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User's manual FLIR Si124 series

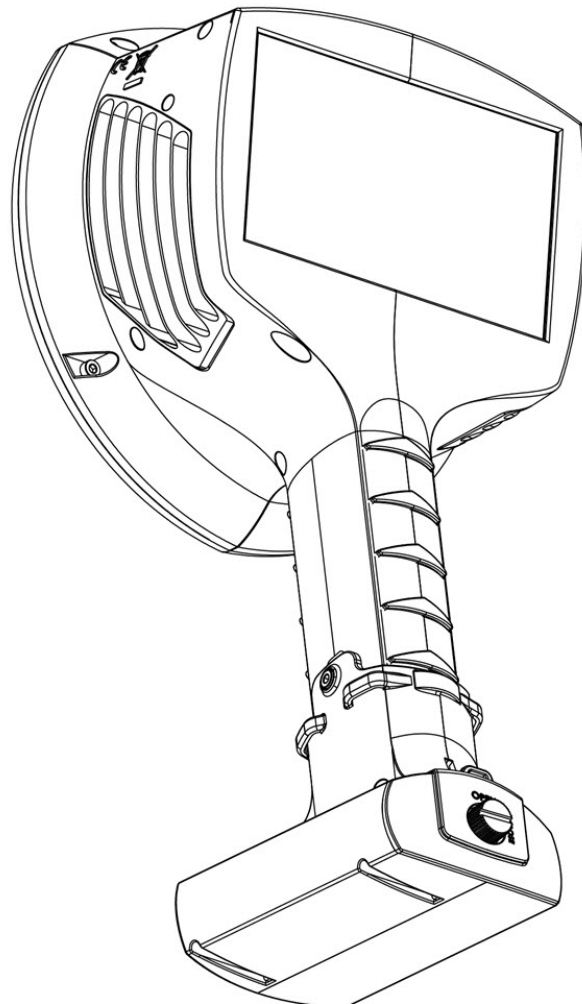


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1.1 Legal disclaimer

Terms of use is available in the user interface of the product.

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

1.2 Export controls

Products described herein may be subject to export regulations.

This document does not contain export-controlled information.

1.3 Patents

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

1.4 Third-party licenses

Information about third-party licenses is available in the user interface of the product.

1.5 Usage statistics

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









1.6 Copyright

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Names and marks appearing on the products herein are either registered trademarks or trademarks of FLIR Systems and/or its subsidiaries. All other trademarks, trade names or company names referenced herein are used for identification only and are the property of their respective owners.

Safety information

 CAUTION
Do not touch the heatsinks when the camera is powered on. The heatsinks become hot when the power is on.
 CAUTION
Take special care around heavy machinery when carrying the camera bag. The strap of the bag is rigid and does not have a separate safety release mechanism.
 CAUTION
Protect the camera and accessories from dirt, dust, impacts, and liquids.
 CAUTION
Always keep the USB port covered. If water enters the camera, damage to the electronics inside can occur.
 CAUTION
Do not disassemble the camera. Damage to the camera can occur.
 CAUTION
Only use the accessories that are provided with the camera.
 CAUTION
Only use spare parts provided by FLIR Systems.
 CAUTION
Do not use any damaged camera, battery, or accessories.

Note For safety information related to the battery, refer to the supplied printed documentation for the battery.

3.1 Thank you!

Thank you for choosing a product from FLIR Systems. We hope that the product will meet your expectations and that you will consider us again for your future needs.

3.2 List of contents

- Camera
- Battery (2 ea)
- Battery charger
- Camera hand strap
- Neck strap
- Hard transport case
- License card: FLIR Si-series Plugin for FLIR Thermal Studio, Perpetual license
- Printed documentation
- USB memory stick

3.3 Read the manual before use

Before operating the device, you must read, understand, and follow all instructions, warnings, cautions, and legal disclaimers. Misuse can cause damage to the camera or false sensor readings.

To access online documentation and technical data specifications for the FLIR Si124, go to:

<http://support.flir.com/resources/g9wc>



3.4 Register your product

By registering your product you gain easy access to updates, product notifications, the status of any pending service cases, and more.

To register the camera, go to <http://support.flir.com/camreg>.

To access the registration form, you must log in to your FLIR account or sign up for a new account.

You will also need the serial number of your camera. A label with the serial number is available at the top of the camera. The serial number format is AC13Fxxx, where xxx is a unique number.

3.5 Customer support

Do not hesitate to contact our Customer Support Center if you experience problems or have any questions. Please include the serial number of the camera in your request.

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

3.6 Important note about this manual

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

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

3.7 Disposal of electronic waste

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

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

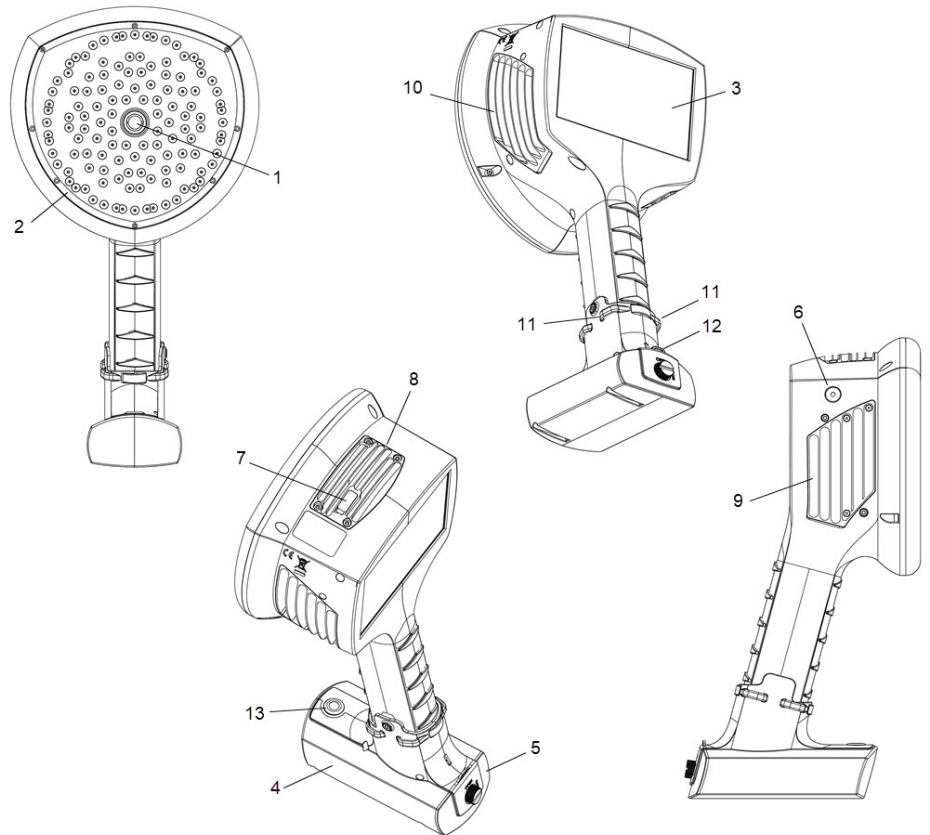
For this purpose all local authorities have established collection schemes under which residents can dispose waste electrical and electronic equipment at a recycling centre or other collection points, or WEEE will be collected directly from households. More detailed information is available from the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



The FLIR Si124 is a standalone system for acoustic image measurements and signal analysis. As a standalone system, no additional equipment is needed for basic usage of the device.

