Tau Camera

User's Manual

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This documentation is subject to change without notice.

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1 Introduction

The Tau camera is a long-wavelength (8 – 14 microns) uncooled microbolometer camera designed for infrared imaging applications that demand absolute minimum size, weight, and power consumption. It is available with multiple different lens focal length options, as well as lens-less (not shown) and narrow-field-of-view (NFOV) options. The Tau Software Developer's Kit (SDK) enables camera control using one of several programming languages including VB6, VB.net, C#, and C++ (MFC). The FLIR Camera Controller GUI is an example of an application created using the SDK—See "Software accessory SDK for Windows & Embedded" on page 2-4.

Figure 1-1: Tau Cameras

The camera provides "power-in, video-out" capability, which means that one need only apply input voltage to receive analog video. For those applications requiring serial control, the Tau camera includes a serial interface (RS-232) for transmitting camera commands and receiving status. The Tau camera also provides 8-bit and 14-bit digital data options, including CMOS, BT-656, and the Legacy Photon LVDS—See "Tau Digital Data Channel" on page 4-1.

All the above lenses are sealed to IP67 (1 meter). All lenses, except the 25mm and 35mm, are diamond-like coated for superior abrasion resistance; while the 25mm and 35mm are High Durability coated.

Table 1-1: Tau Camera Lens Range Performance (Standing Man—1.5m by 0.5m)

Lens	HFOV			
5mm Lens	43° HFOV	115 meters—Detection	27 meters—Recognition	14 meters—Identification
9mm Lens	48° HFOV	205 meters—Detection	52 meters—Recognition	26 meters—Identification
13mm Lens	34° HFOV	300 meters—Detection	74 meters—Recognition	37 meters—Identification
19mm Lens	24° HFOV	450 meters—Detection	112 meters—Recognition	56 meters—Identification
25mm Lens	18° HFOV	560 meters—Detection	140 meters—Recognition	70 meters—Identification
35mm Lens	13° HFOV	780 meters—Detection	190 meters—Recognition	97 meters—Identification
65mm Lens	7° HFOV	1450 meters—Detection	370 meters—Recognition	185 meters—Identification
100mm Lens	4.6° HFOV	2075 meters—Detection	540 meters—Recognition	270 meters—Identification

1.1 Tau Specifications

- 320 (H) × 256 (V) or 160 (H) × 128 (V) uncooled microbolometer sensor array, 25 × 25 micron pixels
- Spectral band: 7.5 - 13.5µm
- NEdT Performance: < 50mK at f/1.0[1]
- Input voltage range: 4.0 – 6.0 VDC
- Power Consumption: < 1.0 Watts (nominal at room temperature using 5V input)
- Time to image: < 3 seconds
- Operating Temperature Range: -40°C to +80°C
- Weight: ≤72 grams with either the 5mm, 9mm, 13mm, or 19mm lens option[2]

Note

The Tau camera is an export controlled item. In order to increase the Camera's exportability, a 'Slow Video' version of Tau is available. The frame rate is reduced to approximately 9 Hz. This change allows Tau to be exported without US export license to most countries. Please contact FLIR for additional information.

- Analog video output:
  NTSC (320 × 240) 30Hz ('Slow Video' rate (7.5Hz) is available for exportability)
  or
  PAL (320 × 256) 25Hz ('Slow Video' rate (8.3Hz) is available for exportability)

Note

The NTSC analog video format is default for cameras with analog video. The FLIR Camera Controller GUI software allows you to select between NTSC or PAL video output formats.

- Digital video output: 8- or 14-bit serial LVDS, CMOS, or BT 656
- Remote camera control RS-232 interface: FLIR Camera Controller GUI software available for free download at www.corebyindigo.com/service/softwareupdates.cfm)
- The VPC accessory used for USB connectivity requires that the driver is installed before using. This driver is installed as part of the FLIR Camera Controller GUI installation.
- 2× and 4× Digital Zoom with electronic pan/tilt (analog video)
- Dynamic Digital Detail Enhancement (DDE)

The latest information concerning specifications, accessories, camera configurations, and other information can be found in the Tau Thermal Imaging Camera Core Data Sheet at: http://www.corebyindigo.com/products/uncooledcores.cfm.

1. NEdT at the camera output measured with FLIR's proprietary noise reduction applied in the as-shipped configuration. Typical performance is approximately 35mK with f/1.0 optics.
2. The WFOV Tau lens options (5mm, 9mm, 13mm, and 19mm) have a nickel-plated magnesium lens flange which is not rated for salt/fog. If salt/fog exposure is expected, please contact your sales representative and order the corrosion resistant version of these lenses.

1.2 Available Tau Configurations

1.2.1 Tau-D Configurations

The Tau-D configuration is a reduced feature set Tau camera designed for large volume OEM customers. Tau-D outputs only digital video; analog video output is not present.

- 8-bit and 14-bit LVDS output is active
- BT-656 output is active
- Available in both Slow and Full frame rate versions
- Lens selection limited to 5 mm (160 only), 9 mm, 13 mm, and 19 mm
- Available in both 160 × 128 and 320 × 256 formats
- Thermal measurement features (Spot Meter and Isotherms) are not enabled
- Snapshot feature is not enabled
- 25mm, 35mm, 65mm lenses and lensless core not available.
- FLIR splash screen at startup

Figure 1-2: Tau Camera as delivered showing 50-pin Hirose Connector and Back Cover

1.2.2 Tau Lens Configurations

The Tau camera is available with different lenses providing different fields of view, the 'Slow Video' or '9 Hz' option for license-free exportability, and also a 160 × 128 resolution at a reduced price.

	Resolution	f/#	FOV (H × V)	Weight with lens
5 mm	160 × 128	1.25	43° × 35°	72 g
9 mm	160 × 128	1.25	25° × 20°	
	320 × 240		48° × 37°	
13 mm	160 × 128	1.25	17° × 14°	
	320 × 240		34° × 26°	
19 mm	160 × 128	1.25	12° × 10°	
	320 × 240		24° × 18°	
25 mm	320 × 240	1.4	18° × 14°	135 g
35 mm	320 × 240	1.4	13° × 10°	129 g
65 mm	320 × 240	1.25	7° × 5°	358 g
100 mm	320 × 240	1.6	4.6° × 3.7°	503 g

Note

The Tau camera lenses are sealed to IP67 (1 meter).
Boresight features are available on Tau WFOV cameras. See "Mechanical IDD Reference" on page D-1.
Contact FLIR CVS Customer Support or your local FLIR sales representative for information on available Tau camera configurations, part numbers, and ordering information.

1.3 Software accessory SDK for Windows & Embedded

The Tau Software Developer's Kit (SDK Part Number 110-0102-46) enables camera control using one of several programming languages including VB6, VB.net, C#, and C++ (MFC). Code examples are included to help illustrate how some of the camera control functions can be used. The FLIR Camera Controller GUI is an example of an application created using the Photon SDK. Refer to http://www.corebyindigo.com/service/softwareupdates.cfm.

1.4 Unpacking Your Tau Camera

The Tau camera is typically delivered as a standalone product; no documentation is included. Documentation and utilities such as the latest version of this User's Manual, the FLIR Camera Controller GUI, and Mechanical Interface Description Documents are available for download from the www.corebyindigo.com website.

Please unpack the camera heeding customary Electrostatic Sensitive Device (ESD) precautions including static safe work station and proper grounding. The Tau camera is packaged in foam to prevent damage during shipping. It is also placed in a conductive anti-static bag to protect from electrostatic discharge damage.

Caution!

Disassembling the camera can cause permanent damage and will void the warranty.

Operating the camera outside of the specified input voltage range or the specified operating temperature range can cause permanent damage.

The camera is not sealed. Avoid exposure to dust and moisture.

This camera contains electrostatic discharge sensitive electronics and should be handled appropriately.

2.1 Tau Video Power Com (VPC) Accessory

The Tau VPC Module is the first thing many users will use to connect to their Tau camera, and for some customers it may be the only thing they will ever need. The VPC Module provides connection to a host computer for power, command/control, and digital image capture; it has a direct connection for analog video output. For instructions on installing the VPC Module refer to paragraph 3.1 "Operation of the Tau Camera using the Video Power Com (VPC) Module Accessory Kit" on page 3-1.

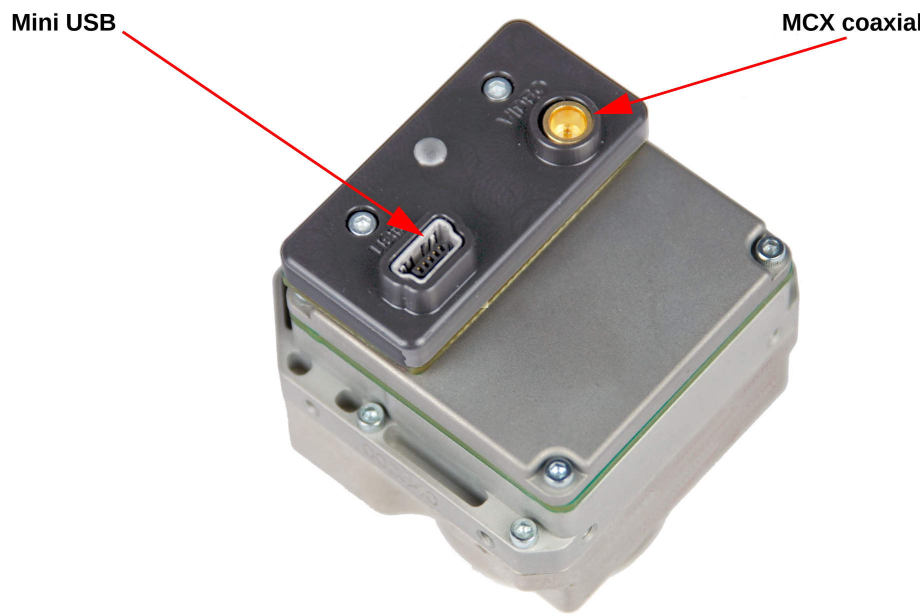


Figure 2-1: Tau VPC Module Installed on a Tau camera

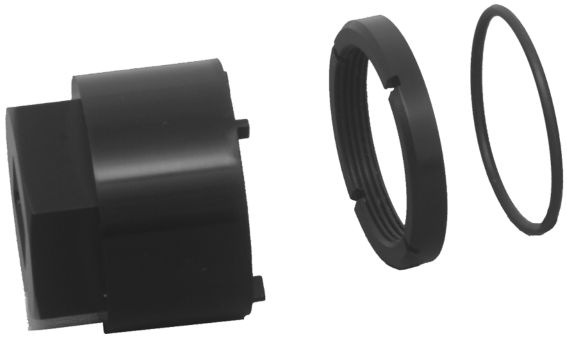
- Connector Type: USB mini 5-pin
- Power over USB: nominal draw 180mA at 5V
  (peak load at startup 500mA at 5V)
- Serial communications baud rate: 57600 Baud or 921600 Baud
- Hot swap protected
- Windows Service for automatic detection supported through SDK

Table 2-1: Miniplug / Microplug

Pin	Name	Color	Description
1	VCC	Red	+5 V
2	D-	White	Data -
3	D+	Green	Data +
4	ID[1]	none	permits distinction of Micro-A- and Micro-B-Plug Type A: connected to Ground, Type B: not connected
5	GND	Black	Signal Ground

1. Pin 4 of mini-USB connector may be not connected, connected to GND, or used as attachment identification at some portable devices.

2.2 Tau WFOV Locking Ring and Tool



421-0041-00 Tau Locking Ring Accessory with o-ring

421-0042-00 Lock Nut Tool

Type 2 - 025 O-ring (not included)

The locking ring is designed to mount a Tau WFOV camera into a bulkhead. The M29 x 1.0 thread on the outside of the lens mount flange is placed through the clearance hole in the bulkhead and the o-ring seals the camera to the face.

The locking ring accessory is made of Delrin so as not to scratch the nickle plating on the Tau camera lens flange. Scratching the external nickle plating can compromise the coating and make the Tau camera more susceptible to corrosion. The lock nut tool will attach to a torque wrench for proper tightening. Torque the locking ring to 4.0 in-lbs.

2.3 Backward-compatible Photon accessories

The following are accessories that offer a development environment and extended features for your Tau camera.

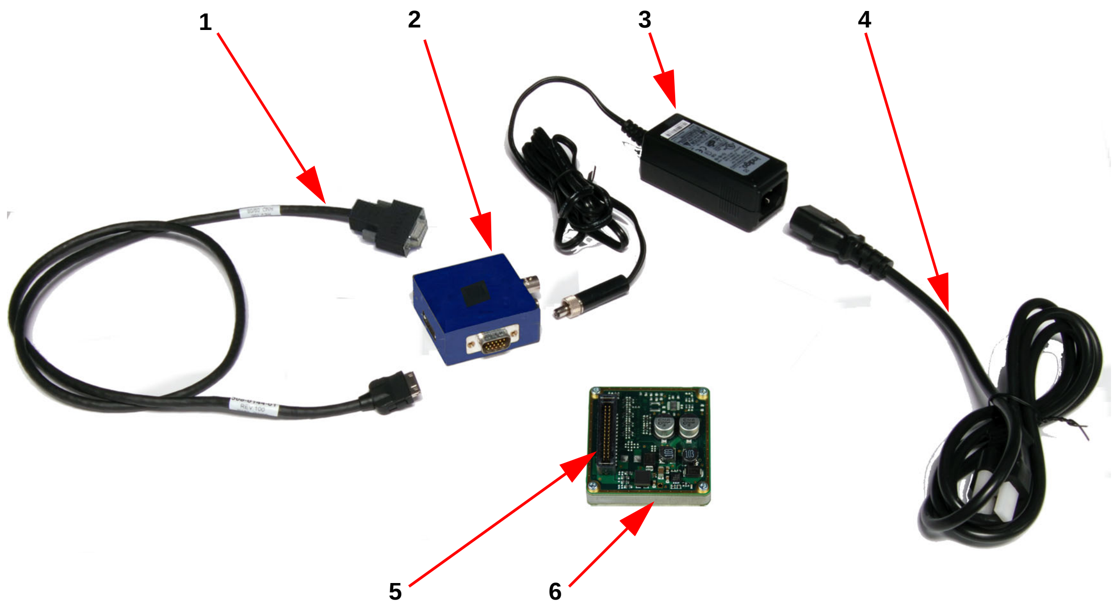


Figure 2-2: Photon Replicator Kit

1. Cable, Tau to I/O Module, 6 foot length
   (Part Number: 308-0076-02)
2. Input/Output (I/O) Module (Part Number: 333-0018-00)
3. AC/DC Power Supply (Part Number: 206-0001-20)[1]
4. IEC Line Cord (Part Number: 208-0004-02)
5. Photon Replicator Kit (Part Number: 250-0324-00)
7. Wearsaver (Part Number: 250-0194-00) Not Shown
8. Rear Cover

The Photon Replicator kit (p/n 421-0045-00) includes all of the above components. With this accessory kit, the user will need a standard BNC cable for analog video output and a standard RS-232 serial COM cable for advanced configuration using the free downloadable FLIR Camera Controller. The Photon Replicator Board adapts the 50-pin Tau connector to a 30-pin Samtec connector that allows the use of existing Photon cables and accessories.

1. The Photon Replicator Board accepts 6-24V. (The Tau core input voltage is 4-6V without the replicator board attached.)

Figure 2-3: Digital Data Serial-to-Parallel Module or SIPO

FLIR's optional serial-in, parallel-out (SIPO) module (p/n 333-0017-00) converts the serial LVDS into parallel data. The SIPO mates directly to the I/O module's digital data port, and furnishes a 68-pin connector that can be attached to a frame grabber via a digital interface cable. This accessory facilitates capture of the LVDS serial digital data channel from the Tau camera and mirrors it in a parallel format used with computer-based capture boards.

These boards require third-party software not offered or formally supported by FLIR. Refer to Chapter 4 for details on known compatible frame grabbers and interface cables, as well as software setup files for the compatible frame grabbers.

2.4 Software accessory SDK for Windows & Embedded

The Tau Software Developer's Kit (SDK p/n 110-0133-16) enables camera control using one of several programming languages including VB6, VB.net, C#, and C++ (MFC). Code examples are included to help illustrate how some of the camera control functions can be used. The FLIR Camera Controller GUI is an example of an application created using the Photon SDK.
Refer to http://www.corebyindigo.com/service/softwareupdates.cfm.

3.1 Operation of the Tau Camera using the Video Power Com (VPC) Module Accessory Kit

The Tau VPC Module is an interface for the camera to provide power and obtain video. It also facilitates serial communication for more advanced camera command and control via the free downloadable FLIR Camera Controller GUI. In this first section, we will discuss installing the VPC Module, applying power, and obtaining analog video.

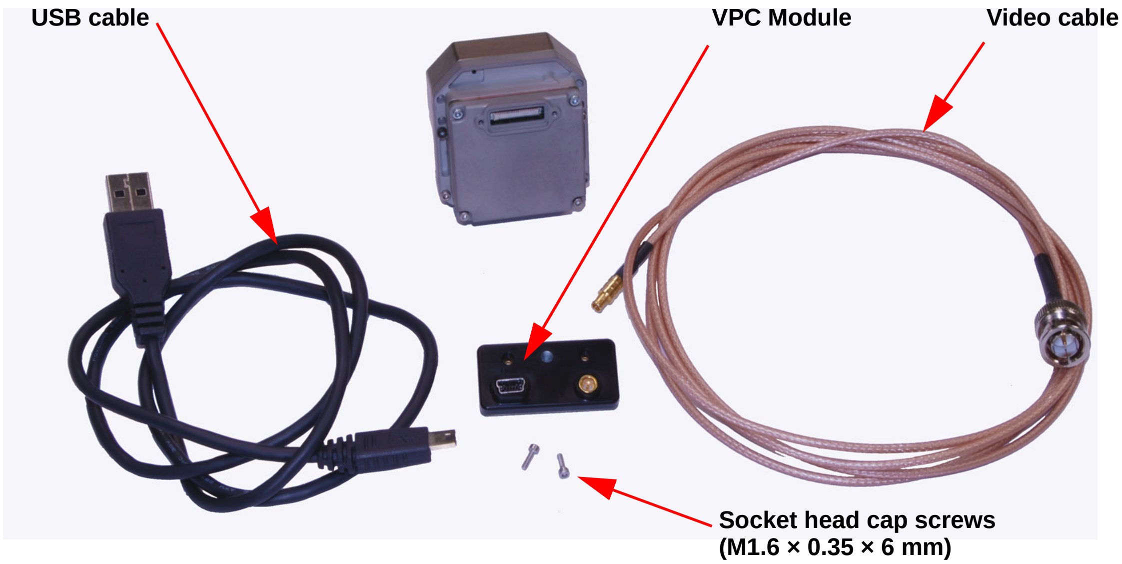


Figure 3-1: Tau Camera and VPC Module Accessory Kit

3.1.1 Installing the VPC Module

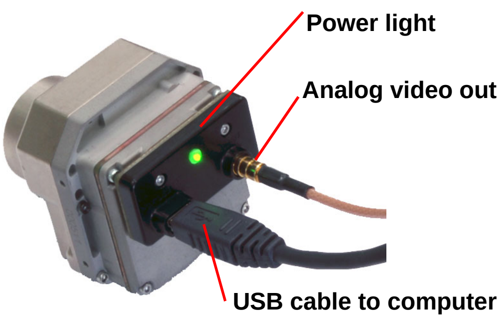
Step 1 Plug the VPC Module into the mating 50-pin Hirose Connector on the back of the Tau camera.

Step 2 Install the two socket head cap screws to secure the VPC Module.

Note

> *Use only M1.6 × 0.35 × 6 mm screws. Longer screws will damage the camera.*

3.1.2 Connecting the Tau Camera



Plug the Video cable into the mating connector on the back of the camera. Attach the other end to a compatible video monitor's composite video input. If your monitor has an RCA input connector, a BNC to RCA adapter can be used.

Plug the mini USB plug into the mating connector on the back of the camera. Connect the other end of the cable to a USB port on the computer. At this point, you are only using the power from the USB port.

3.2 Remote control of the Tau Camera

The Tau camera with the VPC Module Accessory accommodates advanced camera control through a Universal Serial Bus (USB) interface. A user can control the camera through this interface using their own software and hardware by following the Serial Communication Protocol and command structure defined in Appendix B. This requires programming skills and a strong technical background. The user can also use the FLIR Camera Controller GUI offered as a free download from FLIR using a Windows based PC with a standard USB port. This software provides remote control of various camera features and modes.

The FLIR Camera Controller GUI software is compatible with Windows XP with .Net Framework version 2.0 or later. The GUI will prompt the user to update to the latest .Net Framework.

Note

We recommend that Windows Update is turned on, keeping the operating system current.

If your embedded or specialty applications require custom control software, a Software Developer's Kit (SDK) is available. Those intending to generate their own custom software are encouraged to read the remainder of this section regarding the FLIR Camera Controller GUI to better understand the camera modes and parameters.

3.3 Installing the FLIR Camera Controller GUI

Step 1 If you have another version of the FLIR Camera Controller GUI loaded on your PC, you should uninstall it using the Windows Uninstall utility via the Windows Control Panel before proceeding with this installation. This is an important step as camera malfunction is possible if you do not remove any older versions of Tau (or Omega/Micron/A10) software.

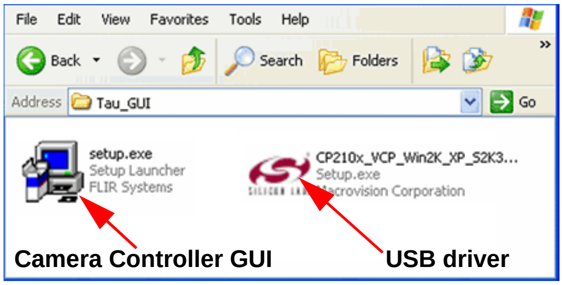
Step 2 Using your favorite WWW browser, navigate to the following URL: http://www.corebyindigo.com/service/softwareupdates.cfm.

Step 3 Click the **Download Tau GUI (Zip file, ~ 6 MB)** link.

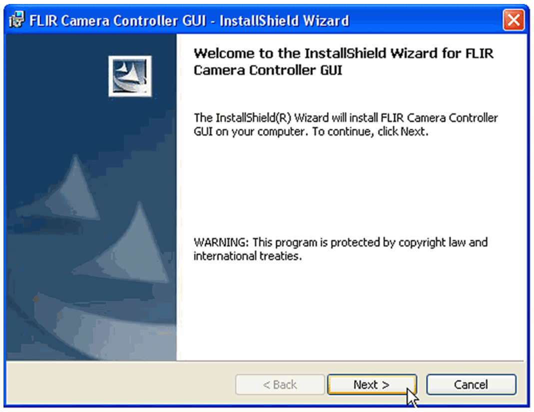
Step 4 When the **File Download** prompt appears, choose **Save**. It is recommended that you create a new empty directory such as "FLIR Camera Controller GUI Installable Files" on your desktop, for download.

