Optris Easy Comm via Ethernet

Introduction

Optris Easy Comm is a small and simple software solution for developers who wants to have direct access to temperature data out of Optris infrared cameras[1]. The complex temperature calculation is fully processed in the device and the user of Easy Comm gets temperature information of all pixels.

This document gives a short overview of the interface and protocol, how to setup the camera and describes the format for the temperature data stream.

Interface and Protocol

Besides the established USB interface for Optris infrared cameras, some cameras also have an Ethernet interface as a second communication path especially for a longer distance between instrument and processing PC. For real-time data streaming Optris use the User Datagram Protocol (UDP). This connectionless communication model provides only checksums for data integrity, source and destination port numbers and the packet length. With this minimal set UDP is preferred for fast data streaming, but has a few drawbacks. UDP has no handshake-mechanism, there is no guarantee of delivery, ordering, or duplication protection. If some error protection is needed, the user must handle this in their application.

Optris infrared cameras with Ethernet interface act as UDP client for video streaming (temperature or raw data) and sends packets to a user selectable port. Easy Comm Ethernet software examples act as UDP server who listen to this port.

The default configuration is the following:

Camera IP address:	**192.168.0.101**
Computer IP address:	**192.168.0.100**
Subnet mask:	**255.255.255.0**
Port number:	**50101**

The transfer from camera to computer does not need to be initiated and it cannot be stopped, but the camera must be configured for it.

[1] only for Xi 80 and Xi 410

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Setup the camera

After installing the latest Optris PIX Connect and connecting an Optris infrared camera with Ethernet interface to your computer (for setup see Xi or PIX Connect manual), you can configure the camera for the specific measurement environment.

It depends on the type of camera what you can configure.

Important: Easy Comm must use Flag automatic enabled!

Function	Xi 80	Xi 410
Tab - Measure areas		
max. measurement areas *)	9	3
Shape	all	
Mode	Minimum, Maximum, Mean value, Distribution [%]	
Measure area depending on emissivity	Yes	No
max. calculated objects	9	
Operation	Difference, Absolute difference, Average, Peak Hold, Valley Hold, Adv. Peak Hold, Adv. Valley Hold	
Tab - Device		
Flag automatic	Yes	
min. / max. Interval	Yes	
Emissivity	Yes	
Transmissivity	Yes	
Ambient temperature	Yes	
Temperature range	Yes	
Video formats	Yes	
Tab - Alarms		
Low / high Alarms	Yes	
Alarms to PIF (AO/DO)	Yes	
Tab – Device (PIF)		
Analog Inputs	Emissivity, Ambient temperature, Flag Control, Reset Peak-/Valley-Hold	
Analog Outputs	Measure area, Internal temperature, Flag Status, Alarm, Frame sync, Fail-safe, Autonomous status	
Digital Outputs	Flag Status, Alarm, Frame sync, Fail-safe, Autonomous status	
Fail-safe	No	Yes

All these configurations are handled by the camera. Some configurations are applied immediately, some configurations must be enabled by checking "*using autonomously by device*".

*) Via a super area several measuring areas can be bundled into one measuring area.

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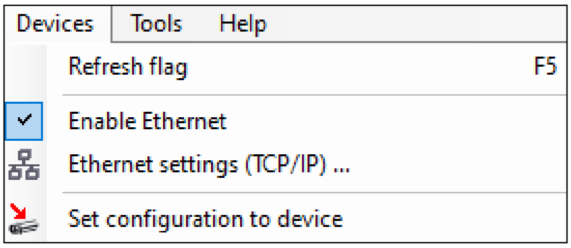
After finishing the configuration, it must be stored in the camera. This is handled differently by device.

Xi 80:

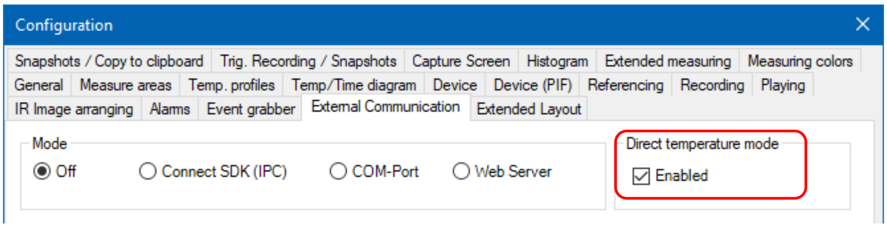
- wait for at least 5 seconds after closing Configuration with “OK”

Xi 410:

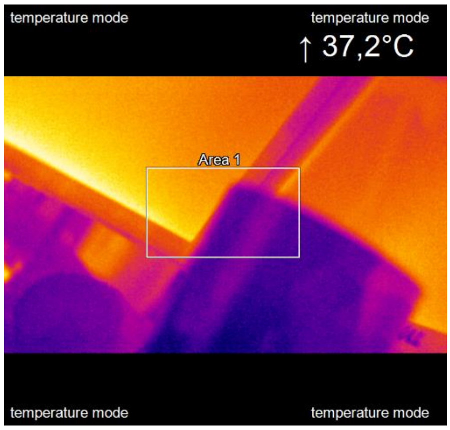
- click on “*Set configuration to device*” in menu bar Devices



Configuration done! Now activate the “*Direct temperature mode*” to work with Easy Comm. This is done in the Configuration menu under *External Communication*.