The FLIR Si124 uses 124 microphones to form a very precise acoustic image in the desired direction. This acoustic image is transposed in real-time on top of a digital camera picture, which allows the user to accurately see from which directions sound is arriving to the camera. Interesting sound sources can then be separated from background noise and saved for deeper analysis and problem classification, using the FLIR Acoustic Camera Viewer service.

The FLIR Si124 is a lot more sensitive and accurate than the human ear, which means that it can locate both sound sources that are inaudible to the human ear, as well as sound sources that the human ear cannot reliably locate. The FLIR Si124 has a frequency range that extends to ultrasonic frequencies, which is a huge benefit since many interesting problems and phenomena can be located precisely using ultrasound.



1. Video camera
2. Microphone array
3. LCD screen
4. Battery housing
5. Battery cover
6. Power LED
7. USB port
8. Top heatsink
9. Right side heatsink
10. Left side heatsink
11. Neck strap attachment points
12. Hand strap attachment point
13. On/off button



CAUTION

Do not touch the heatsinks when the camera is powered on. The three heatsinks (8, 9, and 10) become hot while the power is on.

The front side of the camera consists of a video image sensor (1) and the microphone array (2). The video shown on the display is monochromatic (black and white) and the acoustic image is colored.

The camera has a resistive touch screen (3). The screen can also be used with gloves. Only touch the screen using your finger - do not use the touch screen with anything sharp or with hard objects, which may damage the surface. Do not exert excessive force when pressing the screen as it will affect the durability of the touch screen.

The main power is an integrated RRC battery which is located at the bottom of the camera. You first need to insert the portable battery into the battery housing. Spare batteries

are provided in the packaging of the battery. Only use batteries and cables provided with the camera or otherwise approved for use with the camera

There is also an external battery pack that can be used to power the camera. The external battery pack is connected to the bottom of the camera handle via a battery cable.

The status of the internal power supply unit is indicated by the power LED (6), which is red when the power is on. While the power is on the camera dissipates heat through the three heatsinks (8, 9, 10) which are located on both sides and the top. While using the camera the heatsinks must be uncovered to ensure that the heat dissipation works properly. Do not bag the device while the Power LED is on. Please note that the heatsinks sometimes get hot after prolonged usage, so be careful when touching the heatsinks.

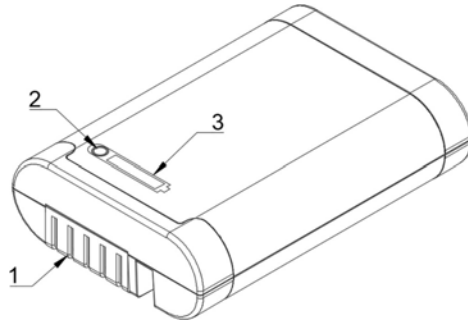
There are two ways to export the results from the camera - using the included FLIR Acoustic Camera Viewer service which requires a secure wifi connection, or through USB export (if available on your unit). The USB port is located under the cover on top of the device (7). Please use the included USB memory stick for result export.

Note Protect the camera lens and the microphone array from any kind of foreign objects, dust, and liquids.

6

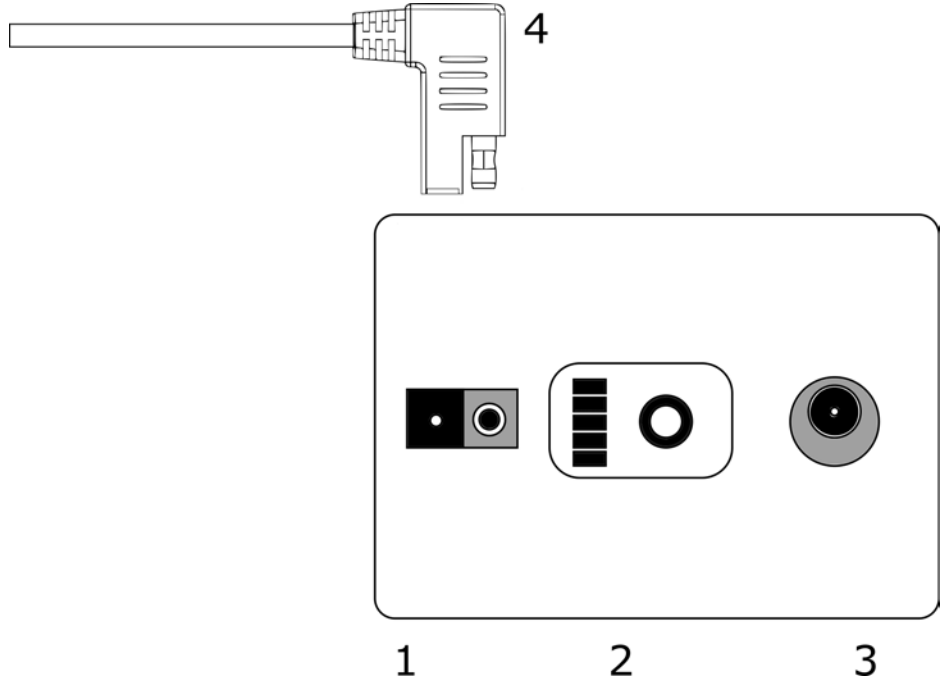
Battery parts

6.1 RRC battery



1. Connectors
2. Battery indicator button
3. Battery indicator lights

6.2 External battery pack



1. Connector for the battery cable
2. Fuel gauge
3. Charging connector
4. Battery cable connector

The camera is powered by two sources of electricity: its own internal battery, and an external battery. The internal power supply is a lithium-based rechargeable battery installed inside the camera. To optimize internal power supply life during first operation, **power on the camera for at least 45 minutes**. When the internal battery needs to be recharged, the camera will prompt the following message: *Please keep the camera on*. Before every use, make sure that the external battery and its accessories are in good condition. The charge of the external battery may be low due to storage time at the supplier and/or goods transport regulations. To ensure long battery lifetime, fully charge the batteries before their first use.

7.1 Charging

The main power source of the camera is the external battery. It should be charged fully before usage - also make sure the battery is charged before prolonged storage. To charge an empty battery fully usually takes 2 hours. Please note that the battery should be charged at temperatures between 0°C and +40°C (+32°F to +104°F). A new battery used in optimal environment conditions yields up to 2.5 hours of usage.

The battery and the charger is delivered with the camera. Only use the provided battery charger.

