

(rev8 January 2016)

## User manual for ThermalCapture 2.0



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# 1 Initial Operation

Before you can use ThermalCapture 2.0 the first time, take some time to learn more about the product and needed steps to a setup tailored to your needs. This guide assumes that ThermalCapture 2.0 is already mounted to a TAU core. If this is not the case please follow the *ThermalCapture 2.0 Mounting Guide* first.

## 1.1 Wiring and Connectors

ThermalCapture 2.0 has the following connectors:

|   |  |
|---|--|
| 1 | 8-pin connector                                |
| 2 | Micro sd card slot                             |
| 3 | Mini-USB for configuration and 5V power supply |



### 1.1.1 Mini-USB Connector

ThermalCapture 2.0 and the connected TAU core can be powered from the Mini-USB interface for configuration. This interface also allows the configuration of the TAU core via the FLIR TAU GUI.

To do TAU core configuration disconnect any memory devices, connect ThermalCapture 2.0 to your PC and execute steps described in chapter Configuration of the TAU Core of this guide.

Thermal Capture is intended to be used with small UAVs. You need an adapter cable from your 5V power supply to either Mini-USB or 8-pin connector. ThermalCapture 2.0 can work with a DC voltage from 4,5 to 5,5V. The source must be able to deliver at least 600mA continuous and peaks up to 1A. Our standard cable includes a power converter to allow higher input voltages (see 1.1.4).

### 1.1.2 Micro SD card slot

This is a slot for a micro sd card. ThermalCapture 2.0 stores the captured images on the memory connected to this interface. The sd card must be formatted with a FAT32 filesystem and support a minimum serial data writing speed of 10MB/s. We recommend a SDHC Class 10 with 32GB capacity for use with the ThermalCapture 2.0.

It is strongly recommended to use the [SD Formatter 4.0 for SD/SDHAC/SDXC](#) instead of formatting utilities provided with operating systems that format various types of storage media. Using generic formatting utilities may result in less than optimal performance for your memory cards.

### 1.1.3 8-pin connector

The 8-pin connector has the following pin definition:

|   |             |
|---|-------------|
| 1 | (reserved)  |
| 2 | (reserved)  |
| 3 | 5V DC input |
| 4 | GND         |
| 5 | TRIGGER_IN  |
| 6 | SERIAL_IN   |
| 7 | VIDEO GND   |
| 8 | VIDEO OUT   |

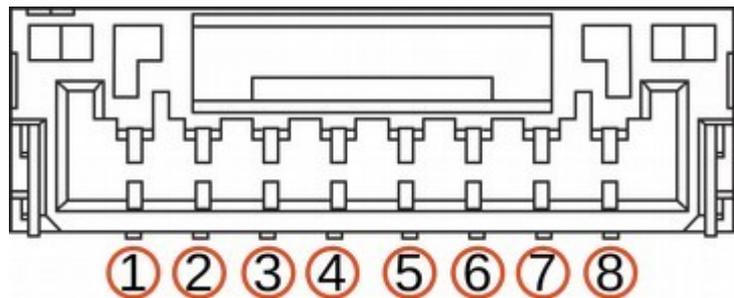


Image capture is triggered when the TRIGGER\_IN pin is pulled to ground. It is connected to 3.3V internally via resistor. You can apply a switch or a transistor between TRIGGER\_IN and GND. It is also possible to connect a digital signal (0-5V) to the trigger input.

Images are captured as long as TRIGGER\_IN is at ground level. It is not possible to connect the trigger input permanently to GND, because in this case there would be no way to switch ThermalCapture 2.0 off or release the sd card, without potentially damaging its file-system.

SERIAL\_IN is a UART interface. It supports inverted and not inverted signals (0-5V). The data

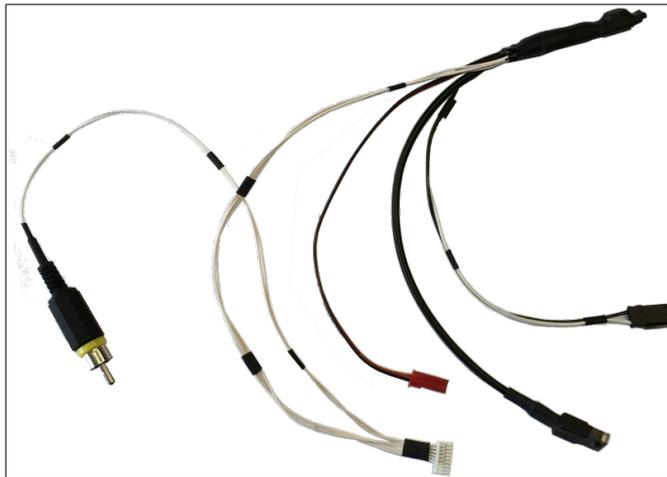
---

received at this pin is continuously stored in an internal buffer. This buffer is added to any stored image. So it is possible to connect a GPS receiver or an IMU to ThermalCapture 2.0. Since the data is only stored but not processed at ThermalCapture 2.0, any UART based protocol can be used as long the sensor begins with data output on its own. Interface settings (baud rate etc.) can be done with the serial configuration tool (see chapter 2.2).

VIDEO\_OUT provides NTSC or PAL composite video out from the TAU core. The video standard and other video related settings can be configured with FLIR TAU GUI, see chapter 2.1.

#### 1.1.4 TeAx Standard Cable Set for ThermalCapture 2.0

With each ThermalCapture 2.0 unit comes a standard cable that splits the 8-pin connector functions into easy-to-use connectors. It also includes a voltage converter which allows the system to be connected to a power source with voltages between 8V and 32V DC.



*Illustration 1: ThermalCapture 2.0 Standard Cable*

More detailed information can be found in the separate Standard cable set description:

<http://thermalcapture.com/thermalcapture-2-0-standard-cable-set>

ThermalCapture hardware itself must be powered with **5V DC**. If your power source is between 8V and 32V use our standard cable with included voltage converter. Make sure that your power source delivers at least 8V in this case.

## 2 Configuration

Before ThermalCapture 2.0 can be used in a specific setup, it is necessary to configure the TAU core correctly. Configuration of ThermalCapture 2.0 is only needed if the serial input (see chapter 1.1.3) is used to connect to a GPS receiver or a similar device.

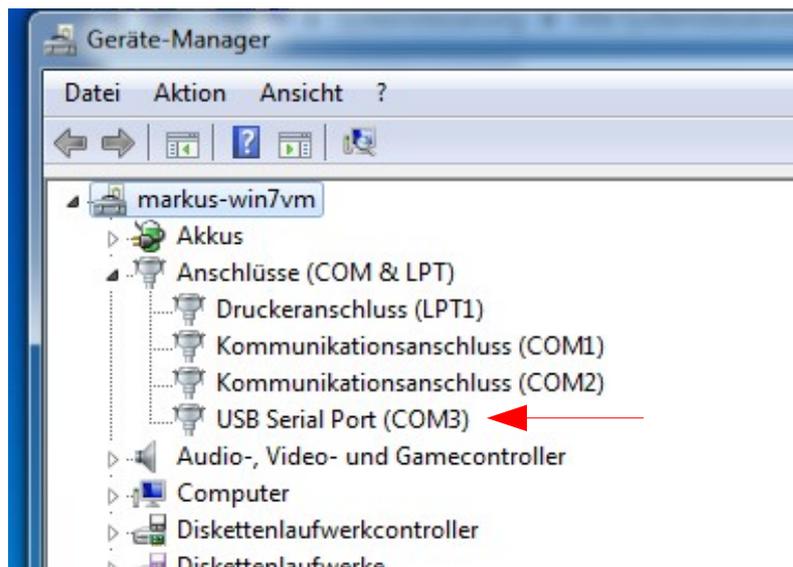
### 2.1 Configuration of the TAU Core

TAU core configuration is only necessary if you have mounted ThermalCapture 2.0 to a TAU core on your own, or if you want to change some core related settings. If this is not the case, please proceed with chapter 3.

