# Tau 640
# Slow Video Camera

## User's Manual



**FLIR Commercial Systems**
70 Castilian Drive
Goleta, CA 93117
Phone: 888.747.FLIR (888.747.3547)
International: +1.805.964.9797
www.flir.com



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If you have questions that are not covered in this manual, or need service, contact FLIR Commercial Systems Customer Support at 805.964.9797 for additional information prior to returning a camera.

This documentation is subject to change without notice.

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

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# 1 Introduction

The Tau 640 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 640 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 640 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 640 camera includes a serial interface (RS-232) for transmitting camera commands and receiving status. The Tau 640 camera also provides 8-bit and 14-bit digital data options, including CMOS, BT.656, and the Legacy Photon LVDS—See "Tau 640 Digital Data Channel" on page 4-1.

## 1.1 Available Tau 640 Configurations

The Tau 640 camera is available with different lenses providing different fields of view. An export license is required in order for international customers to purchase faster frame rate versions of the Tau 640 camera. US customers can specify the 30 Hz (25 Hz) versions of the Tau 640 camera.

| | Resolution | f/# | FOV (H × V) | Weight with lens |
|---|---|---|---|---|
| 13 mm | 640 × 480 (NTSC)<br>640 × 512 (PAL) | 1.25 | 45° × 37° | 80 g |
| 19 mm | 640 × 480 (NTSC)<br>640 × 512 (PAL) | 1.25 | 32° × 26° | 80 g |
| 25 mm | 640 × 480 (NTSC)<br>640 × 512 (PAL) | 1.4 | 25° × 20° | 106 g |
| 35 mm | 640 × 480 (NTSC)<br>640 × 512 (PAL) | 1.4 | 18° × 14° | 129 g |
| 60 mm | 640 × 480 (NTSC)<br>640 × 512 (PAL) | 1.25 | 10.4° × 8.3° | 150 g |
| 100 mm | 640 × 480 (NTSC)<br>640 × 512 (PAL) | 1.6 | 6.2° × 5.0° | 503 g |

**Note**

*The Tau 640 camera lenses are sealed to IP67 (1 meter). The camera itself is sealed only forward of the WFOV o-ring seal or the lens barrel of the NFOV lenses.*

*Boresight features are available on Tau 640 WFOV cameras. See "Mechanical IDD Reference" on page D-1.*

*Contact FLIR Commercial Systems Customer Support or your local FLIR sales representative for information on available Tau 640 camera configurations, part numbers, and ordering information.*

All the above lenses are sealed to IP67 (1 meter). All lenses, except the 35 mm, are diamond-like coated for superior abrasion resistance. The 35 mm lens is High Durability coated.

**Table 1-1: Tau 640 Camera Lens Range Performance (Standing Man—1.5m by 0.5m)**

| | | |
|---|---|---|
| 13mm Lens | 45° HFOV | 390 meters—Detection<br>95 meters—Recognition<br>47 meters—Identification |
| 19mm Lens | 32° HFOV | 570 meters—Detection<br>144 meters—Recognition<br>72 meters—Identification |
| 25mm Lens | 25° HFOV | 820 meters—Detection<br>210 meters—Recognition<br>104 meters—Identification |
| 35mm Lens (f/1.4) | 18° HFOV | 960 meters—Detection<br>245 meters—Recognition<br>122 meters—Identification |
| 60mm Lens | 10.4° HFOV | 1750 meters—Detection<br>450 meters—Recognition<br>225 meters—Identification |
| 100mm Lens | 6.2° HFOV | 2450 meters—Detection<br>650 meters—Recognition<br>330 meters—Identification |

## 1.2 Tau 640 Specifications

An export license is required in order for international customers to purchase faster frame rate versions of the Tau 640 camera. US customers can specify the 30 Hz (25 Hz) versions of the Tau 640 camera.

The latest information concerning specifications, accessories, camera configurations, and other information can be found in the Tau 640 Thermal Imaging Camera Core Data Sheet at: www.flir.com/cvs/cores/uncooled/products/tau/tau640/.

- 640 (H) × 512 (V) uncooled microbolometer sensor array, 17 × 17 micron pixels
- Spectral band: 7.5 - 13.5µm
- NEdT Performance: < 50mK at f/1.0[1]
- Input voltage range: 4.4 – 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: < 55 grams (with shutter, no lens)

**Note**

*The Tau 640 camera is an export controlled item. The 'Slow Video' version of the camera is the baseline version. The frame rate is less than 9 Hz. This allows the Tau 640 camera to be exported without US export license to most countries.*
*Additional information can be found under the* **Export** *tab at:*
*www.flir.com/cvs/cores/uncooled/products/tau/tau640.*

- Analog video output:
  NTSC (640 × 480) 7.5Hz 'Slow Video' rate or 30Hz (US and Export License customers only)
  or
  PAL (640 × 512) 8.3Hz 'Slow Video' rate or 25Hz (US and Export License customers only)

**Note**

*The NTSC analog video format is default for cameras with analog video. The FLIR Camera Controller GUI software (free download) allows you to select between NTSC or PAL video output formats and save this configuration.*

- 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.flir.com/cvs/cores/resources/software/tau/.
- 2×, 4×, and 8× Digital Zoom with electronic pan/tilt (analog video)
- Dynamic Digital Detail Enhancement (DDE)

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.

## 1.3 Unpacking Your Tau 640 Camera

The Tau 640 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 www.flir.com/cvs/cores/uncooled/products/tau/tau640/.

When unpacking the camera, please heed customary electrostatic discharge (ESD) sensitive device precautions including static safe work station and proper grounding. The Tau 640 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 back is not sealed. Avoid exposure to dust and moisture.*

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

Accessories for your Tau 640 camera can be purchased from the online FLIR Camera Accessory Store located at www.flirshop.com.

## 2.1 Tau 640 VPC Module Accessory

The VPC (video, power, communications) module is an expansion board for the Tau 640 camera that provides a convenient way for customers to power and communicate with the camera via USB. The VPC module also incorporates an MCX connector that outputs analog video.

The VPC module accessory includes a USB-A to USB-mini B cable for power and communications, an MCX-to-BNC cable for analog video, and mounting screws. For instructions on installing the VPC Module refer to paragraph 3.1.1 "Installing the VPC Module" on page 3-1.

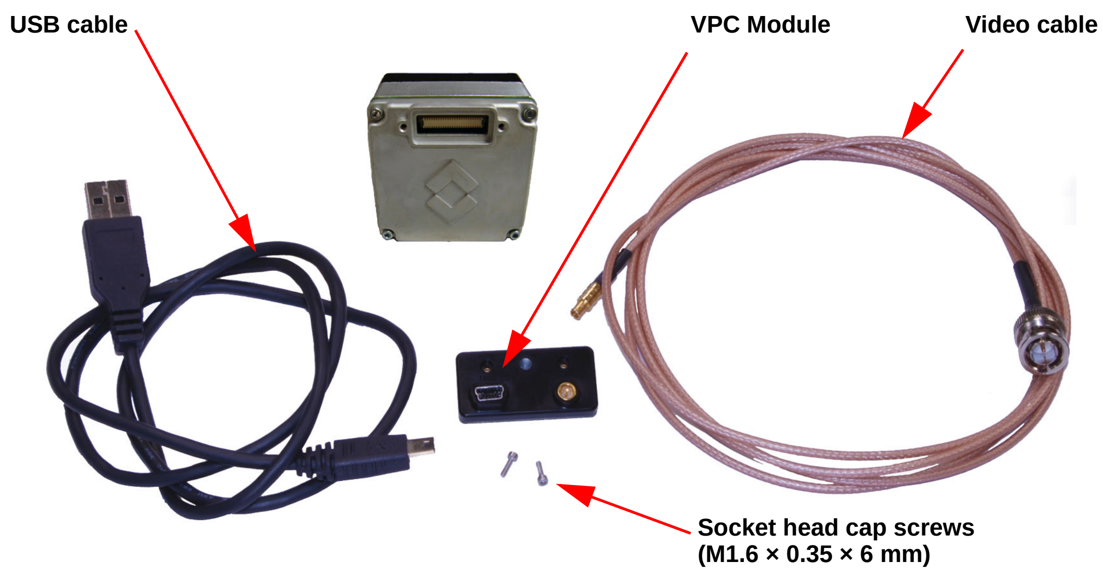



**Figure 2-1: Tau 640 Camera and VPC Module Accessory Kit**

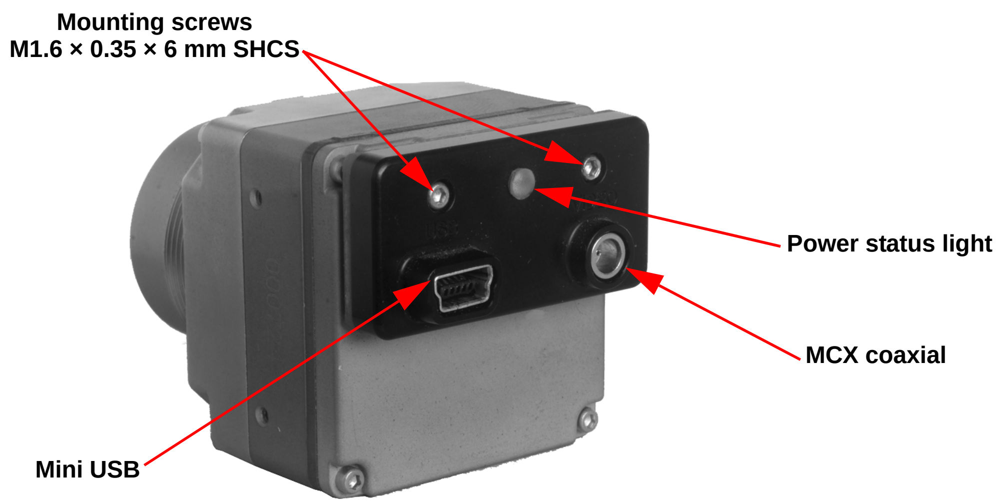



**Figure 2-2: Tau 640 VPC Module Installed on a Tau 640 camera**

## 2.2 Tau 640 Camera Link Module Accessory

The Camera Link module is an expansion board for the Tau 640 camera that provides a convenient way for customers to power and communicate with the camera via USB and access LVDS digital video with a high-speed Camera Link channel. The Camera Link module also incorporates an MCX connector that outputs analog video.

The Camera Link module takes CMOS-type digital data from the Tau 640 camera and converts it to Camera Link. In order to use a Camera Link module for acquisition of data, you will need to first enable the CMOS XP Bus Output using the FLIR Camera Controller GUI. See "Digital Video Tab" on page 3-19. On this same page, you can select either 8-bit or 14-bit digital output. Once you make these changes, it is a good idea to save settings to make them power cycle consistent. See "Save Settings" on page 3-13.

The Camera Link module accessory comes with the spacers and mounting screws shown in Figure 2-3. Note that Camera Link cable, frame grabber, or capture software are not included. For instructions on installing the Camera Link module, refer to paragraph 3.1.2 "Installing the Camera Link Module" on page 3-2.

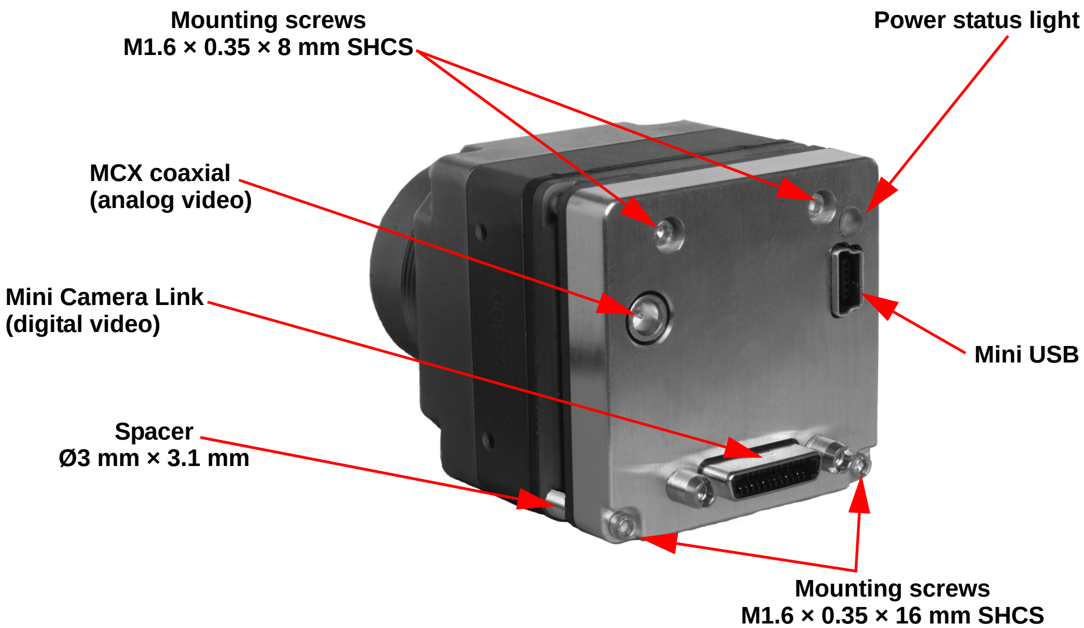


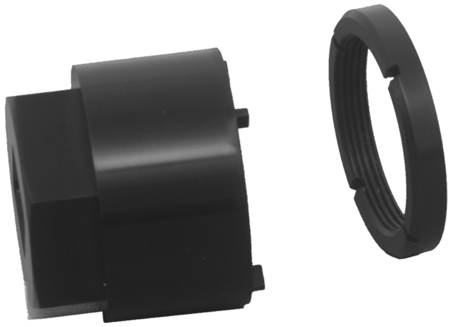

**Figure 2-3: Tau 640 Camera Link Module Installed on a Tau 640 camera**

The Tau 640 camera is powered using the USB connector with a nominal draw of 212 mA at 5VDC and a peak startup draw of 550 mA. The camera uses serial communication at either 57600 or 921600 Baud by creating a virtual COM Port on your computer for USB communications. The Baud Rate is selected using auto-Baud and the camera will communicate at the first Baud Rate in which it receives a valid command until it is powered off.

The digital data complies with Base Camera Link standards and should be compatible with any brand Camera Link Frame Grabber and software. The FLIR Camera Controller allows for control of the Tau 640 camera, but does not support Camera Link frame capture and third-party software must be used.

External sync is not possible with the Camera Link module.

## 2.3 Tau 640 WFOV Locking Ring and Tool



Tau 640 Locking Ring Accessory,
421-0041-00

Lock Nut Tool,
421-0042-00

Type 2 - 025 O-ring
(not included)

The locking ring is designed to mount a Tau 640 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 Type 2-025 O-ring is not for sale through FLIR. This is a standard o-ring available from many suppliers.

The locking ring accessory is made of Delrin so as not to scratch the Tau 640 camera lens flange. Scratching the external plating can compromise the coating and make the Tau 640 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.

## 2.4 Tripod Mount for Tau 640 Camera

Tripod mount,
261-2071-00

This accessory adapts two of the mounting points on the Tau 640 camera to a standard 1/4" x 20 tripod mounting plate. The tripod adapter mounts to the bottom of Tau 640 camera using two furnished socket head screws.

## 2.5 Photon Replicator Board

Photon Replicator Board,
421-0040-00

This expansion board adapts the Tau 640 camera's native 50-pin Hirose connector to the 30-pin SAMTEC connector used on FLIR's Photon cameras. The replicator board makes the Tau 640 camera electrically pin-compatible to a Photon camera, including the provision for operating the Tau 640 camera over the same input voltage range as the Photon camera: 5-24VDC.

A cast magnesium spacer and 4 socket-head machine screws are included.

## 2.6 Software Accessory Alternate Lens Calibration Software

110-0133-72

For customers that furnish their own optics for use with Tau 640 cores, FLIR sells a Windows application program called Alt Lens Cal. This software enables users to perform a supplementary calibration of the camera with a lens. This field-calibration process requires the use of at least one blackbody source (a uniform, controllable temperature reference) that has an area greater than the diameter of the front of the lens.

The Alt Lens Cal software also requires a customer-furnished PC, which should be dedicated to this task. The calibration routine calculates gain terms on a per-pixel basis with the customer-supplied lens attached to the Tau 640 core, and stores the customer-performed calibration in non-volatile camera memory. The original factory calibration coefficients are first uploaded from the camera and stored into a file on the PC, then the new calibration data is downloaded and stored directly into the camera. Multiple calibration files can be stored on the host computer. The original factory calibration file can be restored if necessary, and the customer can actually build a library of lens calibration files for a Tau 640 camera. All OEM customers who add their own lenses to Tau 640 should use this program for optimal image performance.

Alternately, customers can contact FLIR to purchase a Lens Calibration feature that works with the FLIR Camera Controller GUI software. Specifically, a DLL can be added to the FLIR Camera Controller GUI software that provides all the features of the stand-alone Alt Lens Cal software.

## 2.7 Software Accessory SDK for Windows & Embedded

110-0133-16

The Tau 640 Software Developer's Kit 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 Tau 640 SDK. Refer to [www.flir.com/cvs/cores/resources/software/tau/](www.flir.com/cvs/cores/resources/software/tau/).

# 3 Basic Operation of the Tau 640 and GUI

## 3.1 Operation of the Tau 640 Camera using the USB Interface

The Tau 640 VPC Module and Camera Link Module are USB interfaces for the camera to provide power and serial communication for more advanced camera command and control via the free downloadable FLIR Camera Controller GUI. Both modules provide an analog video output, while the Camera Link Module also provides a digital video output in the Camera Link format. Camera Link command and control functions are not supported, only the camera link digital video output is provided.

- Connector Type: USB mini 5-pin
- Power over USB: nominal draw 212 mA at 5 V
  (peak load at startup 550 mA at 5V)
- Serial communications baud rate: 57600 Baud or 921600 Baud
- Hot swap protected
- Windows Service for automatic detection supported through SDK

**Table 3-1: 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<br>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.

### 3.1.1 Installing the VPC Module

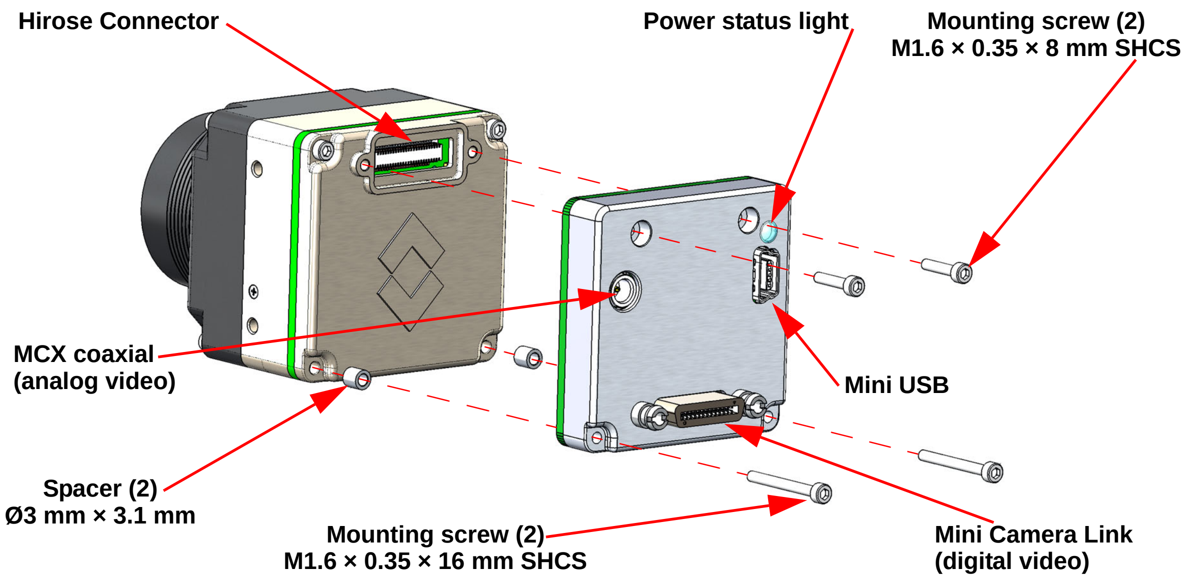
Step 1 Plug the VPC Module into the mating 50-pin Hirose Connector on the back of the Tau 640 camera.

Step 2 Using a 1.5 mm socket driver, install the two socket head cap screws to secure the VPC Module.

**Note**

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

### 3.1.2 Installing the Camera Link Module




Step 1 Using a 1.5 mm socket driver, remove the two case screws at the bottom of the camera (opposite connector).

Step 2 Insert the two M1.6 × 0.35 × 16 mm socket head cap screws through the corner holes of the Camera Link module, install the spacers on the screws, and thread the screws into the camera to replace the case screws removed earlier.

Step 3 Plug the module connector into the mating 50-pin Hirose Connector on the back of the Tau 640 camera.

Step 4 Install the two M1.6 × 0.35 × 8 mm socket head cap screws to secure the module at the connector.

**Note**

*Use only M1.6 × 0.35 × 8 mm screws. Longer screws will damage the camera.*

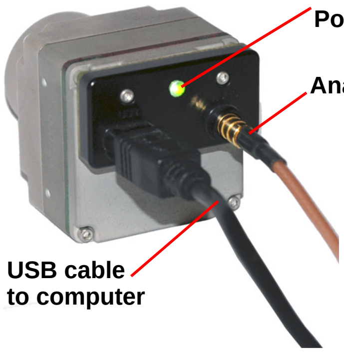
Step 5 Finish tightening the two M1.6 × 0.35 × 16 mm socket head cap screws at the corners of the case.

The digital data complies with the Base Camera Link standard and should be compatible with any brand Camera Link Frame Grabber and software.