Step 5 Extract the Installable files using WinZip or other available software.

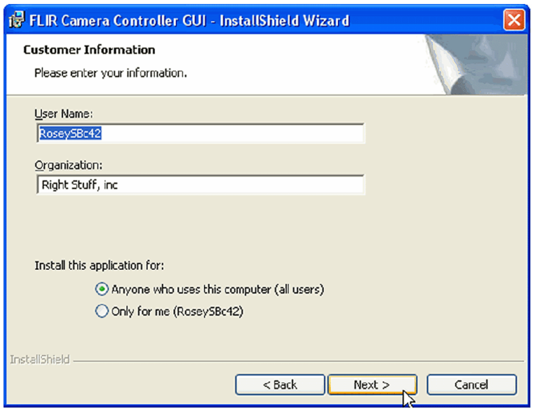
Step 6 Open the directory where you saved the Installable files. Double-click the **setup.exe** file to begin installation.



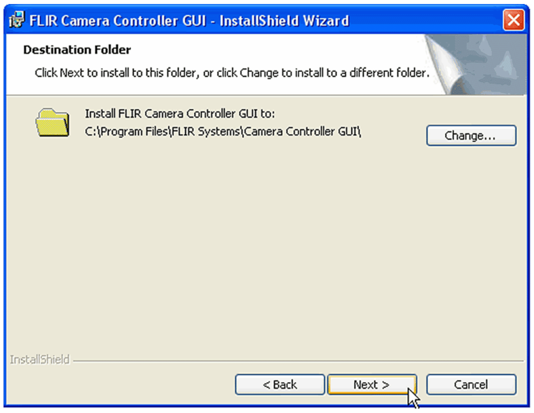
Step 7 Click **Next>** at the Setup Welcome screen.
When the installer finishes loading. Follow the prompts.



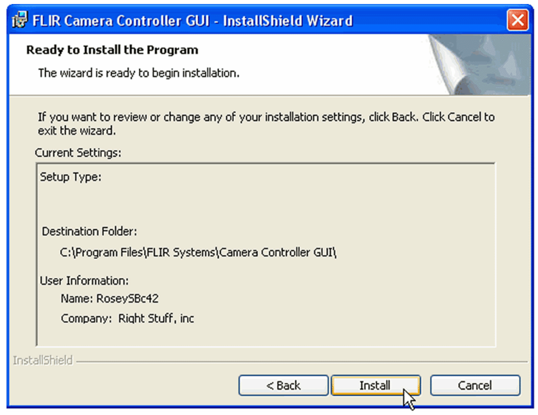
Step 8 Enter your **User Name**, **Organization**, and select your access security.
Click **Next>**



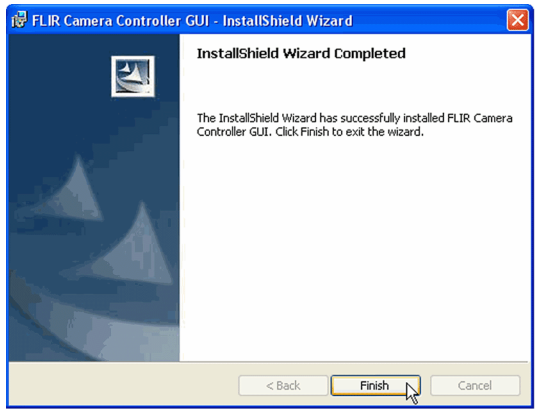
Step 9 Select a Destination Folder if different than the default.
Then, click **Next>>**.



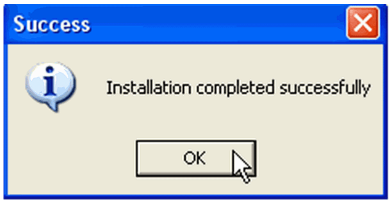
Step 10 Review the settings you have entered for this installation.
Then, click **Install**

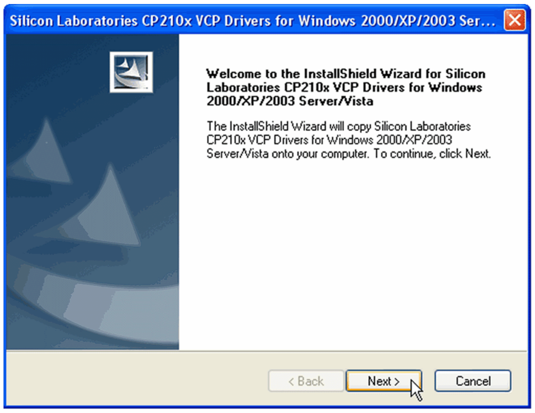


Step 11 Once installation is complete, click **Finish**.

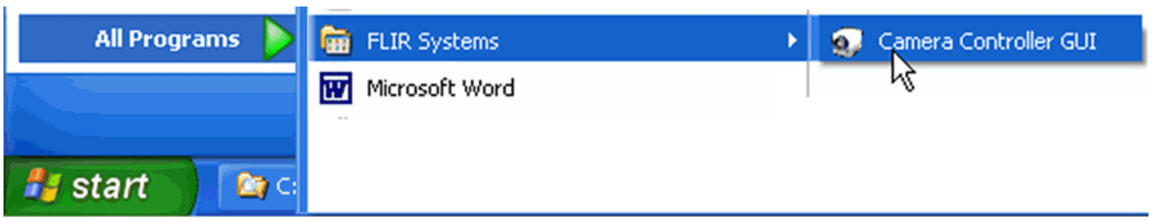


Step 12 The **CP210x_VCP...setup.exe** USB driver installer will start at this point.
Click **Next>** at the Setup Welcome screen.
When the installer finishes loading. Follow the prompts to finish the installation.





Step 13 Installation is complete. You can start the application or create a shortcut to the application via the
Start→All Programs→FLIR Systems→Camera Controller GUI path.



3.4 Connecting the Tau to a PC via the VPC Module

The following steps assume that you have installed the FLIR Camera Controller GUI software and the USB driver on your PC as described in the proceeding paragraphs 3.3.

Step 1 Follow the steps in paragraph 3.1.2 "Connecting the Tau Camera" on page 3-1.

About two seconds after the USB cable from the camera is connected to your PC, you should see video on your monitor. Verify that the camera is producing an image.

Step 2 Launch the FLIR Camera Controller GUI software by selecting **Start→Programs→FLIR Systems→Camera Controller GUI**.

Note

The FLIR Camera Controller GUI remembers the last COM port that successfully communicated with a Tau camera and will use that port as the default when the application starts. If the connected camera is no longer on that port, the port setting pop-up window will appear asking for you to select the proper port setting.

When the FLIR Camera Controller GUI is started, the Status tab of the utility should return data similar to the following.

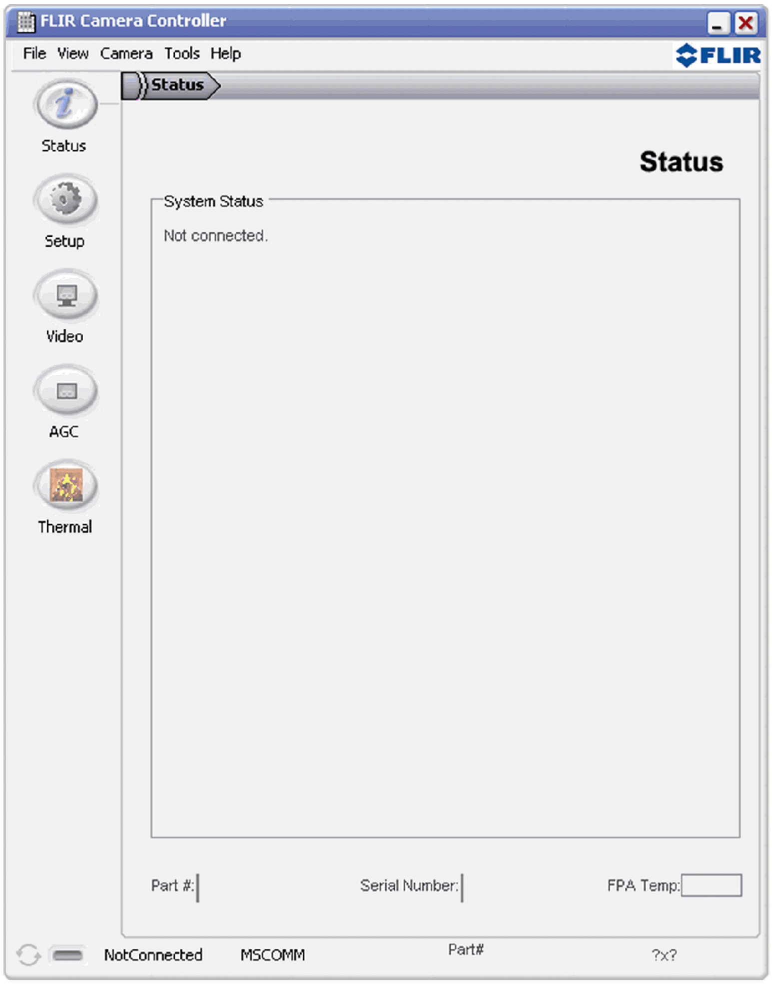
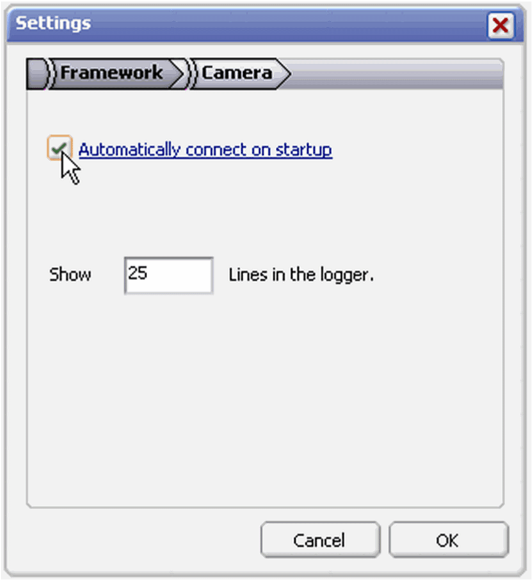


Figure 3-2: FLIR Camera Controller GUI Status Tab

Step 3 Connect to your camera by selecting **Connect** from the **Camera** menu.

Step 4 If you want the FLIR Camera Controller GUI to automatically connect when it is started, select **Settings** from the **Tools** menu, then check the **Automatically connect on startup** box in the **Settings Framework** tab.

Additional settings include camera connection polling, status logging, and FLIR Veneer style.

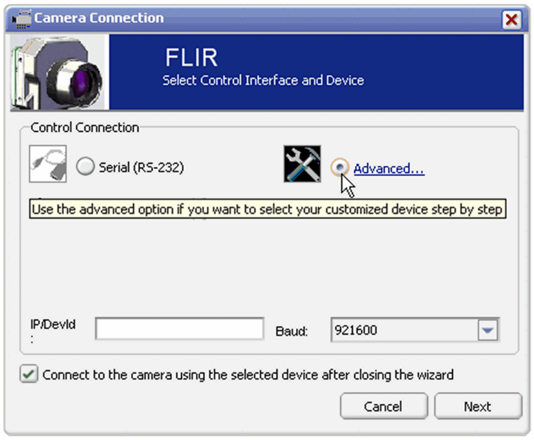


3.5 Troubleshooting the FLIR Camera Controller GUI

If the FLIR Camera Controller GUI does not link with the camera, you may see the popup shown at the right which indicates that the GUI has not been able to communicate with the Tau camera.

Verify the items in the following checklist:

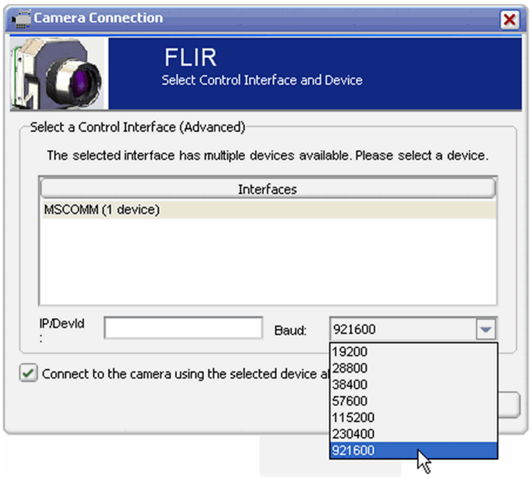
Is the camera properly cabled to the host PC?:



Verify that you selected the proper port 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, then re-launch the GUI.

Is the Baud rate set correctly? Baud rate must be set in the **Tools→Connection...** dialog box. The Tau camera supports Baud rates of 57600 and 921600.

Is the port already in use by another application?:



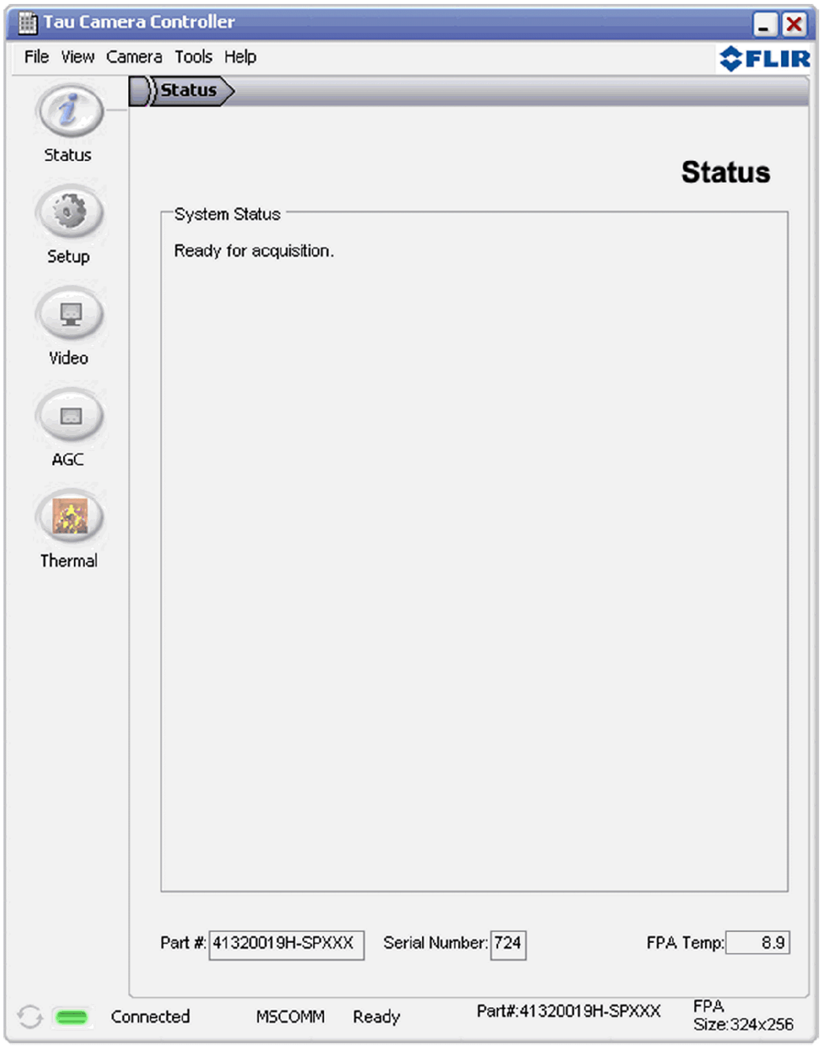
Shut down any other applications that may be using the port. Also, multiple instances of the FLIR Camera Controller GUI Program can be instantiated using different ports so be sure the camera you are interested in controlling is actually connected to the physical port.

Is the Tau camera power on? Verify that the camera is producing an image on a separate monitor. Also, at camera power up, you can hear two sets of a click-click sound, separated by about 5 seconds, as the internal shutter performs its on-power-up calibration. If you don't hear these sounds, it's likely the Tau camera is not being powered correctly.

If you cannot initiate serial communication with the camera after verifying these items, refer to the frequently asked questions (FAQ) at http://www.corebyindigo.com/Tau/TauFAQs_All.cfm or contact FLIR Customer Support at (805) 964-9797.

3.6 Operation of the FLIR Camera Controller GUI

When the FLIR Camera Controller GUI successfully links to the camera, you will see the window shown below. At the bottom of the application window, you should see Camera and FPA status. The GUI provides five tabs allowing for camera control as described below.



Camera Part #: indicates the specific camera configuration connected.

Camera Serial #: This is the serial number of the camera currently connected to the FLIR Camera Controller GUI.

FPA Temperature: The camera's Focal Plane Array (FPA) temperature.

The connection status, Camera status, Camera Part #, FPA Temp, and FPA Size are displayed at the bottom of all tabs.

3.7 Setup Tab

The **Setup** tab, shown below, provides the ability to do the following:

Modify the Flat Field Correction (FFC)
Set the External Sync mode
Freeze the video via the Operating Mode section
Supplemental Offset
Set the camera to generate a Test Pattern
Save the settings to the camera's non volatile memory
Restore the Factory Defaults
Reset the Camera

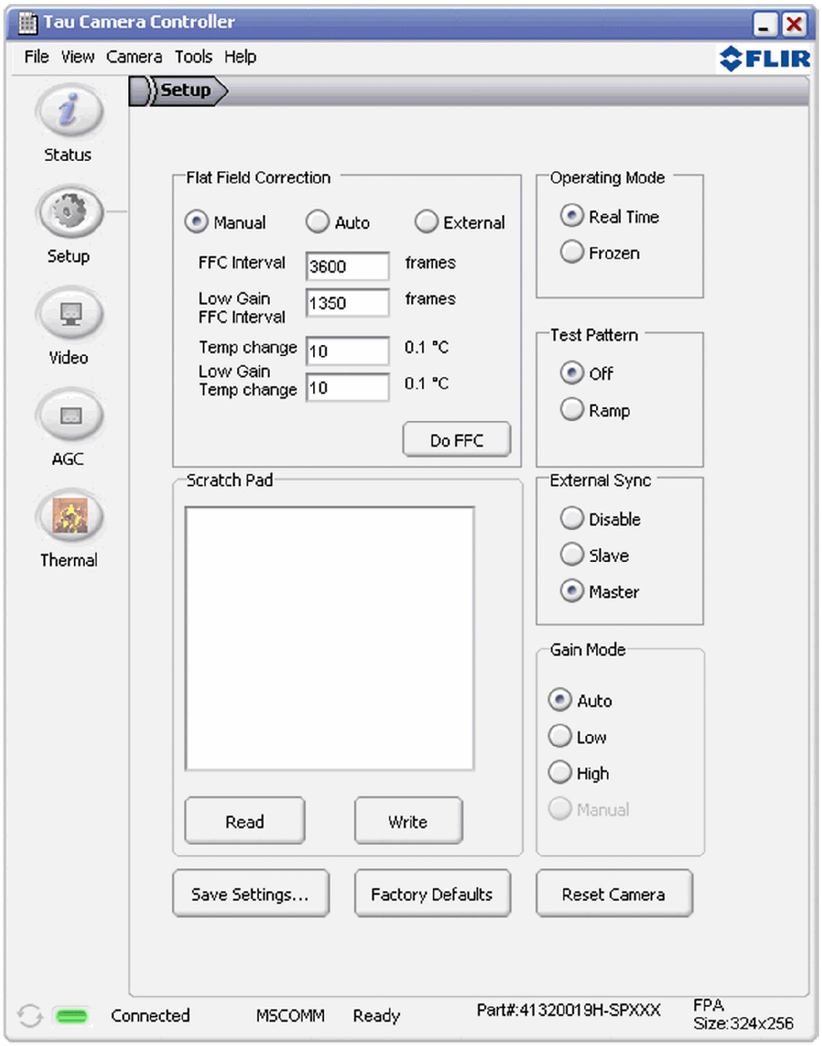
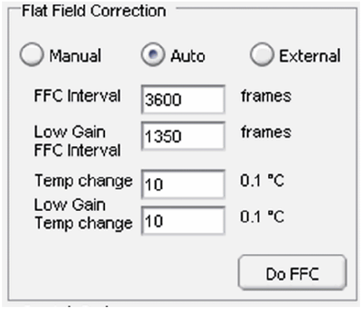


Figure 3-4: FLIR Camera Controller GUI Setup Tab



Flat-Field-Correction Mode: Tau includes internal mechanisms for periodically improving image quality via a process called flat-field correction (FFC). During FFC, a small calibration flag (a shutter) rotates in front of the detector array, presenting a uniform temperature (a flat field) to every detector element. While imaging the flat field, the camera updates correction coefficients, resulting in a more uniform array output. The video image is frozen during the entire process, which takes less than a second, and it 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. FFC can be controlled manually at any time using the **Do FFC** command button.

Tau provides three FFC modes:

Auto: In the Automatic FFC mode, the camera performs FFC whenever its temperature changes by a specified amount or at the end of a specified period of time (whichever comes first). When this mode is selected, input windows are available in the FLIR Camera Controller GUI for specifying the temperature change and the number of frames that trigger automatic FFC. The temperature change is specified in degrees, with valid values in the range 0 to 100 in 0.1 degree increments. The time period is specified in analog video frames (33ms NTSC, 40ms PAL), with valid values in the range 0 to 30,000 frames. The second set of Auto FCC parameters labeled **Low Gain** apply to Tau-P cameras with the auto gain switch enabled.

Note

FLIR recommends using the factory default values for the two automatic-FFC parameters if possible. These values were selected to maintain a high degree of image quality over all camera operating conditions.

Manual: In Manual FFC mode, the camera does not perform FFC automatically based on specified values of temperature change or expired time. The FFC will be performed once upon startup then again using the internal shutter when the "Do FFC" button is clicked.

Note

Large camera temperature excursions cause the camera to perform the FFC operation (even with Manual FFC mode selected), typically at temperature crossings near 0°C and 40 °C.

External: In External FFC mode a uniform source (blackbody) must be placed in front of the camera. The image of this uniform source will be subtracted from all subsequent images. This feature is useful if there are lens or lens mount non-uniformities that are not corrected by an internal FFC. The camera will not perform an FFC process on startup if the saved state of the camera is **External** mode FFC.

The Tau camera displays an on-screen symbol called the Flat Field Imminent Symbol prior to performing an automatic FFC operation. As shown in Figure 3-5, it is the green square in the upper right of the video output and is displayed nominally 2 seconds prior to the FFC operation. The duration of the FFC Imminent Symbol can be set using the **FFC Warn Time** setting in the **Analog Video** tab. Setting the **Warn Time** to less than 15 turns off the warning (see paragraph 3.8).

