General Description

The evaluation kit for the epc611 chip is a tool to learn about the functionality and performance of the epc611 chip. It consists of two implementations of the chip into typical modules:

■ TOF>range 611: A range finder, where the 64 pixels are combined into one cluster pixel. This range finder operates up to 15 meters and allows a measurement accuracy in the cm range.

■ TOF>frame611: A tiny imager with 8x8 pixels and an operating range of two meters. This device allows e.g. people counting, simple gesture recognition, etc.

Both modules operate also under full sunlight condition on the target, to demonstrate the outdoor capabilities.

This document presents an overview of the operation and functionality of the epc611 Evaluation Kit. It also contains the schematic diagrams which can be used as reference designs. In addition to that the complete firmware of the two modules comes in C source code, to support the implementation of your own modules.

Features

■ A quick introduction to the epc611 3D-TOF chip
■ Complete development system for applications using the epc611 chip as a range-finder or 8x8 pixel imager
■ The basic epc611 chip operation modes can be evaluated
■ Includes TOF>range 611, TOF>frame 611 and USB adapter
■ Range-finder TOF>range 611: FOV 0.18° (h/v) Operating range up to 15m on white targets
■ 8x8 pixel imager TOF>frame 611: FOV 12° (h/v) FOV for near-field gesture control
■ Log section to capture single images and picture sequences for further processing
■ User software (PC/Mac) with visualization and logging features. It includes all the source code libraries for development.
■ The book «3D-TOF – A guideline to 3D-TOF sensors that work»

Applications

■ Evaluation and development support

Figure 1: epc611 evaluation kit

1. Precaution and Safety

Eye safety: Do not look directly into the camera under operation. Depending on the mode of operation, the camera device emits highly concentrated non-visible infrared light. It can be hazardous to the human eye. The use of these devices has to follow the safety precautions given in IEC 60825-1 and IEC62471.

Some of the camera modules are bare electronic devices without a housing surround. Therefore, handle them with the necessary ESD precaution.

Over-voltage: Use only power supplies which correspond to the datasheet of the cameras to avoid damage of the devices or cause danger for humans.

Cable-tripping: Place the sensors on solid ground or fix it correctly on a solid support. Place cables carefully. Falling devices can be damaged.

The sensors comes with their own calibrated firmware. For proper operation of the sensors, upload the correct firmware with the evaluation kit to the sensors according the instructions given herein.

Take care that the lens surfaces of the cameras do not get soiled. Do not touch them. Otherwise loss of performance occurs.

EMC compatibility: The epc611 Evaluation Kit is designed on module level. It is not an EMC certified device. It is the responsibility of the user to operate it in compliance with the EMC regulations.

The epc611 Evaluation Kit is designed on module level. It is NOT a CE, UL, CSA certified device. It is the users responsibility to operate it in compliance with the relevant regulations.

The cameras of the epc611 Evaluation Kit and their software may only be be used in accordance with the information contained in their datasheets.

These devices may not be used in safety applications, explosive atmospheres or in radioactive environment.

Limited warranty - Loss of warranty
The epc611 Evaluation Kit should only be installed and used by authorized persons. All instructions in this datasheet and in the related documents shall be followed and fully complied with. In addition, the installer and user is required to comply with all local laws and regulations. Should any of these instructions not be carefully followed, serious injury may occur. The installer and user is fully responsible for the safe use and operation of the system. It is the sole responsibility of the installer and the user to ensure that this product is used according to all applicable codes and standards, in order to ensure safe operation of the whole application. Any alteration to the devices by the buyer, installer or user may result in unsafe operating conditions. ESPROS Photonics AG is not responsible for any liability or warranty claim which results from such manipulation or disregarding of given operating instructions.

UPDATES

ESPROS Photonics is constantly striving to provide comprehensive and correct product information. Therefore, please check our website regularly for updated versions of datasheets and documentations: www.espros.com

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Download the current Datasheet epc611: www.espros.com → Downloads → Datasheets → Chips

Download the current Datasheet TOF>range 611 or TOF>frame 611: www.espros.com → Downloads → Datasheets → Camera_and_Modules

Download the current Manual epc611_Evalkit: www.espros.com → Downloads → Datasheets → Evaluation_Kits

Always download and use the latest epc611 Evaluation Kit software.
Questions: Send an email with your request to your local sales office or to info@espros.com

Update the epc611 Evaluation Kit software : Go to the folder "ESPROS_epc611_Evaluation_Kit_Software_vX.X". Read the Readme file and follow the instructions accordingly.
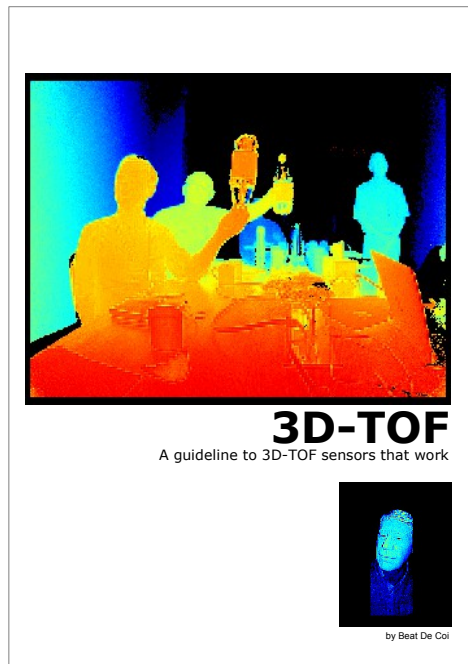
Table of Contents