To charge the battery, do the following:

1. Plug the DC barrel connector of the power supply to the charger.
2. Plug the mains cable of the charger into the wall socket.
3. Ensure that the connectors of the battery and the charger bay are aligned when inserting the battery. When inserted correctly, the battery stands firmly and straight. The charger light starts blinking when the battery is connected properly.

When the battery starts charging, the charger light turn orange. When the battery is fully charged, the light turns green.

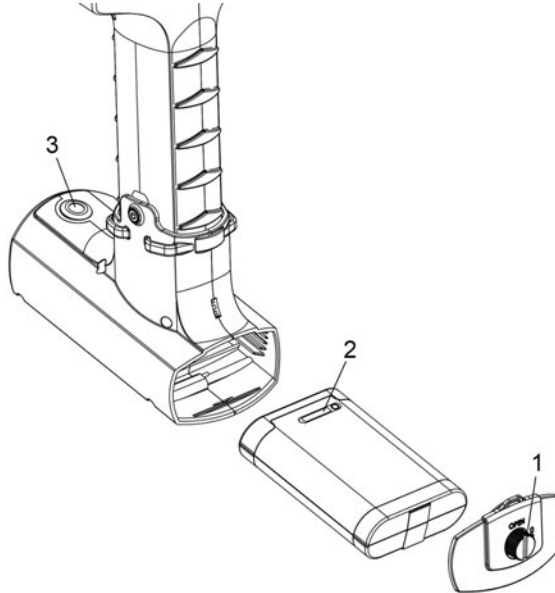
Color of the charging status LED	Explanation
Off	Not powered or no battery
Green	Ready
Yellow	Charging
Red	Malfunction or temperature limits exceeded
Flashing/Changing	Setting up

7.2 Battery indicator

To check the battery level, push the indicator button. The lights indicate the battery level.

Number of lights on	Battery level [%]
4	100–76
3	51–75
2	26–50
1	10–25
1 (flashing)	below 10

7.3 Startup



1. Open the battery cover by turning the knob (1).
2. With the connectors first and the indicator lights (2) facing upwards, push the battery into the battery housing.
3. Close the battery cover. Lock the cover by turning the knob.
4. Push the on/off button (3) to power on the camera.

When the power is on, the Power LED at the top side of the camera is red. If the Power LED is flashing, the battery is discharged.

7.4 Shutdown

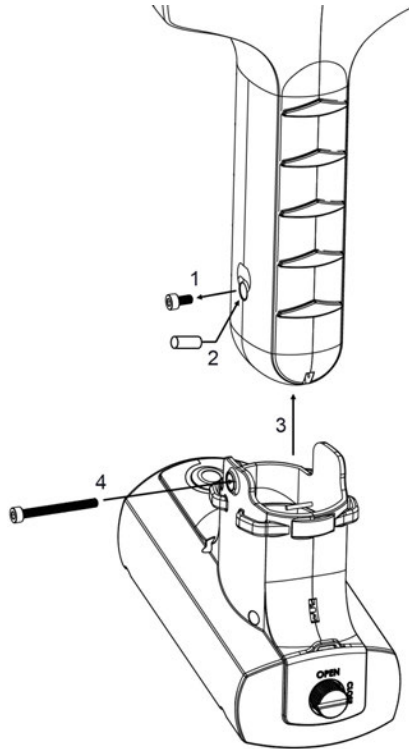
1. To power off the camera, push the on/off button until it clicks and rises up. You can also pull out the battery from the battery housing.
2. The power is now off and the system will safely perform a shutdown.
3. The red Power LED at the top side of the camera will turn off when the shutdown is complete.

If you encounter a problem with the system, a hard shutdown is performed by disconnecting the battery power and waiting longer until the power led will turn off. If the shutdown takes more than a 5 minutes after disconnecting the battery, contact FLIR Systems for service.

7.5 Device setup wizard

The first time the FLIR Si124 is powered up, the device setup wizard is shown. The wizard will help you set up the most important settings needed for using the device. These settings can be changed later through the settings menu. Please see the appropriate section of the Settings below for details.

7.6 Attach the battery housing



1. Unscrew and remove the lowest screw of the camera handle. Tool: 2.5 mm Hex socket screwdriver.
2. Insert the support spacer in the screw hole.
3. Insert the battery housing into the camera handle. The housing is in its correct place when the screw hole of the battery housing is aligned with the lowest screw hole of the camera handle.
4. Screw the 30 mm hex screw through the housing into the handle. Tighten firmly.

7.7 External battery pack

As an alternative to the RRC battery and battery housing, the external battery pack can be used to power the camera. The battery housing must first be removed.

7.7.1 Charging

The external battery should be charged fully before usage - also make sure the battery is charged before prolonged storage. To charge an empty battery fully usually takes 4-6 hours. Please note that the battery should be charged at temperatures between 0°C and +40°C (+32°F to +104°F). A new battery used in optimal environment conditions yields over 7 hours of usage.

Only use the battery charger provided with the battery. Plug the mains cable of the charger into the wall socket and the DC connector to the charging connector of the battery. When the status LED of the charger is red the battery is being charged. When the status LED of the charger is green while the DC connector is connected to the battery the charge is complete. The status LED is also green when the DC connector is disconnected.

Mains cable connected	Charge cable connected	Status LED on charger
No	No	Off
Yes	No	Green

Mains cable connected	Charge cable connected	Status LED on charger
Yes	Yes	Red, Charging
Yes	Yes	Green, Fully Charged

7.7.2 Fuel gauge

Press the fuel gauge button to test the state of the battery charge. This is approximate only and the most accurate results is after 2 minutes of no load.

LEDs	State of the battery charge
3 green, 2 red	Full
2 green, 2 red	Over 50 %
1 green, 2 red	Over 20 %
2 red	Less than 20 % (recharge soon)
1 red	Less than 10 % (near self switch off)
No lights	Empty (recharge within 12 hours)

Nominally the battery yields 7-8 hours of usage. Though the battery usage depends on multiple variables which may decrease the usage time. These are the cell temperatures, the load and the age (cycles) of the battery.

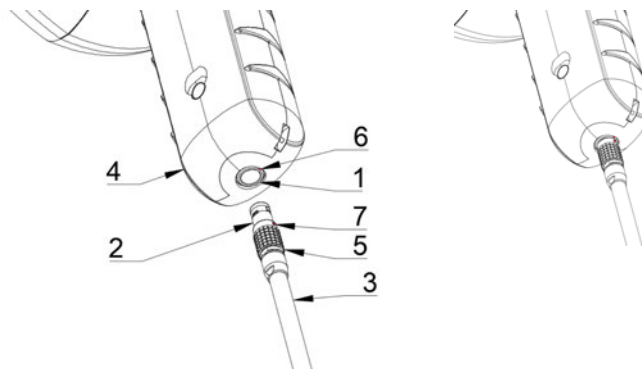
7.7.3 Startup

The camera will start automatically when the power supply is connected. The camera will shut down automatically when the battery is disconnected.

If the battery is disconnected accidentally and immediately reconnected to the camera the unit will reboot. When shutting the device down, it is recommended to wait until the power LED is off before connecting the battery power supply again.

