USER MANUAL

LF10

ACOUSTICS

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This User Manual supports the following LF10 version:
S/N: **AC13xxxx** SW: **22H1**

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1. NOTICE TO USER

1.1 Legal

Contact your distributor for the warranty terms and conditions.

As NL Acoustics Ltd is committed to a policy of continuous development, we reserve the right to make changes and improvements to any of the products or its documentation without prior notice.

EXCEPT AS EXPRESSLY PROVIDED IN THIS SECTION OF THE MANUAL, NL ACOUSTICS LTD PROVIDES NO WARRANTY, EXPRESS, IMPLIED, STATUTORY OR OTHERWISE AND SPECIFICALLY DISCLAIMS ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE PRODUCT AND DOCUMENTATION.

1.2 Compliance

We caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Note: This equipment has been tested and found to comply with the limits for a Class A digital device of CISPR 32. It may cause interference with radio frequency receivers in residential areas, and it is up to the users themselves to correct the interference. The EMC conformity of the equipment is indicated by the CE marking which the equipment bears.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

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

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at its own expense.

Radio operates in standard 802.11 b/g/n in frequency range 2400-2480 MHz and 5150-5260 MHz with max. output power 15 dBm.

EU Declaration of Conformity – NL Acoustics LTD declares that the LF10 complies with the essential requirements and other relevant provisions of the Radio Equipment Directive (2014/53/EU), Low Voltage Directive (2014/35/EU), Electromagnetic Compatibility Directive (2014/30/EU), Restriction of Hazardous Substances Directive (RoHS, 2011/65/EU) and Regulation concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH, 1907/2006/EU). A copy of the Declaration of Conformity is available on request.

NOTICE FOR CANADA

This Class A digital apparatus complies with Canadian ICES-003.
Cet appareil numérique de la classe A respecte est conforme à la norme NMB-003 du Canada.

1.3 Markings

The physical device ID label, CE marking, and WEEE marking are situated on the top left side of the LF10 camera (*Image 1*).

The ID label contains the following information: the product name, Canadian ISED certification label, serial number, Chinese CMIIT ID, country of origin, company name, and approval markings.

The electronic ID label or e-label containing all the regulatory information is the primary ID plate of the LF10. The e-label is available from the LF10 user interface. To open the e-label, press the *Settings* icon and choose *Device info*.

ISED: The certification label of Innovation, Science and Economic Development Canada (ISED) is a word mark consisting of the Company Number (CN) and Unique Product Number (UPN). Serial number: The first four characters of the serial number are the model number of the equipment, while the last four characters are the running identification number:

	Serial number	
Model number	**AC13**xxxx	Device ID

1.4 Customer help
Do not hesitate to contact our Customer Support Center if you experience problems or have any questions about your product. Please include the serial number of the device with your request.

For customer help, go to **support.nlacoustics.com**.

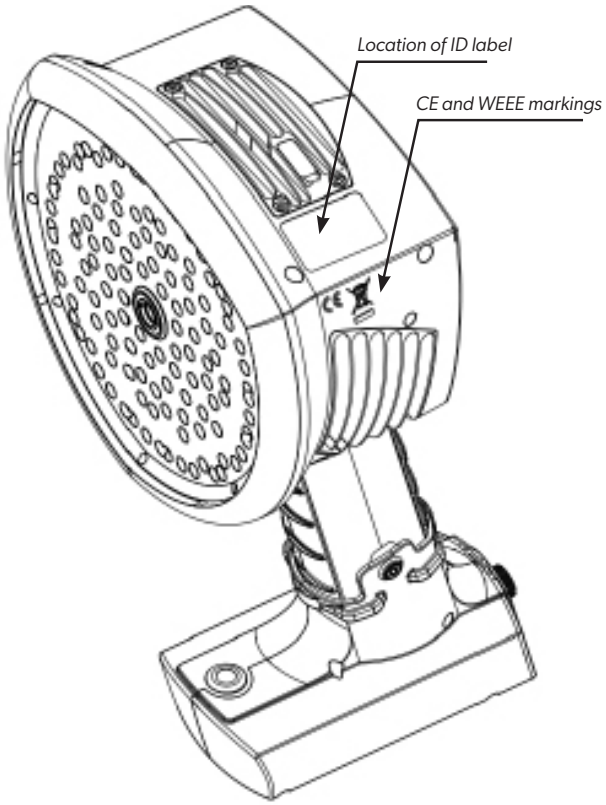
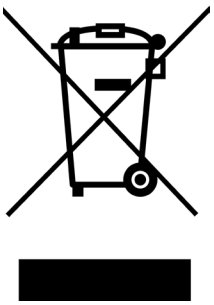


Image 1: Label locations on the LF10 camera.

1.5 Disposal of electronic waste

For users within the European Community

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 crossed-out wheeled bin (*see right*) 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, rather it must be collected separately.

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

2. INTRODUCTION

Thank you for choosing the LF10 camera! The LF10 is a standalone system for acoustic image measurement and signal analysis. The 124 microphones of the LF10 are used to form a precise acoustic image of a specific location. This acoustic image is superimposed in real-time over a digital camera image. The location of the sound source is shown on the camera screen. Sound sources of interest are separated from background noise. The details of each acoustic image can be saved onto the NL Cloud for further viewing and AI-backed analysis.

The LF10 camera is much more sensitive and accurate than the human ear. The camera can locate sound sources that are inaudible to the human ear as well as sound sources that humans cannot reliably locate. The LF10 has a frequency range that extends to ultrasonic frequencies, which is a huge advantage since many relevant problems and phenomena can be precisely located using ultrasound. One of the core benefits of using the LF10 camera comes from its ability to hear and analyze ultrasonic frequencies. Most maintenance and operational problems can be identified and accurately located at these frequencies.

2.1 User safety

Only genuine parts from NL Acoustics should be used with the LF10 camera. Under no circumstances should users make use of third-party parts.

Do not try to repair or open the enclosure of the LF10 camera or the batteries. Do not use any damaged device, battery, or cables.

Protect the device and accessories from dirt, dust, impacts, and liquids. Also protect the camera lens, the microphone array, and the USB port from any kind of foreign objects, dust or liquids.

Charge the battery only when it is disconnected from the LF10 camera.

The LF10 camera is not intended to be used while the battery is charging. Charge the battery only when it is disconnected.

Charge the battery at ambient temperatures between 0°C and +40°C (32°F and 104°F).

Do not leave the battery unattended during charging.

Do not expose the battery to flame or excessive heat.

Hold the LF10 firmly by the handle and fasten the safety lanyard to your wrist.

Do not touch the heat sinks when the device is on, as the heat sinks become hot when the camera is on. Long-term contact may cause burns. For this reason, it is recommended that any USB flash drives be connected directly after starting the device.

Consult with your safety officer in your facility or working environment about using the LF10 and, if powering the device by external battery, about using the carrier bag with shoulder strap. In you use the shoulder strap with your LF10, particular care should be taken to prevent getting entangled in your working environment.

Use only the USB flash drives supplied with the LF10 camera. Using third-party mass storage drives may lead to data loss or corruption.