Figure 2: The comprehensive TOF book,
enclosed in this evaluation kit

2. epc611 evaluation kit

2.1. Scope of delivery

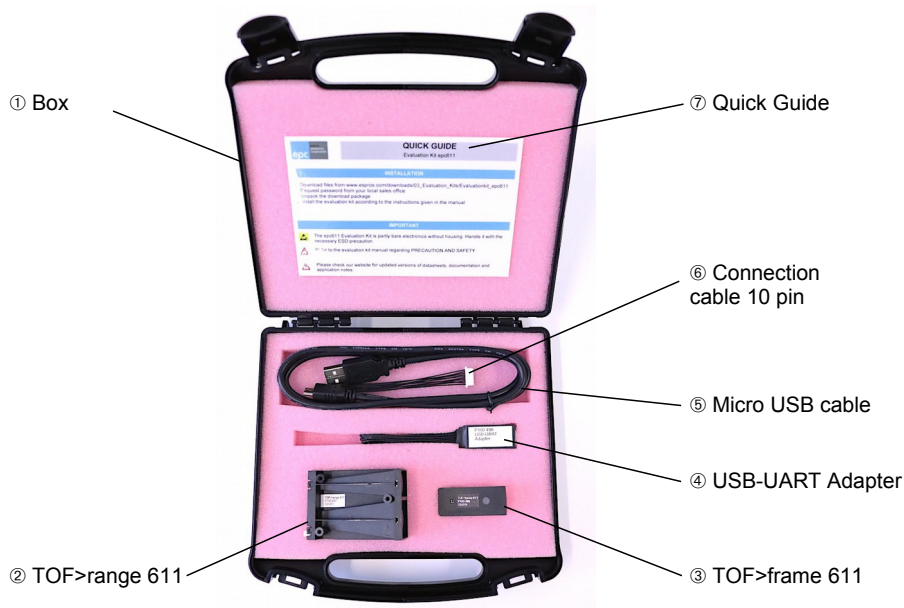Figure 3: epc611 evaluation kit overview

No	Pieces	Designation	Remarks
①	1	Box	
②	1	TOF>range 611	
③	1	TOF>frame 611	
④	1	USB-UART adapter, includes connector 10 pin	USB 2.0, micro plug
⑤	1	Micro USB cable	2.0, A plug - micro plug
⑥	1	Cable 10 Pin F JST 1.0 mm (L=76 mm)	for customized connection
⑦	1	epc611 Quick Guide	
	1	Book "3D TOF - A guideline to 3D-TOF sensors that work"	P/N 100 542. Refer to Chapter 6. Only available with the evaluation kit or as TOF Developer Conference attendee
		Manual epc611 evaluation kit	available at www.espros.com → Downloads
		Datasheet epc611	available at www.espros.com → Downloads
		Datasheet TOF>range 611	available at www.espros.com → Downloads
		Datasheet TOF>frame 611	available at www.espros.com → Downloads
		Use the application and configuration software "ESPROS_epc611_Evaluation_Kit_Software_vX.X". It includes the corresponding tools and software development kit (SDK).	available at www.espros.com → Downloads

Table 1: Bill of material of the delivery

2.2. Ordering information

Part Number	Part Name	Remarks
P100 487	epc611 Evaluation Kit	Includes TOF>range 611, TOF>frame 611, USB adapter and cables
P100 483	TOF>range 611	Distance measurement engine, Spot 3 x3 mm @ 1m, range 0 ... 15m
P100 499	TOF>frame 611	Distance measurement engine, FOV 12° (h/v), range 0 … 2m
P100 498	USB-UART Adapter	
P100 516	Cable 10 Pin F JST 1.0 mm (L=76 mm)	For customized connection

Table 2: Ordering Information epc611 evaluation kit

Figure 4: epc611 evaluation kit

Figure 5: TOF>frame 611 (left) and TOF>range 611 (right)

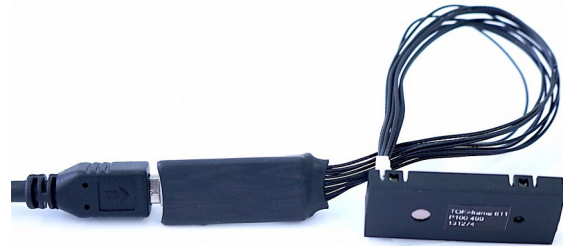Figure 6: TOF>range 611 and USB-UART adapter
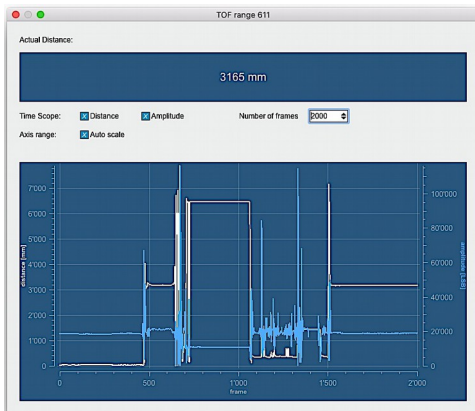

