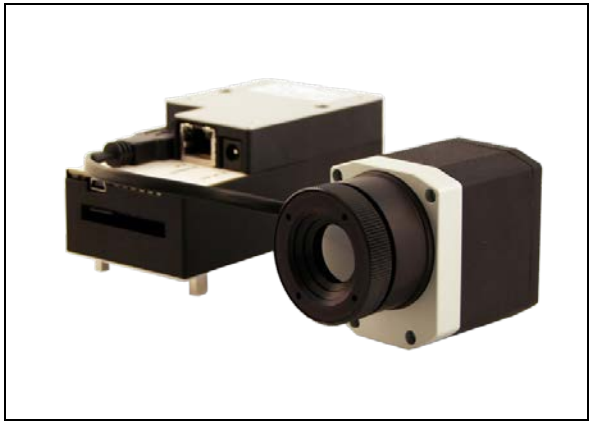
optris® PI LightWeight – Kit

Miniature lightweight PC with IR camera for flight applications



Operators manual

optris
infrared thermometers

Optris GmbH
Ferdinand-Buisson-Str. 14
D – 13127 Berlin
Germany

Tel.: +49 30 500 197-0
Fax: +49 30 500 197-10

E-mail: info@optris.de
Internet: www.optris.de

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1 General notes

1.1 Intended use

The optris PI LightWeight Kit consists of a miniaturized lightweight PC (PI NetBox LW) and a weight-optimized optris PI400 LW or PI450 LW infrared camera. The system is ideally suited for radiometric infrared recordings from the air like for maintenance work and quality inspections of solar and wind power systems and for building thermography.

The PI NetBox LW (Miniature-PC) includes a Windows XP Professional operating system that allows on-flight recording of infrared videos with up to 35 Hz.

The optris PI 400 LW or 450 LW calculates the surface temperature based on the emitted infrared energy of objects **[► 6 Basics of Infrared Thermometry]**. The two-dimensional detector (FPA - focal plane array) allows a measurement of an area which will be shown as thermal image using standardized color palettes. The radiometric processing of the picture data enables the user to do a comfortable detailed analysis with the software PI Connect retrospectively.

The optris PI is a precise instrument and contains a sensitive infrared detector and a high-quality lens. The alignment of the camera to intensive energy sources (high power laser or reflections of such equipment, e.g.) can have effect on the accuracy of the measurement or can cause an irreparable defect of the infrared detector.

- Avoid static electricity, arc welders, and induction heaters. Keep away from very strong EMF (electromagnetic fields).
- Avoid abrupt changes of the ambient temperature.
- In case of problems or questions which may arise when you use the infrared camera contact our service department.

Read the manual carefully before the initial start-up. The producer reserves the right to change the herein described specifications in case of technical advance of the product.

1.2 Warranty

Each single product passes through a quality process. Nevertheless, if failures occur contact the customer service at once. The warranty period covers 24 months starting on the delivery date. After the warranty is expired the manufacturer guarantees additional 6 months warranty for all repaired or substituted product components. Warranty does not apply to damages, which result from misuse or neglect. The warranty also expires if you open the product. The manufacturer is not liable for consequential damage or in case of a non-intended use of the product.

If a failure occurs during the warranty period the product will be replaced, calibrated or repaired without further charges. The freight costs will be paid by the sender. The manufacturer reserves the right to exchange components of the product instead of repairing it. If the failure results from misuse or neglect the user has to pay for the repair. In that case you may ask for a cost estimate beforehand.

1.3 Scope of delivery

- PI NetBox LW (LightWeight) incl. micro SDHC card (8 GB)
- Power supply (100-240 VAC / 24 VDC)
- Power cable (with open ends for direct connection to a Lithium battery)
- Video cable (stereo jack-cinch)
- Video cable (stereo jack-open ends) with recording pin
- Ethernet cable, 1 m
- USB Recovery stick (2 GB)
- optris PI400 LW or PI450 LW (LightWeight) with one lens and fixed mounted USB cable (30 cm) and aluminum case
- Software PIConnect
- Operators manual

For a mobile use you can arrange all components of the system also inside the camera case as shown in **Figure 1**. For that purpose single foam parts of the case can be easily removed.

Figure 1: PI LightWeight kit inside the camera case

1.4 Maintenance

Never use cleaning compounds which contain solvents (neither for the lens nor for the housing).

Take care that no foreign substances penetrate into the venting slots of the NetBox LW.

1.4.1 Cleaning

The housing of the NetBox LW can be cleaned with a soft, humid tissue moistened with water or a water based cleaner.

Blow off loose particles using clean compressed air. The lens surface can be cleaned with a soft, humid tissue moistened with water or a water based glass cleaner.

2 Technical Data

2.1 Data NetBox LW

2.1.1 General specifications

Operating temperature:	0…50 °C
Storage temperature:	-20...75 °C
Relative humidity:	10...95 %, non-condensing
Material (housing):	aluminum anodized/ plastic
Dimensions:	112 mm x 58 mm x 54 mm (L x B x H)
Weight:	160 g
Vibration:	IEC 60068-2-6 (sinus shaped), IEC 60068-2-64 (broad band noise)
Shock:	IEC 60068-2-27 (25 g and 50 g)

Operating system	Windows XP Professional

2.1.2 Electrical specifications

Power supply:	8...48 VDC or Power over Ethernet (PoE/ 1000BASE-T)
Power consumption:	9.5 W (+ additional 2,5 W for PI camera)
Cooling:	passive (active via integrated fan for ambient temperatures > 50 °C)
Board:	COM Express mini embedded board
Processor:	Intel® Atom™ Z530/ 1,6 GHz
Hard disc:	4 GB SSD
RAM:	1 GB (DDR2, 533 MHz)
Ports:	3x USB 2.0
	1x Mini-USB 2.0 (Slave-Modus)
	TV_{out}

	Ethernet (Gigabit Ethernet)
Extensions	microSDHC card (up to 32 GB)
Additional functions	6x Status-LEDs (L1-L6)

2.2 Data PI 400/ PI 450 LW

2.2.1 General specifications

Environmental rating:	IP40
Ambient temperature:	0...50 °C [PI 400 LW] / 0...70 °C [PI 450 LW]
Storage temperature:	-40...70 °C [PI 400 LW] / -40...85 °C [PI 450 LW]
Relative humidity:	10...95 %, non-condensing
Material (housing):	aluminum, anodized/ plastic
Dimensions:	46 x 56 x 84 - 88 mm (depending on lens)
Weight (incl. lens):	220 g

Cable length USB 2.0): 30 cm

Vibration[1)]: IEC 60068-2-6 (sinus shaped)
IEC 60068-2-64 (broad band noise)

Shock[1)]: IEC 60068-2-27 (25 g and 50 g)

1) Used standards:

IEC 60068-1:1988 + **Corr.** 1988 + **A1**: 1992 **DIN EN 60068-1**:1995-03
„Umweltprüfungen - Teil 1: Allgemeines und Leitfaden“

IEC 60068-2-6:2007 **DIN EN 60068-2-6; VDE 0468-2-6**:2008-10
„Umgebungseinflüsse - Teil 2-6: Prüfverfahren - Prüfung Fc: Schwingen (sinusförmig)“

IEC 60068-2-27:2008 **DIN EN 60068-2-27; VDE 0468-2-27**:2010-02
„Umgebungseinflüsse - Teil 2-27: Prüfverfahren - Prüfung Ea und Leitfaden: Schocken“

IEC 60068-2-47:2005 **DIN EN 60068-2-47**:2006-03
„Umgebungseinflüsse - Teil 2-47: Prüfverfahren - Befestigung von Prüflingen für Schwing-, Stoß- und ähnliche dynamische Prüfungen“

IEC 60068-2-64:2008 **DIN EN 60068-2-64; VDE 0468-2-64**:2009-04
„Umgebungseinflüsse - Teil 2-64: Prüfverfahren - Prüfung Fh: Schwingen, Breitbandrauschen (digital geregelt) und Leitfaden“

Figure 2: Used standards

Stress program (camera in operation):

Shock, half sinus 25 g – testing Ea 25 g (acc. IEC 60068-2-27)

Acceleration	245 m/s^2	(25 g)
Pulse duration	11 ms	
Number of directions	6	(3 axes with 2 directions each)
Duration	600 Shocks	(100 Shocks each direction)

Shock, half sinus 50 g – testing Ea 50 g (acc. IEC 60068-2-27)

Acceleration	490 m/s^2	(50 g)
Pulse duration	11 ms	
Number of directions	6	(3 axes with two directions each)
Duration	18 Shocks	(3 Shocks each direction)

Vibration, sinus shaped – testing Fc (acc. IEC60068-2-6)

Frequency range	10-500 Hz

Acceleration	29.42 m/s^2	(3 g)	
Frequency change	1 Octave/ min		
Number of axes	3		
Duration	1:30 h	(3 x 0.30 h)	

Vibration, broadband noise – testing Fh (acc. IEC60068-2-64)

Frequency range	10-2000 Hz		
Acceleration	39.3 m/s2	(4,01 g_{RMS}))	
Frequency spectrum	10-106 Hz	0,9610 $(m/s^2)^2/Hz$	(0,010 g^2/Hz)
	106-150 Hz	+6 dB/ Octave	
	150-500 Hz	1,9230 $(m/s^2)^2/Hz$	(0,020 g^2/Hz)
	500-2000 Hz	-6 dB/ Octave	
	2000 Hz	0,1245 $(m/s^2)^2/Hz$	(0,00126 g^2/Hz)
Number of axes	3		

Duration	3 h	(3 x 1 h)

2.2.2 Electrical specifications

Power Supply: 5 VDC (powered via USB 2.0 interface)

Current draw: Max 500 mA

Digital interface: USB 2.0

2.2.3 Measurement specifications

Temperature ranges:	-20...100 °C; 0...250 °C; 150...900 °C
Detector:	UFPA, 382 x 288 pixel
Spectral range:	7.5...13 µm
Lenses (FOV):	38° x 29°; 62° x 49°
System accuracy [1)]:	±2°C or ±2 %
Temperature resolution (NETD):	PI 400 LW [2)]: 0.08 K with 38° and 62°
	P I450 LW [2)]: 0.04 K with 38° and 62°
Frame rate:	80 Hz
Emissivity:	0.100...1.000
Software:	PI Connect

[1)] At ambient temperature 23±5 °C; whichever is greater; [2)] Value is valid at 40 Hz and 25°C room temperature

2.2.4 Optical specifications

- Make sure that the focus of the infrared camera is adjusted correctly. For focusing turn the lens (**Figure 3**).
- For the PI 400 LW and PI 450 LW two different lenses are available: 38° x 29° and 62° x 49° FOV.

