Tau SWIR ISC1202
User's Guide

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Revision History

Version	Date	Comments
100	December 2016	Initial release
101	February 2018	Added detail to descriptions
102	October 2018	Updated controls for TEC table

List of Abbreviations

Abbreviation/ Acronym	Components
ACE	Actinve Contrast Enhancement
AGC	Automatic Gain Control
CDS	Correlated Double Sampling
DDE	Digital Detail Enhancement
ESD	Electrostatic Damage
FFC	Flat Field Calibration (or Correction)
FOV	Field of View
FPA	Focal Plane Array
FPS	Frames Per Second
GUI	Graphical User Interface
I/O	Input / Output
ICD	Interface Control Drawing / Document
IDD	Interface Description Drawing / Document
InGaAs	Indium Galium Arsenide
ISC1202	Indigo Systems Corporation, February 2012
LACE	Local Area Contrast Enhancement
LUT	Look-Up Table
NTSC	National Television System Committee
NUC	Non Uniformity Correction
OSD	On Screen Display
PAL	Phase Alternating Line

Abbreviation/ Acronym	Components
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RoHS	Reduction of Hazardous Substances
ROI	Region of Interest
ROIC	Read Out Integrated Circuit
SIC-200	Silicon Inspection XX
SWIR	Short Wave Infrared
SSO	Smart Scene Optimization
TBD	To Be Determined
TEC	Thermo Electric Cooler
URL	Uniform Resource Locator
USB	Universal Serial Bus
VPA	Vacuum Package Assembly

1.0 Scope

Tau ™ SWIR is a miniature, 38mm×38mm×47mm, short wave infrared (SWIR) imaging core from FLIR Systems, built around FLIR's ISC1202 InGaAs SWIR sensor. This sensor provides high sensitivity from 0.9 to 1.7µm, low dark current, temperature stabilization and on chip (in-pixel) correlated double sampling (CDS) for noise reduction, CDS fold-over protection (prevents "black sun effect"), anti-blooming (low gain only), snapshot integration, 640 × 512 resolution with a 15µm pixel pitch running at 60 frames per second.

FLIR's proprietary image processing algorithms start with 14-bit digital imagery and result in high-quality, analog video or 8-bit digital imagery in both low light conditions and full daylight. Frame rates may be adjusted from a minimum of 1fps to a maximum of 60fps for a full frame image. A preset 2X window of the central 320 × 256 pixels may be selected allowing for a frame rate of up to 120fps. An external sync mode allows integration with other camera systems, SWIR illuminators or pulsed lasers, synchronizing the integration period of the camera with the external system.

There are three sensor gain modes providing increasing sensitivity, Low, Mid or High. Low gain is appropriate for well illuminated, wide dynamic range scenes while each step up in sensitivity allows imaging under lower SWIR illumination levels with an accompanying decrease in the dynamic range that can be imaged. Within each gain mode, the integration period may be adjusted from as little as 10µs to as high as the frame period. Response of the 14-bit digital imagery increases linearly with increasing integration period.

FLIR's built in Auto-Exposure algorithm allows automatic, smooth transitions of integration period (tint) based on scene content to maximize image quality and detail without user intervention.The camera includes FLIR's advanced Non-Uniformity Correction (NUC), in-camera nonresponsive pixel replacement and Automatic Gain Control (AGC) algorithms. The Tau SWIR comes standard with a C-mount lens adapter installed. This may be removed allowing for custom lens mounts.

This User's Guide includes quick-start information for the Tau SWIR, as well as detailed descriptions of functions and adjustments for the camera that can be performed using FLIR's Tau SWIR Camera Controller GUI.

2.0 Resources

2.1 FLIR Reference Documents

Document Number	Document Title
102-2009-42	Tau SWIR 1202 Software IDD
102-2009-40	Tau SWIR 1202 Product Specification
102-2009-44	Tau SWIR Mechanical IDD

3.0 Unpacking the Camera

When unpacking the camera, please heed customary electrostatic-discharge (ESD) sensitive device precautions including static-safe work station and proper grounding. The camera is placed in a conductive anti-static bag to protect from electrostatic-discharge damage and safely packaged to prevent damage during shipping.

4.0 Standard Camera Kit

Components that come standard with the Tau SWIR camera are:

1. Camera body (includes standard Tau backshell, C-Mount Adapter installed)
2. 2-Wire, 12” lead for TEC power (shown in Figure 5)
3. Black Cap to cover C-Mount

4.1 Electrical Interface

Main Connector
Communication, video, and camera power are all accommodated through the Hirose 50-pin connector shown in Figure 1 and Figure 2. Pin designations are described in Table 1, Table 2, and Table 3.

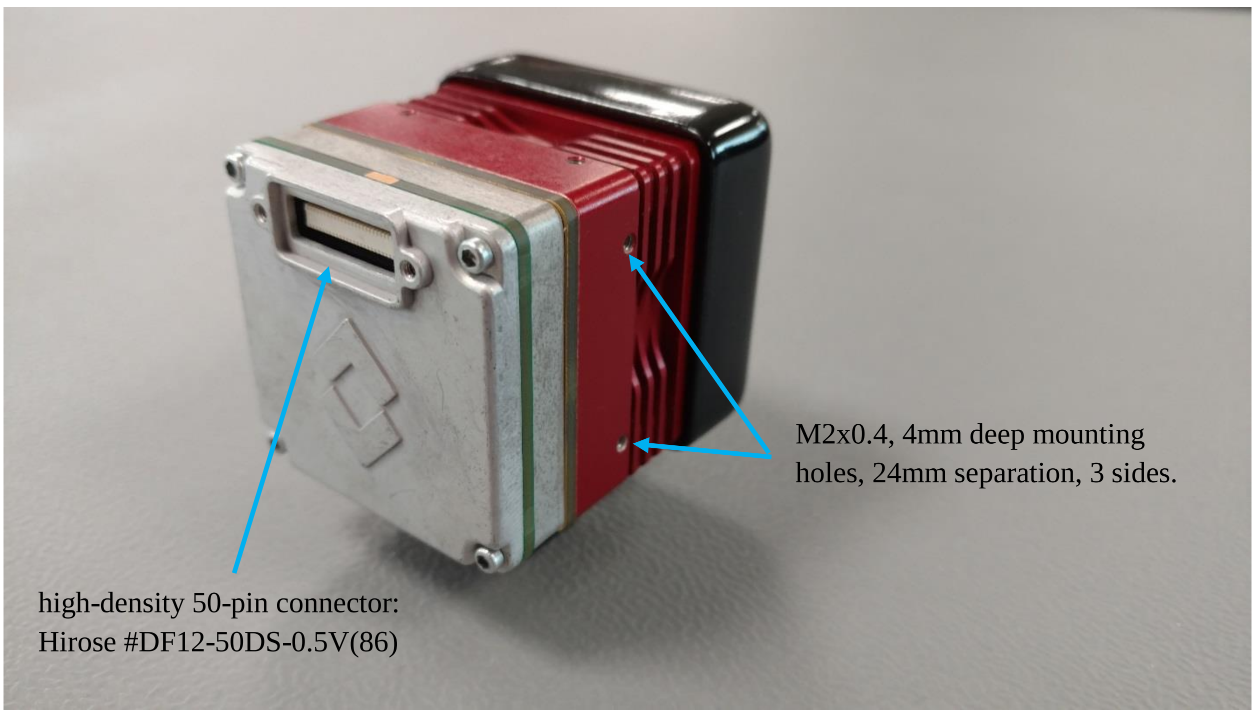

Figure 1. Tau SWIR Camera –Hirose Connector

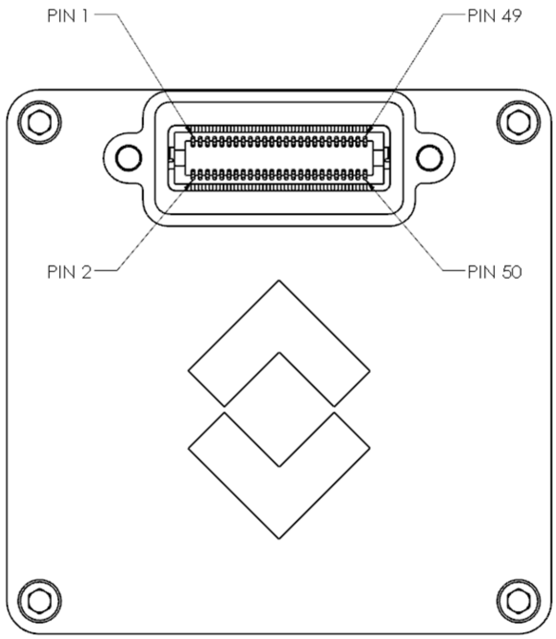

Figure 2. Pins on Tau SWIR Hirose Connector

Table 1. Tau SWIR Pin-Out, Hirose Connector Mode (2) CMOS 14-bit (default)

Pin #	Signal Name	Pin #	Signal Name
1	COMM_TX (RS232_TX_OUT)	2	COMM_RX (RS232_RX_IN)
3	CMOS LINE_VALID_OUT	4	CMOS FRAME_VALID_OUT
5	DGND	6	DGND
7	CAMLINK_CLK [P]	8	CAMLINK_CLK [N]
9	CAMLINK_DATA [0P]	10	CAMLINK_DATA [0N]
11	CAMLINK_DATA [1P]	12	CAMLINK_DATA [1N]
13	CAMLINK_DATA [2P]	14	CAMLINK_DATA [2N]
15	CAMLINK_DATA [3P]	16	CAMLINK_DATA [3N]
17	DGND	18	DGND
19	DISCRETE IO REG [0]	20	CMOS DATA_OUT [13]
21	EXTERNAL_SYNC	22	CMOS DATA_OUT [12]
23	CMOS DATA_OUT [11]	24	CMOS DATA_OUT [10]
25	CMOS DATA_OUT [9]	26	CMOS DATA_OUT [8]
27	DGND	28	DGND
29	CMOS DATA_OUT [7]	30	CMOS DATA_OUT [6]
31	CMOS DATA_OUT [5]	32	CMOS DATA_OUT [4]
33	CMOS DATA_OUT [3]	34	CMOS DATA_OUT [2]
35	CMOS DATA_OUT [1]	36	CMOS DATA_OUT [0]
37	DGND	38	DGND
39	CMOS CLOCK_OUT	40	Z
41	DGND	42	DGND
43	VID_OUT_H	44	VID_OUT_L
45	DGND	46	n/c
47	MAIN_PWR_RTN	48	MAIN_PWR
49	MAIN_PWR_RTN	50	MAIN_PWR

Table 2. Pinout Hirose 50-Pin Connector, Output Mode (3) CMOS 8-bit

Pin #	Signal Name	Pin #	Signal Name
1	COMM_TX (RS232_TX_OUT)	2	COMM_RX (RS232_RX_IN)
3	LINE_VALID_OUT	4	FRAME_VALID_OUT
5	DGND	6	DGND
7	CAMLINK_CLK [P]	8	CAMLINK_CLK [N]
9	CAMLINK_DATA [0P]	10	CAMLINK_DATA [0N]
11	CAMLINK_DATA [1P]	12	CAMLINK_DATA [1N]
13	CAMLINK_DATA [2P]	14	CAMLINK_DATA [2N]
15	CAMLINK_DATA [3P]	16	CAMLINK_DATA [3N]
17	DGND	18	DGND
19	DISCRETE IO REG [0]	20	DISCRETE IO REG [1]
21	EXTERNAL_SYNC	22	(XP 12) Z
23	DISCRETE IO REG [2]	24	DISCRETE IO REG [3]
25	DISCRETE IO REG [4]	26	DISCRETE IO REG [5]
27	DGND	28	DGND
29	CMOS DATA_OUT [7]	30	CMOS DATA_OUT [6]
31	CMOS DATA_OUT [5]	32	CMOS DATA_OUT [4]
33	CMOS DATA_OUT [3]	34	CMOS DATA_OUT [2]
35	CMOS DATA_OUT [1]	36	CMOS DATA_OUT [0]
37	DGND	38	DGND
39	CLOCK_OUT	40	Z
41	DGND	42	DGND
43	VID_OUT_H	44	VID_OUT_L
45	DGND	46	n/c
47	MAIN_PWR_RTN	48	MAIN_PWR
49	MAIN_PWR_RTN	50	MAIN_PWR

Table 3. Pinout Hirose 50-pin Connector, Output Mode (1), BT.656

Pin #	Signal Name	Pin #	Signal Name
1	COMM_TX (RS232_TX_OUT)	2	COMM_RX (RS232_RX_IN)
3	DISCRETE IO REG [6]	4	DISCRETE IO REG [7]
5	DGND	6	DGND
7	CAMLINK_CLK [P]	8	CAMLINK_CLK [N]
9	CAMLINK_DATA [0P]	10	CAMLINK_DATA [0N]
11	CAMLINK_DATA [1P]	12	CAMLINK_DATA [1N]
13	CAMLINK_DATA [2P]	14	CAMLINK_DATA [2N]
15	CAMLINK_DATA [3P]	16	CAMLINK_DATA [3N]
17	DGND	18	DGND
19	DISCRETE IO REG [0]	20	DISCRETE IO REG [1]
21	EXTERNAL_SYNC	22	(XP 12) Z
23	DISCRETE IO REG [2]	24	DISCRETE IO REG [3]
25	DISCRETE IO REG [4]	26	DISCRETE IO REG [5]
27	DGND	28	DGND
29	BT656 DATA_OUT [7]	30	BT656 DATA_OUT [6]
31	BT656 DATA_OUT [5]	32	BT656 DATA_OUT [4]
33	BT656 DATA_OUT [3]	34	BT656 DATA_OUT [2]
35	BT656 DATA_OUT [1]	36	BT656 DATA_OUT [0]
37	DGND	38	DGND
39	CLOCK_OUT BT656 (27Mhz)	40	Z
41	DGND	42	DGND
43	VID_OUT_H	44	VID_OUT_L
45	DGND	46	n/c
47	MAIN_PWR_RTN	48	MAIN_PWR
49	MAIN_PWR_RTN	50	MAIN_PWR

TEC Connector

On one side of the camera housing there is a Molex connector that provides power for the thermo-electric cooler (TEC). The TEC requires 4.9-5.5VDC input. While actual power consumption will vary with the ambient and mounting environment, peak power for this connection is limited to 2.5W. Commonly, this connector requires 0.3W at room ambient temperatures with the camera mounted on a tripod.

Included in the standard camera kit is a matching TEC power cable (FLIR PN 308-0268-00) terminated at one end with a Molex Pico-Lock 2-pin connector. See Figure 5. This connector is keyed to prevent connecting a reversed voltage to the TEC. The wires are black and red. The red is for a +5V supply and the black is for the return or ground.