Once the “*Direct temperature mode*” is enabled, PIX Connect shows “*temperature mode*” in the corners of the live IR image.



Before you close PIX Connect to work with Easy Comm check the focus settings!

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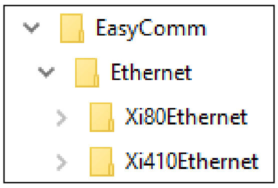
Easy Comm – Ethernet Examples



Easy Comm Ethernet examples (C#) are located in the installation path of PIX Connect or can be easily found in the PIX Connect software menu under *Help* and *Easy Comm*. These ready to use software examples show, how to:

- setup a UDP server listening on the default port 50101
- collect the temperature data from the data stream
- create a bitmap to show this in the user interface

Once the application has a complete temperature array, the user can build their own post processing algorithm.

To understand the structures behind the code, more information about the temperature streaming format is needed.

Streaming Data Format

Due to the different resolution of Xi 80 and Xi 410 the data format is slightly different. But both cameras send packets with a specific length. The length of a packet depends on how many rows are in one packet. For Xi 80 there are three rows and for Xi 410 there is only one row per packet. Each row contains all pixels for this row with two bytes per pixels plus two header bytes. The first byte of the header is a row counter and the second byte is an image counter. Additionally, there are two more rows for metadata.

Data details	Xi 80	Xi 410
Image resolution with metadata	80 x 84	384 x 242
Image resolution	80 x 80	384 x 240
Rows per packets	3	1
Bytes per pixel	2	
Header length in bytes	2	
Packet length bytes	482	770

Table 1: Summary of data details

The packet length is now calculated by following formula:

Packet length = Header length + (Rows per packet * Row length * 2 Bytes per pixel)

Xi 80: Packet length = 2 Bytes + (3 * 80 * 2 Bytes) = 482 Bytes

Xi 410: Packet length = 2 Bytes + (1 * 384 * 2 Bytes) = 770 Bytes

Packet details will be explained with protocol screen shots from “Wireshark”, a free Ethernet protocol tool. It is highly recommended for the developer to verify all data transfers on the camera Ethernet bus with “Wireshark”.

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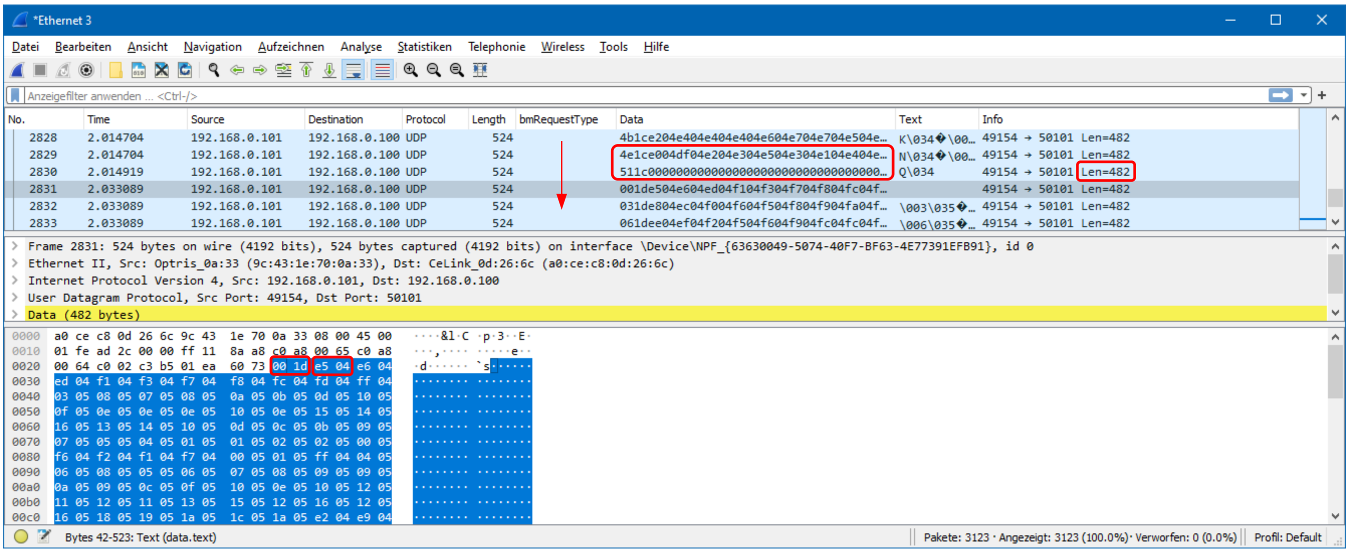
Packet details – Xi 80