Figure 7: TOF>frame 611 and USB-UART adapter
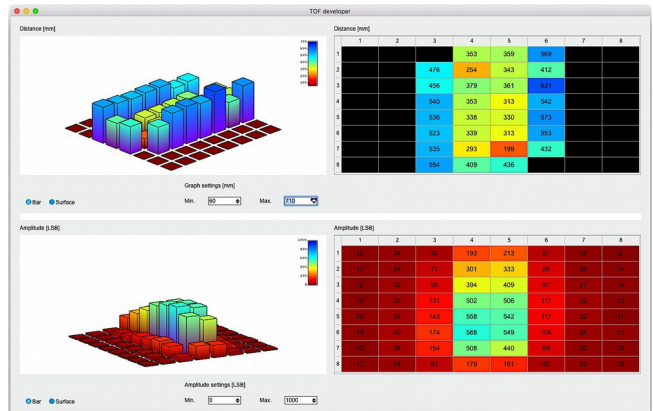

Figure 8: GUI – TOF>range 611

Figure 9: GUI – TOF>frame 611

3. Hardware

3.1. TOF>range 611 and TOF>frame 611

3.1.1. Technical data

The technical data of TOF>range 611 and TOF>frame 611 are specified in the corresponding datasheets.

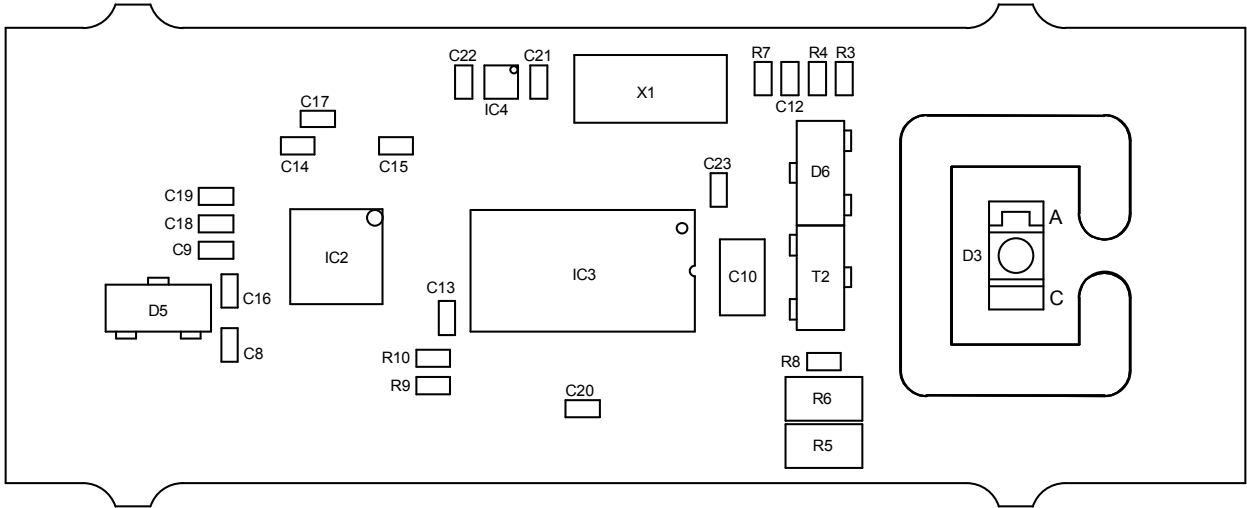### 3.1.2. PCB assembly of the TOF>range 611