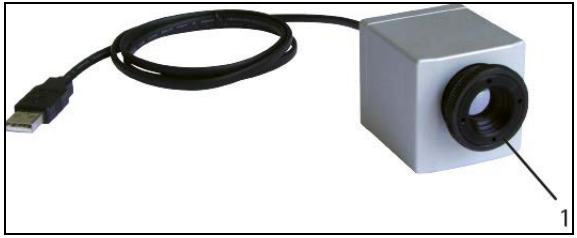


Figure 3: Focusing of the lens

1 Lens

Different parameters are important if using infrared cameras. They display the connection between the distance of the measured object and the size of the pixel (see **Table 1**).

PI400/450 382 x 288 px	Focal length	Angle	Minimum distance*	Distance to object [m]												
					0.02	0.1	0.2	0.3	0.5	1	2	4	6	10	30	100
O38 Standard lens	15 mm	38°	0.2 m	HFOV [m]	0.014	0.07	0.14	0.21	0.35	0.69	1.39	2.77	4.16	6.9	20.8	69.3
		29°		VFOV [m]	0.010	0.05	0.10	0.15	0.25	0.51	1.02	2.03	3.05	5.1	15.2	50.8
		49°		DFOV [m]	0.018	0.09	0.18	0.28	0.46	0.92	1.84	3.68	5.52	9.2	27.6	92.0
		1.81 mrad		IFOV [mm]	0.036	0.18	0.36	0.54	0.91	1.81	3.63	7.25	10.88	18.1	54.4	181.3
O62 Wide angle lens	8 mm	62°	0.5 m	HFOV [m]	0.024	0.12	0.24	0.36	0.60	1.20	2.40	4.80	7.20	12.0	36.0	119.9
		49°		VFOV [m]	0.018	0.09	0.18	0.27	0.45	0.90	1.80	3.60	5.41	9.0	27.0	90.1
		74°		DFOV [m]	0.030	0.15	0.30	0.45	0.75	1.50	3.00	6.00	8.99	15.0	45.0	149.9
		3.14 mrad		IFOV [mm]	0.063	0.31	0.63	0.94	1.57	3.14	6.28	12.56	18.84	31.4	94.2	314.0

Table 1: Table with examples showing what spot sizes and pixel sizes will be reached in which distance. For individual configuration there are different lenses available. Wide angle lenses have a radial distortion due to their large opening angle; the software PIConnect an algorithm which corrects this distortion.

*** Note: The accuracy of measurement can be outside of the specifications for distances below the defined minimum distance.**

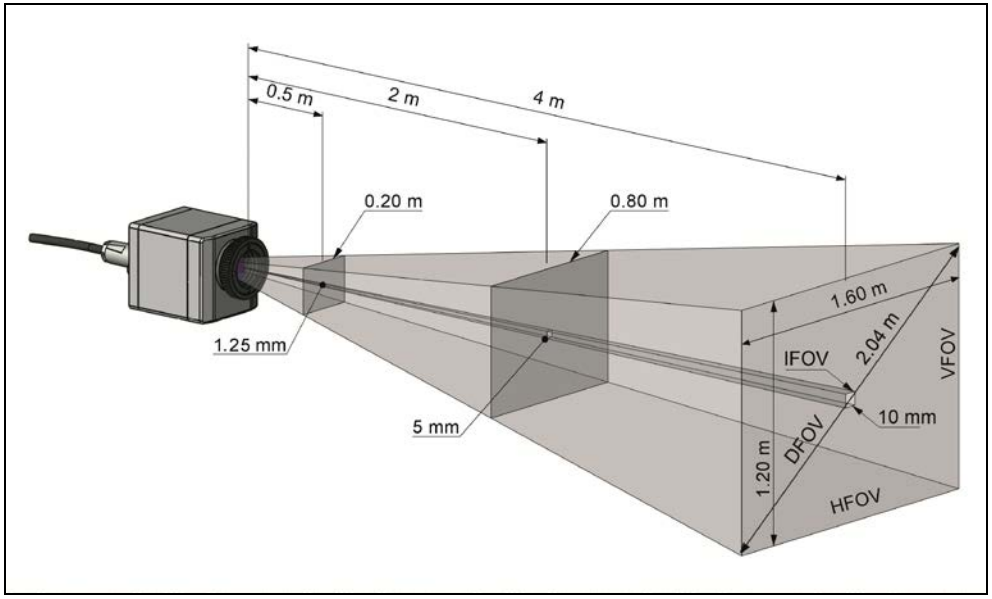


Figure 4: Measurement field of the infrared camera optris PI representing the 23° x 17° lens

- **HFOV**: Horizontal enlargement of the total measuring at object level
- **VFOV**: Vertical enlargement of the total measuring at object level
- **IFOV**: Size at the single pixel at object level
- **DFOV**: Diagonal dimension of the total measuring field at object level
- **MFOV**: Recommended, smallest measured object size of 3 x 3 pixel

3 Installation

The PI 400 LW/ 450 LW are equipped with two metric M4 thread holes on the bottom side (6 mm depth) and can be installed either directly via these threads or with help of the tripod mount (also on bottom side). The separate PI camera sensing head can be mounted on the stabilization platform of a drone together with a visual camera (in the picture: GoPro camera). The NetBox PC can be mounted separately.

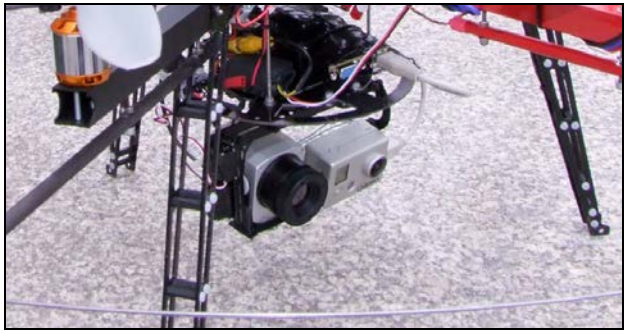


Figure 5: PI LightWeight on a drone together with GoPro HD camera

3.1 Mechanical Data PI 400/ PI 450 LW

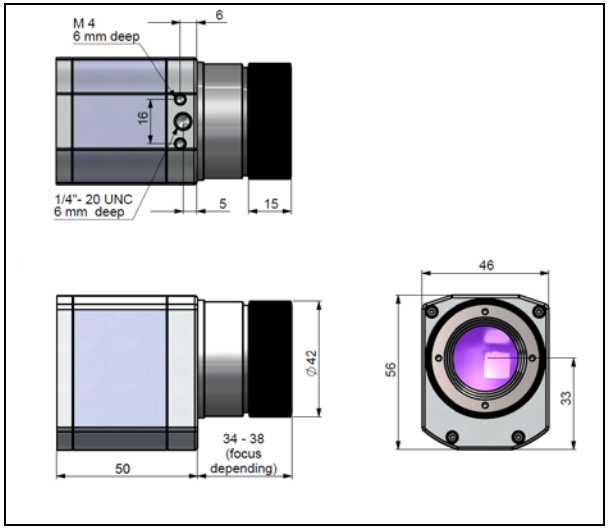


Figure 6: Dimensions PI 400/ PI 450 LW

3.2 Mechanical Data PI NetBox LW

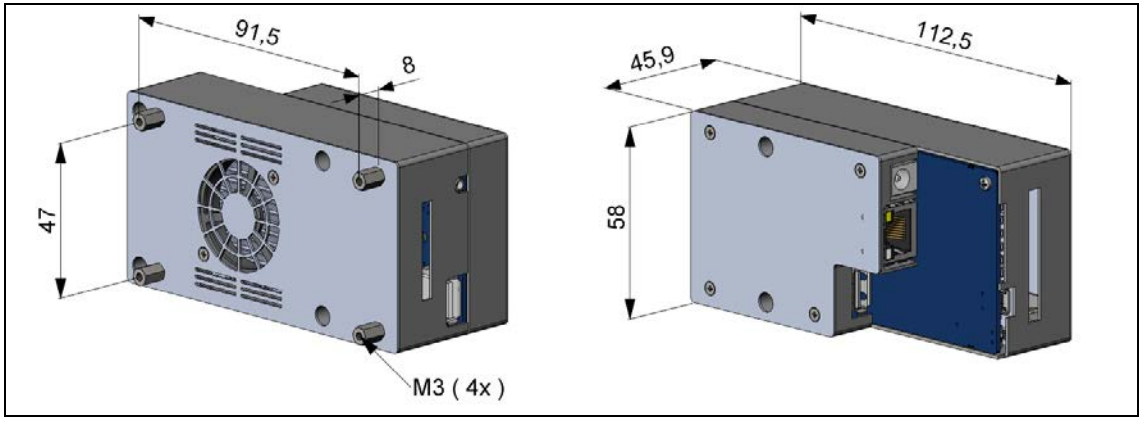


Figure 7: Dimensions PI NetBox LW

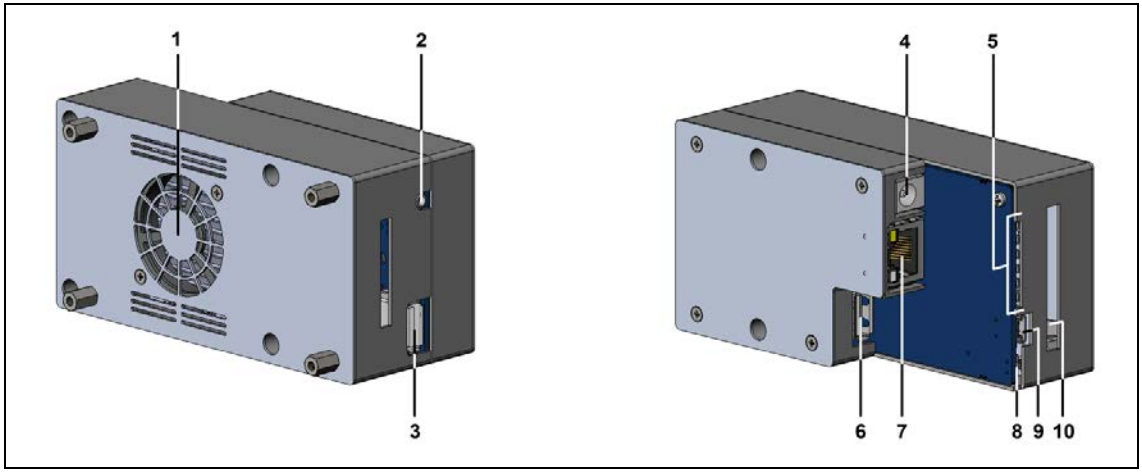


Figure 8: Controls and connections PI NetBox LW

1	Cooling fan	**6**	USB 2.0 socket
2	$Video_{out}$ socket	**7**	Ethernet socket
3	USB 2.0 socket	**8**	Mode switch (S1/ S2)
4	Power supply socket	**9**	Mini USB socket (slave mode)
5	Status-LEDs (L1-L6)	**10**	microSDHC card slot