Figure 3-5: Flat Field Imminent Symbol

External Sync Mode: The Tau camera provides the ability to either accept or output a frame synchronization signal on pin 21 of the 50-pin Hirose connector or pin 26 of the Photon Replicator board. This functionality can also be disabled. The designed signal levels are 0V and 3.3V.

Disabled: The camera will turn off frame synchronization.

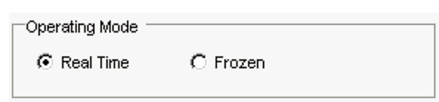
Slave: The camera will accept a frame synchronization signal on the interface connector. The camera output will be frozen if the camera is in slave mode and no external synchronization signal is received.

The focal plane array readout cycle starts when the external synchronization signal is received and the camera will continue the output cycle until the frame is complete. The frame sync signal embeded in the respective digital output should be used to acquire digital data, not the external sync I/O.

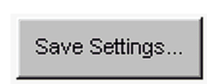
Maximum external sync input rates are up to 29.980 Hz for NTSC and 27.25 Hz for PAL. The 'Slow Video' versions of the Tau camera will have the same external sync frame rates, but the image data output will be at 1/4 the rate (NTSC) or 1/3 the rate (PAL).

Master: The camera will output a frame synchronization signal on the interface connector when configured as a master. The output pulse width will be 100 ns at the standard frame rates (27.970 Hz for NTSC; 25.000 for PAL).

Operating Mode: The Tau camera will freeze the analog frame imaged when **Frozen** is selected. Live video will cease and the frozen frame will persist. To return the camera to live video, select **Real-Time** video mode.

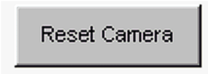


Save Settings: After using the FLIR Camera Controller GUI to change camera modes and settings to your desired values, use the **Save Settings** button to store your current selections as *new* power-up defaults. The next time the camera is powered, the Tau camera will remember these saved settings. If you do not click **Save Settings**, the changes you make 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.

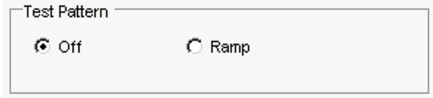


Factory Defaults: The **Factory Defaults** button restores the camera's settings to the initial values specified by the manufacturer.

If you want the factory default settings to become the power up defaults, first click the **Factory Defaults** button, then click the **Save Settings** button.



Reset Camera: The **Reset Camera** button restarts the camera software and is nearly identical to cycling power.



Test-Pattern: A Test-Pattern mode is provided to verify camera electronics. The Test-Pattern mode will not persist over a power cycle.

> **Off**: No test-pattern is provided in this mode. This is the normal mode for viewing thermal imagery.
>
> **Ramp**: In this ramp mode, the test pattern shown below and in the Color/LUT section that follows is provided at the analog and digital data channels.

Figure 3-6: Ramp test pattern example for Top Portion of Tau Ramp Image
(Digital values shown apply to the optional 14-bit digital data stream.)

The above ramp pattern repeats 19 times in the complete 320 × 256 image.

Note

The ramp test pattern is intended primarily for verifying the output of the digital data channel. The pattern will not necessarily look as shown above when displayed on an analog video monitor, particularly if an Automatic Gain Control (AGC) mode other than Automatic is selected. The above image is a horizontal slice of the full displayed image.

Gain Mode: The Tau camera has two gain ranges:

> **High** gain mode is designed to maximize contrast for imaging applications.
>
> **Low** gain mode has lower contrast but a higher dynamic range and is designed for viewing hot targets.
>
> **Auto** gain mode allows the Tau camera to switch between **Low** and **High** gain mode based on the scene being viewed, **Auto** mode is controlled by the **Gain Switch Values** in the **Thermal** tab. See "Thermal Tab" on page 3-25.

3.8 Analog Video Tab

The **Analog Video** tab on the FLIR Camera Controller GUI, shown below, provides the ability to modify Tau camera modes:

- Image Orientation
- Pan & Zoom
- Polarity/LUT (Video Color)
- FFC Warn Time
- Dynamic Digital Detail Enhancement (DDE)
- Video On/Off
- Video Standard NTSC/PAL

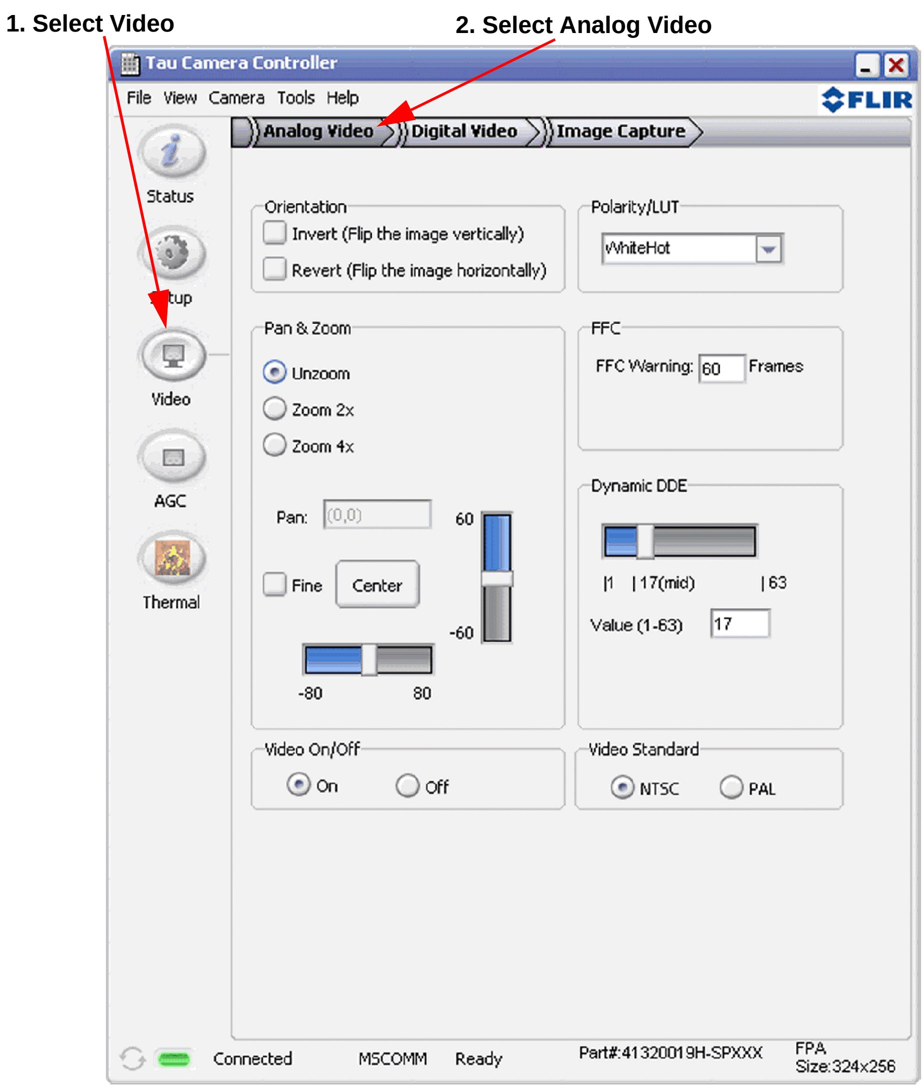


Figure 3-7: FLIR Camera Controller GUI Analog Video Tab

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

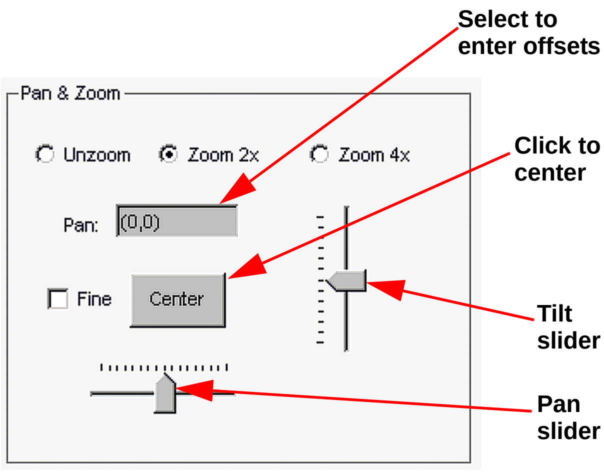
Invert: The normal image is flipped vertically. The pixel on the upper-left corner of the detector array is displayed on the lower-left corner of the video display in Invert mode. Invert is used when mounting the camera upside-down. **Invert** applies to analog, BT-656, CMOS, and LVDS video.

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 in Revert mode. Revert mode produces a mirror-image of Normal mode; use for applications where the camera is imaged through a fold-mirror. **Revert** applies to analog and BT-656 video only.

Note

Any time the image orientation mode is changed, a flat-field correction takes place.

Pan & Zoom, Zoom: The Tau 320 camera has a built-in 2× and 4× digital zoom capability. The Tau 160 camera has a built-in 2× digital zoom. The **Zoom** checkboxes are used to turn on/off the camera zoom. With the **Unzoom** box checked, the Tau camera displays the full sensor array image (NTSC: 320 × 240 pixels or PAL 320 × 256 pixels). When the **Zoom 2x** box is checked, a smaller central region of the sensor array is mapped to the video output creating the zoom effect. For NTSC and PAL video formats in 2× zoom mode, 160 × 120 and 160 × 128 pixels, respectively, are mapped to the analog video output. When the **Zoom 4x** box is checked, 80 × 60 (NTSC) and 80 × 64 (PAL) pixels, respectively, are mapped to the analog video output. This reduced region of the array is called the zoomed array region. The BT-656 video also has the zoom feature, but the CMOS and LVDS do not.



Pan & Zoom, Pan: When in either zoomed mode, you can move the zoomed array region within the full array area. This digitally simulates panning and tilting. Panning and tilting are defined as moving the camera image in the horizontal and vertical axes, respectively.

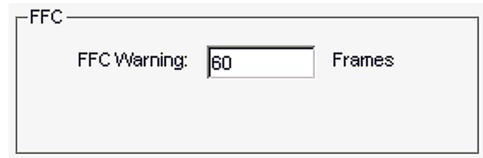
The Pan/Tilt limits for 320 cameras are the same in both 2× and 4× mode.
The Pan/Tilt limits for 160 cameras are ±40/±30; or the same as the **Fine** range.

You can adjust the vertical and horizontal sliders to move the zoomed array region.

When the fine box is not checked the slider controls move the zoomed image from edge to edge of the full sized array. Checking the fine box increases the sensitivity of the slide control so that the zoomed array moves one half the total range but all step values are achievable. Simple experimentation while viewing the displayed image will quickly give you familiarity with this feature.

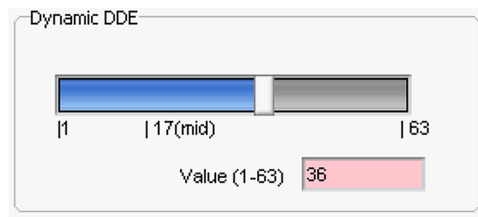
Note

the Spot Meter function always reports values from the center of the full array. Pan/Tilt moves the image but not the location of the Spot Meter. If Pan/Tilt is being used, the Spot Meter readings will not be correct.



Flat-Field Correction (FFC): The Tau automatically performs flat-field corrections (see paragraph "Flat-Field-Correction Mode:" on page 3-10). A green square is displayed on your video monitor as a warning that the FFC is going to take place. Use this function to set the number of analog video frames (33ms NTSC, 40ms PAL) during which the warning will be displayed. The time period, specified in frames, can range from 0 to 30,000 frames. The factory setting of 60 frames equates to a two second warning. Setting the **Warn Time** to less than 15 turns off the warning.

Dynamic Digital Detail Enhancement (DDE) filter:



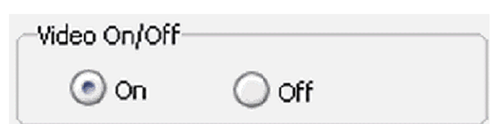
The DDE algorithm sets edge enhancement dynamically proportional to the number of bins occupied in the image histogram.

In a high dynamic range scene the gain will be higher than in a low dynamic range scene. This allows faint details to be visible in high dynamic range scenes without increasing temporal and fixed pattern noise in low dynamic range scenes.

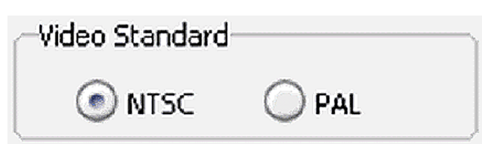
The DDE filter operates independently from the AGC and will enhance edges without effecting brightness or contrast. The valid range of Dynamic DDE setting is from 1 to 63 with 17 being the neutral setting where the filter has no effect. Settings below 17 will smooth the image reducing the appearance of sharp edges. Higher DDE settings will enhance all image non-uniformities resulting in a very detailed but grainy picture especially in high dynamic range scenes. Typical factory settings are between 25 and 30. Settings from 18 to 39 are normal imaging modes where the edge enhancement can be tuned for the scene. Use the slider to adjust the setting, or select the text field and type in the desired setting.

Note

In 14-bit Raw mode, selecting the DDE mode will not affect the digital data output.



Video On/Off: This feature allows you to turn off the analog video output which will result in some power savings (approximately 55mW).



Video Standard: Choose the video standard for your system.

Polarity/LUT: The Tau camera detects and images the temperatures in a given scene. Within the camera, these temperatures 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 grey with, for example, 0 being totally black and 255 being totally white. The 0 to 255 grayshades range sensed is referenced to a Look-Up Table (LUT) permanently stored in the camera to convert the scene to a video image. Different LUTs are available to change the appearance of the displayed image. The most common selection is either White Hot (hotter objects appear brighter than cooler objects in the video display) or Black Hot (hotter objects appear darker than cooler objects). Since the difference between these two modes simply reverses the choice of darker or lighter for temperature extremes, this is sometimes referred to as Polarity. Other color LUTs are available as shown below.

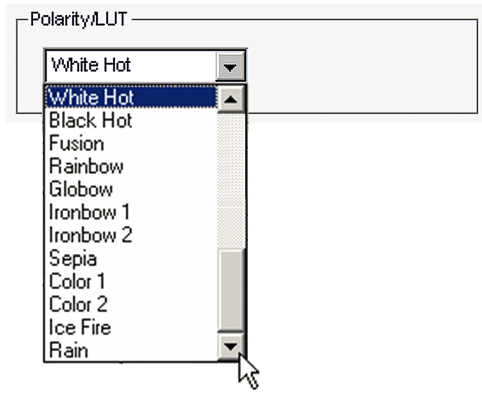


Figure 3-8 shows each of the LUTs as displayed in Test Pattern Ramp Mode starting with the upper left: White Hot, Black Hot, Fusion, Rainbow, Globow, Ironbow1, Ironbow2, Sepia, Color1, Color2, Ice Fire and Rain. Select one of these LUTs from the pull-down menu to view your image displayed using the LUT you choose.

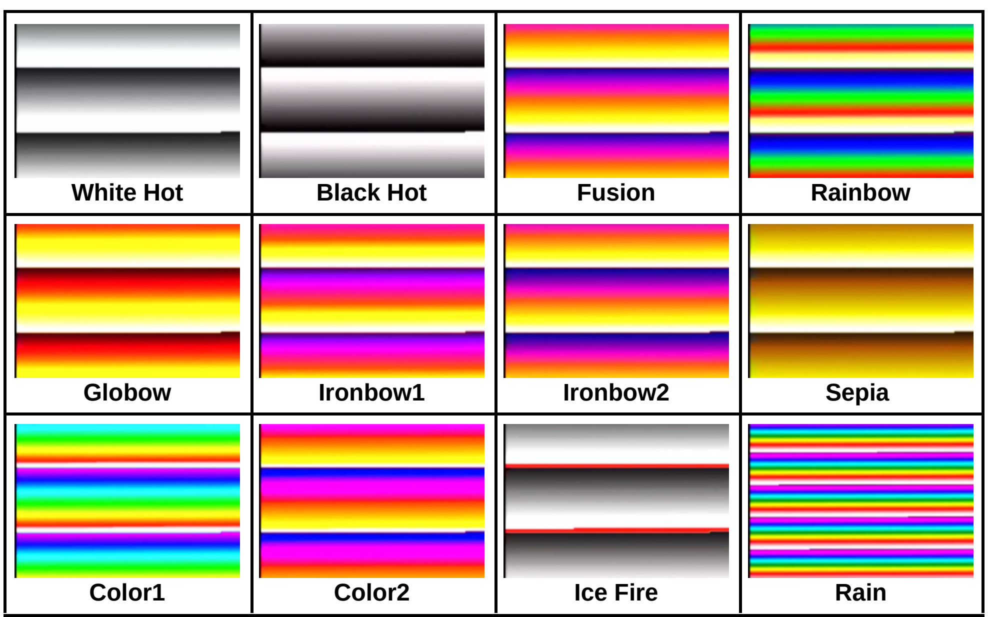


Figure 3-8: Look-Up Table Options

Simple experimentation with this feature while viewing the video image will give you familiarity. Remember that you must click the **Save Settings** button on the **Setup** tab to save the LUT settings as default at power-up.

Note

The setting of the Polarity/LUT mode will not affect the digital data output.

3.9 Digital Video Tab

Tau offers a LVDS interface digital output that can be configured in four modes. Changing these modes will have *no* effect on the *analog* (NTSC or PAL) signal. In order to access the digital output, you must use an advanced interface as described in Chapter 4, Tau Digital Data Channel. See the Tau Electrical Interface Control Document (102-PS220-41) for information on how to access digital video for LVDS, BT 656, and CMOS.

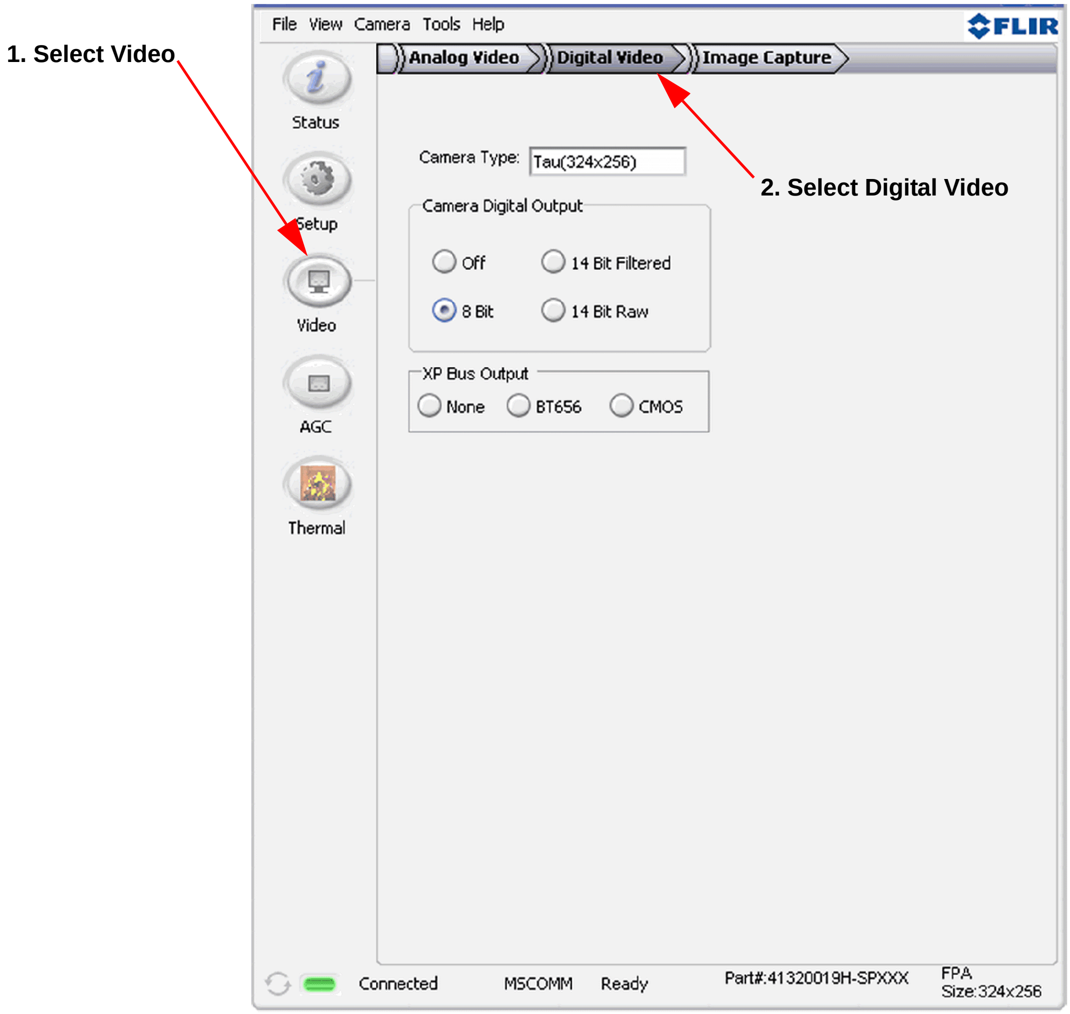


Figure 3-9: FLIR Camera Controller GUI Digital VIdeo Tab

Camera Digital Output

Note

The Revert feature is not available in digital video.

Note

AGC mode will only affect the digital data output if Camera Digital Output mode is set to 8-bit data.

Off: The digital data stream coming from the Tau camera is turned off.

8-bit: Data from the 320 × 240 (NTSC) or 320 × 256 (PAL) video pixels is provided after application of the current Automatic Gain Control (AGC) and Dynamic Detail Enhancement (DDE). The 8-bit data is essentially a digital version of the same data provided on the analog video channel.

14-bit Filtered: Data from 324 × 256 pixels is provided prior to video processing modes in the 8-bit data described above. The 14-bit data is the *filtered* data to include the Dynamic Detail Enhancement (DDE) and will appear gray when saving 16-bit TIFF files. See “Tau Digital Data Channel” on page 4-1.

14-bit Raw: Data from 324 × 256 pixels is provided prior to all video processing and does not include the Dynamic Detail Enhancement (DDE). The 14-bit data is the ‘raw’ data and will also appear gray when saving 16-bit TIFF files. See “Tau Digital Data Channel” on page 4-1.

XP Mode Select

The Tau camera has 18 XP pins on the 50-pin Hirose connector. The XP mode uses a number of these pins to output parallel digital image data.

BT-656: The BT-656 parallel output is a common interface which will drive many LCD displays. The data is digitally encoded NTSC/PAL video and will have AGC, DDE, symbols, and color included.