In the screen shot below it can be seen that with this packet the image starts with row number 0x00 (0 decimal) of an image, numbered with 0x1d (29 decimal) and the length of 482 bytes. Followed by the next UDP packets.



The next 2 bytes contain the temperature of the first pixel in this row, the most left pixel (0,0) in the row of the image, the next two bytes contain the temperature of the next pixel (1,0) to the right and so on. The temperature values are 16 bit numbers, stored with the LSB first. So, value for the top left pixel is 0x04e5 (1253). The value is in a special format, which is defined as:

$$\text{Temperature in °C} = (\text{value} - 1000) / 10$$

For this example: 25.3 °C.

Generally, the packets have this format with row number n.

Header		Data							
row counter	image counter	LSB$_{Px0, n}$	MSB$_{Px0, n}$	LSB$_{Px1, n}$	MSB$_{Px1, n}$	…	LSB$_{Px79, n}$	MSB$_{Px79, n}$
		Data						
		LSB$_{Px0, n+1}$	MSB$_{Px0, n+1}$	LSB$_{Px1, n+1}$	MSB$_{Px1, n+1}$	…	LSB$_{Px79, n+1}$	MSB$_{Px79, n+1}$
		Data						
		LSB$_{Px0, n+2}$	MSB$_{Px0, n+2}$	LSB$_{Px1, n+2}$	MSB$_{Px1, n+2}$	…	LSB$_{Px79, n+2}$	MSB$_{Px79, n+2}$

The next UDP packet is followed by row number n+3.

Header		Data						
row counter+3	image counter	LSB$_{Px0, n+3}$	MSB$_{Px0, n+3}$	LSB$_{Px1, n+3}$	MSB$_{Px1, n+3}$	…	LSB$_{Px79, n+3}$	MSB$_{Px79, n+3}$
		Data						
		LSB$_{Px0, n+4}$	MSB$_{Px0, n+4}$	LSB$_{Px1, n+4}$	MSB$_{Px1, n+4}$	…	LSB$_{Px79, n+4}$	MSB$_{Px79, n+4}$
		Data						
		LSB$_{Px0, n+5}$	MSB$_{Px0, n+5}$	LSB$_{Px1, n+5}$	MSB$_{Px1, n+5}$	…	LSB$_{Px79, n+5}$	MSB$_{Px79, n+5}$

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The last UDP packet with real image data has the row number 0x4e (78). This packet includes 2 rows (row 78 and 79) and the start of the metadata. The next packet with row number 0x51 (81) includes the second part of metadata and two rows with dummy data. Because each UDP frame contains 3 rows of image data the complete UDP image has a format of 80x84 to have a multiple of 3 rows.

The last UDP packet of a complete image has the row number 0x51 (81). Then the row number rolls over to 0x00 and the image number is incremented by one.

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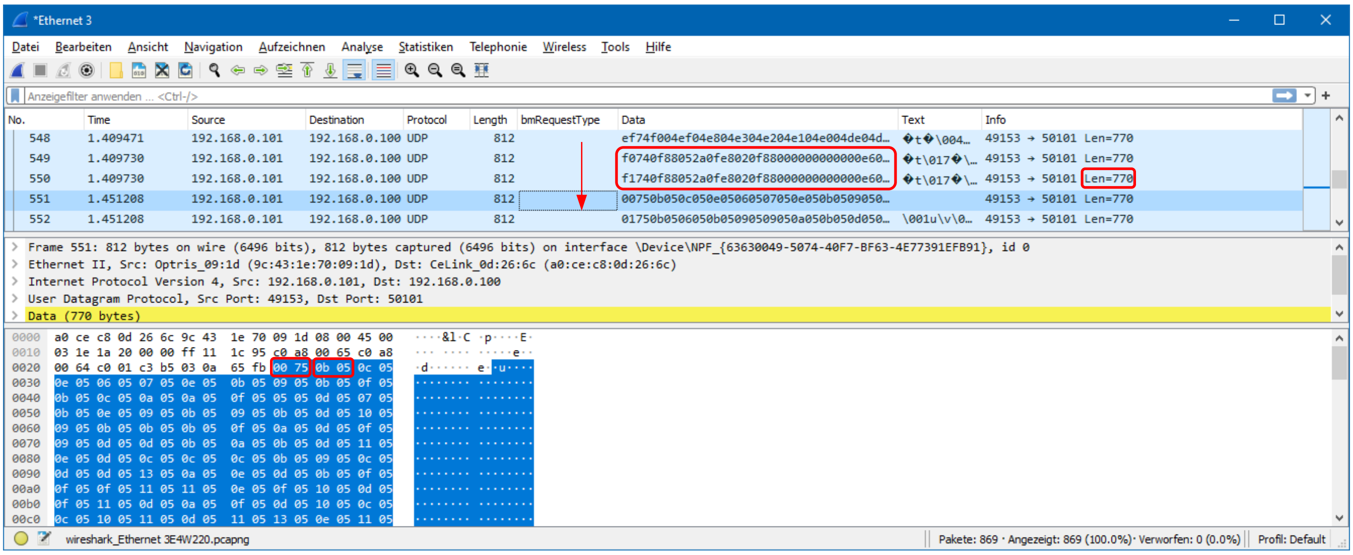
Packet details – Xi 410