The FLIR Camera Controller allows you to control the Tau Camera, but does not support Camera Link frame capture so that a third-party software must be used. FLIR has tested the ImperX FrameLink Express frame grabber (http://imperx.com/frame-grabbers/framelink-express).The ImperX frame grabber comes with FrameLink Express software that allows for recording single or multiple images (BMP, JPG, TIF, and RAW) as well as standard AVI clips. Configuration requires selecting 1 TAP, L->R for the tap reconstruction, selecting the appropriate bit depth that you chose in the FLIR Camera Controller, and clicking "Learn" to discover the number of digital pixels available.

### 3.1.3 Connecting the Tau 640 Camera for Analog Video

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 640 Camera

The Tau 640 camera with a Universal Serial Bus (USB) interface accommodates advanced camera control through the FLIR Camera Controller GUI. A user also 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 FLIR Camera Controller GUI is 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; and that you use the latest version of the FLIR Camera Controller GUI (available on our website).*

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 640 (or Omega/Micron/A10) software.

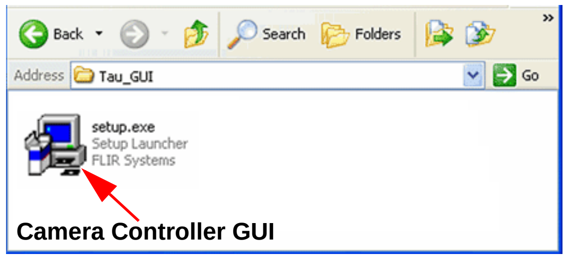
Step 2 Using your favorite WWW browser, navigate to the following URL: www.flir.com/cvs/cores/resources/software/tau/.

Step 3 Click the **Tau GUI** 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.

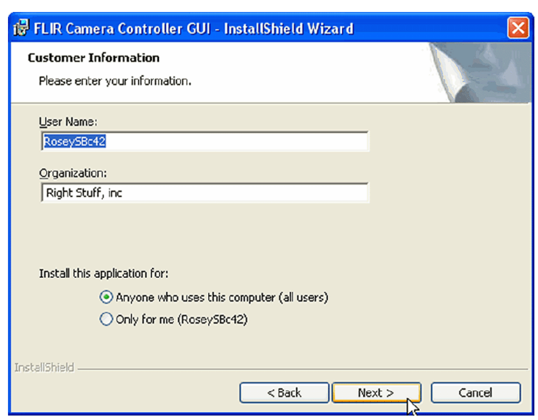
Step 5 Extract the Installable files using WinZip or other available software.

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

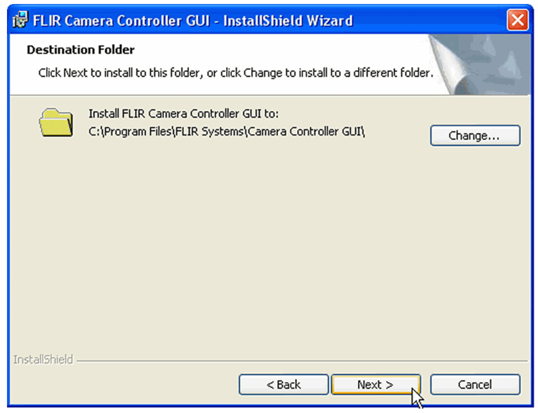



Step 7 Click **Next>** at the Setup Welcome screen.
When the installer finishes loading. Follow the prompts.

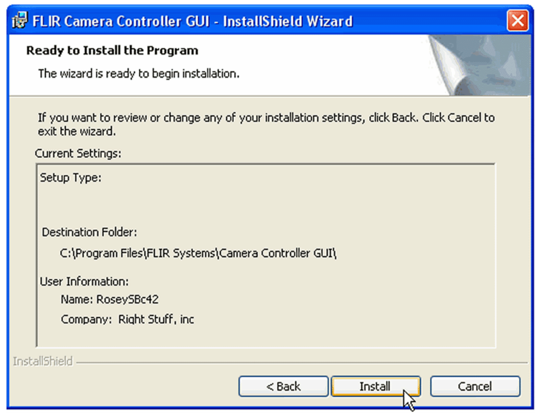

Step 8 Enter your **User Name**, **Organization**, and select your access security.
Click **Next>**



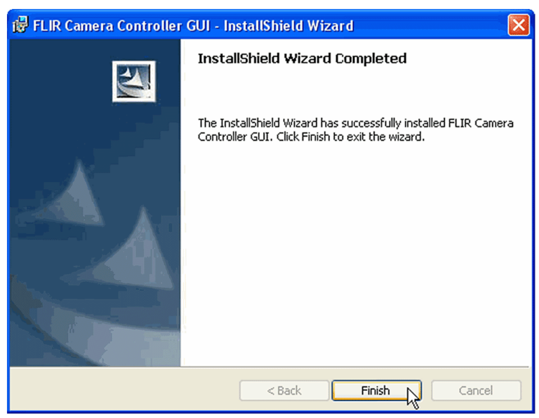
Step 9 Select a Destination Folder if different than the default.
Then, click **Next>>**.



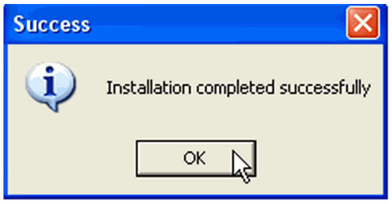

Step 10 Review the settings you have entered for this installation.
Then, click **Install**

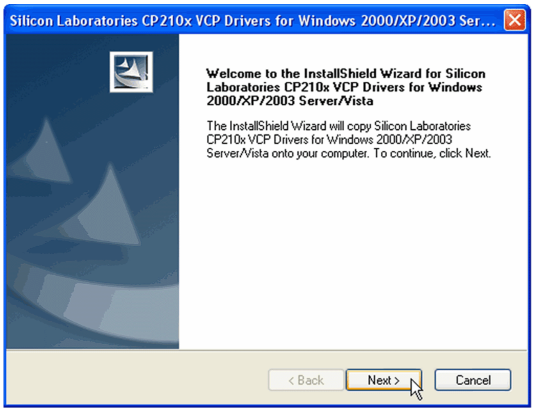



Step 11 Once installation is complete, click **Finish**.

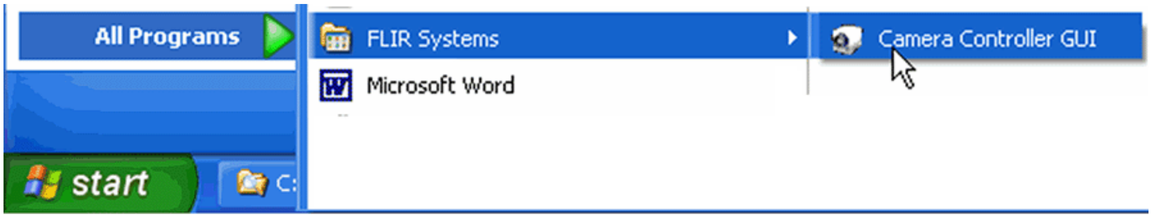


Step 12 The **CP210x_VCP...setup.exe** USB driver installer will start at this point.
Click **Next>** at the Setup Welcome screen.
When the installer finishes loading. Follow the prompts to finish the installation.




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 640 to a PC via USB

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 3.1.3 "Connecting the Tau 640 Camera for Analog Video" on page 3-3.

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 640 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.

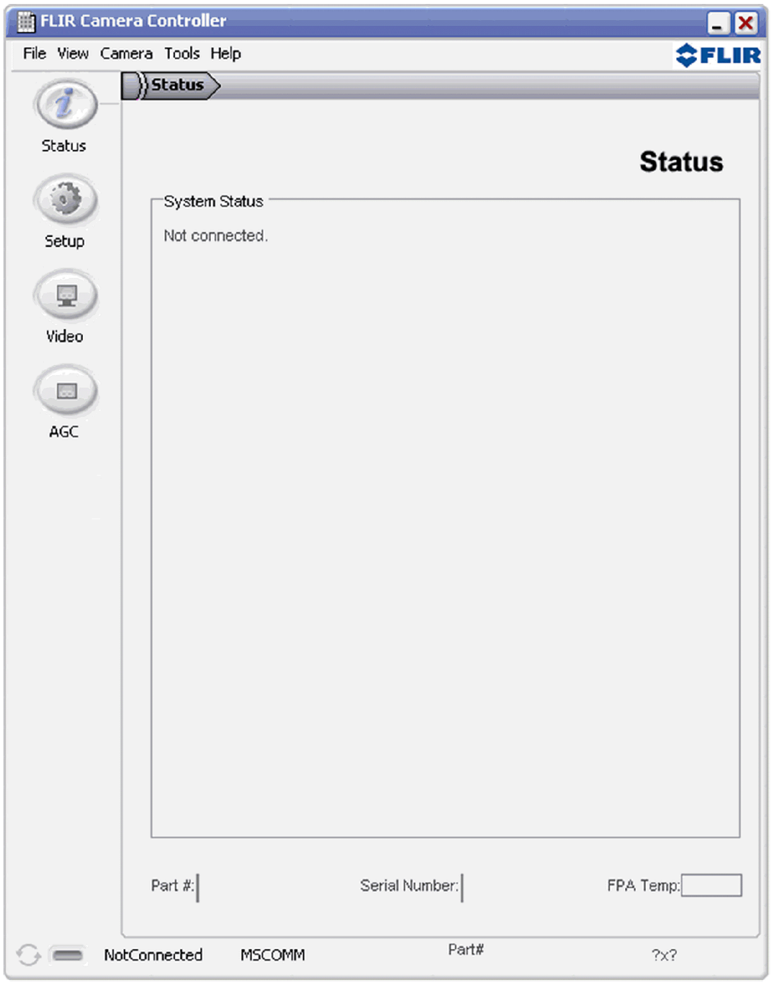
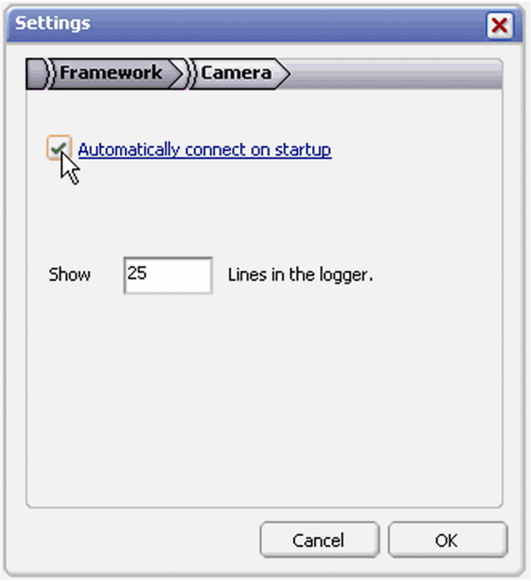



**Figure 3-1: FLIR Camera Controller GUI Status Tab**

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.

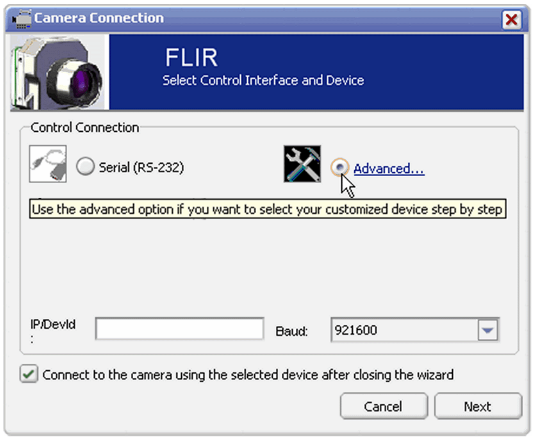


## 3.5 Troubleshooting the FLIR Camera Controller GUI

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 640 camera.


Verify the items in the following checklist:

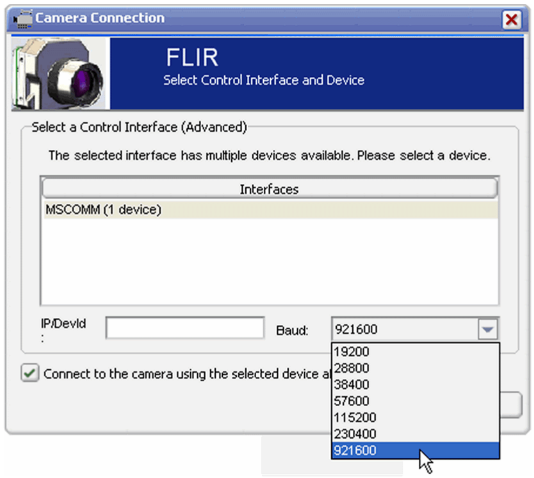
### Is the camera properly cabled to the host PC?:




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 640 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.

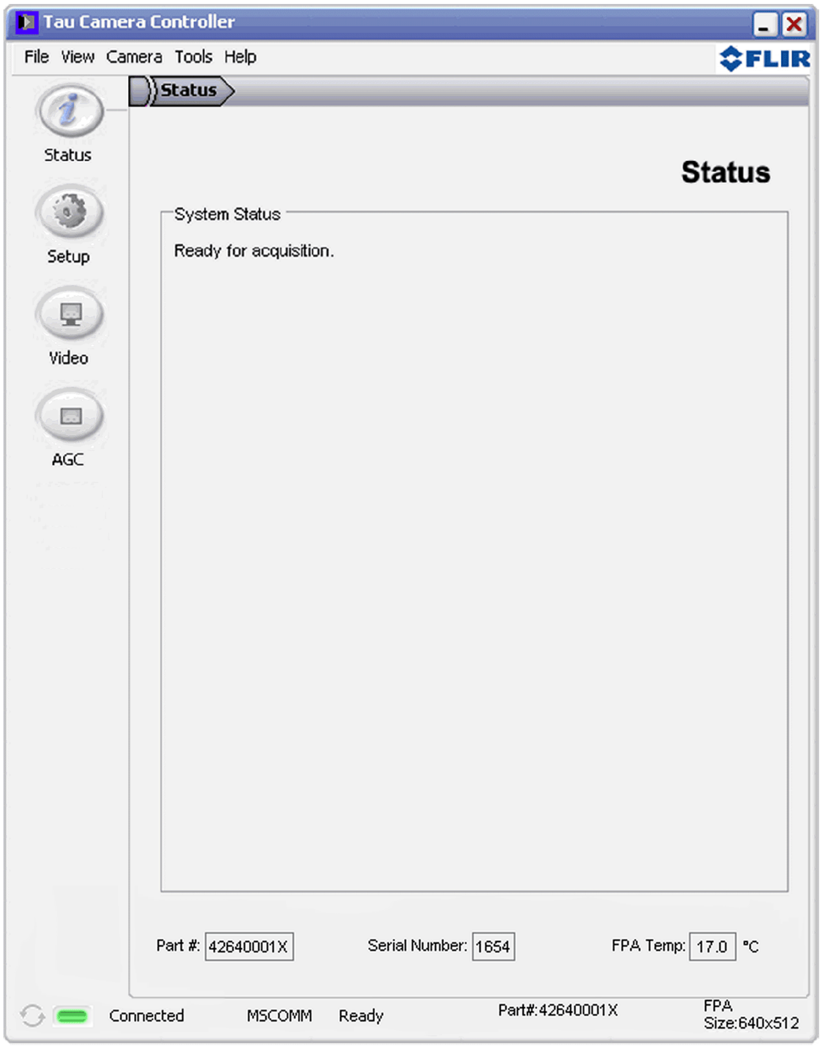
### Is the Tau 640 camera power on?

Verify that the camera is producing an image on a separate monitor. On cameras with a shutter installed, at camera power up, you can hear two sets of a click-click sound, separated by about 5 seconds, as the shutter performs its on-power-up calibration.

If you cannot initiate serial communication with the camera after verifying these items, refer to the frequently asked questions (FAQ) at www.flir.com/cvs/cores/faqs/tau/all/ 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 |
| Populate the Scratch Pad with text |
| 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 |

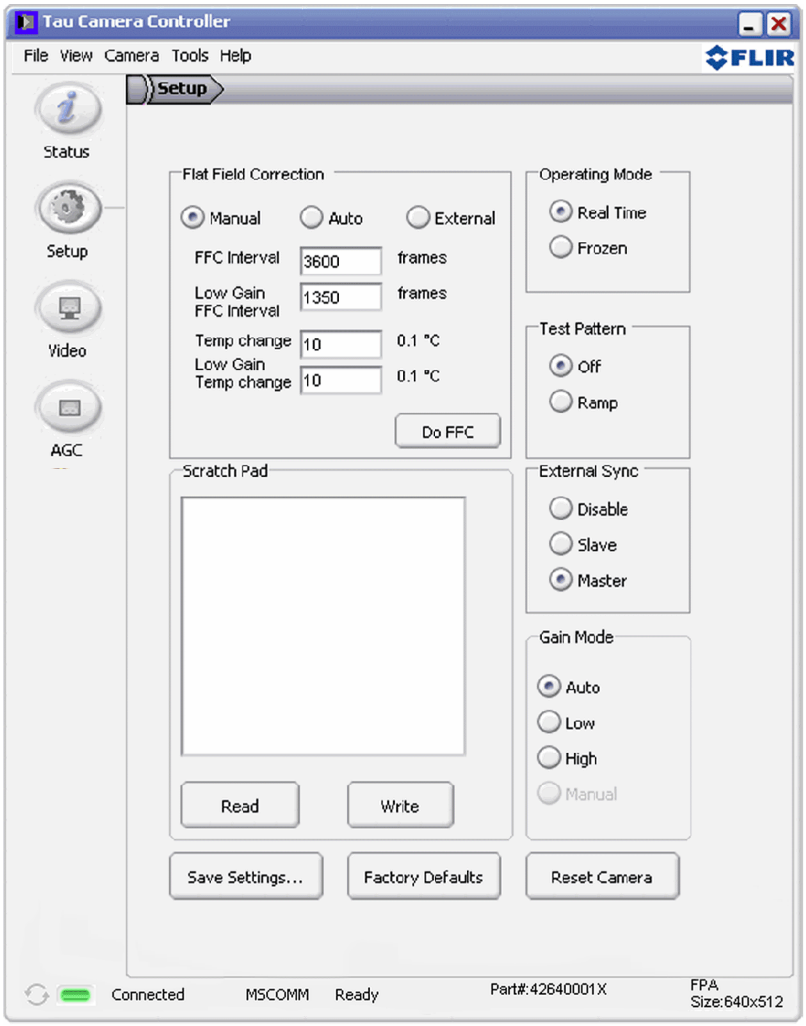
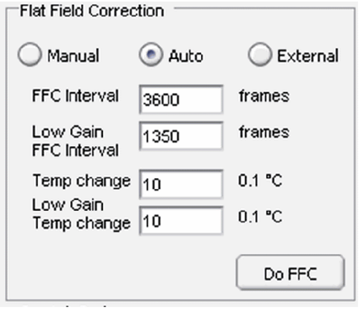



**Figure 3-3: FLIR Camera Controller GUI Setup Tab**




**Flat-Field-Correction Mode:** Tau 640 includes internal mechanisms for periodically improving image quality via a process called flat-field correction (FFC). During FFC, a shutter briefly blocks 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 analog video image is frozen during the entire process, which takes less than a half second, and resumes automatically thereafter. Repeating the FFC operation often prevents the imagery from appearing "grainy". This is especially important when the camera temperature is fluctuating, such as immediately after turn-on or when ambient temperature is drifting. FFC can be controlled manually at any time using the **Do FFC** command button.

Tau 640 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 640-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 whenever the **Do FFC** button is clicked. At camera temperature excursions beyond 0°C and 40 °C, a **Do FFC** command is recommended in order to maintain image quality.

**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.

Many customers have found that the palm of their hand or a table is an adequate uniform source to perform an External FCC.

The Tau 640 camera displays an on-screen symbol called the Flat Field Imminent Symbol prior to performing an automatic FFC operation. As shown in Figure 3-4, it is the 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 3-4: Flat Field Imminent Symbol**

**External Sync Mode:** The Tau 640 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.

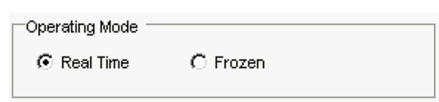
**Slave**: The camera will accept a frame synchronization signal on the interface connector. The camera output will be frozen if the camera is in slave mode and no external synchronization signal is received.

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 embedded in the respective digital output should be used to acquire digital data, not the external sync I/O.

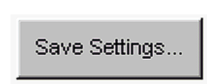
Maximum external sync input rates are up to 29.980 Hz for NTSC and 27.25 Hz for PAL. The 'Slow Video' versions of the Tau 640 camera will have the same external sync frame rates, but the image data output will be at 1/4 the rate (NTSC) or 1/3 the rate (PAL).

**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 640 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.



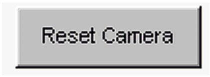

**Save Settings:** After using the FLIR Camera Controller GUI to change camera modes and settings to your desired values, use the **Save Settings** button to store your current selections as *new* power-up defaults. The next time the camera is powered, the Tau 640 camera will remember these saved settings. 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.



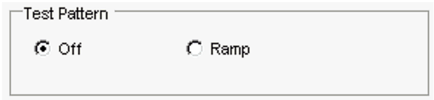
**Factory Defaults:** The **Factory Defaults** button restores the camera's settings to the initial values specified by the manufacturer.


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.