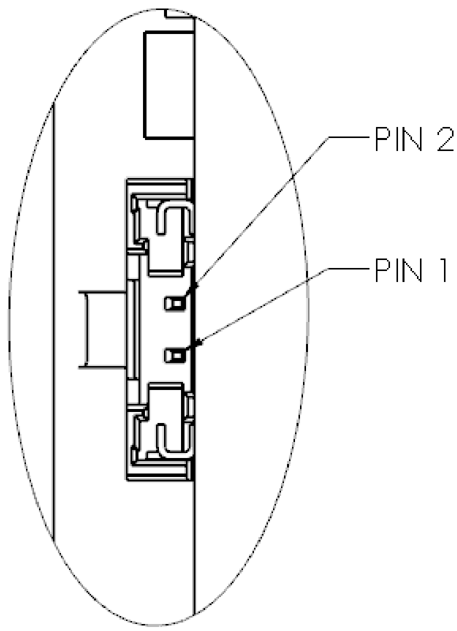

Figure 3. Detailed illustration of TEC power connector

Note: If, for any reason, the TEC power cable must be removed, the Molex Pico-Lock connector must be pinched on both ends to disengage the locking mechanism. Once unlocked, gently pull out and slightly forward (toward the front of the camera), ensuring the connector does not get hung up on the camera body. Apply the minimum force necessary to remove the cable from the connector. Use caution as to not pull the wires out of the connector body.

Connector Pin #	28 AWG	Wire color
1	5V	RED
2	GND	BLACK

Figure 4. TEC Power Connector Pin Assignments

TEC Power Through Accessory Boards

When using either the VPC or Camera Link Adaptor accessory boards, power may be supplied to the TEC Power connector via a cable from the accessory board. See Section 5.0 for a description of these accessory boards. Once connected, a cover plate is installed over the cable and TEC power connector port on the side of the camera. In this configuration both camera power and TEC power are supplied through the USB connector on the accessory board. With either of these two accessory boards a USB cable with a second power input is provided to handle higher than ½ amp current normally supplied through USB from a computer.

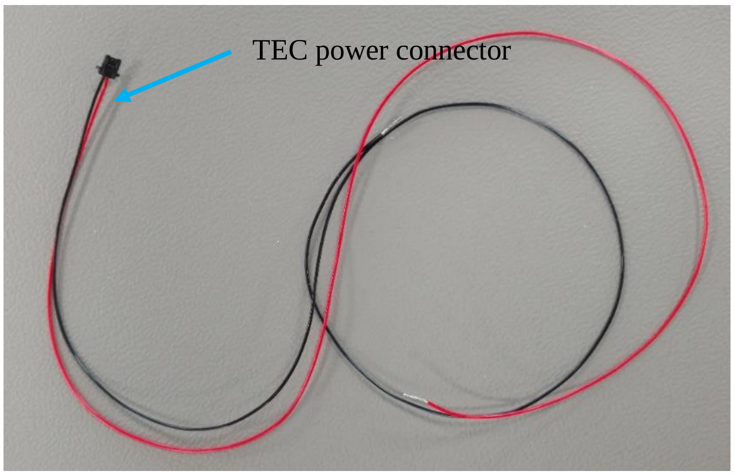

Figure 5. TEC wires

4.2 Mechanical Interface

Mechanically mounting the camera can be accomplished by utilizing the M2.0 x 0.4 mounting holes located on the top, bottom and left side of the camera. Each pair of holes are 4mm deep and have a 24mm separation.

Alternatively, an optional ¼ x 20 mounting accessory (FLIR part number 261-2071-00) can be purchased that utilizes one of the the three M2.0 x 0.4 hole pairs. See Figure 6.

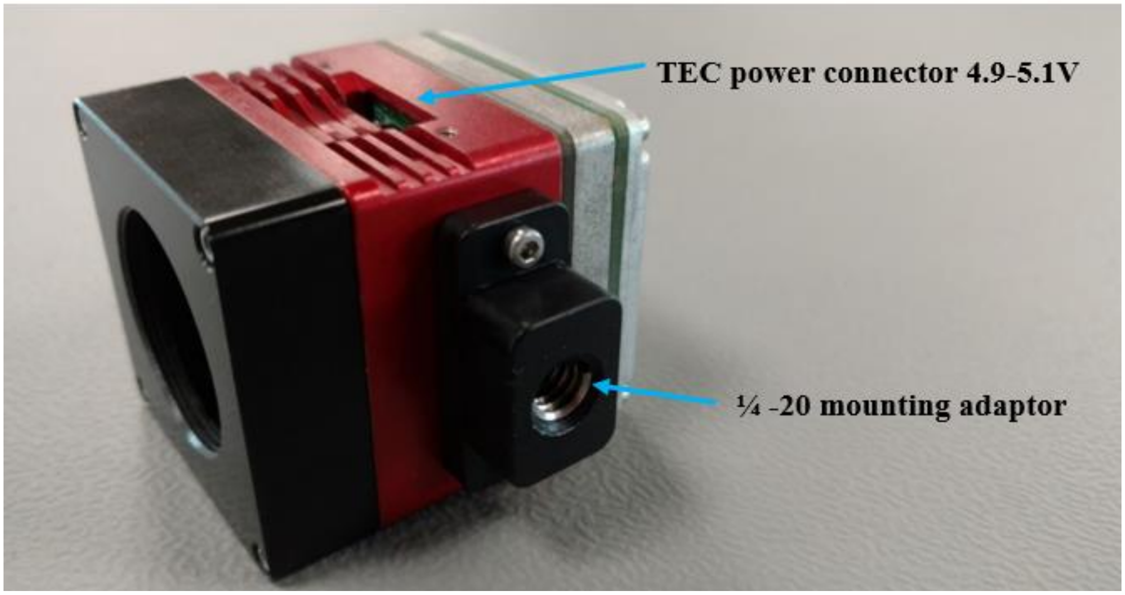

Figure 6. Optional ¼-20 Mount Accessory

4.3 Optical Interface

The standard Tau SWIR camera kit comes with a C-mount optical adaptor, as shown in Figure 7.

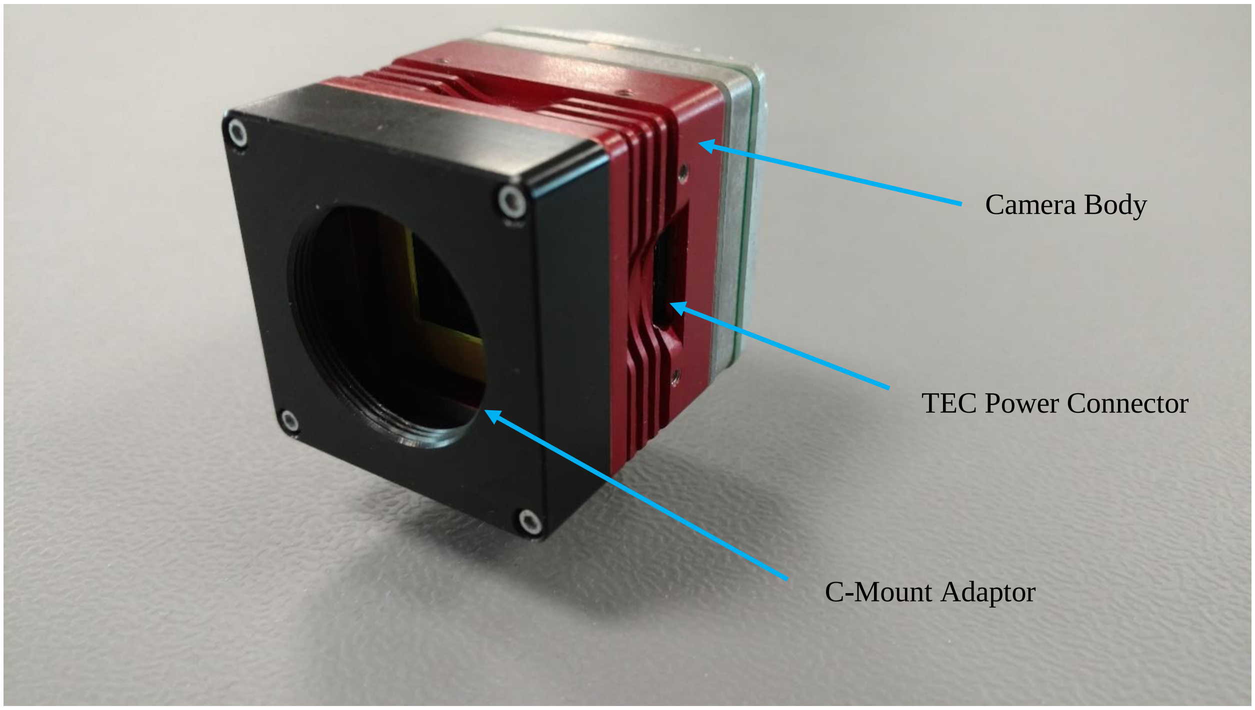

Figure 7. Front-Face C-Mount Adaptor

If the C-mount interface is not needed, it can be removed by unscrewing the four M1.6 mounting screws using an M1.5 allen head wrench. Further details on the optical interface can be found in the Mechanical IDD document. Use extreme caution when working with the optics to prevent contamination of the VPA window. If cleaning becomes necessary, see Section 8.2 for instructions.

5.0 Optional Accessories

The Tau SWIR Camera can be used with either the Tau SWIR VPC Module Accessory (FLIR PN 421-0059-00) or the Tau SWIR Camera Link Module Accessory (FLIR PN 421-0058-00) for simple desktop operation. These accessories provide an easy way to evaluate the camera core and access analog and, in the case of the Camera Link Module, digital video during development. To help simplify mechanical mounting of the Tau SWIR camera, it can be used with the ¼ 20 Mount accessory (261-2071-00).

When using either the VPC or Camera Link Adaptor accessory boards, power may be supplied to the TEC power connector via a cable from the accessory board. A cover plate is installed (see Figure 8) over the cable and TEC power connector port on the side of the camera. In this configuration both camera power and TEC power are supplied through the USB connector on the accessory board.

5.1 VPC Module Accessory

The VPC module accessory kit includes a special USB-A (2-headed) to USB-mini B power and serial communication cable, USB power supply, MCX-to-BNC analog video cable, TEC Power Cover Plate, module mounting screws, and cover plate mounting screws. This module differs from the standard Tau (uncooloed) camera VPC modle in that it has an additional VPC-to-TEC cable. Due to the fact that standard USB ports on computers typically cannot supply enough current to run the TauSWIR camera and TEC, both USB-A connectors on the USB cable must be plugged into a power source when this VPC-to-TEC cable is connected to the camera.

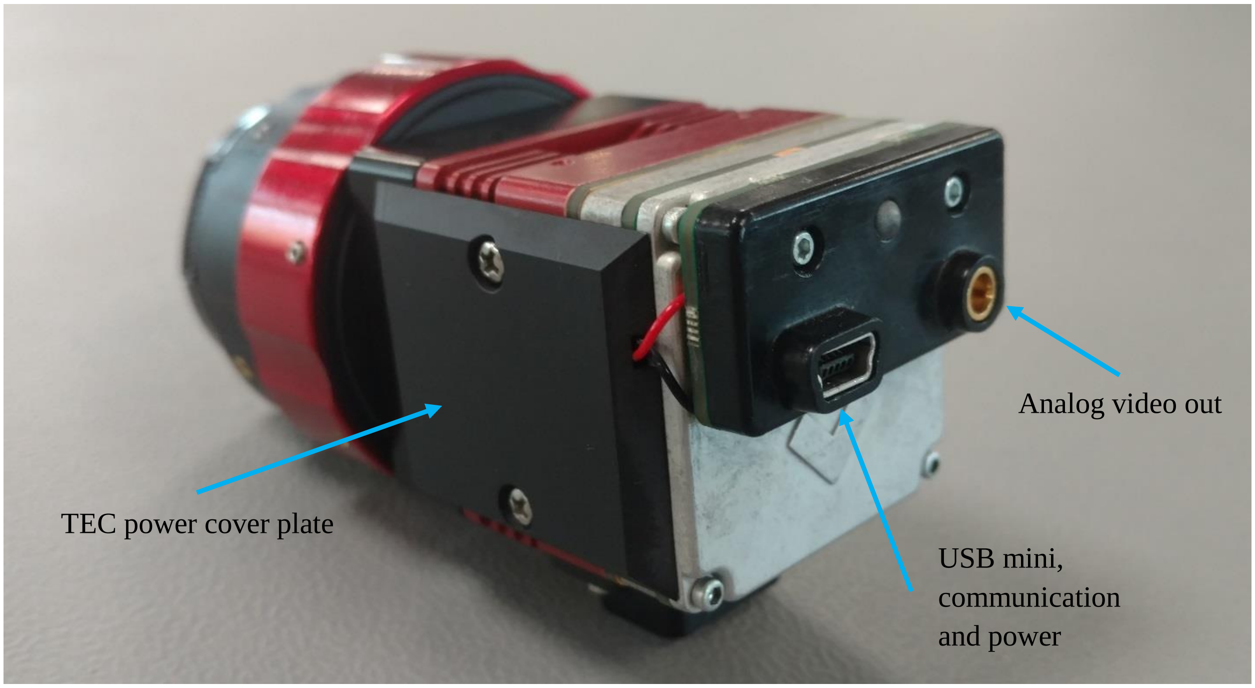

Figure 8. Tau SWIR camera with VPC module

VPC Installation

The VPC module plugs into the Hirose connector on the back of the Tau SWIR camera, as shown in Figure 8. Use the two M1.6 x 0.35 x 8mm screws included in the kit to secure the module to the camera. Plug the TEC cable into the TEC power connector on the side of the camera. Install the TEC power cover plate using the supplied screws.