4 Operation

4.1 Operation modes of the NetBox LW

- Use the recommended PoE injector (**Order No.: ACPIPOE**) only.
- Damages which are caused by usage of another PoE injector are excluded from warranty

The NetBox LW can be used in three different operation modes:

- Stand-alone operation with an IR camera (Standard mode)
- Ethernet direct connection to a PC (point-to-point connection)
- Ethernet communication via a network or via the internet

For powering the NetBox you can use instead of a lithium-polymer battery also the supplied power adapter. Alternatively the NetBox can also be powered via the Ethernet cable (PoE – Power over Ethernet). In this case a PoE injector is needed.

4.2 Stand-Alone operation

- For a self-contained power supply we recommend a lithium-polymer battery with a voltage between 8 and 14 VDC.
- To switch between the analog video output signal of the PI 400 LW / LW 450 and a visual camera we recommend the use of an electronic universal switch from Co. Conrad (**Order No.: 227389-62**).
- To start an IR video recording during the flight we recommend the SMD power switch from Conrad (**Order No.: 191779-62**). Triggering via the GPIO of the Netbox LW.

As a stand-alone PC the NetBox LW expands the IR cameras PI400 LW and PI450 LW to a system for radiometric infrared video recording.

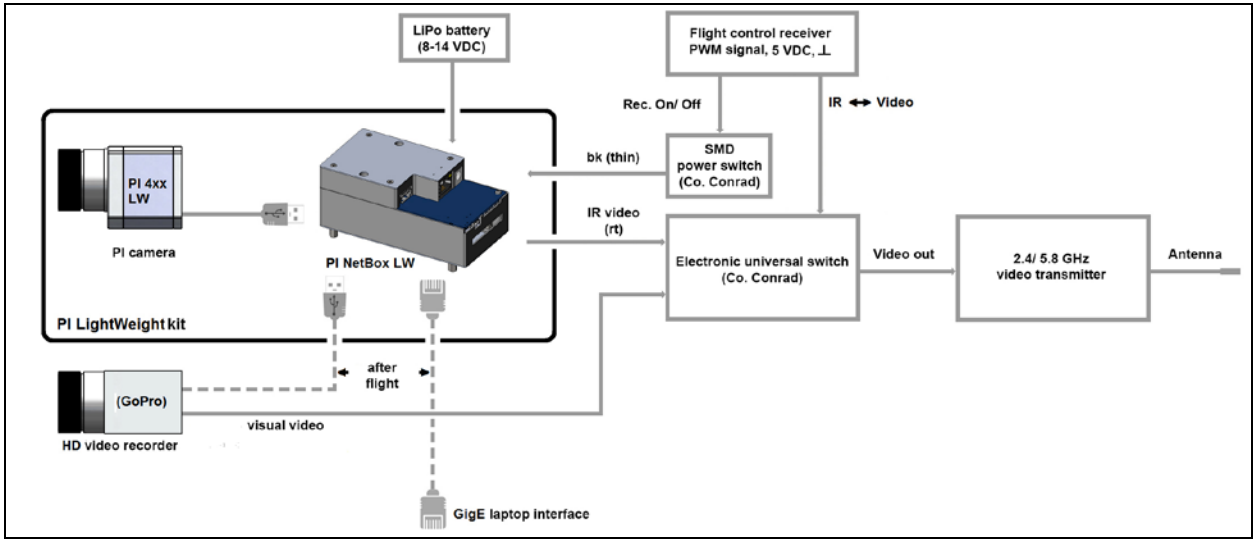


Figure 9: Recommended video system integration of the PI LightWeight

- Before switching on the NetBox LW and monitor must be connected via cable to ensure a correct initialization of the video output.
- A change of the preset PAL mode to NTSC e.g. can be done in the BIOS. [Keyboard and monitor necessary]

After powering the NetBox LW the system will boot and is ready after 2-3 minutes. A video monitor which is connected to the system via the video adapter cable will show then the IR live picture of the camera in full screen mode.

Figure 10: Video$_{out}$ socket of the NetBox LW

4.3 Start a recording

1. To start the recording remotely use the supplied video cable (**Order No.: ACPILKVCB2**), see **Figure 11** left:

bk (thick)	GND
bk (thin)	Recording trigger
rt	Video signal

The recording starts if the trigger is connected with GND and stops if you interrupt this connection.

Figure 11: Video cable (**Order No.: ACPILKVCB2**) left and video cable (**Order No.: ACPILKVCB2C**) right

The second video cable (**Order No.: ACPILKVCB2C**) can be used for a direct connection of the system to a monitor – the recording can be started by the micro switch.

Alternatively you can start the recording by using the red sliding switch at the backside of the IR camera.

1. To start a recording move the switch into the right position.
2. To stop a recording remove the switch back into the left position.

Figure 12: Start and stop a recording

4.4 SD card

- The NetBox LW will be delivered with an 8 GB SDHC card which is already installed on the unit. If required you can exchange this card. The NetBox is supporting SD cards up to **32 GB** capacity.
- After insertion of a SD card a NTFS formatting is needed.

1. To remove the card take a ball pen or similar and push onto the card from outside carefully.
2. Take care when you insert a card. Place it correctly into the according guide slot.

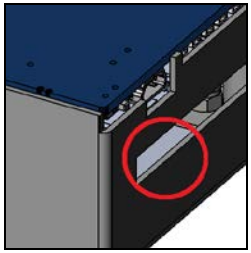


Figure 13: Changing of the SDHC card

4.5 Status-LEDs

The NetBox LW is equipped with 6 status LEDs (L1-L6):

LED	Function	LED is lightning, if
L1	Power	NetBox is powered via PoE or a power supply (via power connector)
L2	Power out	NetBox is powered via PoE and (in this case) supplies 12 V at the power connector
L3	Net data	video frames are transmitted through the network connection continuously (flashing)
L4	USB Data	the imager is connected to an USB port, the calibration files are loaded and the raw data files are delivered by the imager continuously (flashing)
L5	Application OK	the main application (Connect or Imager NNet Server) is running properly
L6	Mini USB-port	a PC is connected to a Mini USB port

Table 2: NetBox status information

4.6 Switch positions

The mode switch is set default to S1. At position S2 the IR camera which is connected to the USB-A socket will be linked directly with the Mini-USB socket. With this you get a direct access to the IR camera from a PC which is connected to the Mini USB socket without changing cables on the NetBox LW.

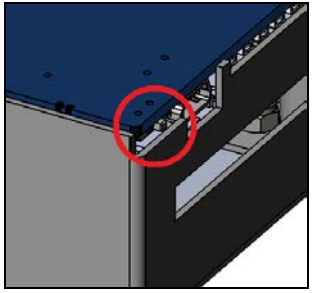


Figure 14: Mode switch (S1/ S2)

4.7 Remote Access to the NetBox LW

For settings on the NetBox LW you can connect a keyboard and a mouse to the available USB sockets as well as a monitor to the VGA socket (or a TV monitor via the TV_{out} adapter cable). ► **4.1 Stand-alone Operation**

Another very simple way is remote control software, for example remote desktop (RDP) which is available on each Windows system or **Ultra VNC** which you will find on your software CD. After installation you can have access to the NetBox either from a PC directly connected over an Ethernet cable or from a PC which is located anywhere and connected to the same network. Also remote connection via the internet is possible.[1)]

[1)] For remote access from outside to a NetBox LW connected to a company network ask your system administrator for possibly necessary settings.

4.7.1 Installation of Ultra VNC

1. Start **`install.bat`** which is located on your PIConnect-CD in the folder **`\PI NetBox`**.

2. After installation you will find the following short cuts on your desktop.

Figure 15: Short cuts

3. Use the short cut **SyncViewer** for access to a NetBox which is directly connected to your PC over an Ethernet cable. This short cut is synchronizing the time automatically on the NetBox and is starting then the UltraVNC viewer which is showing the screen of the NetBox.

The **IP Address Finder** starts a tool which will list all NetBoxes located in your network or directly connected to your PC. Time synchronization is operable as well. At the same time scanning of the whole network or a certain IP address range is provided. With the filter function a selective search for NetBoxes is possible.

The NetBox is set to Central European Time (CET or CEST) by factory default. Depending on the time zone setting of your local PC time differences during synchronization are possible. In this case the time zone setting on the NetBox needs to be changed. ► **4.14 System time**

By pressing one of the **sync** buttons you can synchronize a previously selected NetBox or all listed ones simultaneously with the system time of your local PC while IP Address Finder is running.