**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 3-5: Ramp test pattern example for Top Portion of Tau 640 Ramp Image**
**(Digital values shown apply to the optional 14-bit digital data stream.)**

The above ramp pattern repeats 19 times in the complete 640 × 512 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.*

## 3.8 Analog Video Tab

The **Analog Video** tab on the FLIR Camera Controller GUI, shown below, provides the ability to modify Tau 640 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

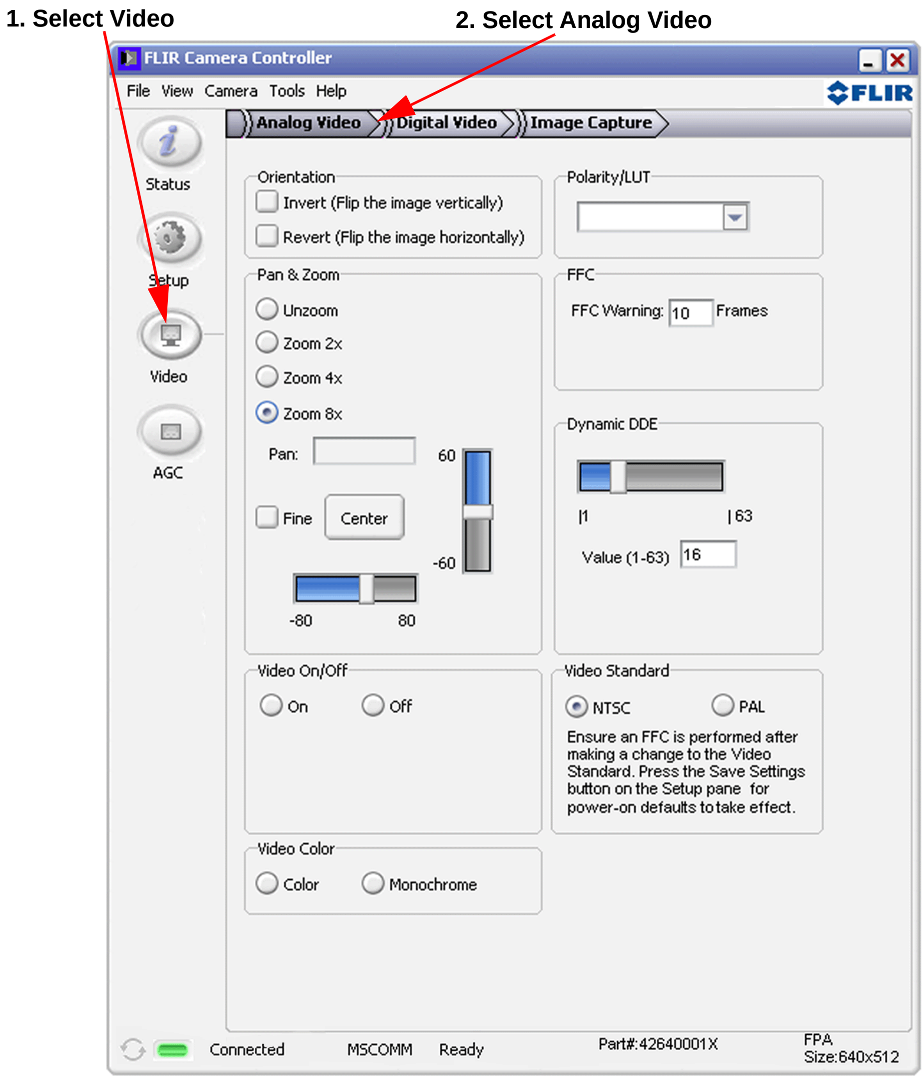



**Figure 3-6: FLIR Camera Controller GUI Analog Video Tab**

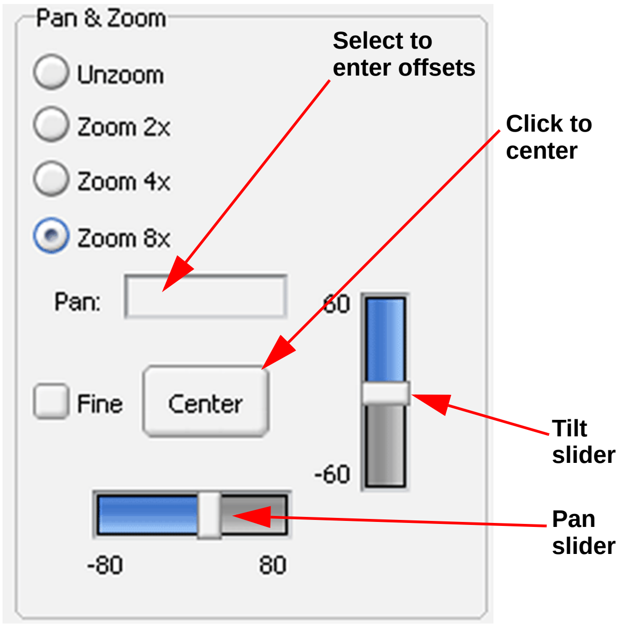
**Image-Orientation Mode:** Two Image-Orientation mode selections are provided. Select one or both to change the orientation of the video image.


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

### Note

> *Any time the image orientation mode is inverted, a flat-field correction automatically takes place. Adjusting image orientation should always be followed by a flat-field correction in all modes.*




**Pan & Zoom, Zoom:** The Tau 640 camera has a built-in 2×, 4×, and 8× digital zoom capability. The **Zoom** check boxes are used to turn on/off the camera zoom. With the **Unzoom** box checked, the Tau 640 camera displays the full sensor array image. 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, 320 × 240 and 320 × 256 pixels, respectively, are mapped to the analog video output. When the **Zoom 4x** box is checked, 160 × 120 (NTSC) and 160 × 128 (PAL) pixels, respectively, are mapped to the analog video output. When the **Zoom 8x** 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 output 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 FLIR Camera Controller GUI Pan and Tilt limits are ±80 × ±60; and ±40 × ±30 when in the **Fine** range.

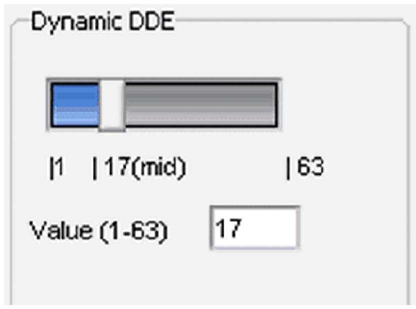
Checking the fine box increases the sensitivity of the slide control so that the zoomed array moves one half the total range but all step values are achievable. Simple experimentation while viewing the displayed image will quickly give you familiarity with this feature.

**Flat-Field Correction (FFC):** The Tau 640 automatically performs flat-field corrections (see paragraph "Flat-Field-Correction Mode:" on page 3-12). 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 **FFC Warning** 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.

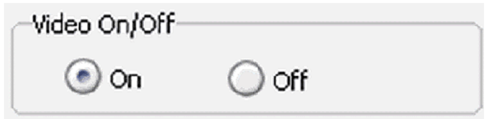



The DDE filter operates independently from the AGC and will enhance edges without effecting brightness or contrast. The valid range of Dynamic DDE setting is from 1 to 63 with 17 being the neutral setting where the filter has no effect. Settings below 17 will smooth the image reducing the appearance 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. Avoid using setting 16.

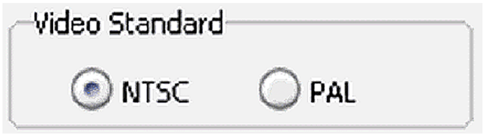
**Note**

> *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 640 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.

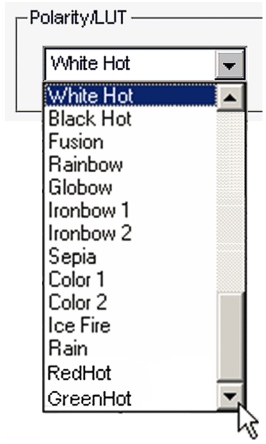



Figure 3-7 shows each of the LUTs as displayed in Test Pattern Ramp Mode starting with the upper left: White Hot, Black Hot, Fusion, Rainbow, Globow, Ironbow1, Ironbow2, Sepia, Color1, Color2, Ice Fire, Rain, Red Hot, and Green Hot. Select one of these LUTs from the pull-down menu to view your image displayed using the LUT you choose. The setting of the Polarity/LUT mode will not affect the digital data output.

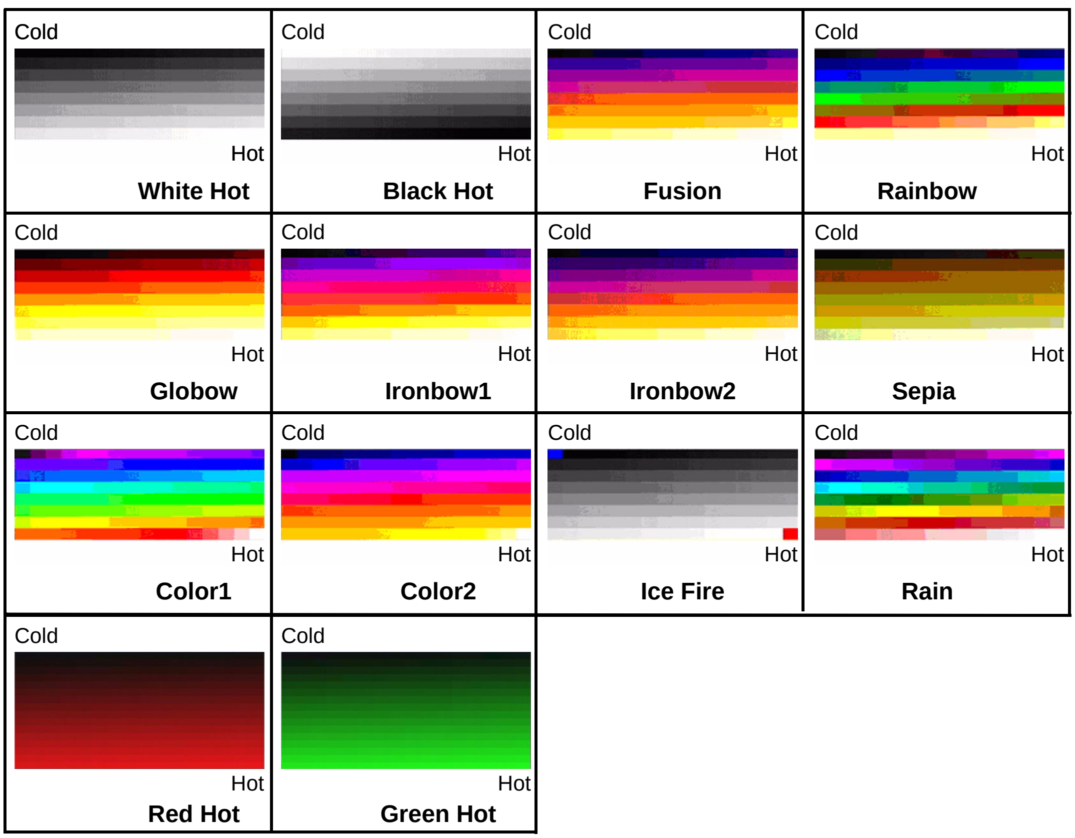



**Figure 3-7: Look-Up Table Options**

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 the default at power-up.

## 3.9 Digital Video Tab

Tau 640 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 640 Digital Data Channel. See the Tau 640 Electrical Interface Control Document (102-PS220-41) for information on how to access digital video for LVDS, BT.656, and CMOS.

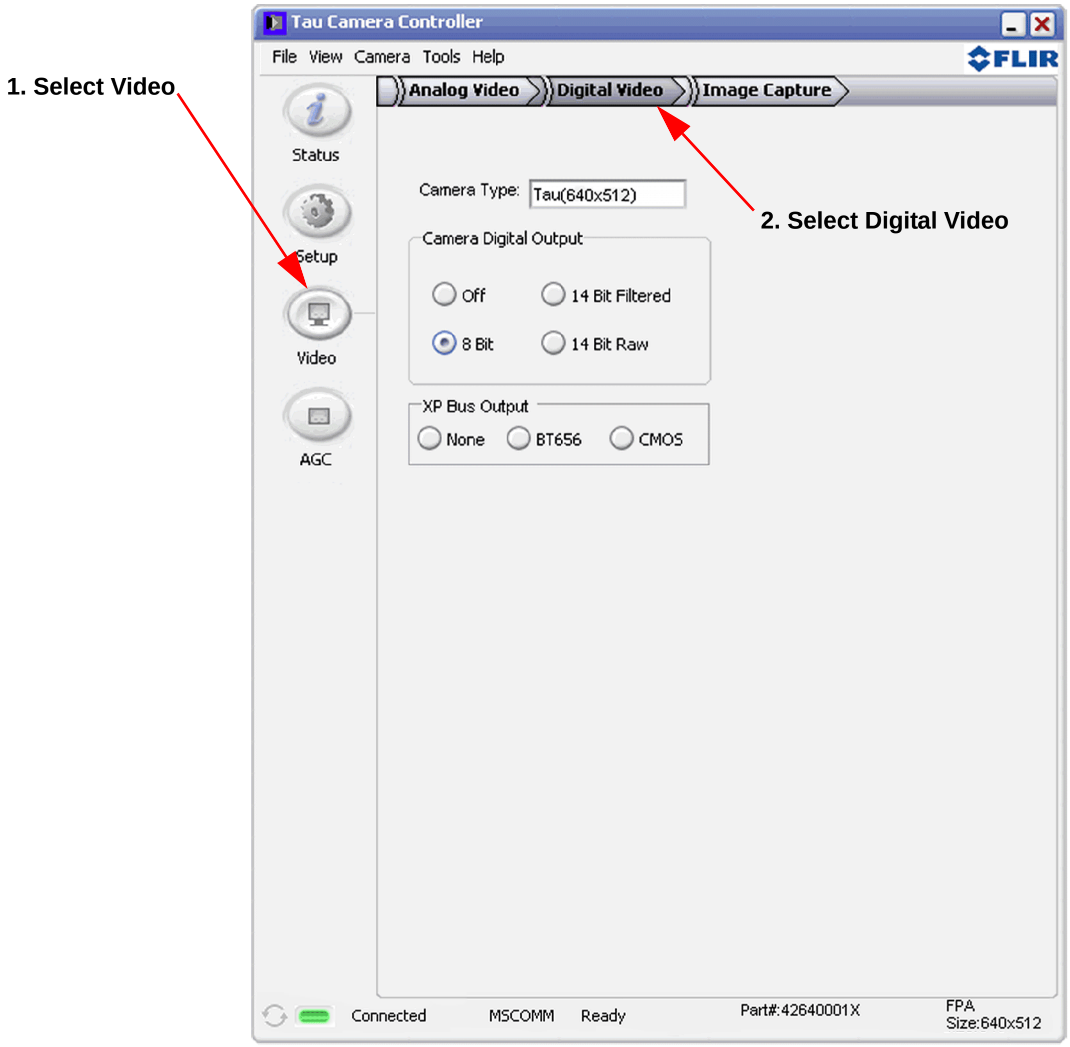



**Figure 3-8: FLIR Camera Controller GUI Digital VIdeo Tab**

### Camera Digital Output

**Note**

*The Revert feature is not available in CMOS or LVDS digital data.*

**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 640 camera is turned off.

**8-bit**: Data from the 640 × 480 (NTSC) or 640 × 512 (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 640 × 512 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 640 Digital Data Channel" on page 4-1.

**14-bit Raw**: Data from 640 × 512 pixels is provided prior to all video processing and does not include the Dynamic Detail Enhancement (DDE) or bad pixel replacement. The 14-bit data is the 'raw' data and will also appear gray when saving 16-bit TIFF files. See "Tau 640 Digital Data Channel" on page 4-1.

### XP Mode Select

The Tau 640 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.

**BT656**: 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 boards mounted directly to the Tau 640 camera. CMOS is not intended to drive a cable. An XP-board (1.5" by 1.5") 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. (The camera actually captures and stores14-bit images and the FLIR Camera Controller GUI displays them as 8-bit images with linear AGC applied.) The Tau 640 camera allows the user to save either 8-bit or 14 bit images. To save an 8-bit images in a .bmp format, click the **Save Currently Displayed Image** button. to save a 14-Bit image right clicking in the image and select save.

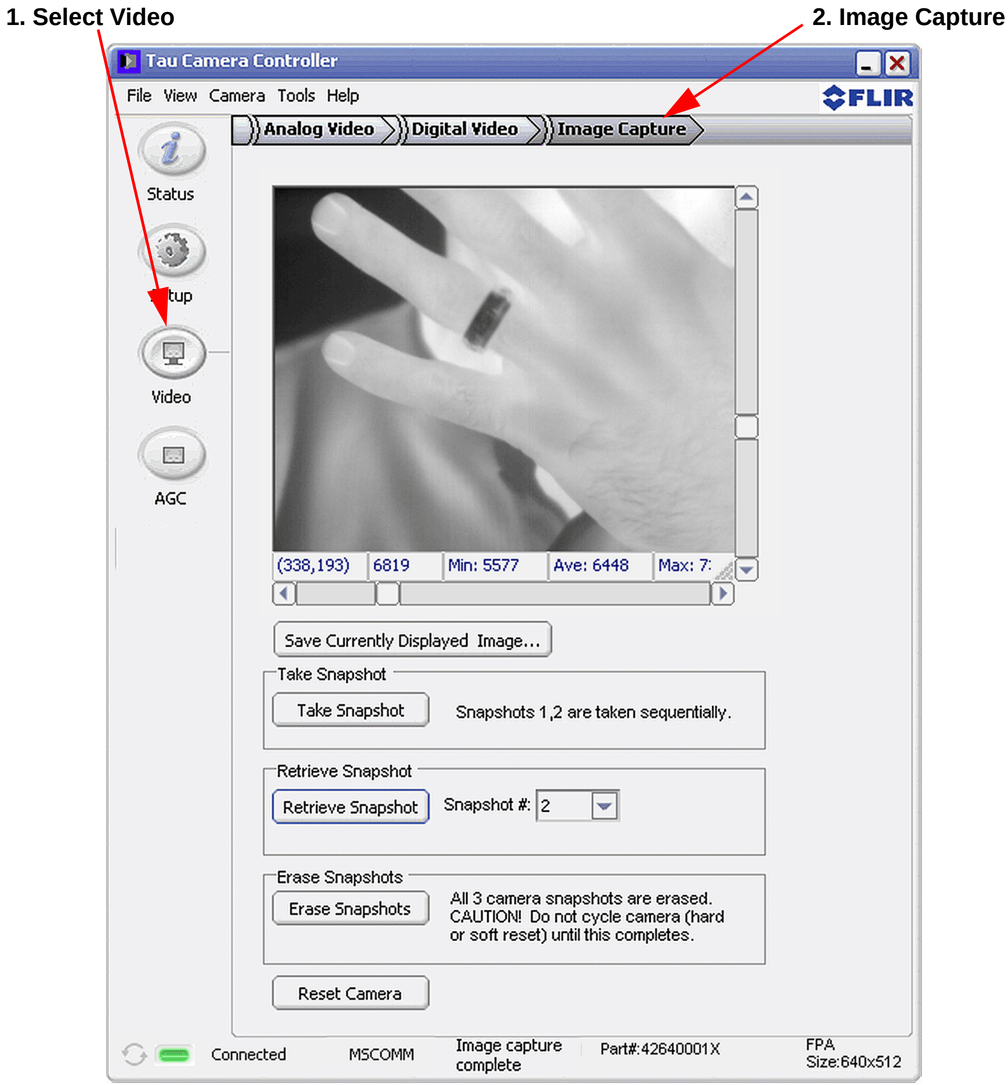



**Figure 3-9: FLIR Camera Controller GUI Analog Video Tab**

**Save Currently Displayed Image...**: Button saves an 8-bit .bmp file as described above. Right-clicking on the image allows you to save 14-bit image data which can be viewed using commercially available image processing software.

**Take Snapshot**: Take two 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 3-10, 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).

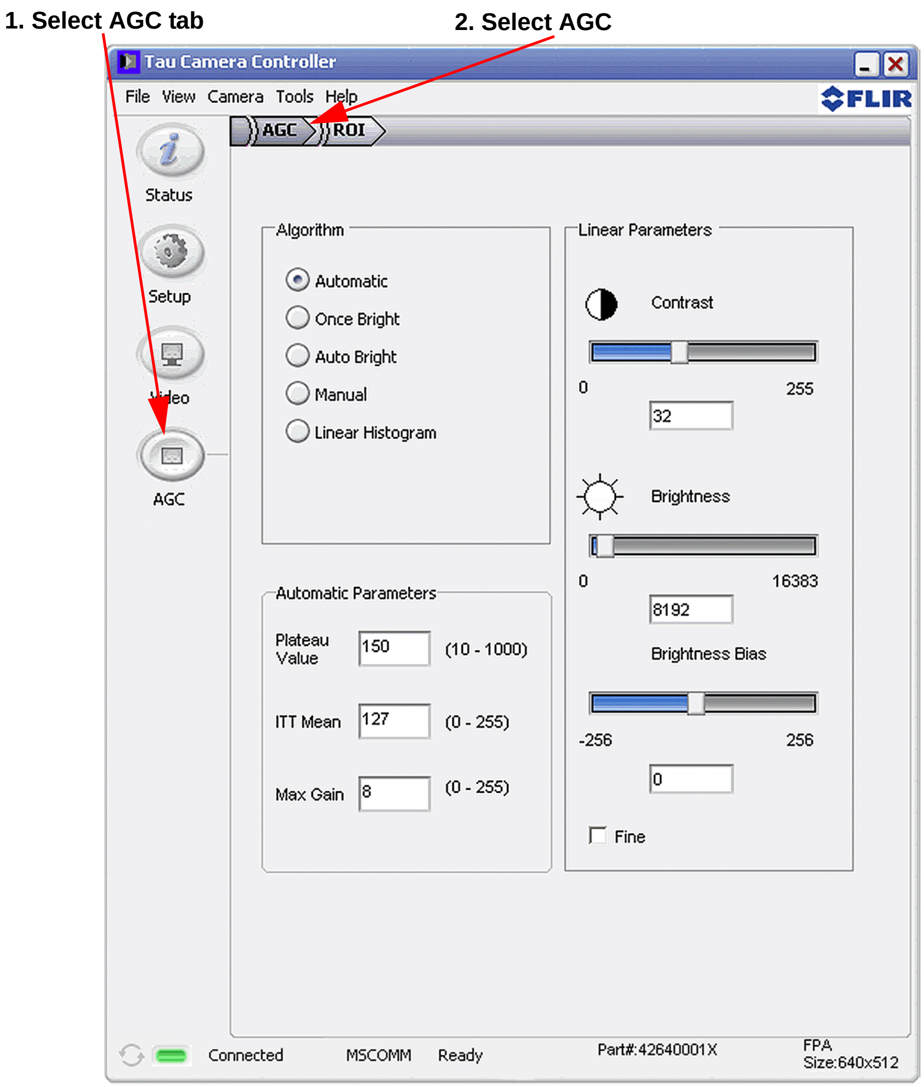
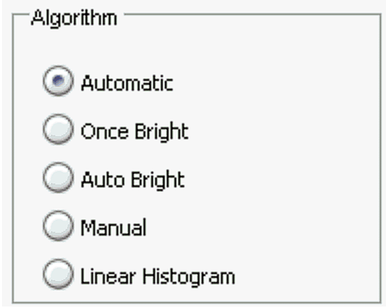



**Figure 3-10: FLIR Camera Controller GUI AGC Tab**

### 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 640 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 640 provides five 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 will be set once when the mode is selected. The brightness (level) is calculated as the mean of the current scene when the **Once Bright** button is selected. The scene is mapped to the analog video using a linear transfer function. Image contrast can be adjusted by the **Contrast** slider. This is the only user adjustable parameter. Upon entry into the once bright mode, the currently-stored value of contrast is applied (i.e. the power-on defaults or the last saved values).