#### 2.1.1 Driver Install

ThermalCapture 2.0 uses a virtual COM port to connect the TAU core to the Mini-USB interface. To get access to the TAU core with your PC, you may need to download and install the STM32 virtual COM port driver from [STM32 Virtual COM Port Driver](#)

After installation the TAU core is connected to a virtual serial interface (COMX). Please open the device manager and look which COM – interface it has got.



## 2.1.2 Flir Software Installation

The configuration of the Tau core is done by software from FLIR.

You need the FLIR Camera Controller GUI for Tau and Quark:

<http://www.flir.com/cvs/cores/view/?id=51880>

and the FLIR GUI User Guide:

[http://www.flir.com/uploadedFiles/OEM/Products/LWIR-Cameras/Vue/flir\\_gui\\_user\\_guide.pdf](http://www.flir.com/uploadedFiles/OEM/Products/LWIR-Cameras/Vue/flir_gui_user_guide.pdf)

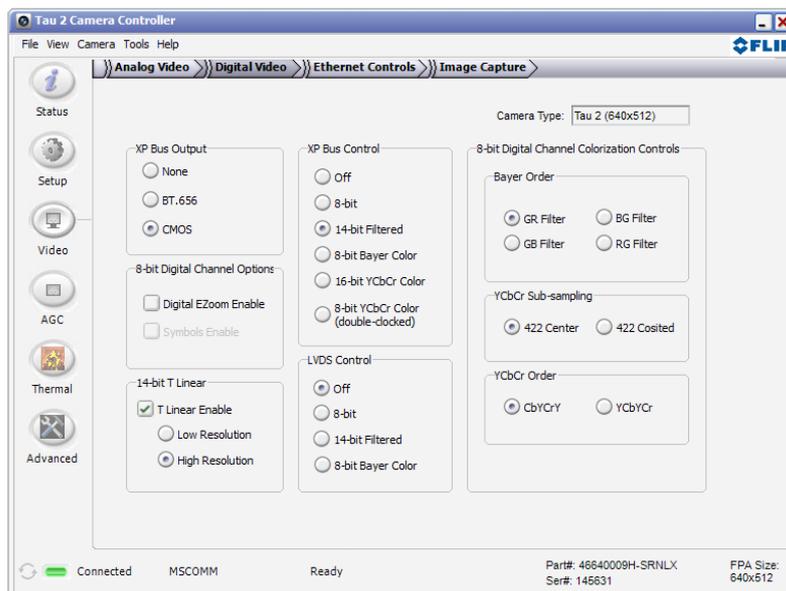
Connect the Mini-USB interface of ThermalCapture 2.0 to your PC and follow Chapter 4 of the FLIR GUI User Guide to connect to the camera.

## 2.1.3 TAU Configuration

ThermalCapture 2.0 gets the images from the digital output of the TAU core. This output is switched off by default. If the output is not enabled, ThermalCapture 2.0 cannot record images.

The digital output must be enabled with the Flir "Camera Controller GUI".

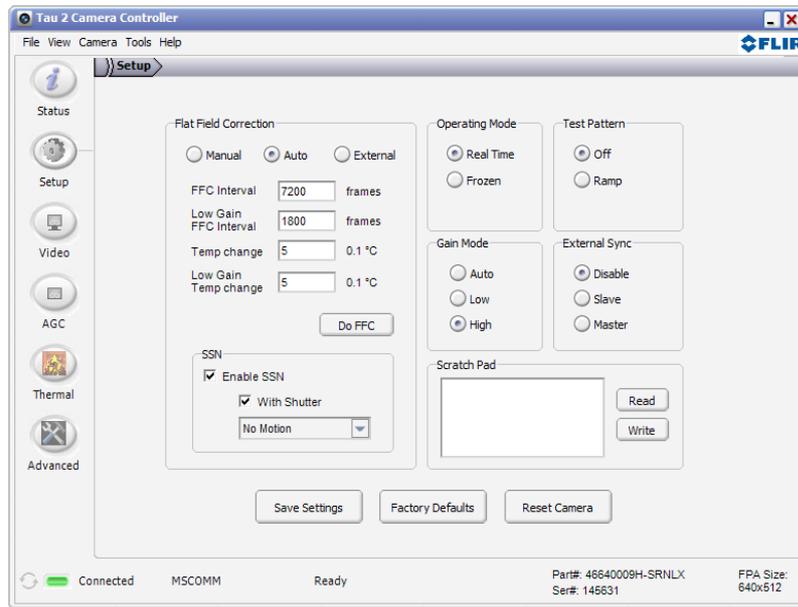
After the FLIR GUI has connected to the TAU core, go to the Digital Video Tab and select CMOS for XP Bus Output and 14-bit filtered output.



If your TAU core has the “advanced radiometry option”, TLinear should be enabled to have per pixel temperature measurement in ThermoViewer.

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These settings must be saved permanently. To achieve this, go to the Setup tab and click to Save Settings.

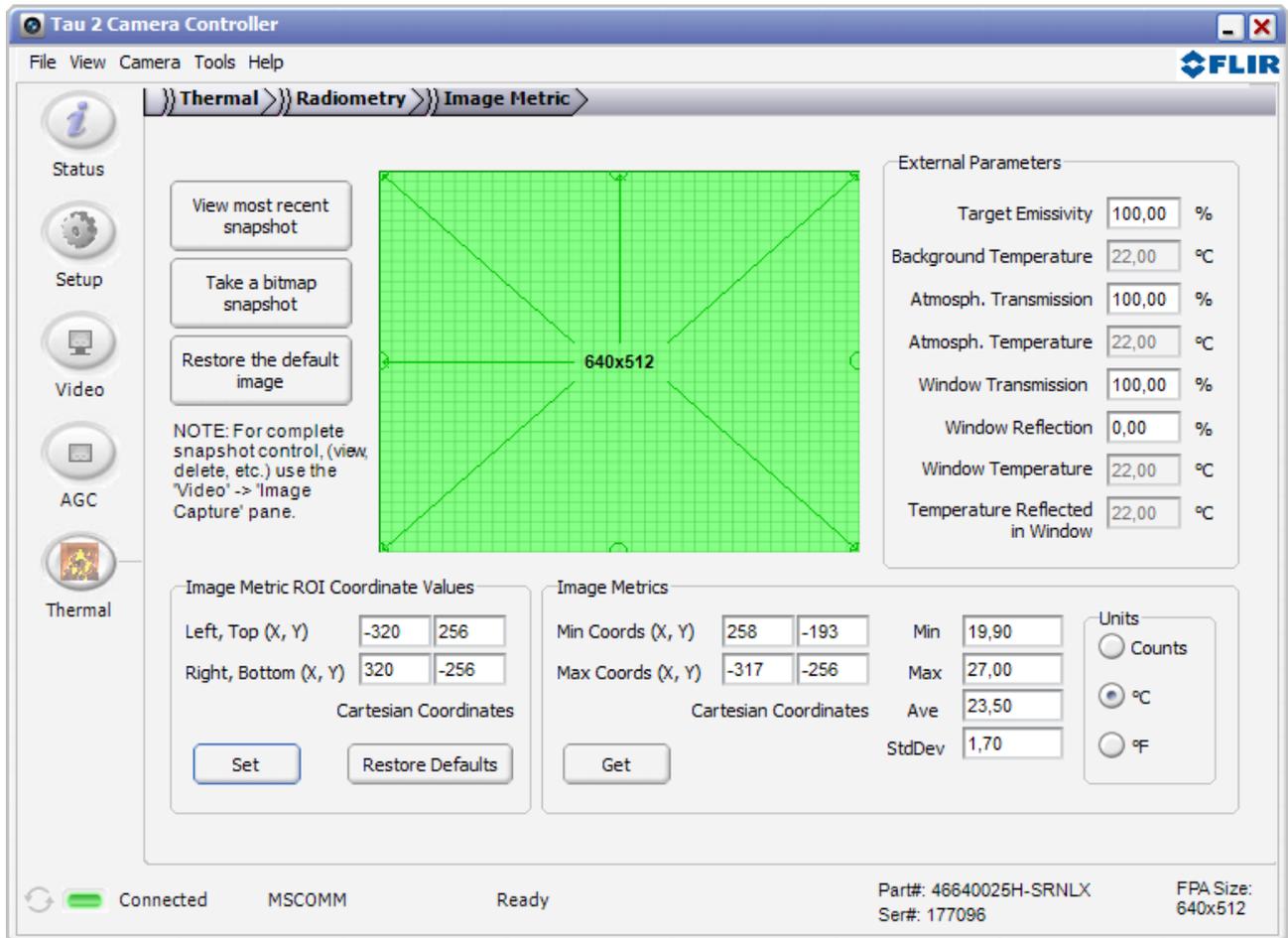


Without saving, settings will be lost with the next power cycle and recording cannot work.