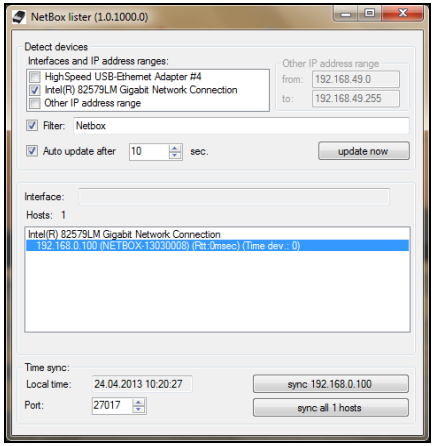


Figure 16: NetBox lister

With the UltraVNC Viewer a ***simultaneous*** access to one NetBox from different PCs inside a network is possible.

For access to a NetBox inside your network start the program **UltraVNC Viewer** which is located in the program folder **NetBox – UltraVNC**. After starting the viewer the following screen appears:

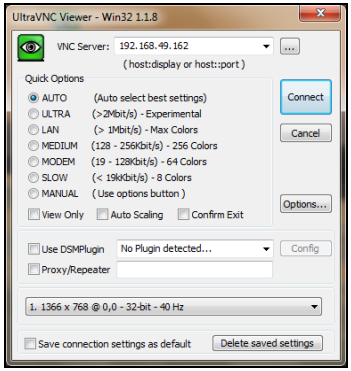


Figure 17: UltraVNC Viewer setup

4.7.2 Display the NetBox

1. Enter the IP-address of the NetBox and press **`Connect`**. The information is provided by the **IP Address Finder**.

2. Enter the password **Remote** and confirm with **`Log On`**.

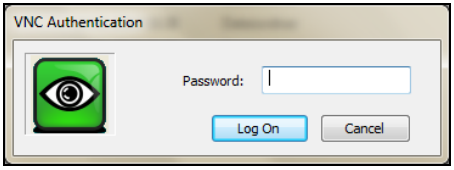


Figure 18: VNC Identification

4.8 Applications and start options

On the desktop of the NetBox LW the following short cuts are available:

Figure 19: Application Start Config short cut and Application Start Manager short cut

Application Start Config: Starts the configuration dialog **(Config Server)**

Application Start Manager: Starts the program selected in the configuration dialog

After booting the system the PIConnect software starts in full screen mode with a special flight layout (factory-provided).

- Option: User defined in Application Start Config

In the configuration dialog you can select programs which start automatically after booting the NetBox:

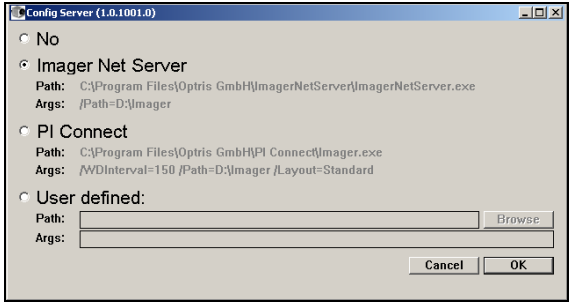


Figure 20: Config Server window

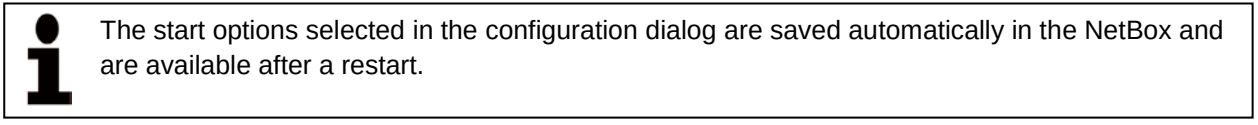
No	**No automatic start of the program**
Imager Net Server	**Automatic start of the server application**
PI Connect	**Automatic start of the PI Connect software**
User defined	**User defined start of one of the upper two programs**

The **Imager Net Server** application is needed for the operation modes:

- Ethernet direct connection to a PC (point-to-point connection)
- Ethernet communication via a network or internet

1. Apply **`User defined`** to start PI Connect or Imager Net Server with modified command line parameters [Args].

Example:



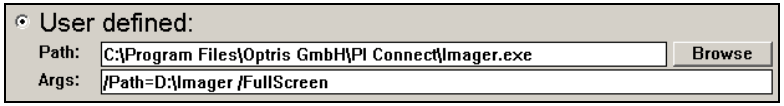


Figure 21: Configuration to start PIConnect in full screen mode

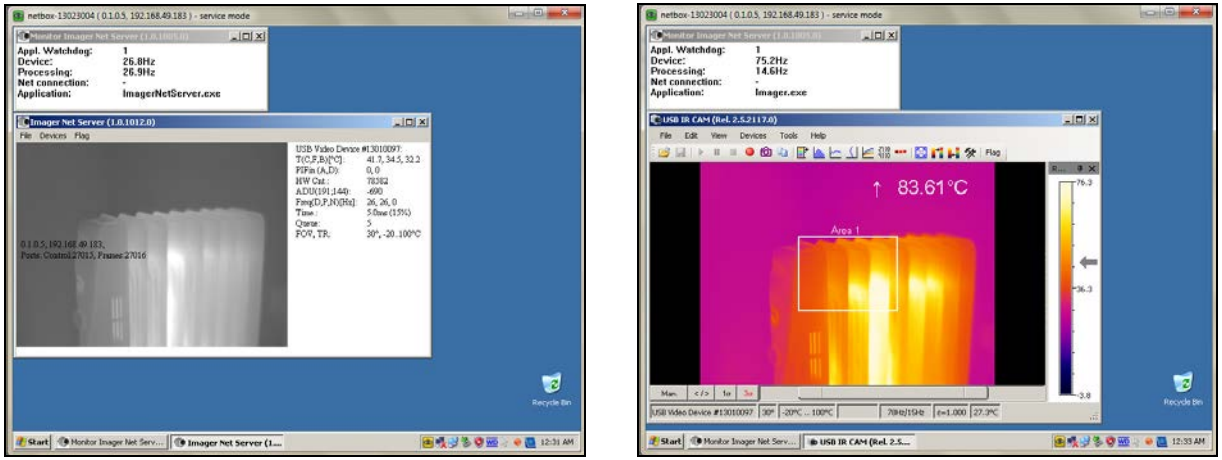


Figure 22: Screen of the NetBox LW – Imager Net Server left and of the NetBox – PI Connect right

If the IR camera is connected to the NetBox two applications are shown:

Monitor Imager Net Server and **Imager Net Server** or **PI Connect**.

Appl. Watchdog:	Counter for the application monitoring function
Device:	Frequency of the device
Processing:	Frequency of the processing
Net connection:	Frequency of the network
Monitor:	Display mode (VGA or TV-Out)
Application:	Monitored software application

Table 3: Monitor Imager Net Server application window

Figure 23: Menu selection

Menu	**File**	**Exit of the program**

Devices	**Shows the connected imager**
Flag	**Manual operation of the camera flag**
USB video device	Serial number of the connected imager device
T (C, F, B):	Device temperatures (°C): C: FPA-Chip F: Flag temperature B: Housing temperature
PIFin (A, D):	Status of the PIF input: A: Analog IN (AI) D: Digital IN (DI)
HW Cnt.:	Hardware-Counter (frame counter)
ADU (192, 144):	ADU value of the center pixel (e.g.192, 144 at PI4xx)
Freq (D, P, N):	Frequency (Hz): D: Device P: Processing N: Network

Time:	Time per single frame
Queue:	Number of frames in network queue
FOV, TR:	Field of view (horizontal) of the imager lens, Temperature range

Table 4: Imager Net Server – Application window

4.9 Watchdog

If the main application (**Imager Net Server** respectively **PIConnect**) for any reason does not work properly (in case of a software crash) or is closed, the monitor application restarts the program automatically.

In addition the Watchdog application observes the Windows operating system continuously – find the symbol [**WD**] in the right part of the task bar:

Figure 24: Watchdog symbol in the task bar

Consider that all restarts will be counted even those which were not initialized by the Watchdog application.

If the Watchdog application identifies a system error the NetBox restarts automatically. The Watchdog window opens by clicking the right mouse button on the symbol in the task bar. It shows the following information.

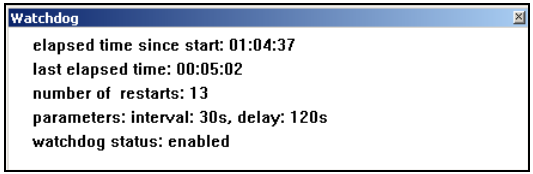


Figure 25: Window Watchdog

- Status information
- Internal set parameters
- Elapsed time since start

- Last elapsed time
- Number of restarts (can be reset with the right mouse button on WD symbol – **`Reset counter`**)

4.10 Autostart

In the Windows `Autostart` folder of the NetBox LW the following short cuts are set by factory default:

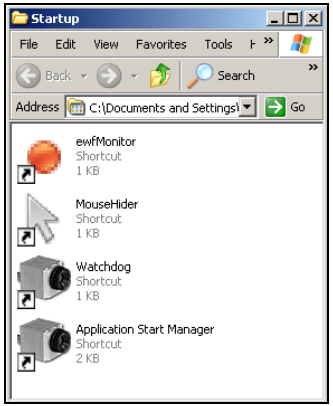


Figure 26: Startup window

ewfMonitor	Write protection filter
MouseHider	Hides the mouse pointer after 10 s of inactivity
Watchdog	Starts the Watchdog application
Application Start Manager	Starts the program selected in the **`Application Start Config`**

4.11 File transfer between NetBox LW and PC

1. To exchange files between the NetBox and a PC which is connected directly or located in the network move the cursor to the title bar of the **UltraVNC Viewer** window and press the right button of the mouse. Start **File Transfer**.

2. Alternatively use the following short cut in the task bar of the viewer:

Figure 27: File Transfer short cut

The window shows the local PC (LOCAL MACHINE) on the left side and the NetBox (REMOTE MACHINE) on the right side. Files can be copied between both computers via the network link by selecting them and by confirming with the **Send** button respectively **Receive** button.