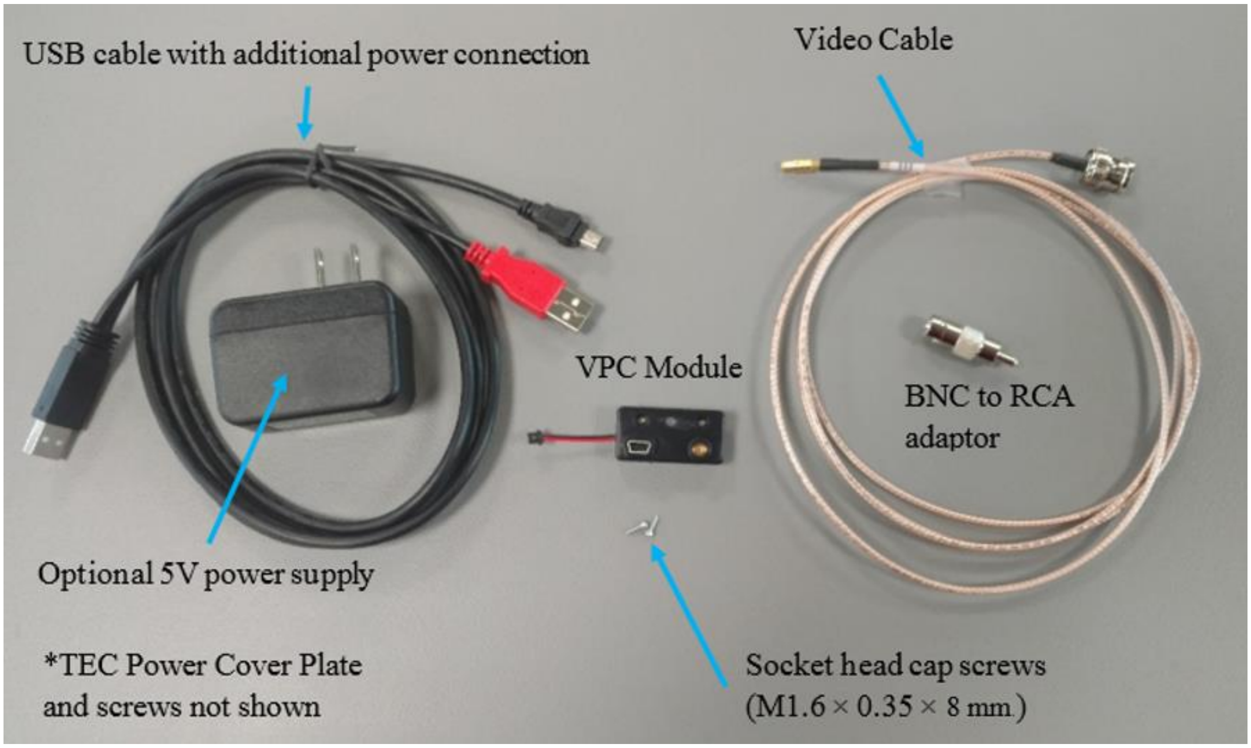

Figure 9. VPC Module Accessory Kit

5.2 Camera Link Module Accessory

The Camera Link module is an expansion board for FLIR cameras that matches the functionality of the VPC Module and adds the ability to access digital data via Camera Link connection. The Camera Link module takes CMOS-type digital data from the camera and converts it to Camera Link. In order to use a Camera Link module for acquisition of data, first enable the digital data output using the FLIR Camera Controller GUI. The red/black wires connect to the TEC board. The black and green wires are connected to the external synchronization signal in the camera. **This accessory does not include a Camera Link cable, frame grabber, or capture software.**

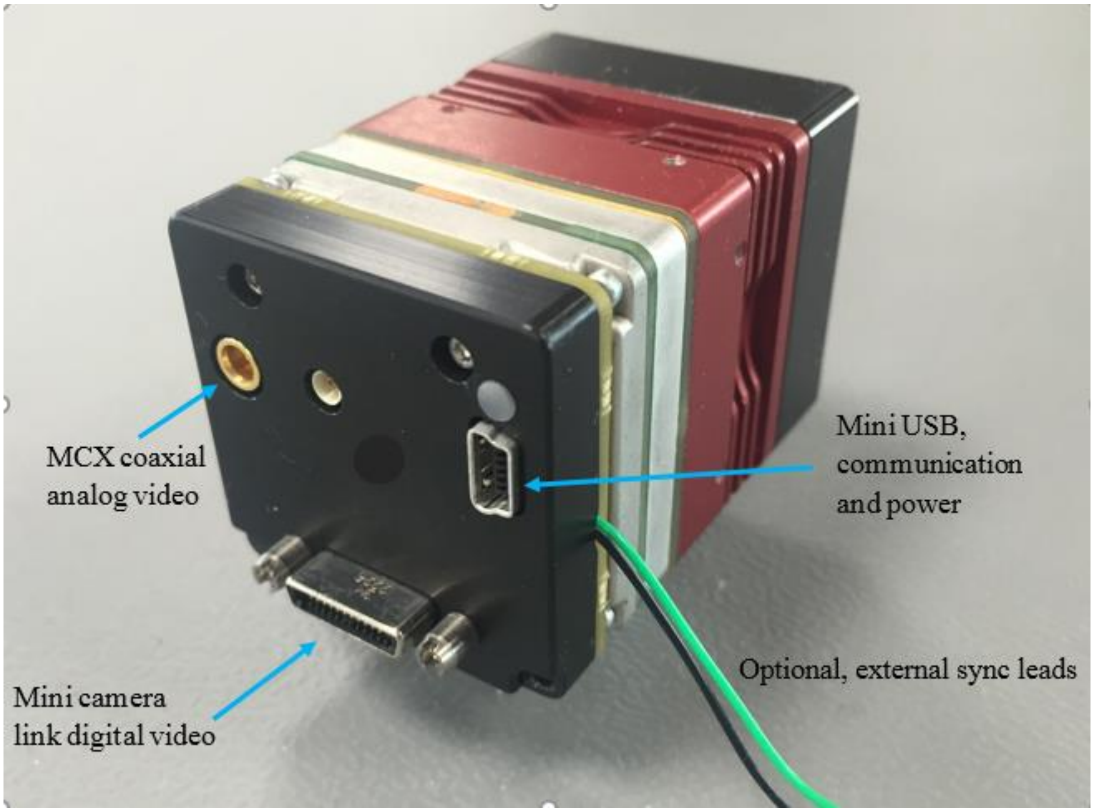

Figure 10. Camera Link Module (shown installed on a Tau SWIR camera)

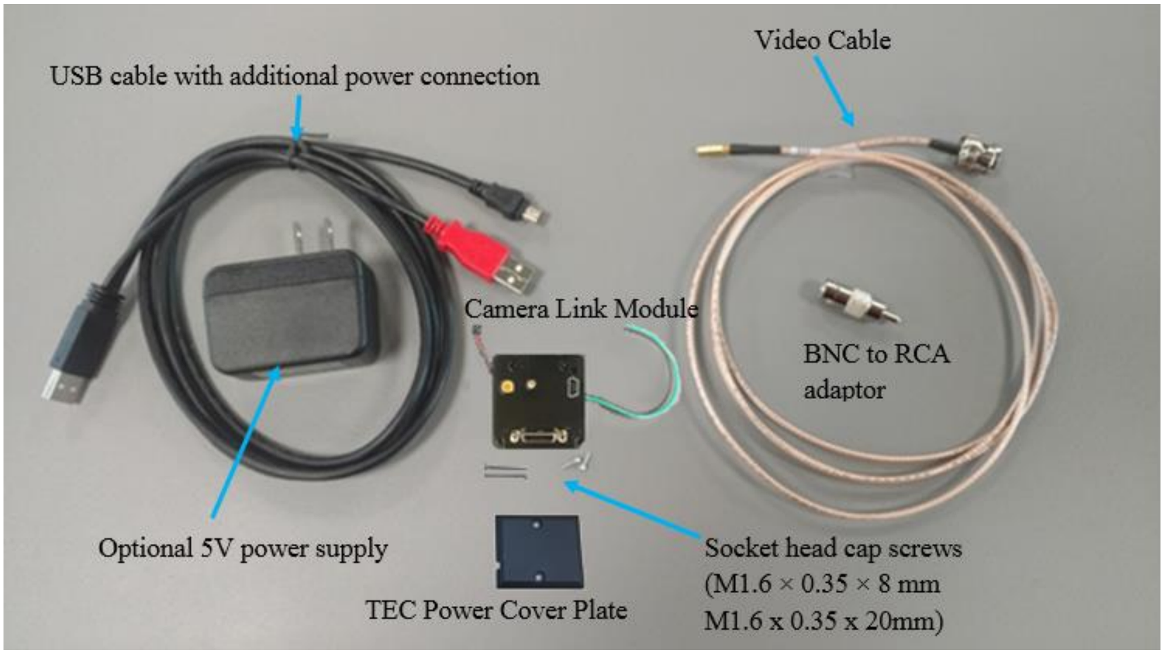

Figure 11. Camera Link Module Accessory Kit

Camera Link Installation

The Camera Link Module plugs into the Hirose connector on the back of the Tau SWIR camera, as shown in.Figure 10. Prior to installing the two M1.6 x 0.35 x 20mm screws, the two mini spacers must be slipped in between the module and the back cover of the camera, as shown in Figure 12.

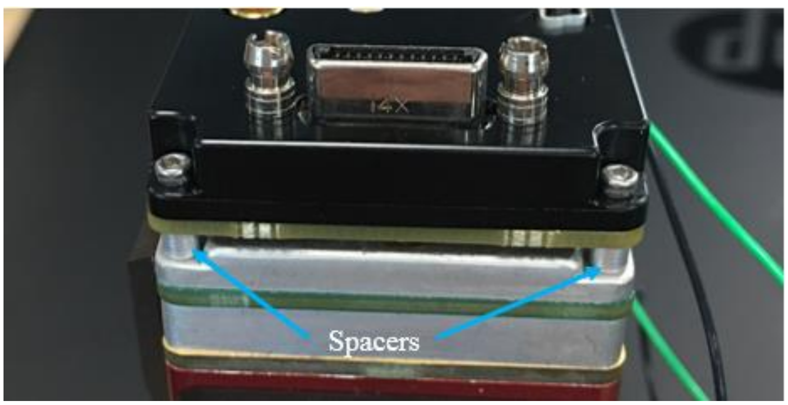

Figure 12. Camera Link Module Installation

Plug the TEC cable into the TEC power connector on the side of the camera, ensureing the locking mechanism engages. Install the TEC power cover plate using the supplied screws. If, for any reason, the TEC power connector must be removed, the Molex Pico-Lock connector must be pinched on both ends to disengagy the locking mechanism. Once unlocked, gently pull out and slightly forward (toward the front of the camera), ensuring the connector does not get hung up on the camera body. Apply the minimum force necessary to remove the cable from the connector. Use caution as to not pull the wires out of the connector body.

6.0 Connecting to the Camera

This section describes installation of necessary software, physical camera connections, and software connection to the camera.

6.1 Physical Connection

This section describes physical connections to the camera and assumes that either the VPC or Camera Link Accessory Module is being used with the camera. For connections not involving either of these FLIR accessories, please see Section 4.1 for a description of the Hirose connector interface.

1. Plug the accessory (VPC or Camera Link) expansion board directly into the 50-pin Hirose connector on the rear of the camera. Use the included hardware to secure the expansion board to the camera. These will insert on either side of the 50-pin connector. The VPC module uses M1.6 × 0.35 × 8 mm screws (see Section 5.1 on VPC installation) and the Camera Link module uses M1.6 × 0.35 × 8 mm screws. Using longer screws could damage the camera. The Camera Link module also requires the installation of two M1.6 x 0.35 x 20mm screws. Make sure to install the two spacers between the back cover of the camera and the Camera Link module (see section 5.2 on Camera Link installation). An M1.5 allen head wrench will be required for tightening the screws.

2. Connect the analog video cable to the VPC or Camera Link Module. There is an MCX mini coaxial connector on the back of each accessory. The opposite end of the cable has a standard BNC connector. Connect this to the video input of an analog monitor. It may be necessary to use a BNC Female to Phono Plug (RCA) adaptor (Figure 13) included in the accessory kit, which allows the camera to be connected to a standard yellow RCA video input on a monitor. The Tau SWIR camera core provides either NTSC or PAL compatible composite video output, selectable in the software GUI or SDK.

Note*: For best transmission of the analog video channel, a coaxial cable with 75 ohm characteristic impedance, similar to what is included in the VPC and Camera Link module kits, is required. The analog output is current mode and a 75 Ohm termination is required. This termination is present in most display devices.*

Figure 13. BNC to RCA Adaptor

3. Connect the USB-mini B cable to the VPC Module or the Camera Link Module and both USB-A connectors to the computer. (If sound is enabled on the computer, a chime will sound and a notification that the device has been connected will pop up). The Tau SWIR ISC1202 core input-voltage range is 4.9V – 5.5V. Core power is **< 3.0W.**

4. If two USB ports are not available on the host computer, a separate 4.9V -5.5V input voltage may be used to power the TEC. Section 4.1 describes the TEC power connection requirements.

5. Analog video (a Splash Screen) should appear within a few seconds after connecting the USB cable. Verify analog video is displayed on the monitor to ensure the camera electronics are properly powered. Some notebook computer USB ports provide just the minimum 500 mA (2.5W) and very little headroom for turn-on current surge. The Tau SWIR camera may not function optimally under this condition.

6.2 FLIR Camera Controller GUI

The FLIR Camera Controller GUI provides communication between a PC and a FLIR camera using either the USB interface or some other means of serial communication through the camera's connector. The Tau SWIR version of the GUI is export controlled software that is used to configure and control the Tau SWIR camera.

1. Computers with an older version of the FLIR Camera Controller GUI should first uninstall it using the Windows Uninstall utility via the Windows Control Panel before proceeding with this installation.
2. The box in which the camera is delivered will contain a CD or USB flash drive with a copy of the install file for the Tau SWIR version of the FLIR Camera Controller GUI described in this manual. Copy this file to a folder on the host computer.
3. Open the directory where the saved file is and double-click "CameraControllerSetup.msi".
4. Walk through the installation steps.
5. When the primary installation is completed, a message will prompt the user to install Silicon Laboratories drivers. This portion of the installation is necessary for using a USB connection to the camera.
6. The program will install to **All Programs→FLIR Systems→Camera Controller GUI**
7. If a connection cannot be established with the camera, access the Device Manager of the host computer to verify proper driver installation and verify the communications port. **Connection issues are most often caused by attempting to use either the wrong COM Port or the wrong baud rate to connect to the camera.**
    a. Right-Click on "My Computer" and select "Manage". This is typically either on the desktop or available through the start menu.
    b. Select "Device Manager" on the left Pane.
    c. Expand the tree for "Ports (COM & LPT)".
    d. Note the COM Port number used for Silicon Labs. The following example shows COM3.