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

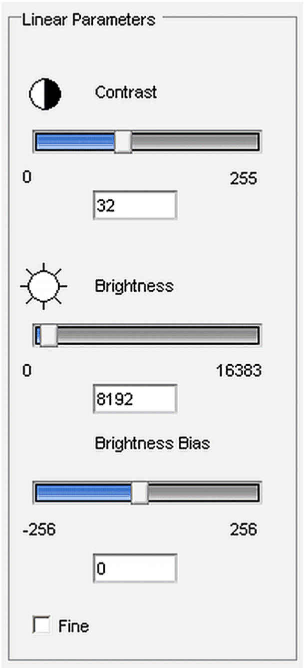
**Manual**: In this mode, image **Contrast** (gain) and **Brightness** (level) are entered completely manually via the sliders. The scene is mapped using a linear transfer function. Upon entry into the manual mode, currently-stored values of brightness and contrast are applied (i.e. the power-on defaults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

**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** *right modes when possible. Also, AGC mode will only affect the digital data output if the Digital Video output mode is set to 8-bit data. The 14-bit digital data bypasses the AGC sections of digital processing.*

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

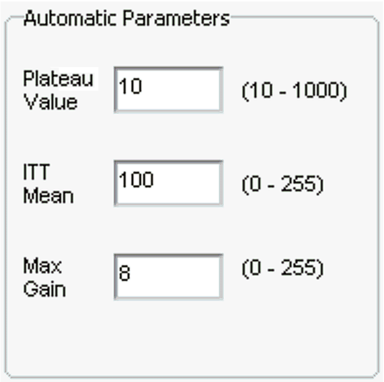



**Once Bright** – Only the **Contrast** control is active.

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

**Manual** – The **Brightness** and **Contrast** controls are active.

**Automatic Parameters:** Used for fine tuning the **Automatic** and **Linear Histogram** 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**.




**Automatic** – The **Plateau Value, ITT Mean,** and **Max Gain** controls are active.

**Manual** – The **ITT Mean** and **Max Gain** controls are active.

## 3.12 ROI Tab

The Tau 640 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 : 640,512) or some smaller portion as shown below. The **ROI** tab, shown in Figure 3-11, provides both a Window Editor and text entry coordinates to control the size and location of the Region of Interest (ROI).

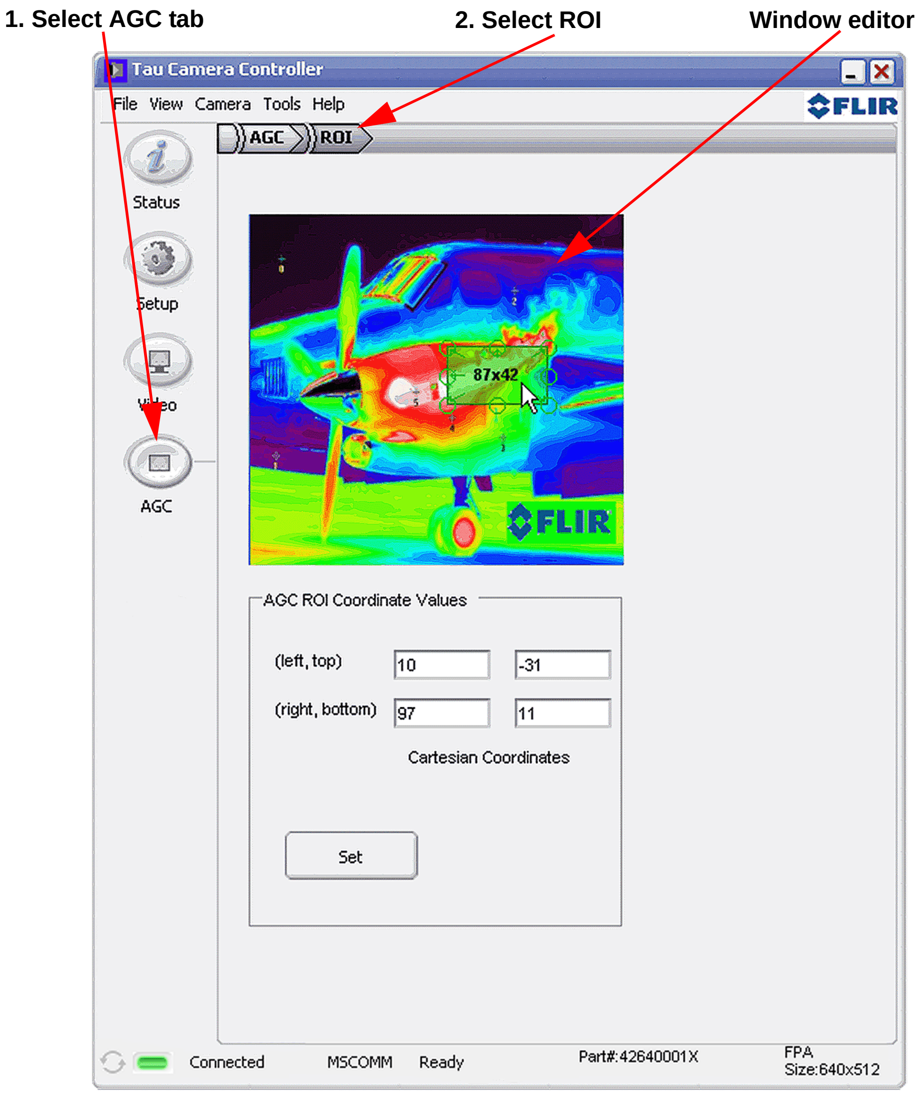
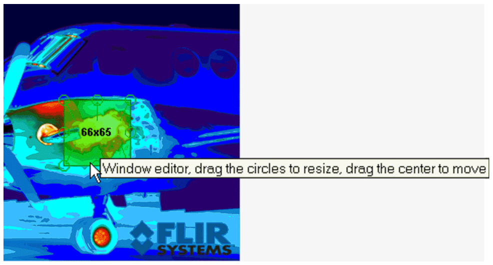
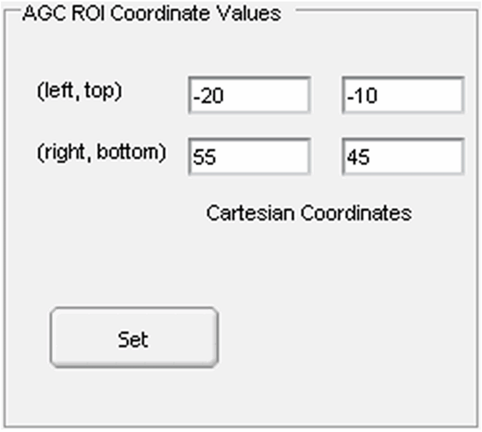



**Figure 3-11: FLIR Camera Controller GUI ROI Tab**




**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×**, **Zoom 4×,** and **Zoom 8×**. 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.

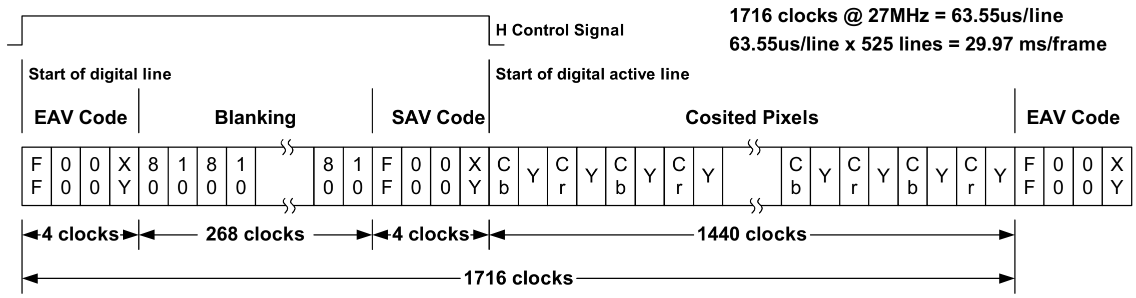
The Tau 640 camera provides three digital data channels which can be configured through software from the generic pinout definitions shown in Table 5-2 on page 5-2. The BT.656 channel output is a digitally encoded analog format which contains image, symbol, and color information. The CMOS channel is a parallel image data output. The Legacy LVDS channel is common with the FLIR Photon camera. Designers and integrators should provide electrostatic discharge (ESD) and over voltage protection for Tau 640 cameras using digital data channels because the digital signals on the 50-pin Hirose connector are routed directly to the FPGA.

## 4.1 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. The signal levels are 0 - 3.3 V CMOS logic and are intended to drive boards mounted directly to the Tau 640 camera. The BT.656 output is not intended to drive a cable. Table 4-1 shows the connector pin definitions with BT.656 enabled. Also shown in the table are the optional discrete input pins. Figure 4-1 details BT.656 format and timing. The horizontal pixels are interpolated such that every eighth pixel is replicated (640 x 9/8 = 720) to produce the 720 pixels per line required by the format.

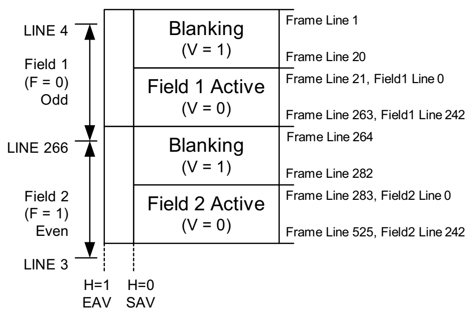
**Table 4-1: 50-pin Hirose connector interface with BT.656 output enabled**

| 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_P1 | 14 | LVDS_DATA_N1 |
| 15 | LVDS_DATA_P2 | 16 | LVDS_DATA_N2 |
| 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 |

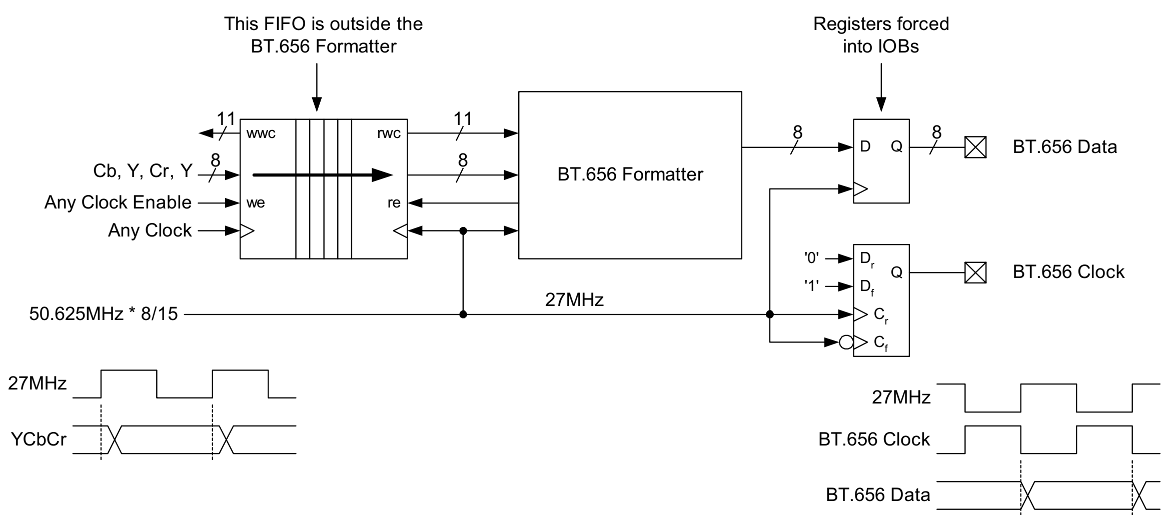



| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|
| Preamble | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Status Word | 1 | F | V | H | P3 | P2 | P1 | P0 |

F = 0 for field 1, F = 1 for field 2
V = 1 during vertical blanking
H = 0 at SAV, H = 1 at EAV
P3 - P0 = protection bits
P3 = V XOR H
P2 = F XOR H
P1 = F XOR V
P0 = F XOR V XOR H




| 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 4-1: BT.656 Video Formatter Timing and Block Diagram**

## 4.2 Discrete I/O

By default the Tau 640 camera does 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 can be used with the BT.656 digital output but are not intended to be compatible with Tau 640 camera using CMOS output. The discrete control file is defined in Table 4-2.

**Table 4-2: Discrete Control Functions**

| 50-pin Connector | 30-pin Connector/ Photon Replicator Name | Tau 640 Name | Function | Detail |
|---|---|---|---|---|
| 19 | Pin 29/DIS 1 | Discrete 0 | White hot/Black hot | Note 1 |
| 20 | Pin 27/DIS 2 | Discrete 1 | Zoom 1x/2x | Note 2 |
| 23 | | Discrete 2 | Do FFC | Note 3 |
| 24 | | Discrete 3 | FCC imminent | Note 4 |
| 25 | | Discrete 4 | FFC mode | Note 5 |
| 26 | | Discrete 5 | LUT toggle | Note 6 |
| 3 | | Discrete 6 | Zoom toggle | Note 7 |
| 4 | | Discrete 7 | Not defined | Note 8 |

Note 1 This function is a backward compatible function with Photon. The voltage level of this pin controls the LUT applied to the analog image. The pin has a pull-up so that the no-connection state is High (3.3 V). When this pin is high (3.3 V), the analog image will use the White Hot pallet (LUT 1 in the standard LUT file). When this pin is low (0 V), the analog image will use the Black Hot pallet (LUT 2 in the standard LUT file). The camera will power up in the saved default state and switch to the discrete input defined state when the pin state is changed.

Note 2 This function is a backward compatible function with Photon. The voltage level of this pin controls the zoom state of the analog image. The pin has a pull-up so that the no-connection state is High (3.3 V). When this pin is high (3.3 V) the analog image will be in the 1x zoom state. When this pin is low (0 V) the analog image will be in the 2x zoom 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.

Note 3 This function is required for effective use of Shutterless Tau 640 cameras. The application of positive going edge to this pin shall perform the Do FFC function (0x12 command).

Note 4 This pin is normally at 0 V and changes to 3.3 V when the FFC imminent icon is present on the analog display. The FFC_Warn_Time command (0x3C) controls both the analog icon and this pin.

Note 5 This function is required to enable additional user control of the camera. The default state is Automatic mode with the input at 3.3 V held by an internal pull-up. When the signal is pulled to zero volts the camera will switch into Manual mode. The FFC_Mode_Select (0x11 0=manual, 1=automatic) command has equal precedence with the discrete pin and the camera will be in the last state set by either the discrete or serial command. The camera will power up in the saved default state and switch to the discrete input defined state when the pin state is changed.

Note 6 This function will change the color LUT from the current value to the next LUT in the table when the Discrete pin transitions from the floating state to the ground state. No LUT change happens on the transition from ground to float. The LUT state after LUT14 will be LUT1.

Note 7 This function will change the current zoom state from Unzoomed to 2x to 4x to 8x zoom whenever the discrete pin changes from the float state to the ground state. The Video_Mode command (0x0F) has equal precedence with this command.

Note 8 Not defined. Connection of either 3.3 V or 0 V to this pin will have no effect on camera operation.

## 4.3 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 640 camera. CMOS is not intended to drive a cable. An XP-board reference design is available upon request.

Table 4-3 shows the connector pin definitions with CMOS enabled.

**Note**

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

**Table 4-3: 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_P1 | 14 | LVDS_DATA_N1 |
| 15 | LVDS_DATA_P2 | 16 | LVDS_DATA_N2 |
| 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 |

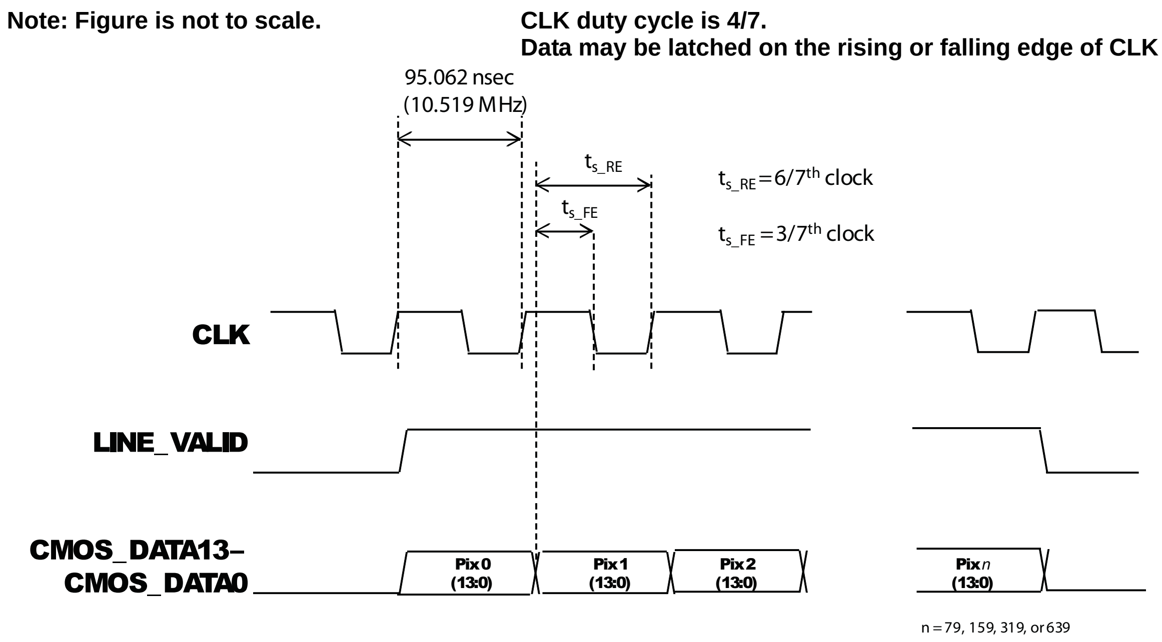



**Figure 4-2: CMOS Line Timing (normal clock configuration)**

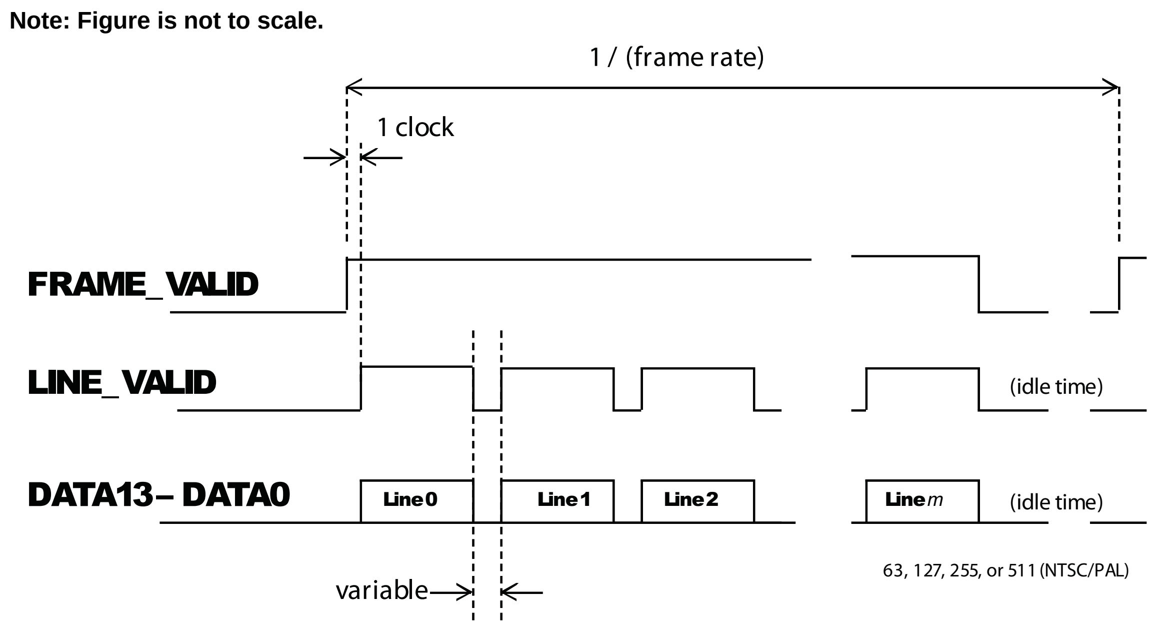



**Figure 4-3: CMOS Frame Timing**

## 4.4 Camera Link Interface

The Tau Camera Link accessory board can be used to capture digital data from the Tau camera. The Tau Camera Link accessory board has four connectors.

- The Camera Link accessory board has the mate to the 80-pin Hirose connector on the Tau core. Power and communication are supplied to the core from the Camera Link accessory. The core receives analog video and CMOS digital data from the core.
- The mini-USB connector receives power and communication from a host though the USB cable. The Camera Link accessory converts USB protocol to high speed serial format for the Tau core.
- The MCX coaxial connection provides access to the camera analog video output (NTSC or PAL)
- The 26-position Mini-D-Ribbon (MDR) Camera link connector provides the output interface for camera digital data. This connector does not support power over Camera link. This connector does not support serial communication over Camera Link.