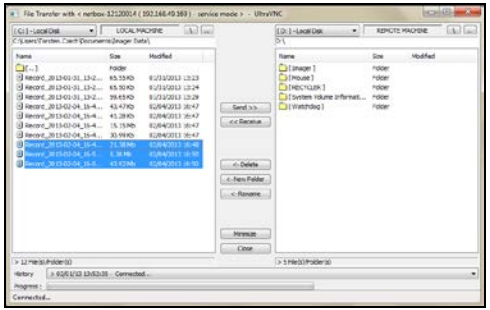


Figure 28: File transfer window

4.12 Communication

4.12.1 Ethernet direct communication

The applied Ethernet cable must be complied at least with category 5 (Cat-5 according ISO/IEC 11801).

1. Connect the IR camera and the NetBox with the supplied USB connection cable.
2. Connect the PC and the NetBox with an Ethernet cable.
3. Add the power supply to the NetBox and connect it to the electric circuit. The NetBox boots up the system and is ready to use after approx. 2-3 minutes. With orderly function LED 1 (L1) and LED 5 (L5) are illuminating.

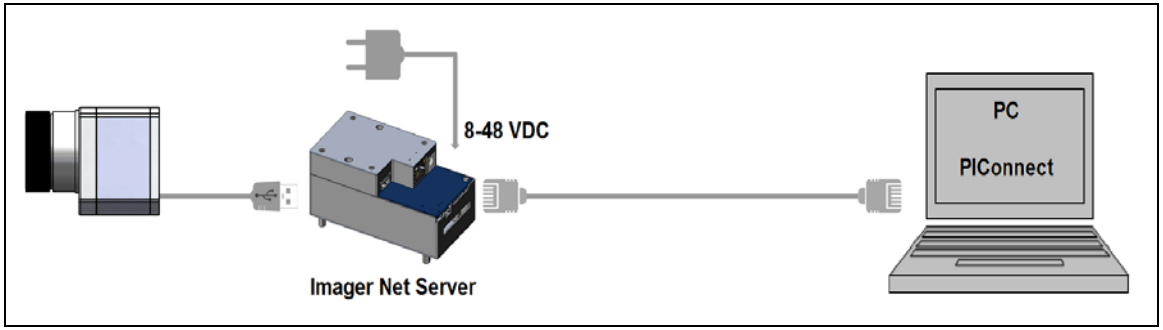


Figure 29: Ethernet direct connection (point-to-point connection)/ NetBox LW powered via power supply

4. Using a PoE injector the power supply for the NetBox is not needed. In this case the PoE injector must be connected as shown in **Figure 30**. With orderly function L1, L2 and L5 are illuminating.

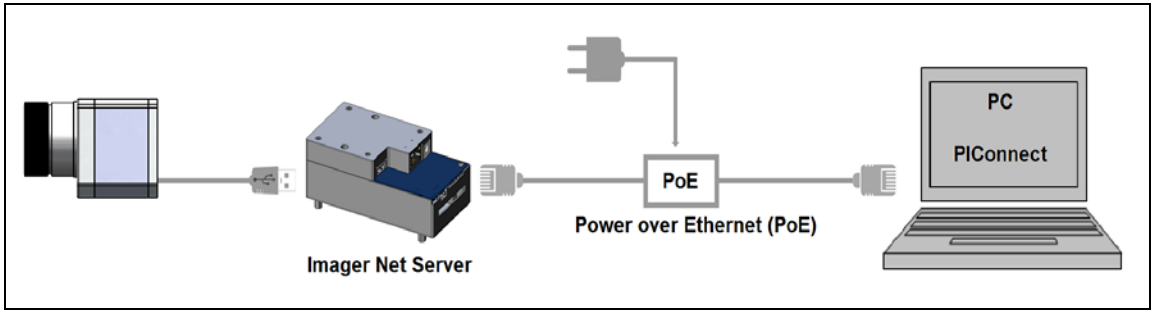


Figure 30: Ethernet direct connection (point-to-point connection)/ NetBox LW via PoE injector

Connection to the NetBox LW

The NetBox is already set to a fixed IP address (192.168.0.100) by factory default.

The communication with the NetBox is occurring via the TCP/ IP protocol (**T**ransmission **C**ontrol **P**rotocol/ **I**nternet **P**rotocol). The NetBox gets its IP address (**I**nternet **p**rotocol address) either from a DHCP server or operates with a fixed IP address.

With a direct connection to a PC both the NetBox as well as the PC must use a fixed IP address. A DHCP server is not available.

Once the following settings must be done on your PC (the procedure is depending on the operating system and can differ from the following description – Windows 7 is specified here).

1. Go to **`System controls`** and open **`Network- and Sharing Center`**. If there is a connection to the network (e.g. company network) the following information appears:

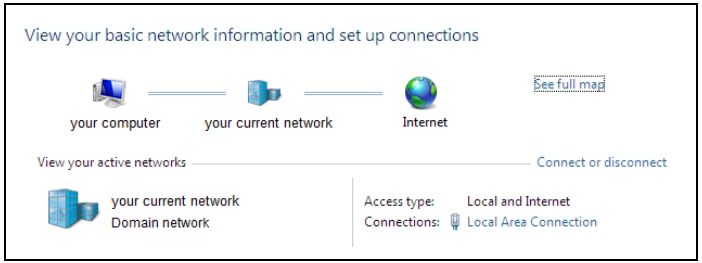


Figure 31: Basic network information

If there is no network connection click **Network- and Sharing Center, then Change Adapter Settings.** After it **Local Area Connection**, right mouse button: **Properties** [-> continue with item 3].

2. Enter **Local Area Connection** – status screen (**Figure 32 [1]**) is shown and subsequently **Properties**.

3. Mark **Internet protocol Version 4 (TCP/IPv4)** in the **Properties** window (**Figure 32 [2]**) and go to **Properties** again.

4. Open register **Alternate Configuration** in window (**Figure 32 [3])** and enable the checkbox **User configured**.

5. Enter a user defined IP address for your PC. Consider that the network part of the address is identic to the network part of the IP address of the NetBox, thus **192.168.0**. For the host part use an address which is different from the one of the NetBox (100); e.g. **1**.

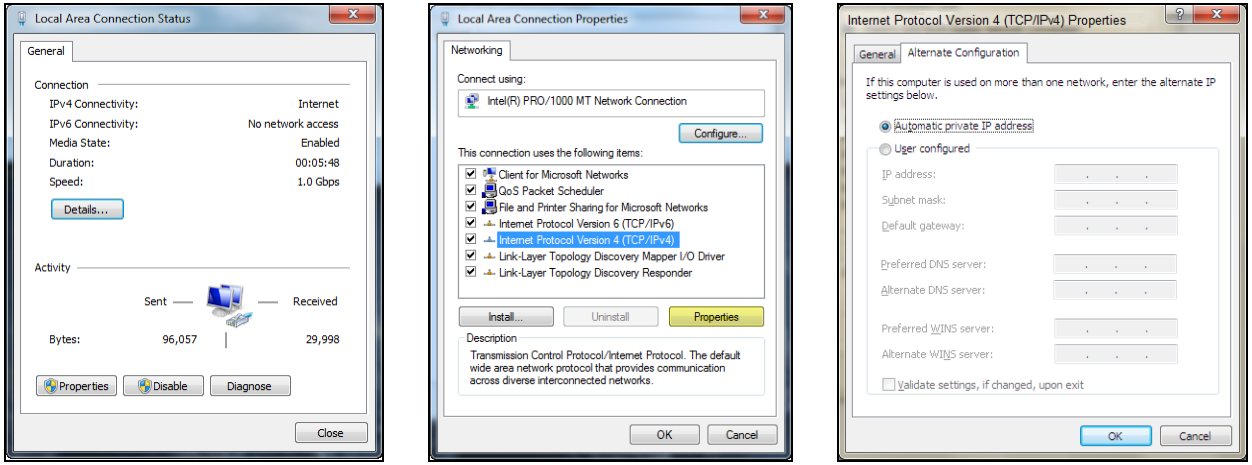


Figure 32: Windows – Local Area Connection Status **[1]**, Local Area Connection Properties **[2]** und Internet protocol version 4 (TCP/IPv4) properties **[3]**

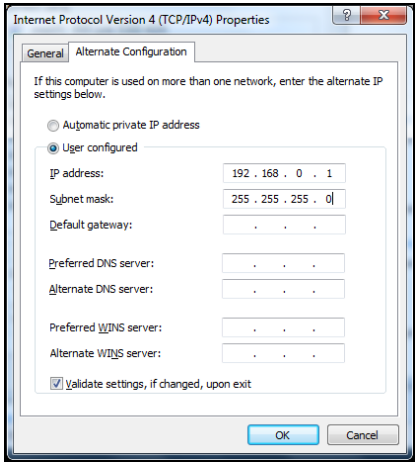


Figure 33: Alternate Configuration

After connecting your PC with the NetBox via an Ethernet cable a point-to-point connection is established. This may take several minutes. Your network is shown as *non-identified network* in the **`Network and Sharing Center`**.

1. Start the PIConnect software on your local PC and open with the menu **`Tools/ Extended/ remote devices...`**

2. Set the **Enable** checkbox and enter the address range of your local network in **Detect devices** (range **0** to **255**).

3. Enable the **Filter** checkbox and enter *NetBox*. Press the Ping button to detect devices within the range and with *NetBox* in their name.