2.2 Specifications

DEVICE

Manufacturer: NL Acoustics Ltd.
Name: LF10

MECHANICAL AND ENVIRONMENTAL

Size: 315 x 170 x 161 mm (12.4 x 6.7 x 6.3 in)
Weight: 0.980 kg (2.2 lb).
Total weight with RRC2040 battery: 1.2 kg (2.7 lb).
Protection class: IP51
Operation and storage temperature ranges: -10 °C to +50 °C (14°F to 122°F) / -20°C to +70°C (4°F to 158°F)
Operation and storage humidity range: 0 to 90% RH
Charging ambient temperature range: 0°C to +40°C (32°F to 104°F)

POWER SUPPLY

Max input rating: 15 V_{DC}, 2.5 A
Internal system backup battery: Li-Ion, 6 Wh

BATTERY OPTIONS

RRC2040 battery: Li-Ion, 10.80 V_{DC}, 3.35 Ah, 36.20 Wh, 0.170 kg (0.37 lb), 85 x 59 x 22 mm (3.34 × 2.31 × 0.86 in), IP40, usage time up to 2.5 h (depending on conditions), charging time 2 to 3 h.

RRC2040 battery charger: input 19 to 26 V_{DC}, 2.8 A max, output: 17.4 V_{DC}/4A max, 120 x 64 x 43 mm (4.72 × 2.51 × 1.69 in), 0.110 kg (0.24 lb), operating ambient temperature range: 0°C to +40°C (32°F to 104°F).

RRC2040 charger power supply: input 100 to 240 V_{AC} / 50-60 Hz, output 19 V_{DC} ± 5% / 3.4 A, maximum power 65 W, 95 x 50 x 25.4 mm (3.74 × 1.96 × 1 in), 0.270 kg (0.59 lb), operating ambient temperature range: 0°C to +40°C (32°F to 104°F).

Tracer external battery: LiFePO4, 12 V_{DC}, 7 Ah, 84 Wh, 985 g (2.2 lb), 90 x 145 x 65 mm (3.5 × 5.7 × 2.6 in), IP64 protection rating, usage time up to 6 h (depending on ambient conditions), charging time 4 to 6 h.

Tracer battery cord length: 0.9 m (3.0 ft), extended 2 m (6.6 ft).

Tracer battery charger: input 100 to 240 V_{AC} ~50/60 Hz, 1.3 to 1.5 A; max. output 13.8 to 14.6V_{DC}, 4.0 A depending on the charger provided; see the charger documentation or ID plate.

USER INTERFACE AND DISPLAY

Display: size: 5 in, 800x480; color: 24-bit RGB;
Brightness: 1000 cd/m2 (adjustable)
Input device: resistive touchscreen
Power ON indicator: red LED
Image resolution: 800x480
Video frame rate: 25 fps (max)
Acoustic image frame rate: 30 fps
Directional resolution: 0.5°, max: 0.25°
Field of view (FOV): 62.2° x 48.8°
Zoom: 2x digital zoom

ACOUSTIC SPECIFICATIONS

Acoustic measurement: 124 low-noise MEMS microphones, real-time sound visualization
Dynamic range, low limit: below -15 dB
Dynamic range, high limit: more than 120 dB
Bandwidth: 2 kHz to 65 kHz (automatic filtering)
Distance: from 0.3 m (1.0 ft) up to and above 130 m (430 ft)
Leak rate: typical industrial environments:
>0.032 l/min @ 3 bar from 3 m (9.8 ft)
>0.05 l/min @ 3 bar from 10 m (32.8 ft)
minimum detection: 0.004 l/min @ 1.2 bar from < 1 m (3.0 ft)

COMMUNICATION AND STORAGE

Wireless data transfer: 2.4 GHz and 5 GHz IEEE 802.11b/g/n/ac secured wireless LAN

Data transfer: USB / direct WiFi transfer / WiFi

Data storage: USB / cloud
Storage, internal: 32 GB SD card, non-removable.
Storage, external: 8 GB USB mass storage device, included in scope of supply

STANDARDS AND COMPLIANCE

RED: ETSI EN 300 328, ETSI EN 301 893
EMC: ETSI EN 301 489-1/17, EN55032: Class A, FCC CFR 47, Part 15, Subpart B: Class A, ICES 003: Class A
RoHS: EN 50581:2012
REACH
Safety: IEC 62368-1:2014, IEC 61010-1, EN 62311:2008 (RF exposure)

2.3 Package contents

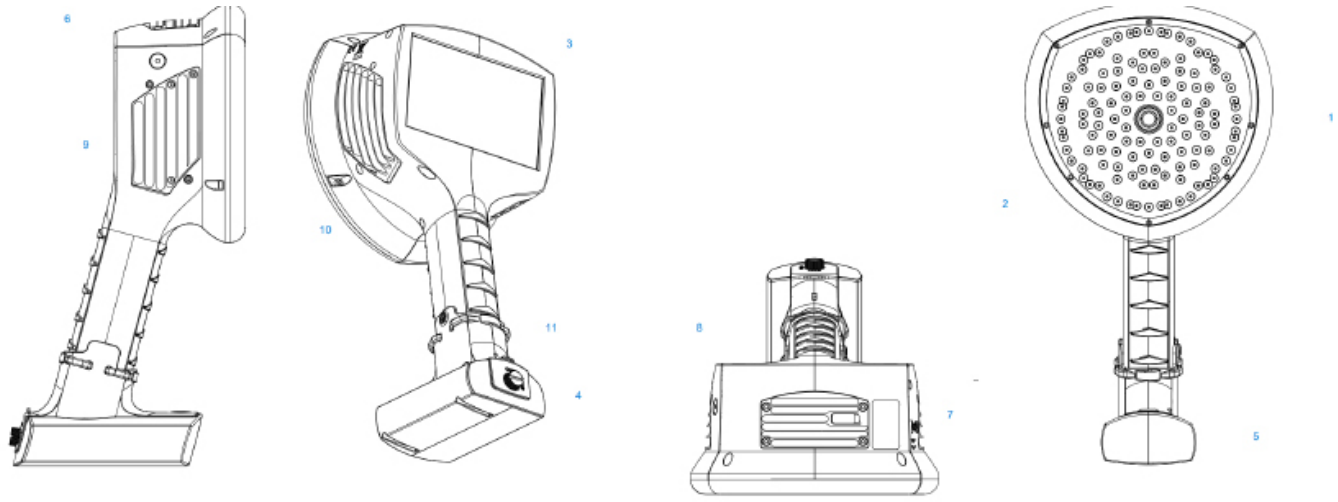
If you choose the LF10 with the **RRC2040** external battery, the product package includes:

1. LF10 camera
2. Two batteries
3. Battery housing
4. Charger
5. Charger power supply unit and a country-specific power cable
6. Mass storage device
7. Lanyard
8. Hard case

If you choose the LF10 with the **Tracer** external battery, the product package includes:

1. LF10 camera
2. Battery
3. Battery cable
4. Charger with detachable power supply cable
5. Mass storage device
6. Carrier bag
7. Shoulder strap

2.4 Camera parts



1: Video camera
2: Microphone array
3: LCD screen
4: Battery cover
5: Battery housing or battery cable (with Tracer external battery), Camera-end connector
6: Power LED
7: Mass storage port
8: Top heatsink
9: Right-side heat sink
10: Left-side heat sink
11: Lanyard fastening point
12: ON/OFF button

Image 2: LF10 camera parts

- NOTE: Refrain from touching the heat sinks (*Items 8, 9, and 10 in Image 2 above*), as they become hot during use. Long-term contact may cause burns. -

The front side of the LF10 camera consists of a video image sensor (*Item 1 in Image 2*) and the microphone array (*Item 2 in Image 2*). The camera screen displays a monochromatic (black and white) image on which the acoustic colored-coded heatmap is overlayed.