1. Attach the battery cable to the battery. The connector of the battery cable can be attached to the battery connector (1) only one way.
2. Attach the connector to the camera according to the following instructions, with the orientation markings facing the same way:

Both the camera and the battery cable have **red orientation markings**. They indicate the position of the key and the slot of the connectors which ensures the proper connection orientation. **Hold the battery cable connector by the locking ring** and make sure that the orientation markings of both connectors are aligned before inserting the battery cable. **Then carefully insert the battery cable connector to the camera.** The connectors should lock audibly.



1. Power input
2. Battery cable connector
3. Battery cable
4. Camera handle

5. Locking ring
6. Orientation marking 1
7. Orientation marking 2

7.7.4 Shutdown

To turn off the camera, simply disconnect the battery connector from the camera.

Note Do not pull by the cord or use any kind of tool to disconnect the cable.

1. Hold the battery cable connector by the locking ring and pull it outwards. The locking ring will slide until it releases the connection. Alternatively disconnect the cable from the battery.
2. The FLIR logo will appear and the system will safely perform a shutdown.
3. The red Power LED will turn off when the shutdown is complete.

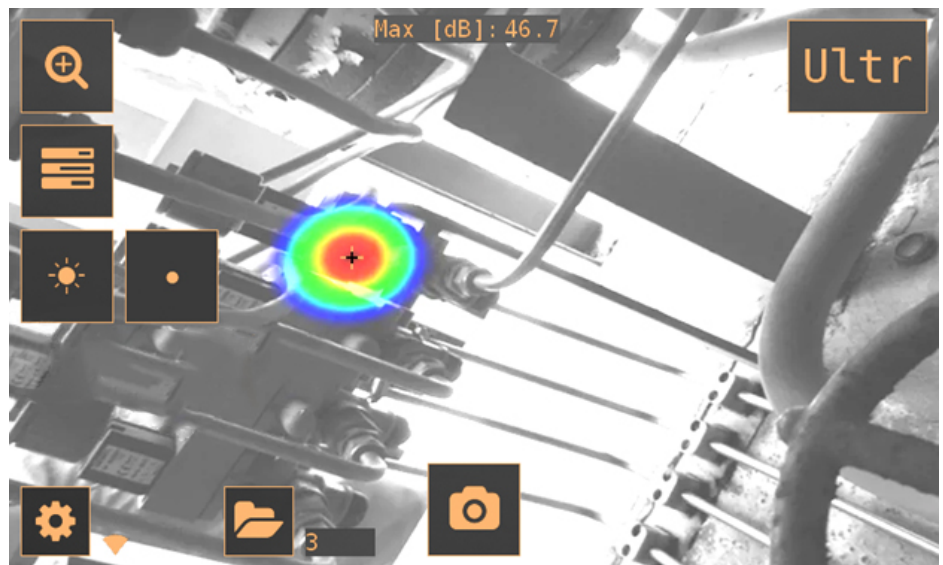
If you encounter a problem with the system, a hard shutdown is performed by disconnecting the battery power and waiting longer until the power led will turn off. If the shutdown takes more than a 5 minutes after disconnecting the battery, contact FLIR Systems for service.

The camera supports the following application modes:

- *Air* mode is used for localization of pressurized air leaks.
- *Power* mode is used for localization and classification of high-voltage partial discharges.

The available functions, settings, and real-time analysis information in the user interface depend on the selected application mode.

An example of the graphical user interface of the camera is shown below.



8.1 Heatmap

The main view of the user interface shows the camera image with a heatmap overlaid on top. The heatmap shows the location of the strongest sound source (single-source mode) or multiple sound sources (multi-source mode). There are two different types of color modes for displaying the heatmap.



Location color mode



Strength color mode

The *location* color mode shows each sound source with several different colors, ranging from blue to red. The center of the sound sources is shown with red color, while the color gradually changes via yellow, green, and cyan to blue outwards from the center of the sound source. The *location* color mode is active in the *Power* application mode.

The *strength* color mode shows each sound source with a single color according to the intensity of the sound source. The intensities range from weak to medium to strong with respective color-coded schemes in green, yellow, and red, respectively. The *strength* color mode is active in the *Air* application mode.

In addition to the heatmap, the location of the strongest sound source is shown with a small crosshair. When taking a snapshot, the sound arriving from the direction of the crosshair will be recorded. Application-specific real-time analysis will also use the sound arriving from the direction of the crosshair.

8.2 Take snapshot



Press the *snapshot* button to take a snapshot containing the current camera image and heatmap as well as a short recording of the strongest sound source. The direction of the strongest sound source is shown with a crosshair.

When taking a snapshot, a keyboard will be displayed, which you can use to enter optional comments about the snapshot. After entering comments, press the button in the upper right corner to save the comments and the snapshot. If you at this stage choose not to save the snapshot, press the *garbage bin* button in the upper left corner instead.

8.3 Record video



Press the *video recording* button to start recording. Please note that the video length is limited to 5 minutes. To stop recording, press the button again. After you have finished recording, you will see the same comments screen that is shown after you take a snapshot. You are also given the choice to save or erase the recorded video clip. You can erase the clip by tapping the *garbage bin* button.

You can view the saved videos later in the FLIR Acoustic Camera Viewer. However, you cannot view the recorded videos in the camera itself.

8.4 Snapshot browser



The number of snapshots currently saved on the camera is shown to the right of the *snapshot browser* button. If there are two dots visible next to the number, snapshots are currently being uploaded to the FLIR Acoustic Camera Viewer.

Press the button to browse through the snapshots. On the bottom of the screen, thumbnails of the snapshots are shown, and you can scroll through these horizontally. When you press a thumbnail, the snapshot will be shown together with additional information.

Note Note that snapshots are not available in the snapshot browser after they have been uploaded to the FLIR Acoustic Camera Viewer service or exported to a USB memory stick.



Press the *upload* button to access automatic upload settings and to trigger manual upload.

Use the *Upload to cloud* function to enable/disable automatic upload of snapshots to the FLIR Acoustic Camera Viewer cloud service.

If you have disabled the automatic data upload, you can manually upload data to the FLIR Acoustic Camera Viewer cloud service using the *Upload to cloud now* function.

For more information, see section 8.10 *Cloud upload*.

8.5 Zoom



The camera is equipped with a 2x digital zoom, which can be used for close-up snapshots. Press the *zoom* button to zoom in or zoom out.

8.6 Quick settings



Press the *quick settings* button to show or hide the quick settings; *screen brightness* and *single-source / multi-source mode*.

8.6.1 Screen brightness



The brightness of the display can be adjusted by pressing the *brightness* button. This is useful to make the display readable under different lighting conditions (indoors/outdoors).

8.6.2 Single-source / multi-source mode



Press the *single-source / multi-source* button to toggle between the two modes. In single-source mode, the camera shows only the sound source with the highest intensity (with a crosshair on top). If there are multiple sound sources with the same or almost the same intensity, they will all be shown.