4. Select the desired frame rate in **Remote framerate** which should be transmitted via network.

5. In the **Hosts** area your NetBox is listed. Assign it and confirm with **OK**.

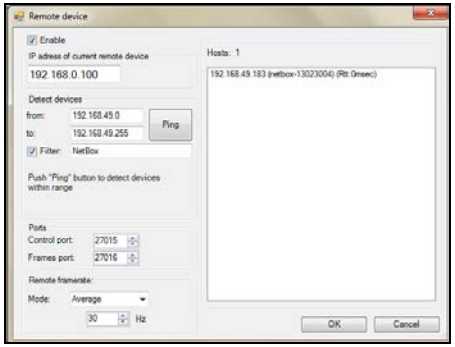


Figure 34: Remote device window

In the menu **Devices** the imager which is connected to the NetBox is shown as remote device. Select the following functions:

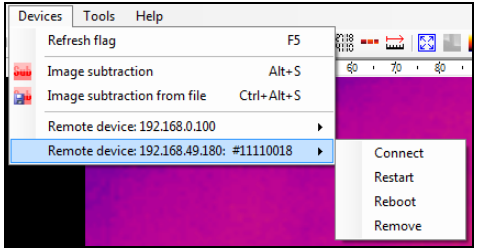


Figure 35: Remote device

Connect Connect with the remote device manually

Restart Restart of the Imager Net Server Application on the NetBox

Reboot Reboot of the NetBox

Remove Remove of the device entry in this menu

6. If the applied imager is connected to the NetBox for the first time a warning message appears. Confirm with **Yes**.

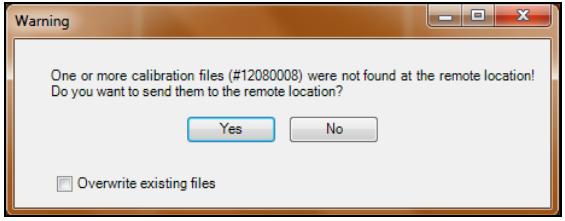


Figure 36: Warning

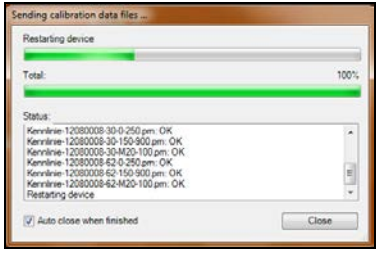


Figure 37: Sending calibration data files

The calibration files are transferred from your PC to the NetBox automatically and stored there. Alternatively a manual copy of the calibration files is possible via USB stick to the NetBox folder **D:\Imager\Cali**.

The live image of the IR camera is displayed on your PC.

4.12.2 Ethernet network communication

Consider that the NetBox must be converted to DHCP using a network connection.

1. Connect the IR camera and the NetBox with the supplied USB connection cable.
2. Connect the Ethernet connection of the NetBox with a network or internet (via a router e.g.).
3. Add the power supply to the NetBox and connect it to the electric circuit. The NetBox boots up the system and is ready to use after approx. 2-3 minutes. With orderly function LED 1 (L1) and LED 5 (L5) are illuminating.

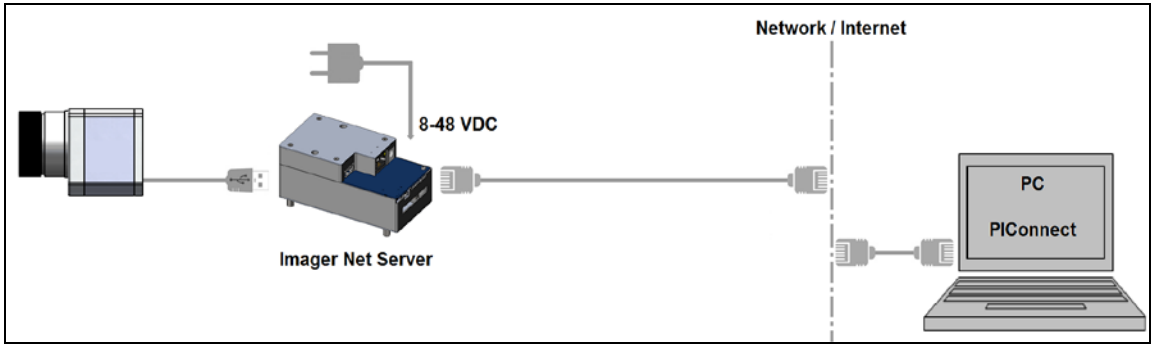


Figure 38: Ethernet network connection/ NetBox LW powered via power supply

4. Using a PoE injector the power supply for the NetBox is not needed. In this case the PoE injector must be connected as shown in **Figure 39**. With orderly function L1, L2 and L5 are illuminating.

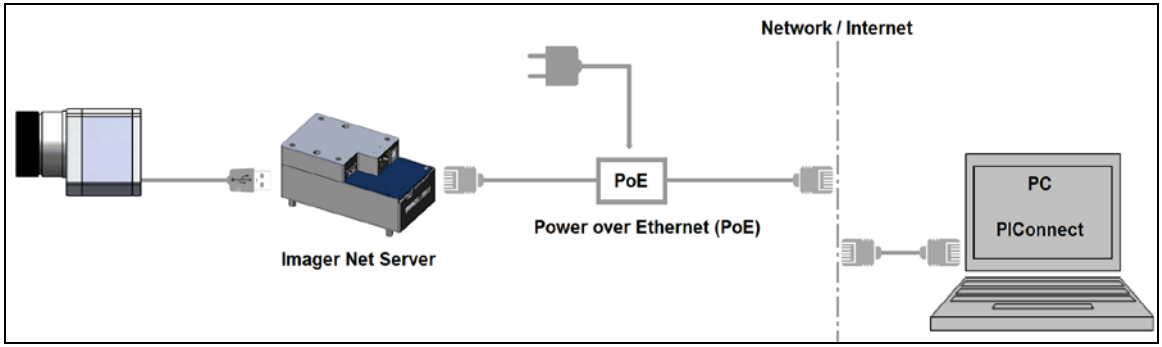


Figure 39: Ethernet network connection/ NetBox LW powered via PoE injector

If the NetBox is used in a network it gets its IP address from a DHCP server. In order to find the PIConnect on your local PC the address range of the local network must be known. For this start the program **IP Address Finder** (► **4.7 Remote access to the NetBox)**.

1. Start the PIConnect software on your local PC and open with the menu **`Tools/ Extended/ remote devices...`**

2. Set the **`Enable`** checkbox and enter the address range of your local network in **`Detect devices`** (range **0** to **255**).

3. Enable the **Filter** checkbox and enter *NetBox*. Press the Ping button to detect devices within the range and with *NetBox* in their name.

4. Select the desired frame rate in **Remote framerate** which should be transmitted via network.

5. In the **Hosts** area your NetBox is listed. Assign it and confirm with **OK**.

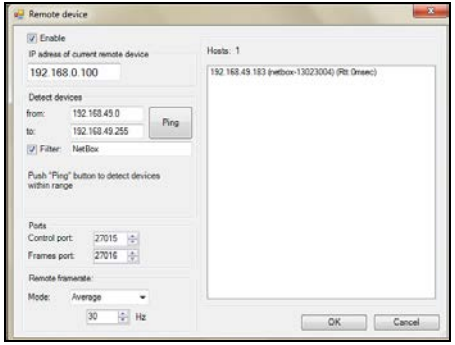


Figure 40: Remote device window

In the menu **Devices** the imager which is connected to the NetBox is shown as remote device. Select the following functions:

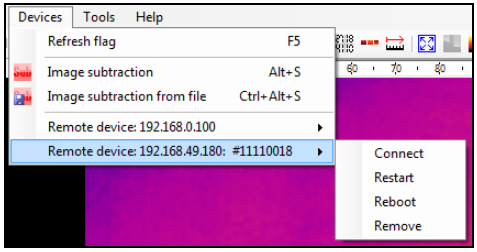


Figure 41: Remote device

Connect Connect with the remote device manually

Restart Restart of the Imager Net Server Application on the NetBox

Reboot Reboot of the NetBox

Remove Remove of the device entry in this menu

6. If the applied imager is connected to the NetBox for the first time a warning message appears. Confirm with **Yes**.

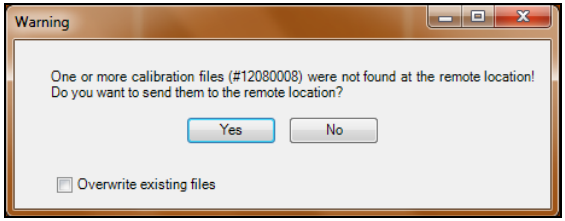


Figure 42: Warning

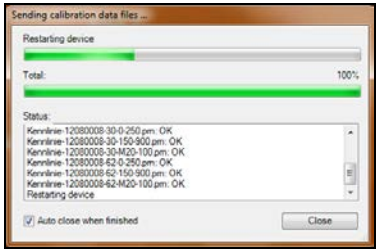


Figure 43: Sending calibration data files

The calibration files are transferred from your PC to the NetBox automatically and stored there. Alternatively a manual copy of the calibration files is possible via USB stick to the NetBox folder **D:\Imager\Cali**.

The live image of the IR camera is displayed on your PC.

4.13 USB Driver

The USB-IR camera as well as the USB sticks, the USB keyboards or the USB mouses do not need a special device driver. To ensure a convenient use of the NetBox LW and its recommended standard components, system messages to new installed USB devices are suppressed therefore.

If other USB devices are connected, which require a specific driver installation it might be necessary to start the installation in the device manager manually.

4.14 System time

- The set time zone can be changed in the tab **`Time Zone`**. To save the new setting permanently the ► **4.15 Write Protection Filter** must be deactivated temporarily.
- The **`SyncViewer`** and the **`IP Address Finder`** tool enable manual time synchronization with a PC which is connected directly or via network.
  ► **4.7 Remote access to the NetBox**

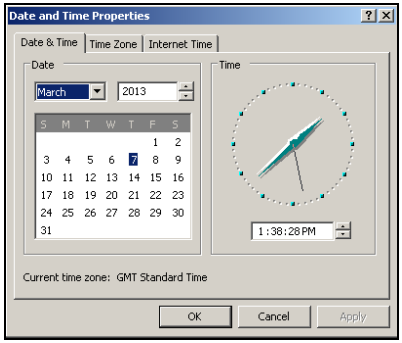


Figure 44: Date and time properties

The NetBox LW does not contain a CMOS battery which is typically used to keep the system time if the computer is switched off. That is why during operation the time is saved continuously. In case of a restart the system time is proceeding automatically beginning at the last saved value. With it achieving a chronology of imager recordings which create an automatic file name generation. If the NetBox is connected with the internet the current time is synchronized after a certain period automatically via internet time server.

4.15 Write protection filter

Use the NetBox with an enabled write protection filter only! [Red dot: Saved mode enabled; green dot: writing mode enabled].

The NetBox LW is equipped with a write protection filter (factory-provided). It reliably protects the operation system and the complete C drive. Furthermore the write protection filter switches off the device without a shutdown of the operating system.