The LF10 camera has a resistive touchscreen (*Item 3 in Image 2*). Users can operate the screen even when wearing gloves. Do not apply any sharp or hard objects to use the screen, as they may damage the surface. Exerting excessive force will degrade the durability of the touch screen.

The status of the internal power supply unit is indicated by the power LED (*Item 6 in Image 2*), which turns red when the power is ON. While the power is ON, the LF10 dissipates heat through the three heatsinks (*Items 8, 9, and 10 in Image 2*) that are located on both sides and on top of the camera. While operating the LF10, the heat sinks must be not be covered. Do not enclose the device while the power is turned ON.

The camera has a USB port located under the cover on top of the device (*Item 7 in Image 2*).

Using the wrist lanyard will protect the LF10 from getting damaged if dropped (*Item 11 in Image 2*). However, do not carry the LF10 camera by the wrist lanyard only.

NOTE: Protect the camera lens and microphone array against coming into contact with any foreign objects, dust, or liquids.

2.5 Battery parts

The LF10 primary battery configuration is the RRC2040, which is a small portable battery in an integrating housing. The RRC2040 battery option is presented in Section 2.5.1, while the second battery option called the Tracer battery – an external battery configuration – is described in Section 2.5.3.

2.5.1 RRC2040 battery parts

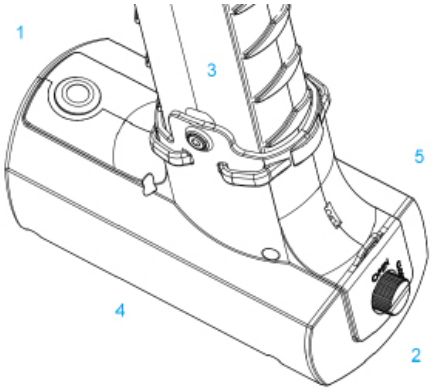


Image 3: RRC2040 battery housing

1: Power button
2: Battery cover
3: Fixing screw
4: Battery housing
5: Lanyard attachment point

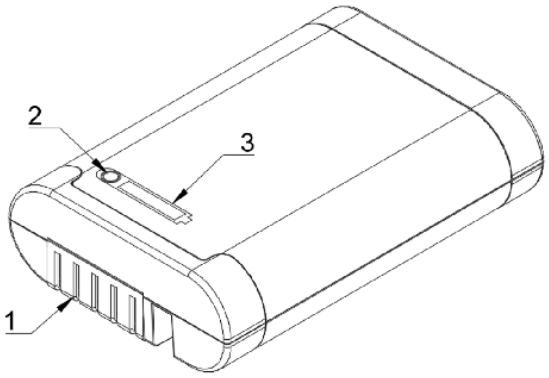


Image 4: RRC2040 battery

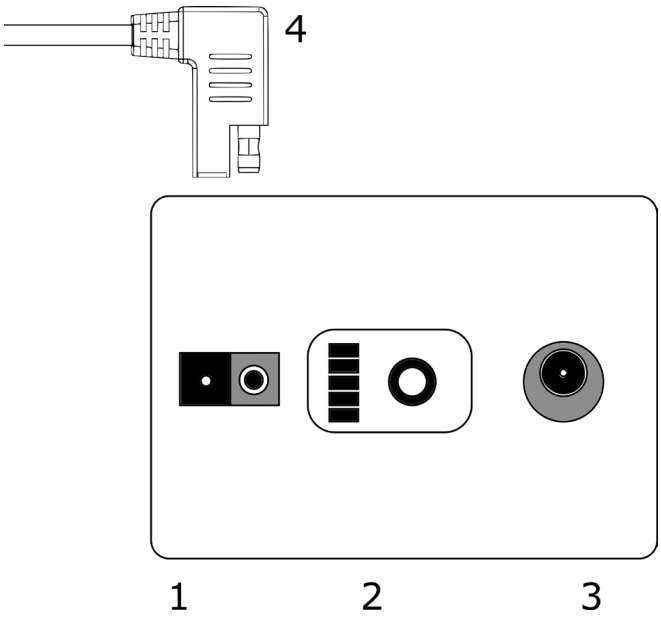
1: Battery connectors
2: Charge gauge button
3: Battery charge indicator

2.5.2 RRC2040 external battery charger

The RRC2040 charger has two parts: the charger unit and the power supply unit. The charger unit has connectors for the battery in the charging bay and a DC barrel input for power supply. The power supply has universal power supply input for which the fitting power cable can be chosen, depending on the given region.

2.5.3 Tracer external battery parts

If you purchase the LF10 supplied with the **Tracer** external battery, see the battery parts below:



Bottom: The main battery of the LF10
1: Output connector for the battery cable
2: Charge gauge
3: Battery charger connector

Top:
4: Battery cable connector

Image 5: Tracer external battery parts

2.5.4 Tracer external battery charger

The charger for the Tracer battery is an AC/DC converter with an output capable of charging lithium iron phosphate (LiFePO4) batteries. The charger has a universal single-phase power supply input, a status LED, and a charging output. The charger is provided with a power supply cable including a plug compatible for the power socket outlets in your region. The charger has a DC barrel plug at the end of the output cable for charging the battery. Do not use any battery chargers other than ones approved by NL Acoustics.

2.6 Spare parts and accessories

Please ask your local reseller for information on what spare parts are available.

3. GETTING STARTED

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 LF10 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.

3.1 Charging

The main power source of the LF10 is an external battery: either the RRC2040 battery, or the Tracer. The batteries should be charged fully before operating the device. Please note that the batteries should also be fully recharged before placing them in storage.

- NOTE: Charge the batteries at temperatures between 0 °C and +40 °C (32 °F to 104 °F). -

- NOTE: The LF10 camera is not intended to be used while the batteries are charging. Charge the battery only when they are disconnected from the camera! -

3.1.1 Charging the RRC2040 battery

Before using the batteries, remember to charge them first. Fully recharging a completely discharged RRC2040 battery usually takes about 2 to 3 hours. Please note that the battery should be charged at ambient temperatures between 0°C and +40°C (32°F and 104°F). A new RRC2040 battery used under optimum environmental conditions yields up to 2.5 hours of usage.

The RRC2040 batteries and charger come delivered with the LF10. Only use the battery charger supplied with the LF10. Please follow these instructions to charge the batteries:

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

When the battery starts charging, the charger light turns orange. When the battery is fully charged, the light turns green. You can see how much the battery has charged by pressing the charge gauge. If the external battery needs to be charged, the camera will prompt the following message: *Low battery*.

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

Charge gauge

The front side of the RRC2040 battery holds the battery connectors, while the top side of the battery holds the charge gauge button and the battery charge display. To check the battery's state of charge, press the charge gauge button (*Item 2 in Image 4*) and the battery charge LEDs will display will the charge percentage.