This accessory conforms to the Camera Link standard as Base Configuration type 14-bit x 1. The Tau CMOS data interface has a Frame sync, Line sync, Data bus, and a pixel clock which runs at 10.5MHz (see section 4.X). To be compliant with the transmission standard the Tau Camera Link accessory up samples data to achieve minimum data rate. The Camera link data clock is running at 21MHz. Data is double sampled so that the output is equivalent to: Pixel1, Pixel1, Pixel2, Pixel2, Pixel3, Pixel3, ..., Pixel638, Pixel 638, Pixel639, Pixel639 in each row. The Frame Valid clock it true during valid lines of data. The Line valid clock is true during valid pixels in each line. The Data Valid clock is true for every other pixel. It is important that the Camera Link receiver device uses all three control clocks (some inexpensive models ignore Data Valid).

In order to use a Camera Link Module for acquisition of data, you will need to first enable the CMOS XP Bus Output using the FLIR Camera Controller. This option is found under Video => Digital Video. On this same page, you can select either 8-bit or 14-bit digital output. Once you make these changes, it is a good idea to save settings to make them power cycle consistent. You can do this after clicking Setup.

The digital data complies with Base Camera Link standards and should be compatible with any brand Camera Link Frame Grabber and software. FLIR has tested the ImperX FrameLink Express frame grabber (http://imperx.com/frame-grabbers/framelink-express).

The FLIR Camera Controller allows for control of the Tau Camera, but does not support Camera Link frame capture and third-party software must be used. The ImperX frame grabber comes FrameLink Express software that allows for recording single or multiple images (BMP, JPG, TIF, and RAW) as well as standard AVI clips. Configuration requires selecting 1 TAP, L->R for the tap reconstruction, selecting the appropriate bit depth that you chose in the FLIR Camera Controller, and clicking “Learn” to discover the number of digital pixels available.

## 4.5 Photon Camera Legacy LVDS Output

The Tau 640 camera provides a digital data channel that outputs camera data in a digital format compatible with FLIR Photon camera tools and accessories. This channel can be used in conjunction with commercially-available digital frame grabbers, digital displays, or custom electronics. For Tau 640 users with applications that require custom control software, a Software Developer's Kit (SDK) is available to support your development. 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 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.flir.com/cvs/cores/resources/software/.

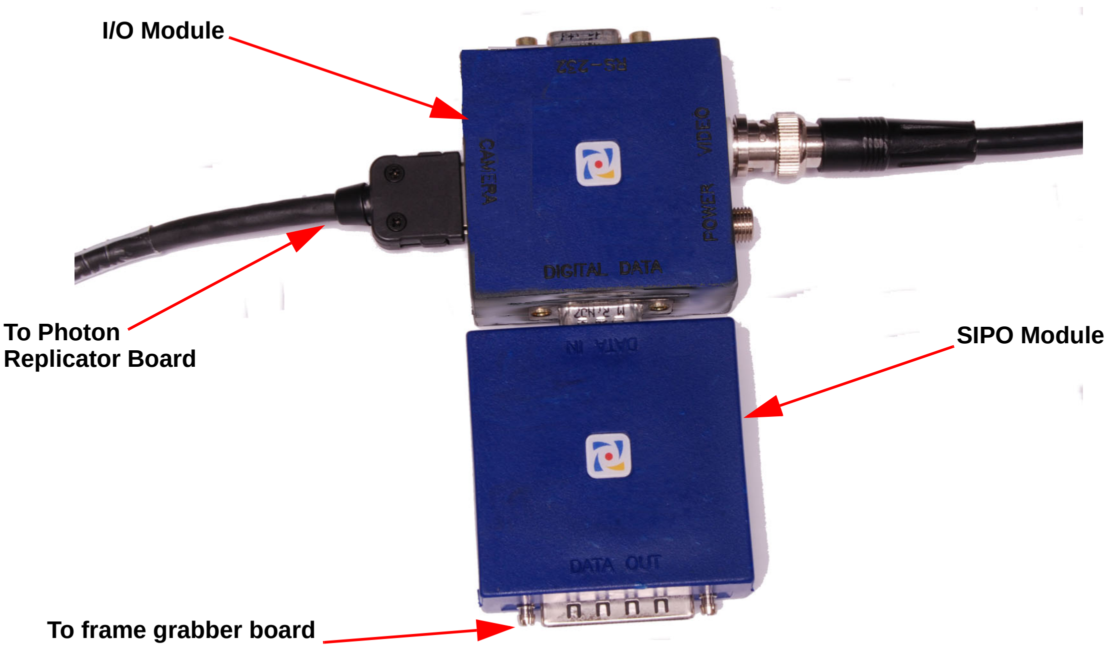
### 4.5.1 Using the Legacy LVDS Digital Data Channel

**Note**

*The following instructions assume that you have purchased the optional Tau 640 Photon Replicator Kit; and have the Photon Legacy serial-to-parallel-out (SIPO) accessory module with parallel data cable and the appropriate Photon Accessory Kit (including the I/O Module and cables shown below. 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 640 Camera using the USB Interface" on page 3-1 for basic operation of the Tau 640 camera. After verifying that the camera is operating properly, disconnect power from the Tau 640 camera.

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 640 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.

### 4.5.2 Legacy LVDS Digital Data Channels

The camera provides two digital ports.

- Port 1 consists of the signals SD_CLK+, SD_FSYNC+, and SD_DATA1+, SD_DATA2.
- Port 2 consists of the signals LVDS_VID1±, and LVDS_VID2±.

**Note**

*14-bit and 8-bit timing and format are identical except only 8 bits (LSBs) are available in 8-bit mode.*
*Port 2 is currently undefined—do not connect to these signals*

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

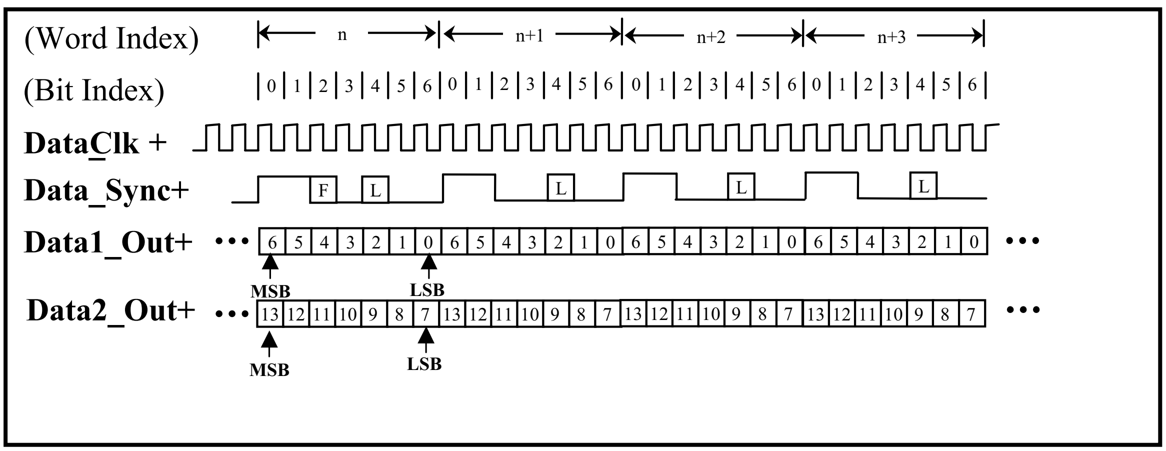
The clock rate of DATA_CLK± is 73.636 MHz.

The timing of the digital data interface is shown in Figure 4-4 and Figure 4-6.

**Note**

*The LVDS Data_Out transitions on the rising edge of DATA_CLK+ and there is no delay. Data should be sampled on the falling edge of DATA_CLK+.*

The format of the digital output shall be is in Figure 4-5.




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

**Figure 4-4: Digital Data Timing**

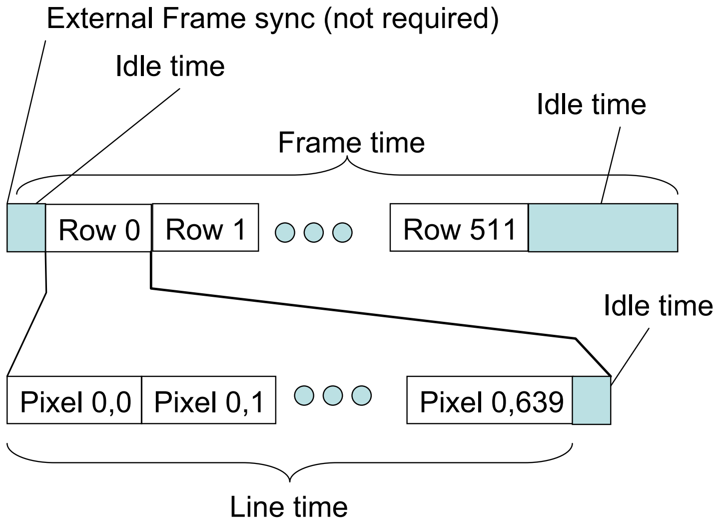



**Figure 4-5: Digital Data Format**

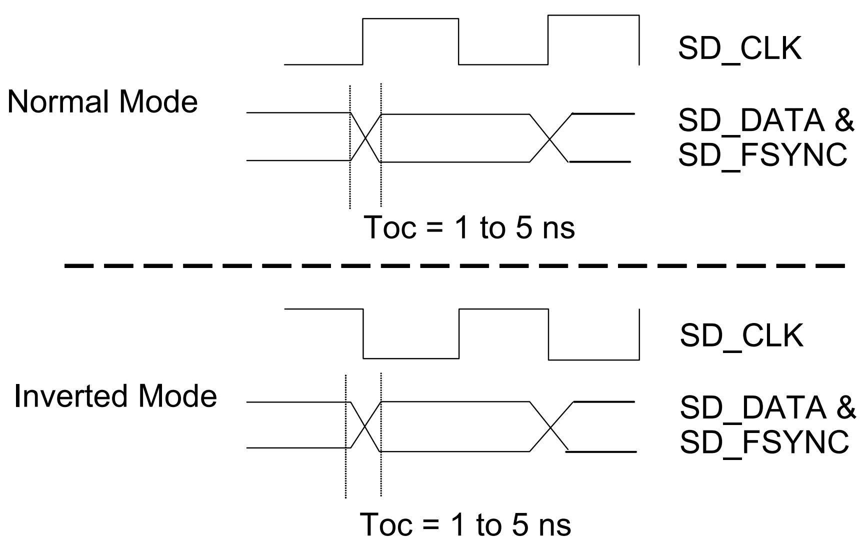



**Figure 4-6: Detailed Digital Data Timing**

The LVDS data is clocked out of the camera on the rising edge of the data clock and should be sampled on the falling edge. There is no delay in the data with respect to the data clock.

## 5.1 Input Power

The Tau 640 camera operates from DC power per the specifications given below. It is common in simple operational scenarios to use an inexpensive wall-powered adapter. The Tau VPC module makes this easy by providing a USB connection.

The camera operating in a steady-state condition consumes around 1W of power. During startup there is an inrush current of up to 1 A (at 5 V) for 1 ms. Cameras equipped with the compact shutter will draw 2.75 W (550 mA at 5 V) for 200 ms during the flat-field operation which occurs during startup and periodically thereafter. Typical start-up times are 3 to 4 seconds.

**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 | 4.4 V | Absolute minimum is 4.4 V |
| Maximum voltage | 6.0 V | Absolute maximum is 6 V |
| Nominal Load Power | ~1.0 W | Room temperature |

The Tau 640 camera has been tested and found to meet radiated emissions specifications of FCC CFR Title 47 Part 15 Subpart B, and EN 61000-6-3 (CISPR-22 limits equivalent to Class B) when properly shielded and grounded. The less stringent Class A requirements are met 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 640 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. Designers and integrators should provide electrostatic discharge (ESD) and over voltage protection for Tau 640 cameras using digital data channels because the digital signals on the 50-pin Hirose connector are routed directly to the FPGA. The primary Tau 640 connector is shown in Figure 5-1.

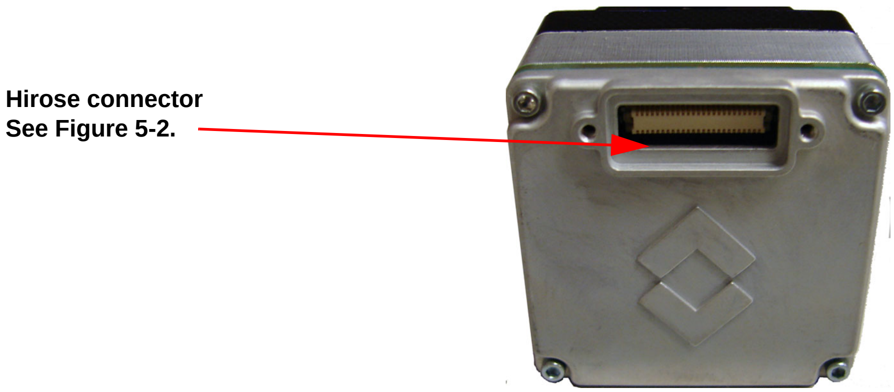



**Figure 5-1: 50-Pin Hirose Connector Interface—DF12-50DS-0.5V(86)**

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 640 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 |

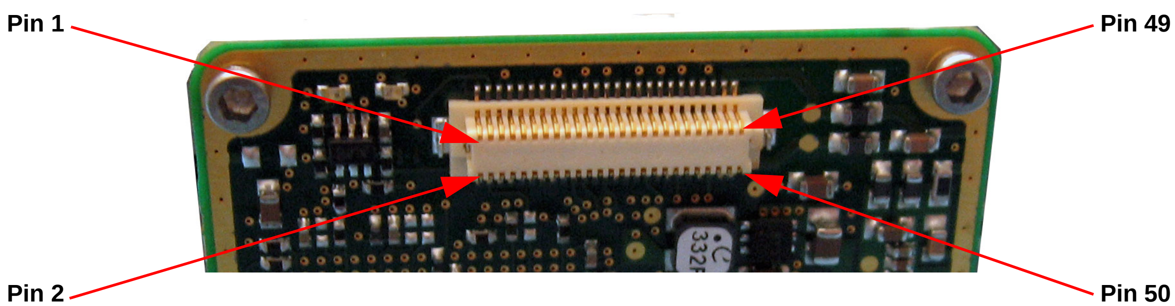



**Figure 5-2: Mechanical Definition for 50-pin Interface Board**

## 5.3 Analog Video Output

The Tau 640 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 640 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 | 640 (H) × 480 (V) | 640 (H) × 512 (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 640 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 640 camera.

## 5.5 LVDS Digital Data Channel

The Tau 640 camera provides 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 serial 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

The Tau 640 camera provides a digital parallel channel with real-time parallel digital video. The XP-Bus may be configured for either CMOS or BT.656 format. Information regarding the digital data interface is provided in Chapter 4.

## 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 |

### Example Process Code

Transmission is LSB first (for each byte) and most significant byte first on multi-byte messages. All bytes are preceded by a zero start bit and followed by a one stop bit.

The camera core is designed to talk to a PC serial port directly and may seem inverted if direct communication to a logic device is desired.

6E = 0 0111 0110 1 = Start bit, E with LSB first, 6 with LSB first, Stop bit

On an oscilloscope the observation is, Idle low but, zero high. Starting at idle, when the signal goes high, that is the first 0; then two 0's high, three 1's low, one 0 high, two 1's low, one 0 high, one 1 low, (6E complete).

**Table B-2: Serial Packet Protocol**

| Byte # | Upper Byte | Comments |
|---|---|---|
| 1 | Process Code | Set to 0x6E on all valid incoming messages<br>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<br>Resp:0 | None | |
| 0x01 | SET_DEFAULTS | Sets all current settings as power-on defaults | Cmd:0<br>Resp:0 | None | |
| 0x02 | CAMERA_RESET | Commands a soft camera reset to the default modes | Cmd:0<br>Resp:0 | None | |
| 0x03 | RESET_FACTORY_ DEFAULTS | Resets camera with factory header values<br>**Note:** It is necessary to send SET_DEFAULTS afterwards to store the settings as power-on defaults. | Cmd:0<br>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<br>Bytes 2-3: Low word camera S/N<br>Bytes 4-5: High word sensor S/N<br>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<br>Bytes 2-3: S/W minor version<br>Bytes 4-5: F/W major version<br>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<br>&<br>Resp: 2 | 0x0000 = Automatic<br>0x0001 = Low Gain Only<br>0x0002 = High Gain Only<br>0x0003 = Manual (no switching)<br>**Note:** The Tau 640 camera does not support Automatic mode. | |
| 0x0B | FFC_MODE _SELECT | Gets and sets the Flat Field Correction (FFC) Mode | Get Cmd: 0 | None | |
| | | | Set Cmd:2<br>&<br>Resp: 2 | 0x0000 = Manual<br>0x0001 = Automatic<br>0x0002 = External | |
| 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.<br>**Note:** Clarification is necessary because shutterless cameras will likely be in Manual mode. | Cmd:0<br>Resp:0 | None | |
| | | | Cmd: 2<br>&<br>Resp: 2 | Bytes 0-1:<br>0x0000 = short FFC<br>0x0001 = long FFC | |

**Table B-4: RS232 Function Codes**

| Function Code (hex) | Command | Description | Byte Count | Argument (i.e, Data Bytes) (hex) | Notes |
|---|---|---|---|---|---|
| 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. Units are Frames; 1 to 30,000. Entry of 0 will result in elapsed time not being used. | |
| | | | Set Cmd: 4 & Resp: 4 | Bytes 0-1: FFC interval, high gain<br>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<br>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<br>0x0001 = Freeze frame<br>0x0004= 2X zoom<br>0x0008 = 4X zoom (Tau 320, 640 only)<br>0x00010 = 8X zoom (Tau 640 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<br>0x0001 = Black hot<br>0x0002 = Fusion<br>0x0003 = Rainbow<br>0x0004 = Globow<br>0x0005 = Ironbow1<br>0x0006 = Ironbow2<br>0x0007 = Sepia<br>0x0008 = Color1<br>0x0009 = Color2<br>0x000A = Ice and fire<br>0x000B = Rain<br>0x000C = OEM custom #1<br>0x000D = Red hot<br>0x000E = Green hot | |

## 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<br>&<br>Resp: 2 | 0x0000 = Normal<br>0x0001 = Invert<br>0x0002 = Revert<br>0x0003 = Invert + Revert | |
| 0x12 | DIGITAL_OUTPUT_MODE | Gets and sets the digital output channel mode.<br>XP signals (CMOS or BT.656) and LVDS channel are available simultaneously. | Get Cmd: 0 | None | |
| | | | Set Cmd: 2<br>&<br>Resp: 2 | Byte 1: 0x00<br>Byte 0: LVDS channel setting:<br>0x00 = 14-bit data<br>0x01 = 8-bit data<br>0x02 = digital off<br>0x03 = 14-bit unfiltered<br>0x04 = 8-bit inverted<br>0x05 = 14-bit inverted<br>0x06 = 14- bit inverted unfiltered | |
| | | Get the XP bus mode | Get Cmd: 2 | Bytes 0-1: 0x0200 | |
| | | | Resp: 2 | Bytes 0-1: XP Mode<br>0x0000 = Generic Bus/No Digital<br>0x0001 = BT656<br>0x0002 = CMOS w/1 Discrete | |
| | | Set the XP bus mode | Set Cmd: 2 | Byte 1: 0x03<br>Byte 0:<br>0x00 = Generic Bus/No Digital<br>0x01 = BT656<br>0x02 = CMOS w/1 Discrete | |
| | | Get LVDS mode | Get Cmd: 2 | Byte 0: 0x04<br>Byte 1: Don't care | |
| | | | Resp: 2 | Bytes 0-1: LVDS Enable<br>0X0000 = disable<br>0X0001 = enable | |
| | | Set LVDS mode | Set Cmd: 2<br>&<br>Resp: 2 | Byte 0: 0x05<br>Byte 1:<br>0x00 = disable<br>0x01 = enable | |

**Table B-4: RS232 Function Codes**

| Function Code (hex) | Command | Description | Byte Count | Argument (i.e, Data Bytes) (hex) | Notes |
|---|---|---|---|---|---|
| 0x13 | AGC_TYPE | Gets and sets the image optimization mode | Get Cmd: 0 | None | |
| | | | Set Cmd: 2<br>&<br>Resp: 2 | 0x0000 = plateau histogram<br>0x0001 = once bright<br>0x0002 = auto bright<br>0x0003 = manual<br>0x0004 = not defined (returns error)<br>0x0005 = linear | |
| 0x14 | CONTRAST | Gets and sets the manual contrast value | Get Cmd: 0 | None | |
| | | | Set Cmd: 2<br>&<br>Resp: 2 | Contrast value<br>(0x0000 to 0x00FF) | |
| 0x15 | BRIGHTNESS | Gets and sets the manual brightness value | Get Cmd: 0 | None | |
| | | | Set Cmd: 2<br>&<br>Resp: 2 | Brightness value<br>(0x0000 to 0x3FFF) | |
| 0x18 | BRIGHTNESS_BIAS | Gets and sets the brightness bias value in the auto bright mode<br>Valid range is +2048 to -2048 decimal<br>MSB is the sign bit | Get Cmd: 0 | None | |
| | | | Set Cmd: 2<br>&<br>Resp: 2 | Brightness bias value (2's complement: 0x0000 to 0x0FFF) | |
| | | | Set Cmd: 2<br>&<br>Resp: 2 | 0x0000 = disabled (off)<br>0x0001 = on, Fahrenheit scale<br>0x0002 = on, Centigrade scale | |
| 0x1F | SPOT_METER_MODE | Gets or sets the spot-meter mode. | Get Cmd: 0 | None | |
| | | | Set Cmd: 2<br>&<br>Resp: 2 | 0x0000 = disabled (off)<br>0x0001 = on, Fahrenheit scale<br>0x0002 = on, Centigrade scale | |
| 0x20 | READ_SENSOR | Gets the FPA temp. in Celsius x 10 or raw counts<br>(e.g. value of 512 decimal represents 51.2C)<br>Sign bit is the MSB. | Set Cmd: 2<br>&<br>Resp: 2 | 0x0000 = temp in C*10<br>0x0001 = temp in raw counts | |
| 0x21 | EXTERNAL_SYNC | Enables or disables the external sync feature | Get Cmd: 0 | None | |
| | | | Set Cmd: 2<br>&<br>Resp: 2 | Ext sync mode<br>0x0000 = disabled<br>0x0001 = slave<br>0x0002 = master | |

