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FLIR® PREMIUM PARTNER

A6000 and A8500 Series

User's Manual

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1 Revision History

Version	Date	Initials	Changes
A	07/27/2020	MGH	Initial Release

2 Introduction

2.1 Camera System Components

The Cooled A-Series infrared camera and its accessories are delivered in a box which typically contains the items below. There may also be additional items that you have ordered such as lenses, software, CDs, etc.

Description	FLIR Part Number
Cooled A-Series Infrared Camera	See table below
Power supply, 24V, 4A	4212680
AC line cord	24124-000
Gigabit Ethernet Cat-6 cable, 2m length	23700-000
Bayonet mount plug, 4-tab	4142249
BNC cable	26393-000
AUX connector breakout cable [A675x, A678x, A858x]	29402-500
Laboratory calibration plate	4223047
Water-resistant transit case	24043-003
CamTools Download Card	N/A

2.2 Camera Models

The A6000 and A8500 series are camera families. There are several different models, ensuring a wide variety of customer needs can be met.

Family	Model	Description	FLIR Part Number
A626x	A6261	• Variable using lens iris (lens fixed at f/4 with cal) • 0.9 – 1.7 µm	29437-261
	A6262	• Variable using lens iris • 0.6 – 1.7 µm	29437-262
A670x	A6700	• f/2.5 • 1.0 – 5.0 µm	29440-200
	A6701	• f/2.5 • 3.0 – 5.0 µm	29440-201
	A6702	• f/4.0 • 1.0 – 5.0 µm	29440-202
	A6703	• f/4.0 • 3.0 – 5.0 µm	29440-203
A675x	A6750	• f/2.5 • 1.0 – 5.0 µm	29440-250
	A6751	• f/2.5 • 3.0 – 5.0 µm	29440-251

Family	Model	Description	FLIR Part Number
	A6752	• f/4.0 • 1.0 – 5.0 µm	29440-252
	A6753	• f/4.0 • 3.0 – 5.0 µm	29440-253
A675x SLS	A6751 SLS	• f/2.5 • 7.5µm (lower), 10-11µm (upper)*	29439-251
	A6753 SLS	• f/4.0 • 7.5µm (lower), 10-11µm (upper)*	29439-253
A678x	A6780	• f/2.5 • 1.0 – 5.0 µm	29440-280
	A6781	• f/2.5 • 3.0 – 5.0 µm	29440-281
	A6782	• f/4.0 • 1.0 – 5.0 µm	29440-282
	A6783	• f/4.0 • 3.0 – 5.0 µm	29440-283
A678x SLS	A6781 SLS	• f/2.5 • 7.5µm (lower), 10-11µm (upper)*	29439-281
	A6783 SLS	• f/4.0 • 7.5µm (lower), 10-11µm (upper)*	29439-283
A858x	A8580	• f/2.5 • Broadband (InSb: 1.5-5µm response)	29443-200
	A8581	• f/2.5 • InSb: 3-5µm response	29443-201
	A8582	• f/4.1 • Broadband (InSb: 1.5-5µm response)	29443-202
	A8583	• f/4.1 • InSb: 3-5µm response	29443-203
A8581 SLS		• f/2.5 • SLS: 7.5-12µm response*	29444-201

NOTE: SLS upper cutoff tolerance is +/- 0.5µm

2.3 System Overview

The A6000 and A8500 infrared camera systems have been developed by FLIR to meet the needs of the commercial R&D user.

The A6000-series can have an InGaAs detector to cover the SWIR band, an InSb detector to cover the MWIR band, or a T2SLS detector to cover the LWIR band. All A6000-series camera utilizes a large format, 640 x 512 array with 15μm pixel pitch.

The A8500 series camera makes use of FLIR's advanced ISC1308 readout integrated circuit (ROIC), mated to an Indium Antimonide (InSb) detector to cover the midwave infrared band and a Type II Strained-Layer Superlattice (SLS) for longwave IR operation. The camera utilizes an HD format, 1280x1024 array with 12μm pixel pitch.

The A6000 and A8500 are stand-alone imaging cameras that interface to a host PC, Mac or Linux system running FLIR Research Studio software using Gigabit Ethernet. An SDK is available, which makes it possible for the system designer to write their own camera controller and acquire image data with their own custom application. This camera series is GenIcam compliant and can be controlled directly with third party GenIcam tools.

2.4 Key features of the A6000 and A8500 Series cameras

Fully GEV/GenICam compliant

> The image stream protocol is GigE Vision 2.0 compliant and the camera is controllable by GenICam.

Improved Linearity to Zero Well-Fill

> Typical direct injection ROIC designs exhibit a non-linear response when the signal drops below 10% of well-fill. FLIR ROICs provides a linear response even at very low signal levels. This results in an increased linear dynamic range, much better NUC performance at low signal levels and makes it easier to perform a user calibration of the camera.

14-Bit Digital Image Data

> The camera systems are built around high performance 14-bit A/D converters, preserving the full dynamic range of the FPA.

Windowing Capability

> Higher frame rates are available by windowing down at the Focal Plane Array (FPA) level.

Presets

> Up to four presets and their associated parameters such as integration time, frame rate, and window size are available for instant selection with a single command.

Superframing [A626x, A675x, A678x, and A858x only]

> Up to four presets can be cycled continuously. This can be used in conjunction with the Dynamic Range Extension (DRX) algorithm to provide a single movie with increased dynamic range.

Independently Adjustable Frame Rates

> Frame rate is user selectable from 0.0015Hz up to the maximum allowed for the selected integration time and window size.

External Sync

> The cameras provide a SYNC input that can be used to control the camera frame rate using an external LVCMOS or TTL input (can handle 5.5V Max).

External Trigger [A626x, A675x, A678x, and A858x only]

> An external trigger input can be used to signal ResearchIR or FLIR Research Studio to start recording or to precisely start the image stream relative to an external event.

Multiple Video Outputs

> The A-Series Cameras feature multiple independent and simultaneous video:
> - Digital – Gigabit Ethernet
> - Digital – CoaXpress (Single CXP-3 link) (A858x only)
> - Digital – HD-SDI

Standard Video Color Palettes

> The cameras support a selection of standard and user-defined color palettes for the standard video output.

Digital Detail Enhancement (DDE)

DDE is an analog video AGC mode that provides a significant improvement to scene detail and contrast.

On-Camera NUCs with Auto Update

NUCs can be stored in camera memory and can be applied independently to the digital and analog video outputs. The camera can be configured to automatically update the NUC using the internal flag based on a change of an internal temperature sensor and/or a timer.

Standard Lens Interface

The A626x-series camera uses a C-mount lens interface. The A678x and A858x camera series use the FLIR FPO-M (4-tab bayonet, motorized). The A670x and A675x cameras use the FLIR FPO 4-tab bayonet.

3 Warnings and Cautions

For best results and user safety, the following warnings and precautions should be followed when handling and operating the camera.

⚠️Warnings and Cautions:

➢ **Do not open the camera body for any reason. Disassembly of the camera (including removal of the cover) can cause permanent damage and will void the warranty.**

➢ **Great care should be exercised with your camera optics. Refer to Chapter 8 for lens cleaning.**

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

➢ **The camera is not completely sealed. Avoid exposure to dust and moisture and replace the lens cap when not in use.**

➢ **Do not image extremely high intensity radiation sources, such as the sun, lasers, arc welders, etc.**

➢ **The camera is a precision optical instrument and should not be exposed to excessive shock and/or vibration. Refer to Chapter 7 for detailed environmental requirements.**

➢ **The camera contains static-sensitive electronics and should be handled appropriately.**

4 Installation

4.1 Basic Connections

All connections to the A858x are located on the Back Panel.

Item	Name	Description
1	Power Switch	LED will light when power is ON
2	Ready Light	LED will turn on when camera is booted
3	Cold LED	LED will light when FPA temp is <80K
4	Gigabit Ethernet (RJ45)	GigE Vision connection for digital IR image data
5	AUX Connector	See Section 6.5.4 for details
6	DC Power Input	24VDC
7	CoaXpress output	Single Link, CXP-3
8	Video Out	HD-SDI (480i, 576i, 720p at 50/59.9Hz, 1080p at 25/29.9Hz according to SMPTE 296M)

All connections to the A6000-series are located on the Back Panel.
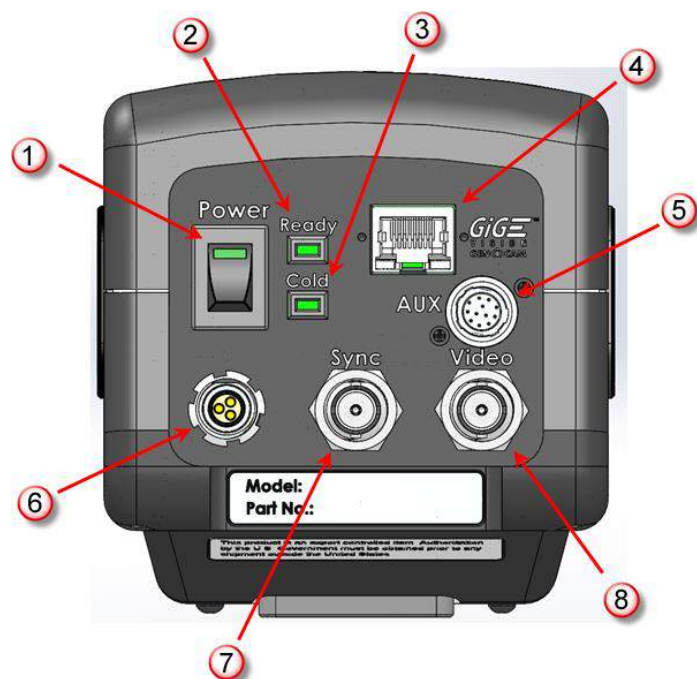
A67xx   **A6705**

Item	Name	Description
1	Power Switch	LED will light when power is ON
2	Ready Light	LED will turn on when camera is booted
3	Cold LED	LED will light when FPA temp is <80K (<30.5C for A6260)
4	Gigabit Ethernet (RJ45)	GigE Vision connection for digital IR image data
5	AUX Connector	A626x/A675x/A678x only. (See Section 6.5.4 for details)
6	DC Power Input	24VDC
7	Sync Input	External Frame Sync
8	Video Out	HD-SDI (480i, 576i, 720p at 50/59.9Hz, 1080p at 25/29.9Hz according to SMPTE 296M). [N/A to A6705]

4.1.1 Power

Plug in the AC power supply to a standard outlet. Connect the DC power cable between the power supply and the power connector located on the rear panel of the camera.   Turn on the camera by pressing the power button on the rear panel. The green power LED will illuminate to indicate that the unit is ON. The camera will automatically boot up into the last saved state. The boot process takes about 60 seconds.

4.1.2 Video (HD-SDI) [All except A6705]

To see the HD-SDI video on a monitor, connect the provided BNC cable from the VIDEO port to your monitor (converter required for HDMI). If you are powering up the camera for the first time, the camera should produce the max resolution image of the particle model with a Non-Uniformity Correction (NUC) and bad pixel replacement enabled.

4.1.3 GigE Digital Video

If you have a PC data system running Research Studio, ResearchIR (or your own custom application based on the SDK or GenICam) you can view the 14-bit digital video over Gigabit Ethernet.

The cameras have a Gigabit Ethernet interface that is GigE Vision (GEV) and GenICam compliant. Use a regular CAT5e or CAT6 Ethernet patch cable. If a crossover cable is used, the camera interface will automatically detect and configure itself to work with this kind of cable.

Depending on the NIC hardware in the PC, the attainable frame rates will be between 40-60 Hz for the A858x and 125Hz for the A6000 Series (A670x – 60 Hz) at full resolution.

5 Camera Controller

The camera controller in FLIR Research Studio software has a top ribbon composed of a "hamburger button" and five control group tabs:
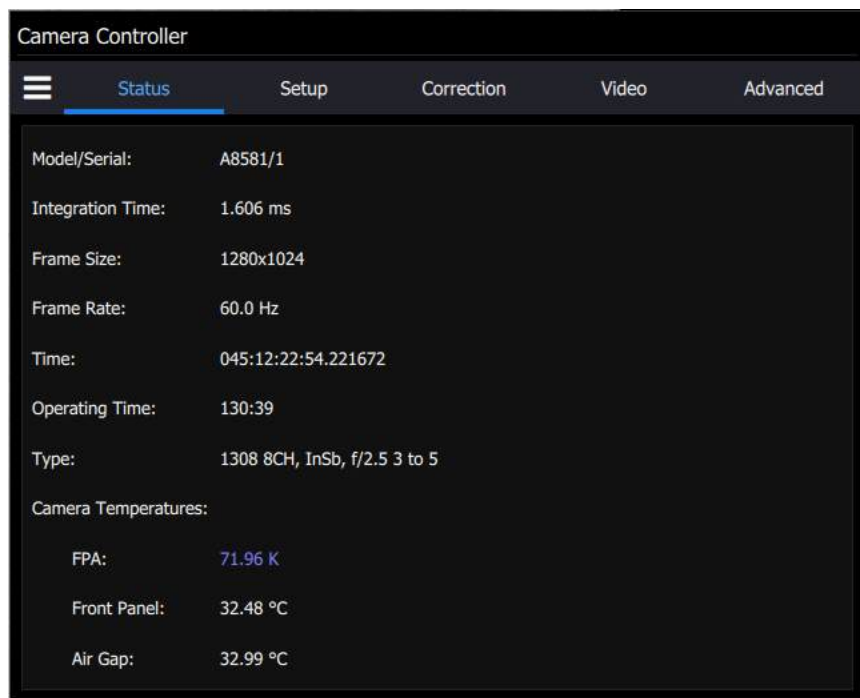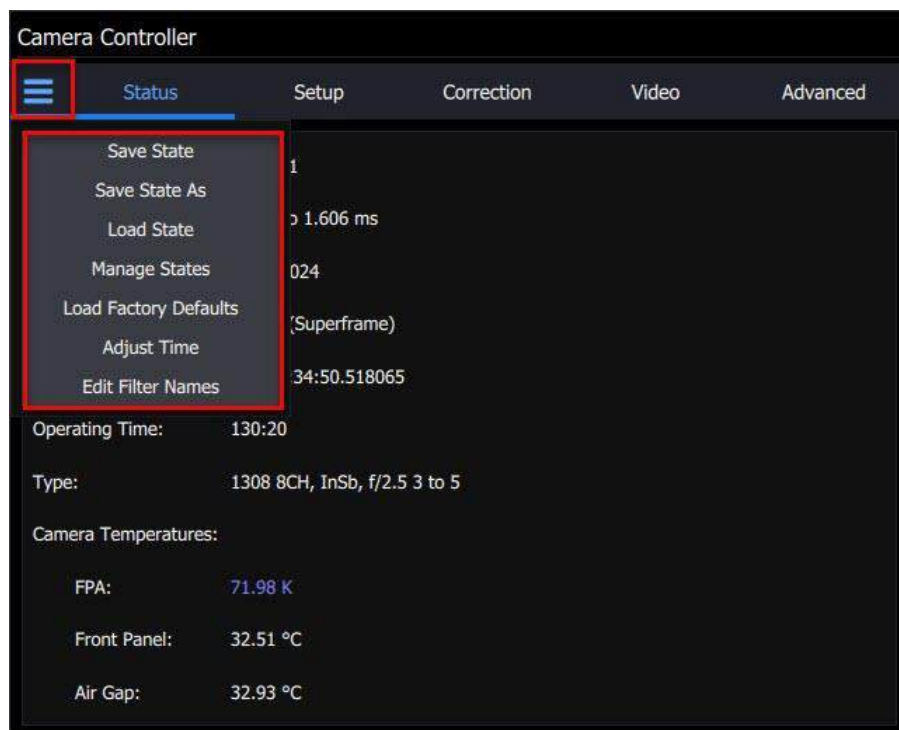

When the camera is in Superframing (Not available in A670x cameras) mode, the total **range** of integration times are shown:
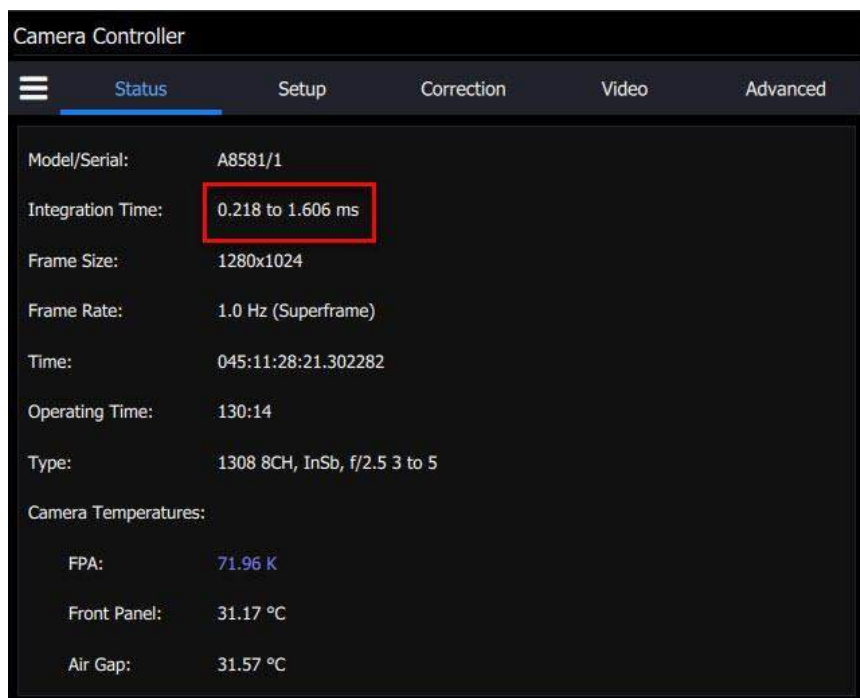
5.1 "Hamburger Button" Menu

The hamburger button is in the upper left corner of the Camera Controller window. It brings up a list of seven control options.


	Save State (Name)	Saves the camera state. This state will be reloaded at power up. Stored in flash memory.
	Save State As	Saves the current camera state to a name chosen by the user. State names other than (name) may be loaded manually. Stored in flash memory
	Load State	Load a state from flash memory.
	Manage States	Rename or delete states from camera memory.
	Load Factory Defaults	Loads factory defaults for all camera Settings and NUCs. The factory defaults cannot be modified by the user.
	Adjust Time	Allows the user to set the time in the camera
	Edit Filter Names	Edits the names of the filters in the filter wheel (A678x and A858x only).

NOTE: Camera states contain information about all configurable camera parameters. They do not contain the NUC data, but they do contain the filenames of the currently loaded NUCs. These NUCs will be reloaded with the state, however, if the NUCs are changed, deleted, or renamed, the state may not be able to load the NUCs.

> **NOTE:** The Cooled A-Series Cameras have two internal clocks: A Real Time Clock (RTC) and a timestamp clock. The RTC is a low-resolution clock used to keep system time. The RTC has a battery backup and will retain time while the camera is off. The timestamp clock is a high-resolution clock (1us). This clock does not have a battery backup but at power up the timestamp clock is initialized to the current RTC time and will free-wheel until the camera is power cycled.