![FLIR logo]

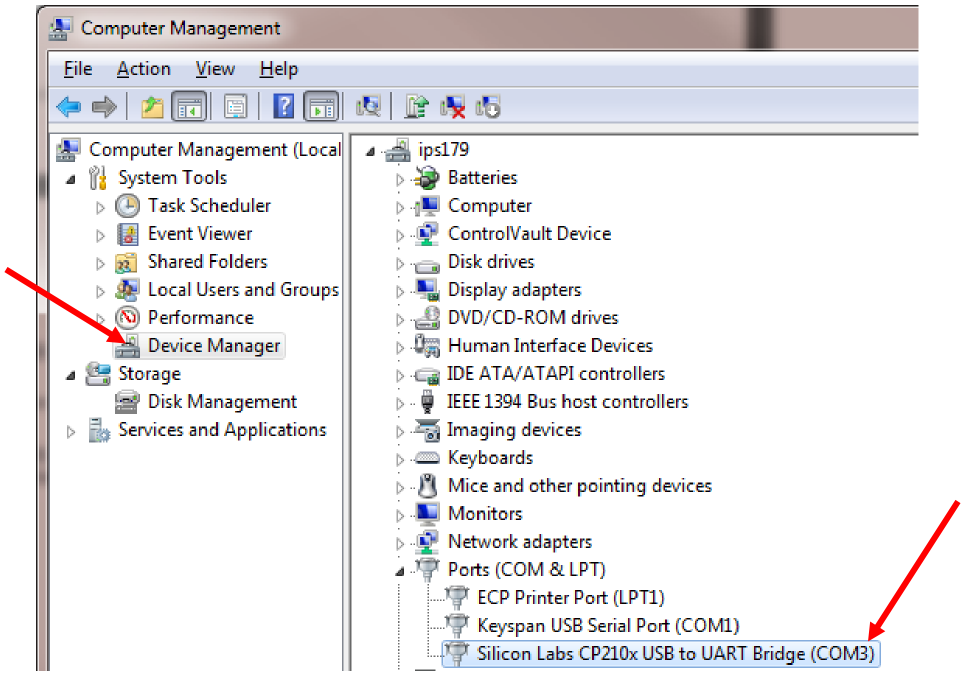

Figure 14. Device Manager showing proper driver installation

6.3 FLIR Camera Controller Software Interface

This section describes simple communication with the camera using the FLIR Camera Controller GUI and assumes that the camera is connected to the PC using a USB cable and either the VPC or Camera Link Accessory Module.

1. Run the FLIR Camera Controller GUI by clicking on the start menu and accessing **Start→All Programs→FLIR Systems→Camera Controller GUI.** The software may take up to 30 seconds to load the first time. The first time the camera is connected, a window will pop up asking the user to select the camera type. Select SWIR.

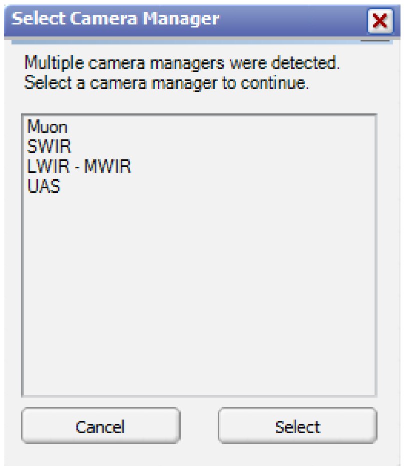

Figure 15. Select Camera Manager

2. When the GUI first opens, it will display "Not Connected" on the bottom left (see Figure 16). The first step is to connect to the camera.

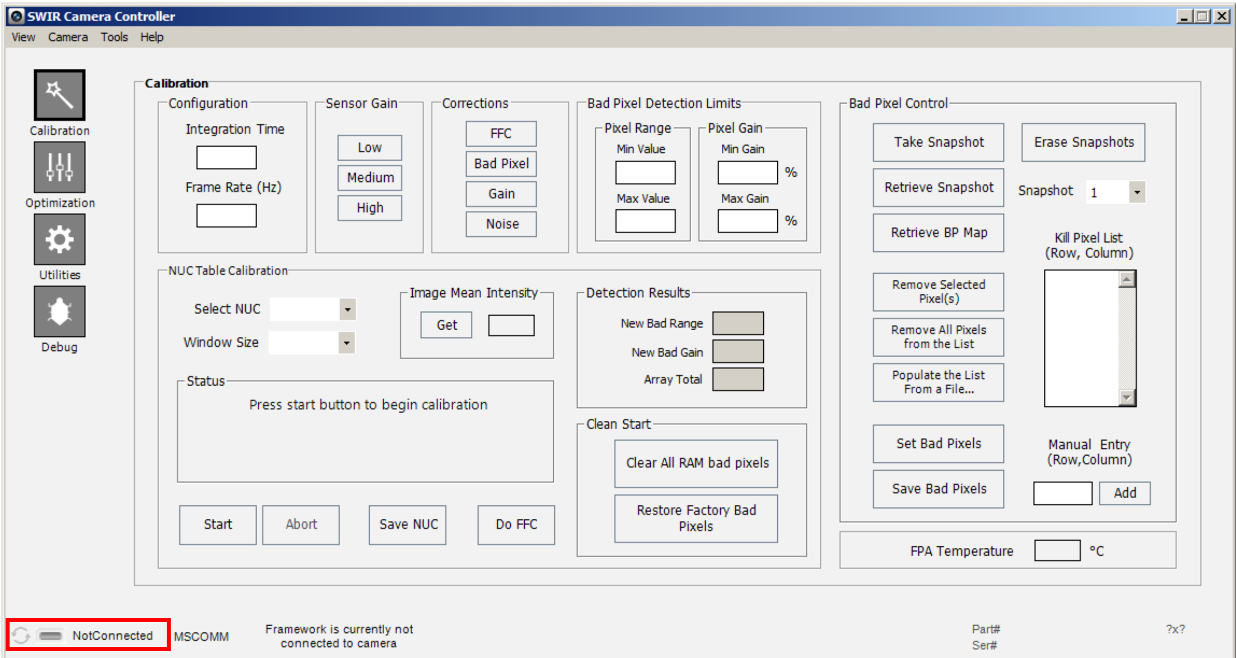

Figure 16. FLIR Camera Controller GUI Status Tab – Not Connected

3. Connect to the camera by selecting **Tools→ Connection**

Figure 17. FLIR Camera Controller GUI Connection Window Part 1

4. Select Serial (RS-232), select **921600** as the Baud Rate for fastest communication, and click Finish. If there are more than one serial communication ports enabled on the computer, the button will display Next.

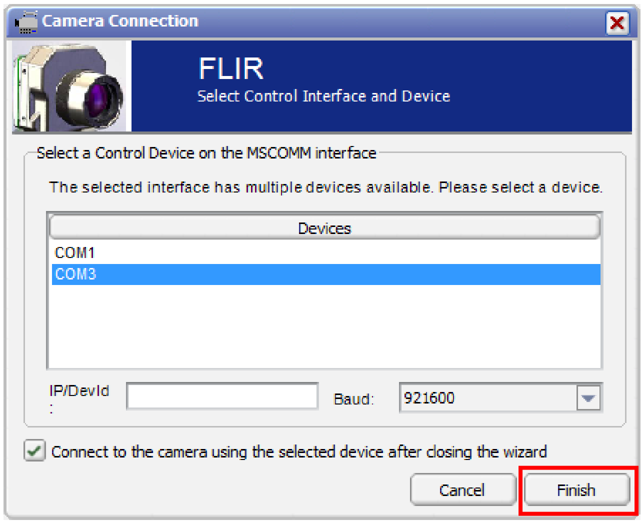

Figure 18. FLIR Camera Controller GUI Connection Window Part 2

5. If required, select the Com port listed in the Device Manager and click Finish. The camera selection can also be switched by selecting Select from the Camera pull-down menu at the top of the user interface window.

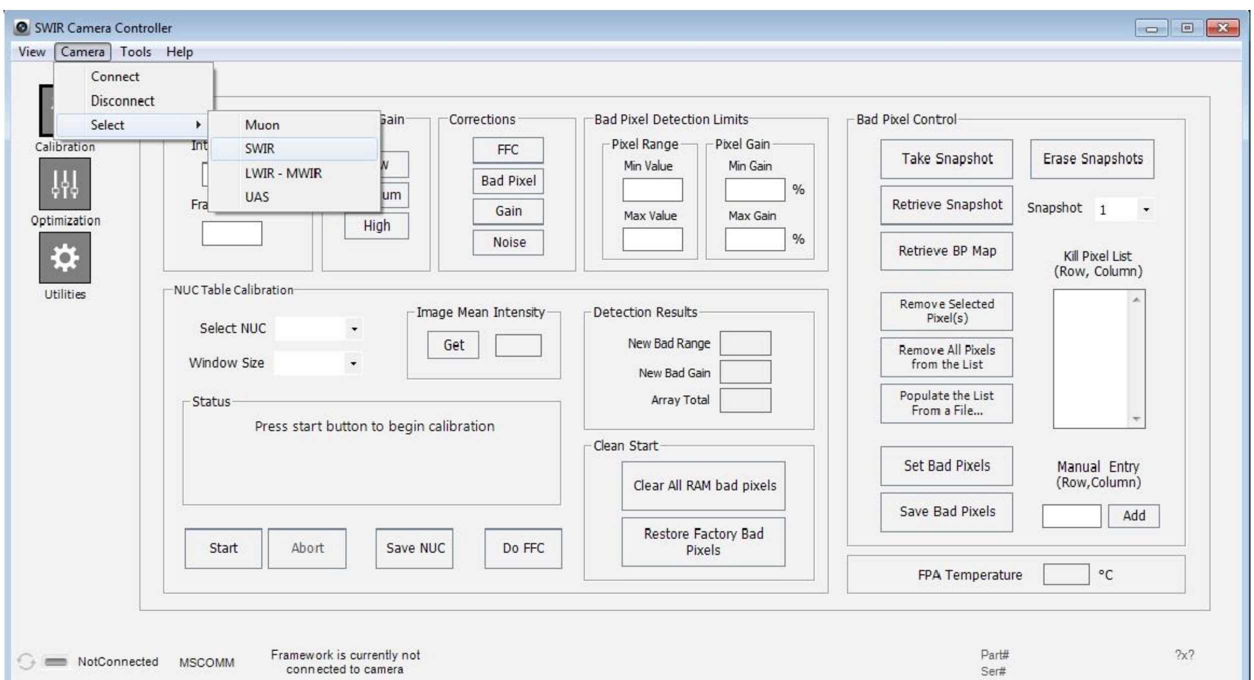

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Figure 19. Camera Type Selection

6. The GUI will now automatically connect to the camera and refresh information in the software. The software will automatically identify the camera type and display "Tau SWIR Camera Controller" in the upper left of the Status screen. The status LED will turn green and it will display "Connected" on the bottom left. It is also possible to retrieve the part number and serial number of the camera from this screen.

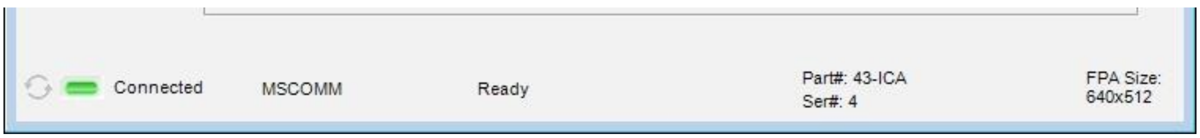

Figure 20. FLIR Camera Controller GUI Status Tab – Connected

***Note**: The connection status, Camera status, Camera Part #, Serial # and FPA Size are displayed at the bottom of all tabs.*

6.4 Troubleshooting the FLIR Camera Controller GUI

If the FLIR Camera Controller GUI does not link with the camera, there will be a popup shown below which indicates that the GUI has not been able to communicate with the camera.

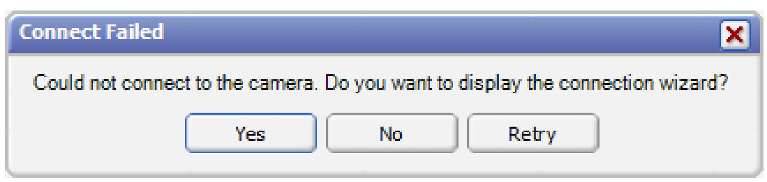

Figure 21. FLIR Camera Controller Error Message

If this is the case, verify the following:

- The USB Cable is properly connected to both the computer and the Accessory Module so that there is a green LED illuminated on the accessory.
- Verify the proper port was selected if it was not detected automatically. Select Advanced, then Next in the Tools→Connection dialog box. Also, try disconnecting and then re-connecting the cable to the PC. If the GUI was launched before the cable was connected, close the GUI, connect the cable, and then re-launch the GUI.
- The Baud rate must be set in the Tools→Connection dialog box. The FLIR camera supports Baud rates of 57600 and 921600. The FLIR camera automatically detects if the Baud Rate of the first incoming message is either 57600 or 921600 and will communicate at that Baud Rate until reset.

- The Port may be occupied by another application. Shut down any other applications that may be using the port. Also, multiple instances of the FLIR Camera Controller GUI Program can be initiated using different ports. Be sure the camera that is intended in being controlled is actually connected to the physical port that was verified in the Device Manager in Section 6.2, step 7.
- Verify that the camera is powered by checking that the camera is producing an image on an analog monitor. The Tau SWIR camera takes approximately 5 seconds to start up, stabilize the temperature of the focal plane array (FPA), and provide video. Until this time a splash screen will be displayed on the monitor. Digital video will not be available until the FPA is stable.
- If the GUI says **LWIR**, **Muon**, or **sUAS Camera Controller** on the top, use the **Camera** pull-down menu and choose S**elect** to select **SWIR**. If this option is not present, the GUI will need to be uninstall using the Windows Uninstall utility via the Windows Control Panel and delete the Program Files directory (C:\Program Files (x86)\FLIR Systems\Camera Controller GUI). Go to the FLIR website (http://www.flir.com/cores/display/?id=51880) to download the latest Tau Camera Controller software.
- Ensure the host computer has all Important Windows Updates installed, including the latest .NET Framework. .NET Framework can also be downloaded and installed from the Microsoft website (http://www.microsoft.com/net/download). It is best to use the client profile from the web. Once all updates are installed, reinstall the Camera Controller GUI and use **Camera→Select** to select SWIR.

If serial communication cannot be initiated with the camera after verifying these items, refer to the frequently asked questions (FAQ) at http://www.flir.com/cvs/cores/faqs/tau/all/. Additionally, a FLIR Applications Engineer can be contacted at **SBA-Cores@flir.com**.

7.0 Operation of the FLIR Camera Controller GUI

This section describes operation of the FLIR Camera Controller GUI and explains adjustments that can be made to the camera.

7.1 Menu Bar

The FLIR Camera Controller GUI has a classic menu bar where drop down menus are displayed.