In multi-source mode, the camera shows multiple sound sources with different intensities. The sound source with the highest intensity will be shown with a crosshair on top. Not all sound sources will be shown. For example, if there is a very strong sound source shown, very weak sound sources will not be visible at the same time.

To see weaker sound sources (in either single-source or multi-source mode), position and rotate the camera so that stronger sound sources are outside the field of view. You can also use the *zoom* button to limit the field of view.

8.7 Settings



Press the *settings* button to show the available settings:

- Network settings
- Time settings
- Change mode
- Air mode settings
- Power mode settings
- Advanced settings

8.7.1 Network settings

Press the *Enable wifi* button to show the available wifi settings.

To be able to scan for and select a wifi network, you must first select the correct wifi country. If the selected wifi country is incorrect, you may not be able to connect to wifi networks or the wifi connection might not work properly.

When pressing the *Select wifi* button, the camera will scan for nearby wifi networks. After the scan, a list of the found networks will be shown. In case the wifi network you wish to connect to doesn't show up, try moving closer to the wifi access point. Once you find and select the desired network, you will be asked to enter the wifi password. Please note that public wifi networks are not supported, only secure wifi networks are supported. The camera accepts wifi networks that require password input (not networks that require both user name and password).

An icon representing the wifi connection status and strength is shown to the right of the *settings* button:



Excellent wifi connection strength.



Good wifi connection strength.



Satisfactory wifi connection strength.



Poor wifi connection strength.



No wifi connection.

8.7.1.1 Device registration

To be able to upload snapshots to the cloud and browse them with the FLIR Acoustic Camera Viewer, the device must first be registered with the cloud service. Please follow the on-screen instructions in order to register the device.

Once the device has been registered, this option will no longer be available.

8.7.2 Time settings

The current time and date is shown under the time settings. Choose the correct timezone in order to show the correct local time. The time and date is automatically synchronized when connected to wifi.

8.7.3 Change mode

Press the *Change mode* button to select the application mode; *Air* or *Power*.

8.7.4 Air mode settings

Please see section 9 *Application-specific features* for the air-mode specific settings.

8.7.5 Power mode settings

Please see section 9 *Application-specific features* for the power-mode specific settings.

8.7.6 Advanced settings

- Language
This option allows you to choose the desired user interface language.
- Distance unit
The distance unit can be changed here to either meters (m) or feet (ft).
- Reset settings
All settings can be reset to their default value by pressing Reset settings. Note that doing a settings reset will not remove any snapshots or revert to any previous software version.
- Available filters
In case the usage application requires the manual selection of filters, this option lets you activate the corresponding optimal filters for finding leaks. Change the setting to Available filters: All to enable all filters. For more information about the filters, see section 9.3.1 *AutoFilter*.
- Remove all data
All user data and settings can be removed from the device by pressing Remove all data. The snapshots and device registration will be removed and the camera can be registered to a new user afterwards. The software will not be reverted to any previous version.
- Calibration mode
This function is used together with the FLIR Si124 Acoustic Camera tester. For more information, refer to the user manual for the FLIR Si124 Acoustic Camera tester.

8.8 Filter



Press the *filter* button to switch between different filters. The available filters depends on the selected application mode. The filters typically change the frequency range that the camera uses for showing sound sources. The same frequency range is also used when taking a snapshot and the sound is recorded.

Try the different available filter settings to see which filter serves your application best. Remember that the most appropriate filter might vary from case to case, and depend not only on the sound source of interest, but also on the background noise. For more information on choosing filters, see section 10.2 *Locating sound sources and taking snapshots*.

8.9 Real-time analysis

Real-time analysis results are shown at the top of the graphical user interface. The level in decibels of sound arriving from the strongest source (shown with a crosshair) is presented. The real-time analysis also provides additional information about problems related to the specific application. For details, see section 9 *Application-specific features*.

8.10 Cloud upload

When connected to the Internet via wifi, the camera will automatically upload any snapshots on the device to the FLIR Acoustic Camera Viewer cloud service as long as *Upload snapshots* is turned on under *snapshot browser*, see section 8.4 *Snapshot browser*. Snapshot upload can also be triggered manually, if the automatic snapshot upload is turned off.

Next to the *snapshot browser* button, the number of snapshots currently on the device is shown. Two dots next to the number indicate that snapshots are currently being uploaded to the cloud.

8.11 USB export

Snapshots on the camera can be exported to a USB memory stick. Open the USB port cover on top of the camera and insert the memory stick in the USB port. Check that the orientation of the memory stick and the port is correct before inserting the stick.

Note Use only the USB memory sticks provided with the camera. Other memory sticks are not guaranteed to work and may lead to loss of data.

The camera will recognize the inserted memory stick and ask if you want to transfer snapshots to the USB device. If you press *Yes*, the transfer will begin. During the transfer, the progress will be displayed, and the transfer can be aborted by pressing the *Stop* button. Snapshots already transferred to the memory stick will remain on the stick and snapshots not transferred will remain on the camera. **Do not remove the memory stick from the USB port while the transfer is in progress**, as this may corrupt the file system on the memory stick. Once the transfer has been successfully completed (or aborted if the *Stop* button was pressed), the main view of the graphical user interface is shown, and the memory stick can be removed from the USB port. Remember to put the USB port cover back in place.

The snapshots transferred to the memory stick can be browsed on a computer and opened using FLIR Thermal Studio, see section 12 *FLIR Thermal Studio*. On the USB stick, the snapshots are organized into subfolders.

Snapshots transferred to a memory stick will not be uploaded to the FLIR Acoustic Camera Viewer cloud service. The snapshot *.nlz* files can be uploaded at a later point in time from the memory stick or other storage location using the *Import files* feature in the FLIR Acoustic Camera Viewer.

Note The top heatsink will get hot when using the camera. It is recommended that USB export is done directly after starting the device, as attempting to export the results after prolonged use might be problematic due to the hot heatsink.

8.12 Remote update

When connected to the Internet via wifi, the camera will automatically download software updates available in the FLIR Acoustic Camera Viewer. If an update has been downloaded, it will be applied the next time the camera is started. The current software version is visible when pressing the *settings* button.

8.13 USB update

In case the remote update feature cannot be used, the camera can also be updated using a USB memory stick. Place the software update file provided by FLIR Systems in the root directory of the memory stick (i.e., not in any folder). Do not rename the file. Open the USB port cover on top of the camera and insert the memory stick in the USB port. Check that the orientation of the memory stick and the port is correct before inserting the stick.

The camera will detect the software update present on the memory stick and ask if you want to apply the update. Press **Yes** to copy the update to the camera. **Do not remove the memory stick while the update is being copied.** Once the update is on the camera, you will be asked to restart the device to apply the update. Remove the memory stick and put the USB port cover back in place. Shut the camera down by unplugging the battery cable and start it again by connecting the battery cable. The update will now be applied.

The typical applications of the FLIR Si124 are leak detection (locating and estimating the size of compressed air leaks) and partial discharge detection (locating and analyzing partial discharges in power grids).