Now the TAU core is ready to be used with ThermalCapture 2.0.

### 2.1.4 Tau Configuration for Overlay Feature

To use the overlay feature the region of interest must be configured to use all available pixels. To do this open Flir "Camera Controller GUI" and go to the **Thermal** → **Radiometry** → **Image** tab. In the Image Metric setup make sure that the "Image Metric ROI Coordinate Values" fit your FLIR Tau core:



For a FLIR Tau core with a resolution of 640x512 pixels use:

|                      |      |      |
|----------------------|------|------|
| Left, Top (X, Y)     | -320 | 256  |
| Right, Bottom (X, Y) | 320  | -256 |

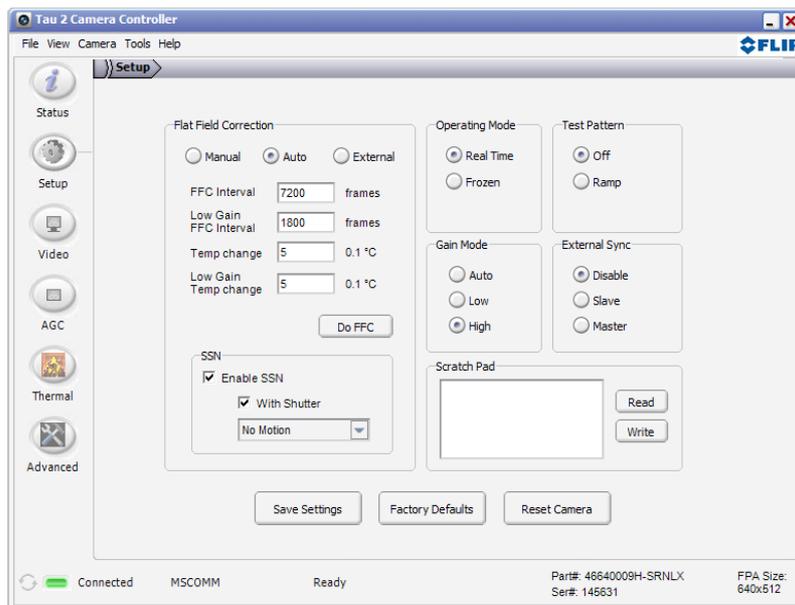
For a FLIR Tau core with a resolution of 336x256 pixels use:

|                      |      |      |
|----------------------|------|------|
| Left, Top (X, Y)     | -168 | 128  |
| Right, Bottom (X, Y) | 168  | -128 |

For a FLIR Tau core with a resolution of 324x256 pixels use:

|                      |      |      |
|----------------------|------|------|
| Left, Top (X, Y)     | -162 | 128  |
| Right, Bottom (X, Y) | 162  | -128 |

After entering the correct values click on “Set”. Additionally these settings must be saved permanently. To achieve this, go to the Setup tab and click to Save Settings.



Without “Set” and “Save Settings”, settings will be lost with the next power cycle and overlay cannot work.

## **2.2 Configuration of ThermalCapture 2.0**

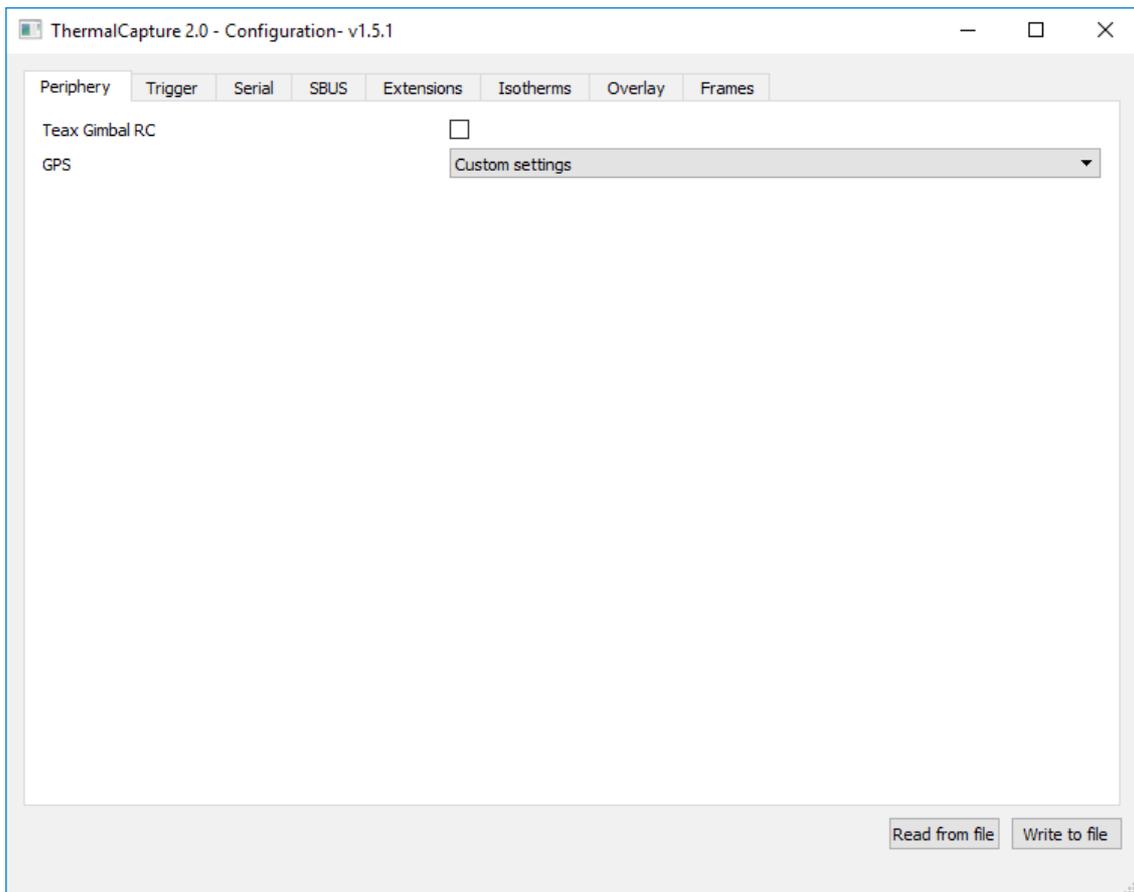
ThermalCapture is configured by placing a TCCONFIG.BIN file in the root directory of the SD card onto which data is recorded. During boot-up ThermalCapture parses this file and stores the included parameters as new default. If no configuration file is found, the default configuration is written to the sd card. Creation of this files is done by using ThermalCapture configuration tool, which is available here: <http://thermalcapture.com/thermalcapture-configurator>

The button “Write to file” opens a file dialog in which the root directory of the sd card should be selected as target. The supposed filename “TCCONFIG.BIN” must be used to allow ThermalCapture 2.0 to read it. The file can also be saved to a different destination and copied to the sd card manually later on.