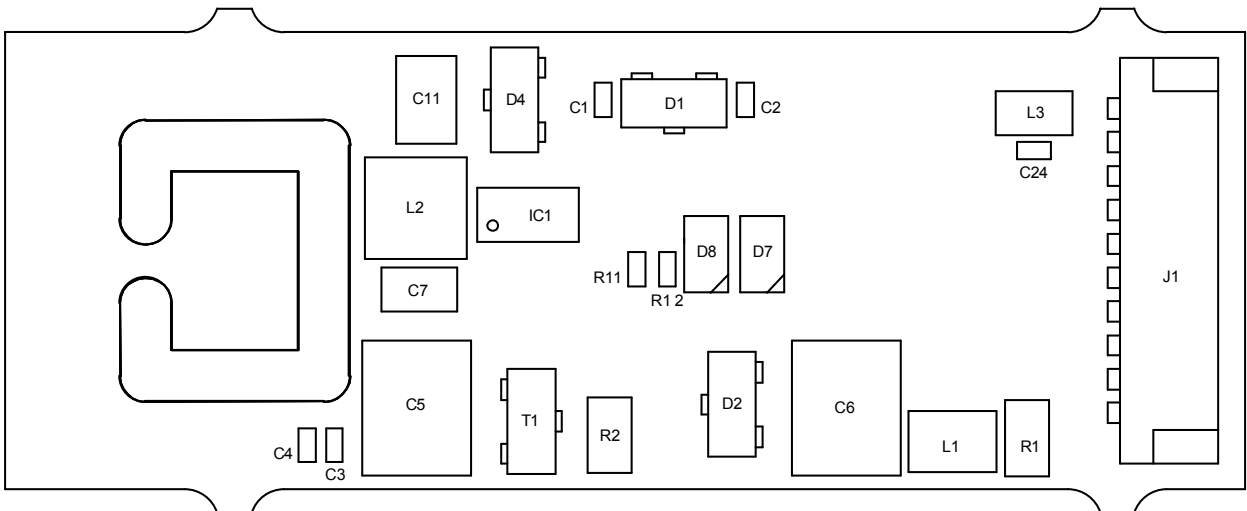

Figure 10: Assembly top TOF>range 611

Figure 11: Assembly bottom TOF>range 611

3.1.3. Schematics TOF>range 611

Figure 12: Schematics TOF>range 611

3.1.4. TOF>frame 611

The TOF>frame 611 uses the same PCB board as TOF>range 611. The only differences are with the epc611 receiver chip, which has a lens bonded to the chip and different software in the microcontroller.
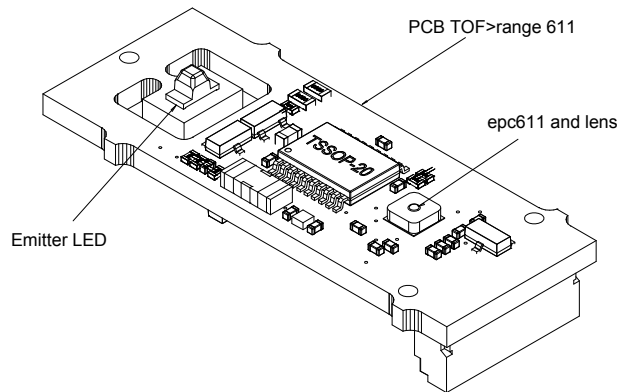

Figure 13: TOF>frame 611 overview
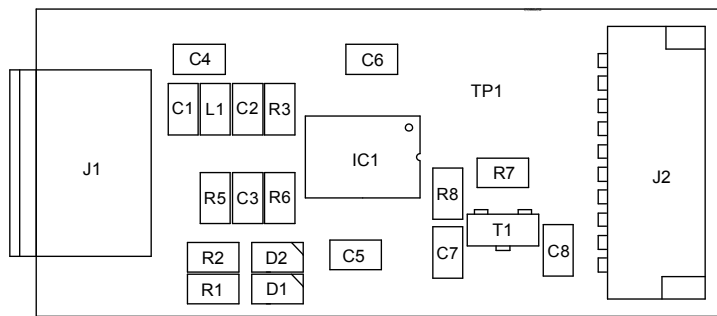
3.2. USB-UART adapter

3.2.1. Assembly USB-UART adapter

Figure 14: Assembly USB-UART adapter
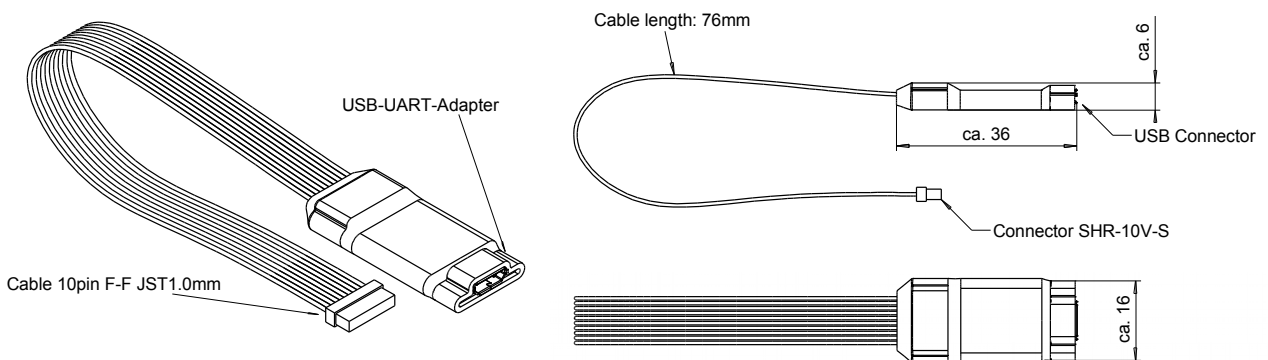
3.2.2. USB-UART adapter drawing