Number of LEDs on	**State of charge [%]**
4	100-76
3	51-75
2	26-50
1	10-25
1 (flashing)	<10

3.1.2 Charging the Tracer external battery

Fully charging a discharged Tracer battery usually takes between 4 to 6 hours. Please note that the battery should be charged at ambient temperatures between 0°C and +40°C (32°F and 104°F). A new Tracer battery used under optimum environmental conditions yields up to 7 hours of usage. This depends, however, on multiple variables which may decrease usage time, including the cell temperatures, the load, and the age (i.e. charging cycles) of the battery.

The Tracer battery and charger come delivered with the LF10. Only use the battery charger supplied with the LF10.

1. First, disconnect the battery cable from the battery output connector (*Item 1 in Image 5*).
2. Plug the charger's power supply cable into the wall socket-outlet.
3. Plug the DC barrel connector into the battery charging connector (*Item 3 in Image 5*).

When the status LED of the charger is red/yellow, the battery is charging. When the status LED of the charger is green while the DC barrel connector is connected to the battery, the charge is complete. The status LED is also green when the DC barrel connector is disconnected. If the external battery needs to be charged, the camera will prompt the following message: *Low battery*.

Power supply cable connected	Charger cable connected	Charger status LED
No	No	Off
Yes	No	Green
Yes	Yes	Red or yellow, charging
Yes	Yes	Green, fully charged

- NOTE: Do not leave the battery unattended during charging! -

Charge gauge

Press the charge gauge button (*Item 2 in Image 5*) to test the state of the battery charge. The indication is approximate only, and the most accurate results are after 2 minutes of no charging. Note that if battery displays no lights, the state of charge is empty. If the battery fails to fully recharge within 12 hours, the battery may be damaged.

LEDs	State of charge
3 greens, 2 reds	Full
2 greens, 2 reds	Over 50%
1 green, 2 reds	Over 20%
2 reds	Less than 20% (recharge soon)
1 red	Less than 10% (nearing automatic switch-off)
No lights	Empty

3.2 Startup

For startup, please see the sections below that provide instructions for starting up the camera using either the RRC2040 battery or Tracer battery.

3.2.1 Startup with the RRC2040 battery

The RRC2040 battery set for the LF10 includes two batteries, a charger, a charger feeder cable, and a country-specific power supply cable.

Please follow the instructions below and see *Image 6* to start the camera using the battery, and if you need to attach the battery housing to the LF10 camera.

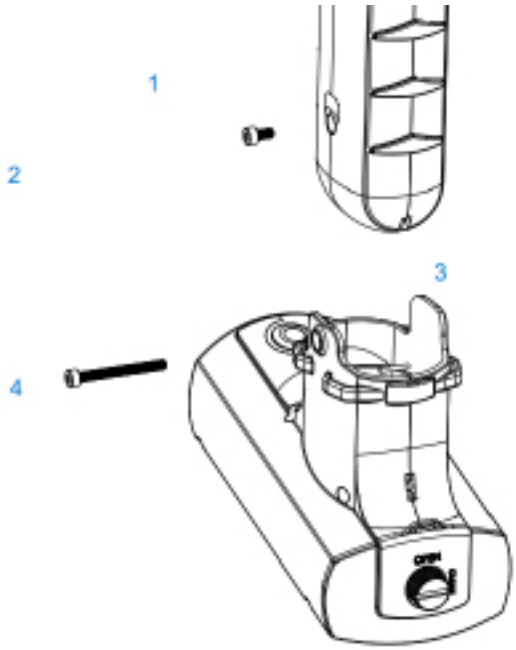


Image 6: Attaching the RRC2040 battery housing

1: Unscrew and remove the lowest screw in the camera handle. (*Item 1 in Image 6*) (tool: 2.5-mm hex socket screwdriver, not included)
2: Insert the support spacer in the screw hole (*Item 2 in Image 6*).
3: Insert the camera handle into the battery housing. The housing is correctly positioned when the screw hole of the battery housing is aligned with the lowest screw hole of the camera handle (*Item 3 in Image 6*).
4: Screw the 30-mm hex screw through the housing into the handle. Tighten firmly (*Item 4 in Image 6*).

After you have attached the battery housing to the LF10, open the lid (*Item 3 in Image 7*) by turning the knob of the battery housing counterclockwise, and insert the battery into the battery housing with the connectors at the front and the charge gauge (*Item 2 in Image 7*) facing upwards. Ensure the battery is inserted all the way

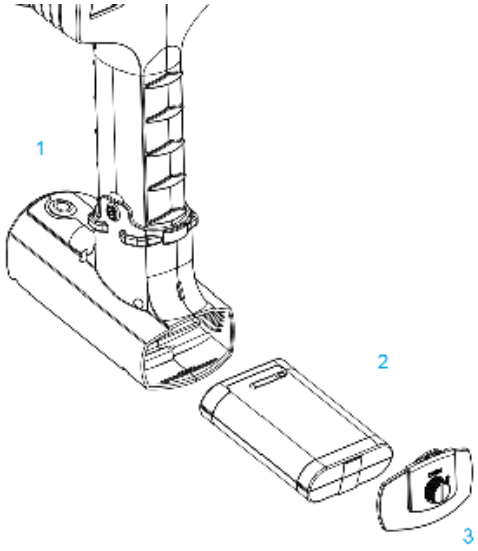


Image 7: Inserting RRC2040 battery

1: Power switch button
2: RRC2040 battery in the correct position when for inserting it into the housing
3: Battery cover

inside the housing. Close the cover of the battery and turn the knob clockwise to lock the cover. Press the ON/OFF button (*Item 1 in Image 7*) at the front of the battery housing to turn the camera on. The LED located on top of the camera will turn red. The camera is now ready to use. If the power LED of the LF10 camera blinks, your battery has depleted its charge before startup.

When the power is ON, the red Power LED of the camera is lit (*Item 6 in Image 2*). The system starts after approximately 10 to 15 seconds. The startup logo will appear on the screen. **Once the system setup has completed, the LF10 camera's user interface starts automatically, and the camera is now ready to use.**

The LF10 has internal system backup batteries which the main battery charges while the LF10 is in use. **At the first system startup**, it is recommended that you leave the camera ON, powered by the main battery, for at least 45 minutes so that the internal backup batteries are fully charged.

If you wish to attach the wrist lanyard that comes with the camera in the battery housing, you can find the attachment point on top of the battery housing lid (*Item 5 in Image 3*).