5.1.1 Adjust Time Controls

This dialog is accessed using the Adjust Time menu option under the "hamburger button". This allows the user to directly set the camera system's time. The Sync camera time to PC time button will pull a time value from the PC clock and set the RTC clock. The Get button displays the current time that the camera has in its RTC clock. The Set button will set the camera's RTC clock using the manually-entered time.
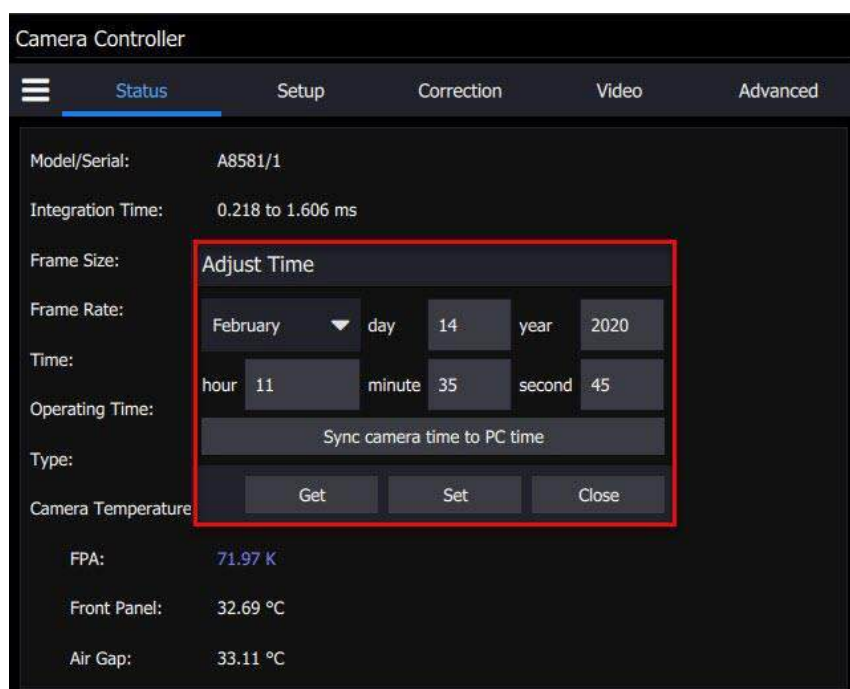
5.2 Edit Filter Names (A678x and A858x only)

This dialog is accessed using the Edit Filter Names menu option under the "hamburger button". This allows the user to manually edit the names of the filters associated with each Filter ID. The user can click "Reset to Default" to reset the Filter Name to the manufacturer default value.

| ID	Name	Actions
	Edit Filter Names	
0	0. Reserved	Reset to Default
1	1. ND 1.0	Reset to Default
2	2. ND 2.0	Reset to Default
3	3. ND 3.0	Reset to Default
4	4. ND 0.3	Reset to Default
5	5. ND 0.6	Reset to Default
6	6. ND 1.45	Reset to Default
7	7. MWIR 3000-5000nm	Reset to Default
8	8. ATM 3400-4170nm	Reset to Default
9	9. SRX 3500-5000nm	Reset to Default
10	10. THRU GLASS 2360nm, 80nm	Reset to Default
11	11. GLASS SURFACE 5000nm, 145nm	Reset to Default
		Save Cancel

5.3 Status Page

The Status Page gives general information about the camera state including camera model and serial number, integration time, frame size, frame rate, camera time, FPA type, and internal temperatures. The FPA temperature turns blue when the camera has reached its setpoint temperature, which is nominally 77 K. The Time is in Julian Day format, with the number of days since the beginning of the year, followed by the hour, minute, second and decimal second to 6 places. The Operating Time display is in HH:MM elapsed since the camera was manufactured, or the timer was reset at the factory.

The Type entry is the configuration of the integrated detector cooler assembly. In the example below, the sensor readout IC type is the 1308 which is used in the A858X camera family. "8CH" means 8 digitizer channels. "InSb" is indium antimonide, the detector type. "f/2.5" is the f/number of the coldshield. "3 to 5" is the wavelength range of the cold filter. "Front Panel" and "Air Gap" are the temperatures of temperature sensors in the camera's lens interface. These sensors are used for Tdrift correction, a type of radiometric compensation for changes in the optics temperature that will affect radiometric measurements. The factory calibrations are done in an air-conditioned laboratory with a nominal temperature of 23 °C. If the camera is subsequently operated in a hot ambient environment, the total radiance reaching the sensor will be higher than it would be if the camera was still at 23 °C. This produces a radiance offset which leads to a temperature measurement error. The Tdrift compensation uses the measurements of the two temperature sensors to correct for the radiance offset in the digital image data.
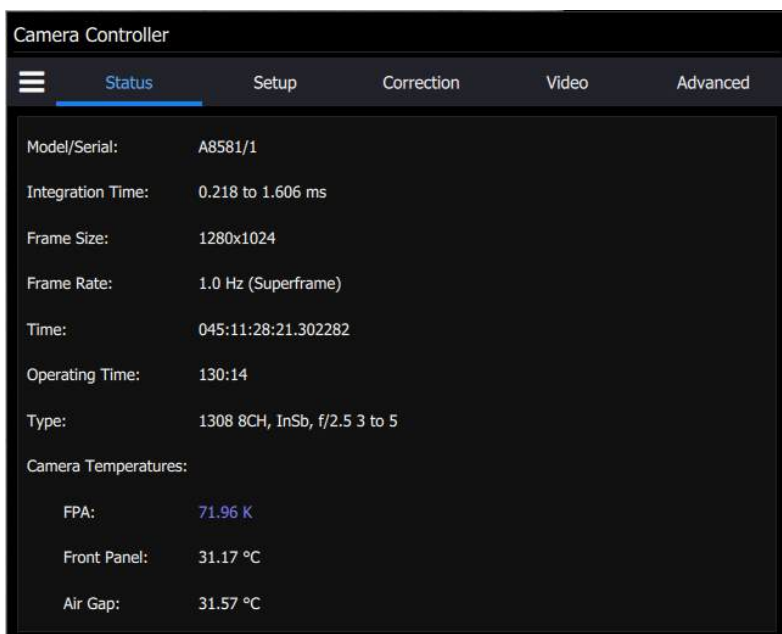
5.4 Setup

The Setup page allows the user to set up the camera for the desired operation. There are five sub-menus, including General Setup, Sync Settings, Video Output Settings, Filter Wheel Settings (A858x and A678x only) and Flag settings.
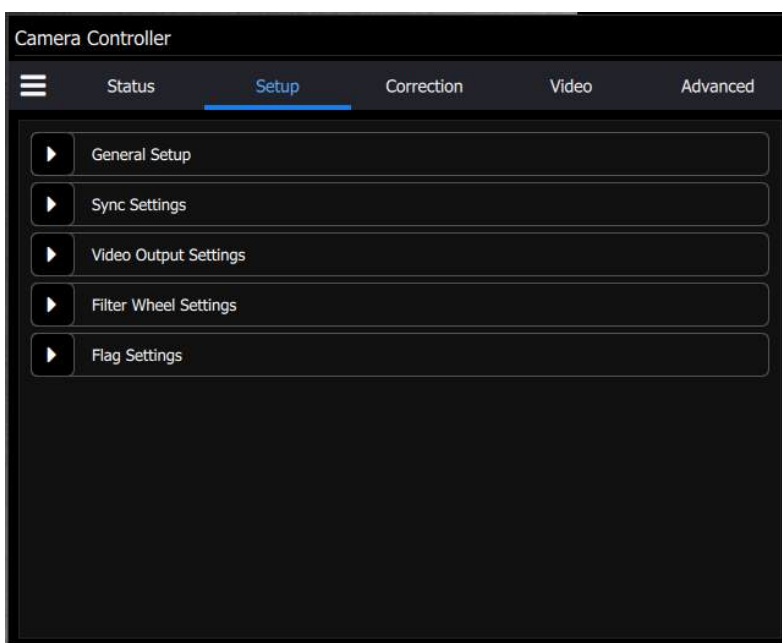

5.4.1 General Setup

The settings under the General Setup menu include loading factory calibrations, changing integration time, selecting superframing (Not available in A670x), frame rate, FPA gain, and motorized lens control (A678x and A858x only).

5.4.1.1 Sequencing Mode (Limited functionality in A670x)

The camera is typically operated in Single Preset mode. This means that a single preset group of camera settings is used for every frame of image data. The other option is Superframing. Superframing is not available in the A670x cameras. This setting enables the camera to cycle through a set of presets to extend the dynamic range of the camera when measuring temperature or radiance. The active preset has its preset number box colored in blue. In the example below, Preset 0 is the active preset.
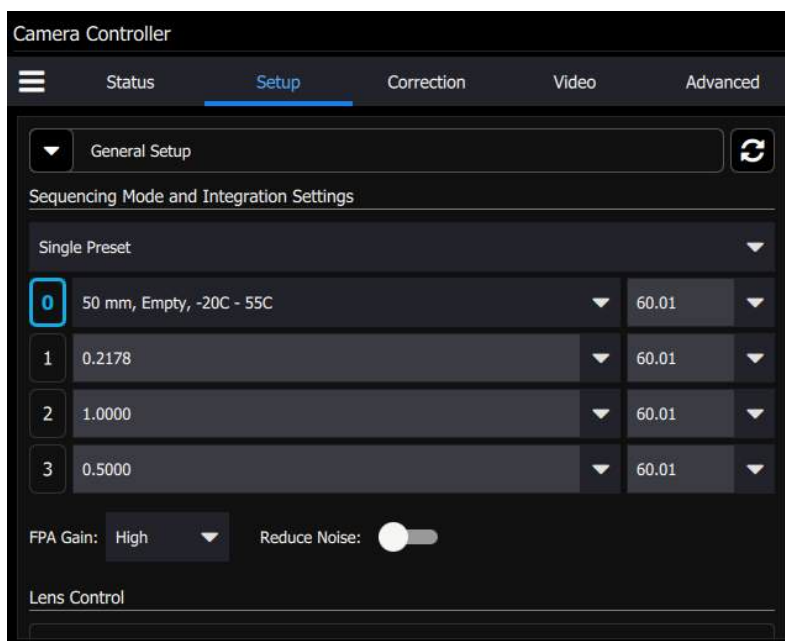
Superframing is selected by pulling down the Single Preset menu to Superframing:
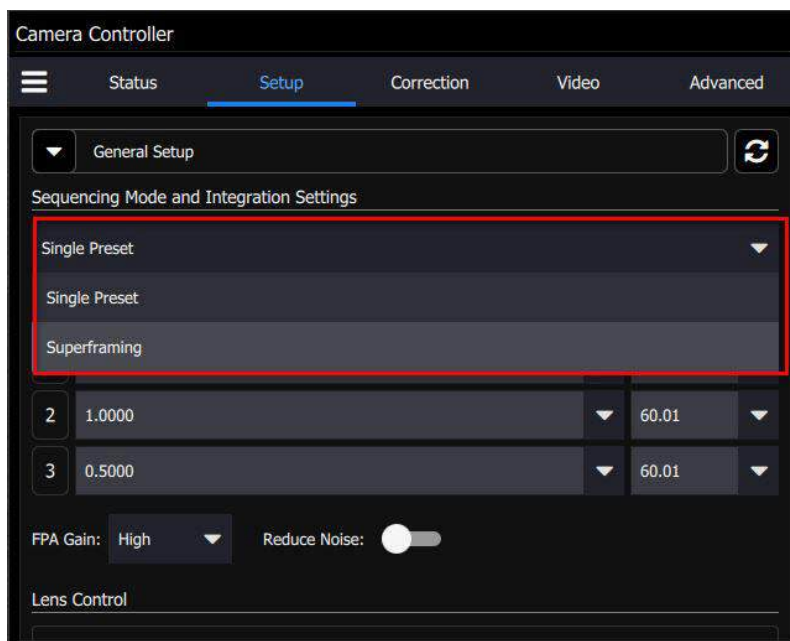
Presets are selected to be included in superframing by clicking on the preset numbers to make them change to a blue circled state. The figure below shows the camera set up with all four presets active. The Video Preset is the preset used to stream HD-SDI video out of the camera.
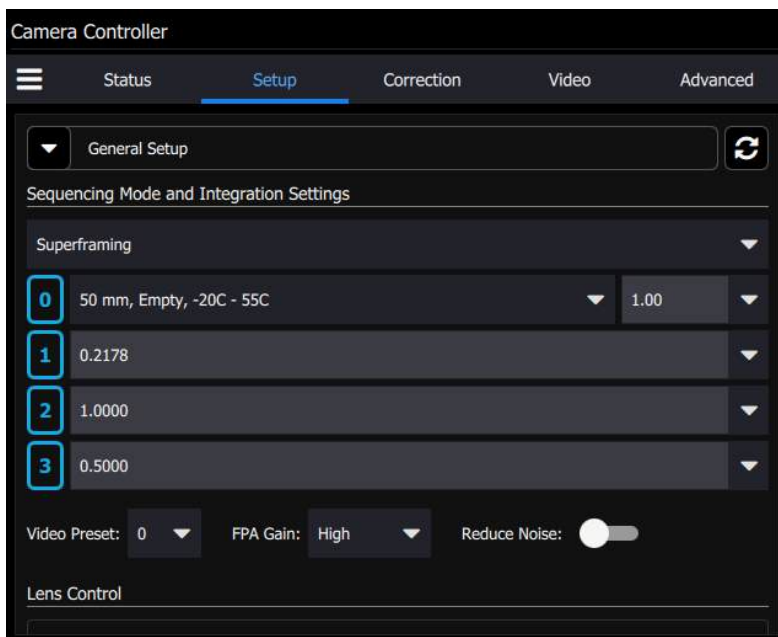
5.4.1.2 Loading Factory Calibrations:

Each preset has a pulldown menu that shows the factory calibrations that are present in the camera. If the camera does not have any factory calibrations, then the only option will be No Factory Calibration. In this example, the factory calibration that is loaded is called "50mm, Empty, -20-55C". The notation indicates that the calibration applies to a 50mm lens calibration with no filter in the filter wheel and a temperature measurement range of -20 to 55C. The other options are shown in the pulldown menu. **Loading a factory calibration into a preset will automatically load the associated NUC.**
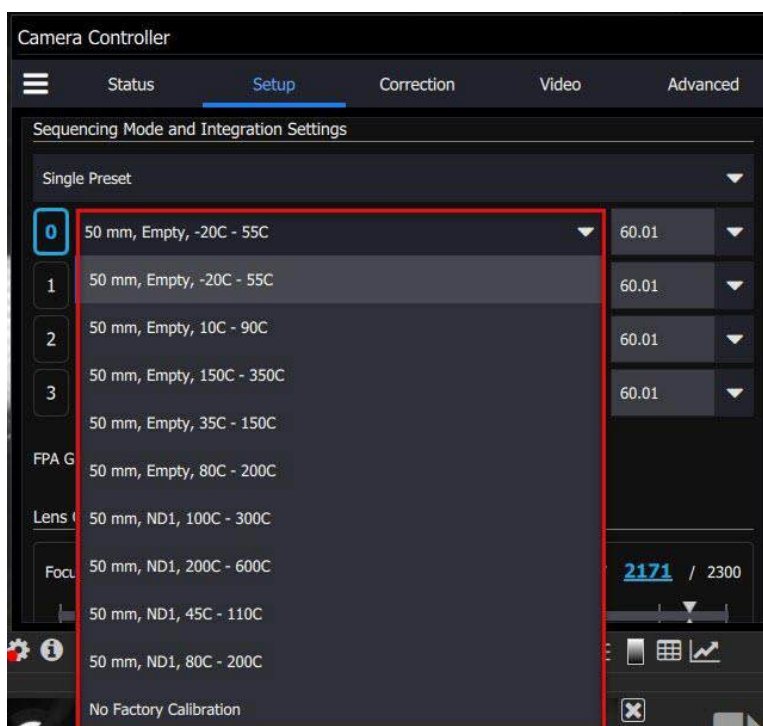
5.4.1.3 Changing Integration Time

If No Factory Calibration is selected, the preset will display the integration time setting, which in this example is set to 1.6064 milliseconds. **The units of integration time are always milliseconds**:
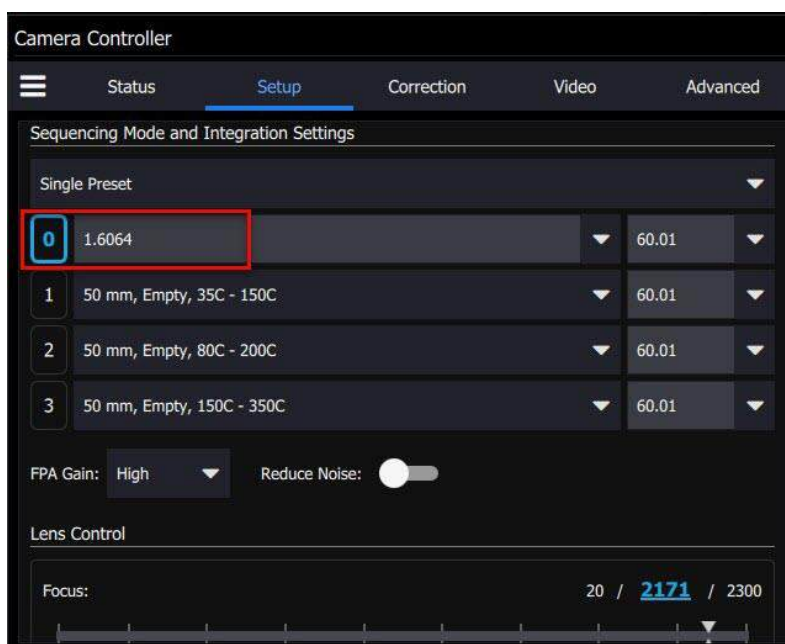
The user can now change the integration time. Note that this may degrade the image quality if the NUC that is loaded was done for a different integration time setting.

5.4.1.4 Changing Frame Rate

The pulldown menu to the right of the Factory Calibration pulldown enables the user to select from a set of frame rates. The user can also type in a custom frame rate.
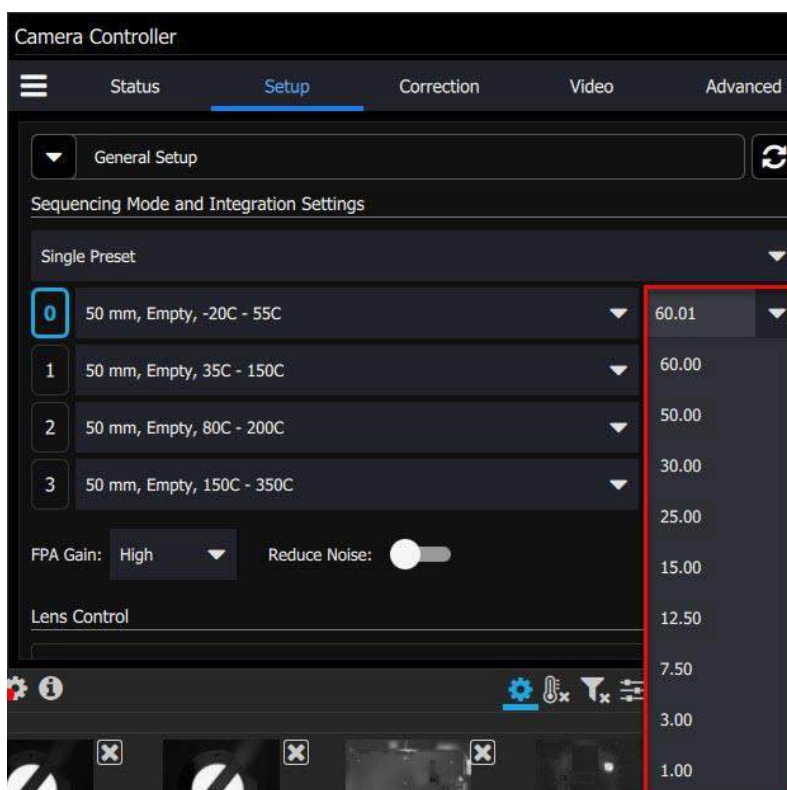

5.4.1.5 Changing FPA Gain

Some cameras have the option to change the FPA gain. This is preconfigured at the factory. For most applications we recommend not changing this setting without consultation with FLIR applications engineering.

5.4.1.6 Reduce Noise

There is a Reduce Noise switch which improves image quality, but it will sometimes affect the frame rate.