CMOS: The CMOS interface is a parallel output that allows the user to access 8-bit AGC corrected data or 14-bit data. The signal levels are 0 - 3.3 V CMOS logic and are intended to drive XP-boards mounted directly to the Tau camera. CMOS is not intended to drive a cable. An XP-board reference design is available upon request.

3.10 Image Capture Tab

The **Image Capture** tab on the FLIR Camera Controller GUI, shown below, allows you to capture three 8-bit AGC corrected images to camera memory for retrieval to a host computer. The images will be 8-bit grayscale only, without symbols.

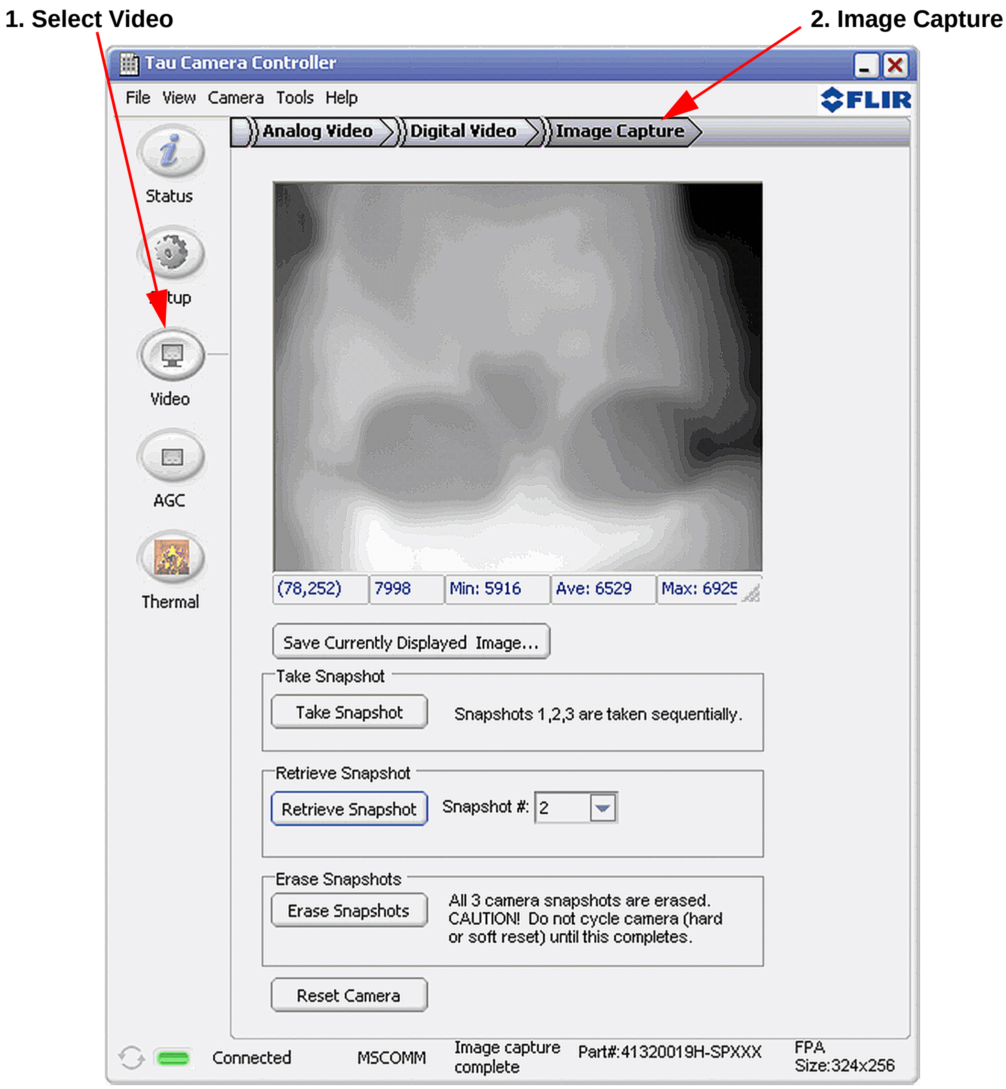


Figure 3-10: FLIR Camera Controller GUI Analog Video Tab

Save Currently Displayed Image...: Saves an 8-bit .bmp file as described above.

Take Snapshot: Take three snapshots sequentially. Snapshot memory must be erased before taking new snapshots; snapshots will not overwrite memory.

Retrieve Snapshot: **Snapshot #** is retrieved and displayed one at a time.

Erase Snapshot: Snapshots will stay in the camera until erased. This button will erase all the snapshots from the camera, allowing new snapshots to be taken.

3.11 AGC Tab

The **AGC** tab, shown in Figure 3-11, controls the Automatic Gain Control (AGC) mode or algorithm along with selectable parameters. Only one mode can operate at a time and is selected by clicking one of the **Algorithm** buttons in the upper left portion of the window. Parameters for a given mode are contextually made available depending on which mode is selected. The Region of Interest (ROI) for the AGC mode is adjustable as well (see paragraph 3.12).

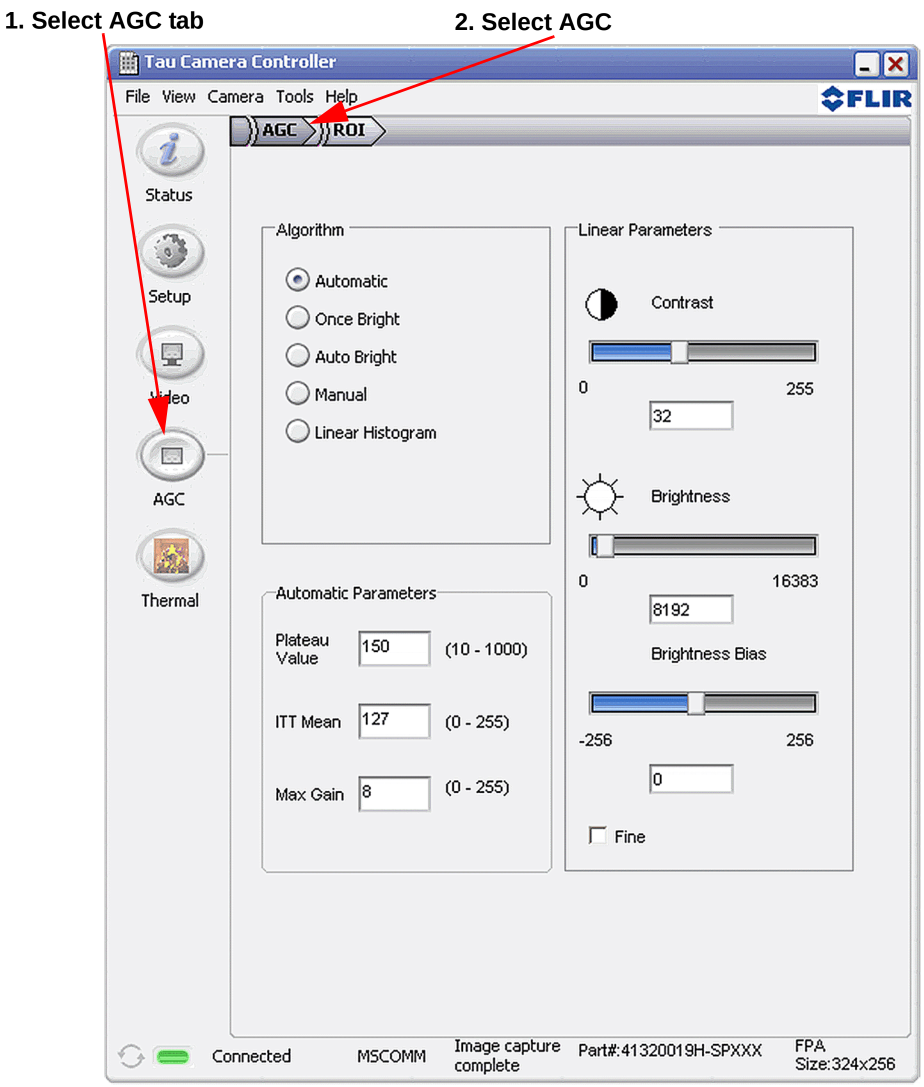
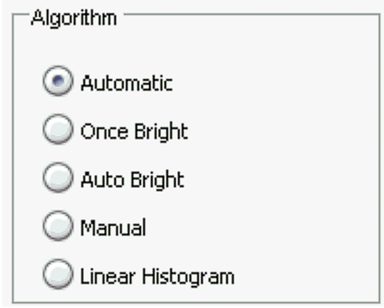


Figure 3-11: FLIR Camera Controller GUI AGC Tab

Note

FLIR has invested heavily in designing high quality AGC algorithms. The default mode (Automatic) along with the default parameter settings for the Automatic AGC mode have been proven to offer the best image quality for generalized scene imaging. Also, be aware that you can make AGC adjustments that will configure the Tau camera to produce no image (all black or all white). Restoring the **Factory Defaults** *on the* **Setup Tab** *will return the camera to its factory default state and likely restore normal camera operation.*

AGC Modes: The Tau provides six AGC algorithms for Image-Optimization:



Automatic: 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 histogram-equalization algorithm. Controls for the **ITT Mean** (gray scale mid-point), **Max Gain** (AGC gain) and **Plateau Value** are enabled.

The histogram equalization used in the automatic mode scales the 14-bit to 8-bit transfer function based on the number of pixels in a bin. The more pixels in a bin, the higher the gain. But the Plateau value is the pixels/bin limit when the transfer function is maximized. Normally 250 is the plateau value for imaging cameras when more contrast is desired.

This algorithm analyzes the scene content in real time and redistributes the dynamic range of the scene. The goal of this redistribution is that every one of the 255 bins of display dynamic range has an equal number of pixels in it. This method tends to give better scene contrast under conditions where the scene statistics are bimodal (for example, a hot object imaged in a cold background. It should be noted that the heat range in a given scene is not divided evenly across the grey levels sent to be displayed. Instead, the AGC algorithm analyzes the scene and distributes the dynamic range to best preserve statistical scene content (populated regions of the histogram) and display a redistributed scene representation.

Once Bright: In this mode, the brightness (level) is calculated as the mean of the current scene at the execution of the command (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).

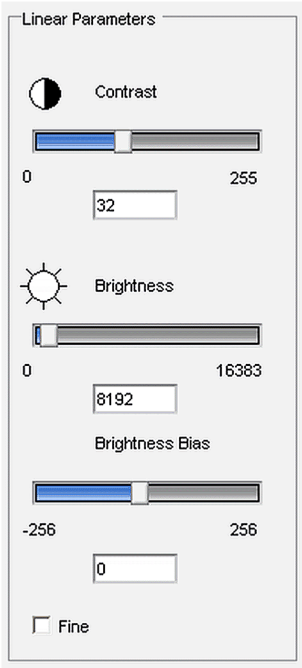
Manual: In this mode, image **Contrast** (gain) and **Brightness** (level) are entered completely manually via the sliders. The scene is mapped using a linear transfer function. Upon entry into the manual mode, currently-stored values of brightness and contrast are applied (i.e. the power-on defaults or the last saved values).

Linear Histogram: Image contrast and brightness (gain and level) optimized automatically based upon scene statistics using a linear transfer function. Controls for the **ITT Mean** (sets grey 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. Upon entry into the linear histogram mode, the currently-stored values are applied (i.e. the power-on defaults or the last saved values).

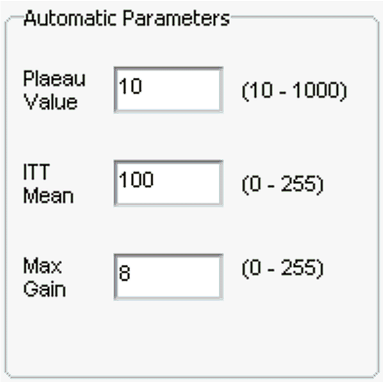
Note

In Manual mode and Once Bright mode, the brightness setting must be updated as the camera temperature changes. To avoid this issue, it is recommended to use Automatic 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.



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



3.12 ROI Tab

The Tau camera allows the user to set a Region of Interest (ROI) or a rectangle of pixels on the sensor array that the AGC algorithm will use for its calculations. The ROI can be set for either the entire frame size (0,0 : 320,256) or some smaller portion as shown below. The **ROI** tab, shown in Figure 3-12, provides both a Window Editor and text entry coordinates to control the size and location of the Region of Interest (ROI).

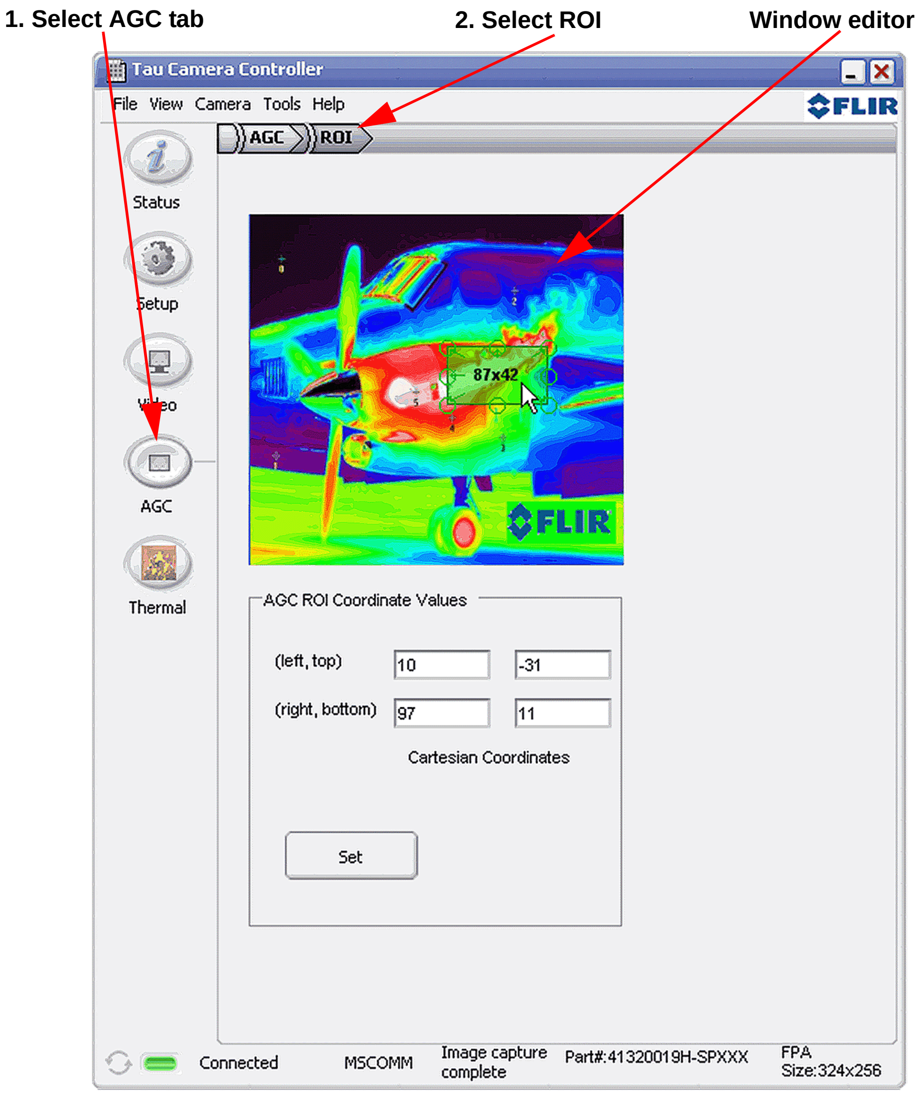
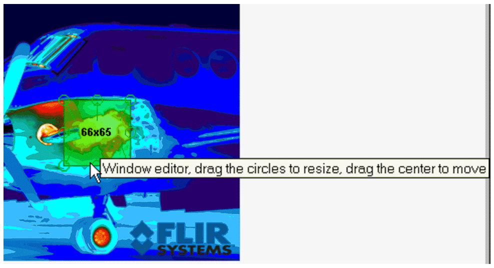
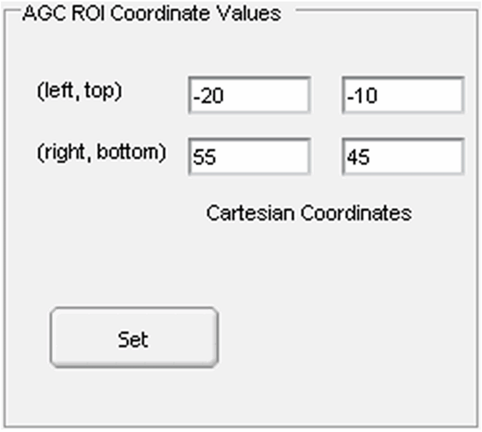


Figure 3-12: FLIR Camera Controller GUI ROI Tab



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.



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. In the example at the right, the ROI is specified as a ROI rectangle 66 × 65 pixels located 20 pixels to the left and 10 pixels down from the center of the FPA.

The new AGC ROI size setting is not active until the **Set** button is pressed.

The AGC ROI may be set independently for **Unzoom**, **Zoom 2×**, and **Zoom 4×**. The AGC ROI may be set anywhere in the full array size, even outside the zoom window. The Pan and Tilt function will attempt to move the Zoom AGC ROI to remain centered on the zoom window. If the camera is being used in zoom mode, it is recommended that the zoom AGC ROI be set to the same size as the zoom window.

3.13 Thermal Tab

The Tau cameras (except the Tau-D) have a rough thermal measurement capability. The Spot Meter reports the temperature viewed by the four pixels in the center of the image. The Isotherm mode enables special colorization of objects in the scene that are above a specified threshold.

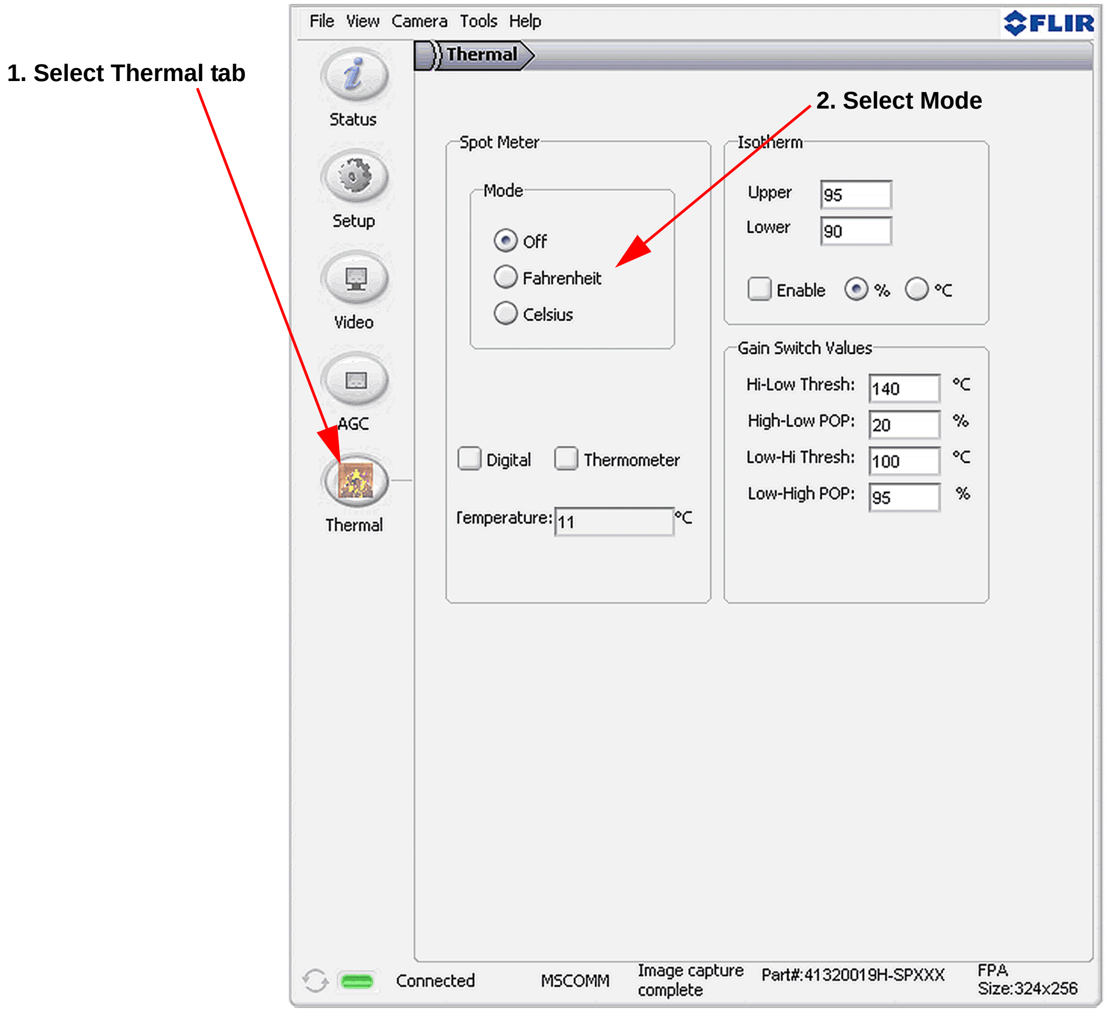


Figure 3-13: FLIR Camera Controller GUI ROI Tab

Spot Meter: The Spot Meter must be on before either the thermal Digital readout or Thermometer can be displayed.

Select either Fahrenheit or Celsius to enable the Spot Meter.

Select **Digital** and/or **Thermometer** to display the symbols on the analog display.

Gain Switch Values are used to control the High Gain/Low Gain switch points. The table switch is enabled using the Gain Mode switch on the Setup tab.

Note

> *The factory settings have hysteresis in the table switch settings. Changing these settings can result in oscillatory behavior or the camera may get stuck in either high or low Gain Mode.*

4 Tau Digital Data Channel

The Tau camera provides three digital data channels. The Legacy LVDS channel is common with the FLIR Photon camera. The BT-656 channel output is a digitally encoded analog format which contains image, symbol, and color information. The CMOS channel is a parallel image data output.

4.1 Legacy LVDS Output

The Tau camera provides a digital data channel that outputs the camera's data in a digital format compatible with FLIR Photon tools and accessories. This channel can be used in conjunction with commercially-available digital frame grabbers, digital displays, or custom receive electronics. For Tau users with embedded or specialty applications that require custom control software, a Software Developer's Kit (SDK) is available to support your development efforts. The SDK accessory is described in the Accessories portion of this User's Manual. Using the Digital Data Channel is an advanced regime that should only be attempted by qualified customers. The Appendices contain details for the Digital Data Channel.