3.2.2 Startup with Tracer external battery

1. Attach the battery cable to the battery. There is only one way to attach the connector of the battery cable to the battery output connector. Push the connector downwards all the way.
2. Attach the connector to the LF10 by following the instructions in *Image 8*, with the orientation markings facing the same way:

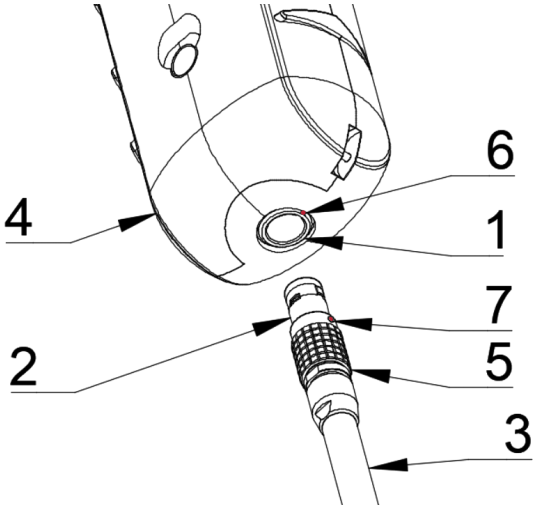


Image 8: The various parts to consider when starting the LF10 camera

1: Input connector
2: Battery cable connector
3: Battery cable
4: LF10 handle
5: Connector lock ring
6: Input alignment Marking
7: Cable alignment Marking

Both the LF10 and the battery cable have **red alignment markings** (*Item 6 and 7 in Image 8*). They indicate the position of the key and the slot of the connectors, thereby ensuring proper alignment for connection. **Secure the battery cable connector using the locking ring** (*Items 6 and 7 in Image 8*), and make sure that the alignment markings of both connectors are neatly aligned before inserting the battery cable. **Then carefully insert the battery cable connector into the LF10**. The connectors should lock audibly.

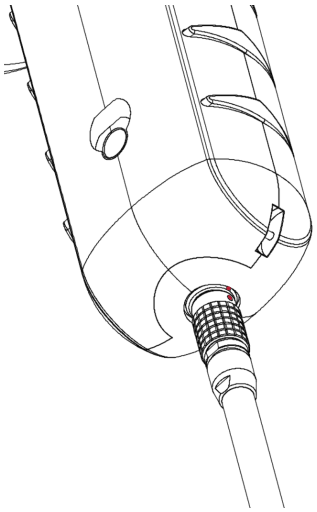


Image 9: Battery cable inserted in the LF10 camera.

When the power is ON, the red Power LED of the camera is lit (*Item 6 in Image 2*). The system starts after approximately 10 to 15 seconds. The startup logo will appear on the screen. **Once the system setup has completed, the LF10 camera's user interface starts automatically, and the camera is now ready to use.**

- NOTE: Hold the LF10 firmly by the handle. -

The LF10 has internal system backup batteries which the main battery charges while the LF10 is in use.
At the first system startup, it is recommended that you leave the camera ON, powered by the main battery, for at least 45 minutes so that the internal backup batteries are fully charged.

3.3 Device setup wizard

The first time the LF10 is powered up, the device setup wizard will appear. The wizard will help you set up the settings needed for using the device, such as the WiFi settings (not supported in all regions), language, location, and time zone. This information can be changed later via the settings menu. Please see *Section 4.7: Settings* for more details.

3.3.1 Device registration

Create an account and register your device on the NL Cloud service. Use the NL Cloud to store and view the uploaded snapshots and videos, among other functionalities *(Section 7: NL Cloud*). Please follow the on-screen instructions given by the setup wizard in order to register the device. You can also register the device later in the network settings (*Section 4.7.1: Network settings*).

3.4 Shutdown

To shut the camera down, please see the sections below that provide instructions for turning the camera off using either the RRC2040 battery or Tracer battery.

3.4.1 Shutdown with RRC2040 battery

To turn off the LF10 camera, **simply press the ON/OFF button. When turned OFF, the button is in the up position**.

1. Press down the ON/OFF button until it clicks and rises up. The power is now switched off. Alternatively, you can withdraw the battery from the battery housing.
2. The shutdown logo will appear, and the system will safely and reliably shut down.
3. The camera's red power LED will turn off once shutdown has completed.

If you encounter a problem with the system, you can perform a hard shutdown by disconnecting the battery power and waiting until the camera's power LED turns off. If shutdown takes more than 5 to 10 minutes after disconnecting the battery, contact NL Acoustics for service.

3.4.2 Shutdown with the Tracer external battery

To turn the LF10 camera off, **simply disconnect the battery connector from the LF10 camera**.

1. Hold the battery cable connector by the lock ring and pull it outwards. The lock ring will slide until it releases the connection. Alternatively, disconnect the cable from the battery.
2. The shutdown logo will appear, and the system will safely and reliably shut down.
3. The camera's red power LED will turn off once shutdown has completed.

If you encounter a problem with the system, disconnect the battery power and wait until the power LED turns off. If shutdown takes more than 5 to 10 minutes after disconnecting the battery, contact NL Acoustics for service.

- NOTE: Do not pull the device by the cable or use any kind of pliers or tools to disconnect cables! -

4. USER INTERFACE

You can control various LF10 functionalities and operations at the user interface. This section describes the functionalities and the settings available to the user when operating the camera, such as the heatmap, snapshots and video capturing, uploading and browsing through the snapshots, settings, real-time analysis, data transfer, and updates.

4.1 Heatmap

The main view of the user interface shows the camera image with a heatmap overlay. The heatmap shows the location of the strongest sound source (*single-source mode*) or multiple sound sources (*multi-source mode*). Each sound source is shown by means of a single color according to the intensity of the sound source (*see Image 10*). The intensities range from weak to medium to strong with respective color-coded schemes in green, yellow, and red, respectively.

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 and analyzed (*Section 5: Air leak detection features*). The dB level of the sound from this direction is shown at the top of the screen.

Image 10: Intensity of the sound source

4.2 Taking a snapshot

Press the *Snapshot* button to take a snapshot that contains the current camera image and heatmap. For analytics purposes, the snapshot includes a short video (4 seconds) and an audio clip of the strongest sound source. The video and audio clip are from the preceding 4 seconds before you press the *Snapshot* button. For this reason, 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. The direction of the strongest sound source is shown with a crosshair. After you have taken a snapshot, the camera displays a screen where you can enter comments. The camera also allows you to input the distance manually in the screen by clicking the Change button that is shown on-screen after a snapshot is taken.

After entering such pieces of information, press the *Save* button to save the snapshot. If at this point you choose to not save the snapshot, press the Trash button in the bottom left corner instead. Please note that if you use the camera to photograph people, remember to ask their consent prior to capturing any images.

4.3 Recording a video

Press the *Video Recording* button to the right of the *Snapshot* button to start recording. Note that the video length is limited to 5 minutes. To stop recording, tap the video recording button again. After you have finished recording, you can enter additional information just like when taking a snapshot. You are also given the option to save or erase the recorded video clip. You can erase the clip by tapping the *Trash* button.

You can view the saved videos later in the NL Cloud, NL Camera Viewer, or NL Camera Viewer Pro. However, you cannot view the recorded videos on the camera itself, or by using any other video player software on your computer.

Please note that if you use the camera to take videos showing people, remember to ask their consent prior to capturing any images.

4.4 Snapshot browser

The number of snapshots currently saved on the LF10 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 NL Cloud.

Press the *Snapshot Browser* button to look through the snapshots you've taken. Thumbnails of the snapshots are shown at the bottom of the screen, and you can scroll through these horizontally. When you press a thumbnail, the snapshot will be shown together with some additional information.

Note that snapshots are not available in the Snapshot Browser after they have been uploaded to the NL Cloud service, exported to a USB flash drive (*see Section 4.10: USB export*), or exported with direct export functionality to a PC (*see Section 4.11: Direct data transfer*).

4.4.1 Snapshot upload options

Press the *Upload* button to select the mode for uploading your snapshots, and three options will be displayed: enable the cloud upload, trigger manual cloud upload, or direct data transfer.