5.4.1.7 High Sensitivity Mode (HSM)

HSM is available in some cameras and is a FLIR-patented algorithm first introduced in the GasFindIR cameras that allows the user to see small temperature changes in the scene
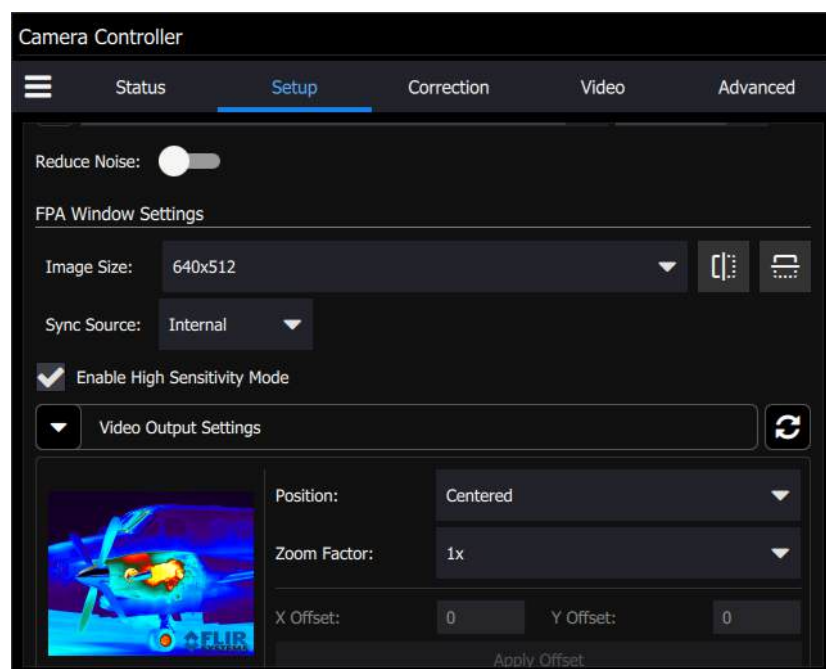

5.4.1.8 Lens Control (A678x and A858x only)

The next menu in the Setup tab is for lens control. If the camera is equipped with a motorized focus lens, then the user can manual focus or use the auto focus button. The user can focus by grabbing the button in the center of the focus slider and moving it left for near focus and right for far focus. (or the user can simply click on the bar itself and the button will snap to that position. The further to the right or left the circle control is moved, the faster the lens motor movement.
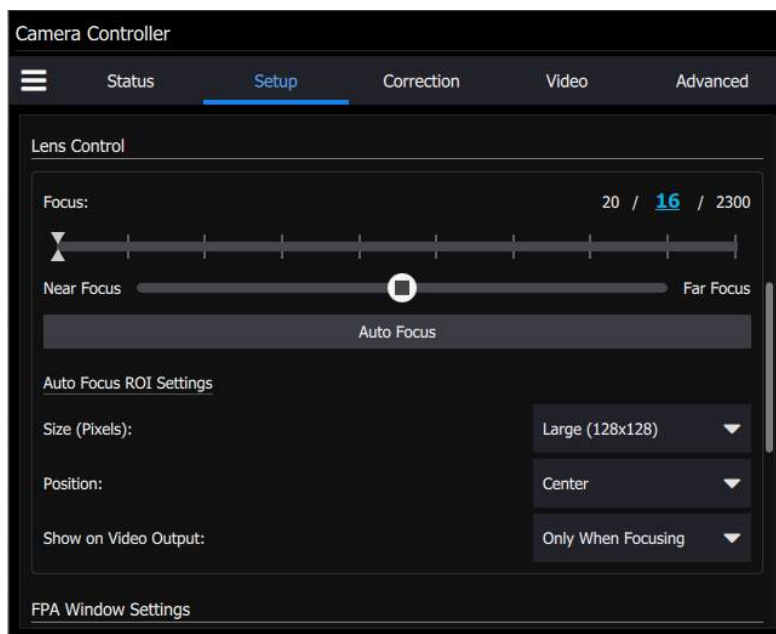
There is an Auto Focus ROI setting menu that enables the user to control the region of the image that is used for auto focus. The options include size, position and whether the ROI is shown in the SDI video output. Here are the size options:
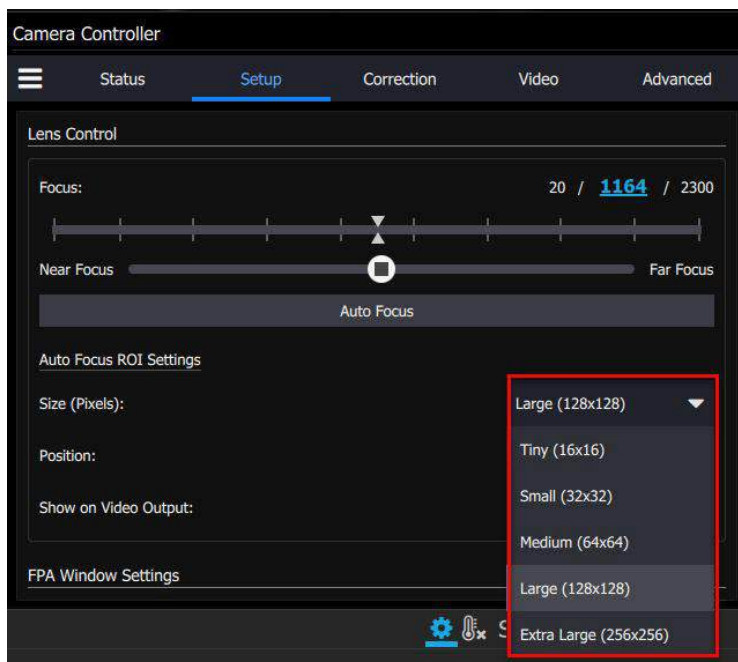
Here are the position options:
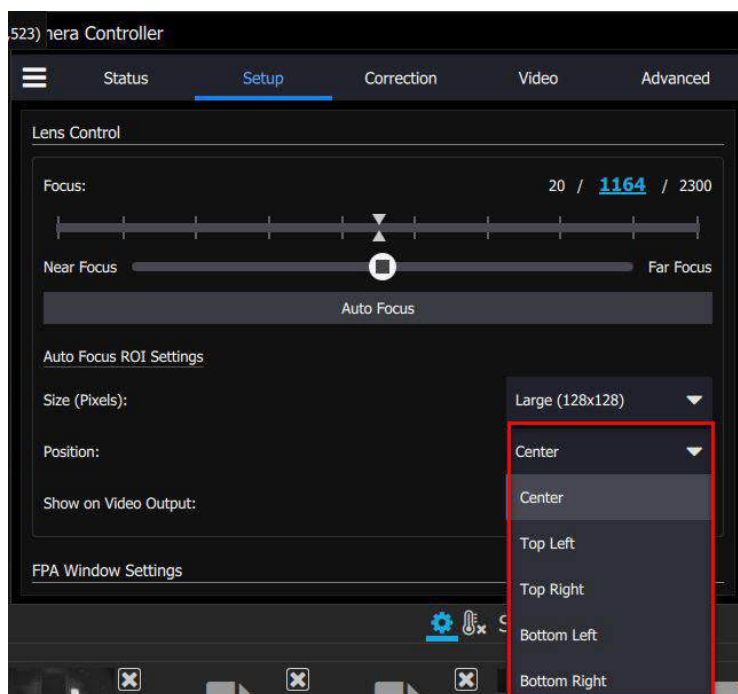
Here are the options for displaying the ROI in the Video output:
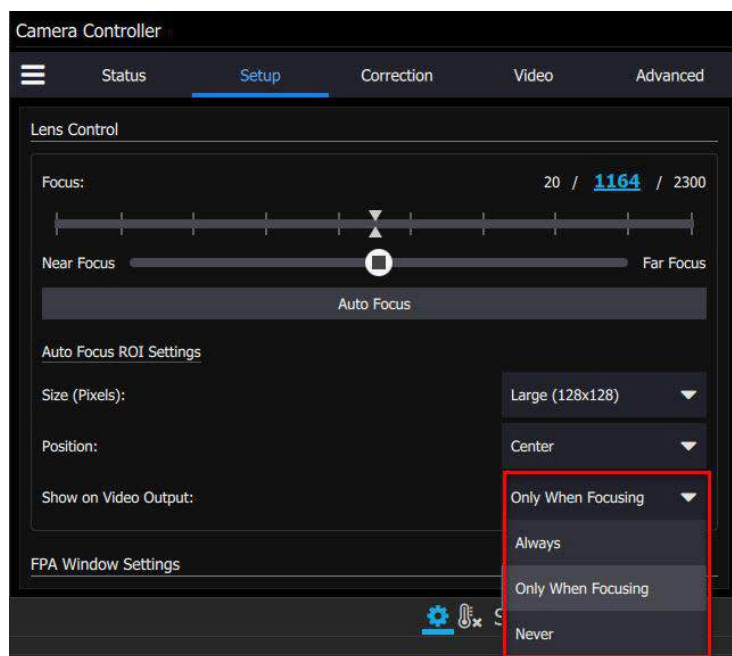
Here is the GUI view for the scenario where the on/off switch on the lens is turned to off or manual focus mode – all the controls are grayed out.
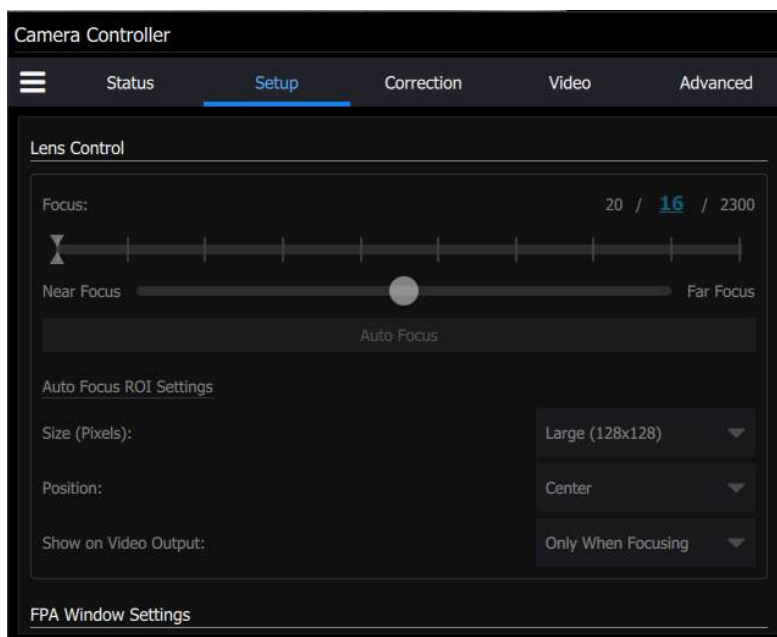
5.4.1.9 FPA Window Settings

The FPA Window Setting menu allows the user to control the size of the FPA Window, as well as flip the image at the FPA level around both the horizontal and vertical axes.

Common sizes can be chosen from the dropdown list or the user can enter the desired width and height directly. The box will turn red if an invalid number is entered.
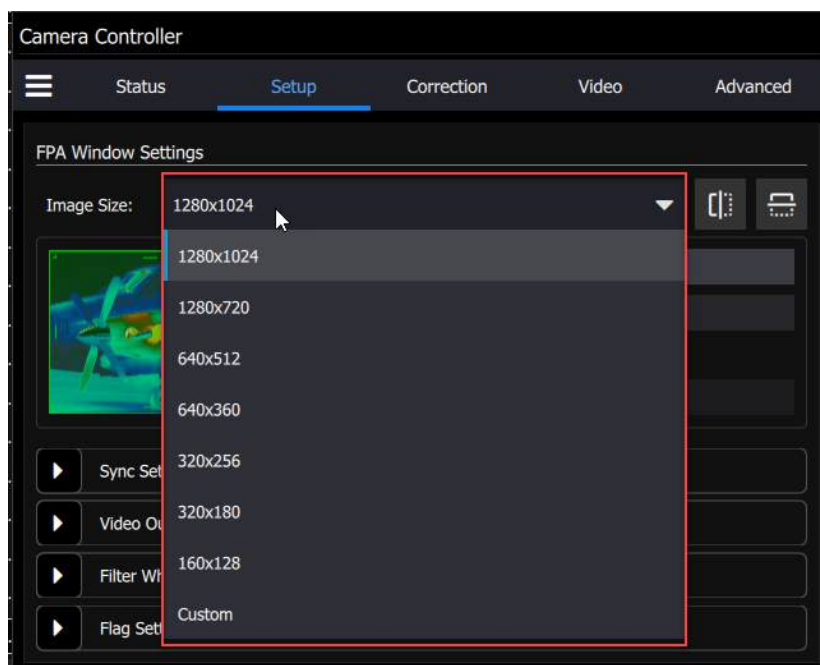
A670x: This control will be simply a dropdown list with the three window size options available (Full, ½, ¼).

5.4.1.10 Invert and Revert

The user can flip the video vertically (invert) or horizontally (revert) using these controls highlighted in the red box:

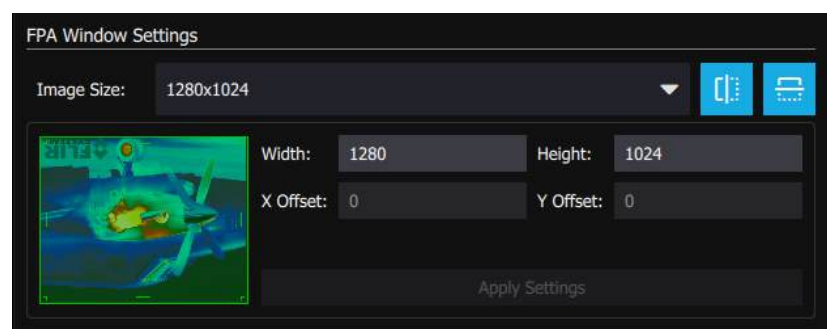When both controls are highlighted in blue, then the image is inverted and reverted, and the airplane image on the left side of the menu changes its orientation to indicate that:

Note: Using the invert and revert buttons change the way the image data is read out of the focal plane array, and the non-uniformity correction will be compromised. If the user needs to invert or revert the image, we recommend redoing the non-uniformity correction with the desired settings.

5.4.2 Sync Settings (Limited functionality in A670x)

The Sync Settings menu is a complex one. There are many options to consider if the intention is to synchronize the camera with another device, and it is well worth reading this entire section carefully.

5.4.2.1 Sync Source

The Source options page allows the user to select the source for Syncs and Triggers.

The pulldown menus show the following options: Sync Source can be Internal, External or Video.

Sync Sources	
Internal	The frame sync is generated internally to run at the frequency set by the user
External	The frame sync is generated externally through the Sync In connect on the camera rear chassis.
Video	The frame sync is generated from the internal video encoder, locking the HD-SDI and FPA clocks together.
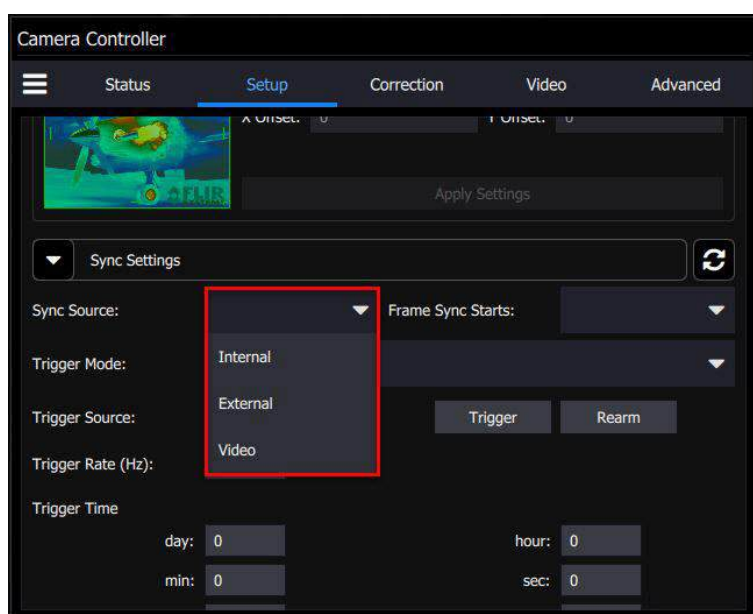
The Frame Sync Starts pulldown shows the following options: Integration or Readout:
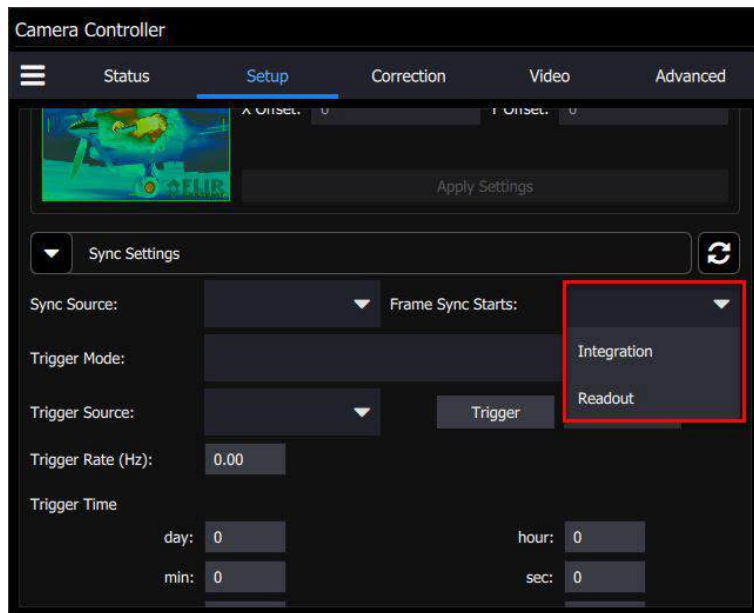
5.4.2.2 Frame Sync Starts

The camera makes use of frame syncs and triggers to control the generation of image data. Frame syncs control the start of individual frames, whereas triggers start sequences of frames.

The generation of a frame consists of two phases: *integration* and *data readout*. Depending on the timing between these two events, you can have two basic integration modes: Integrate Then Read (ITR) and Integrate While Read (IWR). In ITR, integration and data readout occur sequentially. The complete frame time is the combined total of the integration time plus readout time. In IWR, the integration phase of the current frame occurs during the readout phase of the *previous* frame. In other words, ITR and IWR terms refer to whether or not the camera will overlap the data readout and integration periods. In ITR, the data is not overlapped which means lower frame rates but provides a less noisy image. IWR can achieve much faster frame rates with a slight increase in noise. The camera does not require the user to explicitly choose whether to operate in ITR or IWR modes. The camera will automatically select the integration mode based on the integration time, frame rate, and frame sync mode.

The camera supports two Frame Sync Modes: Frame Sync Starts Integration (FSSI), and Frame Sync Starts Readout (FSSR). FSSI and FSSR determine which phase of the frame generation process (integration or data readout) is synchronized to the frame sync. FSSI starts the integration period when a frame sync occurs (i.e. "take a picture now"). The camera automatically calculates when to start data readout. FSSR starts the data readout (for the previous frame) when a frame sync occurs (i.e. "give me data now"). The camera automatically calculates when to start integration for the current frame. In FSSI mode, the camera could be in either ITR or IWR mode. In FSSR mode, the camera is always in IWR mode.

NOTE: When the camera is continuously imaging (i.e. internal sync mode), there is essentially no difference between FSSI and FSSR. In some cases FSSR may allow faster frame rates. However, FSSR may not be appropriate for external sync applications where the camera is stopped for extended periods because when syncs are restarted the first frame may be very old.

5.4.2.3 Frame Sync Starts Integration (FSSI)

Upon frame sync, the camera immediately integrates followed by data read out. Based on integration time, frame size, and frame rate, the camera will automatically choose ITR or IWR mode.

> **NOTE**: When using an external frame sync and superframing, the external frame sync should be set to comply with ITR frame rate limits. If the external sync rate is too fast, the camera will ignore syncs that come before the camera is ready

Frame Sync Starts Integration, ITR

Frame Sync Starts Integration, IWR
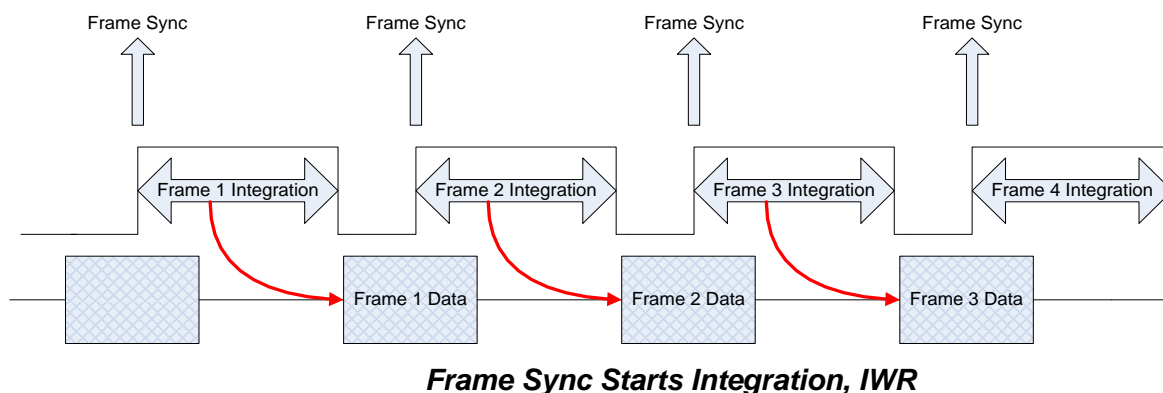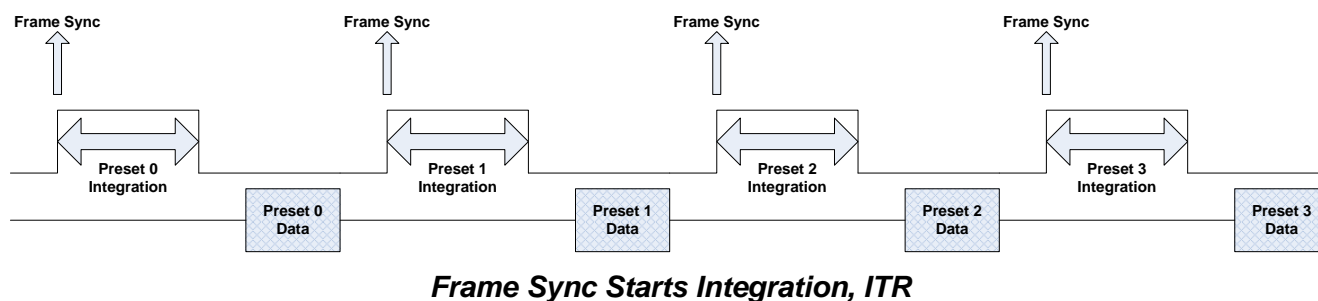
5.4.2.4 Frame Sync Starts Readout (FSSR)

Upon frame sync, the camera immediately transmits the data from the previous frame. The integration period is then placed to meet ROIC requirements. This mode always operates in IWR mode. This mode can be used with either internal or external frame sync at full frame rates.