The digital data channel can be configured to output 14-bit data after application of calibration (Non Uniformity Correction or NUC) terms. This mode is most useful for external signal-processing and/or analysis of the camera output. The digital channel can also be configured to provide 8-bit data after application of video processing algorithms—Automatic AGC mode, white-hot/black-hot polarity, image orientation (**Invert**, but not **Revert**), and DDE filtered. The 8-bit data is essentially a digital version of the video stream provided on the analog video channel and is therefore more appropriate than the 14-bit data for interfacing to a digital display.

The digital data channel employs serial low-voltage differential signaling (LVDS). The channel consists of three signal lines—a clock, a composite sync (frame sync and data valid), and serial data. This is a modern high speed interface employing a twisted pair current loop architecture. National Semiconductor offers a good introduction and overview in the following document: http://www.national.com/appinfo/lvds/files/lvds_ch1.pdf

A serial-in-parallel-out (SIPO) module is available from FLIR for converting the serial data to 14-bit parallel LVDS output (plus frame sync, line sync, and pixel clock). The parallel data can be captured using a frame-grabber board installed in a PC.

One frame grabber possibility is the National Instruments IMAQ PCI-1422 board using digital interface cable part number 308-0013-00. Another frame grabber option is the Bit Flow RoadRunner Model 14-M board using digital interface cable part number 308-0016-00-03. Both of these computer-based frame grabber boards require third-party software not offered or supported by FLIR.

FLIR supplies camera setup files for both the IMAQ and Bit Flow frame grabber boards, but FLIR does not formally support their use, nor do we claim or guarantee that these setup files will be suitable for any particular use or application.
Refer to http://www.corebyindigo.com/service/softwareupdates.cfm

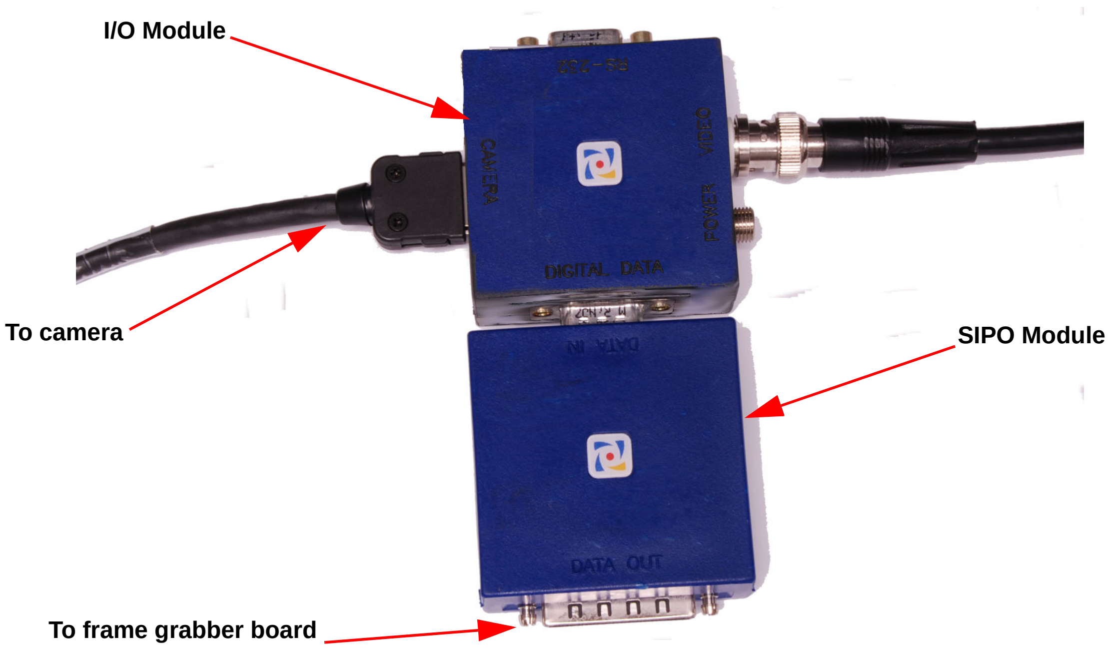
4.2 Using the Legacy LVDS Digital Data Channel

Note

The following instructions assume that you have purchased the optional serial-to-parallel-out (SIPO) accessory module with parallel data cable and Photon Replicator Board. If you are using custom cabling and/or interface electronics, contact FLIR Customer Support at (805) 964-9797 if you need additional assistance.

Follow the steps in paragraph 3.1 "Operation of the Tau Camera using the Video Power Com (VPC) Module Accessory Kit" on page 3-1 for basic operation of the Tau camera. After verifying that the camera is operating properly, disconnect power from the I/O Module.

Step 1 Connect the SIPO accessory module directly to the three-row DB-15 connector on the Interface Module labeled **DIGITAL DATA** as shown below. A cable is NOT required.



Step 2 Connect the parallel data cable to the mating connector on the SIPO module. Connect the other end to the frame-grabber board installed in your PC.

Note

The parallel data cable is specific to a particular frame grabber. Contact the manufacturer of the frame grabber to make sure you have the correct cable.

Step 3 Follow instructions included with the frame grabber for selecting the camera configuration file included with the SIPO module.

Step 4 Reapply power to the Interface Module. This will power-up both the Tau camera and the SIPO module, and digital data will begin streaming.

Step 5 If desired, change the digital data mode using the FLIR Camera Controller GUI software in the **Digital Video** tab.

4.3 Legacy LVDS Digital Data Channels

The camera provides two LVDS digital ports.

- Port 1 consists of the signals DATA_CLK+, DATA_SYNC+, and DATA1_OUT+.
- Port 2 (*DATA2_OUT+ and DATA2_OUT-) is currently undefined—do not connect to these signals*.

Note

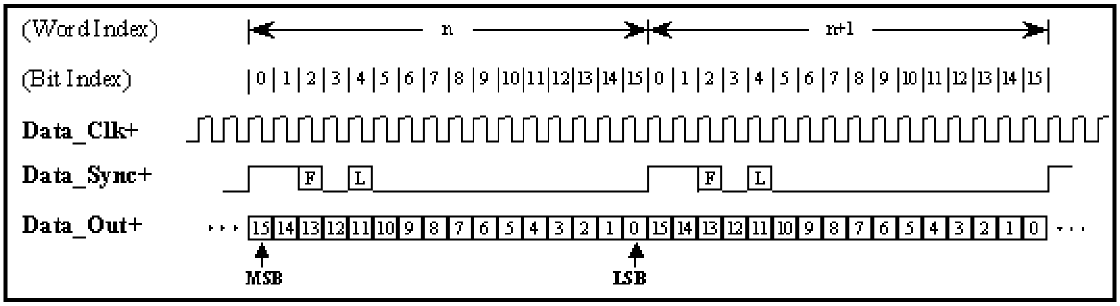
14-bit and 8-bit timing and format are identical except only 8 bits (LSBs) are available in 8-bit mode.
DATA2_OUT+ and DATA2_OUT- are currently undefined—do not connect to these signals

All signals in the digital data interface employ low-voltage differential signaling (LVDS).

The clock rate of DATA_CLK± is 73.636 MHz.

The timing of the digital data interface is shown in Figure 4-1 and Figure 4-3.

The format of the digital output shall be is in Figure 4-2.



F = frame sync; logic high on the first four words starting the frame, logic low otherwise
L = line sync; logic high during valid pixel data, logic low otherwise

Figure 4-1: Digital Data Timing

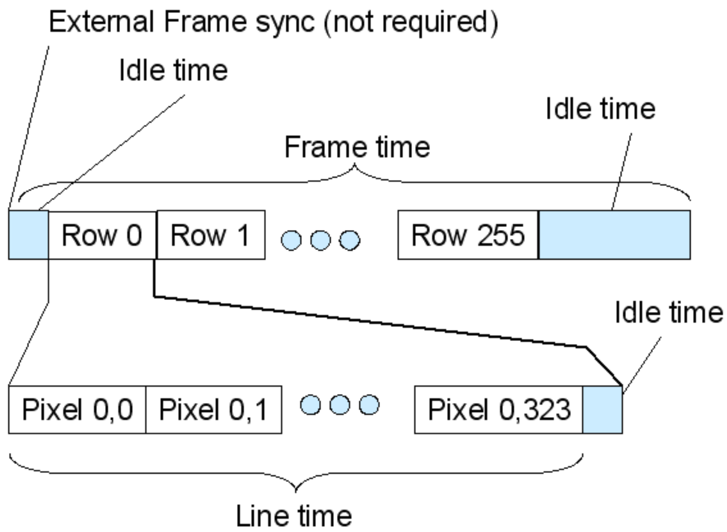


Figure 4-2: Digital Data Format

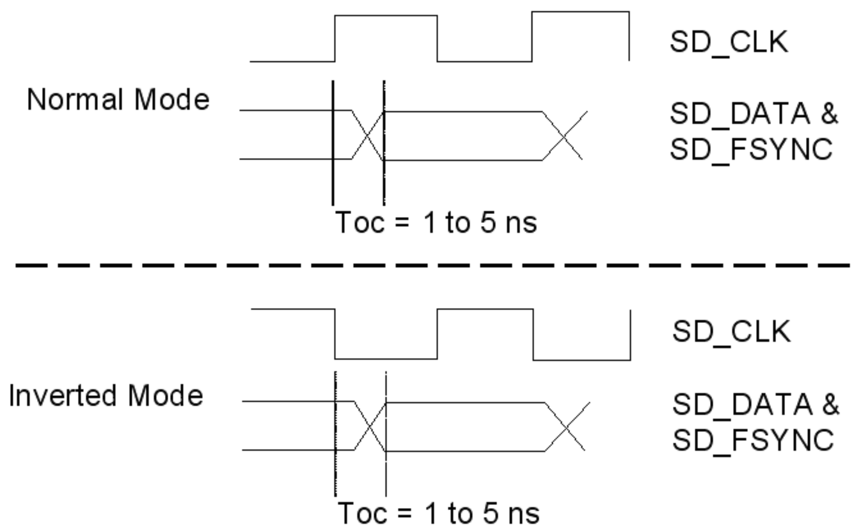


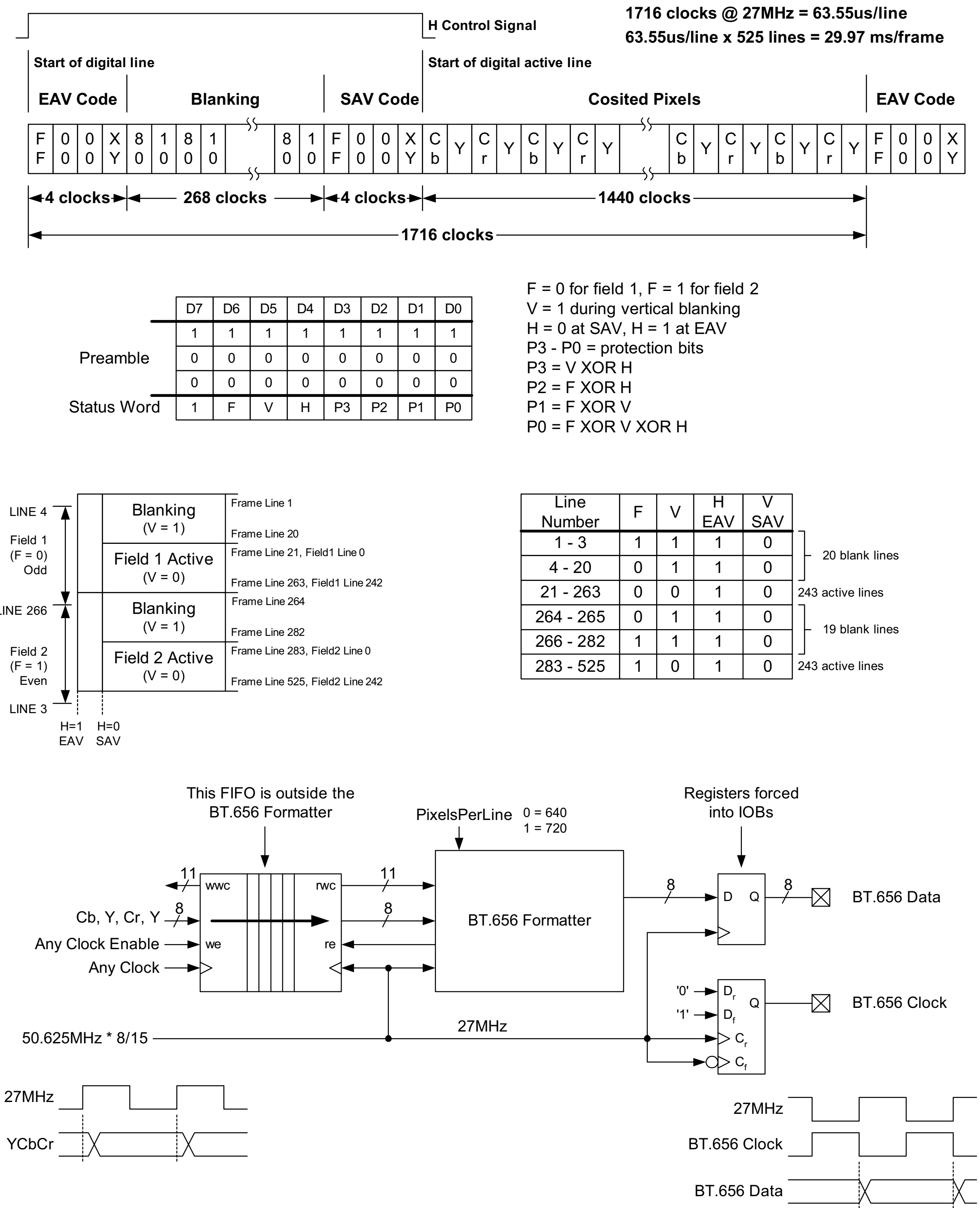
Figure 4-3: Legacy LVDS Detailed Digital Data Timing

4.4 XP Bus Setting—BT-656 Digital Interface

The BT-656 parallel output is a common interface which will drive many LCD displays. The data is digitally encoded NTSC/PAL video and will have AGC, DDE, symbols, and color included. Table 4-1 shows the connector pin definitions with BT-656 enabled. Also shown in the table are the optional discrete input pins. Figure 4-4 details BT-656 format and timing.

Table 4-1: 50-pin Hirose connector interface with BT-656 output enabled

Pin #	Signal Name	Pin #	Signal Name
1	RS232_TX	2	RS232_RX
3	DISCRETE6	4	DISCRETE7
5	DGND	6	DGND
7	unused	8	unused
9	LVDS_CLK_P	10	LVDS_CLK_N
11	LVDS_SYNC_P	12	LVDS_SYNC_N
13	LVDS_DATA_P	14	LVDS_DATA_N
15	unused	16	unused
17	DGND	18	DGND
19	DISCRETE0	20	DISCRETE1
21	EXT_SYNC	22	unused
23	DISCRETE2	24	DISCRETE3
25	DISCRETE4	26	DISCRETE5
27	DGND	28	DGND
29	BT656_DATA7	30	BT656_DATA6
31	BT656_DATA5	32	BT656_DATA4
33	BT656_DATA3	34	BT656_DATA2
35	BT656_DATA1	36	BT656_DATA0
37	DGND	38	DGND
39	BT656_CLK	40	unused
41	DGND	42	DGND
43	VID_OUT_H	44	VID_OUT_L
45	DGND	46	3V3
47, 49	MAIN_PWR_RTN	48, 50	MAIN_PWR



	D7	D6	D5	D4	D3	D2	D1	D0
Preamble	1	1	1	1	1	1	1	1
	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0
Status Word	1	F	V	H	P3	P2	P1	P0

Line Number	F	V	H EAV	V SAV	
1 - 3	1	1	1	0	20 blank lines
4 - 20	0	1	1	0	
21 - 263	0	0	1	0	243 active lines
264 - 265	0	1	1	0	19 blank lines
266 - 282	1	1	1	0	
283 - 525	1	0	1	0	243 active lines

NOTES: The FIFO Write Clock can be any value as long as it is derived from and locked to 50.626MHz. The FIFO must store at least 1440 bytes and must be filled at a minimum rate of 1 byte per 27MHz clock period (faster is OK).

A full line must be made available every 1,716 27MHz clock periods.

Since the BT.656 Formatter has no knowledge of upstream video timing, no data shall be written into the FIFO until the first active line (line 1, field 1) of video is available after reset.

Incoming video must conform to the active/blank times specified in the Timing section of this document.

Figure 4-4: BT-656 Video Formatter Timing and Block Diagram

4.5 XP Bus Setting—CMOS Digital Interface

The CMOS interface is a parallel output that allows the user to access 8-bit AGC corrected data or 14-bit data. The signal levels are 0 - 3.3 V CMOS logic and are intended to drive XP-boards mounted directly to the Tau camera. CMOS is not intended to drive a cable. An XP-board reference design is available upon request.

Table 4-2 shows the connector pin definitions with CMOS enabled.

Note

The optional discrete input pins should be unloaded when using the CMOS output.

Table 4-2: 50-pin Hirose connector interface with CMOS output enabled

Pin #	Signal Name	Pin #	Signal Name
1	RS232_TX	2	RS232_RX
3	CMOS_LINE_VALID	4	CMOS_FRAME_VALID
5	DGND	6	DGND
7	unused	8	unused
9	LVDS_CLK_P	10	LVDS_CLK_N
11	LVDS_SYNC_P	12	LVDS_SYNC_N
13	LVDS_DATA_P	14	LVDS_DATA_N
15	unused	16	unused
17	DGND	18	DGND
19	DISCRETE0	20	CMOS_DATA13
21	EXTERNAL_SYNC	22	CMOS_DATA12
23	CMOS_DATA11	24	CMOS_DATA 10
25	CMOS_DATA9	26	CMOS_DATA8
27	DGND	28	DGND
29	CMOS_DATA7	30	CMOS_DATA6
31	CMOS_DATA5	32	CMOS_DATA4
33	CMOS_DATA3	34	CMOS_DATA2
35	CMOS_DATA1	36	CMOS_DATA0
37	DGND	38	DGND
39	CMOS_CLK	40	unused
41	DGND	42	DGND
43	VID_OUT_H	44	VID_OUT_L
45	DGND	46	3V3
47, 49	MAIN_PWR_RTN	48, 50	MAIN_PWR

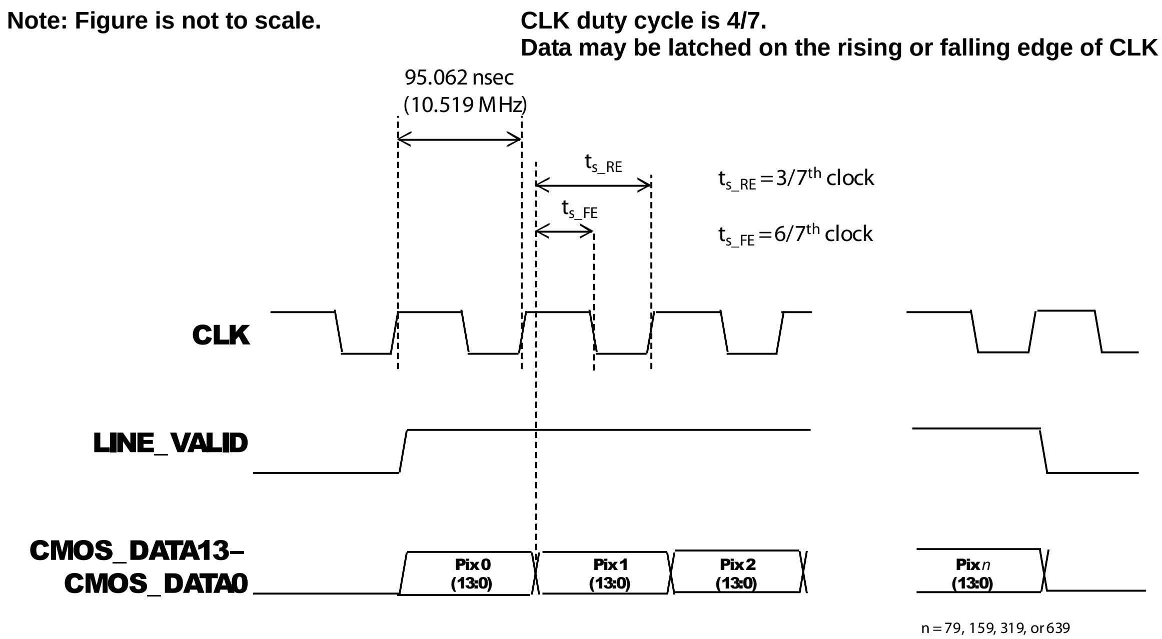


Figure 4-5: CMOS Line Timing (normal clock configuration)

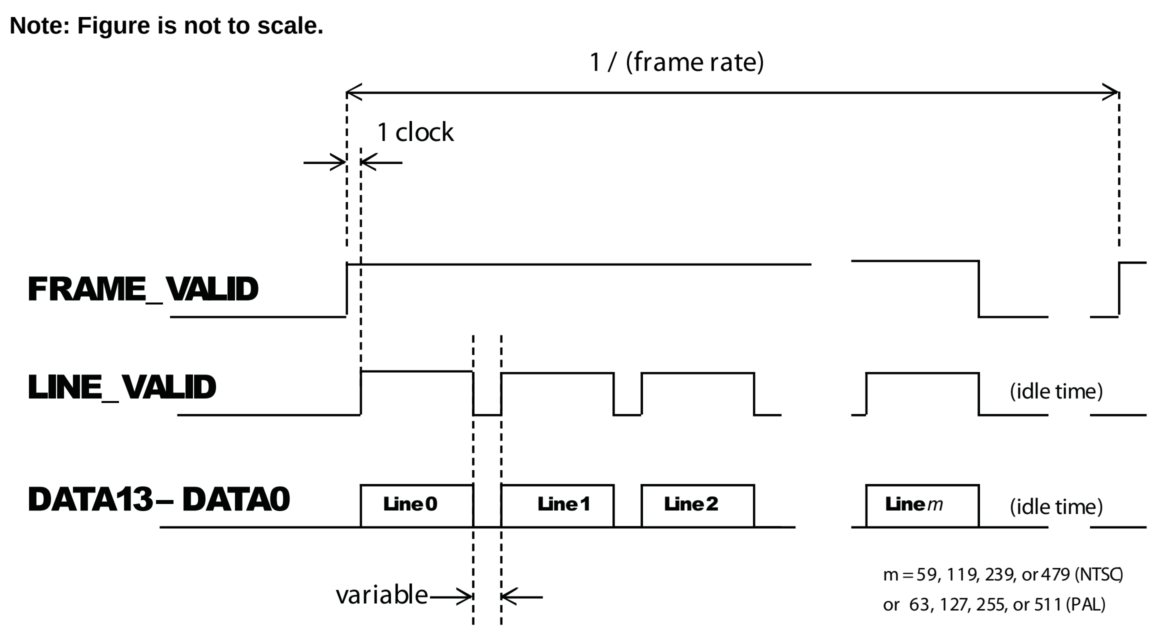


Figure 4-6: CMOS Frame Timing

4.6 Discrete I/O

By default the Tau camera not have discrete input functions loaded. The eight discrete input/output pins with functions are defined by the discrete control file which is available for download and installation. These functions are not intended to be compatible with Tau cameras using CMOS output. The discrete control file is defined in Table 4-3.