Enable/disable automatic cloud upload:
Upload to cloud

With this functionality, you can enable or disable automatic data upload to the NL Cloud. See Section *4.9: Cloud upload* for more information.

Trigger manual cloud upload:
Upload to cloud now

If you have disabled the automatic data upload, you can manually trigger data upload to the NL Cloud. See Section 4.9: Cloud upload for more information.

Transfer snapshots directly to a PC without USB sticks: *Direct data transfer*

This functionality lets you transfer data directly to NL Camera Viewer Pro without using the USB export functionality. See *Section 4.11: Direct data transfer* for more information.

If you wish to transfer files to a USB stick, please see *Section 4.10: USB export*.

4.4.2 Tagging snapshots

Snapshots can be assigned to a tag. Select a snapshot and type on the screen the tag of your choice. This information is then included in the metadata of the snapshot. The tags can be used later in NL Camera Viewer Pro and NL Cloud (*see Sections 7 and 8*) to sort your snapshots.

4.5 Zoom

The LF10 is equipped with a 2x digital zoom that can be used for close-up snapshots. Press the *Zoom Buttons* to zoom in or zoom out. The zooming in option increases the directional resolution of the camera from 0.5° to 0.25°.

4.6 Quick settings

Press the *Quick Settings* button to show the available quick settings. The possible settings are listed below.

4.6.1 Screen brightness

The brightness of the display can be adjusted by pressing the *Brightness* button. This is useful for making the display readily legible under differing lighting conditions (indoors/outdoors).

4.6.2 Single-source / multi-source mode

Press the *Single-source / Multi-source* button to toggle between the two modes. In single-source mode, the LF10 shows only the sound source with the highest intensity (marked by a crosshair). If there are multiple sound sources of equal or almost equal intensity as the strongest sound source, the LF10 will show all these sound sources as well.

In multi-source mode, the LF10 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 dominant sound source, 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.

4.7 Settings

Press the *Settings* button to show the available settings. Please see the various settings in the sections below.

4.7.1 Network settings

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

To be able to scan for and select a WiFi network, first specify your location. Do this by pressing the *Location* button. You will then see a list of locations to choose from. If the selected WiFi location 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 networks detected will be shown. If the WiFi network you wish to connect to is not displayed as detected, 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 only secure, non-public WiFi networks are supported. The LF10 accepts WiFi networks that require password input, but not networks that require both a username 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.

Device registration

If you have not completed the device registration in the setup wizard, you must first register the device with the NL Cloud service to be able to upload snapshots to the NL Cloud. Please follow the on-screen instructions in order to register the device.

4.7.2 Time settings

The current time and date are shown under the time settings. Choose the correct time zone to see the correct local time. The time and date are automatically synchronized when connected to WiFi.

4.7.3 Advanced settings

Language

This option allows you to choose the desired user interface language. The following languages are supported:

- Czech
- Danish
- Dutch
- English
- Estonian
- Finnish
- French
- German
- Greek
- Hungarian
- Indonesian
- Italian
- Japanese
- Korean
- Norwegian
- Polish
- Brazilian Portuguese
- Russian
- Simplified Chinese
- Spanish
- Swedish
- Thai
- Traditional Chinese
- Turkish
- Vietnamese

Distance unit of measurement

The distance unit of measurement can be changed here to either meters (m) or feet (ft).

Reset settings

All settings can be reset to their default value by choosing *Reset settings*. Please note that doing a settings reset will **not** remove any snapshots, revert to any previous software version, or remove the device registration.

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. See more information on the filters in *Section 5.1: 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. All users currently paired with this device will be unpaired from the device. To continue operating the camera, proceed to pairing the device again. The camera software will **not** be reverted to any previous versions.

Calibration mode

The NL Sonic Tester calibrator is available as an accessory for periodically checking the accuracy of the LF10. For more information, please contact your local distributor. For details about the calibration mode, please see the documentation provided with the NL Sonic Tester.

4.8 Real-time analysis

Real-time analysis results are shown on the display of the camera's screen, including the dB levels, leak rate, leak cost, and the distance to the sound source.

The dB levels of the strongest sound source are shown marked with a crosshair. The real-time analysis also provides information about air leaks. The leak unit of measurement is the estimation of the leak size in liters per minute (l/min) or cubic feet per minute (CFM). The leak cost is the estimated cost of the air leak detected given in a specific currency as an energy cost, and these parameters can be modified accordingly. For details, see *Section 5: Air leak detection features*.

The AutoDistance function is a feature from real-time analysis. The LF10 estimates the distance from the camera to the source of interest automatically. If you wish to input a manual distance, the screen display prompts the + and - signs, and you can use them to manually input an estimated distance.

4.9 Cloud upload

When connected to the Internet via WiFi, the LF10 will automatically upload any snapshots on the device to the NL Cloud as long as *Upload snapshots* is turned on under the *Snapshot Browser* (*see Section 4.4: Snapshot Browser*). Snapshot upload can also be triggered manually if the automatic snapshot upload is turned off. The number of snapshots currently saved on the device is shown next to the *Snapshot Browser* button. If there are two dots visible next to the number, snapshots are currently being uploaded to the NL Cloud.

4.10 USB export

Snapshots in the LF10 can be exported to a USB flash drive. Open the cover on top of the LF10 (*Image 11*) and insert the memory stick in the USB port. Check to ensure that the memory stick is correctly aligned to the port before inserting the stick.

- NOTE: Use only the USB flash drives supplied with the LF10. Other flash drives are not guaranteed to work and may lead to loss of data! -

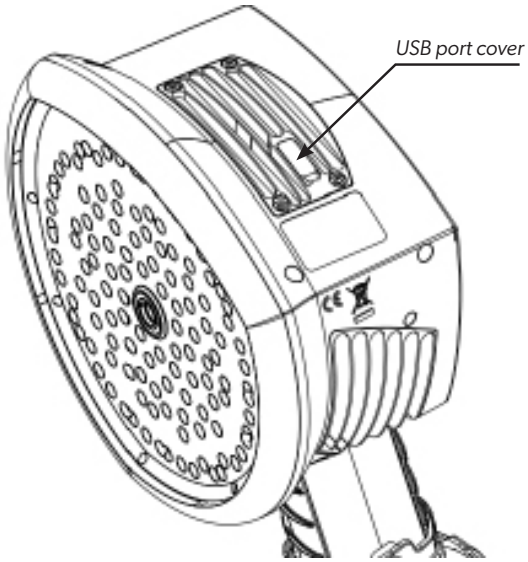


Image 11: Location of the USB port cover

The LF10 will recognize the inserted flash drive 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 USB flash drive will remain on the flash drive and snapshots not transferred will remain on the LF10. **Do not remove the flash drive from the USB port while the transfer is in progress**, as this may corrupt the file system on the flash drive. Once the transfer has been successfully completed (or aborted if you pressed the Stop button), the main view of the user interface is shown, and the flash drive can be removed from the USB port. Remember to put the USB port cover back in place.

The snapshots transferred to the flash drive can be browsed on a PC with the NL Camera Viewer software (*see Section 8: NL Camera Viewer and NL Camera Viewer Pro offline software* for more information). The snapshots on the USB flash drive are organized into subfolders.