In the screen shot below it can be seen that with this packet the image starts with row number 0x00 (0 decimal) of an image, numbered with 0x75 (117 decimal) and the length of 770 bytes. Followed by the next UDP packets.



The next 2 bytes contain the temperature of the first pixel in this row, the most left pixel (0,0) in the row of the image, the next two bytes contain the temperature of the next pixel (1,0) to the right and so on. The temperature values are 16 bit numbers, stored with the LSB first. So, value for the top left pixel is 0x050b (1291). The value is in a special format, which is defined as:

$$\text{Temperature in °C} = (\text{value} - 1000) / 10$$

For this example: 29.1 °C.

Generally, the packets have this format with row number n.

Header		Data						
row counter	image counter	$LSB_{Px0, n}$	$MSB_{Px0, n}$	$LSB_{Px1, n}$	$MSB_{Px1, n}$	…	$LSB_{Px383, n}$	$MSB_{Px383, n}$

The next UDP packet is followed by row number n+1.

Header		Data						
row counter+1	image counter	$LSB_{Px0, n+1}$	$MSB_{Px0, n+1}$	$LSB_{Px1, n+1}$	$MSB_{Px1, n+1}$	…	$LSB_{Px383, n+1}$	$MSB_{Px383, n+1}$

The last UDP packet with real image data has the row number 0xef (239). The next two packets with row number 0xf0 (240) and 0xf1 (241) are metadata rows, both contain the same data.

The last UDP packet of a complete image has the row number 0xf1 (241). Then the row number rolls over to 0x00 and the image number is incremented by one.

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Metadata details

The Easy Comm – Ethernet examples are built in a way that the receiving buffer size is the multiplication of WIDTH and HEIGHT of the image with metadata (**Table 1**: Summary of data details).

Xi 80: 80x84 with 16-bit numbers or 80x84x2 bytes = 13.440 bytes

Xi 410: 384x242 with 16-bit number or 384x242x2 bytes = 185.856 bytes

If an UDP packet arrives at the programmed port (DEFAULT_PORT) and has the specific packet length (UDP_PACKAGE_LENGTH), then the first byte is a pointer to the Y-coordinate of the buffer, where to store the receiving bytes. For

Xi 80: 480 bytes or 240 16-bit numbers, or

Xi 410: 768 bytes or 384 16-bit numbers

when the first 2 header bytes of that UDP packet have been removed.

When a UDP packet arrives with the row counter is equal META_DATA_INDEX these data are copied to another byte array (metaData).

Two indices are important here:

FLAG_INDEX_IN_METADATA and IS_TEMPERATURE_MODE_IN_METADATA.

The FLAG_INDEX_IN_METADATA-index is the 11th byte in the metadata contains information of the flag. The cameras need to rebuild from time to time the internal reference. This is done by bringing a flag with a known temperature into the optical path. During this time, the sensor does not "see" the target and the image is not displayed. To inform the user about that situation two states are defined.

Flag states:

0x00: open
0x01: close

The IS_TEMPERATURE_MODE_IN_METADATA-index is the 33rd byte in the metadata which contains the information if the camera is set to "*Direct temperature mode*". The 3rd bit checks the state.

Direct temperature mode states:

0: Direct temperature mode OFF
1: Direct temperature mode ON

When the last row of the UDP packet has arrived (LAST_EMPTY_ROW_INDEX), then a full image has arrived and can be processed or displayed. With the row and image numbers it is easy to check whether all rows of an image have been received or some rows (UDP packets) are missing. The UDP protocol does not guarantee delivery of each frame in exchange for simplicity and speed.

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