Table 4-3: Discrete Control Functions

50-pin Connector	30-pin Connector/ Photon Replicator Name	Tau Name	Function	Note
19	Pin 29/DIS 1	Discrete 0	White hot/Black hot	1
20	Pin 27/DIS 2	Discrete 1	Zoom 1×/2×	2
23		Discrete 2	Do FFC	3
24		Discrete 3	FCC imminent	4
25		Discrete 4	FFC mode	5
26		Discrete 5	Not defined	6
3		Discrete 6	Not defined	6
4		Discrete 7	Not defined	6

1. This function is a backward compatible function with Photon. The voltage level of this pin controls the look-up-table (LUT) applied to the analog image. The pin has a pull-up so that the open state is High (3.3 V). When this pin is High, the analog image will use the White hot LUT. When this pin is Low, the analog image will use the Black hot LUT. The camera will power up in the saved default state and switch to the discrete input defined state when the pin state is changed.

2. This function is a backward compatible function with Photon. The voltage level of this pin controls the zoom state applied to the analog image. The pin has a pull-up so that the open state is High (3.3 V). When this pin is High, the analog image will use the Zoom 1× state. When this pin is Low, the analog image will use the Zoom 2× state. The camera will power up in the saved default state and switch to the discrete input defined state when the pin state is changed.

3. This function is required for effective use of shutterless Tau cameras. A positive going edge pulse to this pin will direct the camera to perform the Do FFC function (0x12).

4. This pin is normally at 0 V and changes to 3.3 V when the FCC imminent icon is present on the analog image. The FFC_Warn_time command (0x3C) controls both the analog icon and the state of this pin.

5. This pin is used to enable additional control of the camera. The default state is automatic FFC mode with this pin held at 3.3 V by an internal pull-up. When this pin is pulled low, the camera will change to Manual FFC mode issuing the FFC_Mode_Select command (0x11 0=manual, 1=Automatic). The camera will power up in the saved default state and switch to the discrete input defined state when the pin state is changed.

6. Not defined. Connection of either 3.3 V or 0 V to this pin will not have an effect on camera operation.

5.1 Input Power

The Tau camera operates from DC power per the specifications given below. It is common in simple operational scenarios to use an inexpensive wall-powered adapter. This type of adapter is what is included with the Accessory Kit. The connector pin-out tables indicate where power is to be applied (PWR_IN and GND pins).

The camera operating in a steady-state condition consumes less than 1W of power. During start up or when the shutter is operating for the camera's periodic calibration, peak power levels of 5W (sustained for less than one second) are typical.

Caution!

Reversing the polarity of the input power will damage the camera's internal power supply. This damage will not be covered under the camera warranty.

Table 5-1: Input Power Requirements

Parameter	Baseline Value	Comment
Minimum voltage	4.0 V	Absolute minimum is 4 V
Maximum voltage	6.0 V	Absolute maximum is 6 V
Nominal Load Power	≤ 1.0 W	Typical power is 0.85 mW with digital output enabled ONLY

The Tau core is tested per EN55022 Class B for radiated emission with and without the rear cover. The emissions are below the Class B limit with the back cover off; and below the Class A limit with the back cover on. It is the responsibility of the systems integrator to verify EMI/EMC compliance at the system level.

5.2 Hirose 50-Pin Connector

In the Tau camera's simplest form (no accessories attached), one connector provides the electrical interface. This connector is a 50-pin Hirose board-to-board style connector, per Hirose Part Number: DF12-50DS-0.5V(86). Hirose offers a variety of mating connectors including their SFM(L), SMT, and SFSD style products. The primary Tau connector at the rear of the camera is identified in the figure below:

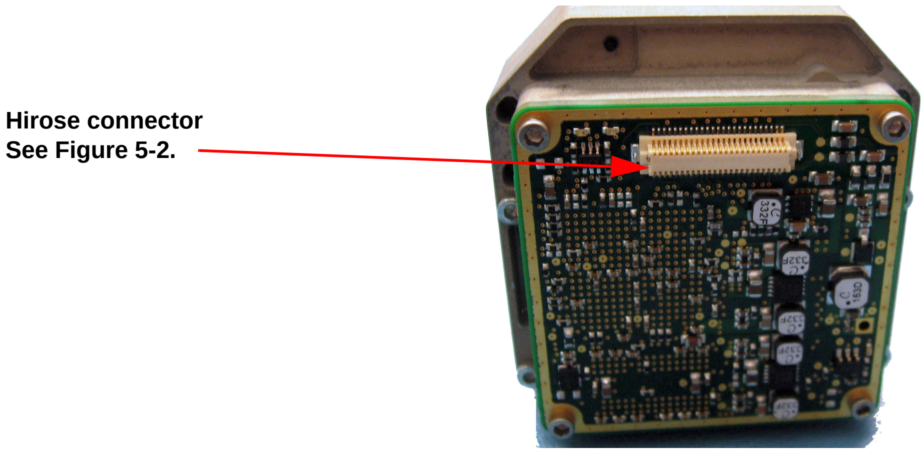


Figure 5-1: 50-Pin Hirose Connector Interface (DF12-50DS-0.5V(86))

Table 5-2 below identifies the function of each pin on the standard surface mount mating connector, Hirose DF12-50DS-0.5V(86).

Table 5-2: 50-pin Hirose Connector Interface of the Tau Camera

Pin #	Signal Name	Signal Definition	Pin #	Signal Name	Signal Definition
1	RS232_TX	Primary serial communication transmit, data output 57600 baud	2	RS232_RX	Primary serial communication receive, data input 57600 baud
3	SPARE0	Not Used	4	SPARE1	Not Used
5, 17, 27, 37, 41, 45	DGND	Ground	6, 18, 28, 38, 42	DGND	Ground
7	LVDS_RX0_P	Not Used	8	LVDS_RX0_N	Not Used
9	LVDS_TX0_P	Digital Port1, clock, positive output	10	LVDS_TX0_N	Digital Port1, clock, negative output
11	LVDS_TX1_P	Digital Port1, Sync, Positive output	12	LVDS_TX1_N	Digital Port1, Sync Negative Output
13	LVDS_TX2_P	Digital Port1, Output data 1, Positive output	14	LVDS_TX2_N	Digital Port1, Output data 1, Negative output
15	LVDS_TX3_P	Not Used	16	LVDS_TX3_N	Not Used
19	XP15	Not Used	20	XP14	Not Used
21	XP13	Not Used	22	XP12	Not Used
23	XP11	Not Used	24	XP10	Not Used
25	XP9	Not Used	26	XP8	Not Used
29	XP7	Not Used	30	XP6	Not Used
31	XP5	Not Used	32	XP4	Not Used
33	XP3	Not Used	34	XP2	Not Used
35	XP1	Not Used	36	XP0	Not Used
39	XP_CLK_OUT	Not Used	40	XP_CLK_IN	Not Used
43	VID_OUT_H	Analog Video +	44	VID_OUT_L	Analog Video -
			46	3V3	3.3V output
47,49	MAIN_PWR_RTN	Input voltage ground	48, 50	MAIN_PWR	Input Voltage

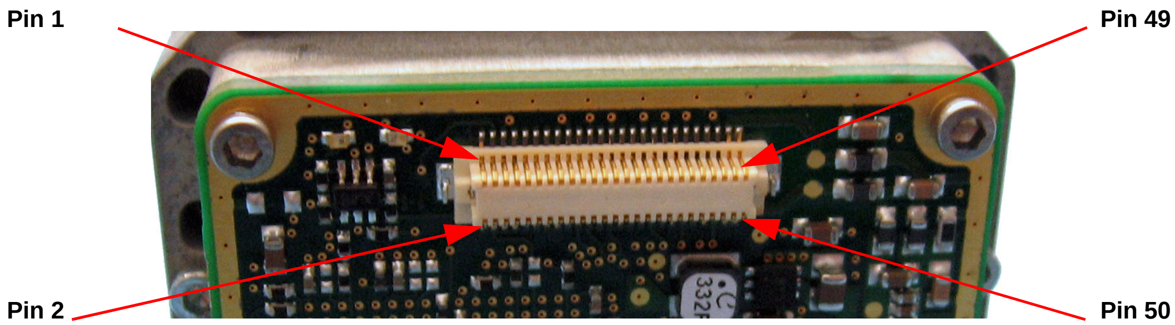


Figure 5-2: Mechanical Definition for 50-pin Interface Board

5.3 Analog Video Output

The Tau camera can be configured to provide either NTSC or PAL analog video output. These analog output standards allow direct video connection to common video display or recording devices such as TV monitors and VCRs. Typically, an analog monitor input signal is provided over a coaxial cable and uses either an RCA (consumer based electronics) or BNC (generally associated with professional or scientific equipment) style connector.

When the VIDEO_LO signal is tied to ground, the analog video signal meets the timing and voltage requirements of either NTSC or PAL protocol. (The FLIR Camera Controller GUI software allows you to select between NTSC or PAL video output formats. The NTSC analog video format is the default in all cameras.)

If you are creating a custom cable to carry the analog video signal from the Tau camera to your monitoring or recording device, you should use 75 Ohm characteristic impedance coaxial cable and terminate into a 75 Ohm monitor. These specifications represent standard video cabling and I/O and will likely be the default for any generic video receiving hardware you purchase. Per the pin function table, you will use the VIDEO_LO and VIDEO_HI pins for the analog video output signal. Specific video characteristics are given in the table below.

Table 5-3: Video parameters

Parameter	NTSC	PAL
Monochrome equivalent	RS-170A	CCIR
Frame rate	29.97 Hz	25 Hz
Update rate	30 Hz/7.5 Hz	25 Hz/8.3 Hz
Active video lines	480	510
# displayed detector samples	320 (H) × 240 (V)	320 (H) × 256 (V)

Note

Analog output is always NTSC/PAL compatible. Changes for reduced frame rate and reduced size array do not effect analog video format.

5.4 Command and Control Channel

Remote control of the Tau camera is provided via a RS-232 serial interface consisting of signals named RX, TX and GND using 3.3 volt signal levels. Chapter 3 provides information regarding remote control using the FLIR Camera Controller GUI. Appendix B describes the serial communications protocol in detail for the Tau camera.

5.5 LVDS Digital Data Channel

Tau provides a digital channel with real-time serialized digital video. The camera outputs either 8-bit or 14-bit data using the SD_CLK±, SD_FSYNC± and SD_DATA± signals. Conversion of the digital data to a parallel format for data acquisition requires a serial-to-parallel converter accessory. Information regarding the digital data interface is provided in Chapter 4.

5.6 Parallel Digital Data Channel

A.1 I/O Module 333-0018-00

- Camera Connector: See Chapter 5.
- Power Connector: Mates to Switchcraft S760 Miniature Power Plug.
- Video Connector: Mates to 75Ω BNC twist-on plug.
- Serial Connector: Mates to DB9 Male.
- Digital Data Connector: Mates to Three-Row DB-15 Female.

Table A-1: I/O Module Power Connector Pin-Out

Pin #	Signal Name	Signal Definition
Pin	PWR	input power
Sleeve	PWR_RTN	input power return

Table A-2: I/O Module Video Connector Pin-Out

Pin #	Signal Name	Signal Definition
Pin	VIDEO	analog video output
Sleeve	VIDEO_RTN	analog video return

Table A-3: I/O Module Serial Connector Pin-Out

Pin #	Signal Name	Signal Definition
2	RX_232	RS232 Receive channel
3	TX_232	RS232 Transmit channel
5	DGND	Digital Ground
1,4, 6-9	NC	Spare (do not connect)

Table A-4: I/O Module Digital Data Connector Pin-Out

Pin #	Signal Name	Signal Definition
1	DATA_SYNC+	Digital data sync (LVDS high)
2	DATA1_OUT+	Digital data 1 output channel (LVDS high)
3	DATA2_OUT+	Digital data 2 output channel (LVDS high)
4	DATA_CLK+	Digital output channel clock (LVDS high)
6	DATA_SYNC-	Digital data sync (LVDS low)
7	DATA1_OUT-	Digital data 1 output channel (LVDS low)
8	DATA2_OUT-	Digital data 2 output channel (LVDS low)
9	DATA_CLK-	Digital output channel clock (LVDS low)
10	DGND	Digital ground
11	PWR	input power (connected to power connector pin)
12	PWR_RTN	input power return (connected to power connector sleeve)
13	NC	Spare (do not connect)
5,14,15	NC	Spare (do not connect)

B.1 Serial Communications Primary Interface

The camera is capable of being controlled remotely through an asynchronous serial interface consisting of the signals named RX, TX, and GND using *3.3 volt* signal levels.

Note

The camera is compatible with most RS232 drivers/receivers but does not implement signaling levels compliant with the RS232 standard voltage levels.

B.2 Serial Communications Protocol

- The required serial port settings are shown in Table B-1.
- The camera does not generate an outgoing message except in reply to an incoming message.
- The camera generates an outgoing reply to each incoming message.
- All messages, both incoming and outgoing, adhere to the packet protocol defined in Table B-2 and the subparagraphs that follow. The first byte i.e., the Process byte is transmitted first followed by the rest of the bytes in the order specified.
- All multi-byte arguments defined herein uses big-endian ordering (MSB first).
- The serial inter-byte timeout is factory set to 100ms
- Only use the function commands listed in Table B-4. Unsupported commands may corrupt the camera's software.
- For reference only, a sample command and response is shown in Table B-5.

Table B-1: Serial Port Settings

Parameter	Value
Baud rate:	57600
Data bits:	8
Parity:	None
Stop bits:	1
Flow control:	None

Table B-2: Serial Packet Protocol

Byte #	Upper Byte	Comments
1	Process Code	Set to 0x6E on all valid incoming messages Set to 0x6E on all outgoing replies
2	Status	See Table B-3
3	Reserved	
4	Function	See Table B-4
5	Byte Count (MSB)	
6	Byte Count (LSB)	
7	CRC1 (MSB)	
8	CRC1 (LSB)	
	(Data)	See argument data bytes in Table B-4
...	(Data)	
N	(Data)	
N+1	CRC2 (MSB)	
N+2	CRC2 (LSB)	

B.3 Status Byte

For all reply messages, the camera sets the Status Byte as shown in Table B-3 to indicate the receipt of the previous incoming message.

Table B-3: Status Byte Definition

Status Byte Value (hex)	Definition	Description
0x00	CAM_OK	Function executed
0x01	CAM _BUSY	Camera busy processing serial command
0x02	CAM _NOT_READY	Camera not ready to execute specified serial command
0x03	CAM _RANGE_ERROR	Data out of range
0x04	CAM _CHECKSUM_ERROR	Header or message-body checksum error
0x05	CAM _UNDEFINED_PROCESS_ERROR	Unknown process code
0x06	CAM _UNDEFINED_FUNCTION_ERROR	Unknown function code
0x07	CAM _TIMEOUT_ERROR	Timeout executing serial command
0x09	CAM _BYTE_COUNT_ERROR	Byte count incorrect for the function code
0x0A	CAM _FEATURE_NOT_ENABLED	Function code not enabled in the current configuration.

B.4 Function Byte

The list of valid commands that can be set in the Function Byte is shown in Table B-4.

For all reply messages, the camera will echo back the Function Byte of the previous incoming message.

For all commands in which the byte count is listed in Table B-4 as either 0 or some non-zero value, the camera will change the value of the specified parameter according to the incoming data bytes if there are any (i.e., the camera shall set the parameter) or it will reply with the current value of the parameter if the incoming message contains no data bytes (i.e., the camera shall get the parameter).

Table B-4: RS232 Function Codes

Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
0x00	NO-OP	No Operation.	Cmd:0 Resp:0	None	
0x01	SET_DEFAULTS	Sets all current settings as power-on defaults	Cmd:0 Resp:0	None	
0x02	CAMERA_RESET	Commands a soft camera reset to the default modes	Cmd:0 Resp:0	None	
0x03	RESET_FACTORY_ DEFAULTS	Resets camera with factory header values **Note:** It is necessary to send SET_DEFAULTS afterwards to store the settings as power-on defaults.	Cmd:0 Resp:0	None	
0x04	SERIAL_NUMBER	Gets the serial number of the camera and sensor	Get Cmd: 0	None	
			resp: 8	Bytes 0-1: High word camera S/N Bytes 2-3: Low word camera S/N Bytes 4-5: High word sensor S/N Bytes 6-7: Low word sensor S/N	
0x05	GET_REVISION	Gets the firmware / software version	cmd: 0	None	
			Resp: 8	Bytes 0-1: S/W major version Bytes 2-3: S/W minor version Bytes 4-5: F/W major version Bytes 6-7: F/W minor version	
0x0A	GAIN_MODE	Gets and sets the dynamic-range-control mode	Get Cmd: 0	None	
			Set Cmd:2 & Resp: 2	0x0000 = Automatic 0x0001 = Low Gain Only 0x0002 = High Gain Only 0x0003 = Manual (no switching) **Note:** All Tau-P cameras have firefighting features. Automatic mode is necessary for firefighting.	
0x0B	FFC_MODE _SELECT	Gets and sets the Flat Field Correction (FFC) Mode	Get Cmd: 0	None	
			Set Cmd:2 & Resp: 2	0x0000 = Manual 0x0001 = Automatic 0x0002 = External	

Table B-4: RS232 Function Codes

Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
0x0C	DO_FFC	A "short" or "long" FFC can be optionally specified. (The core will only switch NUC tables when in manual FFC mode if a long FFC command is specified.) If sent with no argument, a short FFC is executed. **Note:** Clarification is necessary because shutterless cameras will likely be in Manual mode.	Cmd:0 Resp:0	None	
			Cmd: 2 & Resp: 2	Bytes 0-1: 0x0000 = short FFC 0x0001 = long FFC	
0x0D	FFC_PERIOD	Gets and sets the interval (in frames) between automatic FFC	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	FFC interval for current gain state.	
			Set Cmd: 4 & Resp: 4	Bytes 0-1: FFC interval, high gain Bytes 2-3: FFC interval, low gain	
0x0E	FFC_TEMP_ DELTA	Gets and sets the temperature difference used to trigger automatic FFC.	Get Cmd: 0	None	
			Set Cmd:2 & Resp: 2	Temp delta (in steps of 0.1C) for current gain state	
			Set Cmd:4 & Resp: 4	Bytes 0-1: Temp delta, high gain Bytes 2-3: Temp delta, low gain	
0x0F	VIDEO_MODE	Gets and sets the video signal mode. Setting Freeze frame freezes the image. Setting Zoom zooms the image by 2x.	Get Cmd:0	None	
			Set Cmd: 2 & Resp: 2	0x0000 = Real time 0x0001 = Freeze frame 0x0004= 2X zoom 0x0008 = 4X zoom (Tau 320 only)	
0x10	VIDEO_LUT	Gets and sets the analog video LUT or intensity transform.	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	0x0000 = White hot 0x0001 = Black hot 0x0002 = Fusion 0x0003 = Rainbow 0x0004 = Globow 0x0005 = Ironbow1 0x0006 = Ironbow2 0x0007 = Sepia 0x0008 = Color1 0x0009 = Color2 0x000A = Ice and fire 0x000B = Rain 0x000C= OEM custom #1	

Table B-4: RS232 Function Codes

Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
0x11	VIDEO_ ORIENTATION	Gets and sets the analog video orientation. Invert is valid only for block 2. Digital data is unaffected by the revert setting.	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	0x0000 = Normal 0x0001 = Invert 0x0002 = Revert 0x0003 = Invert + Revert	
0x12	DIGITAL_ OUTPUT_MODE	Gets and sets the digital output channel mode. XP signals (CMOS or BT-656) and LVDS channel are available simultaneously.	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	Byte 0: XP channel setting: 0x00 = disabled 0x01 = BT.656 (post-AGC) 0x02 = CMOS 14-bit (pre-AGC) 0x03 = CMOS, 8-bit (post-AGC) 0x04 = CMOS, 14-bit inverted 0x05 = CMOS, 8-bit inverted Byte 1: LVDS channel setting: 0x00 = 14-bit data 0x01 = 8-bit data 0x02 = digital off 0x03 = 14-bit unfiltered 0x04 = 8-bit inverted 0x05 = 14-bit inverted 0x06 = 14- bit inverted unfiltered	
0x13	AGC_TYPE	Gets and sets the image optimization mode	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	0x0000 = plateau histogram 0x0001 = once bright 0x0002 = auto bright 0x0003 = manual 0x0004 = not defined (returns error) 0x0005 = linear	
0x14	CONTRAST	Gets and sets the manual contrast value	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	Contrast value (0x0000 to 0x00FF)	
0x15	BRIGHTNESS	Gets and sets the manual brightness value	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	Brightness value (0x0000 to 0x3FFF)	

Table B-4: RS232 Function Codes

Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
0x18	BRIGHTNESS_BIAS	Gets and sets the brightness bias value in the auto bright mode Valid range is +2048 to -2048 decimal MSB is the sign bit	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	Brightness bias value (2's complement: 0x0000 to 0x0FFF)	
			Set Cmd: 2 & Resp: 2	0x0000 = disabled (off) 0x0001 = on, Fahrenheit scale 0x0002 = on, Centigrade scale	
0x1F	SPOT_METER_ MODE	Gets or sets the spot-meter mode.	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	0x0000 = disabled (off) 0x0001 = on, Fahrenheit scale 0x0002 = on, Centigrade scale	
0x20	READ_SENSOR	Gets the FPA temp. in Celsius x 10 or raw counts (e.g. value of 512 decimal represents 51.2C) Sign bit is the MSB.	Set Cmd: 2 & Resp: 2	0x0000 = temp in C*10 0x0001 = temp in raw counts	
0x21	EXTERNAL_SYNC	Enables or disables the external sync feature	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	Ext sync mode 0x0000 = disabled 0x0001 = slave 0x0002 = master	
0x22	ISOTHERM	Gets or sets the isotherm mode (on/off). If isotherm option is not enabled (see CAMERA_OPTIONS), command returns an error.	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	0x0000 = Disabled 0x0001 = Enabled	
0x23	ISOTHERM_ THRESHOLDS	Gets or sets the isotherm thresholds in percent of full-scale-range (e.g. 97 decimal = 97% FSR) or in deg C. Bit 15 of the lower threshold is used to specify units (1 = deg C, 0 = %).	Get Cmd: 0	None	
			Set Cmd: 4 & Resp: 4	Bytes 0 -1: lower threshold Bytes 2 -3: upper threshold	
0x25	TEST_ PATTERN	Gets and sets the test pattern mode. Before turning on the test pattern, turn off the correction terms and set the flat field and the gain mode to manual.	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	0x0000 = test pattern off 0x0001 = ascending ramp 0x0003=big vertical 0x0004 = horizontal shade 0x0006 = color bars 0x0008 = ramp with steps	
0x2A	GET_SPOT_METER	Returns the value of the spot meter in degrees Celsius (regardless of spot meter mode). If the spot meter option is not enabled (see CAMERA_OPTIONS), returns an error.	Get Cmd: 0	None	
			Resp: 2	Spot temperature value	