Snapshots transferred to a USB flash drive will not be uploaded to the NL Cloud. The snapshot .nlz files can be uploaded at a later point from the flash drive or any other storage location using the *Import files* upload feature in the NL Cloud.

4.11 Direct data transfer

If the USB export function cannot be used for exporting the data to a PC, direct data transfer is an alternative way to transfer snapshots directly from the LF10 to the NL Camera Viewer Pro software (*see Section 8: NL Camera Viewer and NL Camera Viewer Pro offline software*) only supported on the NL Camera Viewer Pro.

This feature uses a direct WiFi connection between a PC and the LF10. Direct data transfer can be accessed in the snapshot browser (see Section 4.4: Snapshot Browser). Click on the Snapshots Upload button, press direct upload on the menu, and the camera will then be ready to start the Direct data transfer. Open the NL Camera Viewer Pro on your PC and click on Import from Camera in the upper bar menu. Once the PC and the camera are connected, the file transfer will start. After the files are transferred, the PC prompts a confirmation message, and you then click the *Stop* button on the camera. The camera then reboots and you can re-connect your PC to WiFi.

4.12 Remote update

When connected to the Internet via WiFi, the LF10 will automatically download available software updates. If an update has been downloaded, it will be applied automatically the next time the LF10 is started. The current software version can be noted at the bottom of the screen when pressing the *Settings* button.

4.13 USB update

If the remote update feature cannot be used, the LF10 can also be updated using a USB flash drive. Place the software update file provided by NL Acoustics in the root directory of the flash drive. Be careful not to place the file just in any folder. Do not rename the file. Open the USB port cover on top of the LF10 and insert the flash drive in the USB port. Check to ensure that the USB flash drive is correctly aligned to the port before inserting it in the port.

The LF10 will detect the software update present on the flash drive and ask if you want to apply the update. Press Yes to copy the update to the LF10. **Do not remove the flash drive while the update is being copied.** Once the update has been copied to the camera, you will be asked to restart the device to apply the update. Remove the flash drive and put the USB port cover back in place. Shut the LF10 down and restart it. You are now ready to use the camera with the updated software.

5. AIR LEAK DETECTION FEATURES

The LF10 detects compressed air leaks based on the sound the leak emits. The LF10 uses the functionalities called AutoDistance and AutoFilter for this purpose. The AutoDistance 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 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, the leak-related settings found in *5.3 Specific settings* are correctly entered.

5.1 AutoFilter

The LF10, automatically selects the most suitable filter in order to obtain the most accurate leak detection results. It also eliminates known industrial disturbance by actively taking into account the environment where the LF10 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 chose 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*. Press the *Settings* button and go to the second page under *Advance Settings*. From the button at the top-right of the main screen you can then choose from the following filters:

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.

5.2 AutoDistance

The smart functionalities of the LF10 allow it to estimate distances automatically. 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 AutoDistance functionality does this in real-time and automatically. 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.

5.3 Specific settings

The following settings specific to leak detection are available:

Leak unit: Adjust the unit of measurement used to display the estimated leak size. The available options are liters per minute (l/min) and cubic feet per minute (CFM).

Currency: Select the currency for the leak cost estimate 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. This usually means the local price per kWh of electricity. Please note that if the currency is changed, the energy price 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.

Env. temp.: The environmental (i.e. ambient) temperature affects how the sound from a leak propagates through air. Specify the temperature to get the most accurate leak size estimate. The temperature can be entered either in °C or °F.

Rel. humidity: The relative humidity of the surrounding environment affects how the sound from a leak propagates through air. Specify the relative humidity to get the most accurate leak size estimate.

Leak corr.: The LF10's 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 of measurement is either kW/m^3/min or kW/100 CFM. This option is for advanced users, so 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.

6. USAGE TECHNIQUES

See the sections below for recommendations on how to get the most out of your LF10.

6.1 General practice

Use the wrist lanyard to ensure that you do not accidentally drop the LF10. Do not carry or lift the camera by the lanyard. Always carry it by its handle or body. Always keep the USB port covered. Water must not ingress the LF10, as this will damage the electronics inside. Do not touch the video camera lens or the conical microphone holes.

A carrier bag can be purchased separately to facilitate carrying the LF10. If you use this accessory, the camera allows you to carry the bag with the strap over your shoulder to free your hands for using the single-handed camera (*Image 12*).

Please be aware of your surroundings and ensure that the shoulder strap fits snugly to your body. Always place the LF10 inside the carrier bag when you need both hands free for other tasks, such as climbing ladders. Ensure that the camera is placed inside the bag in such a way that it does not fall out.

Image 12: Using the LF10 camera

6.2 Locating sound sources

In the *single-source* mode, the LF10 will always show the strongest sound source in the field of view. 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. In addition, using the zoom button narrows the field of view to locate the sources.

In the *multi-source* mode, the LF10 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.

When inspecting for weaker sound sources, these must be made the most predominant sound sources within the field of view. Focus on the weaker sound sources by moving and rotating the camera as well as using the *Zoom* buttons. The crosshair on the display points in the direction where the analysis is being made.

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 LF10. The NL Cloud is useful in such cases, as by taking a snapshot and viewing it in the NL Cloud, it is possible to adjust the dynamic range of the heatmap with the slider below the image. By increasing the dynamic range, you are able to tell how large the sound source actually is.

Best practices involve inspecting sound sources of interest from multiple directions and taking snapshots. The exact location of the source is easier to determine when viewed from different angles. Sound sources can also be directional, meaning that the sound level will differ depending on the direction.

6.3 Reflections

The LF10 can sometimes show reflections of sound sources, most commonly in closed environments. In the event you suspect a reflection, move around the object you are inspecting and examine it with the camera from different directions. If the sound moves around or completely disappears, it is most likely a reflection or interference. If the source stays in one place when you move the camera, you have located an actual sound source.

To determine whether the camera displays an actual sound source or a reflection, you can also utilize the *multi-source* mode. The multi-source mode brings visibility to actual sound sources and one or multiple reflections. By moving the LF10 around the object you are inspecting, you can discard reflections (*Image 13*).

6.4 Capturing distance

The minimum recommended sound source distance for the LF10 is approximately 0.3 meters (1.0 ft). If the distance is shorter than this, the location of sound sources will not be accurately displayed.

There is no specific maximum distance at which the LF10 can be used. In practical cases, the distance is often limited to approximately 130 meters (430 ft). This depends on how loud the sound source of interest is, and louder sound sources in an otherwise quiet environment can be detected at even larger distances. Conversely, quieter sound sources usually require closer proximity.