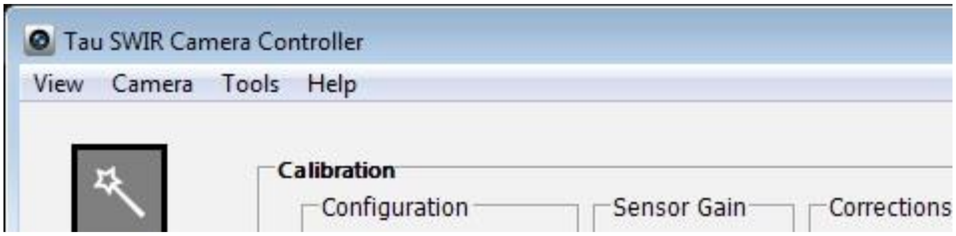

Figure 22. FLIR Camera Controller GUI – Menu Bar

View: Select Log to display a log at the bottom of the GUI. This does not display all commands sent to the camera, but rather displays connection information and possible error messages. This Logger pane is displayed in some of the screen shots below. Click Refresh to refresh the GUI. This can also be done with the F5 function key on a keyboard.

Camera: Select Connect to connect to a camera using the same communications parameters that were used previously. If connection cannot be established, it will ask to retry or open the connection wizard.

Select Disconnect to open the COM port that the GUI is occupying and disconnect from the camera. This can be useful if using other software to communicate with the camera.

The Select submenu allows selection of different camera types. The type “LWIR-MWIR” can be used for Tau SWIR, Quark, Tau 2, Tau, and Photon.

Tools: Select Clear Log to clear the log that can be displayed using the View menu.

Select Connection to open the connection wizard. This allows the ability to configure communication settings such as COM Port and baud rate.

Select Settings to configure the GUI. It is possible to configure the GUI to automatically connect at startup using the previous settings, allow multiple instances to be open at once, or change communication timing parameters.

Help: Open the Camera Controller User Guide in the default pdf viewer. The latest version of this document installs in the Program Files directory. ***Note: This selection is not enabled as of the release date for this manual.***

Select About Camera Controller to open a separate window with version information for the GUI and the camera.

About: The GUI Framework is the version of the GUI. The Main App is the software version of the camera. The version in the example is 123.21.16.126. The firmware is 16.14.0.23.

Click Details to view versions for each individual dll in the GUI.

Figure 23. Help -- About Camera Controller

7.2 Calibration Tab

When the FLIR Camera Controller GUI successfully links to the camera, the window shown below will be visible. At the bottom of the application window, there is the Camera and FPA status. The GUI provides six tabs allowing for camera control as described below.

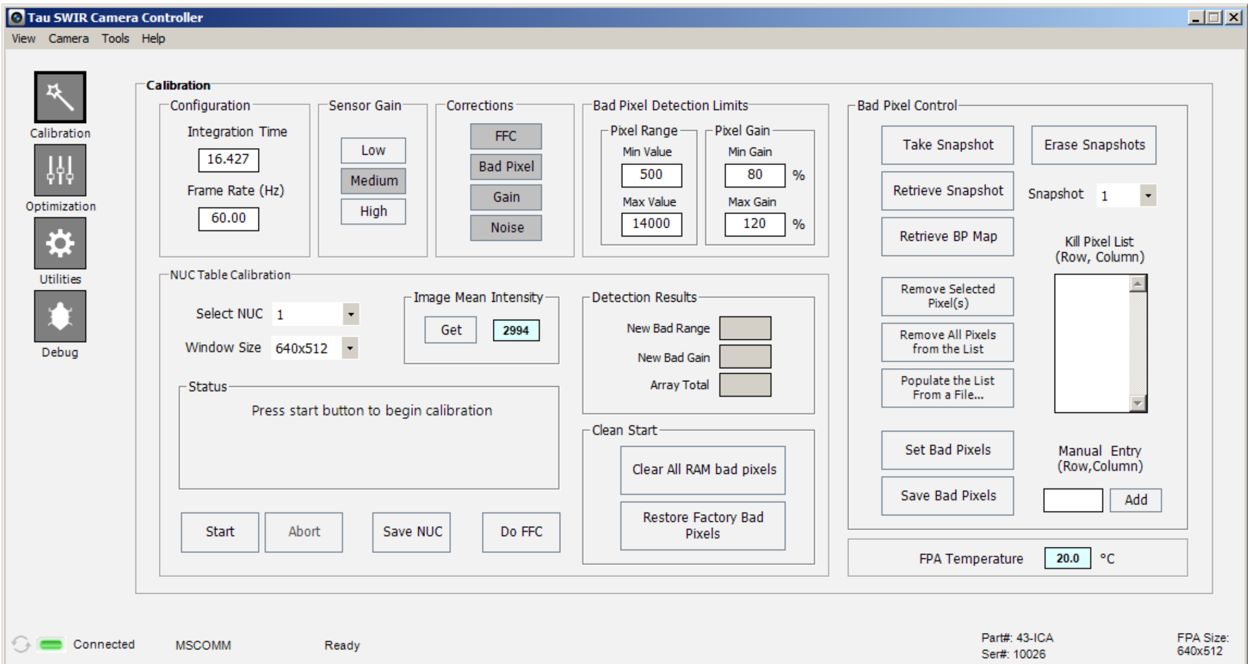

Figure 24. FLIR Camera Controller GUI – Status Tab

Configuration

Integration Time: The Integration Time text box is used to set the integration time in milliseconds. The integration time is similar to the exposure time of a standard daylight camera and is the time per frame during which charge is collected. The camera operates in "snapshot" mode, meaning that charge is collected on the entire array of pixels at the same time. Integration times may be set as low as 0.010ms, while the upper limit depends on the frame rate and is limited to about 0.032ms less than the frame period, about 16 milliseconds in 60fps mode or 33ms in 30fps mode . Short integration times should be used for viewing very bright objects, while long integration times are used for low illuminiation conditions. If integration times that are too short or too long are used, the image will appear non-uniform and will seem to be non responsive to the signal, so some experimentation is required to determine the best integration time for the scene being imaged. Using the **Image Mean Intensity** feature will assist in determining the best integration time. An integration time resulting in good imagery for a typical application is when the camera is "looking" at the scene of interest and the image mean intensity is between 3000 and 6000 counts.

Note: *In order to manually select values for integration time, Auto-Exposure, located on the Optimization tab, must be disabled.*

Frame Rate: The Frame Rate box is used to set the frame rate of the camera's digital output. The NTSC or PAL analog output will not be affected, except to output repeated frames for frame rates less than 30fps or to skip frames for frame rates greater than 30fps..

Sensor Gain: Some FLIR SWIR cameras support multiple gain modes. Selecting between these modes will adjust the intrascene range and control the sensitivity.

Corrections: The Corrections buttons turn on and off the NUC corrections for the camera. These states are saved with the Save Settings command and so are global rather than applying separately to each NUC table.

FFC: Flat field correction (FFC) is a process whereby offset terms are updated to improve image quality. This is done by presenting a uniform brightness (a flat field) to every detector element. While imaging the flat field, the camera updates correction coefficients, resulting in a more uniform array output. During an FFC, the analog and buffered digital video is frozen for less than 500 ms, and resumes automatically thereafter.

Repeating the FFC operation often prevents the imagery from appearing "grainy". This is especially important when the camera temperature is fluctuating, such as immediately after turn-on or when ambient temperature is drifting.

Bad Pixel: The Bad Pixel button turns on or off the bad pixel replacement function.

Gain: The Gain button turns on or off the application of the gain correction table.

Noise: The Noise button turns on and off a temporal noise filter which will reduce the temporal noise of the camera by about a factor of two without otherwise affecting the image.

Bad Pixel Detection Limits: These are the parameters outside of which a pixel is considered "bad" during the 2-point NUC process. The Min and Max Pixel Range parameters define the limits of the absolute value in A/D counts within which each pixel must fall in order to be considered good. The Min and Max Gain parameters are the limits of the gain correction factors by which the pixel values must be multiplied in order to be equal to the array average value. These limits can be set for the NUC process, but not saved.

NUC Table Calibration: The NUC Table Calibration area is one of the most critical sections in generating a good image. Some of the camera's most important functions are performed here. First, the desired NUC table to be calibrated should be selected using the Select NUC pulldown menu. Be sure to disable the auto-exposure feature. Then the integration time should be set appropriately to the scene illuminaiton to be imaged. The Image Mean Intensity (see below) is useful in doing this. Two uniform, flat white sources are needed for the 2-point correction and it is best if they span a large part of the range of scene illumination values to be imaged. Integrating sphere sources are ideal for this purpose, however a very near field uniformly illuminated white paper may be used. The Image Orientation and Bad Pixel Detection Limits also need to be set appropriately before the process is started. Now, push the Start button to initiate the 2-point NUC process. Follow the prompts to place the bright and dark sources in front of the camera so they fill the entire field of view. A message will appear when the process is complete. The Abort button will be active during the NUC process and will allow the user to abort and possibly restart the 2pt NUC process. When the NUC process is complete, check to see that the image is good and the number of bad pixels found is not unreasonably high, then press the Save NUC button to save the NUC parameters. The NUC parameters include a header with the selections relevant to that NUC (integration time, invert/revert, etc.), a gain table with the gain values for each pixel, and an offset table with the offset values for each pixel. If a pixel is found to be bad, a bit is set in the gain table for that pixel indicating its status and the value of the average of the eight nearest good neighbors is substituted in the image. If it is not desired to save the NUC, reselecting it from the pulldown menu will return to the NUC table values which were active before the process was initiated.

Image Mean Intensity: Each time the "Get" button is pressed, the camera will calculate the average intensity value of the entire array, in 14-bit A/D counts (0-16383). The range of values may not span the entire A/D converter range, but will be about 500 to 15800 counts

Detection Results: These boxes show the bad pixels resulting from the last 2-point NUC performed. The significance of the word "New" is that those boxes only report pixels which were not already in the bad pixel map for that NUC. Note that if a good NUC has already been performed, and unless the Clear All RAM Bad Pixels button has been pressed, they will usually be 0. Also, the gain bad pixel calculation is done first, and only those pixels which are not gain bad pixels will be reported as bad range. The Array Total will always report the total bad pixels in the bad pixel map, whether they come from the last NUC or were there before.

Clean Start

Clear All RAM Bad Pixels: This button is used before performing a 2-point NUC if a new bad pixel table is desired. Note that a warning text will come up saying that the gain table will be initialized during this process. Therefore a new 2-point correction will need to be performed subsequently in order to generate a satisfactory image.

Restore Factory Bad Pixels: A bad pixel map will be generated at the factory during Acceptance Testing that will include pixels which are not typically found by the standard 2-point NUC, such as noisy or flickering pixels. This map should always be installed to give the best image. It will need to be Restored if the Clear All RAM Bad Pixels function is used. The bad pixel map can always be viewed by pressing the Retrieve BP Map button.

Important: If the image for that NUC table is to be Inverted or Reverted, first set the Orientation to Normal (not Inverted or Reverted), then Restore the Factory Bad Pixels, then reset the Orientation to the desired configuration for that NUC table.

Do FFC: This button will cause the camera to do a one-point (offset only) NUC correction. A uniform flat white source should be placed in front of the camera before pressing this button. This function is useful to achieve the most uniform correction possible, for example if the camera power has been cycled since the last 2-point NUC has been performed.

Bad Pixel Control: All defective pixels are identified by FLIR as part of the standard factory Acceptance Test. However, it is possible that a camera in the field may have a pixel that needs replacing. Usually these are flickering pixels, or pixels which have developed an offset, and may appear as white on a black background.

Note: *When eliminating pixels, it is important that the camera is not inverted and not reverted.*

The bad pixel kill procedure involves taking a snapshot of a scene that clearly shows the bad pixel. Once a snapshot is taken, the Retrieve Snapshot button will open a separate window that has pane on the right that shows a reticle with a zoomed subframe. Use the mouse, then the arrow keys to fine tune the cursor location until the offensive pixel is between the crosshairs. The zoom value of the subframe can be adjusted using the slider bar. Use the Enter key to select the pixel and add it to the pixel kill list.

Bad pixels can also be manually added to the list by entering the row and column, and clicking Add.

Bad pixels can be removed from the Kill Pixel List by selecting them one by one and clicking Remove Selected Pixels. Use Ctrl to select multiple pixels or Shift to select a group of pixels to be removed. There is also a Remove All Pixels from the List button that will clear the list.

Once the list is populated, click Set Bad Pixels to add these pixels to the camera's bad pixel map. This will immediately affect the video output. Verify that the pixel is being replaced and click Save Bad Pixels to save this change in the camera. If the pixels are not being replaced, reset the camera using the Setup Tab to revert back to the previous state.

The bad pixel map currently in the camera can always be displayed by pressing the Retrieve BP Map button.

FPA Temperature: The camera's Focal Plane Array (FPA) temperature in Celsius is reported in this edit box. The factory setting for this target FPA temperature is 20°C, as managed by the TE Cooler in the VPA. If the camera cannot maintain this temperature due to extreme environmental temperatures or to insulating mounting configurations then the camera will automatically step to the best TEC temperature that can be maintained and will display the actual temperature of the FPA in this edit box.

7.3 Optimization Tab

The Optimization tab, shown in Figure 25**Error! Reference source not found.** below, provides the ability to control the Automatic Gain Control (AGC) features and the enhancement algorithms. Parameters for a given mode are contextually made available depending on which mode is selected. If configuration options are changed in the camera the Save Settings button should be used before resetting the camera. Factory Defaults helps the customer return the camera to the options originally configured by the factory when shipped.