Figure 15: USB-UART adapter including cable

3.2.3. Schematics USB-UART adapter

Figure 16: Schematics USB-UART adapter

4. Installation and setup
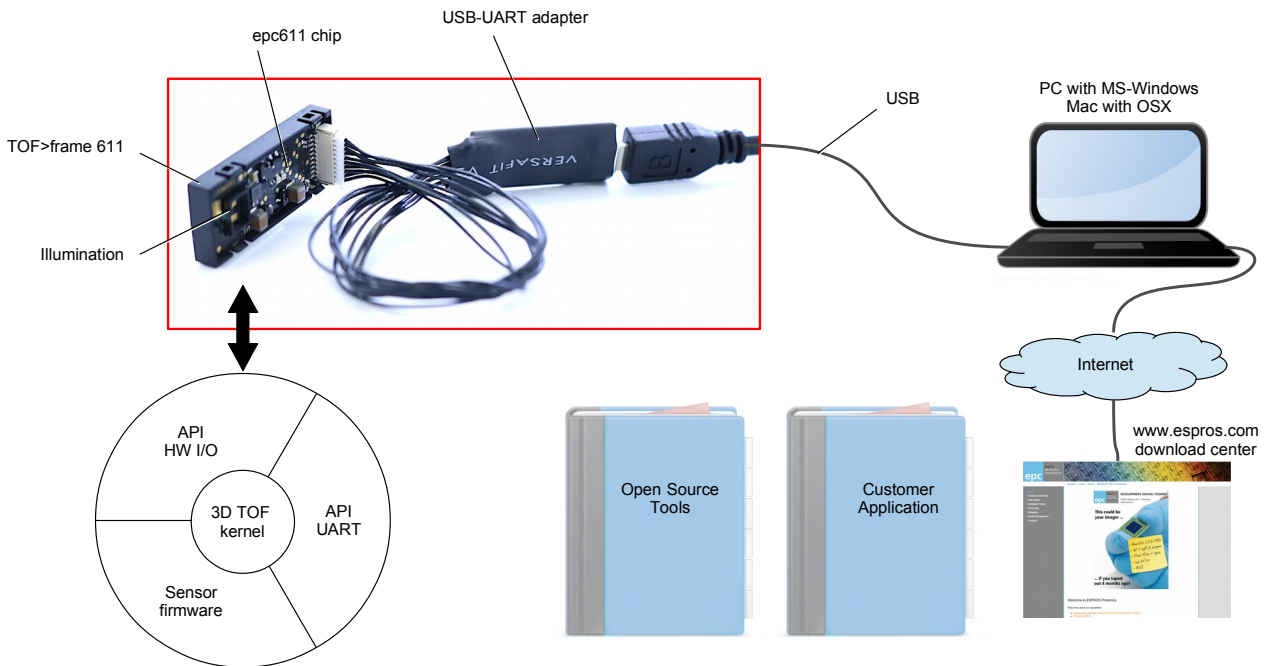
4.1. Setup the epc611 evaluation kit system

Figure 17: Principal system setup e.g. for TOF>frame 611
Refer also to Figure 6 and Figure 7.

The epc611 evaluation kit uses the TOF>range 611 and TOF>frame. They are general purpose camera/sensor modules based on the epc611 chip:

■ The sensor/camera is based on a board with a small microprocessor.

■ The sensors, with their UART interface, communicate with the computer via USB-UART adapter, using a virtual "COM" port.

■ The USB interface supplies the sensor with power.

■ The application firmware on the sensors have a 3D-TOF kernel which manages the camera, including correction algorithms.

Connecting the system

1: Connect the USB-UART adapter to the TOF>range 611 or TOF>frame 611 and the USB cable.

2: Plug the USB cable to the computer. System is powered up and ready to use.

3: Run the evaluation kit software

Disconnecting the system

1: Close the evaluation kit software

2: Disconnect the USB cable from the computer to power-off USB-UART adapter and the sensor.

4.2. Software, software development kit (SDK) and application tools

ESPROS Photonics supports the user's development and application by having various support tools available e.g. software development kit (SDK), updates and program downloads for the epc611 chip, application interfaces (API), etc. They are all available by downloading the ESPROS_epc611_Evaluation_Kit_Software_vX.X. Updates of camera firmware are also included in the package.

After the download, first read the README and CHANGELOG files to get the latest operation and application information.

4.3. Software installation

The epc611 evaluation kit uses software which can be downloaded from the ESPROS homepage at www.espros.com. Click the link "Downloads" as shown below:
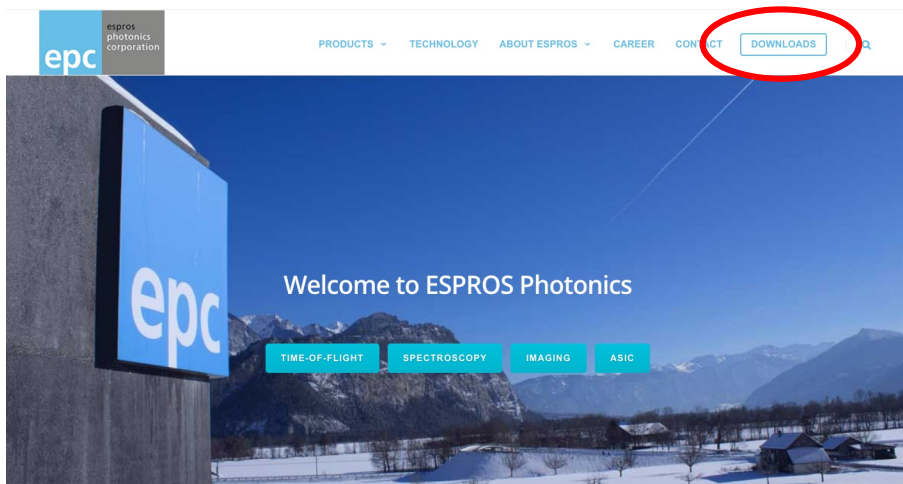