**Table B-4: RS232 Function Codes**

| Function Code (hex) | Command | Description | Byte Count | Argument (i.e, Data Bytes) (hex) | Notes |
|---|---|---|---|---|---|
| 0x22 | ISOTHERM | Gets or sets the isotherm mode (on/off). If isotherm option is not enabled, command returns an error. | Get Cmd: 0 | None | |
| | | | Set Cmd: 2 & Resp: 2 | 0x0000 = Disabled<br>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<br>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<br>0x0001 = ascending ramp<br>0x0003 = big vertical<br>0x0004 = horizontal shade<br>0x0006 = color bars<br>0x0008 = ramp with steps | |
| 0x26 | VIDEO_COLOR_MODE | Gets or sets video Color mode (color or monochrome) | Get Cmd: 0 | None | |
| | | | Set Cmd: 2 & Resp: 2 | 0x0000 = monchrome<br>0x0001 = color | |
| 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, returns an error. | Get Cmd: 0 | None | |
| | | | Resp: 2 | Spot temperature value | |
| 0x2B | SPOT_DISPLAY | Gets or sets the spot meter display mode. If the spot meter option is not enabled, returns an error. | Get Cmd: 0 | None | |
| | | | Set Cmd: 2 & Resp: 2 | 0x0000 = display off<br>0x0001 = numeric only<br>0x0002 = thermometer only<br>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<br>0 = immediate<br>1-255 = Numerator (Denominator = 256) | |

**Table B-4: RS232 Function Codes**

| Function Code (hex) | Command | Description | Byte Count | Argument (i.e, Data Bytes) (hex) | Notes |
|---|---|---|---|---|---|
| 0x3F | PLATEAU_LEVEL | Specifies the Plateau level for Plateau AGC | Get Cmd: 0 | None | |
| | | | Set Cmd: 2<br>&<br>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, 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).<br>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, 4X zoom, or 8X zoom).<br>When byte count of the incoming message is 2 (GET) or 32 (set), the 32-byte argument of the reply contains the normal ROI, 2X zoom ROI, 4X zoom ROI, and 8X zoom ROI. | Resp: 8 | Bytes 0-1: Left<br>Bytes 2-3: Top<br>Bytes 4-5: Right<br>Bytes 6-7: Bottom | |
| | | | Get Cmd: 2 | Don't care | |
| | | | Set Cmd: 24<br>&<br>Resp: 24 | Bytes 0-1: Left, normal ROI<br>Bytes 2-3: Top, normal ROI<br>Bytes 4-5: Right, normal ROI<br>Bytes 6-7: Bottom, normal ROI<br>Bytes 8-9: Left, 2X ROI<br>Bytes 10-11: Top, 2X ROI<br>Bytes 12-13: Right, 2X ROI<br>Bytes 14-15: Bottom, 2X ROI<br>Bytes 16-17: Left, 4X ROI<br>Bytes 18-19: Top, 4X ROI<br>Bytes 20-21: Right, 4X ROI<br>Bytes 22-23: Bottom, 4X ROI<br>Bytes 24-25: Left, 8X ROI<br>Bytes 26-27: Top, 8X ROI<br>Bytes 28-29: Right, 8X ROI<br>Bytes 30-31: Bottom, 8X ROI | |
| 0x55 | ITT_MIDPOINT | Gets and sets the ITT midpoint offset | Get Cmd: 0 | None | |
| | | | Set Cmd: 2<br>&<br>Resp: 2 | Data Range is 0 to 255 | |
| 0x66 | CAMERA_PART | Gets the camera part number<br>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<br>&<br>Resp: 2 | Data Range 0 to 2048 | |

**Table B-4: RS232 Function Codes**

| Function Code (hex) | Command | Description | Byte Count | Argument (i.e, Data Bytes) (hex) | Notes |
|---|---|---|---|---|---|
| 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. The limits of pan and tilt positions change with a change in zoom setting (see VIDEO_MODE 0x0F). | Get Cmd: 0 | None | |
| | | | Set Cmd: 4 & Resp: 4 | Bytes 0-1: Tilt position in rows relative to the center of the array.<br>±128—2X zoom<br>±192—4X zoom<br>±196—8X zoom<br>Bytes 2-3: Pan position in columns relative to the center of the array.<br>±160—2X zoom<br>±240—4X zoom<br>±280—8X zoom | |
| 0x72 | VIDEO_STANDARD | Gets or sets the video standard (affects frame rate). | Get Cmd: 0 | None | |
| | | | Set Cmd: 2 & Resp: 2 | 0x0000 = NTSC<br>0x0001 = PAL | |
| 0x79 | SHUTTER_POSITION | Opens or closes the shutter | Get Cmd: 0 | None | |
| | | | Set Cmd: 2 & Resp: 2 | Shutter position<br>0x0000 = open<br>0x0001 = close | |
| 0x2C | DDE_GAIN | Sets the gain of the DDE filter (input only in manual mode. In automatic mode this is set internally).A DDE_GAIN setting of 0 turns off DDE and bad pixel replacement. | 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<br>(0x0000 to 0x00FF) | |
| 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<br>(0x0000 to 0x000F)<br>Byte 1 = Mode<br>0x0000 = manual<br>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<br>Bytes 2-3: hiToLoPopulation<br>Bytes 4-5: loToHiThreshold<br>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

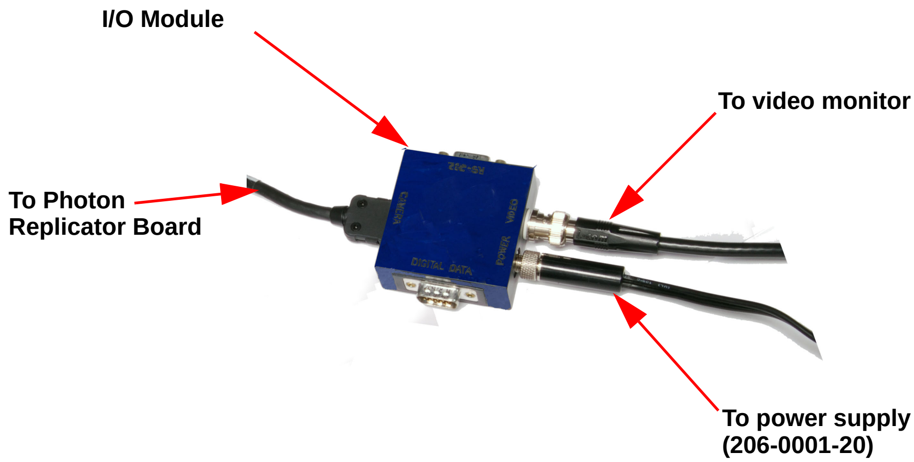
The DIGITAL_OUTPUT_MODE command allows the users to select one of the following digital data options

- 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 640 camera using the Photon Accessory Kit

Backward compatibility with existing Photon equipment allows Photon users to connect to the Tau 640 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.

Using the Accessory Kit's Interface Cable and I/O Module, plug one end of the Interface Cable into the mating connector of the Photon Replicator Board 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 ~3 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 640 camera

The Tau 640 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 and Windows 7. The PC must have a spare serial communications port or you must use one of the Tau 640 USB accessories (VPC module or Camera Link module). High-speed communication (921600 Baud) is possible using the USB accessories.

**Note**

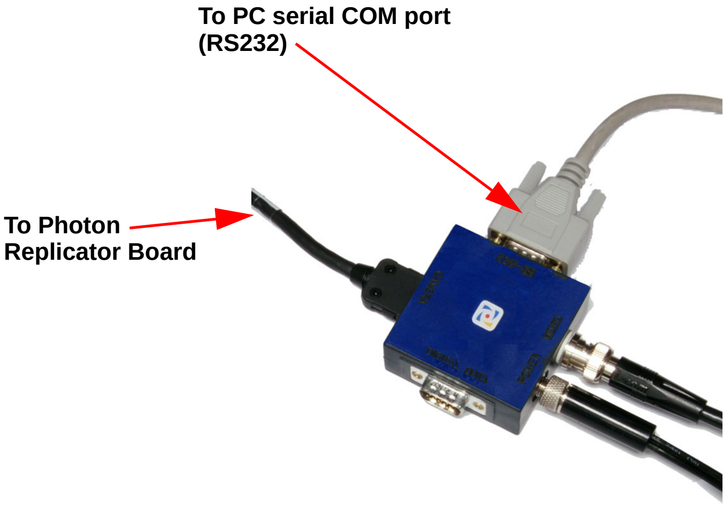
*A USB to Serial port adapter is acceptable, but the data communication rate must be set to 57600 BAUD.*

If your embedded or specialty applications require custom control software, a Software Developer's Kit (SDK) is available.

## 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 640 camera using the Photon Accessory 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
http://www.flir.com/cvs/cores/uncooled/products/tau/tau640/,
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.

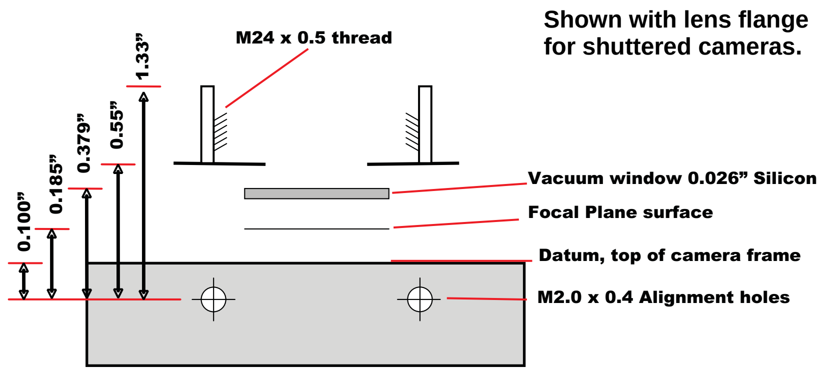



**Figure D-1: Focal Plane Dimensions and Relationships**

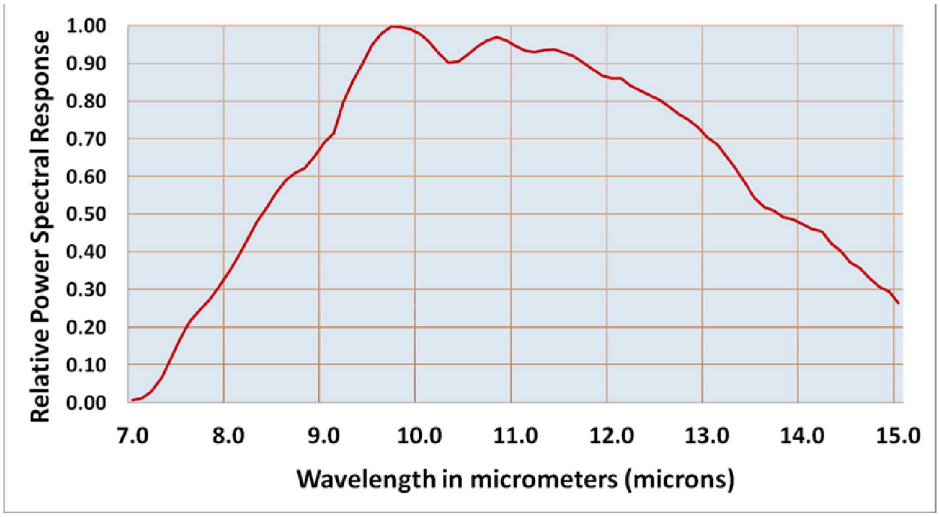



**Figure D-2: Spectral Response Curve from a Typical Tau 640 Camera**

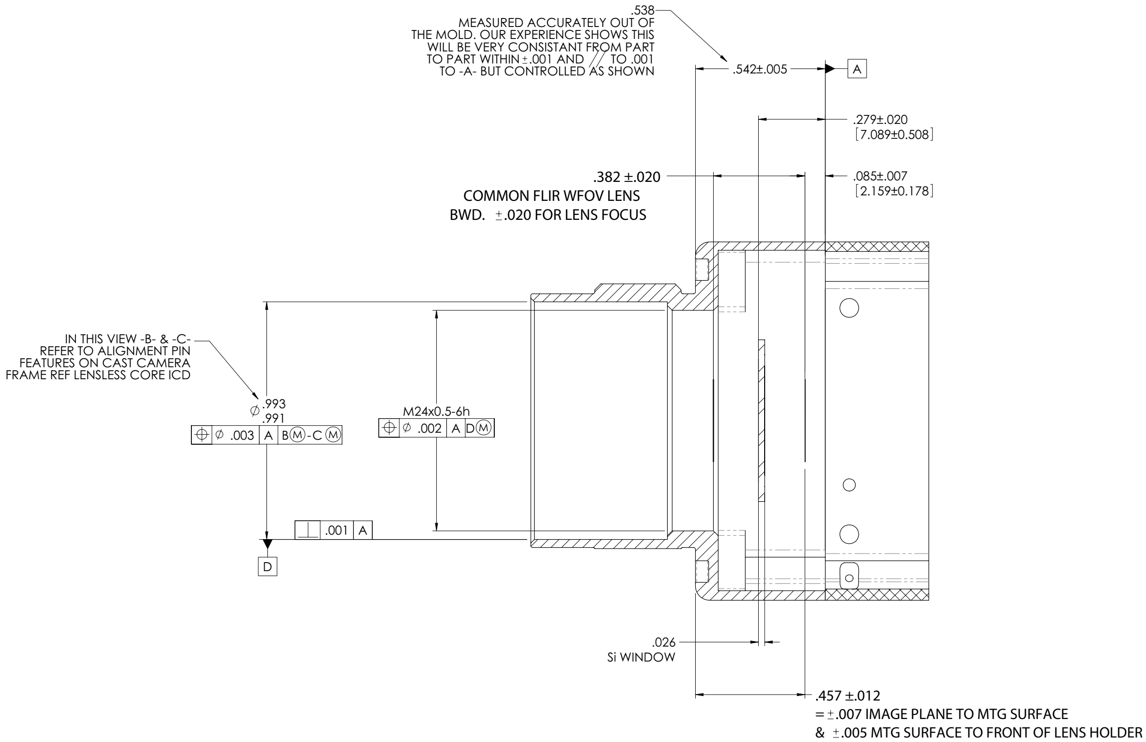
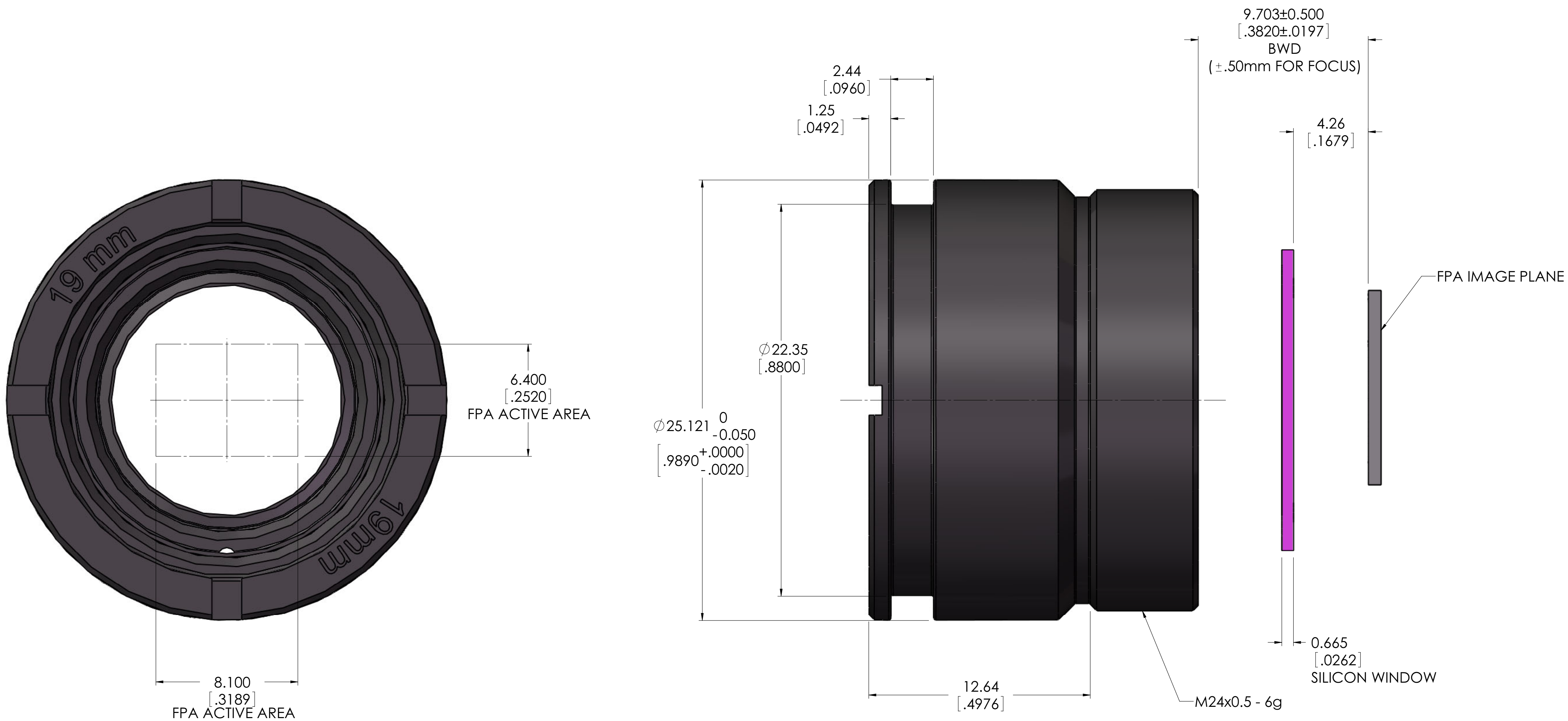



**Figure D-3: WFOV Lens Interface to Tau 640 Lensless Core**

The following Mechanical Description Documents detail the outline and mounting for the Tau 640 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 640 Thermal Imaging Camera Core Data Sheet available from the website contains important mechanical interface data as well.