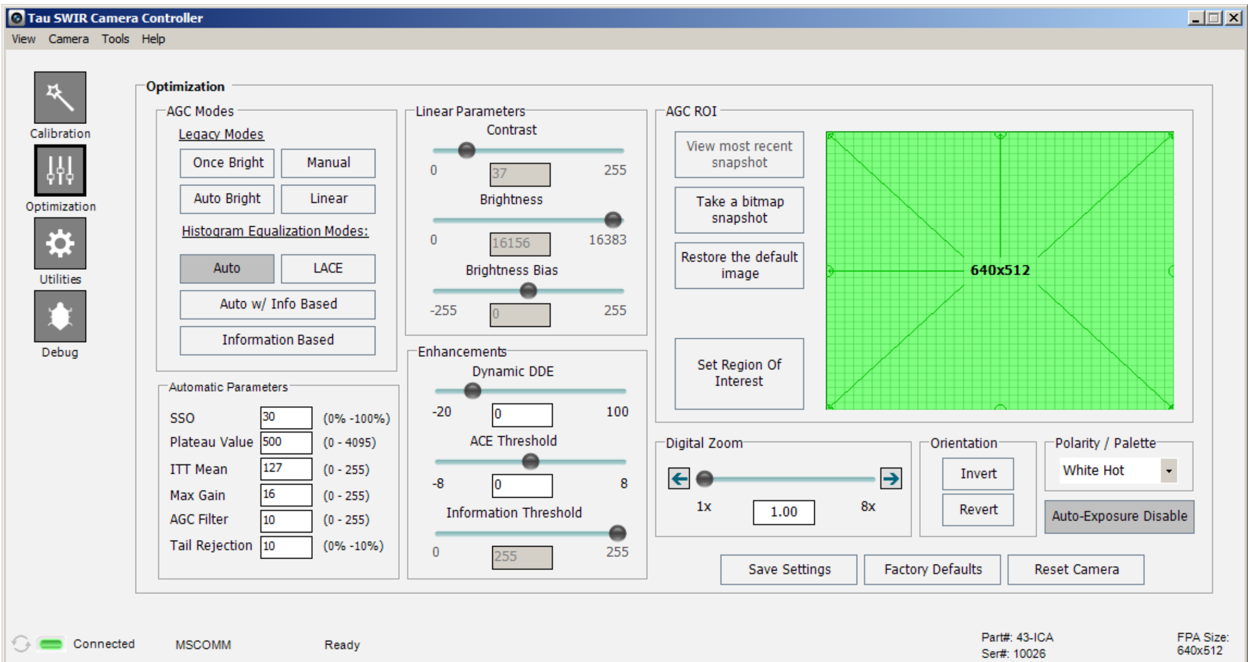

Figure 25. FLIR Camera Controller GUI -- Optimization Tab

AGC Modes: There are four Histogram Equalization Modes included in the Tau SWIR camera. There are also four Legacy Modes for customers wishing to stay with existing AGC modes from previous revisions of FLIR cameras.

Histogram Equalization Modes: The Plateau Histogram Equalization algorithm seeks to maximize the dynamic range available for the content of the scene. It does this using a transfer function that is based on the number of pixels that are in each bin and allocating more 8-bit range for that bin. The Plateau value is the pixels/bin limit when the transfer function is maximized. When this number is small, the Automatic AGC will approach a linear algorithm that preserves a linear mapping between the 14-bit and 8-bit data. The goal of the Automatic algorithm is to try and make each of the 255 bins have the same number of pixels in it, which should give the best contrast for the given scene. When the plateau value is higher, the algorithm is more able to redistribute the data to achieve this goal. This prevents wasted levels of grey on regions that have no scene content and can visually be seen in the histograms by noticing that peaks are much smoother and the data is spread much more evenly.

Automatic ("Auto"): This is the most sophisticated algorithm and for most imaging situations, the best all-around choice. This factory default along with the default parameter settings should be used in general imaging situations. In Automatic, image contrast and brightness are optimized automatically as the scene varies. This mode provides an AGC which is based on a plateau histogram equalization algorithm. An excellent starting point for the understanding of histogram equalization can be found in Wikipedia at http://en.wikipedia.org/wiki/Histogram_equalization. The implementation in the Tau SWIR camera is much more sophisticated than the basic, providing controls for the Linear Percent (low "bin" enhancement), Plateau Value (histogram high "bin" clipping level), ITT Mean (gray scale mid-point), Max Gain (AGC gain), AGC filter (speed at which the AGC reacts), and Tail Rejection (removes outermost values of the histogram) with available ranges to the side of the configurable values. Adjusting these parameters beyond the standard default settings can be used to optimize for specific scenes. Creating a generalized AGC algorithm for any scene and all users is very difficult. Most specific scenes can be optimized to provide the best image for that particular situation and that particular users needs. The default settings are those that FLIR has chosen to work over a variety of scenes.

LACE: Local Area Contrast Enhancement performs histogram equalization separately over 20 tiled regions of the image. This accentuates the contrast in each local area rather than the entire scene. LACE can greatly enhance the visual quality of imagery where there is a lot of local contrast and detail in a scene with a wide global dynamic range. Dynamic DDE, ACE threshold and ITT mean are all applicable to LACE. This mode is defined for the full 640 × 512 window size.

Auto w/ Info Based: This mode can most easily be explained as a joining of the two AGC modes Auto Mode and Information Based Mode. The result should lie somewhere in between those two modes in terms of relative dynamic range distribution for various irradiance ranges.

Information Based: Tau SWIR includes Information-based algorithms which reserve more shades of gray for areas with more information or scene content by assigning areas with less information or scene content lesser gray shades. By assigning fewer gray shades to areas with less information (e.g. sky, sea, roads) the fixed pattern noise is reduced in these areas and allows for more detail to be given to the more interesting portions of the image. Both Information-based algorithms undergo the plateau equalization process described in a previous paragraph, and therefore all parameters described also apply.

The differences between the Information-based and Information-based Equalization algorithms are noteworthy as both have advantages. The Information-based algorithm completely excludes pixels from histogram equalization if they are below the information threshold (described later in this section). This is advantageous in that noise is completely removed from areas of the image determined by the algorithm to not contain information, but scenarios in which the user is attempting to detect small temperature or emissivity variations are not ideal for this mode because desired information may be lost depending on the threshold. The Information-based Equalization algorithm includes every pixel independent of scene information in the histogram equalization process, but simply weights each pixel based on the information threshold. This mode shows more moderate improvements in scenes with large areas void of information, but the advantage over the Information-based mode is that scene content will never be removed.

***Note**: The default mode ("Auto") along with the default parameter settings for the Automatic AGC mode have been proven to offer the best image quality for generalized scene imaging. It may be possible to tune the AGC to achieve a better image for a given scenario. However, be aware that it is possible to make AGC adjustments that will configure the camera to produce no 8-bit image (all black or all white). If these settings have not been saved, simply reset the camera to restor previously saved settings. Alternatively, restoring the factory defaults on the Optimization or Utilities Tab will return the camera to its factory default state.*

Legacy Modes:

Once Bright: In this mode, the brightness will be set once when the mode is selected. The brightness (level) is calculated as the mean of the current scene when the Once Bright button is selected. The scene is mapped to the analog video using a linear transfer function. Image contrast can be adjusted by the Contrast slider. This is the only user adjustable parameter. Upon entry into the once bright mode, the currently- stored value of contrast is applied (i.e. the power-on defaults or the last saved values).

Auto-Bright: In this mode, the brightness (level) is calculated as the mean of the current scene just as in Once Bright mode. The difference with Auto-Bright is that the values selected for the start and end of the linear transfer function are automatically updated in real-time, not only at the start of AGC mode selection. The Brightness Bias offsets the displayed image in intensity. Upon entry into the auto bright mode, the currently-stored values of Contrast and Brightness Bias are applied (i.e. The power-on defaults or the last saved values).

Manual: In this mode, image Contrast (gain) and Brightness (level) are entered completely manually via the sliders. The scene is mapped using a linear transfer function. Upon entry into the manual mode, currently-stored values of brightness and contrast are applied (i.e. the power-on defaults or the last saved values). The brightness adjustment is ranges from 0 to 16383 and spans the 14-bit data. The One-shot brightness adjustment button can be used to set the brightness in Manual mode. This finds the mean of the 14-bit histogram and sets it as the value for the brightness. This is the same method as used in Once-Bright and Auto-Bright.

Linear Histogram: Image contrast and brightness (gain and level) are optimized automatically based on scene statistics using a linear transfer function. Controls for the ITT Mean (sets gray scale midpoint) and Max Gain (AGC gain) are adjustable by entering the value in the Automatic Parameters section. The Linear Histogram algorithm uses scene statistics to set a global gain and offset (contrast and brightness) for the image. The Tail Rejection control determines what percentage of the outermost values of the histogram to remove when performing the algorithm. Upon entry into the linear histogram mode, the currently stored values are applied (i.e. The power-on defaults or the last saved values).

***Note**: In Manual mode and Once Bright mode, the brightness setting must be updated as the camera scene changes. To avoid this issue, it is recommended to use Automatic, Linear Histogram, or Auto Bright modes when possible. Also, AGC mode will only affect the digital data output if the*

Digital Video output mode is set to 8-bit data. The 14-bit digital data bypasses the AGC sections of digital processing.

Linear Parameters: Used for fine tuning the Auto Bright, Once Bright, and Manual modes, these settings are contextually active depending on which Algorithm is selected. Each of their settings is described above.

Once Bright – Only the Contrast control is active.

Auto Bright – The Brightness Bias and Contrast controls are active.

Manual – The Brightness and Contrast controls are active.

Automatic Parameters: Used for fine tuning the Histogram Equalization Modes and Linear Histogram modes, these settings are contextually active depending on which AGC algorithm is selected. Each of their settings is described below as they pertain to the particular Algorithm.

Smart Scene Optimization (SSO): The Smart Scene Optimization value defines the percentage of the histogram that will be allotted a linear mapping. Enabling this feature facilitates the avoidance of irradiance level compression, which is specifically important for bi-modal scenes. With SSO enabled, the difference in gray shades between two objects is more representative of the difference in reflected energy). SSO helps to set how linear the HEQ and information based AGC algorithms are allowed to be to provide the highest amount of perceived contrast in every scene. SSO can range from 0% to 100%.

Plateau Value: When plateau value is set high, the algorithm approaches the behavior of classic histogram equalization – gray shades are distributed proportionally to the cumulative histogram, and more gray shades will be devoted to large areas of similar temperature in a given scene. On the other hand, when plateau value is set low, the algorithm behaves more like a linear AGC algorithm – there is little "compression" in the resulting 8-bit histogram. The plateau ranges from 0 to 4095 and default setting is 500.

ITT Mean: The ITT Midpoint can be used to shift the 8-bit histogram darker or brighter. The nominal value is 127. A lower value causes a darker image. A darker image can help improve the perceived contrast, but it is important to note that more of the displayed image may be railed (8bit value = 0 or 255) by moving the midpoint away from the nominal value. The ITT Mean ranges from 0 to 255 and effects automatic, information based and linear AGC modes.

Max Gain: For scenes with high dynamic range (that is, wide 14-bit histogram), the maximum gain parameter has little effect. For a very bland scene, on the other hand, it can significantly affect the contrast of the resulting image. The Max Gain ranges from 0 to 255 and effects automatic and information based AGC modes.

AGC Filter: The AGC filter ranges from 0 to 255 and effects all AGC modes and determines how fast the AGC is allowed to change when the scene changes. A value of 1 being the slowest update rate, a value of 255 being the quickest update rate and zero causing no updates (freezes current settings).

Tail Rejection: The Tail Rejection parameter defines the percentage of the total number of pixels in the array that will be excluded prior to histogram equalization. The user-selected percentage of pixels will be removed from both the bottom and top of the 14-bit histogram prior to AGC. This feature is useful for excluding outliers and the most extreme portions of the scene that may be of less interest. FLIR recommends tail rejection settings less than 1% to avoid the exclusion of important scene content. Tail Rejection ranges from 0 to 10 percent and affects all dynamic AGC modes by not using the upper and lower tail rejection percent in the AGC algorithm. This allows for the removal of anomalous pixels from skewing the AGC away from actual information.

Enhancements:

Digital Detail Enhancement (DDE): DDE is an advanced nonlinear image processing algorithm that preserves detail in high dynamic range imagery. The detail is enhanced so that it matches the total dynamic range of the original image making the details more visible. Use Factory Defaults to recover from inappropriate settings.

Active Contrast Enhancement (ACE): The Active Contrast Enhancement (ACE) feature provides a contrast adjustment dependent on the relative scene temperature. ACE thresholds greater than 0 impart more contrast to hotter scene content and decrease contrast for colder scene content (e.g. sky or ocean). ACE threshold less than 0 do the opposite by decreasing contrast for hotter scene content and leaving more of the gray-scale shades to represent the colder scene content. ACE can range from -8 to 8 where -8 decreases contrast in darker regions while +8 increases contrast in darker regions.

Information Threshold: The information threshold parameter defines the difference between neighboring pixels used to determine whether the local area contains “information” or not. Lower thresholds result in the algorithm determining that more of the scene contains information, resulting in more areas included in the Information-based algorithm and given a higher weighting in the Information-based Equalization algorithm. Decreasing the threshold will result in imagery approaching the appearance of the Plateau Equalization algorithm. Increasing the threshold will result in a more information-dependent image, that is the flat portions of the scene (e.g. sky or sea) are given less contrast and the pixels exceeding the information threshold will be given more contrast.

AGC ROI: FLIR cameras allow the user to set a Region of Interest (ROI) or a rectangular area of pixels on the sensor array that the AGC algorithm will use for its calculations. The AGC ROI applies to the Automatic and Linear Histogram algorithms. The ROI can be set for either the entire frame size (-320,256,320,-256) or some smaller portion. The ROI tab provides both a Window Editor and text entry coordinates to control the size and location of the Region of Interest (ROI). The Set button must be clicked for any changes to take effect. **The AGC ROI is one of the most significant factors in improving image quality.** It can be used to ignore the sky or other large objects that would otherwise be used for calculation of AGC.

The AGC ROI is set using the full resolution of the sensor (640x512). When zoom is other than 1X, the ROI will scale with Zoom. When a small initial ROI is set and then zoom is performed, the ROI may need to be adjusted for optimal AUTO video.

Window Editor: Use the mouse to drag the green ROI rectangle to any location on the FPA. The size of the ROI rectangle (in pixels) is displayed. To change the size of the ROI rectangle, drag one of the corner or side bubbles. The Set button must be clicked for changes to take effect.

Snapshot: The Tau SWIR camera is configured with the ability to take snapshots. This feature allows snapshots to be taken and viewed as the background to aid in setting the ROI for a particular scene. Below is the ROI encompassing the entire FOV and the second has the ROI cropped to improve contrast on the portion of the scene most important to the user.

AGC ROI Coordinate Values: The settings use an X-Y coordinate system with (0, 0) being at the center of the sensor array. The upper two numbers marked (left, top) are the pixel coordinates of the upper left corner of the ROI rectangle. The lower two numbers marked (right, bottom) define the lower right corner of the ROI rectangle. The example to the right shows a full screen ROI for a 640x512 camera. The Set button must be clicked for changes to take effect.

Note: *The AGC ROI coordinates are static relative to the image orientation. If the second image above was inverted, then the AGC ROI would still be cropped to exclude the sky in the inverted image and the increased contrast would still be visible on the land portion of the image.*

Digital Zoom: The Tau SWIR camera has built in discrete steps of digital zoom capability. For 640 x 512 resolution cameras, it is possible to zoom to 8x. The camera always zooms to the center of the video.

Orientation: Two Image-Orientation mode selections are provided. Select one or both to change the orientation of the video image.

Invert: The normal image is flipped vertically. The pixel on the upper-left corner of the detector array is displayed on the lower-left corner of the video display in Invert mode. This is the recommended mode when the core images the scene via a vertical fold mirror. Invert applies to all output channels (i.e., also CMOS, and LVDS).