The availability of the features is dependent on the camera model:

- FLIR Si124: Leak detection and Partial discharge features
- FLIR Si124-LD: Leak detection features
- FLIR Si124-PD: Partial discharge features
- FLIR Si124-LD Plus: Leak detection features + AutoDistance and AutoFilter features

9.1 Compressed air leak detection

The FLIR Si124 detects compressed air leaks based on the sound emitted by the leak. The different filters available on the FLIR Si124 filter out background noise and concentrate on the ultrasonic frequencies where the sound of a leak typically is much stronger than the background noise.

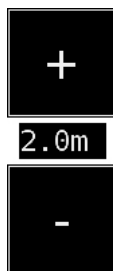
Based on the sound from a detected sound source, the FLIR Si124 will determine if the source is likely to be a leak. When a leak is detected, the FLIR Si124 will estimate the size of the leak. The estimate relies on the user setting the distance to the leak correctly (see section 9.1.2 *Distance*), as well as setting leak-related settings correctly (see section 9.1.3 *Air mode settings*).

The FLIR Si124 will also display an estimate of how much the detected leak costs annually. The estimate relies on the user setting the distance to the leak correctly (see section 9.1.2 *Distance*), as well as setting leak-related settings correctly (see section 9.1.3 *Air mode settings*).

9.1.1 Filter

The *High* and *Ultr* filters both filter out audible background noise, concentrating on ultrasonic frequencies where the sound of leaks often is prominent. The *SLM* filter emphasizes the sound from leaks by further filtering out the sound of many typical industrial noise sources. The most appropriate filter might vary from case to case, test the different available filters to see which filter gives the best results.

9.1.2 Distance



The FLIR Si124 has buttons for setting the distance to the detected leak. Use the + and - buttons to select the distance that you think is closest to the real distance of the leak. The distance is used to compensate for the fact that the intensity of sound is reduced over distance. This information is used when estimating the size of the leak.

9.1.3 Air mode settings

The following settings specific to leak detection are available:

- Leak unit
The unit used to display the leak size estimate can be adjusted. Available options are: l/min (liters per minute) and CFM (cubic feet per minute).

-
- **Currency**
The currency in which to display the leak cost estimate can be selected from the available options.
 - **Energy cost**
If the leak cost estimate for compressed air leaks is based on energy costs, you must enter the applicable price of energy here. Typically this means the local price (per kWh) of electricity. Note that if the currency is changed, the energy cost must be updated accordingly.
 - **Cost calculation**
The estimated cost of a leak can be calculated based either on the energy cost or the cost per volume unit. Select the option you prefer and then enter either of these corresponding costs.
 - **Environmental temperature**
The environmental temperature affects how the sound from a leak propagates through the air. Specify the temperature in order to get as accurate a leak estimate as possible. The temperature can be in either °C or °F.
 - **Relative humidity**
The relative humidity of the environment affects how the sound from a leak propagates through the air. Specify the relative humidity in order to get as accurate a leak estimate as possible.
 - **Leak correction factor**
The leak size estimate is based on a large set of various measured leaks. In some cases, however, it might underestimate the leak size or in other cases overestimate the leak size, as the leak size depends on a large number of different variables. If the leak size estimate systematically differs from your own observations, you can adjust it by setting the leak correction (leak corr.) factor. The final leak size estimation on the screen will be multiplied by the specified leak correction factor.
 - **Specific power**
The specific power is a measure of how much energy is needed to produce a certain amount of compressed air. The unit is either kW/m³/min or kW/100 CFM. This option is for advanced users; leave it at the default value if you do not know the specific power of your compressed air system.
 - **Utilization**
The leak cost calculation allows you to select the intervals that the compressed air system is in use: e.g. only workdays, excluding weekends. By entering the hours, days, and/or weeks of use, you can describe how often the equipment is being used in practice. The resultant utilization figure will be taken into account as a factor in leak cost calculations.
 - **Non-air leak detection**
The air mode can be changed to non-air leak detection. The user can manually pick the analytics options to be implemented and displayed by the camera. Under the Settings menu, press on the Leak Mode Settings where you can then select Leak Type to see the available options. Recommended only for advanced users.

9.2 Partial discharge detection

The FLIR Si124 detects partial discharges based on the sound they emit. The different filters available on the FLIR Si124 filter out background noise and concentrate on the high and ultrasonic frequencies where the sound of partial discharges typically is much stronger than the background noise

The FLIR Si124 will automatically determine when a detected sound source is likely to be a partial discharge. This autodetection works for AC frequencies of 50 and 60 Hz.

When a possible partial discharge has been detected, its so called PRPD (phase-resolved partial discharge) pattern will be shown on the top of the screen. By default, the

pattern is shown in a small window. Press on the window to enlarge it. Press once more to make it small again. The severity assessment in the FLIR Acoustic Camera Viewer relies on the user setting the distance to the leak correctly (see section 9.2.2 *Distance*).

9.2.1 Filter

The *Norm* filter filters out low frequency background noise, while the *High* and *Ultr* filters both filter out all audible background noise, concentrating on ultrasonic frequencies where the sound of partial discharges often is prominent. If there is only little background noise, try the *Norm* filter. In the presence of strong background noise, the *High* or *Ultr* filter will most likely work better. The most appropriate filter might vary from case to case, test the different available filters to see which filter gives the best results.

9.2.2 Distance



The FLIR Si124 has buttons for setting the distance to the detected partial discharge. Use the + and - buttons to select the distance that you think is closest to the real distance of the partial discharge. The distance is used to compensate for the fact that the intensity of sound is reduced over distance. This information is used when estimating the severity of the partial discharge.

9.3 FLIR Si124-LD Plus features

The FLIR Si124-LD Plus detects compressed air leaks based on the sound the leak emits. The FLIR Si124-LD Plus uses the features AutoDistance and AutoFilter for this purpose.

The AutoDistance feature calculates the distance to the sound source. This distance information is used to calculate and display an estimate of how much the detected leak costs annually and the distance to the leak. The AutoFilter feature facilitates this functionality by automatically choosing the correct filter to receive the most accurate readings for the sound signal itself.

For the most accurate readings, make sure the leak-related settings are correctly entered. See section 9.1.3 *Air mode settings*.

9.3.1 AutoFilter

The camera automatically selects the most suitable filter in order to obtain the most accurate leak detection results. It also eliminates known industrial disturbances by actively taking into account the environment where the camera is being used. The most suitable filter is therefore chosen automatically by the AutoFilter. The frequency range of detection is from 2 kHz to 65 kHz, from which the AutoFilter will choose the most suitable filter. It is recommended to leave the AutoFilter setting on.

If desired, it is also possible to manually choose between a number of predefined filters by activating them in the *Advanced Settings*, see section 8.7.6 *Advanced settings*.

The following filters are available:

- **Ultr (30 to 65 kHz)**
The best alternative for cases with strong background noise. Typically only to be used at short distances.