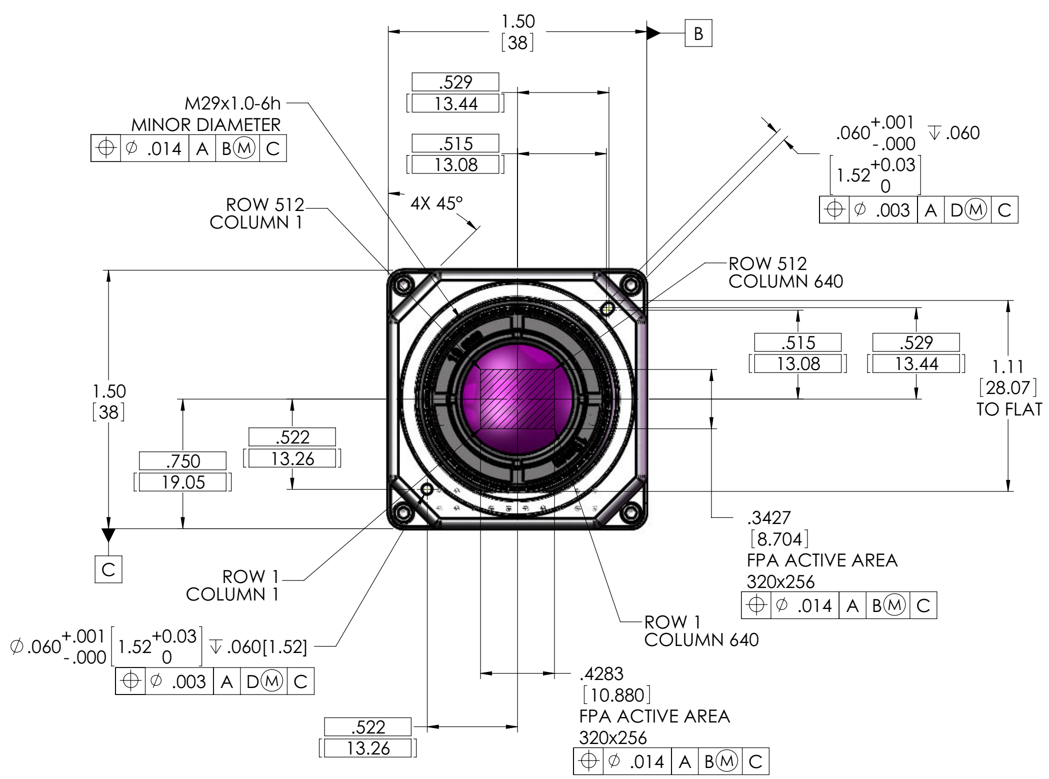
NOTES: UNLESS OTHERWISE SPECIFIED

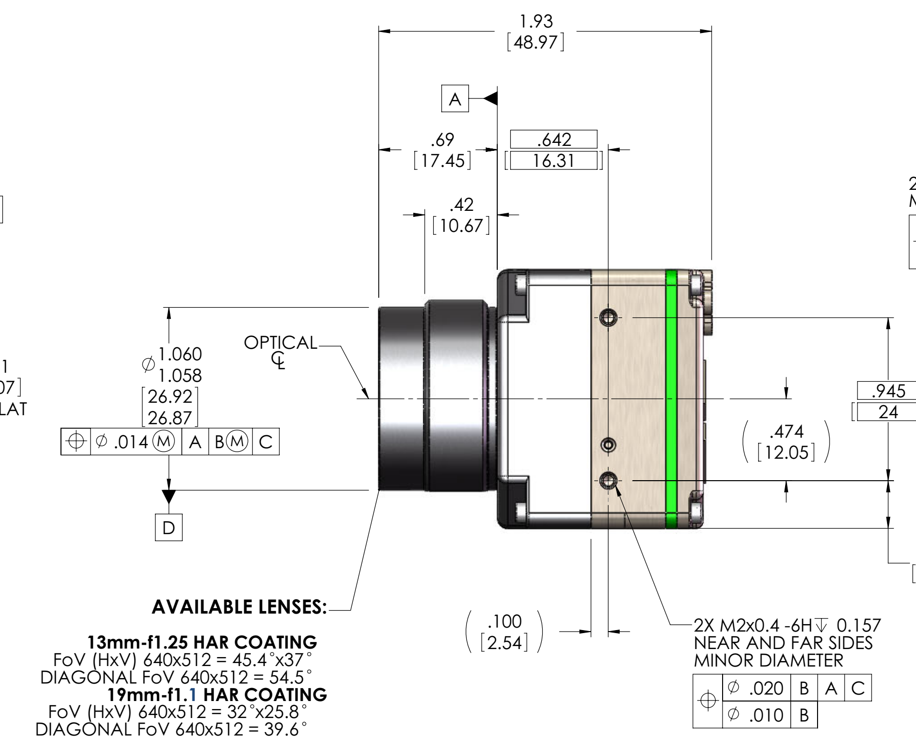


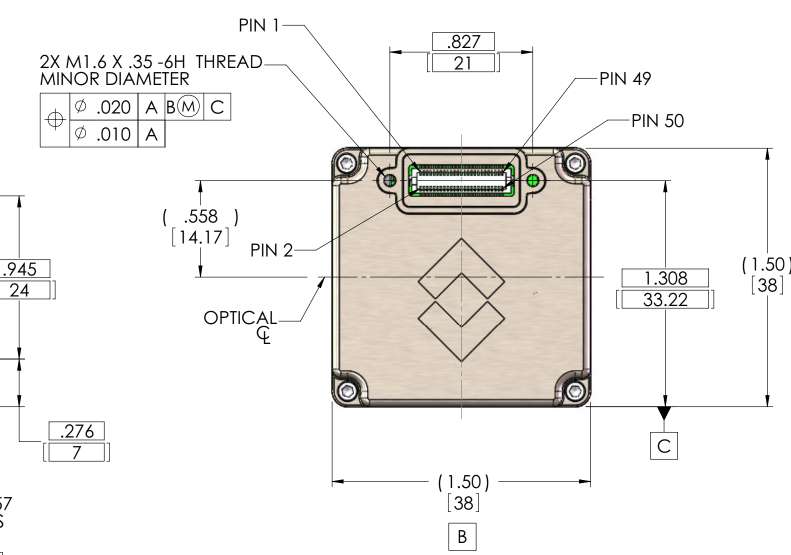

Tau 640 Camera Mechanical Interface Control Document WFOV Sheet 1

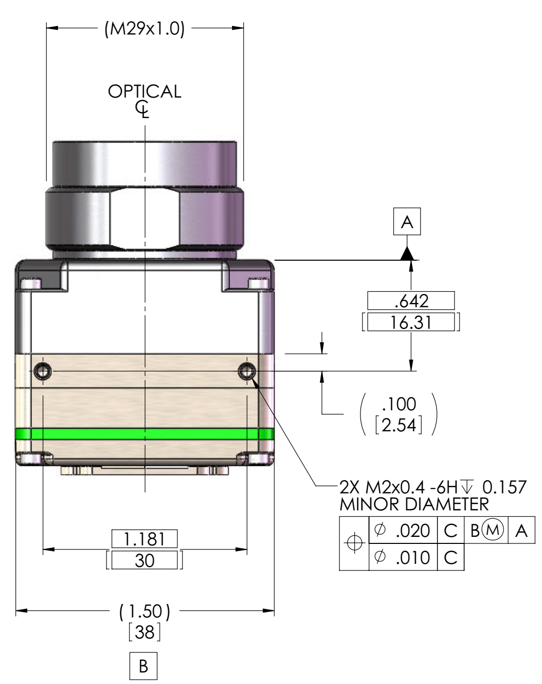
NOTES: UNLESS OTHERWISE SPECIFIED

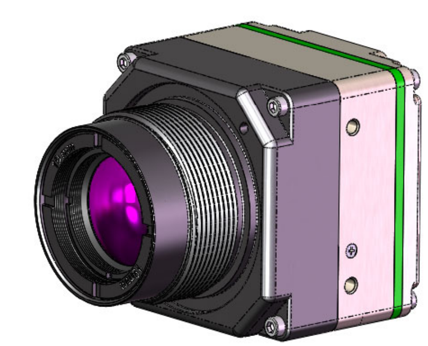
1. INDICATED DIMENSIONS ARE FOR AN ARRAY SIZE OF 640x512.
2. CONECTOR INTERFACE: HIROSE 50 PIN DF12-50DS-0.5V(86). MATING CONNECTOR P/N DF12(5.0)-50DS-0.5V(86). FOR PIN-OUT DESIGNATIONS SEE TAU CAMERA USERS MANUAL.



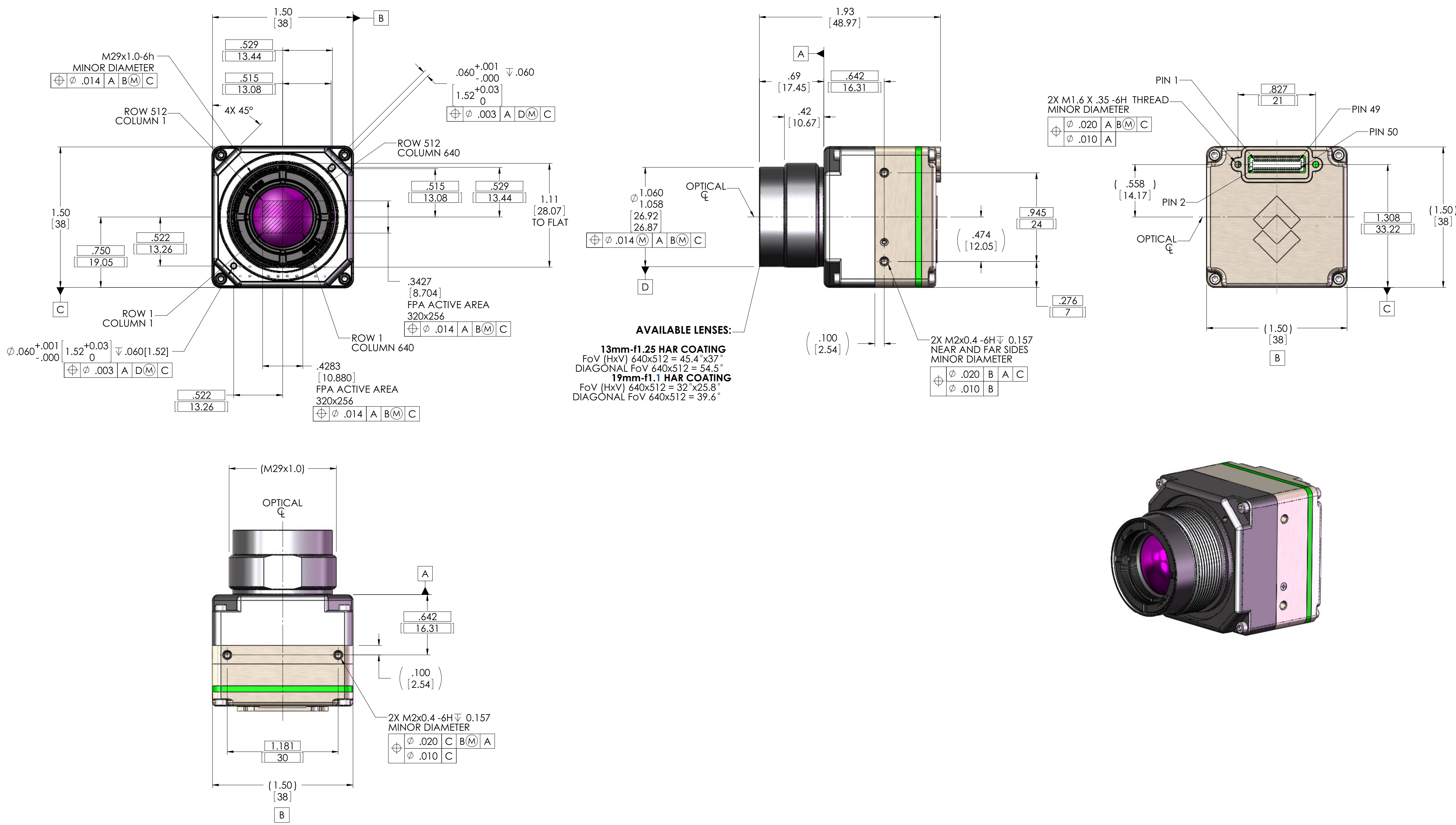



**Tau 640 Camera Core Interface Description Document 13mm, Sheet 1**

NOTES: UNLESS OTHERWISE SPECIFIED

1. INDICATED DIMENSIONS ARE FOR AN ARRAY SIZE OF 640x512.
2. CONECTOR INTERFACE: HIROSE 50 PIN DF12-50DS-0.5V(86). MATING CONNECTOR P/N DF12(5.0)-50DS-0.5V(86). FOR PIN-OUT DESIGNATIONS SEE TAU CAMERA USERS MANUAL.

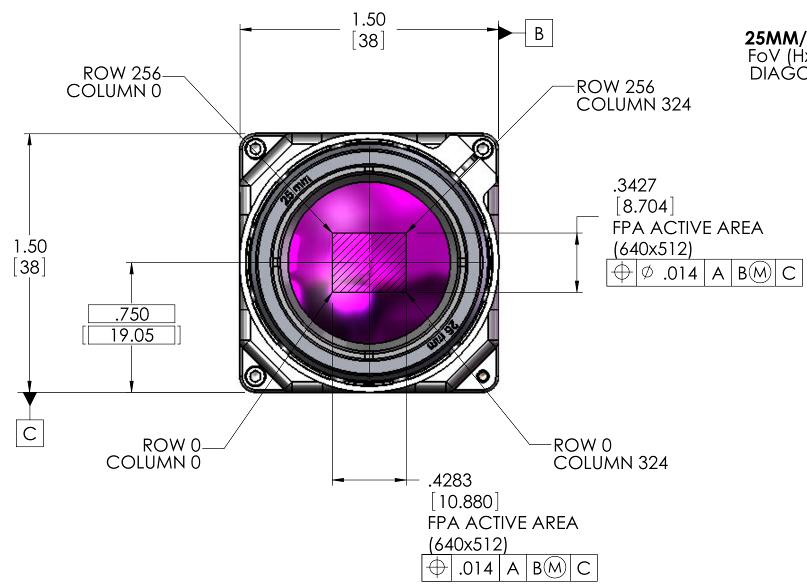


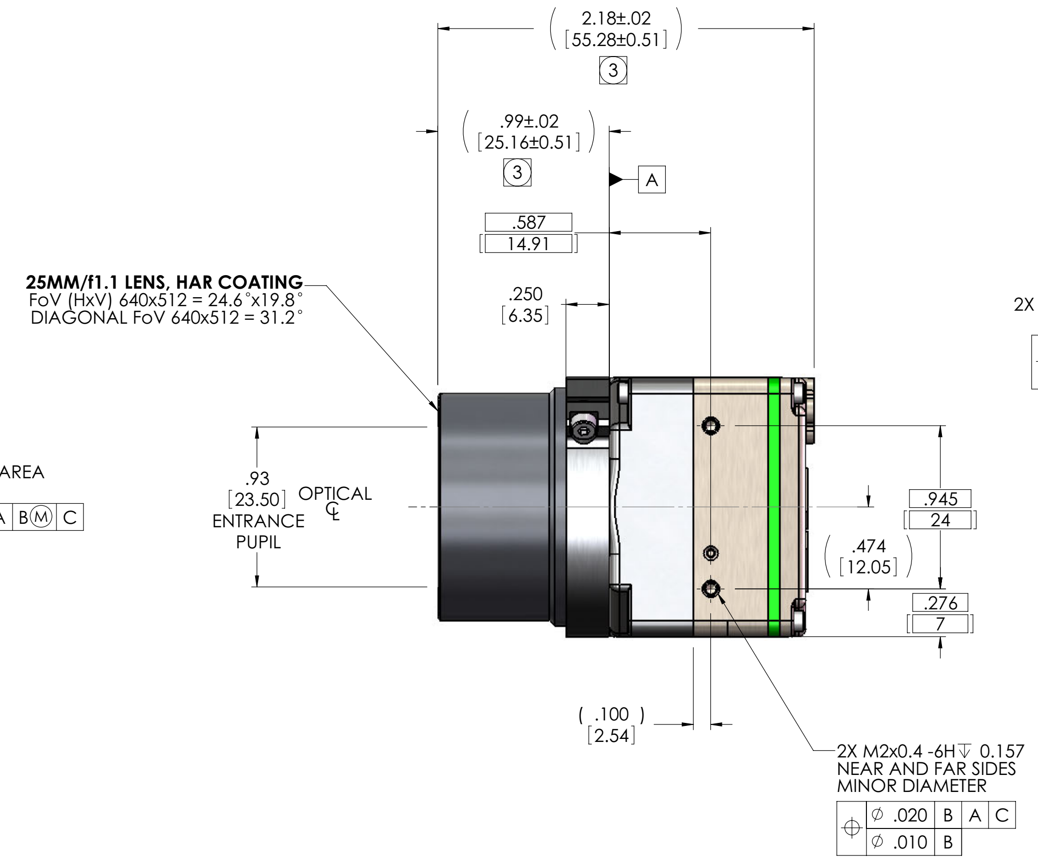

Tau 640 Camera Core Interface Description Document 19mm Sheet 1

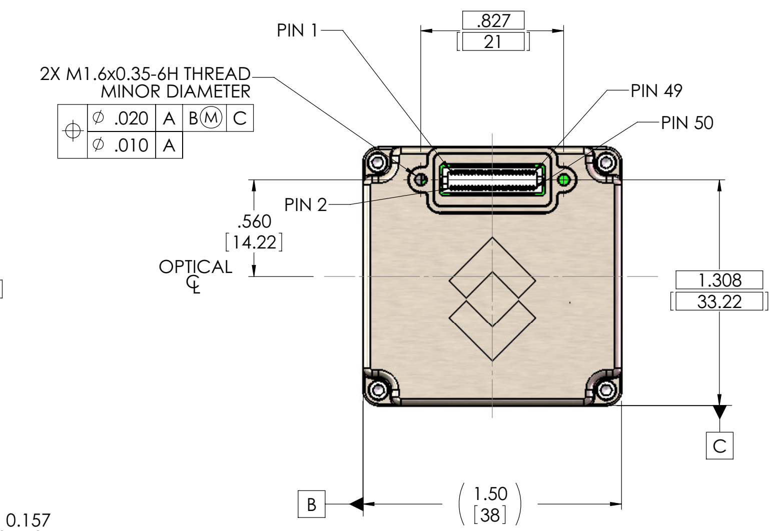
NOTES: UNLESS OTHERWISE SPECIFIED

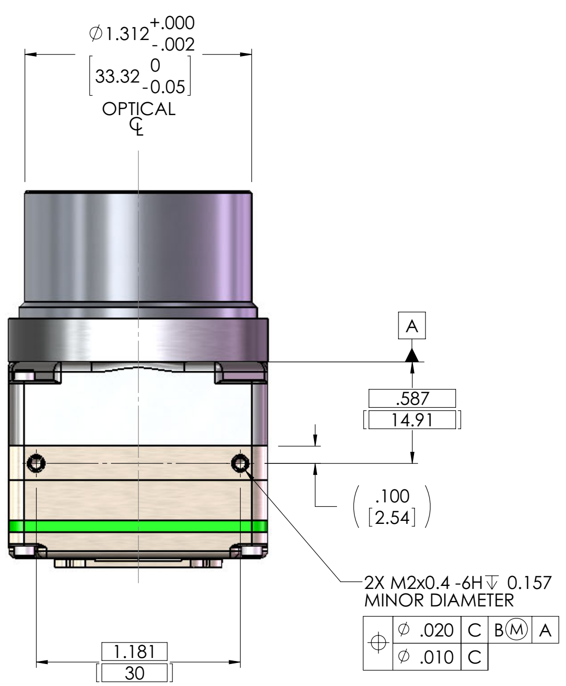
1. INDICATED DIMENSIONS ARE FOR AN ARRAY SIZE OF 640x512.
2. CONECTOR INTERFACE: HIROSE 50 PIN DF12-50DS-0.5V(86). MATING CONNECTOR P/N DF12(5.0)-50DS-0.5V(86). FOR PIN-OUT DESIGNATIONS SEE TAU CAMERA USERS MANUAL.

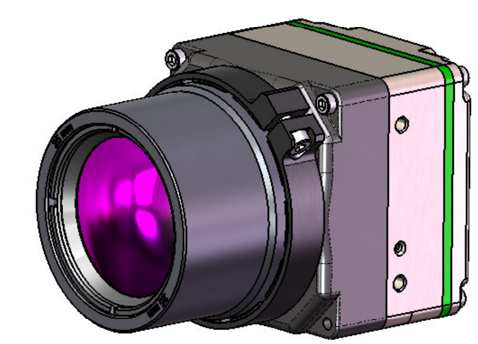
3 INDICATED ALLOWABLE TRAVEL FOR FOCUS



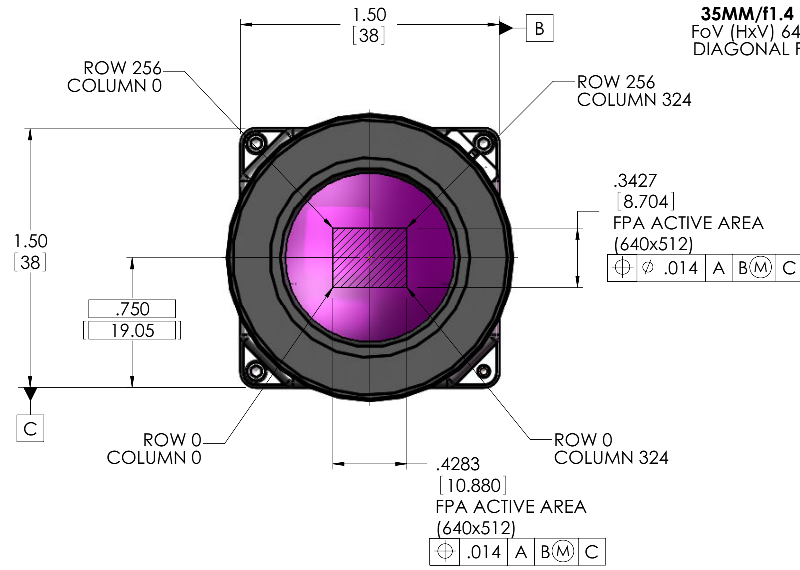



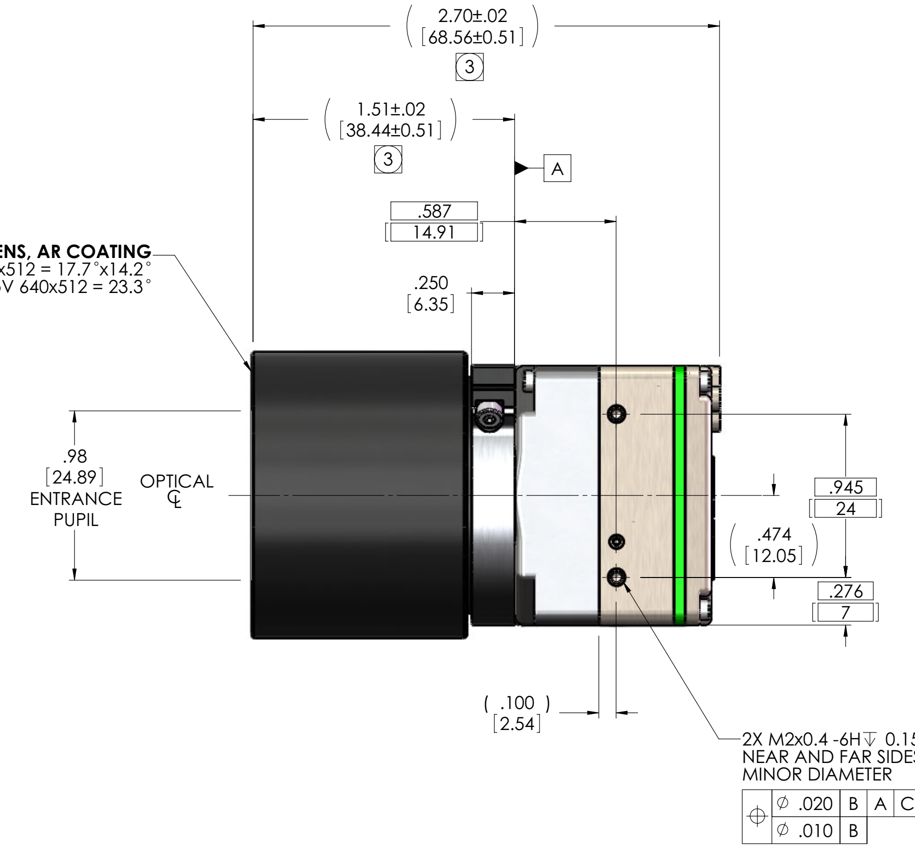
**Tau 640 Camera Core Interface Description Document 25mm   Sheet 1**

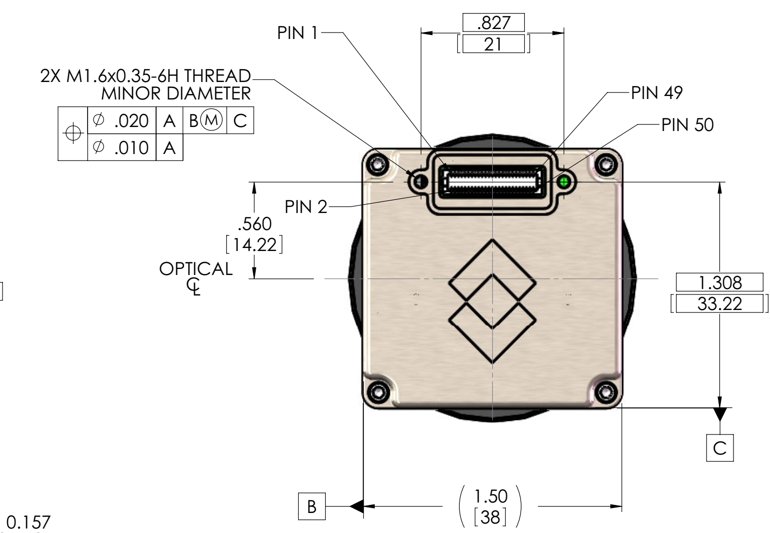
NOTES: UNLESS OTHERWISE SPECIFIED

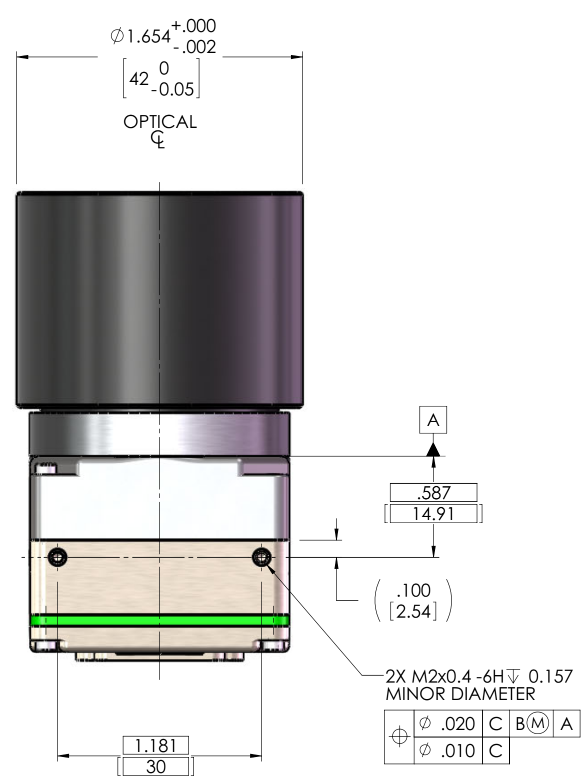
1. INDICATED DIMENSIONS ARE FOR AN ARRAY SIZE OF 640x512.
2. CONECTOR INTERFACE: HIROSE 50 PIN DF12-50DS-0.5V(86). MATING CONNECTOR P/N DF12(5.0)-50DS-0.5V(86). FOR PIN-OUT DESIGNATIONS SEE TAU CAMERA USERS MANUAL.