Revert: The normal image is flipped horizontally. The pixel on the upper-right corner of the detector array is displayed on the upper-left corner of the video display. This is the recommended mode when the core images the scene via a horizontal fold mirror, when used in a rear-facing application intended to simulate the view through a rear-view mirror. Revert applies to all output channels (i.e., also CMOS, and LVDS).

Invert/Revert: Both should be selected if the camera is to be mounted upside down, or a lens is used which has a number of elements (*e.g.* 1 or 3) which themselves perform an inversion and reversion.

Note*: Adjusting image orientation should always be followed by a 2-point calibration event (located on the Calibration tab). A Flat Field Calibration (FFC) may be used to give a quick* *check to see if the desired orientation has been achieved, but that may not give the best image over scene temperature.*

Polarity / Palette: The camera detects and images the SWIR illumination in a given scene. Within the camera, these illumination values are mapped (as determined by the AGC algorithm selected) to a range of 0 to 255 values. In a black and white display mode, this range is converted to shades of gray with 0 being totally black and 255 being totally white.

The range of these 0 to 255 gray shades can also be referenced to a Look-Up Table (LUT) permanently stored in the camera to convert the scene to a color video image. Different LUTs are available to change the appearance of the displayed image. The most common selection is either White Hot (objects with higher illumination appear brighter than objects with lower illumination in the video display) or Black Hot (direct opposite of White Hot). Since the difference between these two modes simply reverses the choice of darker or lighter for illumination extremes, this is sometimes referred to as Polarity. Other color LUTs are available as shown below.
Figure 26 below shows each of the LUTs as displayed in Test Pattern Ramp Mode starting with the upper left: White Hot, Black Hot, Fusion, Rainbow, Glowbow, Ironbow1, Ironbow2, Sepia, Color1, Color2, Ice Fire, and Rain. Select one of these LUTs from the pull-down menu to view the image displayed using the chosen LUT. Setting the Polarity/LUT mode will not affect the CMOS or LVDS digital data output

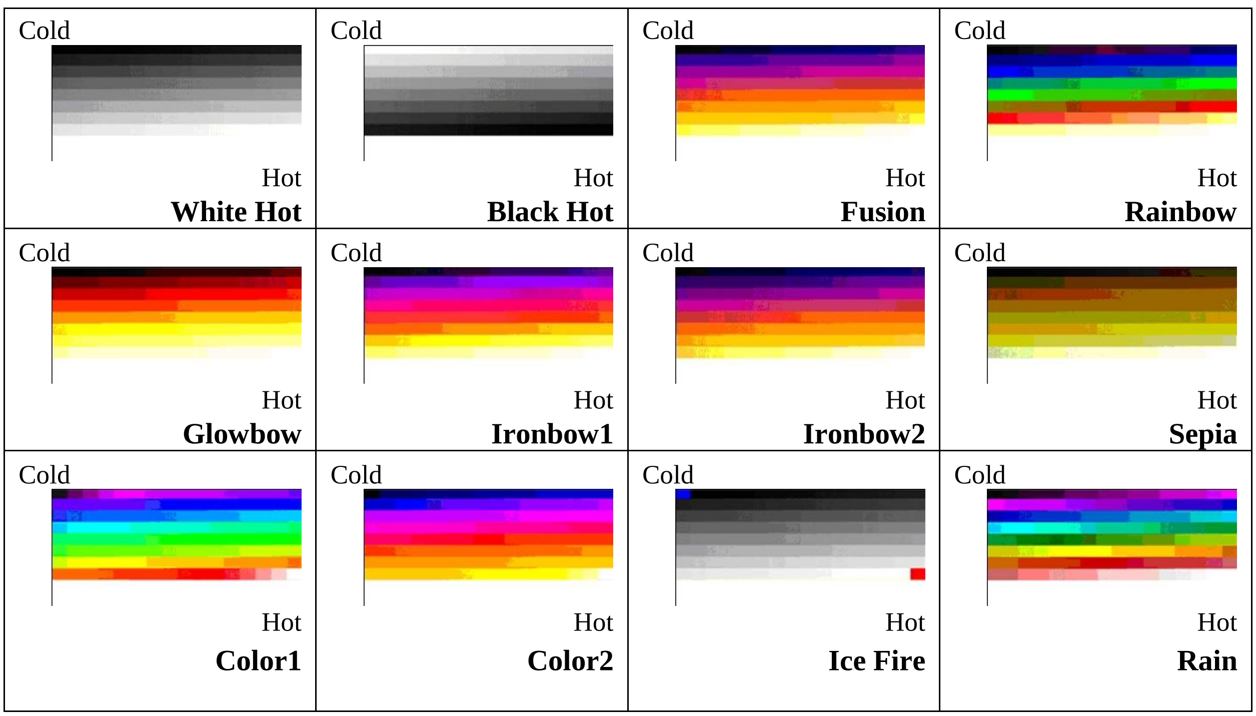

Figure 26. Look-Up Table Options (as seen with test pattern enabled)

Simple experimentation with this feature while viewing the video image will provide familiarity. Remember to click the Save Settings button on the Setup Tab to save the LUT settings as the default at power-up.

Auto-Exposure Enable: This mode will automatically adjust the integration period such that, if possible, the resulting histogram fills about 80% of the dynamic range.

Save Settings: After using the FLIR Camera Controller GUI to change Camera modes and settings to desired values, use the Save Settings button to store many of the current selections as new power-up defaults. The next time the camera is powered; the camera will remember these saved settings. If the Save Settings button is not clicked, any changes made via the FLIR Camera Controller GUI will be valid only for the current session. Cycling power to the camera will revert to the previously saved settings.

***Note**: The Save Settings button applies to changes made anywhere in the GUI, not only the Setup Tab.*

Factory Defaults: The Factory Defaults button restores the camera's settings to the initial values specified by FLIR. To save the factory default settings as the power up defaults, first click the Factory Defaults button, then click the Save Settings button.

Reset Camera: The Reset Camera button performs a soft reset that restarts the camera software.

7.4 Utilities Tab

The Utilities tab on the FLIR Camera Controller GUI, shown below, provides the ability to configure the camera's analog output.

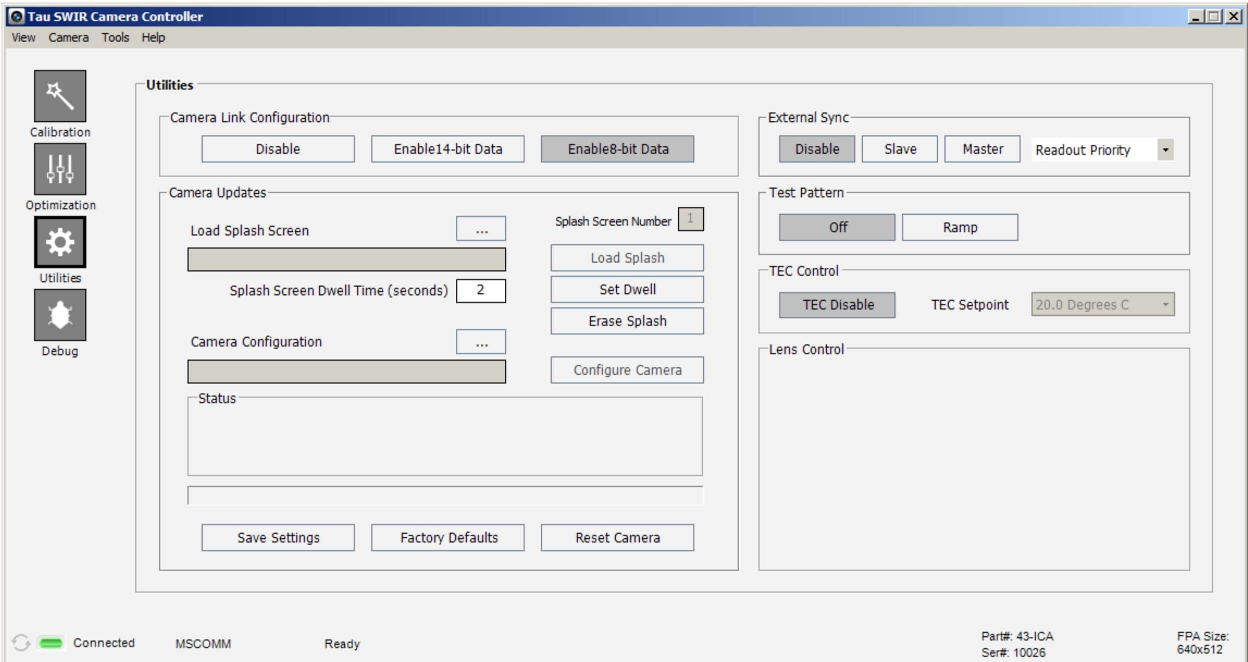

Figure 27. FLIR Camera Controller GUI -- Video Tab

Camera Link Configuration: This section describes digital data acquisition with the Camera Link accessory and assumes that all prior sections have been successfully completed.

1. Connect one end of the Camera Link cable to the camera. The camera connection is a Mini-Camera Link connector and frame grabbers may use either standard or Mini-Camera Link. It is possible to purchase cables that have mini connectors on both ends or standard on one end with mini on the other.

2. Select either 14-bit or 8-bit data, depending upon preference. 8-bit data has the AGC applied and looks similar to the analog video image. 14-bit data does not have AGC applied. Once these changes are made, it is a good idea to save settings to make them power cycle persistent. This can be done on the Setup Tab by clicking the "Save Settings" button.

3. The digital data complies with Base Camera Link standards and will be compatible with most off-the-shelf Camera Link frame grabbers. FLIR has tested the ImperX FrameLink Express frame grabber (http://imperx.com/frame-grabbers/framelink-express) and the Matrox Solios Camera Link frame grabber. (http://www.matrox.com/imaging/en/products/frame_grabbers/solios/solios_ecl_xcl_b/). It is

important to note that this module provides access to digital data only and the other portions of the Base Camera Link specifications are not met. Camera control, external frame sync, and power through the Camera Link connector are not supported.

4. If a BitFlow framegrabber is to be used, consult FLIR for the necessary hardware.
5. The FLIR Camera Controller GUI allows for control of the FLIR camera, but does not support Camera Link frame capture and so third-party software must be used. The ImperX frame grabber includes FrameLink Express software that allows for recording single or multiple images (BMP, JPG, TIF, and RAW) as well as standard AVI clips. Configuration requires selecting: "1 TAP, L->R" for the tap reconstruction, selecting the same bit depth that was chosen in the FLIR Camera Controller GUI in step 2, and clicking "Learn" to discover the number of digital pixels available.

6. Click Apply and Start Grab

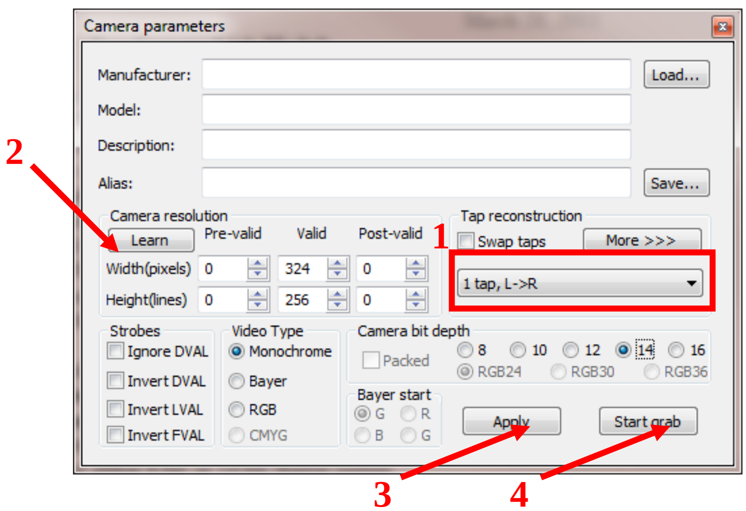

Figure 28. Imperx FrameLink Express Software – Camera Parameters Window

Note: *If the image appears to have very little contrast, the output is likely in 14-bit mode. If that is the intended setting, use the histogram feature in the frame-grabber software to change the display range. Otherwise, set the camera to 8-bit Digital Output Mode and the frame-grabber to 8-bit capture mode. Click "Apply" in the frame grabber software. The camera will now use its built in AGC functionality that is accessible from the AGC tab in the FLIR Camera Controller GUI.*

Camera Updates

Load Splash Screen: It is possible to load a custom 256 color bitmap for display in the analog video. Refer to the Application Note on Splash Screens for more information. Tau SWIR cameras support dynamically changing the dwell time with the Set button. This will apply the dwell time to the splash screen number specified. Erasing the Splash Screen on a Tau SWIR camera will result in a black Splash Screen with a 2 second dwell time.

Camera Configuration: This is used to load "pcf" files into the camera that can perform a wide variety of functions such as updating firmware and/or software, loading Discrete I/O files, or loading different symbology files. Refer to the Application Note written to address the individual topic of interest for more information.

External Sync: The Tau SWIR camera provides options for external synchronization and triggering. The camera is in "Free Run" mode whenever the External Sync is Disabled. Options for the synchronized event (integration, data readout, video output) are discussed below. When an option other than Free Run is selected, a warning dialog will appear telling the user that an external synchronization source (3V to 3.3V square wave) must be connected before using the new external sync mode.

***Integration Priority*:** Probably the most common synchronization task is to control the **start** of the FPA integration period with an external signal. The Slave **-** Integration Priority mode offers the most flexibility for accomplishing this.

Figure 29 illustrates the camera level timing of this mode. The externally provided frame sync controls the start of the integration period, which causes scene charge to be collected for the length of time that has been programmed by the user. The delay between external sync and the start of integration is 650ns±70ns. At the end of the integration period, the FPA readout process begins for the integration period just ended. This is shown in the lower part of the figure which includes the Camera link frame and line valid signals.

The duration of the readout process is determined by the user selected window size – all pixels in this window must be read out. At a time that is approximately the selected integration time *prior to the end of read out* it is possible to start the next integration period (i.e. *integrate while read*). This is indicated in the figure by the end of the lockout period; at that point the camera will accept another frame sync input. As illustrated here, the user waits a short period before issuing the sync – at that time, the integration period and lockout period begin again. During the lockout period, the camera will ignore any external syncs.