Figure 18: ESPROS homepage with the Download link

You will see a folder structure. Go to the subfolder 03_Evaluation Kits/Evaluationkit_epc611 and download the corresponding file "ESPROS_epc611_Evaluation_Kit_Software_vX.X" for Windows or Mac. Unpack the file. You will get a folder structure as shown in Figure 19.
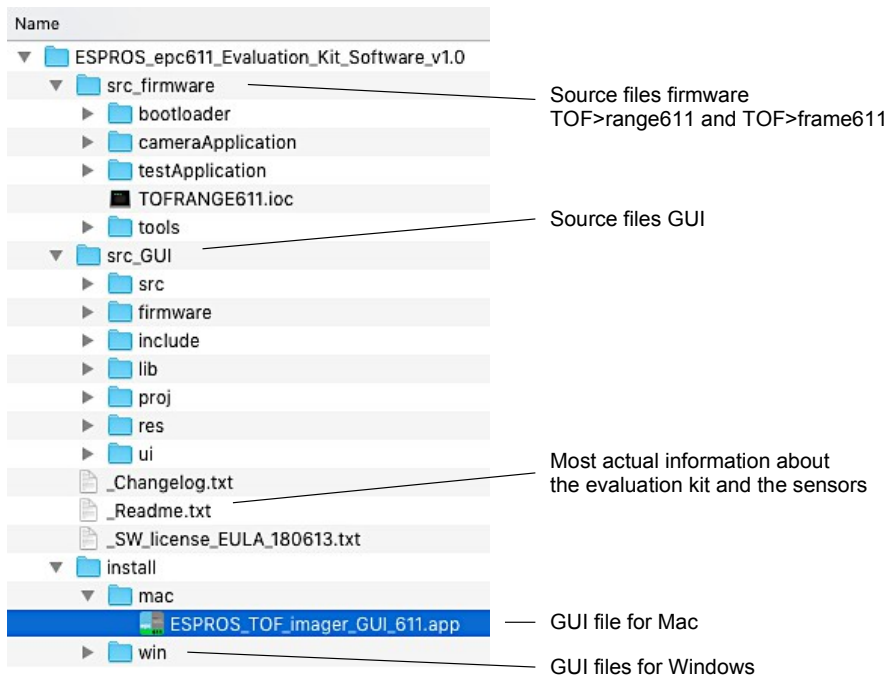

Figure 19: Folder structure after installation

Note:
The ESPROS_epc611_Evaluation_Kit_Software_vX.X does not need any driver installation. It can be run directly.

5. GUI functionality

5.1. Start the GUI software

Note:
First, after installation of a new software release, read the README and CHANGELOG files of the download package to get latest evaluation kit information.

After starting the "ESPROS_TOF-imager_GUI_611" application file, the software connects automatically to the device. The corresponding control window of the Graphical User Interface (GUI) appears.
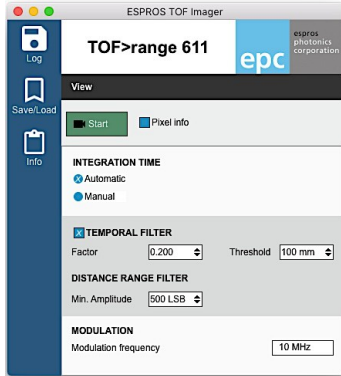

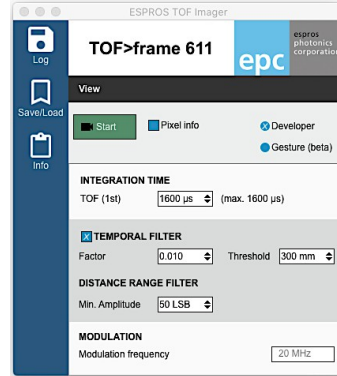Figure 20: Control window after startup for TOF>range 611

Figure 21: Control window after startup for TOF>frame 611

The GUI consists of different windows: The control window is on top, the corresponding display windows are on a lower level. The control window is used to set parameters, choose the way of displaying the camera data or images and to log data. It consists of two sections: Left is the dock with the Apps and right is the control section.

Most of the functions are self-explanatory and are not described here. However, some tool tip windows support the usage.

5.2. Operate the sensors

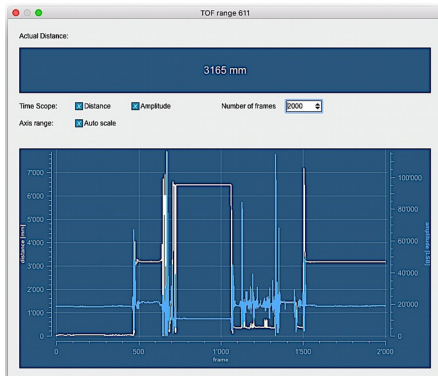Press the "Start" button. You get get the main data window:

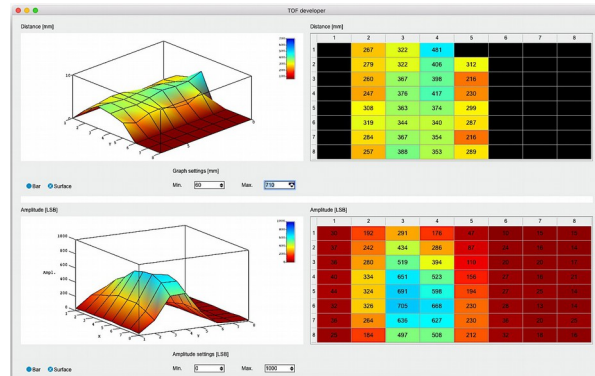Figure 22: Main data window for TOF>range 611