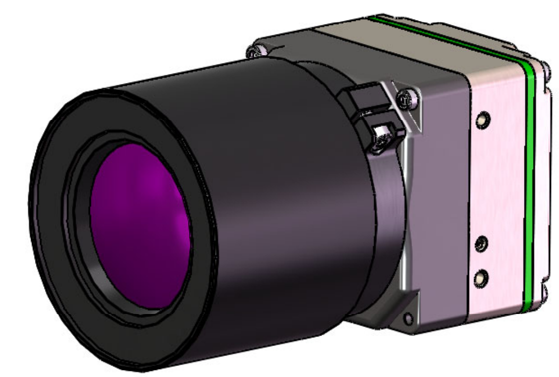
3 INDICATED ALLOWABLE TRAVEL FOR FOCUS



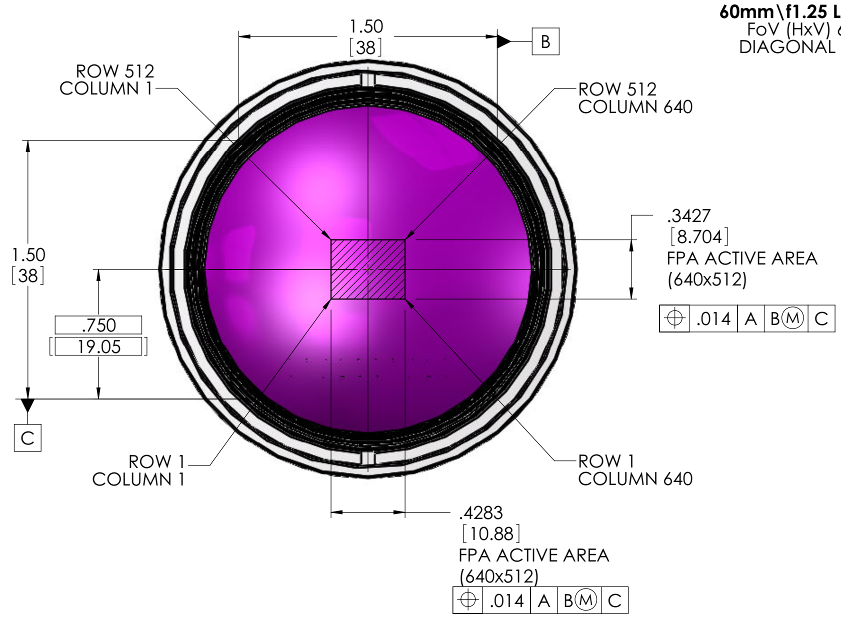



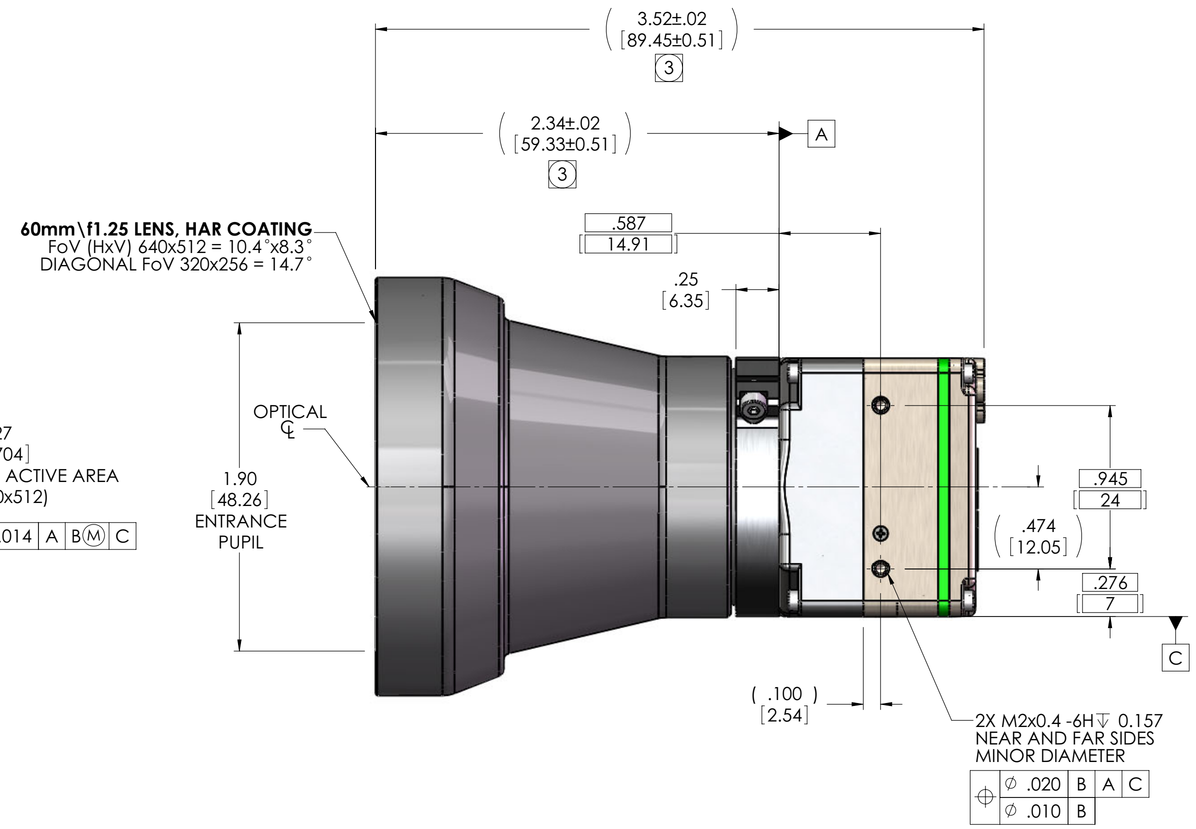
**Tau 640 Camera Core Interface Description Document 35mm Sheet 1**

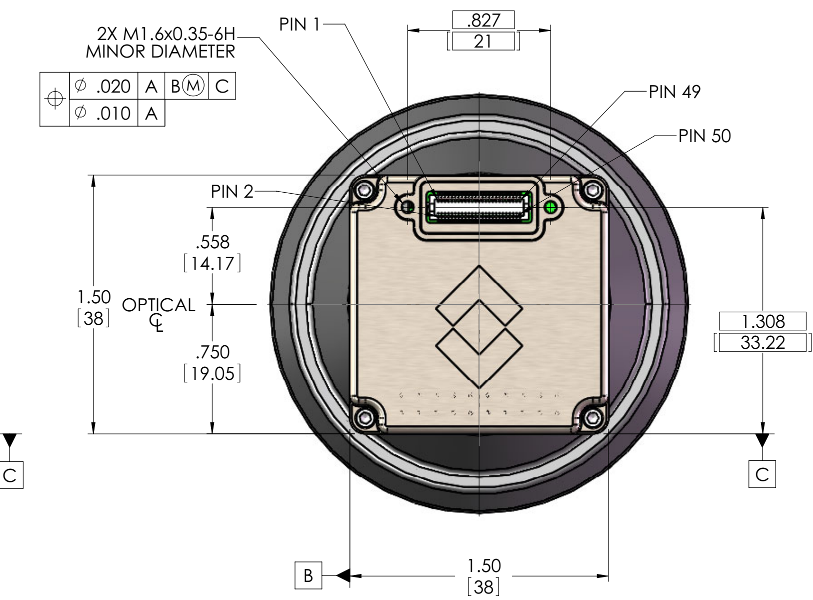
NOTES: UNLESS OTHERWISE SPECIFIED

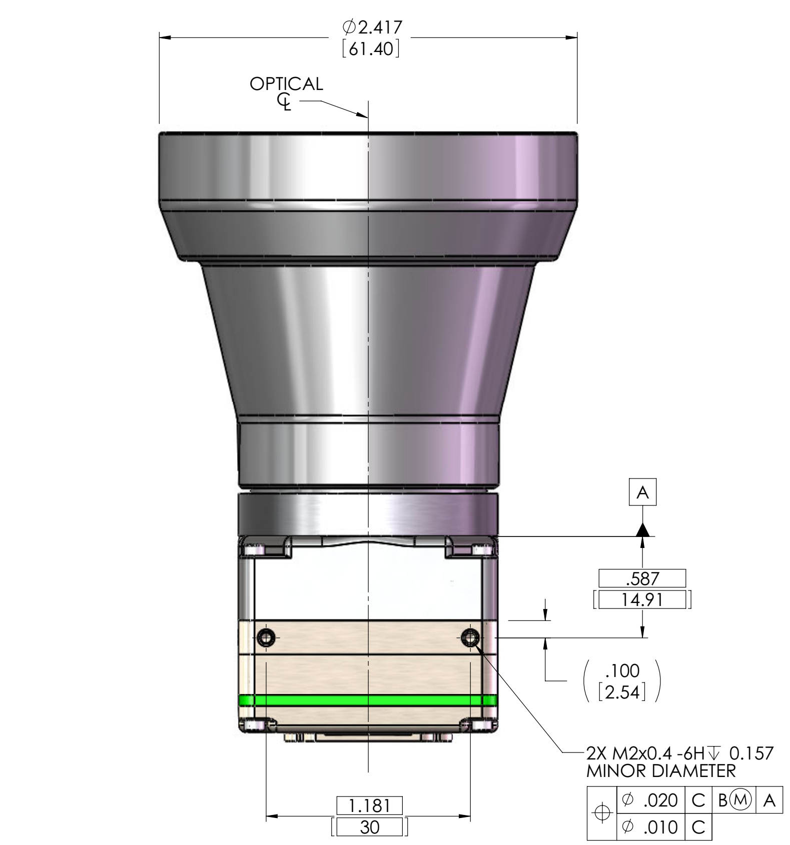
1. INDICATED DIMENSIONS ARE FOR AN ARRAY SIZE OF 640x512.
2. CONECTOR INTERFACE: HIROSE 50 PIN DF12-50DS-0.5V(86). MATING CONNECTOR P/N DF12(5.0)-50DS-0.5V(86). FOR PIN-OUT DESIGNATIONS SEE TAU CAMERA USERS MANUAL.

3 INDICATED ALLOWABLE TRAVEL FOR FOCUS



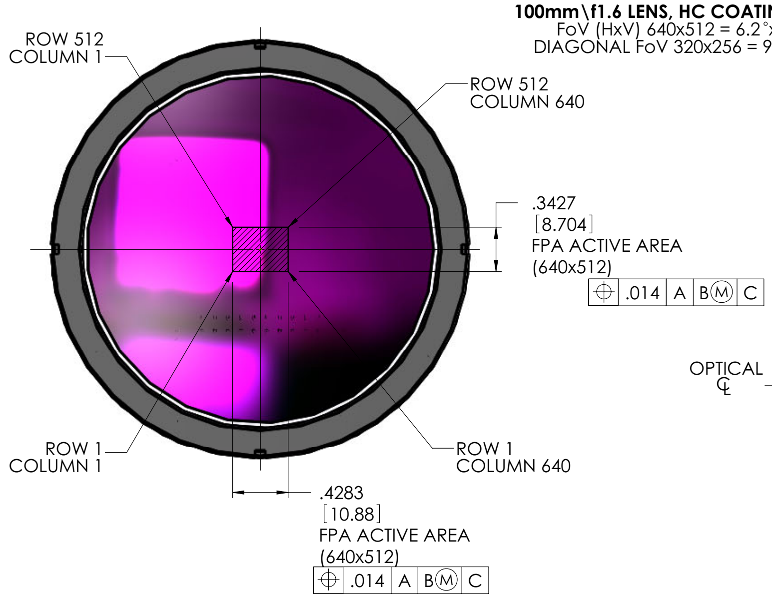



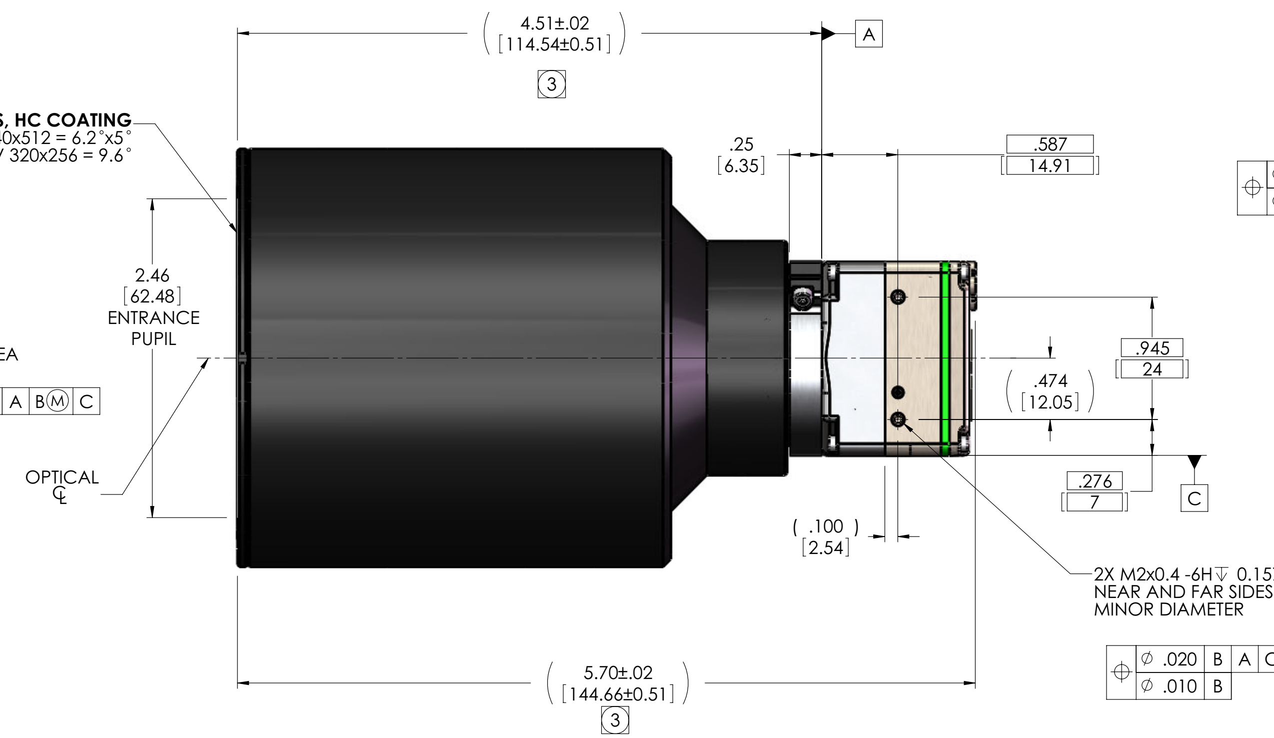

**Tau 640 Camera Core Interface Description Document 60mm Sheet 1**

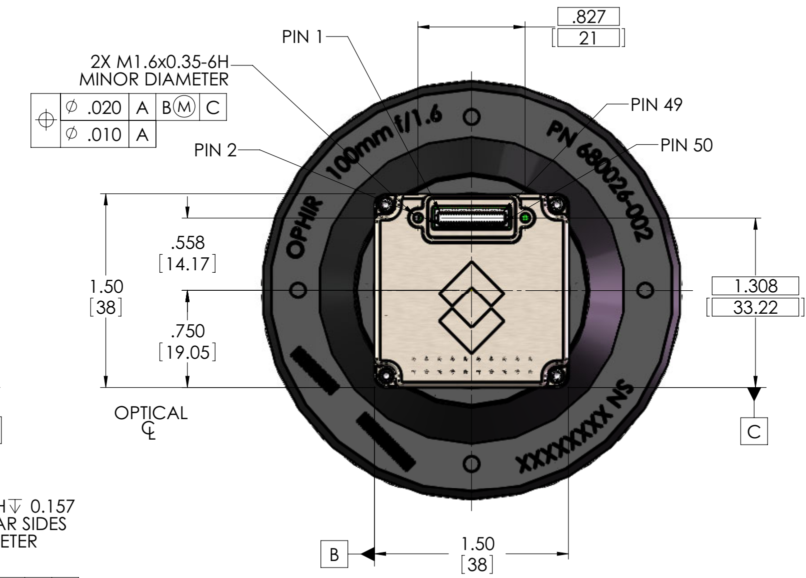
NOTES: UNLESS OTHERWISE SPECIFIED

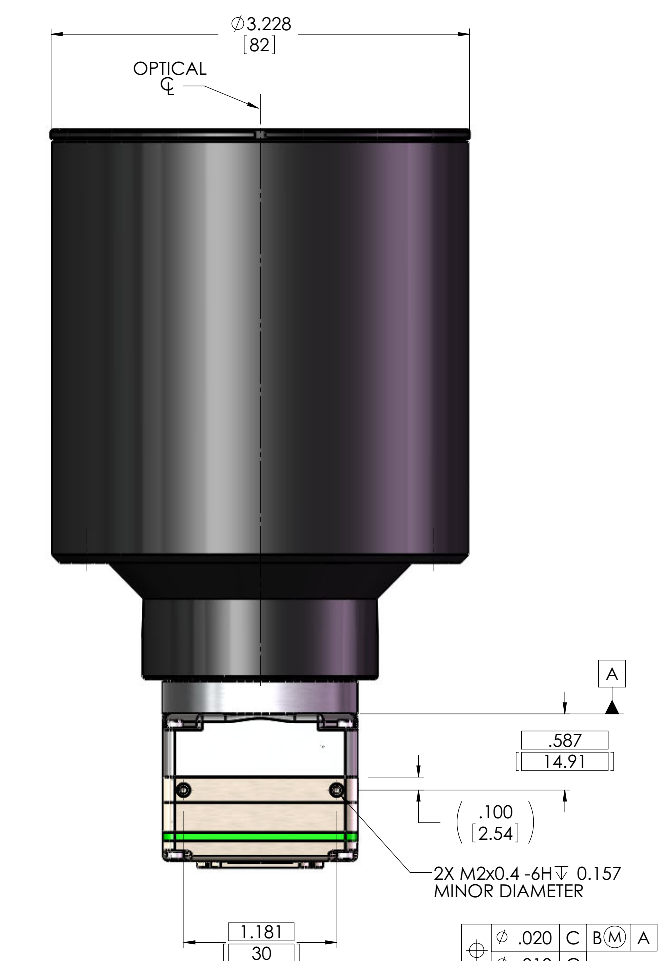
1. INDICATED DIMENSIONS ARE FOR AN ARRAY SIZE OF 640x512.
2. CONECTOR INTERFACE: HIROSE 50 PIN DF12-50DS-0.5V(86). MATING CONNECTOR P/N DF12(5.0)-50DS-0.5V(86). FOR PIN-OUT DESIGNATIONS SEE TAU CAMERA USERS MANUAL.

3 INDICATED ALLOWABLE TRAVEL FOR FOCUS




**Tau 640 Camera Core Interface Description Document 100mm Sheet 1**