## 2.2.1 Periphery

The *Periphery* tab allows easy access to preconfigured settings for various devices:

- TeAx Gimbal RC
- ThermalCapture GPS Receiver - based on u-blox 6 SuperSense® chipset
- ThermalCapture GPS Receiver - based on u-blox 8 Multi GNSS UBX-M8030-KT chipset



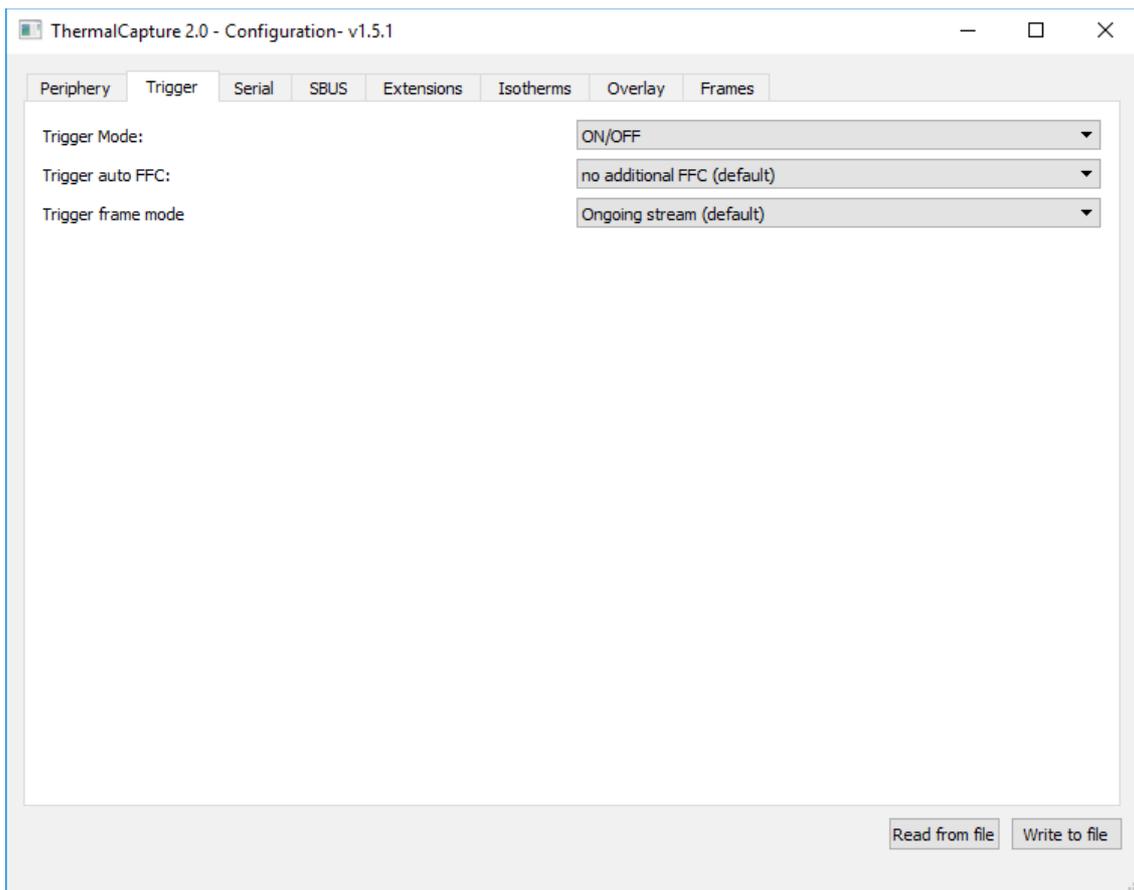
## 2.2.2 Trigger detection

**Trigger Mode** ThermalCapture can be configured to automatically detect the type of trigger signal. These choices are possible:

- Standard trigger detection
- SBUS
- Serial input
- PWM
- PWM (inverted signal)

**Trigger auto FFC** ThermalCapture can be configured to enforce a flat field correction every time a recording is started.

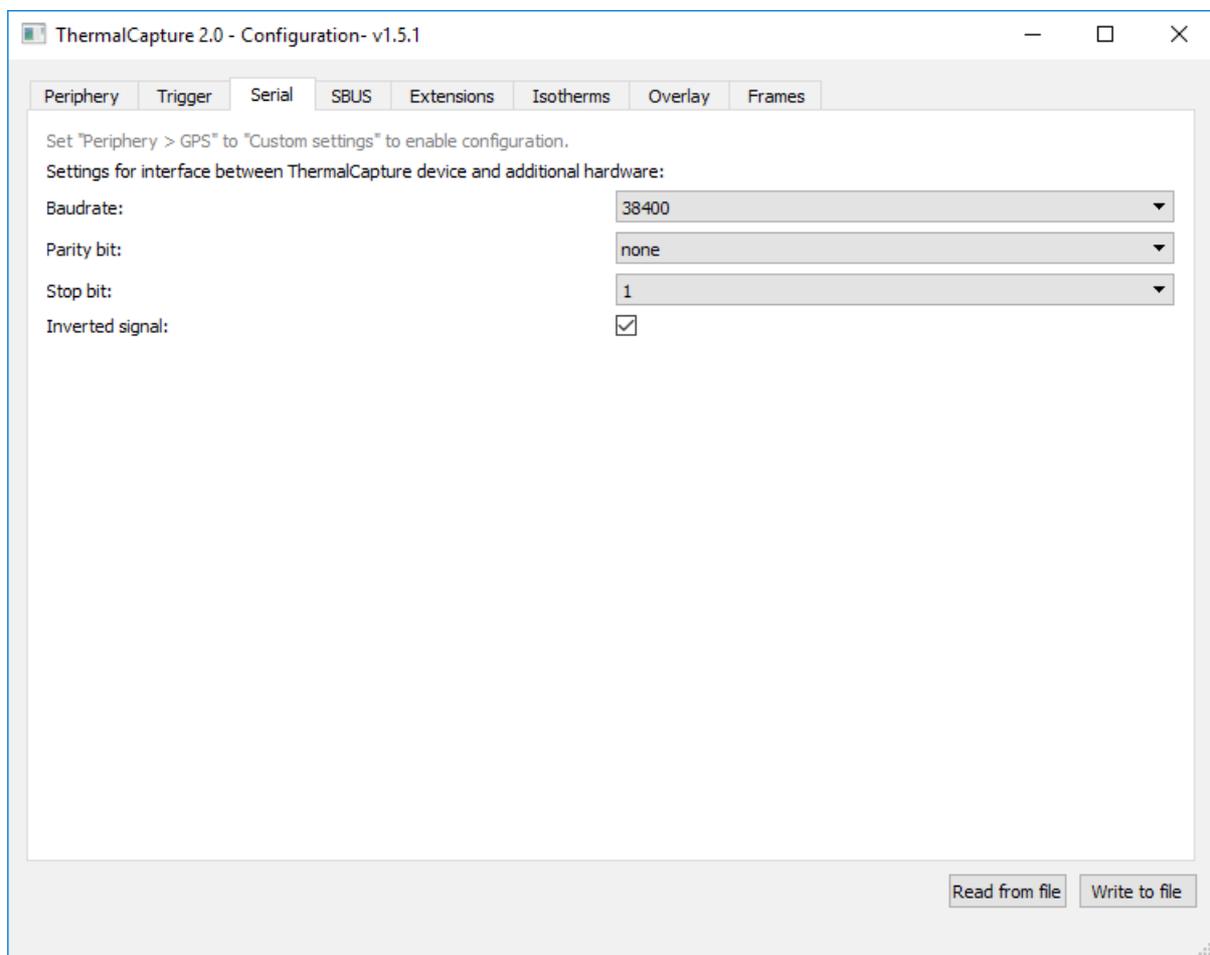
**Trigger frame mode** ThermalCapture can be configured to record an ongoing stream of images or just one single frame when recording is started.



### 2.2.3 Serial interface

If the serial input (see chapter 1.1.3) is used, it needs to be configured for a specific data source. ThermalCapture 2.0 is delivered together with a configuration software to set up this serial interface. This chapter describes how to use the TC-Configurator software.

If ThermalCapture 2.0 is used together with the official TeAx GPS receiver no configuration file is needed. ThermalCapture 2.0 comes pre-configured for this add-on.



Settings for the serial interface are communicated to ThermalCapture 2.0 by generating a configuration file and saving it onto the sd card, which is used for picture storage. This file contains information about the Baudrate, Parity Bit-, Stop Bit- and Inversion-settings. These settings must match with the settings of the connected hardware.