- High (20 to 30 kHz)
Filters out most background noise sources with a good detection distance.
- Full (2 to 65 kHz)
This filter is only available when enabling all available filters from the advanced settings. It utilizes the full frequency range of 2 to 65 kHz. This filter is not ideal for finding leaks, as it is affected by low-frequency background noise and might not be able to pick up very quiet sound sources.

The most appropriate filter will vary from case to case. It is good practice to test the different filters available to see which filter delivers the best results.

9.3.2 AutoDistance

The AutoDistance feature allows the camera to estimate distances automatically and in real-time.

The AutoDistance calculates the distance to the loudest leak by using the acoustic sensors of the camera. Accurate cost and leak size estimates are produced by taking into account the loss in sound intensity over distance. The precisely calculated distance is shown on the display screen.

In challenging environments, the user can choose to modify the distance parameters manually. If the camera analytics recognize challenging environments, the display screen will make the user aware of the situation. The + and - buttons can be used to select the distance that you estimate to be the most accurate.

10.1 General usage

Attach the neck strap to the two attachment points (11) on the camera handle. Carry the camera with the neck strap over your shoulder to free your hands for using the camera.

If you use the external battery pack, keep the battery inside of the carrying bag and carry the bag with the strap over your shoulder.

Note Consult your safety officer about using the camera with the neck strap or carrying bag in your facility or working environment. The neck strap and carrying bag strap are rigid and do not have a separate safety release mechanism, so special care should be applied around heavy machinery.

When you are not carrying the camera in your hand, always use the neck strap or put the camera securely inside the carrying bag to prevent it from falling. Always carry the camera by the neck strap or in the carrying bag when you need both hands for other tasks, such as climbing ladders.

Use the hand strap to ensure that you do not accidentally drop the camera. Do not carry or lift the camera by the hand strap. Always carry it by the handle, chassis, or neck strap.

Always keep the USB port covered. Water must not enter the camera, as this will damage the electronics inside. Protect the microphone array at all times. Do not touch the video camera lens or the conical microphone holes.

10.2 Locating sound sources and taking snapshots

The camera has different filters that are useful for finding different types of sound sources. These filters limit the frequency range of the sound sources that are displayed. The higher the frequency range is, the more local the sources of interest are - even in the presence of a lot of background noise. Background noise (for example traffic or factory noise) is often dominant at low frequencies, while many interesting phenomena have a lot of energy at high frequencies.

More in depth analysis is always done on the **location of the crosshair** on the screen.

In the *single-source* mode, the camera will always show the strongest sound source in the field of view. The strongest source will depend on the currently selected filter; different filters might display different sound sources. In order to see weaker sound sources in the presence of a strong sound source, move or rotate the camera so that the strong sound source is clearly outside the field of view. You can also use the *zoom* button to limit the field of view.

In the *multi-source* mode, the camera will show not only the strongest sound source, but also weaker sound sources. Note that sound sources considerably weaker than the strongest source will not be shown. The *multi-source* model is useful in finding weaker sound sources. If you want to examine these sources closer, you can move and rotate the camera as well as use the *zoom* button. Always keep in mind that any analysis is done in the direction of the crosshair on the display.

The camera will not only show actual physical sound sources, but also reflections from these sound sources. In order to verify that a source shown on the display is an actual sound source and not a reflection, move around to look at the source from different directions. If the location of the source remains the same from all different directions, the source is an actual sound source. If the location of the source moves along a surface (or completely disappears) when you move around, the source is probably a reflection.

The *multi-source* mode might also be useful when determining whether a source shown on the display is an actual sound source or a reflection. With the multi-source mode, you might be able to see both the actual sound source and one or several reflections, and by moving the camera around you might be able to tell which of the sources are reflections.



The image shows an example of one actual sound source and three reflections shown by the camera in *multi-source* mode. The actual sound source lies on the floor, while there are three reflections shown on the walls. When the camera is moved around, the location of the actual sound source remains the same, while the reflections move around on the walls, and are not seen from all angles.

Note, that if an actual sound source is large (for example a large vibrating surface), the source shown on the display might be smaller than the actual source. The source might in this case also move around as you move around the surface, depending on which point of the surface is closest to the camera. In this case, taking a snapshot and viewing it in the FLIR Acoustic Camera Viewer might help. In the FLIR Acoustic Camera Viewer, it is possible to adjust the dynamic range of the heatmap with the slider below the image. By increasing the dynamic range, you might be able to tell how large the sound source actually is.

It is often useful to take snapshots of interesting sound sources from several different directions. The exact location of the source is easier to find when viewed from different angles. Sound sources can also be directional, meaning that the sound level will differ depending on the direction.

When pressing the *snapshot* button, the sound coming from the direction of the crosshair will be saved. The device will save 2 seconds of sound, from the moment that the *snapshot* button is pressed backwards. This means that you should keep the camera steady for a few seconds before taking a snapshot, in order to get a clear signal from the source of interest. If you observe a sporadic event, take a snapshot directly when or after you observe the event in order to record the signal of the event.

The minimum recommended sound source distance for the camera is approximately 0.3 meters. If the distance is shorter than this, the location of sound sources will not be accurately displayed. In addition, the optical camera will not be focused at such short distances.

There is no specific upper limit for the distance at which the camera can be used. In practical cases, the distance is often limited to approximately 100 meters, but strong sound sources in an otherwise quiet environment can be detected at even larger distances. Respectively, weak sound sources usually require closer proximity.

The FLIR Acoustic Camera Viewer cloud service expands your sound imaging experience by offering various analysis methods for the sound image and the signal. It also serves as a storage for snapshots taken, and can be used for generating reports.

To access the FLIR Acoustic Camera Viewer services, use a modern web browser and enter the following address:

<https://si124viewer.flir.com/>

To use the cloud service, you must first register as user and register the device to the cloud service (see section 8.7.1.1 *Device registration*).

11.1 Browse through snapshots

Once logged in to the FLIR Acoustic Camera Viewer, the main view lists the snapshots taken with the currently selected camera or cameras. Each page in the main view shows a limited number of snapshots, and you can navigate back and forth through the pages.

11.2 Snapshot view

When clicking on a snapshot in the main view of the FLIR Acoustic Camera Viewer, a view of that snapshot will be opened. You can see the camera image and the acoustic heatmap overlaid on top of it.

11.2.1 Dynamic range slider

Underneath the image, there is a slider that can be used to adjust the dynamic range of the acoustic heatmap.

By changing the dynamic range slider, you can analyze the snapshot in more detail – you can decrease the range to get the precise location of the strongest sound source, and increase it to see if there are multiple sound sources. The camera captures sound from numerous directions, and the information is superimposed on top of the optical image.

The dynamic range determines which part of the information is shown, e.g. if the Max. level (sound level of the strongest sound source) is 50 dB, and the Dynamic range is 20 dB, all of the directions emitting a sound level between 50 dB and 30 dB will be shown with colors on top of the optical image.

11.2.2 Details

- *Label* is the name of the snapshot entered on the camera when taking the snapshot.
- *Serial* is the unique identifier for the camera.
- *ID* is a unique identifier to access the snapshot quickly by typing it in the address bar of the browser.
- The *Creation date* and *Synchronization date* show when the snapshot was taken and synchronized to the cloud in your current time zone.