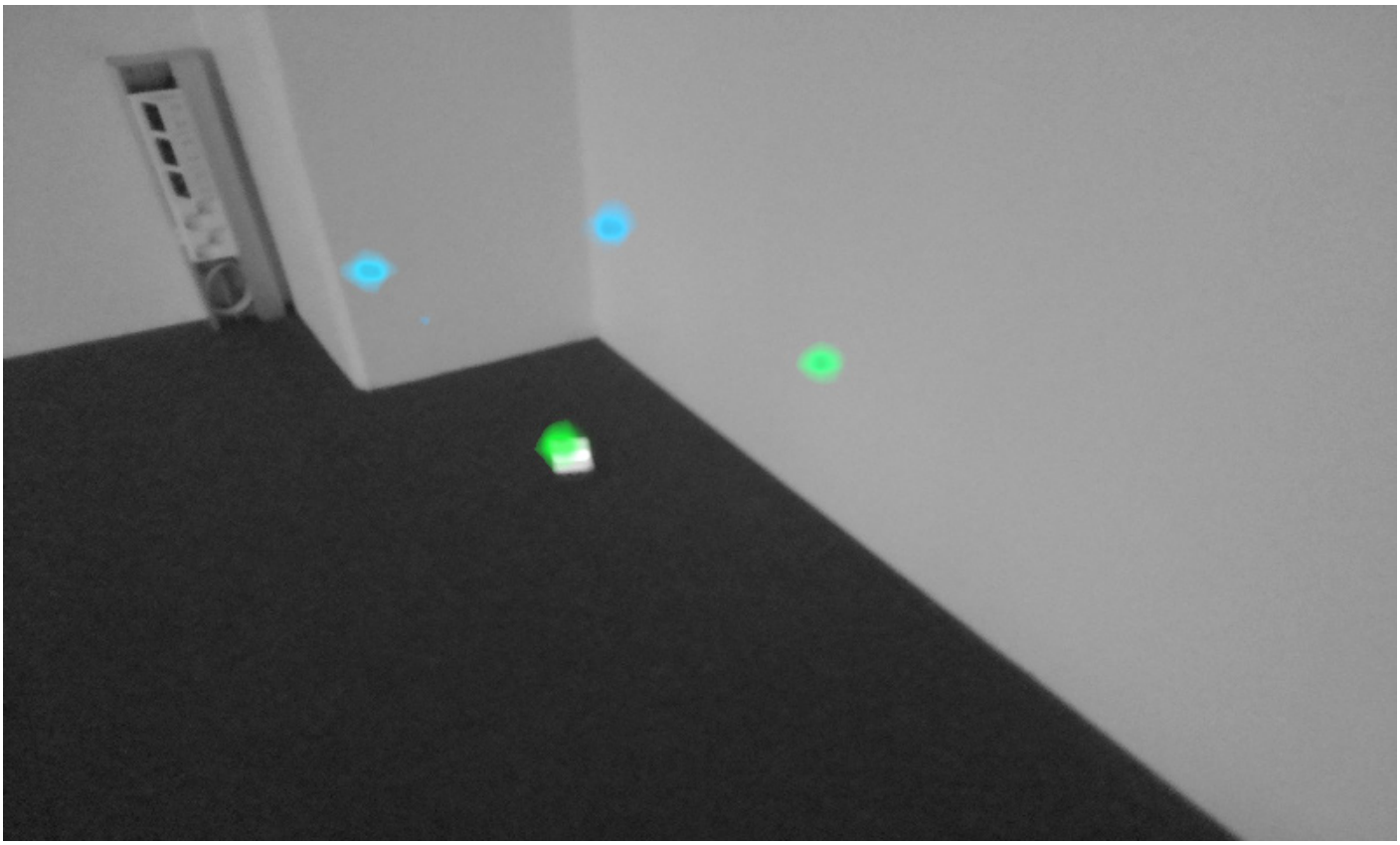


Image 13: An example of an actual sound source and three reflections shown by the LF10 in multi-source mode. The actual sound source is on the floor, while the three reflections are visible on the walls. When the camera is moved around, the location of the actual sound source remains the same, while the reflections move around on the walls and are not visible from all angles.

7. NL CLOUD

The NL Cloud is a free-of-charge online service that provides various analysis methods for sound imaging and signals, expanding the capabilities of the LF10. The NL Cloud stores the snapshots taken over a period of time, and reports can be generated.

Connect to the NL Cloud by accessing it from any modern web browser (e.g. Google Chrome, Microsoft Edge, or Mozilla Firefox) at the following address:
view.nlacoustics.com

To use the cloud service, first register as a user and register your device(s) with the NL Cloud (see *Device registration* under *Section 4.7.1: Network settings*).

The NL Cloud offers further instructions. Simply click the question mark icon when viewing a specific snapshot.

8. NL CAMERA VIEWER AND NL CAMERA VIEWER PRO OFFLINE SOFTWARE

NL Camera Viewer is an offline computer software program for Microsoft Windows 10 and 11 operating systems that is used for viewing and analyzing snapshots taken with the LF10. The NL Camera Viewer can be downloaded from the NL Cloud: simply access your account and click *"Download NL Viewer"* on the upper menu bar of the landing page, and the installation file will download to your computer. To install the offline viewer, open the installation file and follow the steps in the installation wizard. Further documentation on the NL Camera Viewer is available in the software itself.

NL Camera Viewer Pro is an upgraded offline version of the NL Camera Viewer that provides full analytics and expanded capabilities for Microsoft Windows 10 and 11 operating systems. The NL Camera Viewer Pro offers in-depth analysis, viewing, and reporting of the snapshots taken with the LF10. You can upgrade the NL Camera Viewer to the Pro version by purchasing a license. For more details, please contact your local distributor. Further documentation for the NL Camera Viewer Pro is available in the software itself.

9. MAINTENANCE

- NOTE: Do not try to repair or open the enclosure of the LF10 camera or the batteries. Do not use any damaged device, battery, or cables. Protect the device and accessories from dirt, dust, impacts, and liquids. -

The intended usage conditions and instructions are specified in this User Manual. Please read and follow the instructions carefully in order to maintain your LF10 in optimum condition and prevent damage to the device and accessories. If any problems occur, contact your local distributor for support.

9.1 Storage

Before storing your LF10, keep the LF10 powered on for at least 10 minutes. Store the equipment when it reaches ambient temperature in a dry location. Store the batteries fully charged, and recharge them once every three months. Start up the LF10 at least once every three months. These actions ensure the camera's operational reliability.

9.2 Cleaning

Do not use any strong cleaning solutions to clean the device. Do not use running or dripping water or other liquids, and do not immerse any part of the device in any liquid.

Before cleaning the LF10, disconnect all the cables, remove the RRC2040 battery, and make sure that no part of the equipment is electrically live. Use a damp cloth with water or mild soapy water to clean the surface of **the housing, screen, and cables**. Make sure that the cloth is not dripping wet.

Contact your local distributor for cleaning **the microphone array**, as these parts are susceptible to damage. However, if you decide to clean the microphone array yourself, you can use indirect, **low-pressure air** from a distance to blow particles away from the conical holes of the microphones. If this does not work and the microphone array is still dirty, contact your local distributor. NL Acoustics is not responsible for any damage caused by attempts to clean the microphone array.

Use a dry cleaning cloth only to clean the **batteries and chargers**.

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

9.3 Visual and/or permanent damage

Broken accessories: Contact your local distributor to replace any broken accessories with genuine NL Acoustics spare parts. Properly dispose of and/or recycle broken equipment.

LF10 camera unit: Contact your local distributor for repairs.

9.4 Recycling

Recycle and properly dispose of all broken devices and packaging material. This electronic device is manufactured in accordance with regulations that restrict the use of hazardous materials. All the implemented electronic components of this device can be reused as industrial raw materials. Contact your local authorities for instructions for proper disposal. For more information, please refer to Section 1.5 Disposal of electronic waste in this User Manual.

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