Frame Sync Starts Readout
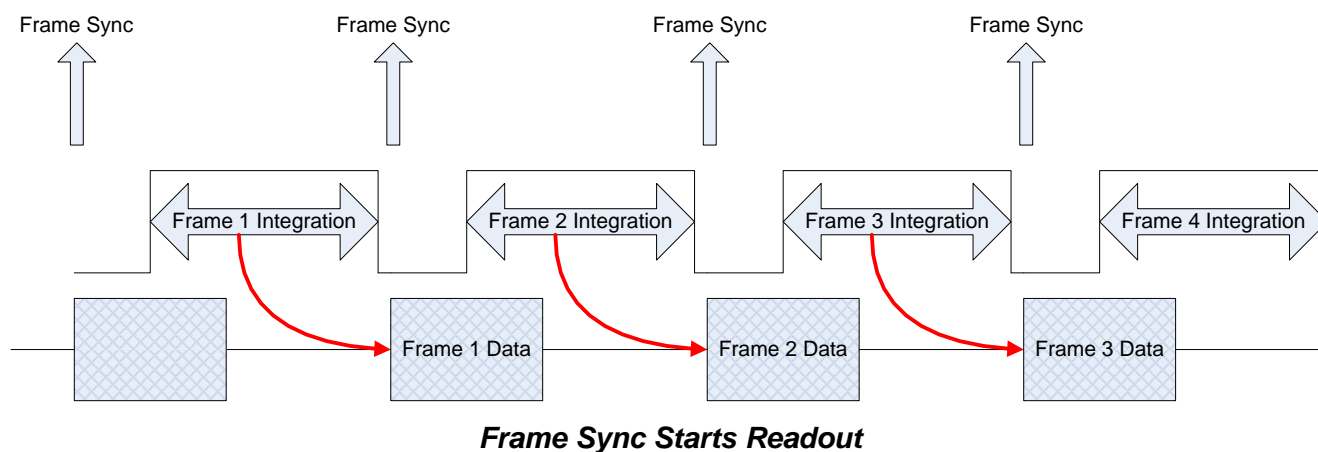
5.4.2.5 Trigger Mode

When the camera is placed in a triggered mode, the image stream will stop until the trigger is received.

Trigger Modes	
Free Run (No Trigger)	In free run the camera cycles through frames/sequences continuously.
Trigger then free run	Upon receiving a trigger (external or software) the camera will start to generate sequences continuously.

The Trigger Mode options are Free Run, Triggered Free Run, and Triggered Superframe:
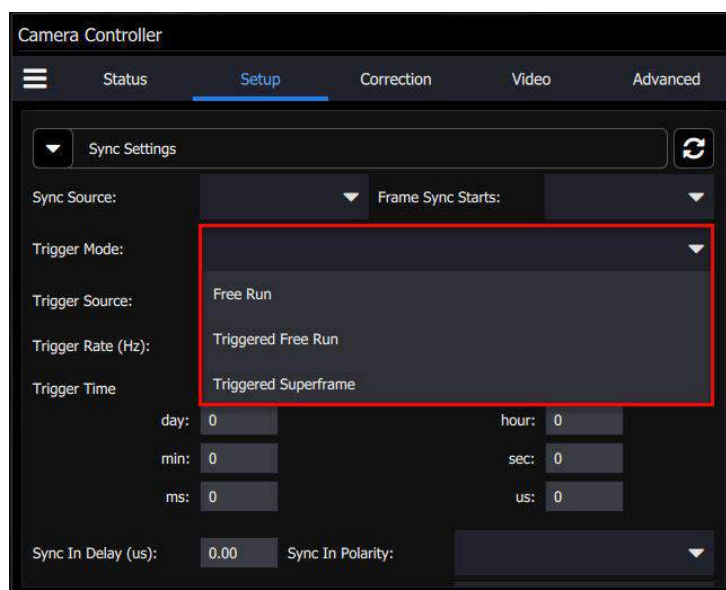
The Trigger Source can be Internal, External, Software or Time:
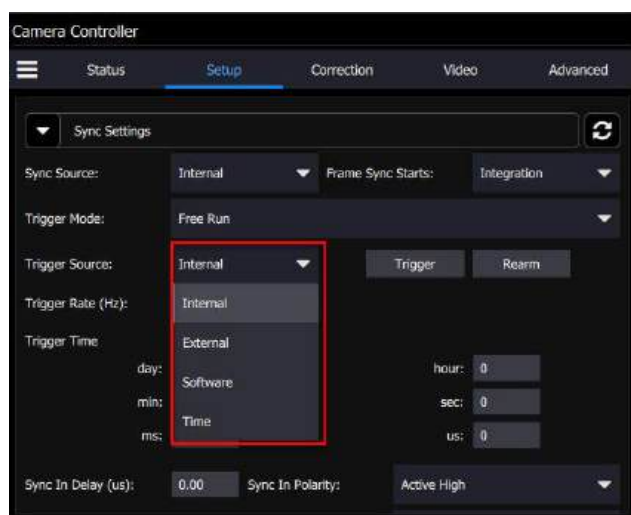
The Trigger Time can be set to activate on a very specific time as measured by the real time clock in the camera.
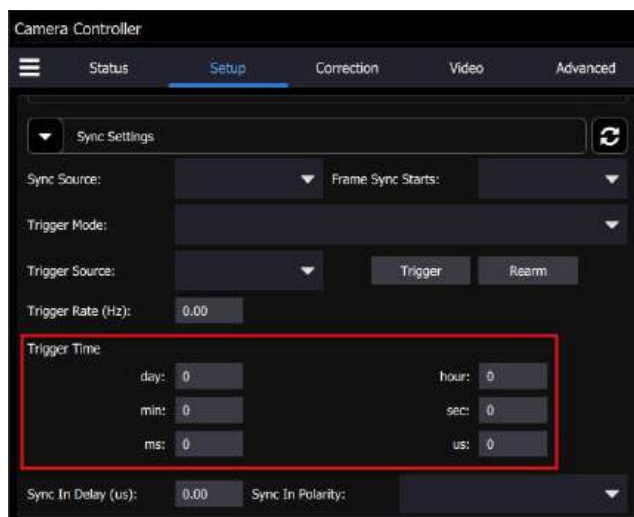
Trigger Sources	
Internal	The trigger is generated internally to run at the frequency set by the user (Hz).
External	The trigger is generated externally through the Trigger In connector on the camera rear chassis. (3.3V LVCMOS)
Software	The trigger is generated via a software button (Trigger button)
Time	Camera generates an internal trigger when the internal timestamp clock reaches a specified time.

5.4.2.6 Sync Options

The Sync Options page allows the user to set delays, sync out reference, and polarities for the Sync and Trigger In. The delays can be set individually for each preset.

Sync In	
Delay	Allows for the user to set a delay (µsec) for the external sync. See timing diagrams below.
Polarity	The sync is edge triggered. Allows for the camera to use the rising or falling edge.
Trigger In	
Delay	Allows for the user to set a delay (µsec) for the external trigger. See timing diagrams below.
Polarity	Trigger is edge triggered. Allows for the camera to use the rising or falling edge.

5.4.2.7 Sync Out

The Sync Out options allow the user to set a delay for the sync out pulse as well as the sync delay reference and polarity. The Sync Out signal always has a jitter of ±1 clock (160nsec).
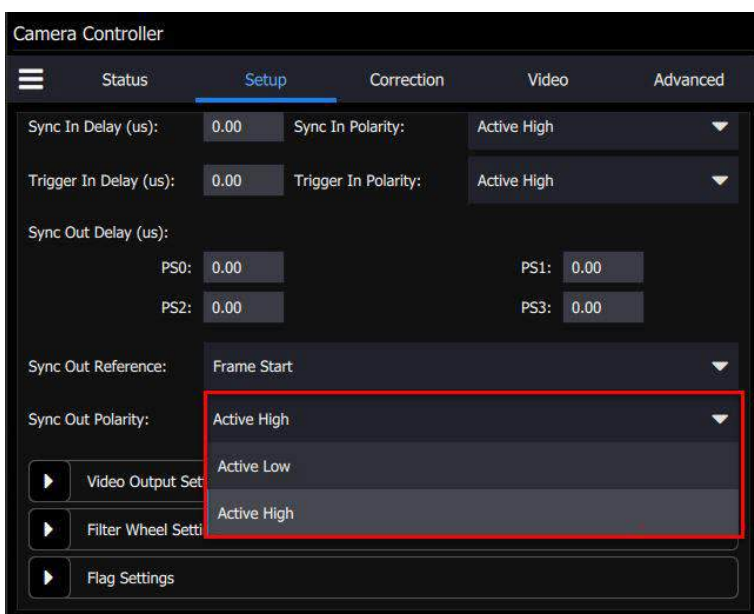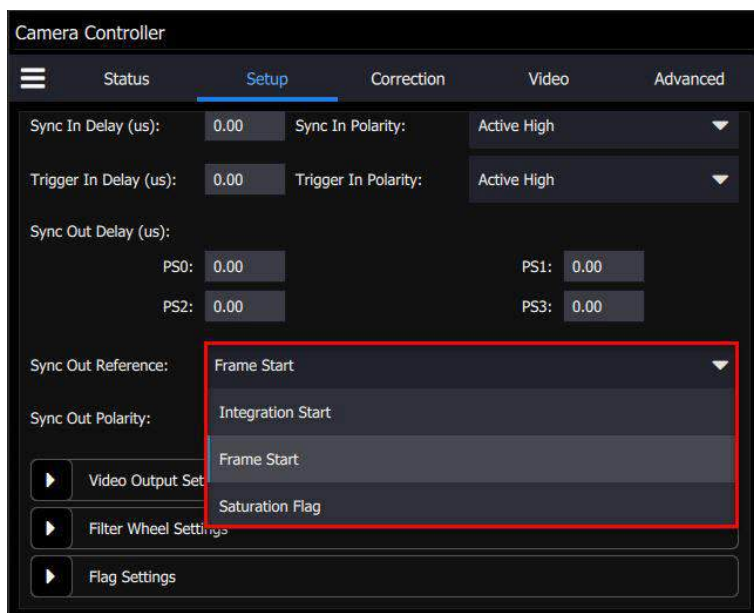
Sync Out Options	
Sync Out Delay	Allows for the user to set a delay for the sync out on a preset basis.
Sync Out Source	Allows for the sync out to be referenced to the start of frame or start of integration.
Sync Out Polarity	Allows for the sync out to be active high or low.

5.4.3 Filter Wheel Settings [A858x and A678x only]

The A858x and A678x have a motorized 4-position (A858x) / 3-position (A678x) filter wheel which can be populated with warm filters at the time of manufacturing. The filter wheel can hold 1-inch diameter filters. Each holder can hold up to two filters with a combined thickness of 2mm. The camera can store a text description for the filter ID. These filters are typically neutral density filters which reduce the light signal reaching the sensor in order to facilitate the observation of very bright sources, such as rocket plumes, or decoy flares. In this example, the filter wheel is empty and shows the empty ID number of 63. The user can select the filter they want to use. The wheel will rotate around to locate the correct filter ID. A typical filter load is Empty, ND1, ND2 and ND3. These choices make it possible to do radiometry up to 3000C.
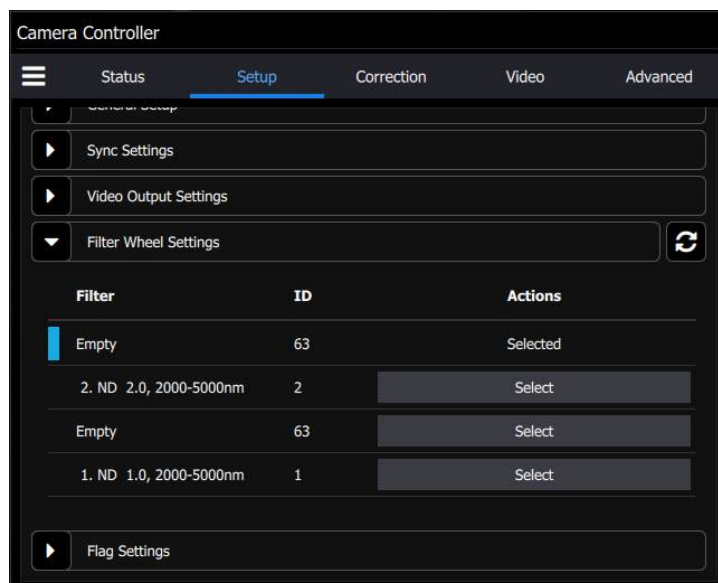
The filter names that are displayed in the GUI can be edited by the user using a menu accessed by the "hamburger" button:

5.4.4 Flag Settings

The flag is at the ambient temperature inside the camera. It can be commanded to move into the field of view, and then be stowed. It is sometimes useful to move the flag into the field of view for test purposes, particularly when the camera is being operated remotely and there is no way to put a lens cap on the lens, for example.
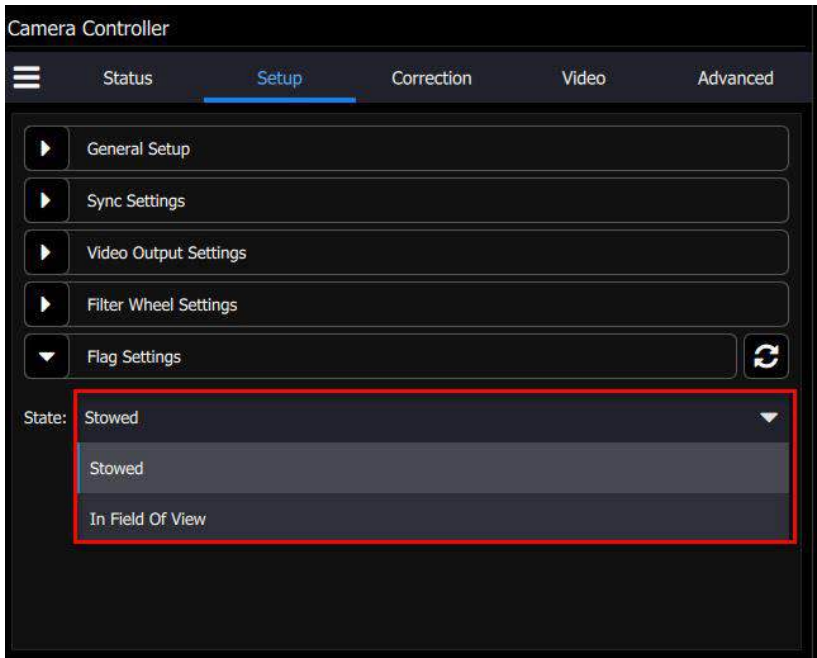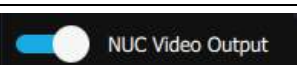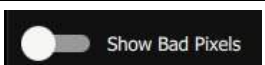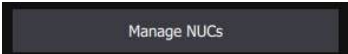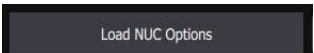
5.5 Correction Page

The Correction Tab contains all the controls needed to manage the on-camera NUCs. On-camera NUCs are stored in two types of memory:

RAM memory. This type of memory is used to store NUCs that will be applied to live image data. There is enough RAM memory for one NUC to be loaded for each Preset. This memory is volatile and is lost when then camera is turned off. If a NUC was loaded into RAM, the camera will reload that NUC from flash automatically when the camera is turned on if a Save State was performed.

Flash Memory. This type of memory is used as nonvolatile NUC storage. There is about 4GB of flash memory available for storing NUCs. This is enough space to store hundreds of full frame NUCs.
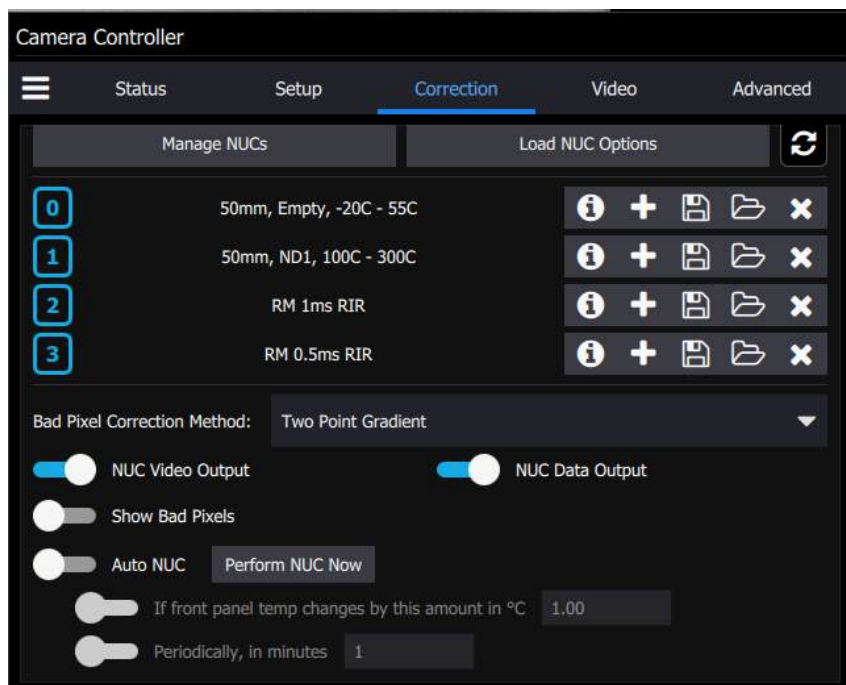
NUC Controls	
	NUC Info. Displays camera parameters and statistics related to the selected NUC
	Perform NUC. Starts the NUC Wizard.
	Updates the current NUC to flash memory
	Load a NUC from flash to RAM memory.
	Unload NUC from RAM memory. No on-camera NUC will be applied to the data.
NUC Video Output	Apply NUC to SDI video data
NUC Data Output	Apply NUC to Digital output (GigE, CoaXpress (A858x only))
Show Bad Pixels	Displays all pixels marked as "bad" as white dots on both the analog and digital outputs.
Auto NUC Perform NUC Now	When enabled, the camera will automatically drop the internal flag and perform a NUC Offset Update when selected criteria are met. The NUC update can be triggered on demand, by a change in the internal temperature sensor or by a timer
Manage NUCs	Displays a list of NUCs stored in flash memory. User can delete NUCs from flash memory as well as upload/download NUCs (*.NPK files) from the host PC.
Load NUC Options	Displays options for loading NUCs.