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- Supported Baudrates range from 1200 to 115200
- Parity can be set to “none”, “odd”, or “even”
- 1 or 2 Stop bits
- Inverted signal check box determines, if inversion is active or not

Required settings for TeAx GPS receiver are the following ones:

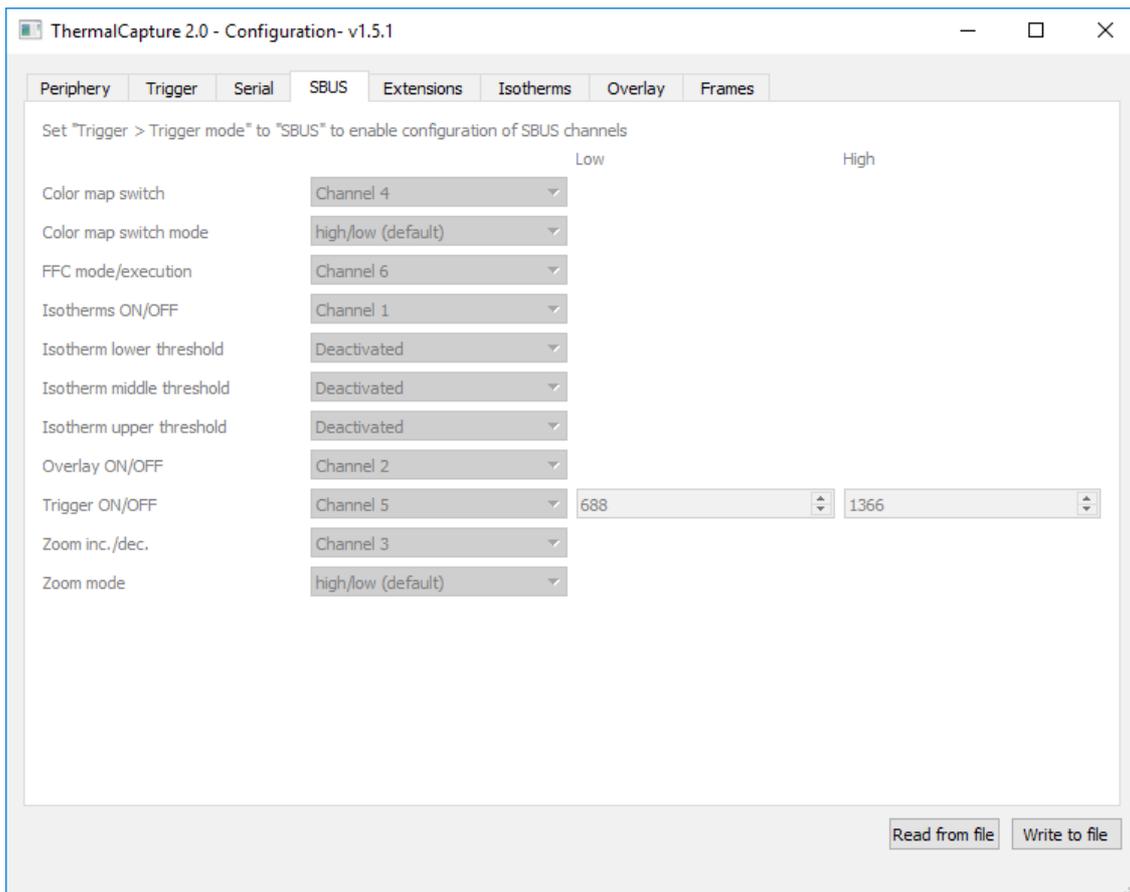
Baudrate: 38400  
Parity bit: none  
Stop bit: 1  
Inverted signal: yes

ThermalCapture comes preconfigured with this settings. They only have to be re-applied if changed before.

## 2.2.4 SBUS configuration

ThermalCapture can be controlled via SBUS. Adjustable features are the following:

- Color-palette for live video
- FFC mode/execution: Switch between Auto/manual and enforced execution of a FFC.
- Isotherms activated/deactivated the isotherms in live video
- Isotherms thresholds changes the lower/middle/upper thresholds of the isotherms.
- Activate/Deactivate overlay of hotspot marker in live video
- Trigger Start/Stop/Single recording. Switch between ongoing stream, stop recording and single frame capture. In stream mode the trigger starts/stops recording. In single frame mode a single frame is recorded when the trigger is started.
- Digital zoom level in live video



For each feature a single SBUS channel can be assigned.

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### **2.2.5 Extensions**

The two extension lines of ThermalCapture can be configured for specific tasks. Currently its possible to synchronize several ThermalCaptures via expansion line 1 and enforce a FFC event via line 0. Please contact us before using this feature.

### **2.2.6 Isotherms**

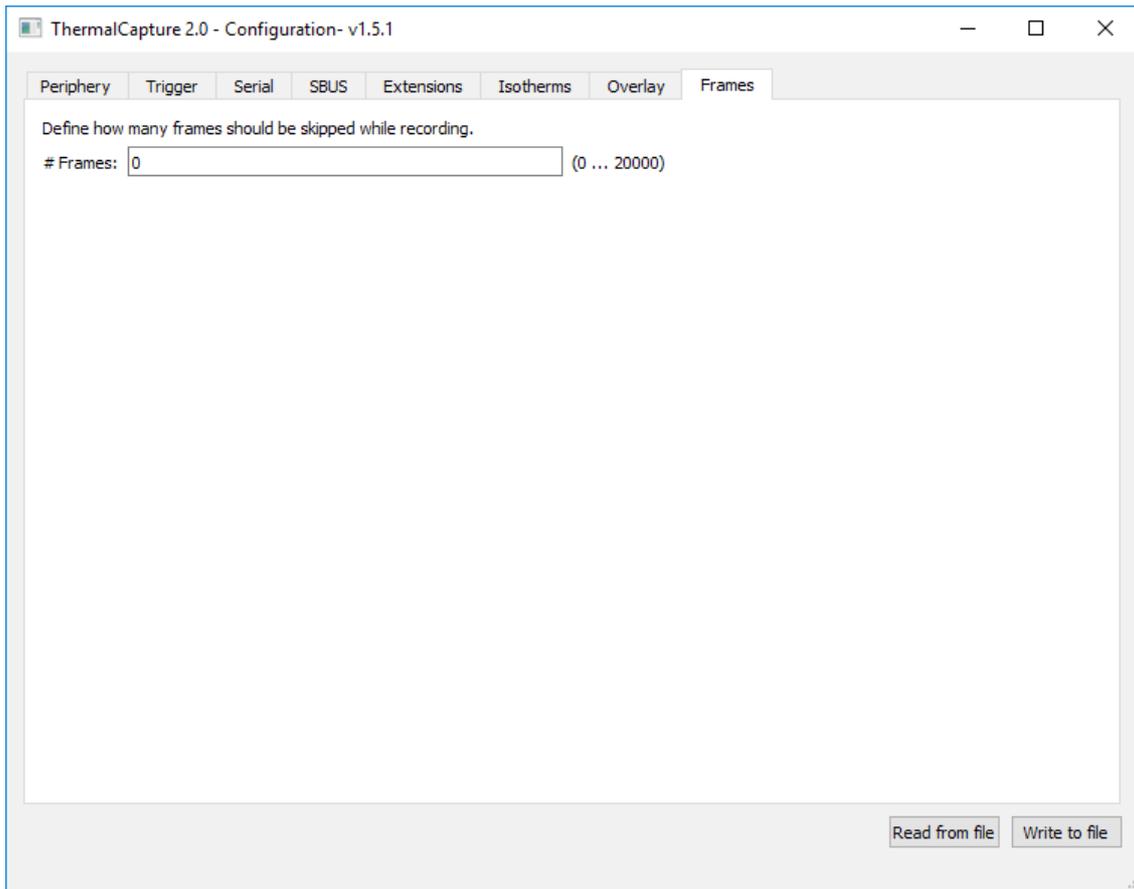
The isotherms mode for live view can be configured in this screen. In can be activated/deactivated and the default lower/middle/upper thresholds can be configured.

### **2.2.7 Overlay**

The overlay function can be configured to be automatically on upon startup.

## 2.2.8 Frame skip

For some applications it may not be necessary to record all frames coming from the Tau Core in order to reduce the amount of data in post-processing steps. Therefore it is possible to chose the amount of frames that should be skipped between each recording.