The write protection filter (ewfMonitor) is illustrated as a red or green dot in the task bar or as a short cut.

The colors have the following meaning:

Red dot: saved mode

Green dot: writing mode

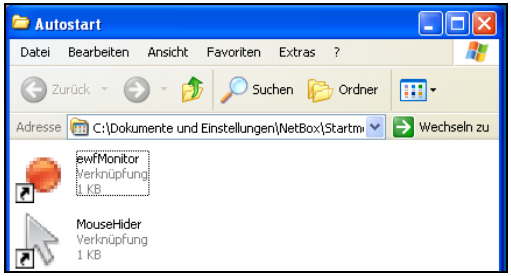


Figure 45: Short cut - Write protection filter (ewfMonitor) in `Autostart` folder

To save changed settings or to install additional software the write protection must be deactivated temporarily.

1. Move the cursor to the red dot in the task bar and click the right mouse button.

   Select between four different actions:

   Save and reboot Changes will be saved + restart

   Save and shutdown Changes will be saved + shutdown

Standard write mode	Switch to writing mode (green dot)
Reboot	Restart without saving changes

The SSD drive of the NetBox LW has two partitions by factory default. The write protection refers to partition C only. In partition D application data can be saved. The calibration data of the imager is stored there too.

5 System Recovery

- In case a recovery of the Windows operating system of the NetBox LW is necessary you should use the supplied USB recovery stick. Follow the steps described hereafter. **Do not disconnect power from the NetBox during the recovery procedure.**
- After the system recovery the NetBox is in the delivery status. All data stored before on the SSD will get lost.
- The write protection filter must be enabled (red dot is displayed) after recovery.

1. Connect the NetBox WL with a VGA monitor and an USB keyboard, put in the USB recovery stick to a free port and switch on the NetBox. If the start display (Fig. 41) is indicated confirm with the **ESC button** for **at least 2 seconds**.

Figure 46: Start display of the NetBox LW

2. Select **USB Device** and press **Enter**. Then the connected USB stick is shown. Confirm with Enter as well.

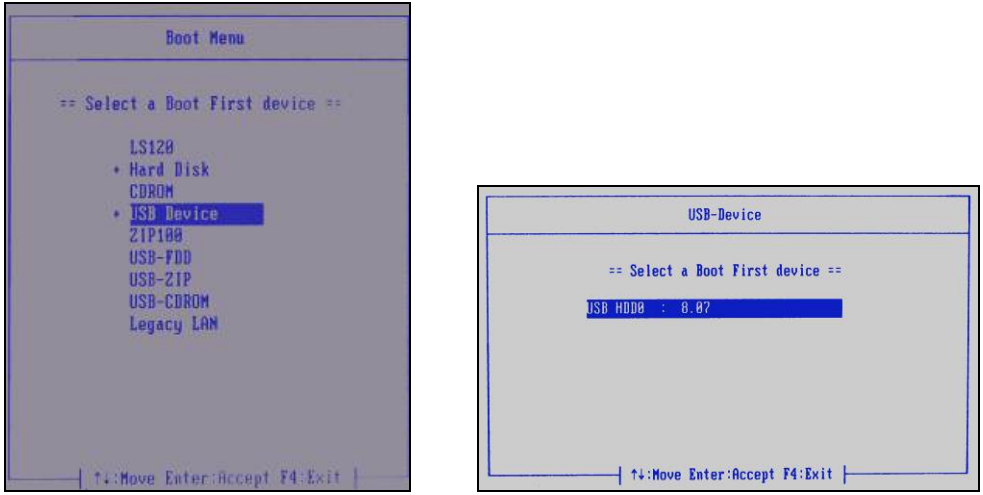


Figure 47: Selecting the USB-Stick

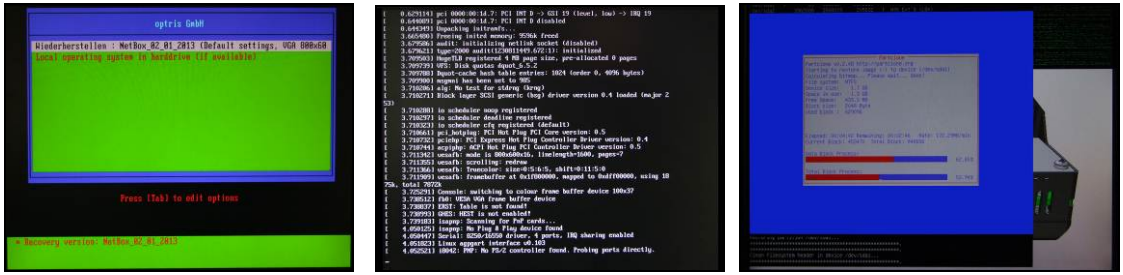


Figure 48: Several displays during recovery

After complete system recovery the NetBox shuts down automatically and switches off (all LEDs are off).

3. Disconnect the power supply shortly (pulling off the power supply unit). Afterwards reconnect the power and boot the system up.

4. Click the **Next** button and select **Random SID**. Confirm with **Next**.

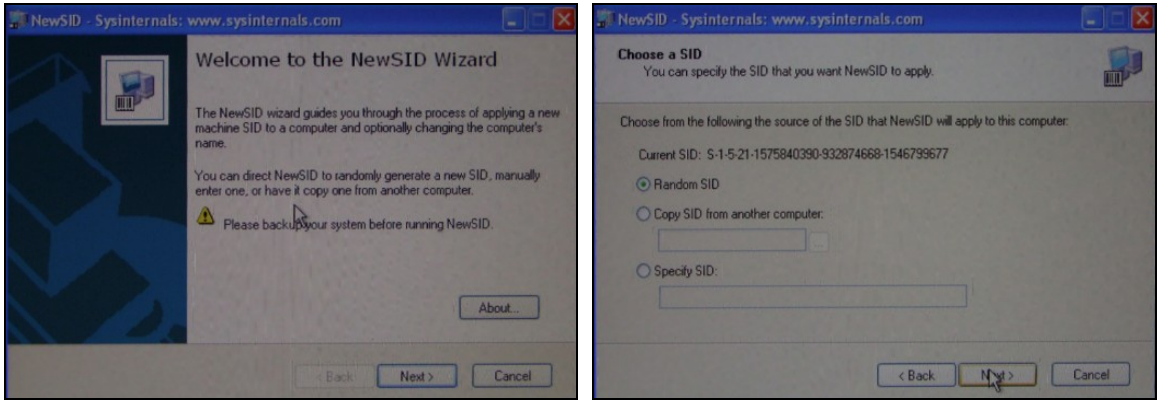


Figure 49: SID selection

With the rename option you can give the NetBox a different name.

5. Rename the NetBox (optional). It must not be more than 15 characters. Then confirm with **Next** for two times.

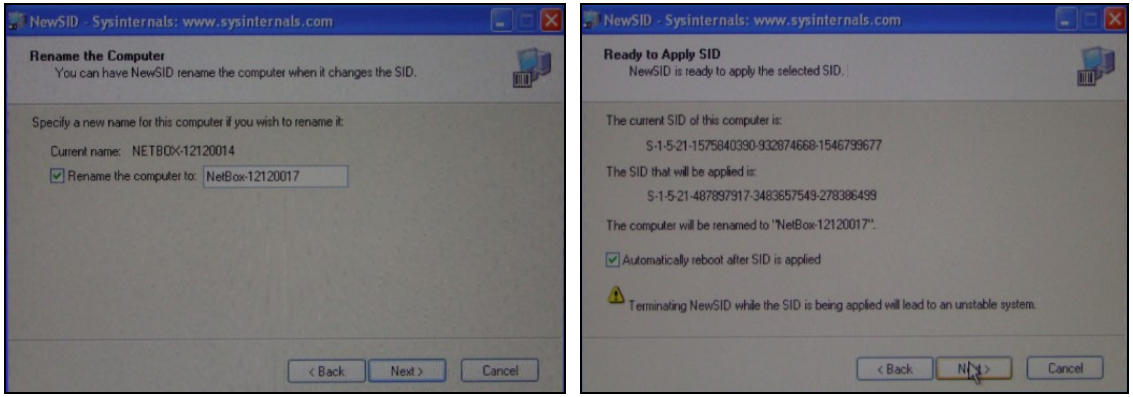


Figure 50: Rename option

After this the system shuts down. The NetBox is ready for use again.

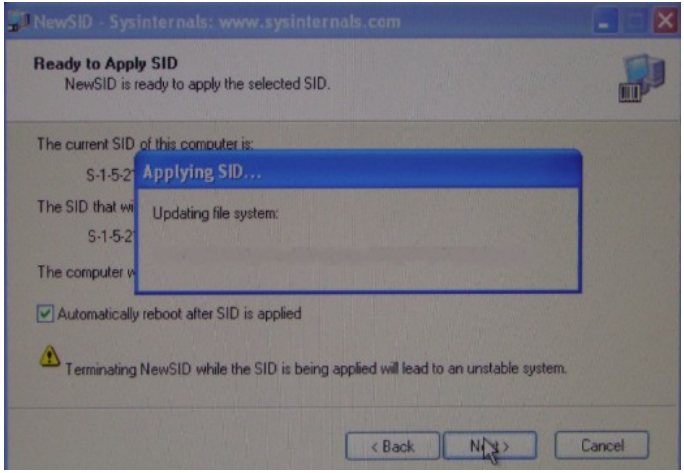


Figure 51: System update

6 Basics of Infrared Thermometry

Depending on the temperature each object emits a certain amount of infrared radiation. A change in the temperature of the object is accompanied by a change in the intensity of the radiation.

Searching for new optical material William Herschel by chance found the infrared radiation in 1800.