11.2.3 Leak analysis

If the *Air* mode was selected when the image was taken, compressed air leak specific analysis results will be shown.

The *Estimated leak size* and *Estimated annual cost* depend on the distance and air mode settings. You can change the distance setting in the snapshot view and the air mode settings by clicking *Settings* on top of the screen.

11.2.4 Partial discharge analysis

If the *Power* mode was selected when the image was taken, partial discharge specific analysis results will be shown.

11.2.4.1 PRPD

If the snapshot is recognized as a possible partial discharge, the PRPD (Phase Resolved Partial Discharge) pattern will be shown.

The pattern is used widely for analyzing the PD type – different PD types typically have a distinct pattern.

Depending on the AC frequency, the PD pattern is constructed with different period lengths, e.g., 20 ms for 50 Hz and 16.7 ms for 60 Hz.

11.2.4.2 Partial discharge type

If the snapshot has been recognized as PD, the system automatically determines the likely Partial discharge type.

There are four categories:

- Negative corona
- Positive and negative corona
- Floating discharge
- Surface or internal discharge

The length of the color bar indicates how certain the system is that the detected PD is of a specific type. Several color bars may have approximately the same length, which means that the system is uncertain as to which type it is.

11.2.4.3 Analysis parameters

The sound attenuates over distance, which needs to be considered. A very precise *Distance* is not a requirement for the severity assessment but may produce more accurate results.

The *Voltage* and *Location* affect the severity assessment and recommended actions.

11.2.4.4 Severity assessment

The colored bar, ranging from green, yellow, and orange to red, shows the severity assessment. The highlighted region indicates the estimated severity range of the detected partial discharge.

The more the parameters (distance, voltage, and location) are specified, the more precise the severity assessment will typically be.

The assessed severity is also shown as text. The *Description* describes the type of partial discharge while the *Recommendation* provides suggestions for the actions to be taken.

Note The severity assessment only provides general guidelines based on the likely type of PD and the data available. Always consult an expert to decide on the actions that need to or need not be taken when PD has been detected.

11.2.5 Additional tools

There are additional audio analysis tools for further acoustic analysis. They are typically not needed for air leak or partial discharge applications but they may be useful for further analysis or other custom use cases.

There is a view of the last 100 ms of the sound signal from the dominant source in the image (i.e. the location of the crosshair when taking the picture). You can choose between five different ways to visualize the signal:

- *Signal* is a waveform representation of the audio signal as a function of time.
- *FFT* shows the magnitude spectrum of the signal.
- *Autocorrelation* is the correlation of the signal with itself.
- *Spectrogram* is a frequency spectrum of the signal in the function of time.
- *Cepstrum* can be used for analyzing the periodicity of the spectrum.

11.3 Settings

The settings dialog can be opened from the top of the page. The following options are available in the settings dialog:

- currency
- leak unit
- energy cost
- leak size correction factor
- distance unit

For details, see section 9.1.3 *Air mode settings*.

In the settings dialog, you can also change the password.

11.4 Import files

To upload snapshots from a USB memory stick to the FLIR Acoustic Camera Viewer for storage and further analysis, click on the *Import files* button on top of the screen. Either drag and drop the files into the designated area or select the files to upload by first clicking the link. The snapshot files that should be uploaded have the *n/z* extension on the USB memory stick.

Once you have selected the files you want to upload, click on the *Import Files* button to start the upload. Once the upload is done, it might take a few minutes until the new snapshots are visible in the snapshot list.

11.5 Report generation

To generate a PDF report or export data to MS Excel, first select the snapshots to include by clicking on the checkbox in the lower right corner of each snapshot shown in the list. By clicking on the *Reports* menu on top of the screen, you also have the possibility to select all snapshots taken with the currently selected cameras, or to deselect all snapshots.

- Generate PDF report
Once you have selected the snapshots you want to include, click on the *Reports* menu and then choose *Generate...* A dialog appears where you can choose the report type, how the snapshots should be ordered, and which date format should be used. Click on *Generate* to create the PDF report. The report generation will take some time, depending on the number of snapshots, and the progress will be shown. Once the report has been generated, click on the *Download* button to download the report.
- Export to MS Excel
Once you have selected the snapshots you want to include, click on the *Reports* menu and then choose *Generate Excel file....* This exports the data to an MS Excel file and downloads the file to your computer.

11.6 Camera selection

If you have multiple cameras registered to your user account, click on the *Cameras* menu on top of the screen to choose the camera or cameras to display.

FLIR Thermal Studio is a powerful, flexible, and efficient software for advanced image post-processing and reporting. The software supports images and videos from all modern FLIR thermography cameras, as well as acoustic images from the FLIR Si124.

To open your acoustic images in FLIR Thermal Studio, you must first export the image files (.nlz) from the camera to a USB memory stick.

In FLIR Thermal Studio, you can view and analyze your acoustic images. You can also change the settings.

For reporting, you can use one of the predefined acoustic reporting templates or create your own custom templates.

For more information, refer to the FLIR Thermal Studio user manual.

Note Do not try to repair or open the enclosure of the camera or the battery. Do not use any damaged devices, batteries or cords. Protect the device and accessories from dirt, dust, impacts and liquids.

Please read and follow the instructions in this user manual carefully in order to avoid damage to the device and accessories. If problems occur, contact your distributor for support.

13.1 Storage

Store the equipment in a dry location at room temperature. Store the batteries fully charged and recharge once every three months. Also start up the camera at least once every three months. These actions ensure reliability.

13.2 Cleaning

Do not use any strong cleaning solutions. Do not use any running or dripping water or liquid. Do not immerse any of the equipment.

Before cleaning the camera, disconnect all the cords and make sure that no equipment is powered.

For surface cleaning of the chassis, the screen and cables, use a damp cloth (w/ water or mild soap water), squeeze the cloth until it does not drip water.

Cleaning of the microphone array is not suggested to be performed by the user, as this may damage the device. Contact your distributor for support. However, if you decide to clean the microphone array yourself: Indirect **low** pressure air from a distance can be used to blow particles away from the conical holes of the microphones. No direct and/or highly compressed air should be applied to the microphone array. If the suggested method does not work and the microphone array is still badly soiled, contact your distributor for support. FLIR Systems is not responsible for any damage caused by the user in an attempt to clean the microphone array.

For the batteries and the chargers, use a dry cleaning cloth only.

Bags and cases can be vacuum cleaned or brushed. Make sure that the bag or case is completely empty first.

13.3 Visual and/or permanent damage

Broken accessories: Replace using FLIR Systems official spare parts. Properly dispose of and/or recycle broken equipment.

FLIR Si124 camera unit: Contact your distributor for repairs.

Recycle and properly dispose of all broken devices and packaging material. Contact your local authorities for instructions for proper disposal.

Website
<http://www.flir.com>

Customer support
<http://support.flir.com>

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