The Tau Core delivers frames with 8.33Hz in the not export restricted versions. If a recording frame rate of approximately 1Hz is desired a value of 7 skipped frames does exactly this. The result is 1 frame gets recorded; the next 7 frames are discarded; 1 frame is recorded; and so on.

This parameter is also useful if only one frame should be recorded with each trigger event. If for example the trigger is activated automatically by the waypoint functionality of the UAV, this parameter should be set to a number > 10. That ensures that even, if the UAV activates the trigger for 1 second, only one frame is stored. The number can be set even higher, because the counter is reset with every new trigger event.

## **3 ThermalCapture 2.0 Usage**

ThermalCapture 2.0 was designed to be used with UAVs. Its task is to store thermal image data from the TAU core, when the trigger signal occurs. So there is only limited human intervention necessary to operate ThermalCapture 2.0. In the following the complete process from power up through data recording to power down is described.

### **3.1 Power On**

You can power on with or without a connected sd card. ThermalCapture 2.0 begins to boot immediately when 5V is supplied to the MINI-USB connector or to the 8-pin connector. During boot up the LED on the back side glows red. This will take one or two seconds. After boot up ThermalCapture 2.0 waits for the sd card and the LED glows green. When the sd card was found and ThermalCapture 2.0 is ready to work, this LED will start blinking green.

### **3.2 Data Recording**

When the trigger input is pulled to ground images from the TAU core are captured and stored to the sd card. The LED on the back side will flicker red and the letters "REC" are shown in the analog video output. Do not power off ThermalCapture 2.0 or release the sd card when the red LED is flickering. The file-system of the sd card may get damaged. If an error occurred while writing the data to the sd card the LED will blink green and red alternately. This will also happen if the sd card is full.

### **3.3 Power Off**

Every time the LED does not flicker red, it is safe to remove the sd card or to power off ThermalCapture 2.0. Power off can only be done by turning off the power supply which is connected to the MINI-USB connector or 8-pin connector.

## 4 Post Processing with ThermoViewer Software

ThermoViewer is the post-processing software provided by TeAx Technology to process RAW data captured with ThermalCapture 2.0. It allows the user to quickly browse through recorded data and tune every single frame into the perfect result. For further usage of the data it can be exported into images like JPG and PNG, videos and CSV data. CSV is especially useful, if further automatic data processing follows. There is also the option to export data into radiometric JPGs. Those files can be opened with powerful FLIR tools for deeper analysis, or automatic report generation.

### 4.1 Overview

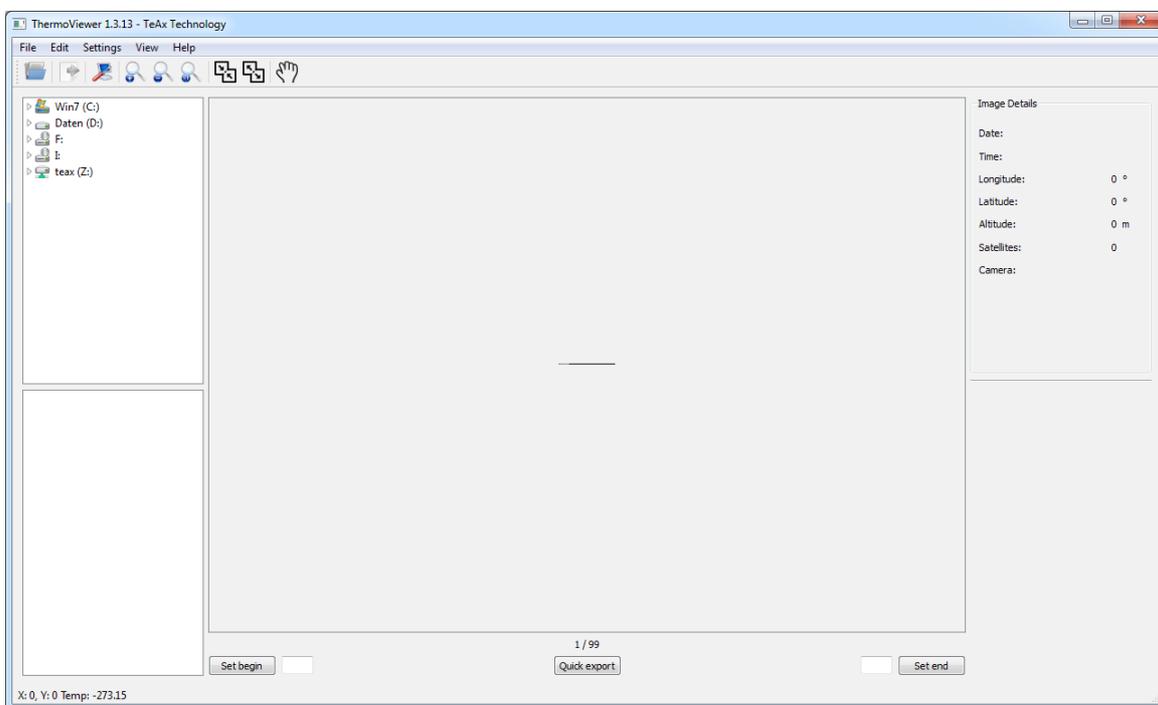


Figure 1: ThermoViewer after loading

Once you open up ThermoViewer you will see a window like shown above. On the top there are menu- and tool bar. The main window part below is split into three areas:

On the left side there are folder and file browsing areas (see 4.2.1). In the middle is the canvas for images. Underneath are the video control elements. On the right side additional image properties are displayed.

## 4.2 File handling

This section describes everything about opening and viewing of data, recorded with ThermalCapture 2.0.

### 4.2.1 Open and browse files

Opening files can be done in three different ways:

1. Select the folder directly in the directory tree on the left side of the window. Once you select the desired directory, the file list underneath will show all compatible files within it.
2. Use the toolbar button: 
3. Use the corresponding menu item within the “File” menu.

Either way the first image is loaded and shown in the center area of ThermoViewer. All parameters needed for conversion from RAW into a user friendly representation are determined automatically, if this feature is not disabled by the user.

### 4.2.2 Playback

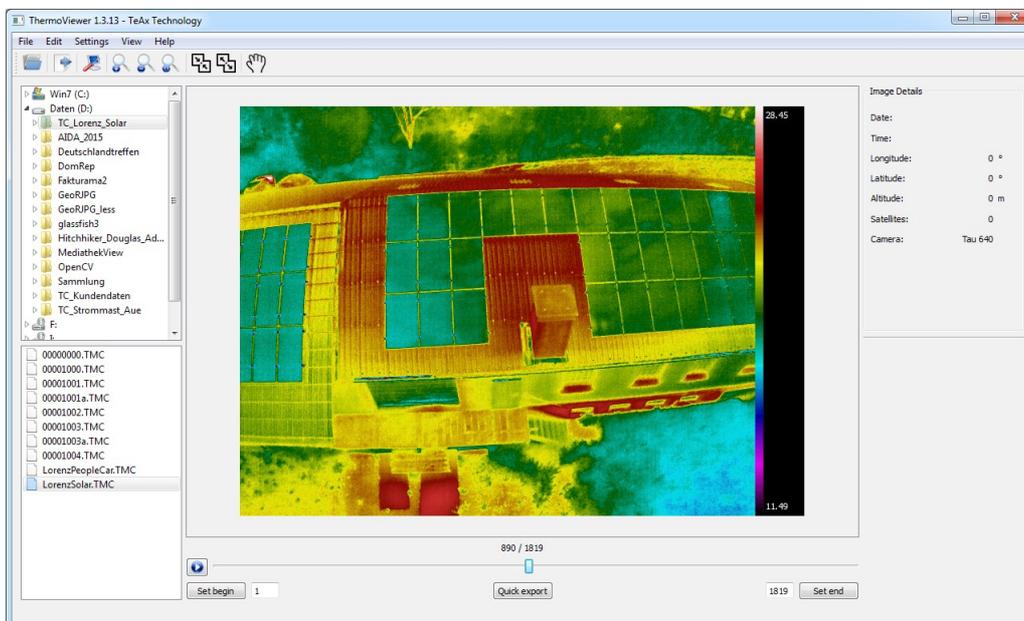


Figure 2: ThermoViewer after loading RAW data file



Figure 3: Video controls

A data set contains from 1 to 1000 frames, when recorded with ThermalCapture 2.0. To quickly browse through the frames, a simple slider drag, shown in Figure 3 is enough. Left to the slider there is a playback button which starts an automatic replay.