Table B-4: RS232 Function Codes

Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
0x2B	SPOT_DISPLAY	Gets or sets the spot meter display mode. If the spot meter option is not enabled (see CAMERA_OPTIONS), returns an error.	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	0x0000 = display off 0x0001 = numeric only 0x0002 = thermometer only 0x0003 = numeric & thermometer	
0x3C	FFC_WARN_TIME	Time to display the FFC imminent icon in number of frames before the flat field happens	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	Bytes 0 to 1: Time in frames (Data Range is 0 to 600 frames)	
0x3E	AGC_FILTER	Gets and sets the AGC ITT filter value	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	Bytes 0 to 1: ITT filter value 0 = immediate 1-255 = Numerator (Denominator = 256)	
0x3F	PLATEAU_LEVEL	Specifies the Plateau level for Plateau AGC	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	Data Range is 0 to 1000	
0x43	GET_SPOT_METER_DATA	Returns the value of the spot meter in degrees Celsius (regardless of spot meter mode). If the spot meter option is not enabled (see CAMERA_OPTIONS), returns the average value of the center four pixels.	Get Cmd: 0	None	
			Resp: 2	Spot temperature value (in deg C) or average pixel value (in counts)	
0x4C	AGC_ROI	Gets or sets the Region of Interest (ROI) for AGC in normal and zoom modes. Assumes signed coordinates relative to center value of (0,0). When the byte count of the incoming message is 0, the 8-byte argument of the reply is the ROI for the current zoom state (unzoomed, 2X zoom, or 4X zoom). When byte count of the incoming message is 2 (GET) or 24 (set), the 24-byte argument of the reply contains the normal ROI, 2X zoom ROI, and 4X zoom ROI	Resp: 8	Bytes 0-1: Left Bytes 2-3: Top Bytes 4-5: Right Bytes 6-7: Bottom	
			Get Cmd: 2	Don't care	
			Set Cmd: 24 & Resp: 24	Bytes 0-1: Left, normal ROI Bytes 2-3: Top, normal ROI Bytes 4-5: Right, normal ROI Bytes 6-7: Bottom, normal ROI Bytes 8-9: Left, 2X ROI Bytes 10-11: Top, 2X ROI Bytes 12-13: Right, 2X ROI Bytes 14-15: Bottom, 2X ROI Bytes 16-17: Left, 4X ROI Bytes 18-19: Top, 4X ROI Bytes 20-21: Right, 4X ROI Bytes 22-23: Bottom, 4X ROI	

Table B-4: RS232 Function Codes

Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
0x55	ITT_MIDPOINT	Gets and sets the ITT midpoint offset	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	Data Range is 0 to 255	
0x66	CAMERA_PART	Gets the camera part number Response contains the part number. If the host system is little endian the bytes need to be reversed as the camera is big endian	Get cmd: 0	None	
			Response: 32	String(32)	
0x6A	MAX_AGC_GAIN	Gets and sets the max value of video gain	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	Data Range 0 to 2048	
0x70	PAN_AND_TILT	Gets and sets the pan position (x axis) and the tilt position (y axis) when the camera is in zoomed mode	Get Cmd: 0	None	
			Set Cmd: 4 & Resp: 4	Bytes 0-1: Tilt position in rows relative to the center of the array (-68 to +68) Bytes 2-3: Pan position in columns relative to the center of the array(-82 to +82)	
0x72	VIDEO_STANDARD	Gets or sets the video standard (affects frame rate).	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	0x0000 = NTSC 0x0001 = PAL	
0x79	SHUTTER_POSITION	Opens or closes the shutter	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	Shutter position 0x0000 = open 0x0001 = close	
0x2C	DDE_GAIN	Sets the gain of the DDE filter (input only in manual mode. In automatic mode this is set internally)	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	Gain value (0x0000 to 0x00FF)	
0xE2	DDE_THRESHOLD	Sets the threshold of the DDE filter (input only in manual mode. In automatic mode this is set internally)	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	Threshold value (0x0000 to 0x00FF)	

Table B-4: RS232 Function Codes

Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
0xE3	SPATIAL_THRESHOLD	Gets or sets the spatial threshold of the DDE filter and the DDE mode (auto or manual)	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	Byte 0 = Threshold (0x0000 to 0x000F) Byte 1 = Mode 0x0000 = manual 0x0001 = auto	
0xDB	GAIN_SWITCH_PARAMS	Gets or sets the population (as a percentage) and temperature (in deg C) thresholds for high/low gain switching	Get Cmd: 0	None	
			Set Cmd: 8 & Resp: 8	Bytes 0-1: hiToLoThreshold Bytes 2-3: hiToLoPopulation Bytes 4-5: loToHiThreshold Bytes 6-7: loToHiPopulation	

B.4.1 Byte Count Bytes

- On all incoming and outgoing messages, the Byte-Count Bytes are used to specify the total number of data bytes in the packet.

Note

The number of data bytes in the packet is not equal to the total number of bytes in the packet. For example, a No-Op serial command contains zero data bytes.)

- The Byte Count must be an even number from 0 to 0x1F4 (500 decimal).

B.4.2 CRC Bytes

- On all incoming and outgoing messages, two cyclical redundancy checks (CRCs) are calculated using CCITT-16 initialized to 0.
- CRC1 is calculated using only the first 6 bytes of the packet.
- CRC2 is calculated using all previous bytes in the packet (i.e. bytes 0 through N).

B.5 Example of the format of a serial message

Table B-5 describes the bytes that are transferred when the FFC_MODE_SELECT (0x0B) command is issued to the camera to set the mode to Auto (0x01) and to get the FFC mode:

Table B-5: Sample FFC_MODE_SELECT (0x0B) Command

Set Message sent to camera:							
Process Code	**Status**	**Reserved**	**Function**	**Byte Count**	**CRC**	**Data**	**CRC**
0x6E	0x00	0x00	0x0B	0x00 0x02	0x0F 0x08	0x00 0x01	0x10 0x21
Response from camera to set message:							
Process Code	**Status**	**Reserved**	**Function**	**Byte Count**	**CRC**	**Data**	**CRC**
0x6E	0x00	0x00	0x0B	0x00 0x02	0x0F 0x08	0x00 0x01	0x10 0x21
Get Message sent to camera:							
Process Code	**Status**	**Reserved**	**Function**	**Byte Count**	**CRC**	**Data**	**CRC**
0x6E	0x00	0x00	0x0B	0x00 0x00	0x2F 0x4A		0x00 0x00
Response from camera to get message:							
Process Code	**Status**	**Reserved**	**Function**	**Byte Count**	**CRC**	**Data**	**CRC**
0x6E	0x00	0x00	0x0B	0x00 0x02	0x0F 0x08	0x00 0x01	0x10 0x21

B.6 Description of Serial Commands

B.6.1 Camera Defaults

The RESET_FACTORY_DEFAULTS command sets the current settings to the factory default values. In order to save these values as power up defaults, it is necessary to do a SET_DEFAULTS command.

B.6.2 AGC algorithms

Use the AGC_TYPE command to select one of the following AGC algorithms:

- Automatic
- Once Bright
- Auto Bright
- Manual
- Linear

B.6.3 Pan and Tilt

The PAN_AND_TILT command controls this feature in the camera when the image is zoomed. It does not have any effect when the image is not zoomed. The center of the screen is considered as coordinate (0,0).

A positive number is needed to pan right and negative number to pan left. A pan value of 1 pans to the right by one column and a pan value of -1 pans to the left by one column from the center of the image.

A positive number is needed to tilt downwards and a negative number to tilt upwards. A tilt value of 1 tilts downwards by one row and a tilt value of -1 tilts upwards by one row from the center of the image.

When the image is being panned or tilted the ROI moves along with these coordinates. The limits for the zoom ROI have been set to one and a half times the number of rows and columns in the video. This is to enable a user to pan and tilt the zoomed portion of the image without any change in the AGC if the image being looked at does not change. This also means that the AGC of the image is also determined by portions of the image that is not being currently viewed.

B.6.4 DDE filter

The commands to control the DDE filter settings are DDE_GAIN to control the gain, DDE_THRESHOLD to control the DDE filter threshold, and SPATIAL_THRESHOLD to control the spatial threshold of the DDE filter. The image remains unchanged when the value of the DDE gain is 0 and 17. The image becomes unfocused/unsharpened when the value is between 1 and 15. The image becomes more sharpened when the value is above 17. Increasing the DDE threshold will make the edges sharper. For threshold values between 0 and about 50 the effect on the image is lesser and has a greater effect above approximately 50. Increasing the spatial threshold value will make the image look smoother.

The DDE filter has an automatic mode that when activated controls the DDE Gain using a combination of the Dynamic DDE setting and the scene dynamic range. The valid range of the Dynamic DDE setting is from 1 to 63. Dynamic DDE settings between 1 and 16, provide image smoothing, with a setting of 1 providing the most smoothing. A Dynamic DDE setting of 17 turns off the Dynamic DDE. A Dynamic DDE setting between 18 and 39 sets the imaging mode DDE Gain between 16 and 40. A Dynamic DDE setting of 40 or greater provides maximum enhancement but image artifacts may also be enhanced giving an image with some fixed pattern noise.

B.6.5 Spare Serial Communications Channel

The camera provides a spare serial communications port consisting of the signals: RX2, TX2, and GND.

Note

This serial communications channel is intended for communication with RS-232 controllable systems.

B.6.6 Digital data

The DIGITAL_OUTPUT_MODE command allows the users to select one of the following digital data options

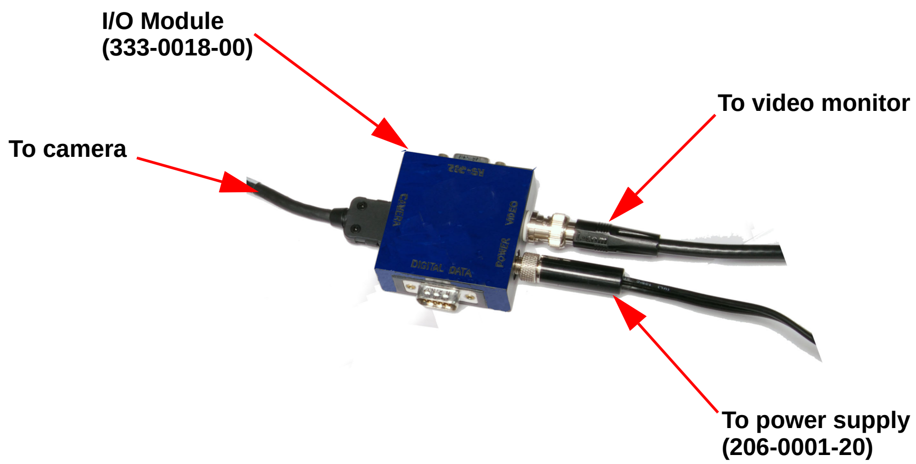
- 14-bit data
- 8-bit data
- digital off
- 14-bit unfiltered
- 8-bit inverted
- 14-bit inverted
- 14- bit inverted unfiltered
- XP-channel setting

C.1 Operation of the Tau camera using the Photon development kit

Backward compatibility with existing Photon equipment allows Photon users to connect to the Tau camera to provide power and obtain video. It also facilitates serial communication for more advanced camera command and control via the free downloadable FLIR Camera Controller GUI. In this first section, we will discuss simply applying power and obtaining video.

Remove the lens cap. (Remember to replace the lens cap when the camera is not in use to prevent accidental scratching and dust contamination.)

Using the Development Kit's Interface Cable and I/O Module, plug one end of the Interface Cable into the mating connector on the back of the camera. Connect the other end of the Interface Cable to the mating connector on the I/O Module labeled **CAMERA**.



Attach one end of a standard BNC cable to the video port labeled **VIDEO** on the I/O Module. Attach the other end to a compatible video monitor's composite video input. If your monitor has an RCA input connector, a BNC to RCA adapter can be used.

Plug the power supply into an electrical outlet. Insert the circular plug at the other end of the power supply into the power jack labeled **POWER** on the I/O Module and tighten the locking screw finger tight. The camera will take ~2 seconds to produce an image after you apply power.

You should see an initial splash screen with the FLIR logo displayed, and then live long-wave infrared video will follow! Point the camera in different directions and notice the imagery. If the video image appears low in contrast, point the camera at a target with high thermal contrast such as at a person.

C.2 Remote control of the Tau camera

The Tau camera accommodates advanced camera control through an RS-232 serial interface. A user can control the camera through this interface using their own software and hardware by following the Serial Communication Protocol and command structure defined in Appendix B. This requires programming skills and a strong technical background. The user can also use the FLIR Camera Controller GUI offered as a free download from FLIR using a Windows based PC with the standard serial communications and components provided in the Development Kit. This software provides remote control of various camera features and modes. The FLIR Camera Controller GUI software is compatible with Windows XP. The PC must have a spare serial communications port or you must use the Tau VPC module USB accessory.

Note

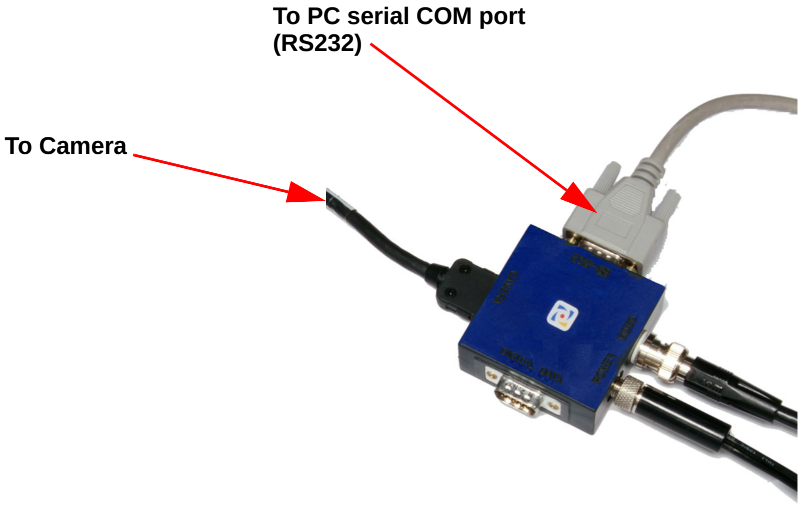
A USB to Serial port adapter is acceptable, but the data communication rate must be set to 57600 BAUD.

If your embedded or specialty applications require custom control software, a Software Developer's Kit (SDK) is available. Those intending to generate their own custom software are encouraged to read the remainder of this section regarding the FLIR Camera Controller GUI to better understand the camera modes and parameters.

C.3 Connecting the serial communications interface using the development kit

You should have successfully operated the camera and obtained live video on a monitor as described in paragraph C.1 "Operation of the Tau camera using the Photon development kit" on page C-1.

The only additional hardware required for serial communication is a serial cable connected as shown below.



Attach one end of a standard RS-232 serial port (9-pin) PC cable to the communications port labeled **RS-232** on the I/O Module. Attach the other end to the serial port on your PC. This cable should be a standard RS-232 cable, not a cross-over configured serial cable, or null-modem cable.

Due to export restrictions, limited data is available at
www.corebyindigo.com,
additional data can be obtained from your local sales representative or application engineer.

Figure D-1 and Figure D-2 provide important mechanical information for lens designers.

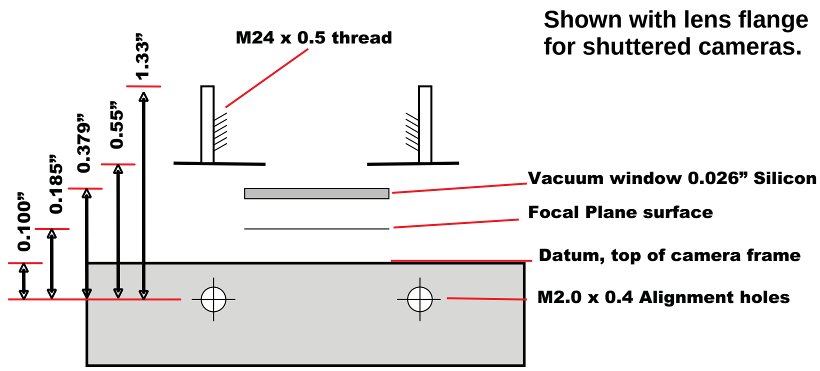


Figure D-1: Focal Plane Dimensions and Relationships

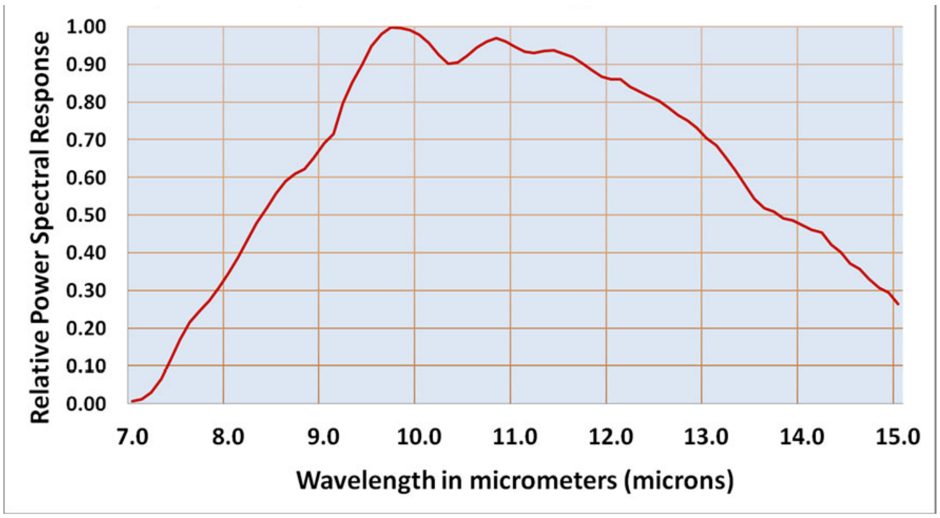
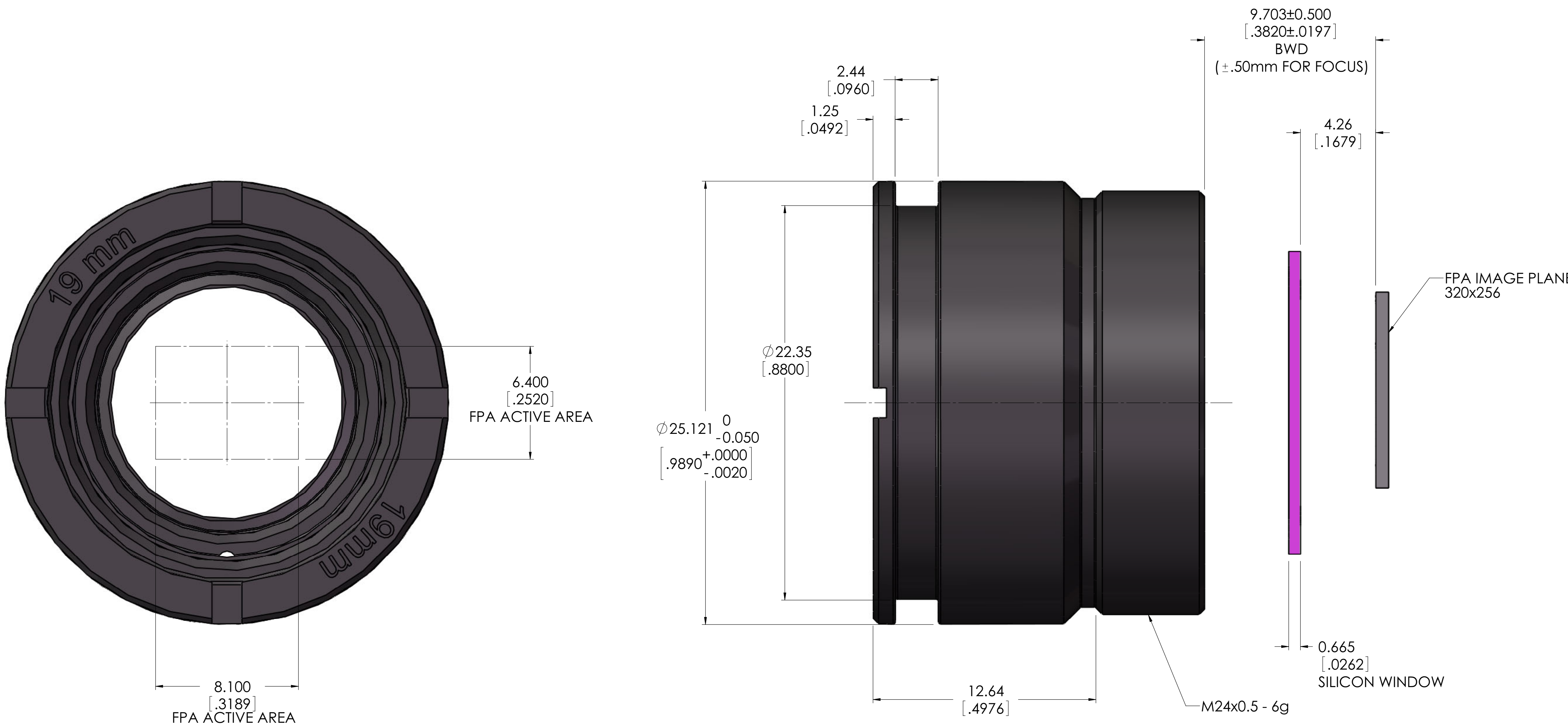


Figure D-2: Spectral Response Curve from a Typical Tau Camera

The following Mechanical Description Documents detail the outline and mounting for the Tau cameras. These documents are provided for reference only. You should consult your local sales representative or application engineer to obtain current IDD information. Also, the Tau Thermal Imaging Camera Core Data Sheet available from the website contains important mechanical interface data as well.

See:
http://www.corebyindigo.com/tau.