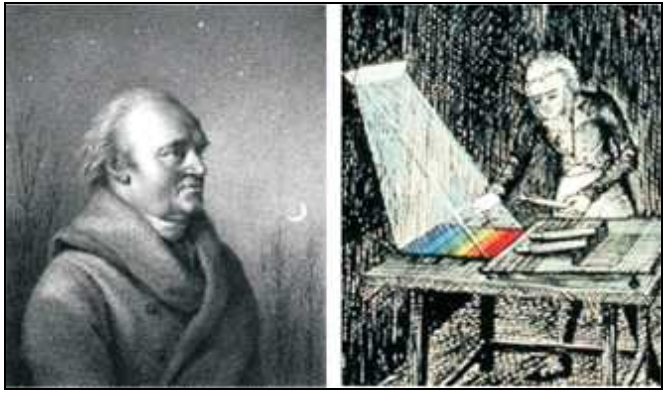


Figure 52: William Herschel (1738-1822)

He blackened the peak of a sensitive mercury thermometer. This thermometer, a glass prism that led sun rays onto a table made his measuring arrangement. With this, he tested the heating of different colors of the spectrum. Slowly moving the peak of the blackened thermometer through the colors of the spectrum, he noticed the increasing temperature from violet to red. The temperature rose even more in the area behind the red end of the spectrum. Finally he found the maximum temperature far behind the red area.

Nowadays this area is called “infrared wavelength area”.

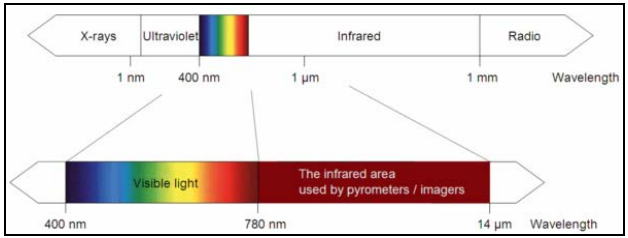


Figure 53: The electromagnetic spectrum and the area used for temperature measurement

For the measurement of “thermal radiation” infrared thermometry uses a wave-length ranging between 1 µ and 20 µm. The intensity of the emitted radiation depends on the material. This material contingent constant is described with the help of the emissivity which is a known value for most materials (see enclosed table emissivity).

Infrared thermometers are optoelectronic sensors. They calculate the surface temperature on the basis of the emitted infrared radiation from an object. The most important feature of infrared thermometers is that they enable the user to measure objects contactless. Consequently, these products help to measure the temperature of inaccessible or moving objects without difficulties.

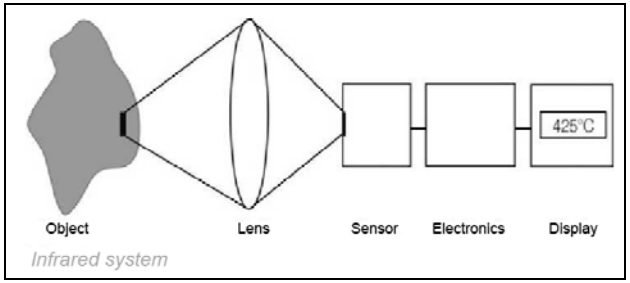


Figure 54: Main principle of noncontact thermometry

Infrared thermometers basically consist of the following components:

- Lens
- Spectral filter
- Detector
- Electronics(amplifier/ linearization/ signal processing)

The specifications of the lens decisively determine the optical path of the infrared thermometer, which is characterized by the ratio Distance to Spot size. The spectral filter selects the wavelength range, which is relevant for the temperature measurement. The detector in cooperation with the processing electronics transforms the emitted infrared radiation into electrical signals.

The advantages of noncontact thermometry are clear - it supports:

- temperature measurements of moving or overheated objects and of objects in hazardous surroundings
- very fast response and exposure times
- measurement without inter-reaction, no influence on the
- measuring object
- non-destructive measurement
- long lasting measurement, no mechanical wear

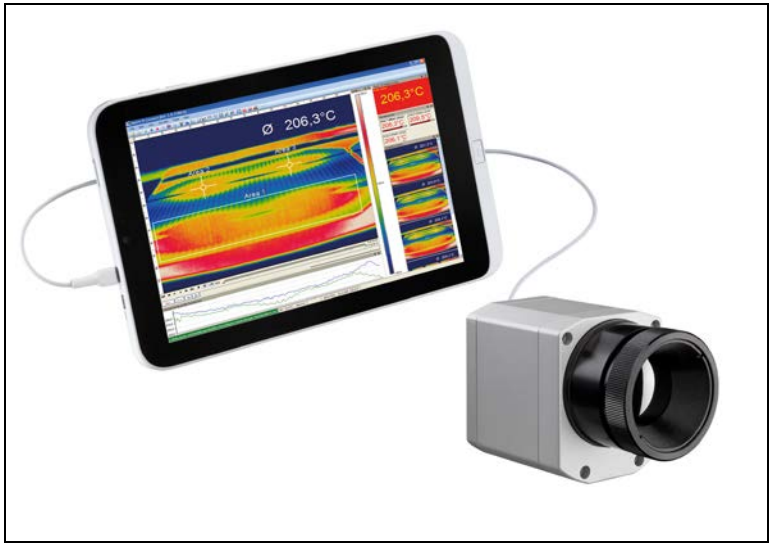
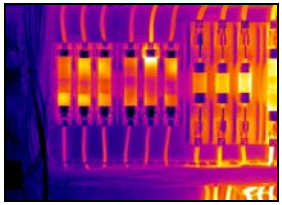
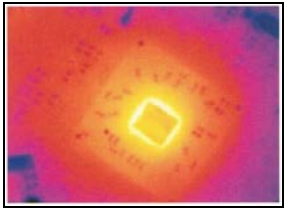


Figure 55: Noncontact thermometry

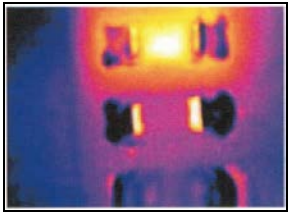
Application field:



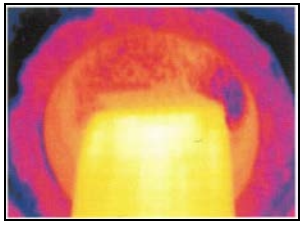
Monitoring of electronic cabinets



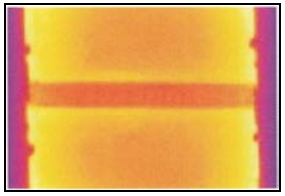
R&D of electronics



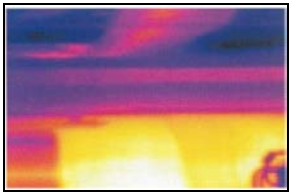
R&D of electronic parts



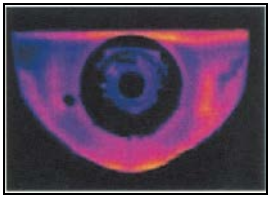
Process control extruding plastic parts



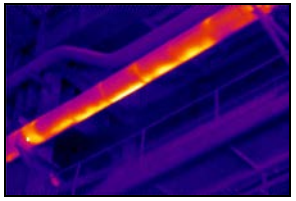
Process control manufacturing solar modules



Process control at calendering



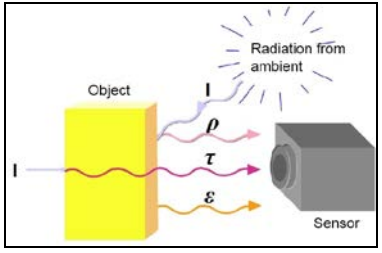
R&D of mechanical parts



Monitoring of cables

6.1 Emissivity

Definition: The intensity of infrared radiation, which is emitted by each body, depends on the temperature as well as on the radiation features of the surface material of the measuring object. The emissivity (ε – Epsilon) is used as a material constant factor to describe the ability of the body to emit infrared energy. It can range between 0 and 100 %. A “blackbody” is the ideal radiation source with an emissivity of 1.0 whereas a mirror shows an emissivity of 0.1. If the emissivity chosen is too high, the infrared thermometer may display a temperature value which is much lower than the real temperature – assuming the measuring object is warmer than its surroundings. A low emissivity (reflective surfaces) carries the risk of inaccurate measuring results by interfering infrared radiation emitted by background objects (flames, heating systems, chamottes). To minimize measuring errors in such cases, the handling should be performed very carefully and the unit should be protected against reflecting radiation sources.



I	Passed radiation
ε	Reflection
ρ	Transmission
τ	Emissivity=Absorption

ε + ρ+ τ = 1

Figure 56: Capability of an object to emit radiation

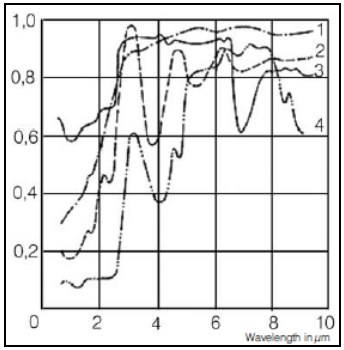


Figure 57: Spectral emissivity of several materials: **1** Enamel, **2** Plaster, **3** Concrete, **4** Chamotte

7 CE Conformity

EG-Konformitätserklärung
EU Declaration of Conformity

optris infrared thermometers

Wir / We

Optris GmbH
Ferdinand Buisson Str. 14
D-13127 Berlin

erklären in alleiniger Verantwortung, dass
declare on our own responsibility that

die Produktserie optris PI
the product group optris PI

den Anforderungen der EMV-Richtlinie **2004/108/EG** und der Niederspannungsrichtlinie **2006/95/EG** entspricht.
meets the provisions of the EMC Directive **2004/108/EG** and the Low Voltage Directive **2006/95/EG**.

Angewandte harmonisierte Normen:
Applied harmonized standards:

EMV Anforderungen / EMC General Requirements:

EN 61326-1:2006 (Grundlegende Prüfanforderungen / Basic requirements)
EN 61326-2-3:2006

Gerätesicherheit von Messgeräten / Safety of measurement devices:

EN 61010-1:2010
EN 60825-1:2007 (Lasersicherheit / Laser safety)

Dieses Produkt erfüllt die Vorschriften der Richtlinie **2011/65/EU** des Europäischen Parlaments und des Rates vom 8. Juni 2011 zur Beschränkung der Verwendung bestimmter gefährlicher Stoffe in Elektro- und Elektronikgeräten.
This product is in conformity with Directive **2011/65/EU** of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

Berlin, 18.09.2014

Ort, Datum / place, date

Dr. Ulrich Kienitz
Geschäftsführer / General Manager