5.5.1 NUC Information

The ⓘ button brings up a list of camera parameters that are saved as part of the NUC as well as bad pixel statistics. Note that there is a scroll bar that can be used to see the whole list. The Save button allows the user to dump this list to a text file:
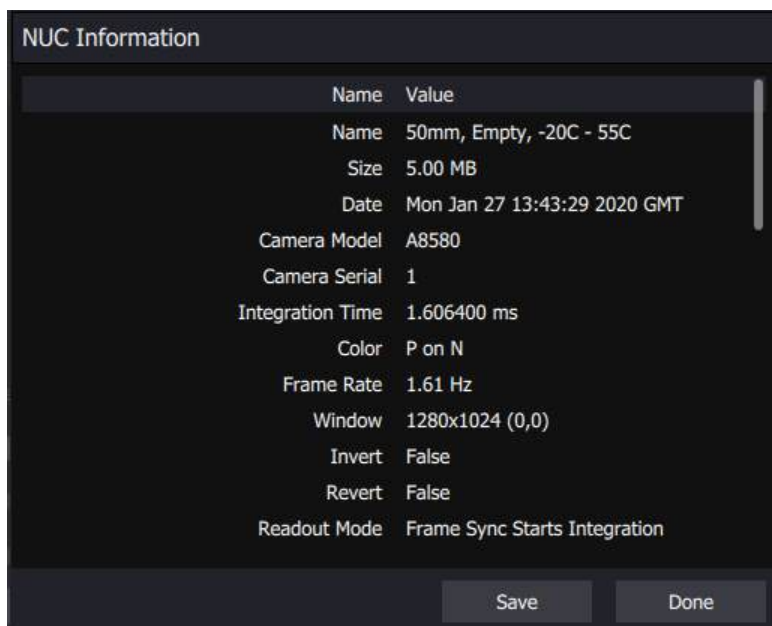
5.5.2 Manage NUCs

This dialog box allows the user to manage NUCs stored in non-volatile flash memory. Changes here will persist through a camera power cycle. For example, if you rename a NUC here and do not update the NUC loaded into RAM and the camera state, the camera will not be able to reload the NUC after a power cycle.
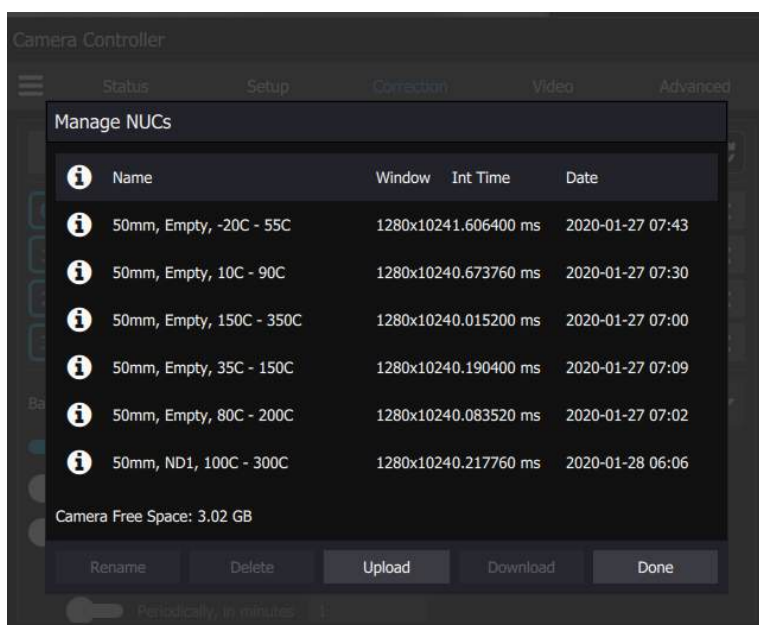
5.5.3 Load NUC Options

Typically, all the camera configuration parameters are derived from the current Camera State. When the camera is powered up, it loads the last saved camera state. The names of the NUCs are stored as part of the state. Normally the NUC is performed with the settings that are eventually going to be part of the state. If a NUC is loaded that has a setting that differs from the camera state, the state will override the NUC. If the user wants the NUC setting to override the state, then "Load NUC Options" can be set.
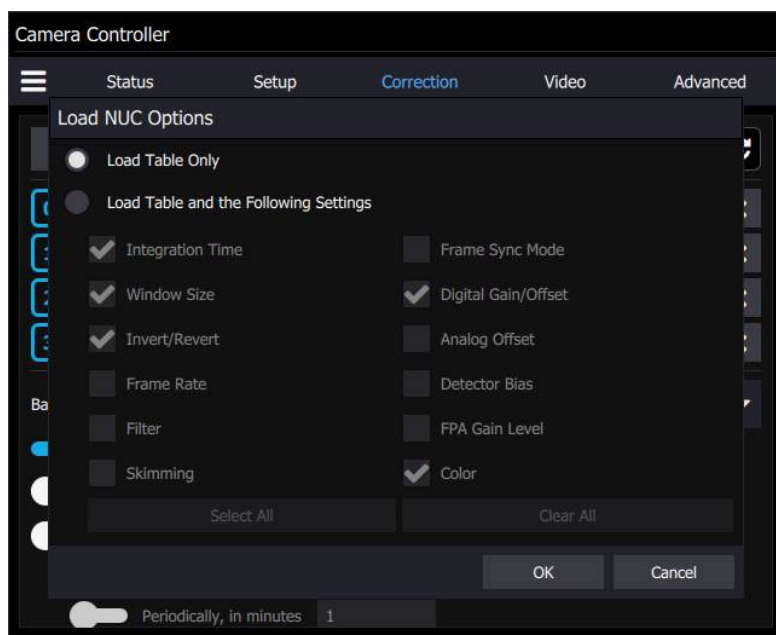
The default setting is to "Load Table Only", in which case only the NUC coefficients are used from a NUC file. When the user selects "Load Table and the Following Settings", the user can select which parameters from the NUC will override the current state. The option will not affect NUCs that are currently loaded into RAM, only those NUCs that are subsequently loaded from Flash memory. Unless a new state is saved, these override settings will not be remembered after a power cycle.

FLIR recommends that the user make use of the Load Table and the Following Settings option when operating the camera with user-created NUC tables, particularly when the window size has been modified from its full frame configuration.

5.5.4 Performing a NUC

To build a NUC table using the camera electronics, select the *Perform Correction* icon to start the NUC Wizard for the desired preset.

NOTE: Due to differences in camera electronics and FPA timings it is important to perform the NUC with the camera operating modes configured as it will be used when imaging.

After selecting the *Perform Correction* a second window comes up to allow the user to select correction parameters. The user can choose between a Two-Point and an Offset Update. The Offset Update can be done with either the internal flag or an external blackbody. We recommend using an external blackbody for the Offset Update whenever possible to get the best uniformity because the correction will include any non-uniformities in the lens. It is also a good idea to set the focus of the lens to the desired setting before performing an Offset Update, otherwise subtle ring-shaped artifacts can appear in the image when viewing a very uniform scene.

When all selections have been made, click *Next>>* to continue.
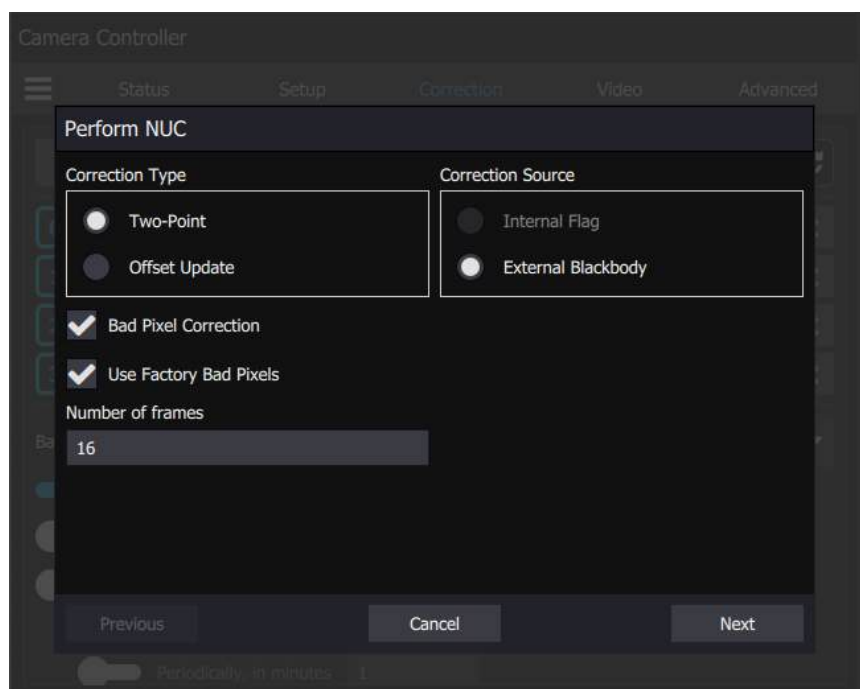
Correction (NUC) Types	
Two Point	Sets both the gain and offset terms. Uses two NUC sources. Computes a bad pixel correction.
Offset Update	Retains the current NUC gain terms and updates the offset terms. Uses a single NUC source. Retains the current bad pixel (BP) correction.
Correction Sources	
Internal Flag	Use the internal flag as the NUC source. Because the flag is not temperature controlled, it can only be used for 1-point and Offset Update NUC functions
External Blackbody	Use an external blackbody as the NUC source. Program will prompt the user to place each source in front of the camera. NUC source needs to fill the entire field of view.
Number of frames	Set the number of to average when computing NUC coefficients. "16 frames" is the default value, which works well for most scenarios. The value can be to be 2, 4, 8, 16, 32, 64, or 128.

After configuring the correction parameters and selecting *Next>>* the next window allows the user to set up the parameters used for the Bad Pixel Detection. Once the parameters are set, select *Next>>* to continue.
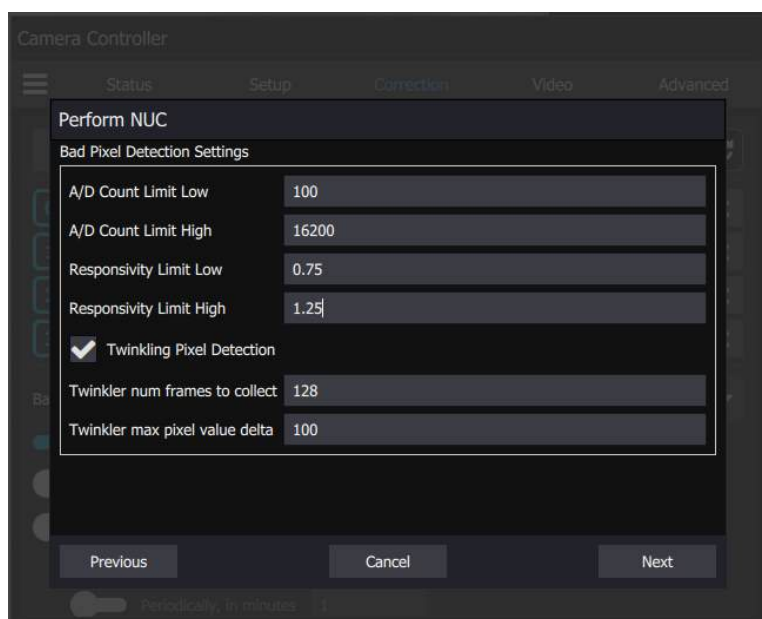
The next window allows the user to name the NUC. Simply type in the name for the table in the text box or select a previously saved file to replace it. Select *Next>>* to continue.
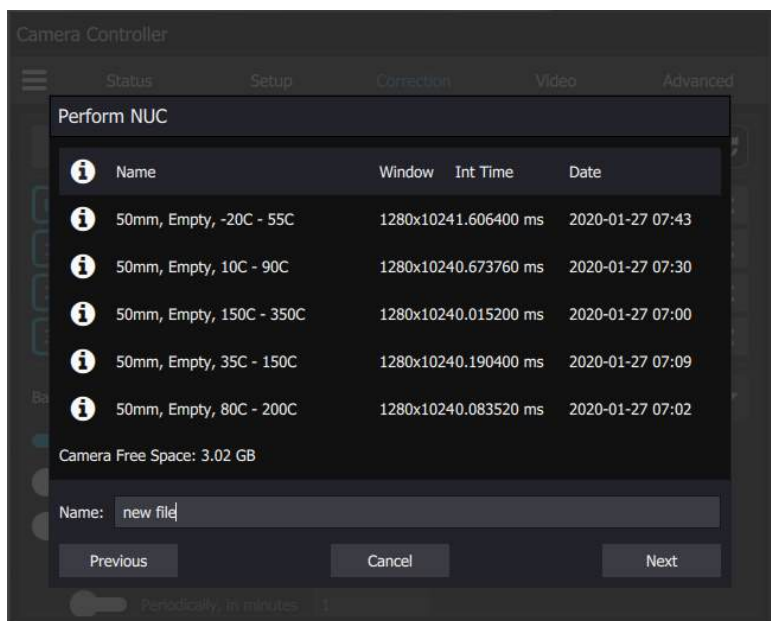
The next screens will collect data from the NUC sources. If using the internal flag, you will only see a few status messages. If using external blackbodies, you will be prompted. After each step, click *Next>>* to continue.
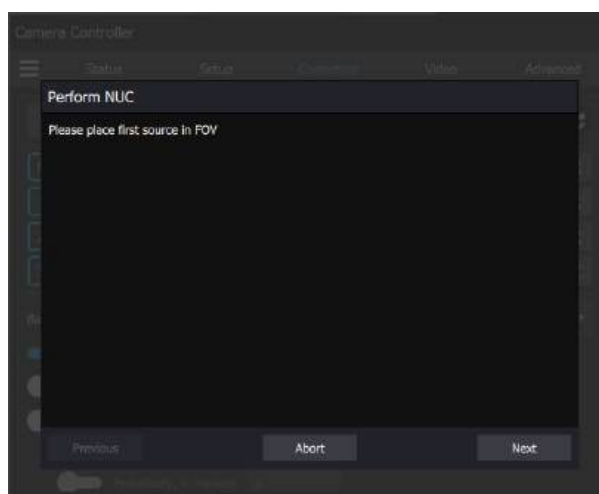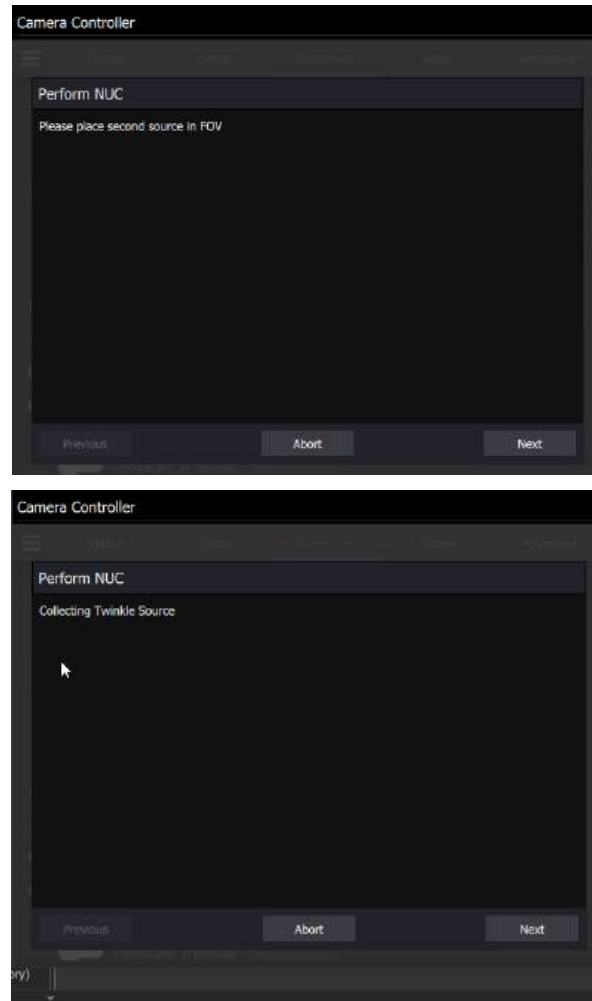
The last screen gives a report of the bad pixels found. The dialog shows how many pixels failed in each category. If the result is satisfactory, click Accept to save the NUC. The NUC table will be stored to flash memory and loaded into RAM memory for that preset. If the NUC gives a poor-quality image and you want to abort, click *[Discard]*.

Camera Controller

Status | Setup | Correction | Video | Advanced

Perform NUC

Bad Pixels

Total Bad Pixels	1078000
Factory	142
New	1077858
Twinkler	1
Responsivity Low/High	741302/336652
Src1 A/D Count Low/High	0/16
Src2 A/D Count Low/High	0/16

Accept this correction?

Previous | Discard | Accept

Periodically, in minutes | 1
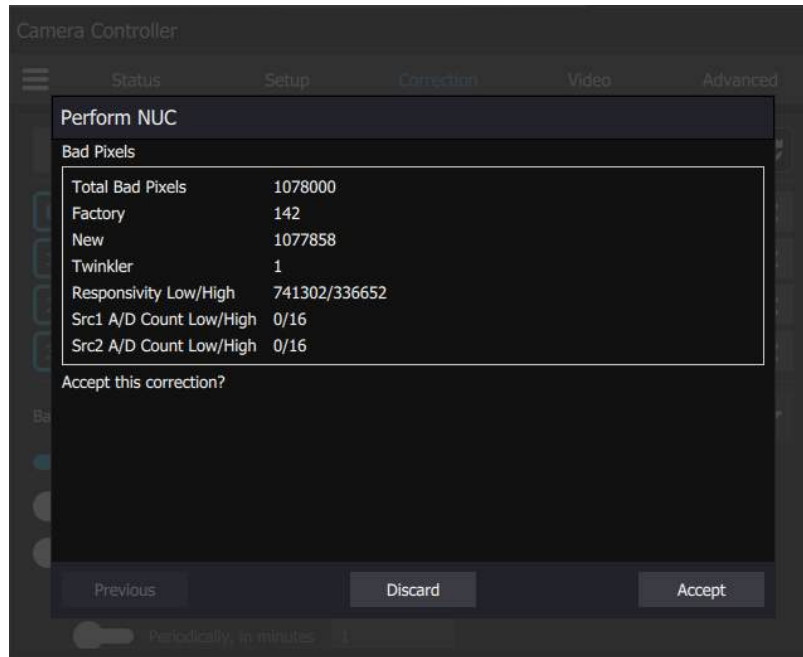
NOTE: It is possible for a bad pixel to fail more than one category, so the total bad pixels may be less than the sum of each category. "Factory" bad pixels are those that were determined to be bad during camera production testing.

5.5.5 What is a Non-Uniformity Correction (NUC)?

Non-Uniformity Correction (NUC) refers the process by which the camera electronics correct for the differences in the pixel-to-pixel response for each individual pixel in the detector array. The camera can create (or allow for the user to load) a Non-Uniformity Correction (NUC) table which consists of a unique gain and offset coefficient and a bad pixel indicator for each pixel. The table is then applied in the digital processing pipeline as shown in Figure 4-12. The result is corrected data where each pixel responds consistently across the detector input range creating a uniform image.
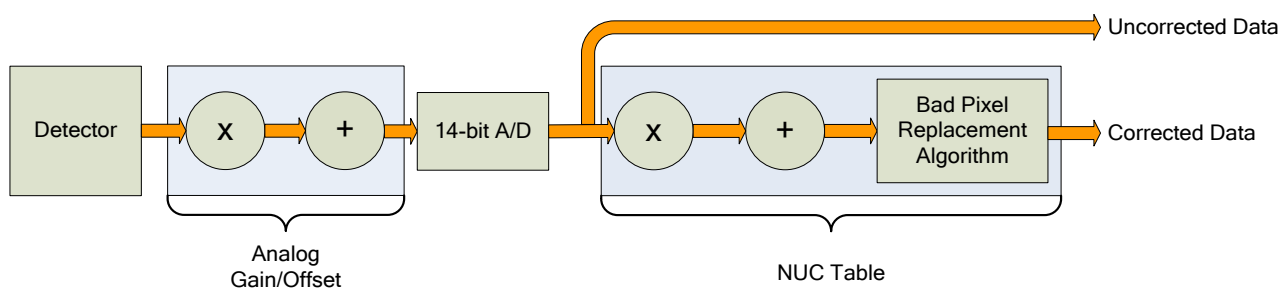
Figure 4-12: Digital Process Showing NUC Table Application

To create the NUC table, the camera images either one or two uniform temperature sources. The source can be an external source provided by the user or the camera's internal NUC flag which is basically a shutter the camera places in front of the detector. If the source is external it should be uniform and large enough to overfill the cameras field-of-view (FOV). By analyzing the pixel data from these constant sources, the non-uniformity of the pixels can be determined and corrected. There are two types of processes which are used to create the NUC table; Two-Point, and Offset Update.

