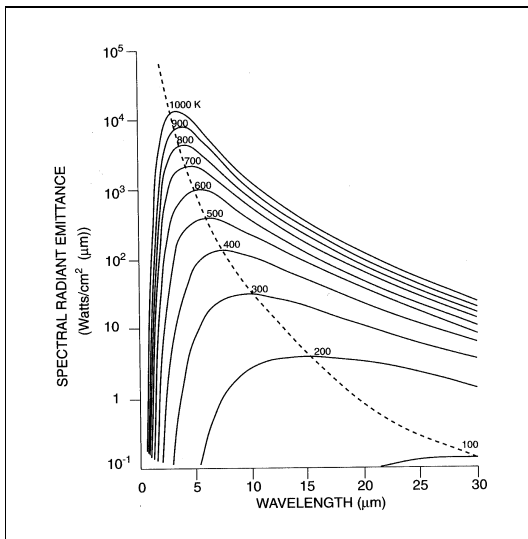


Figure 9.3 Planckian curves plotted on semi-log scales from 100 K to 1000 K. The dotted line represents the locus of maximum radiant emittance at each temperature as described by Wien's displacement law.

9.3.3 The Stefan-Boltzmann law

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

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

where

σ = the Stefan-Boltzmann constant = $5.7 \times 10^{-8} \text{ Watt}/\text{m}^2$.

This is the Stefan-Boltzmann formula, 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 under 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.

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.

9.3.4 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 behaviour in certain spectral intervals. For example, white paint appears perfectly »white« in the visible light spectrum, but becomes distinctly »grey« at about $2 \mu\text{m}$, and beyond $3 \mu\text{m}$ 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:

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

For opaque materials $\tau_\lambda = 0$, 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 $\varepsilon_1 = \varepsilon = 1$.
- A greybody, for which $\varepsilon_1 = \varepsilon = \text{constant less than } 1$.
- 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 to 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 greybody radiator, the Stefan-Boltzmann formula becomes

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

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

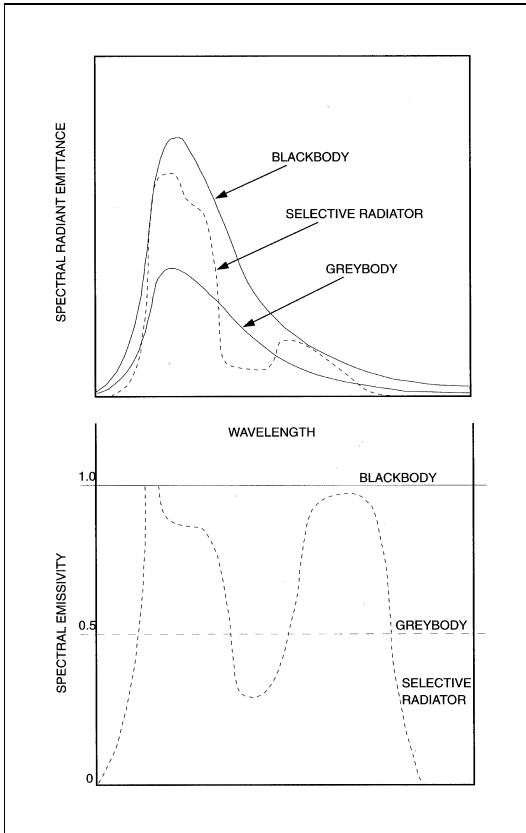


Figure 9:4 Spectral radiant emittance and spectral emissivity of three types of radiators.

9.4 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

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

This formula represents a generalisation of Kirchhoff's law, which is reduced when the plate becomes opaque ($\tau_{\lambda} = 0$) 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.