### 4.2.3 Zooming and dragging

To zoom in and out simply place the mouse cursor over the image and turn the mouse wheel up, or down.

Alternatively three buttons from the toolbar can be used:



Zoom in



Zoom out



Original size

If the zoom level is high, the image may not fit into the canvas anymore. To move the currently visible part of the image, either the two scrollbars can be moved, or the mouse behavior can be changed.



Switch to drag mode



Switch to measurement mode

When in drag mode the image can be dragged around by holding down the left mouse button and moving the mouse.

### 4.2.4 Temperature reading

ThermalCapture 2.0 stores radiometric data. That means, that for every pixel in every frame, temperature information is available. To determine the temperature of a given pixel, simply move

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the mouse cursor over the pixel. It is recommended to switch the mouse mode to “measurement” to be able to select pixels more accurately. The temperature value is shown together with the pixel position in the lower left corner of the ThermoViewer window.

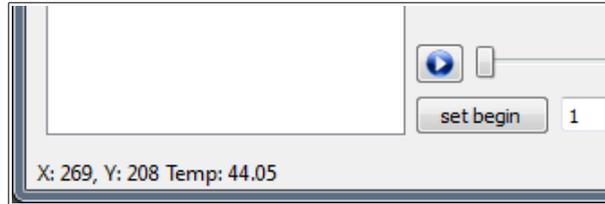


Figure 4: Temperature reading

If instead of the temperature a RAW value is displayed you need to change the “Radiometry” setting. See 4.3.4 how to do this.

#### 4.2.5 Split and merge

Sometimes it is useful to combine multiple recorded .TMC files into one, or split a single file into smaller parts. There are two buttons within the toolbar for this tasks:



Merge



Split

**Merge:** Opens a dialog where multiple files can be chosen and merged into one single output file.

**Split:** Splits the currently loaded .TMC file starting with the frame defined using the “Set begin” button up to the one defined by “Set end”. After clicking, a file browse dialog appears, where location and name for the new file can be defined.

### 4.3 Adjust RAW conversion parameters

In general ThermoViewer uses a built-in algorithm to convert every recorded dataset into a good looking image. But in some cases the user wants to adjust parameters to specific needs in order to highlight details, or to fade out meaningless areas. This section describes the available tools to optimize the results.

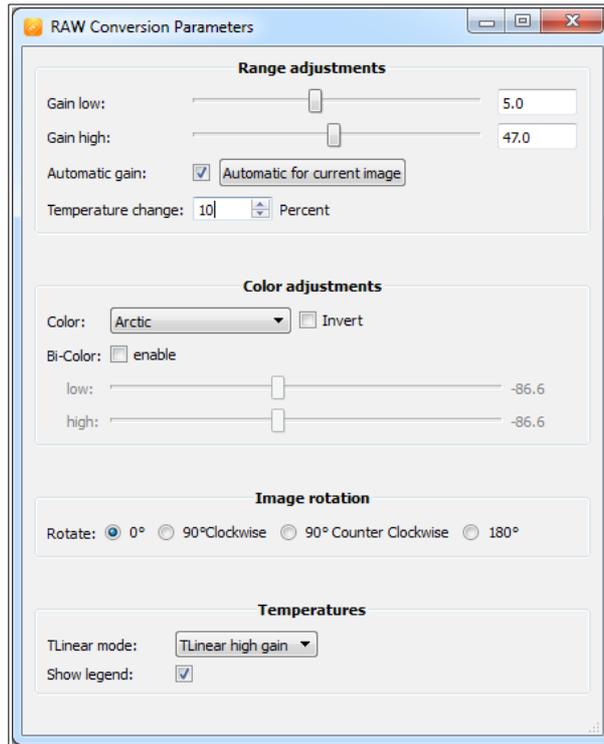


Figure 5: RAW Conversion Parameters dialog

### 4.3.1 Range adjustments

“Gain low” and “Gain high” represent the minimum and maximum temperatures, or RAW values that are used to produce the false color representation of measured data. In standard settings this values are determined automatically for each frame. If this is not wanted, deselect the “Automatic gain” option.

Manual settings are recommended, if recorded data contains a wide range of temperatures, but only a smaller range is of interest. By adjusting the boundaries, objects of interest can be segmented without the need for further post-processing. An example for this is given in Figure 6.



*Figure 6: Left: Automatic gain, Right: Manual gain settings*

If the data results in flickering representation during automatic playback or after video export, the maximum changes for “Gain low” and “Gain high” from one frame to the next can be delimited. This acts like a low-pass filter for video and playback.

### 4.3.2 Color adjustments

There are four different color palettes available, which all can be inverted for even better adoption to needed results. Figure 7 shows resulting false color images for the same dataset.

Each of the four palettes can be inverted, so that in total eight false color representations are available. Depending on the required result, different settings should be tested and verified.

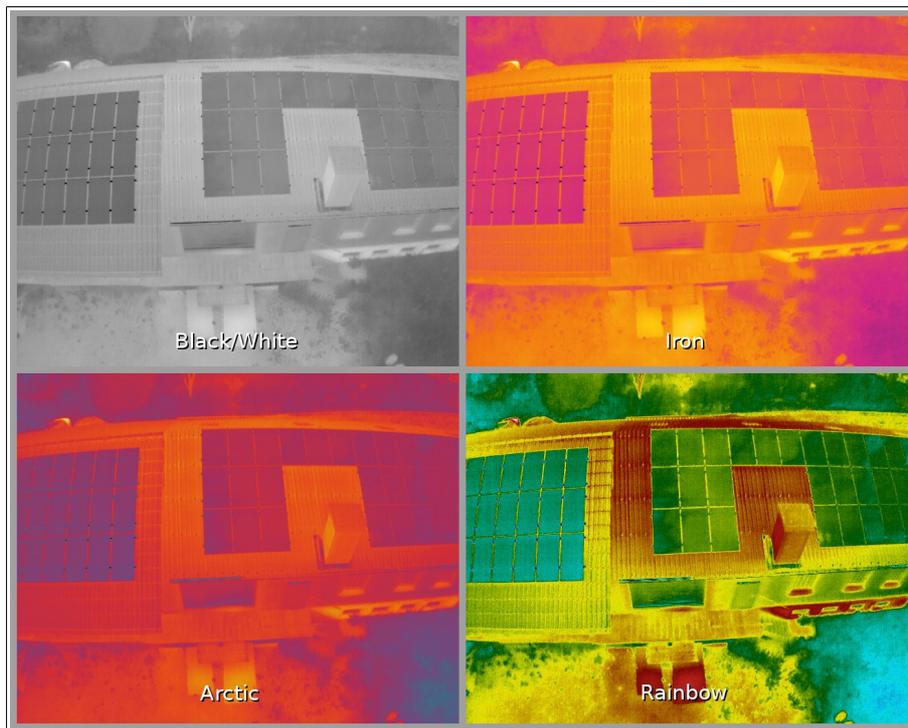


Figure 7: Color palettes

### 4.3.3 Image rotation

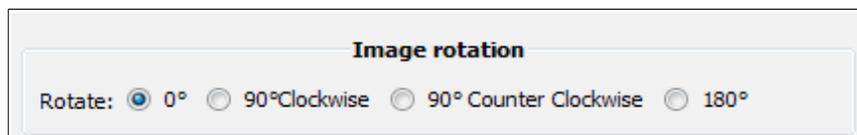


Figure 8: Image rotation options

Depending on how ThermalCapture 2.0 is mounted, it may be necessary to rotate recorded data. 90° steps are available.