Figure 23: Main data window for TOF>frame 611

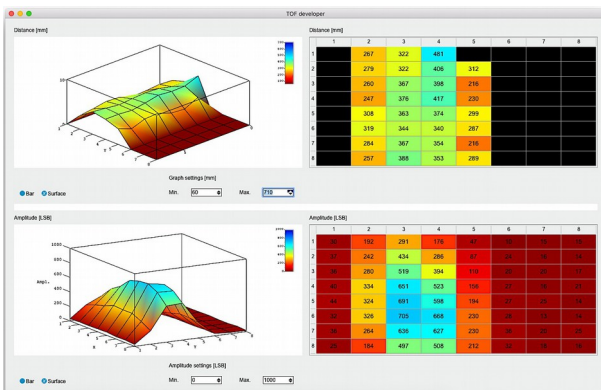## 5.3. Special functions TOF>frame 611

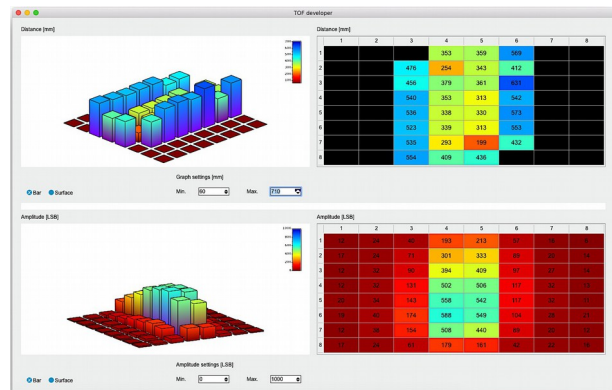Figure 24: Surface plot distance and amplitude

Figure 25: Bar graph plot distance and amplitude
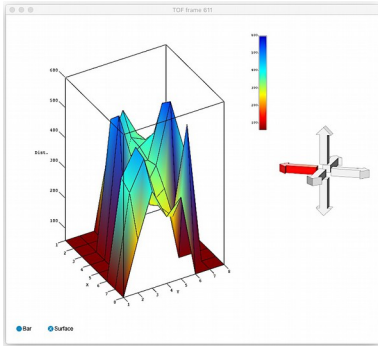
Figure 26: Gesture mode surface plot:
Distance and moving direction