5.5.5.1.1   Two-Point Correction Process

The Two-Point Correction Process builds a NUC table that contains an individually computed gain and offset coefficient for each pixel as seen in Figure 4-14. Two uniform sources are required for this correction. One source at the low end and a second source at the upper end of the usable detector input range. Because of the use of two images at either end of the input range, the Two-Point Correction yields better correction results. A two-point correct will also work better over a wider range of scene temperatures.
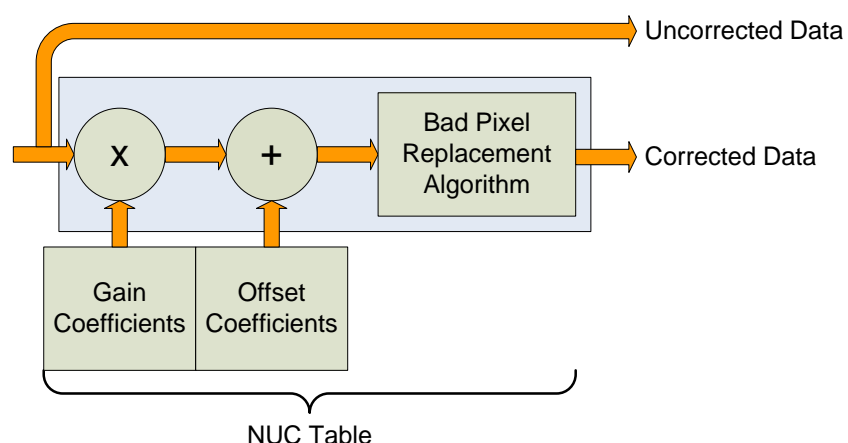
Figure 4-14: Two-Point Correction

5.5.5.1.2   Offset Update

Often during the normal operation of a camera, the electronics and/or optics will heat up or cool down which changes the uniformity of the camera image. This change requires a new NUC. However, this change is mainly in the offset response of the image while the gain component stays constant. An Offset Update simply computes a new offset coefficient using the existing gain coefficient and corrects the image non-uniformity. Offsets Update are typically performed when a Two-Point NUC table is being used.

An Offset Update requires only one uniform source, usually set at a temperature on the lower edge of the operational range.

5.5.5.1.3 Bad Pixel Correction

Within the NUC table there is an indication if a particular pixel has been determined to be bad, as seen in Figure 4-15. There are two methods the camera uses to determine bad pixels.
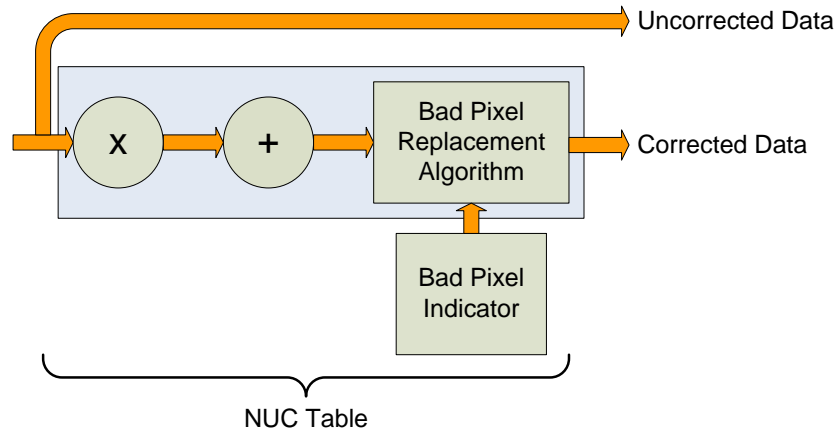
Figure 4-15: Bad Pixel Correction

First, the NUC table gain coefficients are compared to a user defined acceptance boundary, *Responsivity Limit Low/High (%)*. The responsivity of a pixel can be thought of as the gain of that pixel. The gain coefficient in the NUC Table is a computed value that attempts to correct the individual pixel gain, or responsivity, to a normalized value across the array. Since the responsivity value directly relates to the gain coefficient in the NUC table, the camera can scan the NUC table gain coefficients and use them to determine if a pixel's responsivity exceeds the limits as set by the user.

The second method of determining bad pixels is to search for twinklers. Twinklers are pixels that have responsivity values within normal tolerances, but still exhibit large swings for small input changes. These pixels are on the "verge" of being bad and often appear to be noisy. To find these types of pixels the camera collects N number of frames and records the maximum and minimum values across that sample set for each pixel. If the delta between max and min exceeds the *Twinkler max pixel value delta* then the pixel is determined to be bad.

The camera supports two algorithms for bad pixel replacement: 2-point Gradient, and Nearest Neighbor.

The 2-point gradient algorithm is the default bad pixel correction method. With this algorithm, the two pairs of pixels above and below and to the left and right of the bad pixel are evaluated. The algorithm compares the differences between the pixels and chooses the pair with smallest gradient (difference). It then averages the two adjacent pixels and uses that value for the replacement value. This algorithm is better at handling bad pixels near a high contrast edge and is the default method. If the algorithm encounters a situation is cannot solve (for example, an edge or corner) it will fall back on the nearest neighbor algorithm.
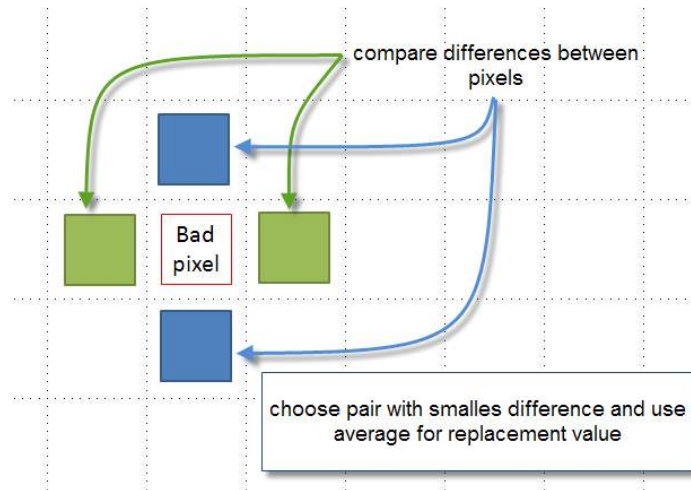
Nearest neighbor uses a simple replacement using an adjacent pixel. The adjacent pixel is picked using the pattern depicted below. When a bad pixel is near an edge, those search positions are skipped.
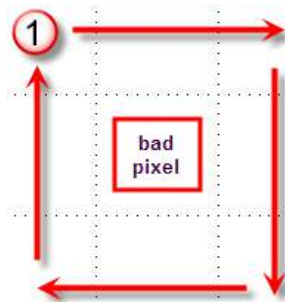
5.6 Video Page (Not available in A6705)

The camera has a 14-bit digital video output. However, the SDI output is only 8-bit. An Automatic Gain Control (AGC) algorithm is used to map the 14-bit digital to the 8-bit analog data. The Video Tab provides controls related to optimizing the Analog video output. **These controls affect only the HD-SDI video output**.
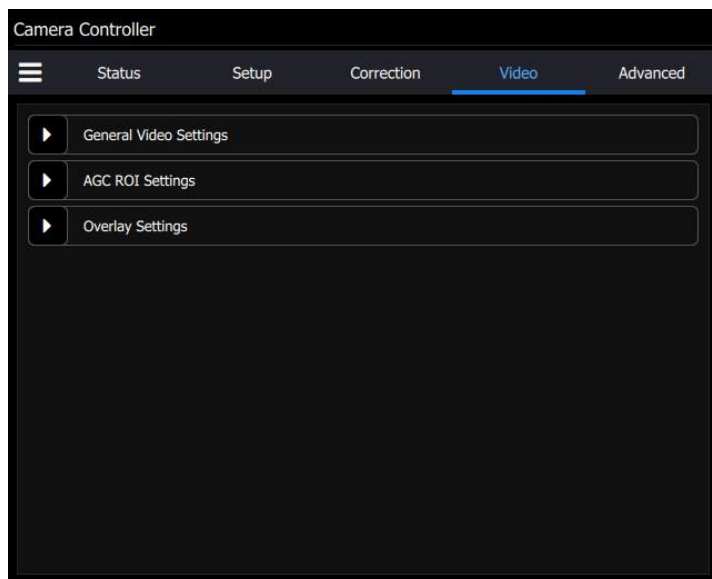
The general video settings include the image format, the filter rate and dampening.
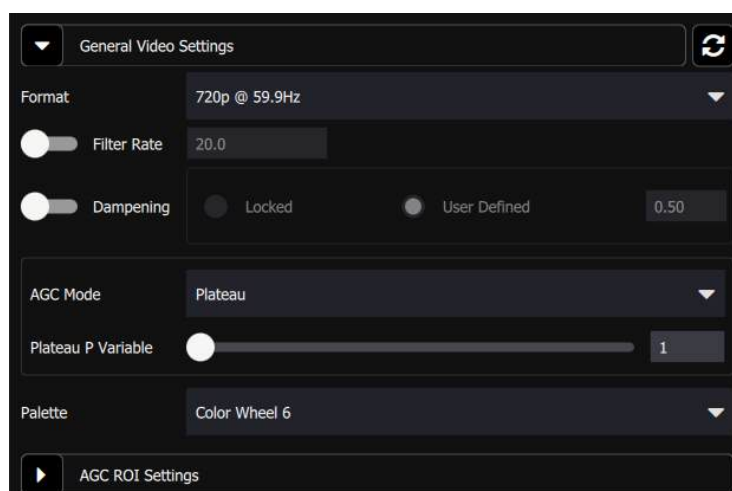
The formats for the video output are as follows: 480i, 576i, 720@50Hz, 720p@59.9Hz, 1080p@25Hz, and 1080p@29.9Hz:

Analog Video Setup Options	
Format	HDMI/SDI: 1080p @ 29.9/25Hz, 720p @ 59.9/50Hz, NTSC, PAL
Overlay	Enables the video overlay.
Filter Rate	Rate at which AGC is computed (1 to 20 Hz). Enable with checkbox
Dampening	Rate at which AGC is allowed to change. This will keep the AGC from responding rapidly to fast tridents changes. Specified as a fraction from 0 to 1. This fraction is used as a weighting factor for the current AGC vs. the newly computed AGC. Setting this to 0 will "lock" the AGC to its current settings. Enable with checkbox.
AGC Mode	Plateau: Uses a plateau equalization (PE) algorithm to scale the image data for video display DDE: Digital Detail Enhancement. Manual Linear: Scales the image data to a windowed section of data range as set by the user Auto Linear: Same as Manual Linear except camera analyzes image and sets limits at ~1% and 98% of the histogram.
Plateau P	Scaling factor for the Plateau Equalization function Note: Plateau P is only visible when AGC Mode>>Plateau is selected
Bounds	Sets the lower and upper data range to be scaled to on the video data.

Analog Video Setup Options	
	Note: Bounds is only visible when AGC Mode>>Manual Linear is selected
DDE Sharpness	Only visible when AGC is set to DDE. Selects the amount of enhancement processing.
Palette	Allows user to select the color scheme to use on the analog video channel.

These are the different AGC Modes that are available in the Cooled A-Series Cameras:
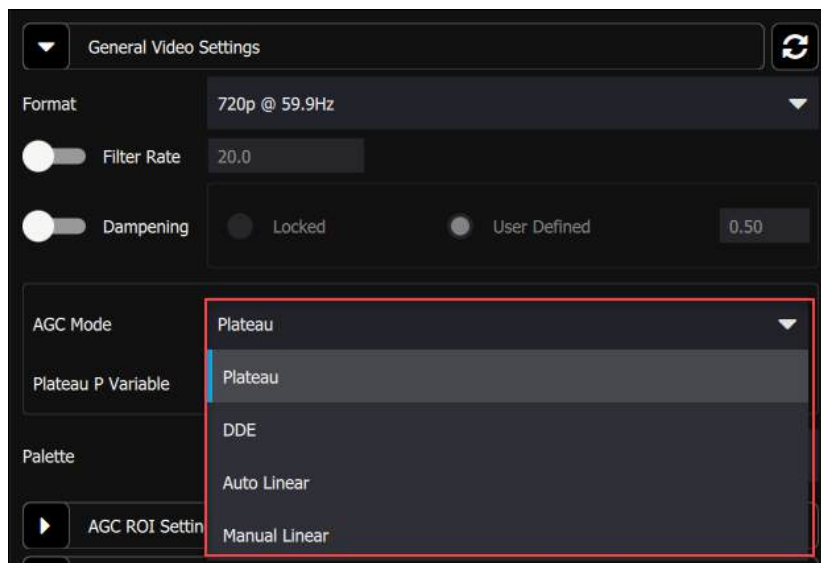
The Manual Linear algorithm evenly distributes the grayscale values over the digital values. This works fairly well if the image dynamic range is fairly evenly distributed but in general does not produce high contrast imagery, but it also does not saturate or clip the hot and cold regions either. The Plateau Equalization algorithm (also called PE) is a nonlinear AGC algorithm that uses the image histogram to optimally map the 256 gray scales. This algorithm works well for most scenes, but it works best when the scene has a "bi-modal" distribution (two clumps). It usually the most popular because algorithm because it produces high contrast (but more saturated) video. The following pictures illustrate the differences in AGC algorithms. (The data was captured from the digital output, but the effect is similar for the analog side.)

40 C Blackbody (Linear AGC scaling)

Image histogram

40C Blackbody (PE AGC scaling)
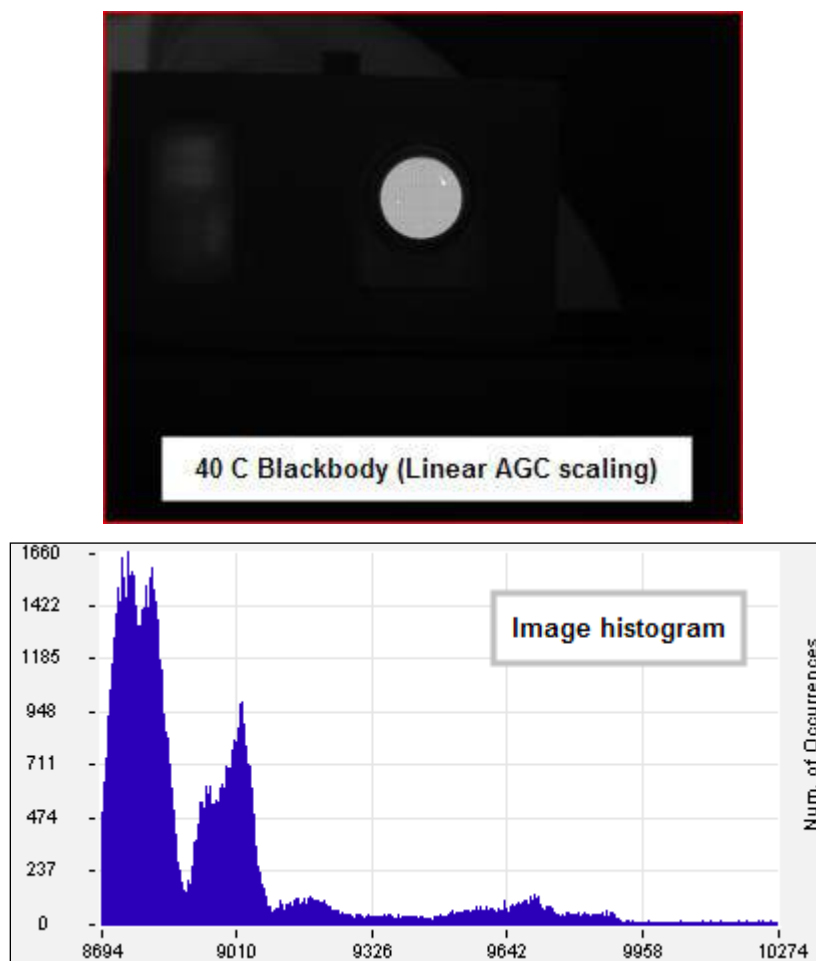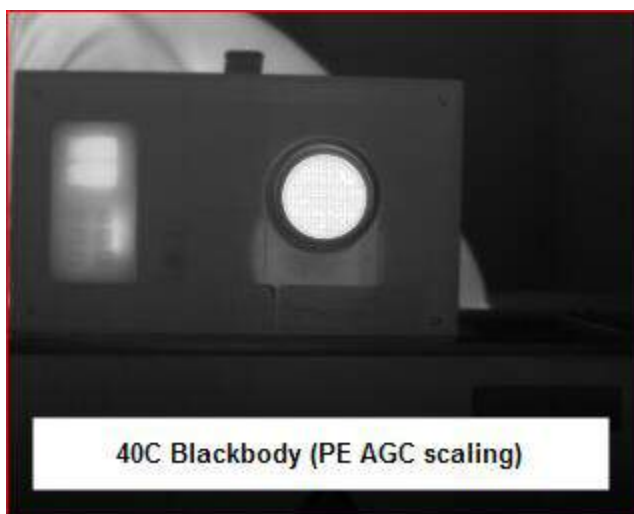
One final note about the PE algorithm: it is very aggressive. It can pull detail out of very low contrast imagery. It can also greatly enhance some very low-level NUC and FPA artifacts and noise if the contrast is low enough. This does not necessarily mean there is a problem with either the camera or the NUC.

5.6.1 AGC ROI Settings

The AGC ROI Settings panel allows the user to define a box region. Only the pixels within the box will be used to calculate the AGC coefficients. This is particularly useful if there is part of the scene that is much higher or lower in intensity than the target of interest. The ROI is defined by entering the size and position directly in the parameter fields or the user can use the mouse to drag the corners of the green box to create the desired rectangular region. The default is that the AGC ROI is not enabled, in which case the panel controls are grayed out:
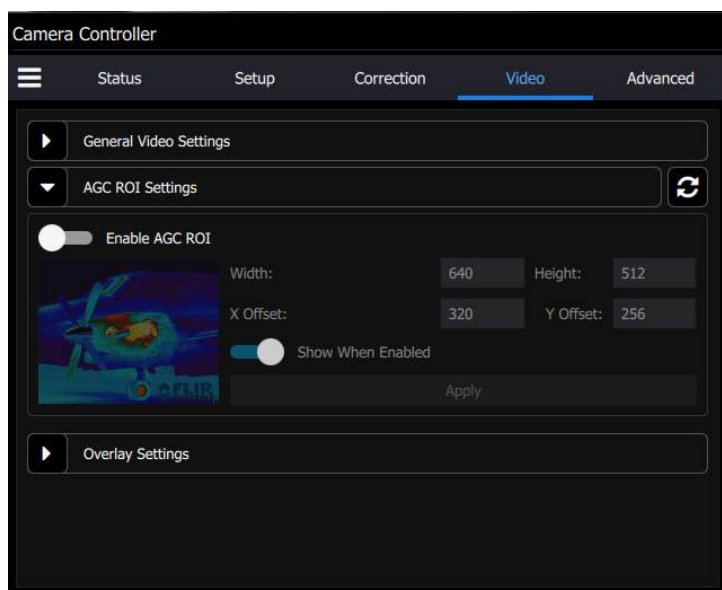
When Enable AGC ROI is on, the panel controls can be accessed. The user can change the size and position of the box. At this point, the Apply button will not be grayed out. When the user hits the Apply button, the changes are made and the apply button grays out again. The Show When Enabled control makes the ROI visible on the SDI video as an overlaid rectangular frame.
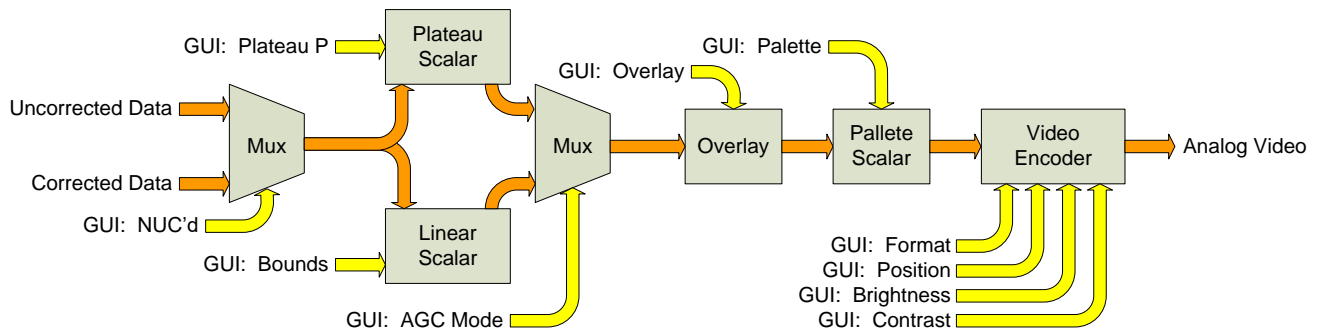
Figure 4-1: Analog Video Flow

5.7 Advanced

The Advanced menu contains four submenus. They are Digital Settings, Analog Settings, and Saturation Setting.
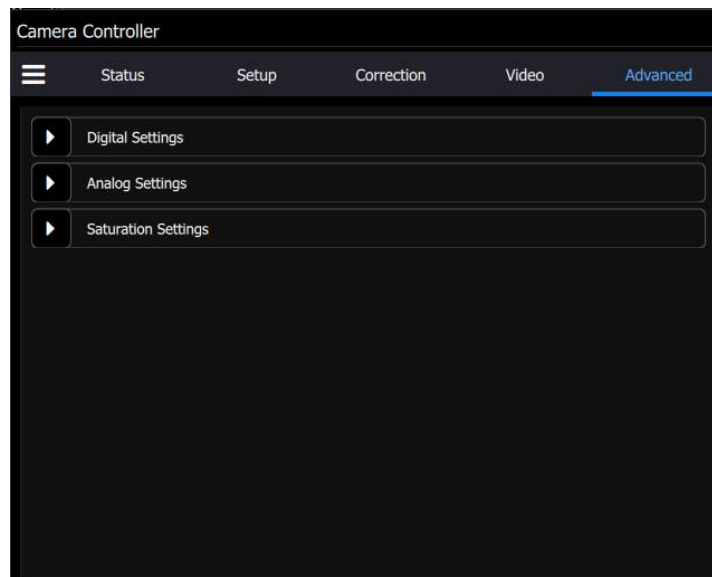
5.7.1 Digital Settings

The digital settings menu contains digital gain and digital offset values for each of the four presets. If a Factory Calibration is loaded into a preset, then these boxes will be populated with values that are derived from the Tdrift compensation, and the user is NOT allowed to change the values. If the user attempts to change them, a red outline appears around the box.