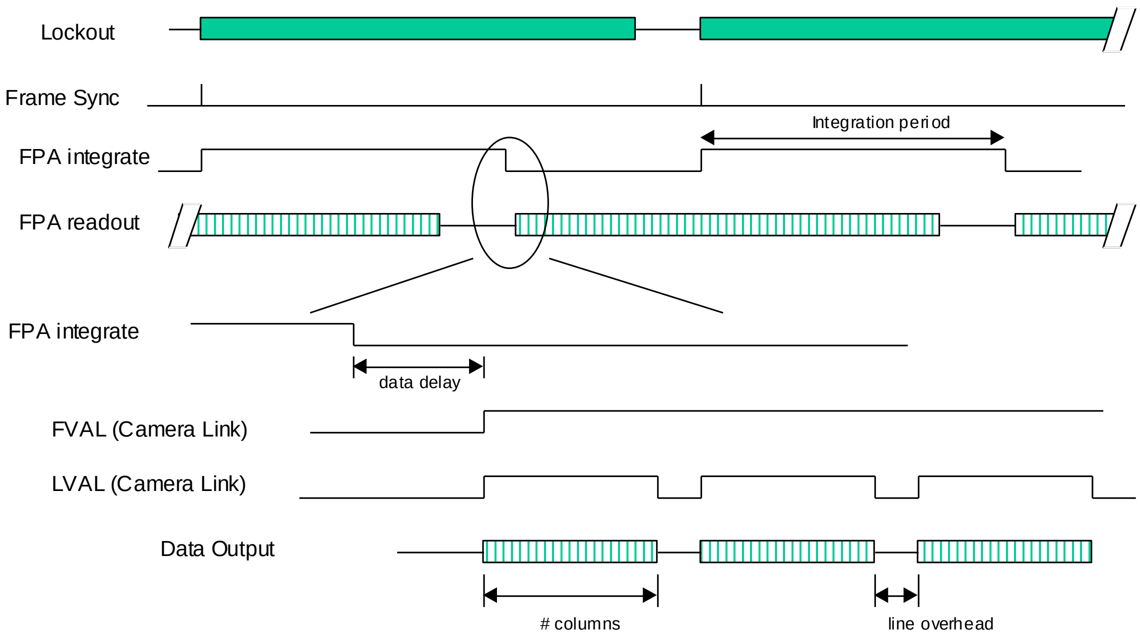

Figure 29. Integration Priority Mode Synchronization

Readout Priority*.** This mode is used to synchronize the ***readout of scene information. This mode is useful for downstream signal processing elements that either need to control when data is sent or need a fixed relationship between the sync and when data is available.

Referring to Figure 30, below, the external frame sync initiates the readout period of the FPA. While not immediately apparent, it also initiates the start of the integration period at a time calculated by the camera which is approximately the time required for readout, less the user selected integration time.

At the end of the integration period, the FPA readout process is automatically started but the camera halts this *immediately prior to the appearance of the first valid pixel.* At this point, the lockout period ends and the camera will accept another sync. When the sync is received, the data readout process continues with the readout of the first valid pixel, the lockout period begins, and at a later time, the integration period starts again.

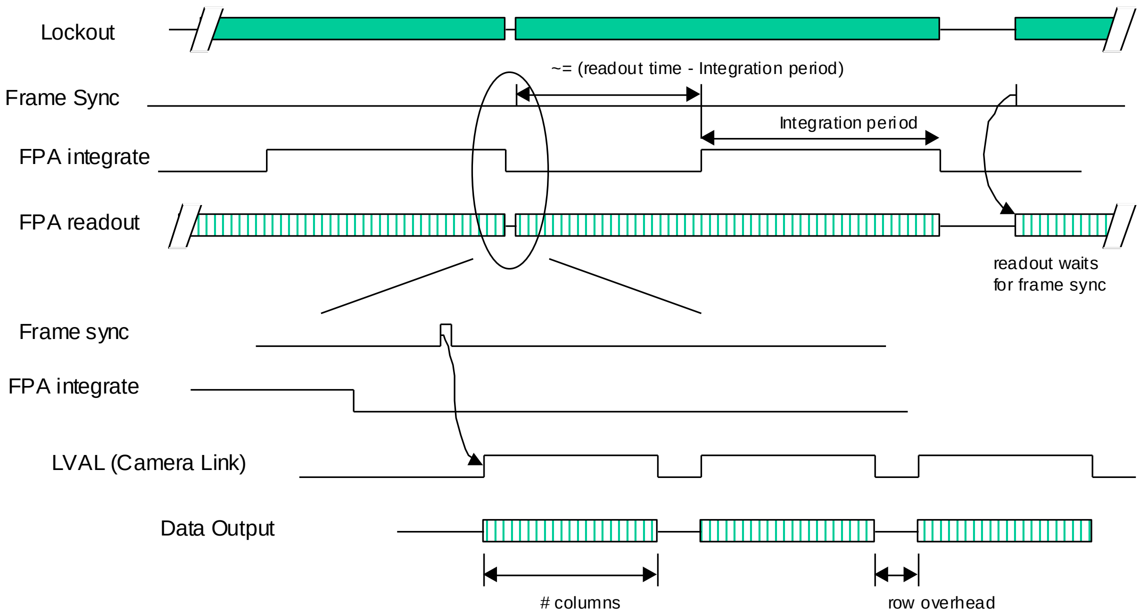

Figure 30. Readout Priority Mode Synchronization

Test Pattern: A Test-Pattern mode is provided to adjust display properties and/or for diagnostic purposes (for example, to verify the core is providing a valid output). The Test-Pattern mode will not persist over a power cycle.

Off: No test-pattern is provided in this mode. This is the normal operation mode.

Ramp: In this mode a ramp test pattern is provided at the analog and digital data channels. This test pattern is shown in Figure 26.

TEC Control: Enable /Disable TEC control. The TEC set point is set at the factory to 20°C. The camera will maintain this temperature unless the environmental temperature is too extreme, in which case the set temperature will be stepped to the next set point (lower if the environment is too cold, higher if the environment is too warm). The actual environmental tempeeratures at which this step will take place is dependent on the mounting configuration which determines the heat exchange between the camera and the environment.

Lens Control: Functions in the Lens Control section are not part of the Tau SWIR initial release.

Save Settings: After using the FLIR Camera Controller GUI to change Camera modes and settings to desired values, use the Save Settings button to store many of the current selections as new power-up defaults. The next time the camera is powered; the camera will remember these saved settings. If the Save Settings button is not clicked, any changes made via the FLIR Camera Controller GUI will be valid only for the current session. Cycling power to the camera will revert to the previously saved settings.

***Note**: The Save Settings button applies to changes made anywhere in the GUI, not only the Setup Tab.*

Factory Defaults: The Factory Defaults button restores the camera's settings to the initial values specified by FLIR. To save the factory default settings as the power up defaults, first click the Factory Defaults button, then click the Save Settings button.

Reset Camera: The Reset Camera button performs a soft reset that restarts the camera software.

7.5 Debug

The FLIR Camera Controller GUI provides an easily accessible way to communicate with FLIR cameras by providing a point and click interface. When a button is clicked in the GUI (ex. Do FFC), the GUI takes the corresponding serial command (0C) and formats the command according to the FLIR packet protocol detailed in the software IDD. The message control tab allows users to send serial commands found in the Tau SWIR Software IDD (102-2009-42) directly to the camera.

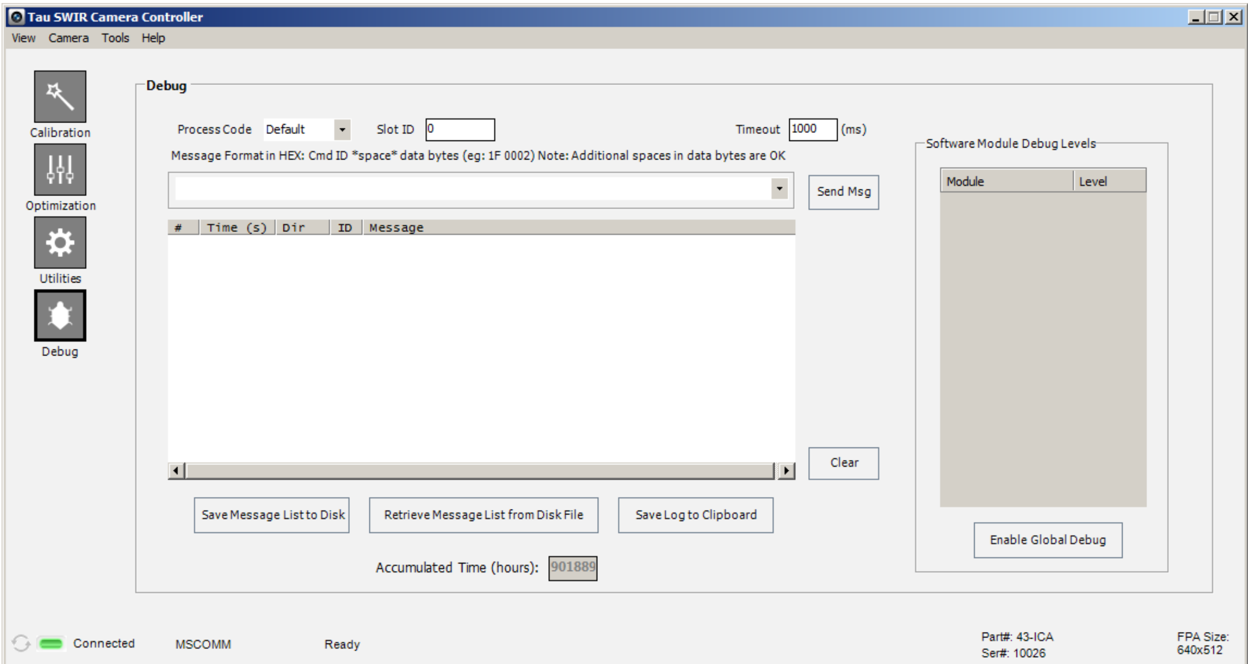

Figure 31. FLIR Camera Controller – Debug Tab

FLIR

8.0 Appendix – Extraordinary Conditions

8.1 Disassmbly

Disassembling the camera should not be done without first consulting FLIR Tech Support (SBA-Cores@flir.com) because it could cause permanent damage and void the warranty. Note that all noise measurements and figures of merit are changed with a change in physical configuration.

8.2 Cleaning the VPA Window

Touching of the VPA window with any object should be avoided at all costs. If the window does become contaminated, cleaning should be performed in a clean, low dust environment while wearing powder-free, acetone-impenetrable, ESD safe gloves or finger cots (Nitrile gloves are preferred).

1. Dusting: Use clean dry compressed air or dry nitrogen (no greater than 20-30 psi) to remove any loose debris particles from the optic. If no visible stains are present after dusting, discontinue the procedure and cover the optic so that no further contamination accumulates.
2. Solvent and lens tissue: Lens tissue should always be used in conjunction with a solvent. FLIR recommends a solvent mix of 50% acetone (hence the use of acetone-impenetrable gloves) and 50% Isopropyl alcohol. For water-based contaminats (saliva, etc.), Deionized water can be used as the solvent. Do not use glass cleaning solvent as it will create streaks. Isopropyl alcohol alone can be used, but its relatively slow evaporation time can leave drying marks on the optic. Lay a piece of unfolded lens tissue over the optic. Using an eye dropper, drop on some solvent and slowly drag the wetted tissue across the optic's surface. Use caution on the amount of sovent applied…over soaking can be messy, under wetting can streak. The only pressure applied to the window is the surface adhesion created by the solvent. Do not scrub. Be sure to clean the edges of the optic prior to attempting the center section. The final clean should be a solvent-saturated cleanroom wipe dragged across the window, followed quickly (immediately) by a dry nitrogen blow off. In most cases, a single pass should be sufficient. If necessary, use a new piece of lens tissue for each additional pass.
3. Under no circumstances should the window be rubbed with a swab, Q-tip, **dry** lens tissue, or tee shirt.
4. For severely contaminated optics, cameras can be returned to the factory for cleaning. Contact FLIR at SBA-CameraReapair@flir.com to obtain a Return Material Authorization number.

8.3 External Conditions

Operating the camera outside of the input voltage range or operating temperature range specified in the Tau SWIR Product Specification (102-2009-90) can cause permanent damage and/or degrade the life of the camera. Avoid exposure to dust and moisture. The camera contains electrostatic-discharge-sensitive electronics and should be handled appropriately.

This product is protected by patents, design patents, patents pending, or design patents pending.

If you have questions that are not covered in this manual contact FLIR Commercial Systems Customer Support (SBA-Cores@flir.com) for additional information. Contact Customer Support for questions related to the use of open-source software in this product. And contact Customer Support prior to returning a camera which is in need of service.

This documentation and the requirements specified herein are subject to change without notice.

This equipment must be disposed of as electronic waste.
Contact your nearest FLIR Commercial Systems, Inc. representative for instructions on how to return the product to FLIR for proper disposal.

FCC Notice. This device is a subassembly designed for incorporation into other products in order to provide an infrared camera function. It is not an end-product fit for consumer use. When incorporated into a host device, the end-product will generate, use, and radiate radio frequency energy that may cause radio interference. As such, the end-product incorporating this subassembly must be tested and approved under the rules of the Federal Communications Commission (FCC) before the end-product may be offered for sale or lease, advertised, imported, sold, or leased in the United States. The FCC regulations are designed to provide reasonable protection against interference to radio communications. See 47 C.F.R. §§ 2.803 and 15.1 et seq.

Industry Canada Notice. This device is a subassembly designed for incorporation into other products in order to provide an infrared camera function. It is not an end-product fit for consumer use. When incorporated into a host device, the end-product will generate, use, and radiate radio frequency energy that may cause radio interference. As such, the end-product incorporating this subassembly must be tested for compliance with the Interference-Causing Equipment Standard, Digital Apparatus, ICES-003, of Industry Canada before the product incorporating this device may be: manufactured or offered for sale or lease, imported, distributed, sold, or leased in Canada.

Avis d'Industrie Canada. Cet appareil est un sous-ensemble conçu pour être intégré à un autre produit afin de fournir une fonction de caméra infrarouge. Ce n'est pas un produit final destiné aux consommateurs. Une fois intégré à un dispositif hôte, le produit final va générer, utiliser et émettre de l'énergie radiofréquence qui pourrait provoquer de l'interférence radio. En tant que tel, le produit final intégrant ce sous-ensemble doit être testé pour en vérifier la conformité avec la Norme sur le matériel brouilleur pour les appareils numériques (NMB-003) d'Industrie Canada avant que le produit intégrant ce dispositif puisse être fabriqué, mis en vente ou en location, importé, distribué, vendu ou loué au Canada.

EU Notice. This device is a subassembly or component intended only for product evaluation, development or incorporation into other products in order to provide an infrared camera function. It is not a finished end-product fit for general consumer use. Persons handling this device must have appropriate electronics training and observe good engineering practice standards. As such, this product does not fall within the scope of the European Union (EU) directives regarding electromagnetic compatibility (EMC). Any end-product intended for general consumer use that incorporates this device must be tested in accordance and comply with all applicable EU EMC and other relevant directives.