NOTES: UNLESS OTHERWISE SPECIFIED



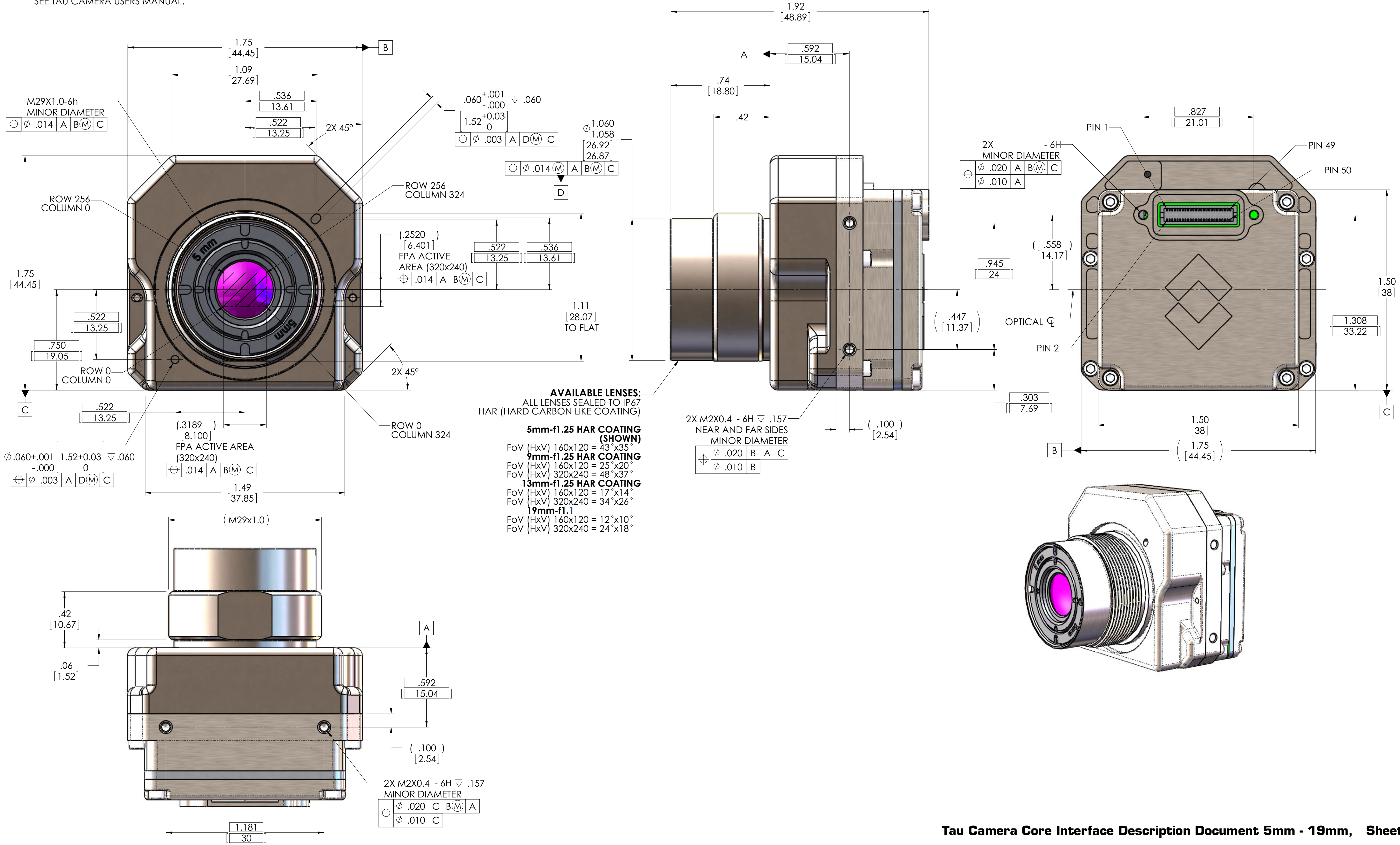
THIS DOCUMENT IS CONTROLLED TO FLIR TECHNOLOGY LEVEL 2.

THE INFORMATION CONTAINED IN THIS DOCUMENT PERTAINS TO A DUAL USE PRODUCT CONTROLLED FOR EXPORT BY THE EXPORT ADMINISTRATION REGULATIONS (EAR). FLIR TRADE SECRETS CONTAINED HEREIN ARE SUBJECT TO DISCLOSURE RESTRICTIONS AS A MATTER OF LAW. DIVERSION CONTRARY TO US LAW IS PROHIBITED. US DEPARTMENT OF COMMERCE AUTHORIZATION IS NOT REQUIRED PRIOR TO EXPORT OR TRANSFER TO FOREIGN PERSONS OR PARTIES UNLESS OTHERWISE PROHIBITED.

Tau Camera Mechanical Interface Control Document WFOV Sheet 1

NOTES: UNLESS OTHERWISE SPECIFIED

1. TOLERANCES ALSO APPLY FOR 160x120 ARRAY SIZE.
2. CONNECTOR INTERFACE: HIROSE 50 PIN DF12-50DS-0.5V(86). MATING CONNECTOR P/N DF12(5.0)-50DP-0.5V(86). FOR PIN-OUT DESIGNATIONS SEE TAU CAMERA USERS MANUAL.

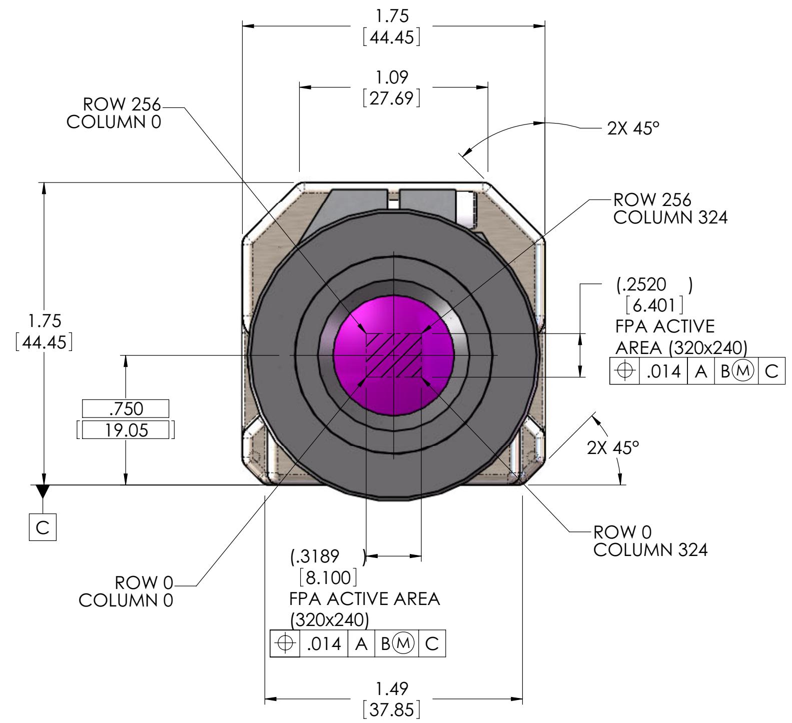


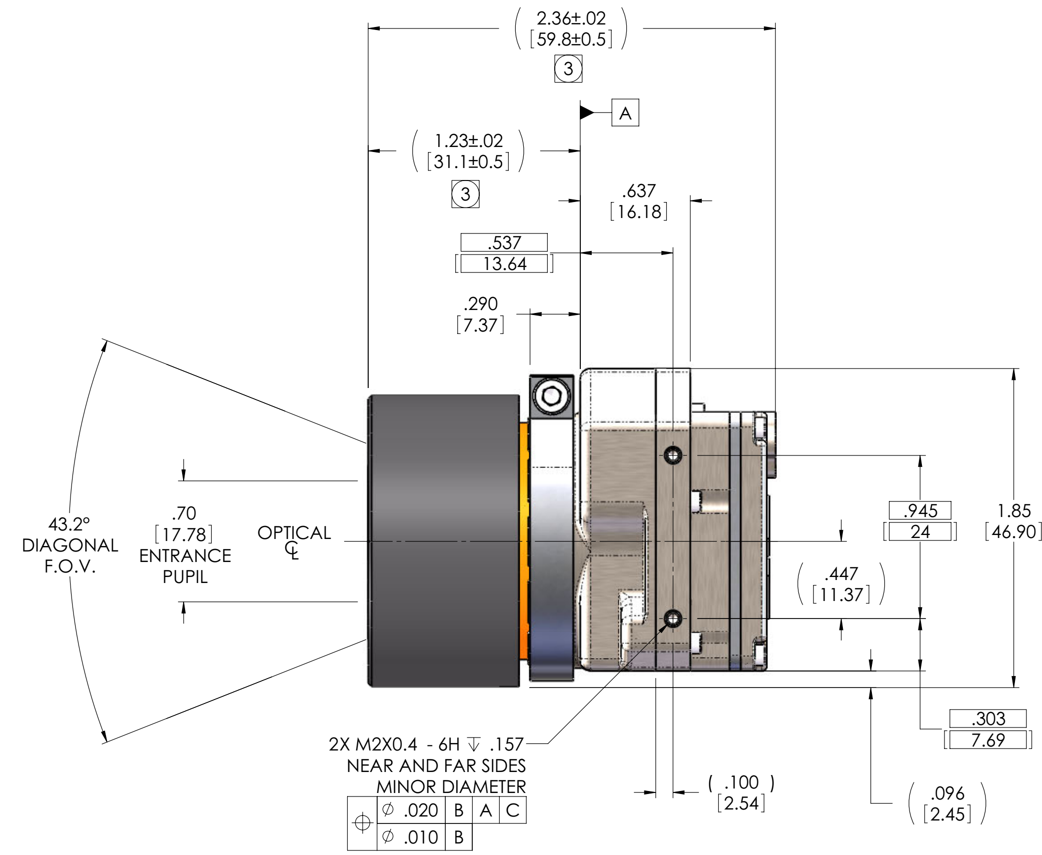
Tau Camera Core Interface Description Document 5mm - 19mm, Sheet 1

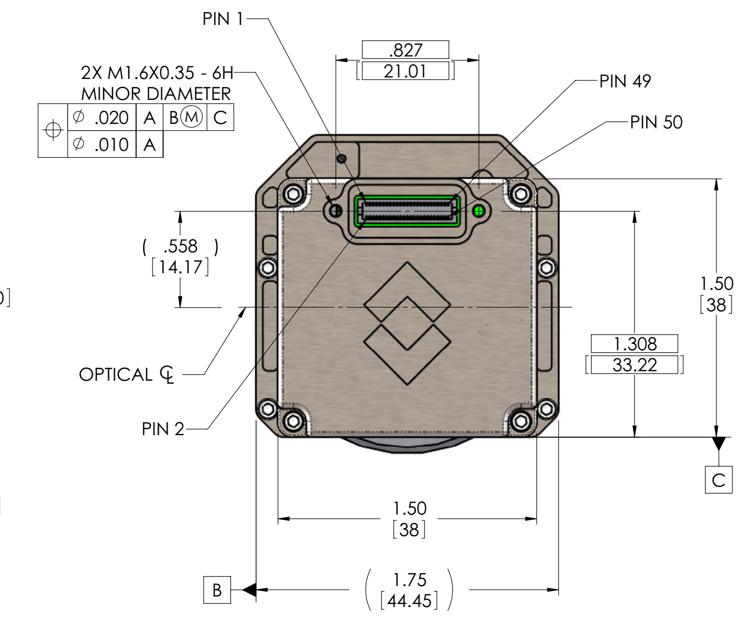
NOTES: UNLESS OTHERWISE SPECIFIED

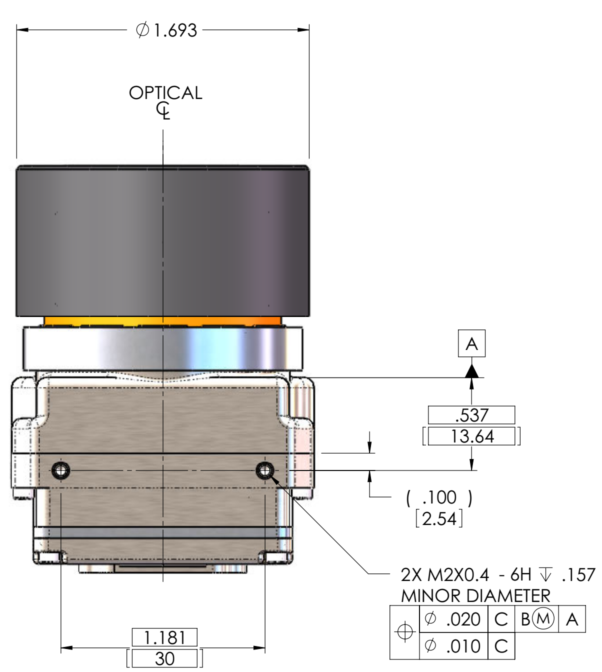
1. INDICATED DIMENSIONS ARE FOR AN ARRAY SIZE OF 320x256. POSITIONAL TOLERANCES ALSO APPLY FOR 160x120 ARRAY SIZE.
2. CONNECTOR INTERFACE: HIROSE 50 PIN DF12-50DS-0.5V(86). MATING CONNECTOR P/N DF12(5.0)-50DP-0.5V(86). FOR PIN-OUT DESIGNATIONS SEE TAU CAMERA USERS GUIDE.

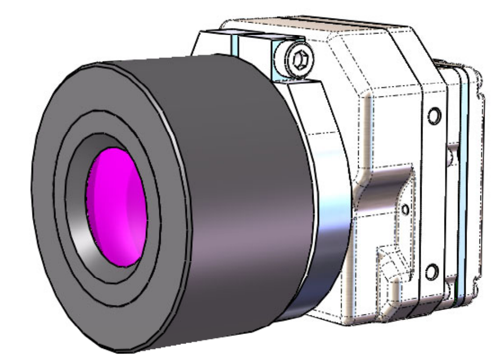
3 INDICATED ALLOWABLE TRAVEL FOR FOCUS.









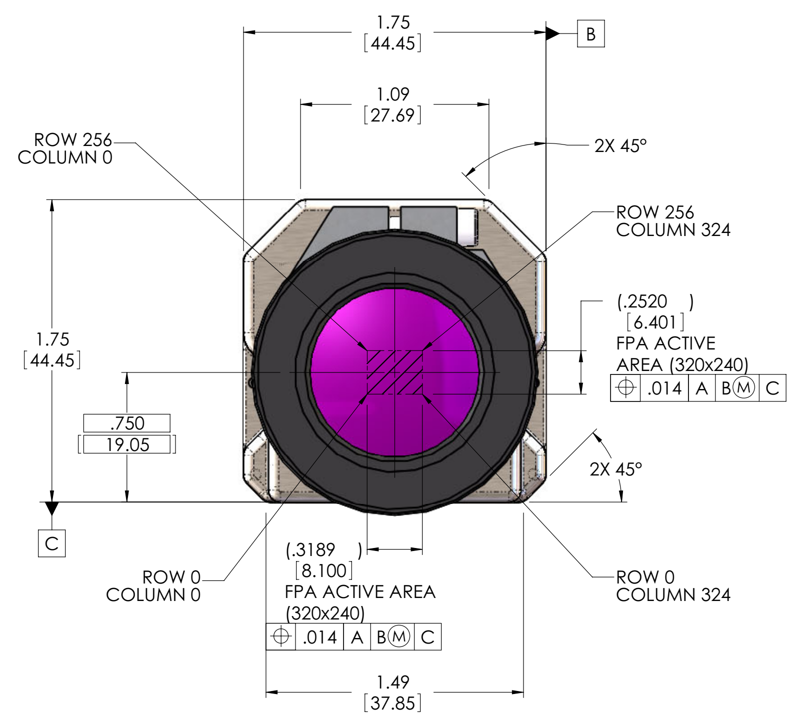


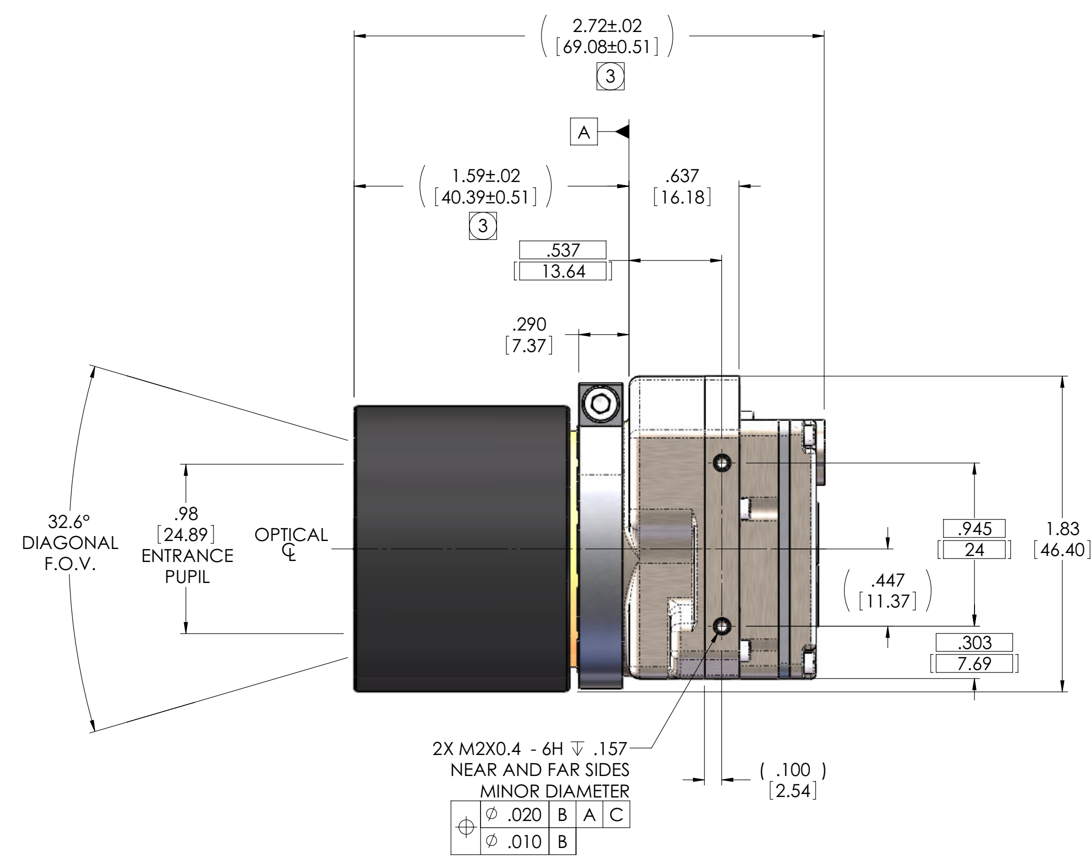
Tau Camera Core Interface Description Document 25mm Sheet 1

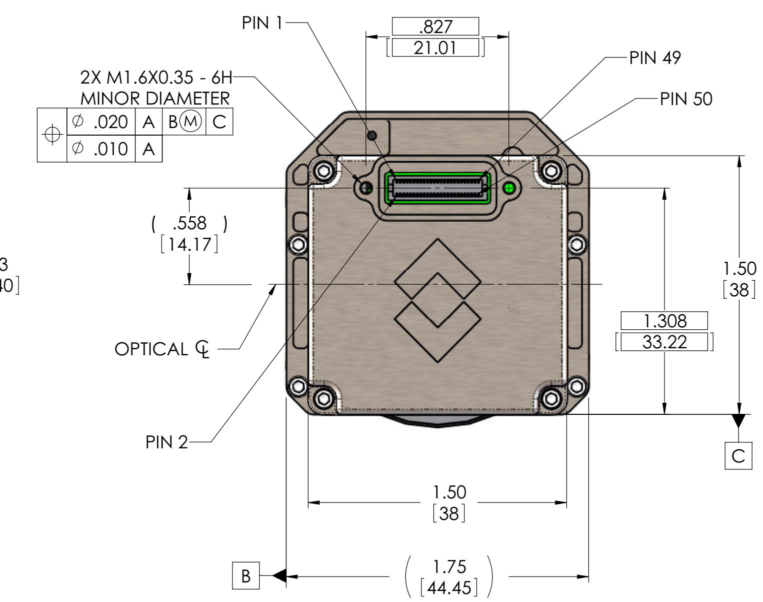
NOTES: UNLESS OTHERWISE SPECIFIED

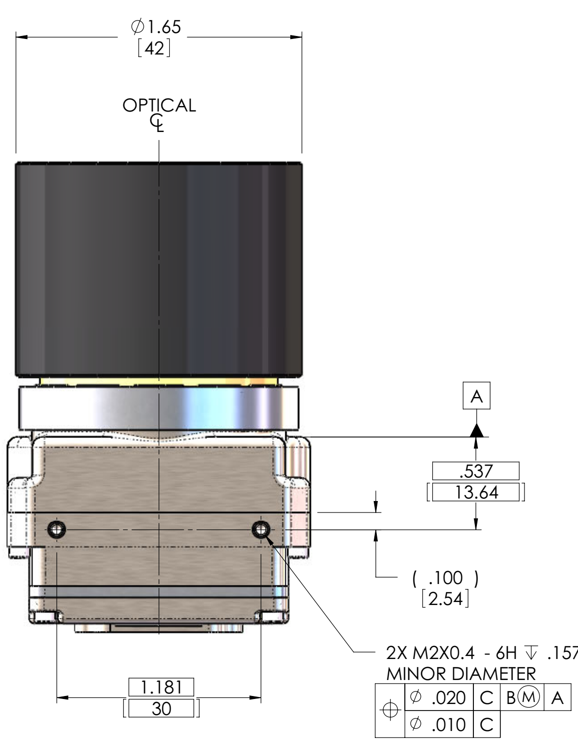
1. INDICATED DIMENSIONS ARE FOR AN ARRAY SIZE OF 320x256. POSITIONAL TOLERANCES ALSO APPLY FOR 160x120 ARRAY SIZE.
2. CONNECTOR INTERFACE: HIROSE 50 PIN DF12-50DS-0.5V(86). MATING CONNECTOR P/N DF12(5.0)-50DP-0.5V(86). FOR PIN-OUT DESIGNATIONS SEE TAU CAMERA USERS GUIDE.

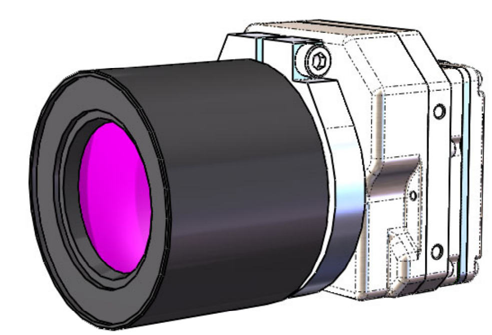
3 INDICATED ALLOWABLE TRAVEL FOR FOCUS.











Tau Camera Core Interface Description Document 35mm Sheet 1