If a preset does not have a factory calibration loaded, then it is possible to edit these values, as shown below:
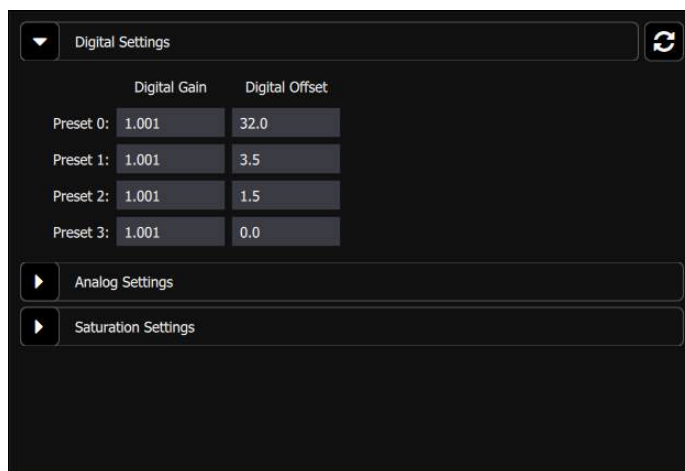
The digital gain and offset stages are digital features of the camera that allow the corrected digital output of the camera to be mapped to different output ranges. The following diagram illustrates the position of these stages in the signal path:
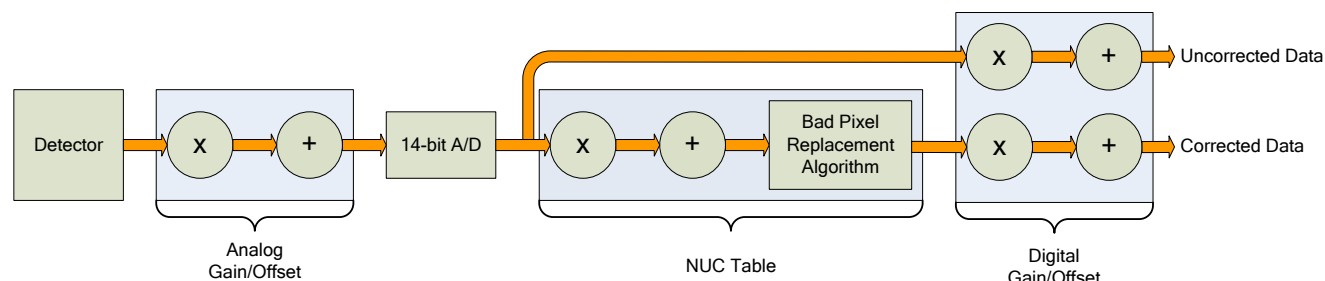
A-Series Signal Processing Chain

The analog FPA data is passed through an analog gain and offset stage that are factory-set to ensure that the entire range of the FPA output is matched to the A/D input. This is shown in the figure below, which plots the digital output of a typical camera against background photon flux. The actual scale of the flux depends on integration time setting. The figure shows an example where the user desires to operate the camera between two flux points such that these two limits use the entire 14-bit range. With no global gain and offset adjustment these two points correspond to 3200 counts and 15800 counts for the low and high flux ranges respectively. Having obtained these numbers, we set the gain to use the full 14-bit range:

$$gain = \frac{16383}{15800 - 3200} = 1.30$$

Since the offset stage is *after* the gain stage, we calculate the offset value using the gain:

$$offset = -3200 \times gain = -4160$$

These values are then entered into the global gain and offset controls and the linearized (red curve) transfer function shown is the result.

The available gain range is 1.999 to essentially zero; the available offset range is $\pm$ 32,767. The default values are a gain of 1 and an offset of zero. Because the system sensitivity (NEΔT) is set prior

to the A/D stages, there is no detrimental effect on performance from the use of the global gain and offset controls.
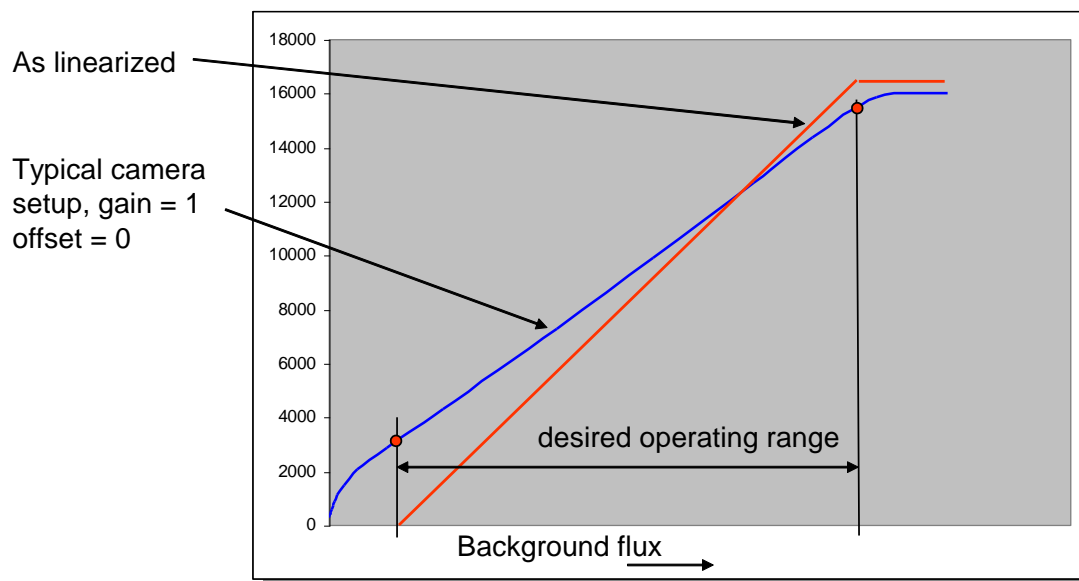
Use of global gain and offset to linearize the camera

5.7.2 Analog Settings

These controls are set at the factory for the focal plane array in the camera. The controls are intended only for the power user who should consult with FLIR application support before changing these values.
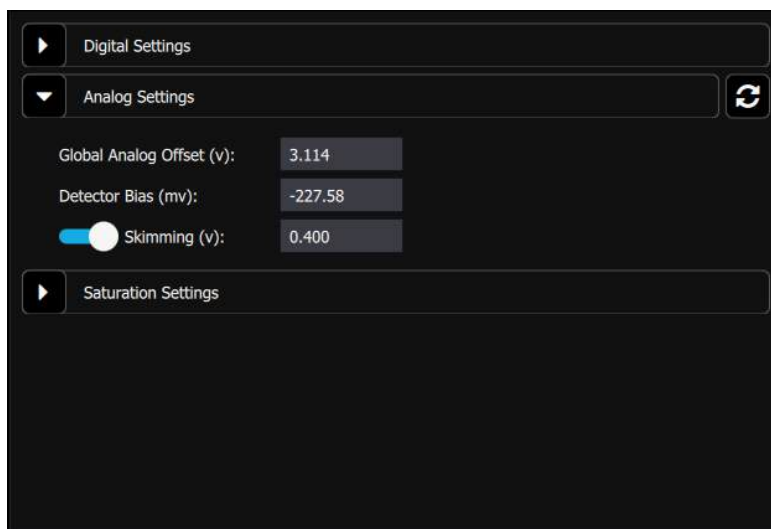
5.7.3 Saturation Settings

These settings control the flag for saturated pixels. If the criteria for saturation is met, then a flag in the metadata switches to T from F. The Count Threshold value is the count value above which a pixel is considered to be saturated. Pixel Threshold is the number of pixels that need to meet the Count Threshold condition in order to trigger the Saturated Pixels flag.
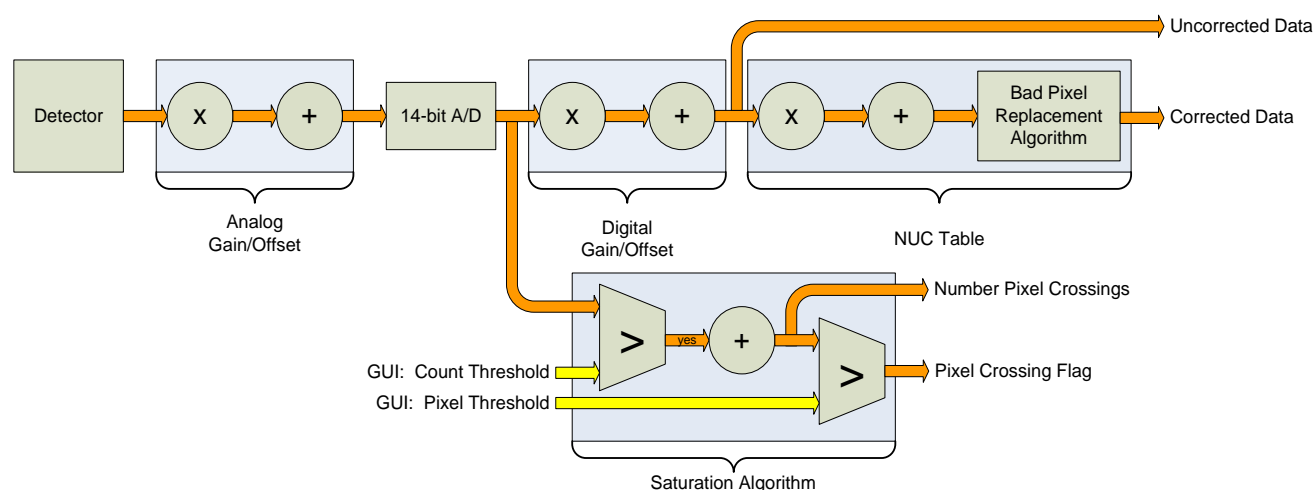
Saturation Detection

One example of this feature is to use the information to adjust the integration time. If the A/D count threshold is set to 75% of the full value (12,288) then the camera will count the number of pixels that are within 25% of saturation. If a set number of pixels fit that criterion, then the integration period should be lowered.

It is important to note the camera does not account for bad pixels when counting for saturation. When determining the threshold the user should account for the typical number of bad pixels.

6 Interfaces

6.1 Mechanical (dimensions in inches)

A858x
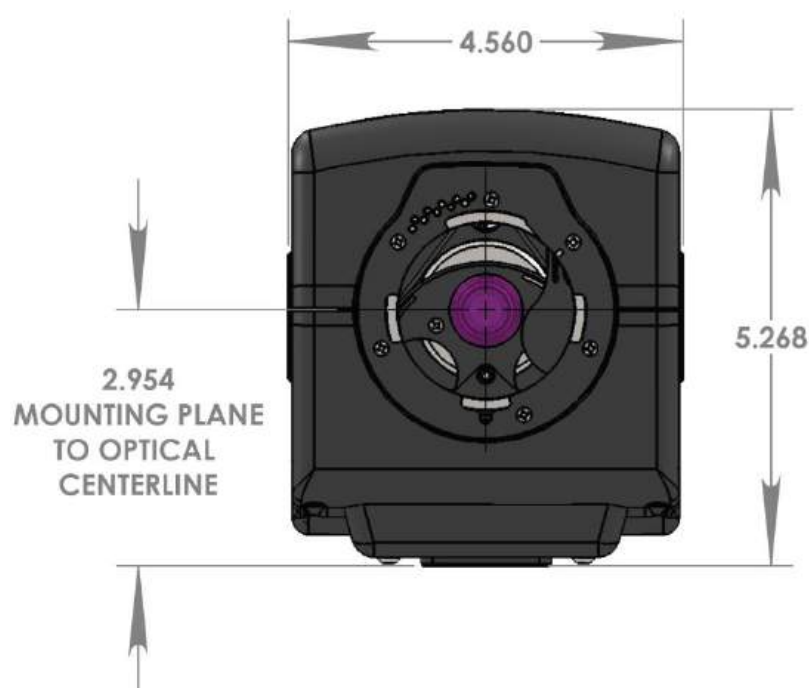
Figure 6-1: Front view of A858x
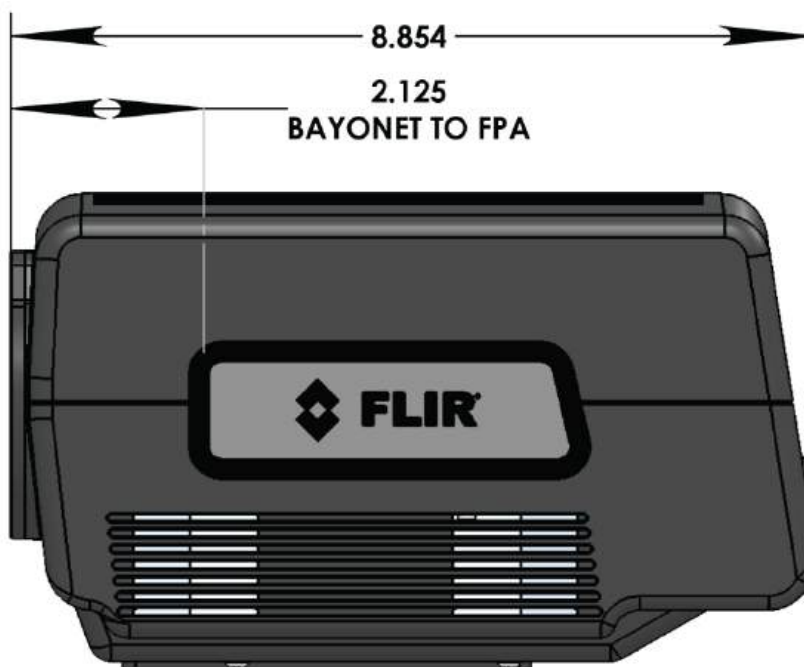
Figure 6-2: Side view of A858x without lens
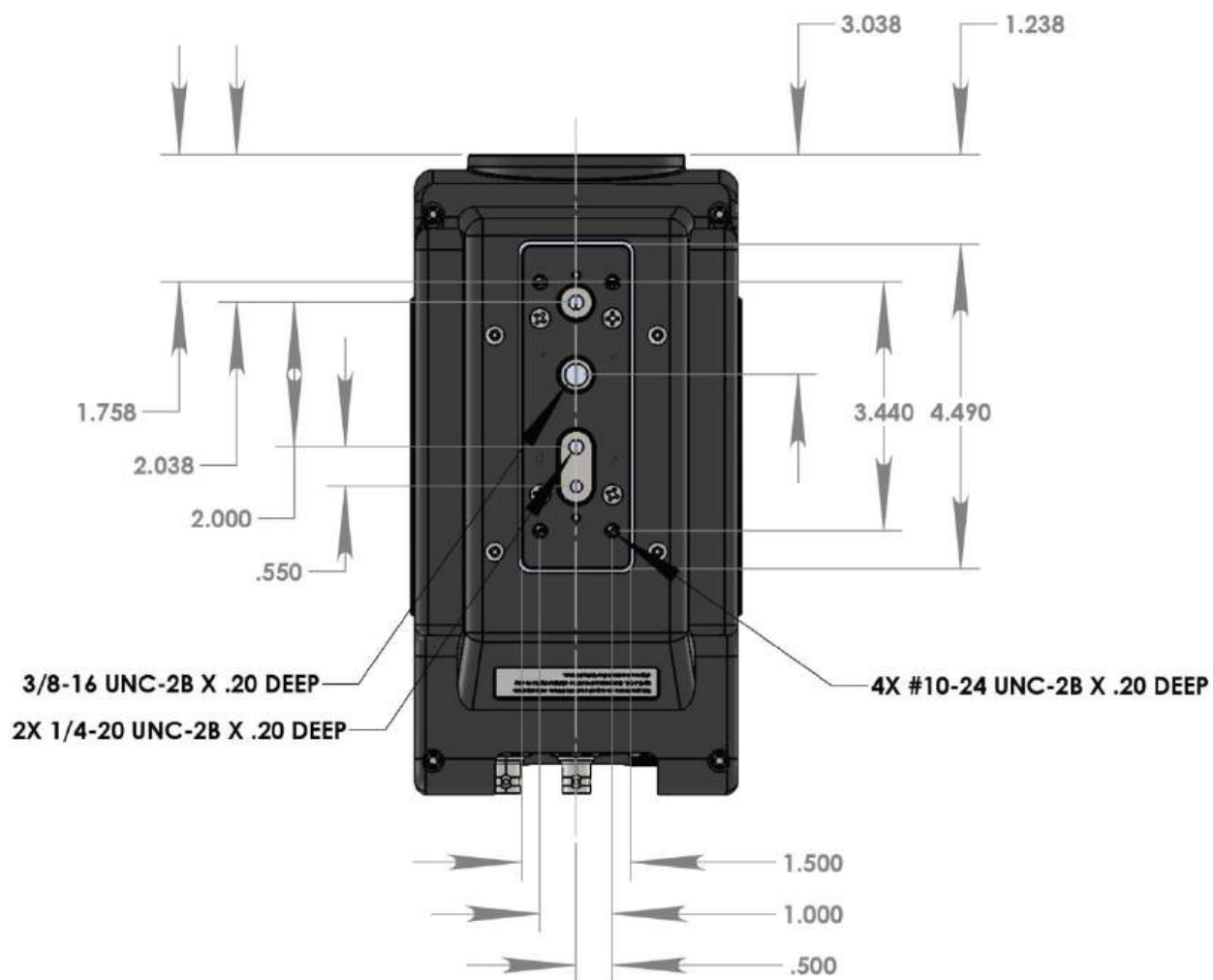
Figure 6-3: Bottom view of A858x