Figure 27: Gesture mode bar graph:
Distance and moving direction

5.4. Miscellaneous functions

Figure 28: Pixel info TOF>range 611

Figure 29: Pixel info TOF>frame 611
Yellow arrows show selected pixel

Figure 30: GUI, firmware and chip info TOF>range 611

Figure 31: GUI shows pop-up tool tip window

Figure 32: Log dialog

Figure 33: Save, reload GUI configurations
and update the firmware

6. 3D TOF - A guideline to 3D-TOF sensors that work
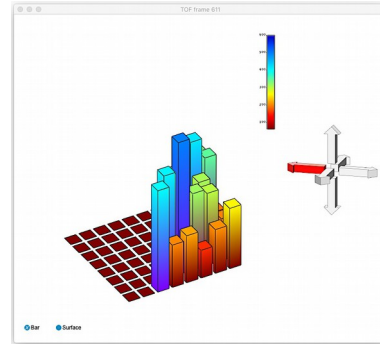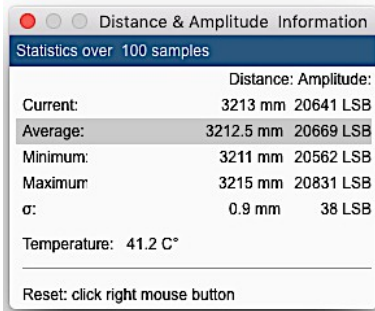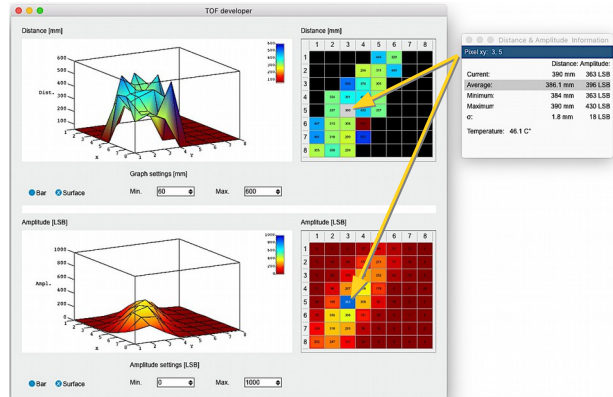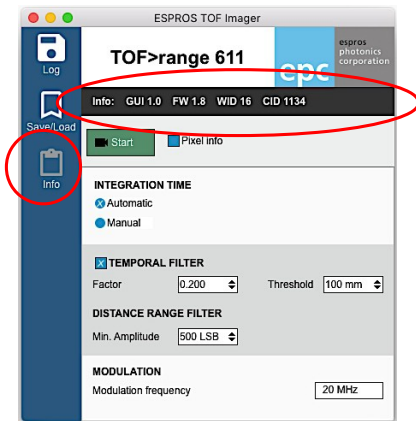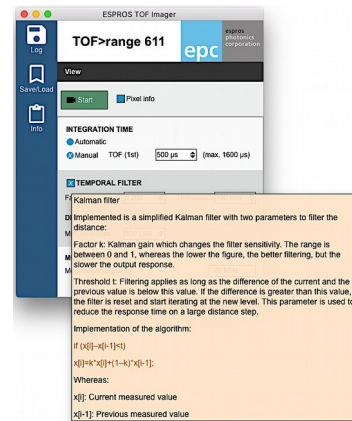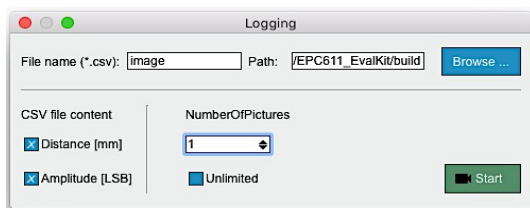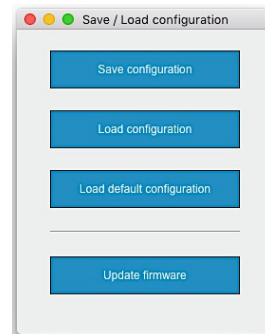
The book «3D-TOF – A guideline to 3D-TOF sensors that work», by Beat De Coi, provides the important ingredients to make TOF systems work first-time-right. In order to support the engineers with comprehensive documentation and tools about theory, background and application information, it is enclosed in this evaluation kit package.
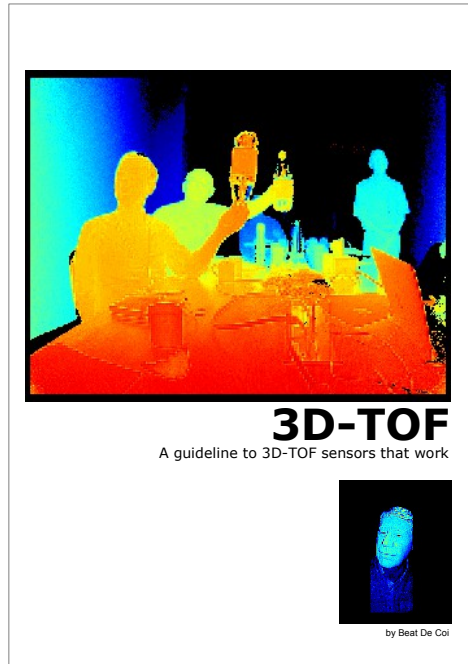

Figure 34: The comprehensive TOF book

On 200 pages, all relevant topics about to understand the background and how to implement a TOF System are presented in a very comprehensive way. In addition, lots of useful system design information are published, like the reflectivity of more than 50 different materials, the spectral power of sunlight (day and night), optical power calculation, eye safety considerations, and so on.
The book is available only with the evaluation kit or as TOF Developer Conference attendee, refer to www.espros.com.

7. Maintenance and disposal

7.1. Maintenance

The components of the device do not need regular maintenance. A functional check is recommended each time the device is taken into operation:
- Check the mounting position and the detection area of the sensor with respect to the operational conditions. Also check that there is no hazardous situation.
- From time to time, clean the lens with a soft towel and a little soapy water, to remove dust or dirt.

7.2. Disposal

Disposal should be done using the most up-to-date recycling technologies for electronic components according to the local regulations and laws. The design and manufacture of the kit's components are done in compliance with the RoHS legal regulations. Traces of dangerous materials may be found in the electronic components, but not in harmful quantities.

8. Addendum

8.1. Related documents

- Datasheet epc611, ESPROS Photonics Corp.
- Datasheet TOF>range 611, ESPROS Photonics Corp.
- Datasheet TOF>frame 611, ESPROS Photonics Corp.
- Application note AN10 TOF Calibration and Compensation, ESPROS Photonics corp.
- Application note AN12_Distance_Noise_Reduction_with_Kalman_Filter, ESPROS Photonics corp.

8.2. Links

www.espros.com

www.pointcloud.org - Point Cloud Library (PCL)

www.pdal.io - Point Data Abstraction Library (PDAL)

www.opencv.org - OpenCV (OpenSource Computer Vision)

8.3. Licenses

We appreciate the use of the following open source or free software in our tools and respect the large amount of work the owners have done:

- **Qt-5.10.0**: http://www.gnu.org/licenses/old-licenses/lgpl-2.1.html
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- **QwtPlot3D**: http://qwtplot3d.sourceforge.net/web/navigation/license.txt
  Copyright (C) 2003-2005 Michael Bieber

- **Qwt-6.1.2**: https://sourceforge.net/projects/qwt/files/qwt/6.1.2/qwt-6.1.2.pdf/download
  Copyright (C) 1997 Josef Wilgen, Copyright (C) 2002 Uwe Rathmann

- **Doxygen**: http://www.stack.nl
  Copyright (C)1997-2018 Dimitri van Heesch

- **cppUTest 3.8**: https://cpputest.github.io/
  Copyright(C) 2007, Michael Feathers, James Grenning and Bas Vodde

- **modellio3.8**: https://www.modelio.org/about-modelio/license.html
  Copyright(C) 2011-2019 Modeliosoft

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