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### 4.3.4 Temperatures

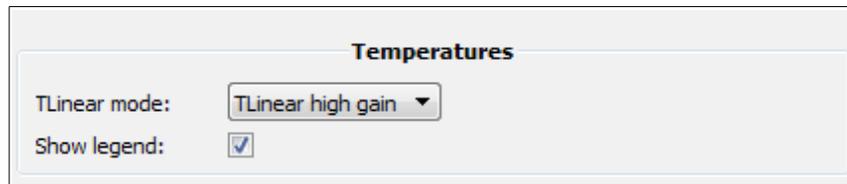


Figure 9: Temperature options

ThermalCapture 2.0, respectively the Tau Cores can operate in two different temperature ranges, which are called “High gain” and “Low gain”. In “High gain” mode temperatures between -25°C and +135°C can be measured. “Low gain” mode allows temperatures between -40°C and +550°C to be obtained. Settings within ThermoViewer must match settings within the Tau Core to provide valid temperature output.

The “Show legend” checkbox determines, if a temperature scale together, with the minimum and maximum temperature of the scene is placed to the right side of an image, or not.

## 4.4 Export functions

Data can be exported into several output formats, in order to use them for reports or further post-processing with other software tools. Most requested feature is the compatibility to FLIR software packages like, FLIR Tools(+), or ResearchIR and the export into CSV (comma-separated-values) files.



Figure 10: Toolbar

To open the export dialog press the 2<sup>nd</sup> item from the left within the toolbar, or select the item “Export frames” from the file menu.

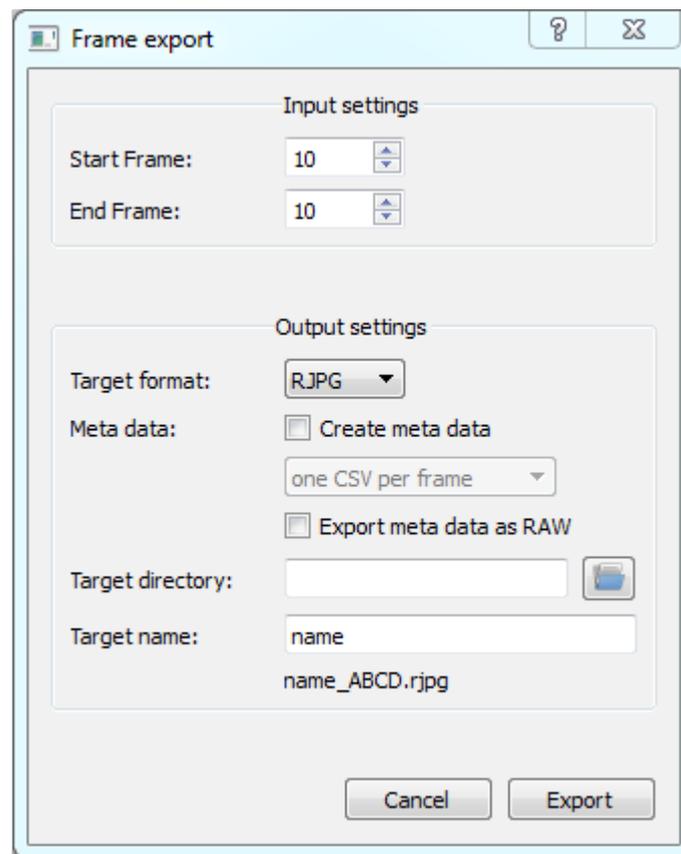


Figure 11: Frame export dialog

In the “Frame export” dialog the user can set all necessary options for the export of single or multiple frames. The first step is to select frames, which should be exported. The values in the input fields are taken from the main window input fields, but can be adjusted here if needed.

#### 4.4.1 Target format

Target format can be selected by the drop down menu. Available formats are radiometric JPG (RJPG), PNG, JPG, TIF, CSV and AVI.

**RJPG:** 24-bit RGB image with compression; Includes complete radiometric information to be compatible with FLIR software.

**PNG:** 24-bit RGB image with lossless compression

**JPG:** 24-bit RGB image with compression

**TIF:** Single channel 16-bit image without compression. Contains the 14-bit data shifted to 16-bit.

**CSV:** Comma-separated value file, which contains the RAW measurements, respectively the measured temperature per pixel. Output depends on the temperature settings (page 28) within the RAW conversion parameters dialog (page 25).

**AVI:** Video in motion JPG format. Settings from the RAW conversion parameters dialog (page 25) are applied.

#### 4.4.2 Meta data

There is also the option to export meta information together with each frame to have position information. There are three target formats:

**CSV:** This selection creates either one file per frame, or one file for all frames containing rows for each frame in the following format:

| Column | Content                                 |
|--------|---|
| 1      | Date: DD.MM.YYYY                        |
| 2      | Time: HH.MM.SS                          |
| 3      | Latitude: -180 to +180 decimal degrees  |
| 4      | Longitude: -180 to +180 decimal degrees |
| 5      | Pitch: decimal degrees                  |
| 6      | Roll: decimal degrees                   |
| 7      | Yaw: decimal degrees                    |
| 8      | Altitude above N.N. in meters           |
| 9      | Number of visible satellites            |

A third option for CSV is “*one CSV for all frames (Pix4D)*”. This creates a file, which is readable by Pix4D in order to have exported data geo-referenced.

**KML:** This selection creates a Google Earth compatible output, which places a marker at each position, where a frame is recorded.

**RAW:** This exports the raw data recorded with each frame into a .DAT file, which can be parsed in post processing.

### **4.4.3 Filename**

Target directory into which the output files will be written can be entered manually into the text field, or can comfortably be selected by opening a file browsing window using the button.

The target name consists of three parts. The first part can be entered by the user. ThermoViewer will automatically add a continuous number to this name and also the extension determined by the selected target format.

### **4.4.4 Quick export**

Once the settings for export are made and further frames with the same settings shall be exported, the Quick export button below the image slider can be used. Every time the button is pressed, the currently visible frame is exported using the settings made before.

## **4.5 NMEA Parser**

If a GPS receiver is connected to the serial interface of ThermalCapture 2.0 and the device is set up to send NMEA data, then the “Parse NMEA Data” option in Settings menu can be activated. Extracted data from the GPRMC messages is then shown on the right side of ThermalViewer main window.

## **4.6 Command line arguments**

In order to automate conversion from .TMC data format into different output formats ThermoViewer can be started using command line arguments. The available parameters are listed in Appendix A.

## Appendix A

### Man page of ThermoViewer command line arguments:

NAME

ThermoViewer - Application to process ThermalCapture files

SYNOPSIS

ThermoViewer [OPTIONS]

OPTIONS

- c  
Automatically closes the application after processing all given tasks
- cp palette  
Sets the color palette  
Available are: gray, iron, arctic, rainbow
- folder path  
Processes all files in given path
- help  
Displays this help screen
- i file  
Loads the given file after opening the application
- ic  
Enables color inversion
- exef number  
Sets export ending frame to number
- exfn name  
Sets the name prefix for exported files to name
- exfo <format>  
Sets the export format  
Available are: png, jpg, tif, avi, csv, rjpg
- expa path  
Sets the directory to which exports are written to path
- exsf number  
Sets export starting frame to number
- exmeta <type>  
Set the output format for meta data. If omitted, no meta data will be written  
Available options are:
  - CSVpf - One CSV per frame
  - CSVfa - One CSV for all frames
  - KML - One .kml for all frames
  - RAW - Binary raw data
- tl format  
T Linear settings  
Available are: none, high, low

```
high = Tau core is in high gain mode  
low  = Tau core is in low gain mode
```

-l

Adds a legend to the exported image

-r degree

Rotates the input frames. Supported degrees are 0, 90, 180, 270.

EXAMPLE

```
ThermoViewer -i 00000001.TMC -r 180 -l -cp iron -expa /home/thamke/Desktop/ -exfn  
image -exfo jpg -exsf 42 -exef 42 -c
```

- \* Opens the file '/home/thamke/Desktop/00000001.TMC'
- \* Rotates the output by 180 degrees
- \* Adds a legend to the image
- \* Sets the color palette to iron
- \* Set the export directory to '/home/thamke/Desktop/'
- \* Sets the file prefix to 'image'
- \* Sets the export format to 'jpg'
- \* Sets the start frame to 42
- \* Sets the end frame to 42
- \* Closes the application after export