A67xx
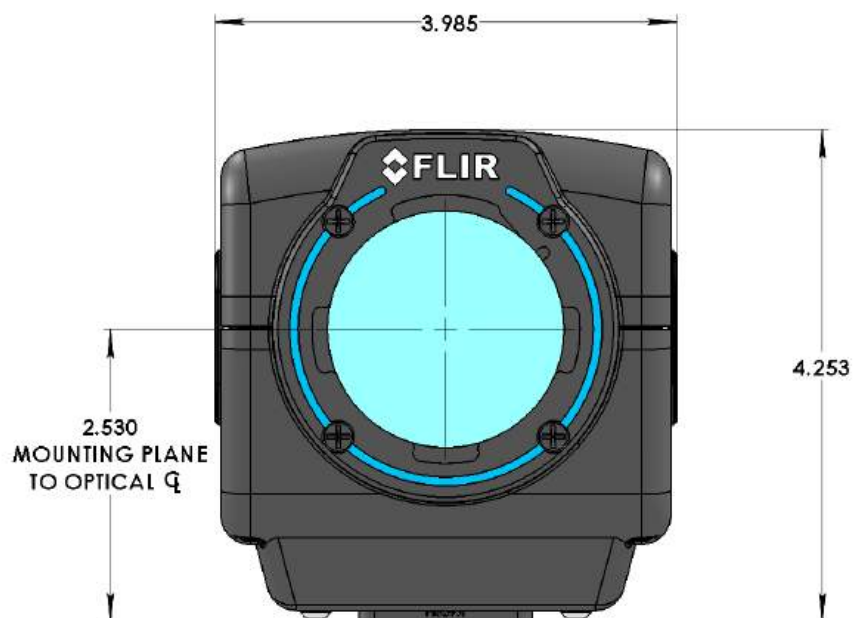
Figure 6-1: Front view of A670x/A675x
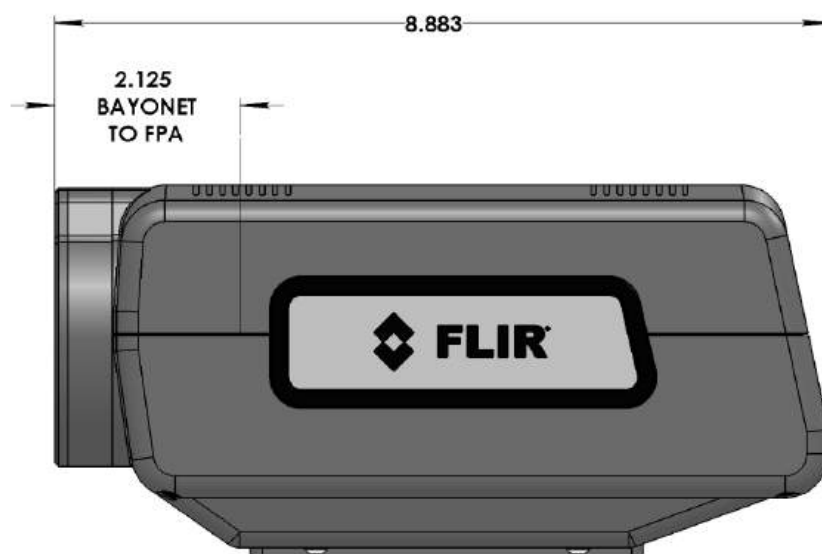
Figure 6-2: Side view of A670x/A675x
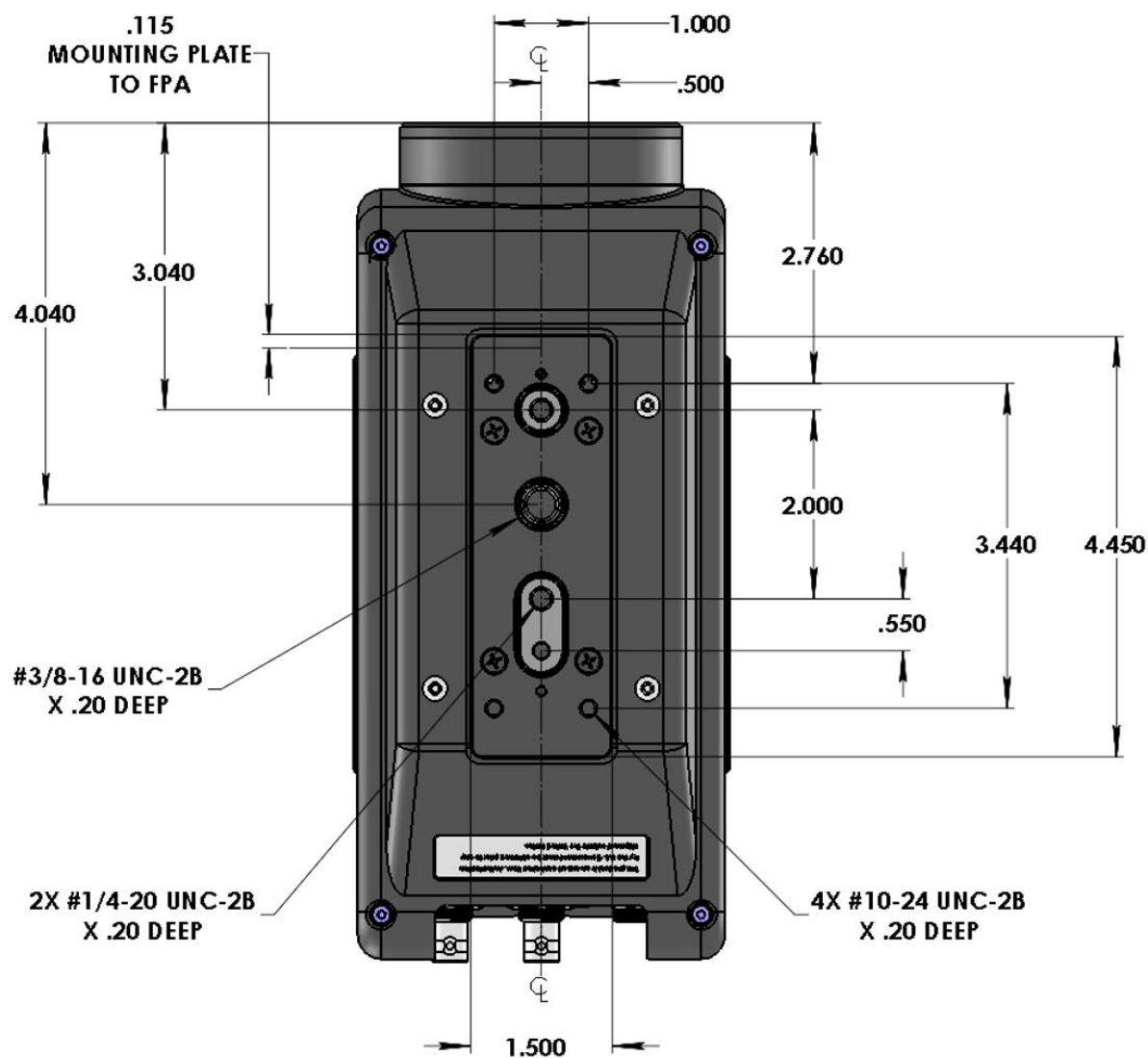
Figure 6-3: Bottom view of A670x/A675x

A626x
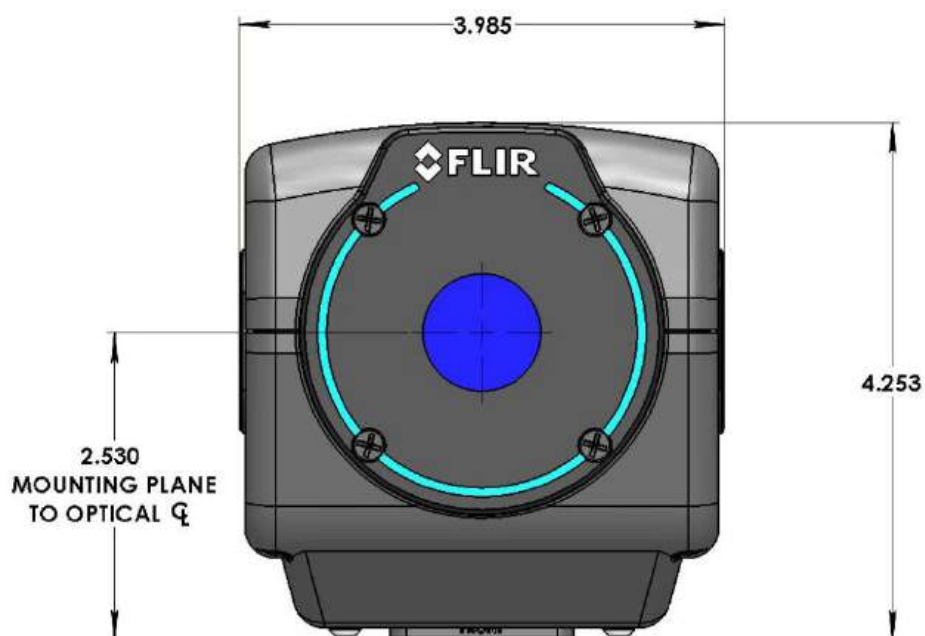
Figure 6-4: Front view of A626xsc

Figure 6-5: Side view of A626xsc
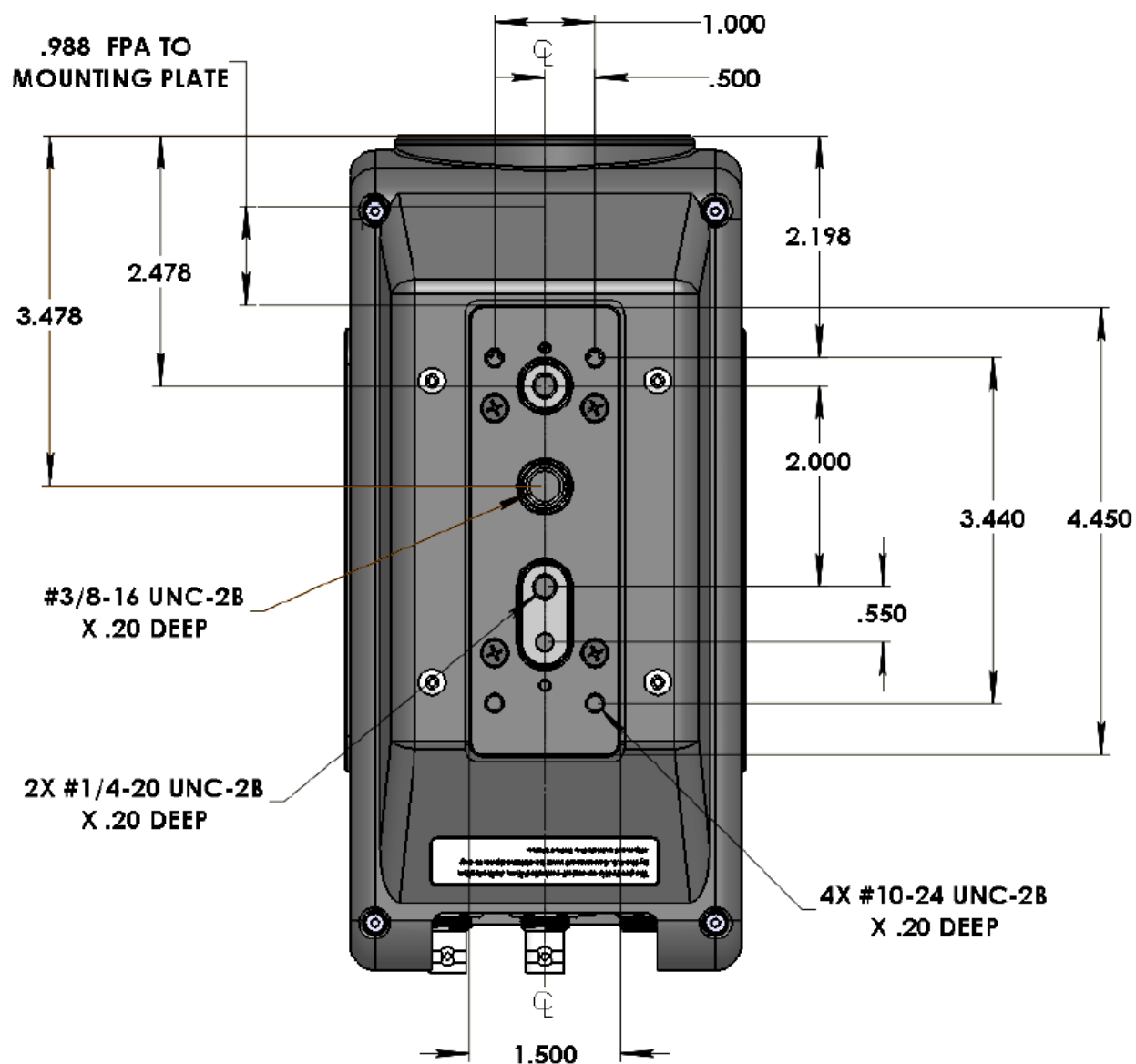
Figure 6-6: Bottom view of A626xsc

6.2 Status Lights

The cameras provide a set of status indicators on the back panel to give the user some visual feedback on the camera operating state.

	POWER (on power switch): Indicates that the camera is ON.
	READY: Camera electronics have completed boot up. Camera is ready to accept commands.
	COLD: Indicates that the FPA has reached operating temperature (<80K for InSb or SLS, 30C for InGaAs).

6.3 Power Interfaces

6.3.1 Power Interface [All except A6705]

24VDC nominal (20-28V acceptable), external AC-DC power converter is provided with the camera system as a standard accessory. Power supply specifications are:

Input voltage range: 100-250VAC 50/60Hz

Current draw: 24 VDC at up to 4.0 amps input to the camera

Converter dimensions: 6.25 inches x 3.5 inches x 2.75 inch (L x W x H)

Converter weight: approximately 1 pound

The power input pinouts are shown in Figure 6-4.

Pin1: +Power input
Pin2: Power return
Pin3: Chassis ground
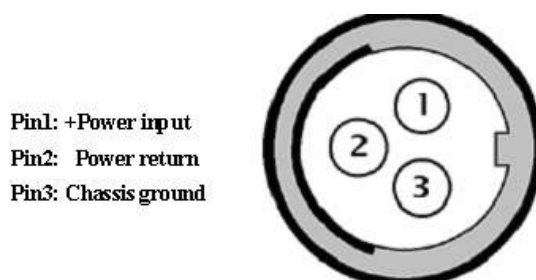
Figure 6-4: A858x Power Input Pinouts

When using your own DC power supply, you should take note of the following information:

Output voltage: 24 VDC nominal (20-28V acceptable)

Current draw: 1.4 amps nominal steady state, 2.6 amps peak (during cooldown)

Power dissipation is <50 Watts steady state at nominal ambient temperature.

Mating Connector: Fisher Connectors, S103A052-130+E31 103.1/5.7 +B. (FLIR PN 26399-000). The power cable should be 20AWG (stranded 10/30), 3 conductor, no shield, max diameter of 0.223 inches. (Example: Alphawire PN 882003)

6.3.2 Power Interface [A6705 only]

The camera is designed for +24VDC power. An AC/DC power supply is not provided with the camera. The power connector is an industrial standard M8-3 type. The power input pin out is shown in Figure 6-.
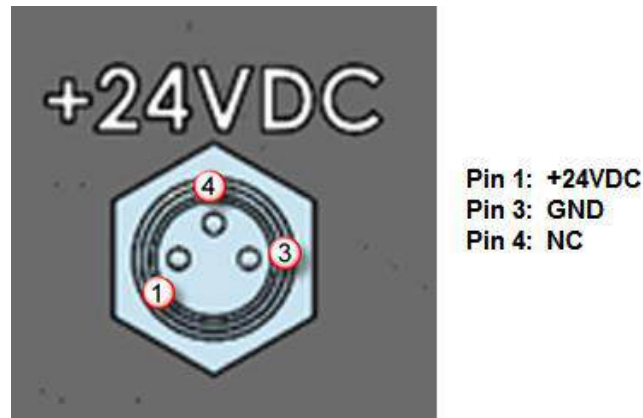
Figure 5-1: A6705 Power Input Pinouts

When using your own DC power supply, you should take note of the following information:

Input voltage: 24 VDC nominal (20-28V acceptable)

Current draw: 1.4 amps nominal steady state, 2.6 amps peak (during cool down)

A6705 power dissipation is <50 Watts steady state at nominal ambient temperature.

Mating Connector: Digikey PN 277-4338-ND, Phoenix Contact PN 1681172

6.4 Lens Interfaces

6.4.1 C-Mount (A626x only)

The A6260 and A6261 supports a standard C-mount interface. The camera ships with the C-mount interface installed. The A6260sc has the FPA (detector) position set for the standard C-mount back working distance of 17.526 mm (0.6900 inches).

Figure 6-8: Removable lens mount

6.4.2 Warm Filter (A670x and A675x Only)

The FPO Manual Focus lenses accept a filter holder that threads into the back of the lens. Here is an example of an ND1 filter installed on the back of a 1X microscope lens. ND2 and ND3 filters are available as well. These filters are used in conjunction with high-temperature radiometric calibrations, but they can also be used without a calibration to reduce signal levels. ND1 reduces signals by a factor of 10, ND2 and ND3 by factors of 100 and 1000 respectively.

Figure 6-9: HDC lens with ND1 filter screwed into the back

6.4.3 Warm Filter Holder (A626x Only)

The C-mount interface has a provision for holding a 1-inch warm filter behind the lens. To access the holder, remove the four screws holding the interface to the camera. On the back side of the lens mount there is a removable screw-on cap (FLIR P/N 4133832). Unscrew the cap and place the warm filter in the holder. Because warm filters can come in different thicknesses, be careful when screwing the cap back on. Do not overtighten or you could crack the filter. The filter holder recess is designed for a 1mm thick filter.

Figure 6-10. Removable lens C-mount and filter retainer cap

6.4.4 FLIR FPO Lens interface [A670x and A675x only]

This is a FLIR proprietary lens interface. This lens interface is compatible with FLIR FPO manual focus lenses. It will not accept FLIR FPO-M motorized lenses

Figure 6-11. FLIR 4-Tab FPO Manual Focus Lens Bayonet

6.4.5 FPO-M Motorized Lens Interface [A678x and A858x only]

This is a FLIR proprietary lens interface.   This interface supports both FPO-Motorized and FPO Manual Focus lenses.

Figure 6-12. FLIR 5-Tab FPO Motorized Focus Lens Bayonet

6.5 Other Interfaces

6.5.1 Gigabit Ethernet

Gigabit Ethernet (GigE) is a common interface found in most PC's. The GigE interface can be used for image acquisition and/or camera control. The GigE interface is GigE Vision/GenICam compliant.

6.5.2 CoaXpress (CXP) [A858x only]

CoaXpress is a digital video standard that is becoming popular for machine vision applications because it uses standard RG-59/RG-6 coax cable. This interface can be used for image acquisition and camera control. The CXP interface is also GenICam compliant.

6.5.3 HD-SDI Video

The A858x video output produces HD-SDI video according to the SMPTE 296M standard. The camera supports 720p at 50/59.9Hz or 1080p at 25/29.9Hz

The A6000-Series cameras video output produces SDI digital video. 720p format at 50/59.9/60Hz. The video supports user-selectable color palettes.

6.5.4 AUX Connector [A626x, A675x, A678x, A858x]

The AUX connector provides access to additional signals. The diagram below shows a close-up view of the rear panel connector.
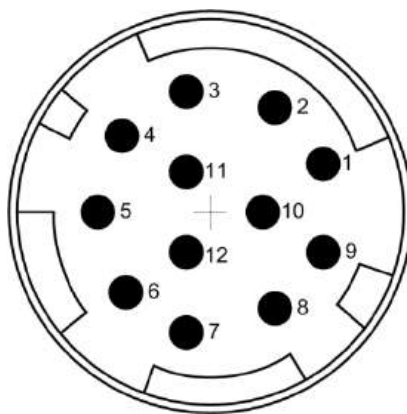
A breakout cable is provided with all A626x, A675x, A678x, and A858x cameras.

The provided breakout cable has numerical markings on the BNC overmolding that are described in the table below.

Pin	Name	Breakout Connector	Type	Description
1	NC			
2	NC			
3	RECORD START	BNC 3	INPUT	Sets RecordStart bit in image header. Can be used by FLIR Research Studio to start recording.
4	SYNC OUT	BNC 4	OUTPUT	20 microsecond wide pulse at start of integration
5	GROUND			
6	GPIO IN	BNC 6	INPUT	8-bits. Sets bits in image header. Reflected in the "DigitalIn header field (hex). Updated at ~1Hz rate.
7	Reserved	BNC 7		
8	TRIGGER LOCK-IN (OPTIONAL) [A6260/A6750 only]	BNC 8	INPUT	External trigger. Can be used by FLIR Research Studio to start recording. If lock-in option is enabled, replaces TRIG IN.
9	INTEGRATE ACTIVE	BNC 9	OUTPUT	This output is either high or low (user selectable) when the camera integration is occurring.
10	SYNC IN	BNC 10	INPUT	The Sync In can be selected, by the user, to operate as an external clock. It is a rising edge LV-CMOS signal (5.5V max). The minimum width is 160nS.
11	RS-232 TX	DB9 Male	OUTPUT	For camera control
12	RS-232 RX	DB9 Male	INPUT	For camera control
Inputs are all LV-CMOS. High>2V, Low<0.2V. Max is 5.5V				

If you wish to make your own breakout cable, there are three variants of the Hirose mating connector that will work: HR10A-10P-12S(73), HR10-10P-12S(73) or HR10A-10P-12SC(73).

6.5.5 Sync In [All except A6705 and A858x]

The Sync In can be selected, by the user, to operate as an external clock. It is a rising edge TTL signal (5.5V max). The minimum width is 160nS. Nominal operating voltage is 0 to 5.5V. The absolute maximum range is -0.5V to 6.5V. Vih=2V, Vil=0.8V. Vih is the minimum voltage at which the camera will interpret the signal as a "high" and Vil is the maximum voltage at which the camera will interpret the signal as a "low".

6.5.6 Trigger In [A6705 only]

The A6705 has a trigger input that allows an external signal to control when images are generated. One image is generated for each trigger event. The trigger is designed to accept a 24V (max) signal. >18V is considered "high" and less than 10V is considered "low". The trigger can be configured to look for a rising or falling edge. The connector is an industrial standard M8-4. The pin out is shown below.

Pin 1: Trigger
Pin 2: GND
Pin 3: NC
Pin 4: NC
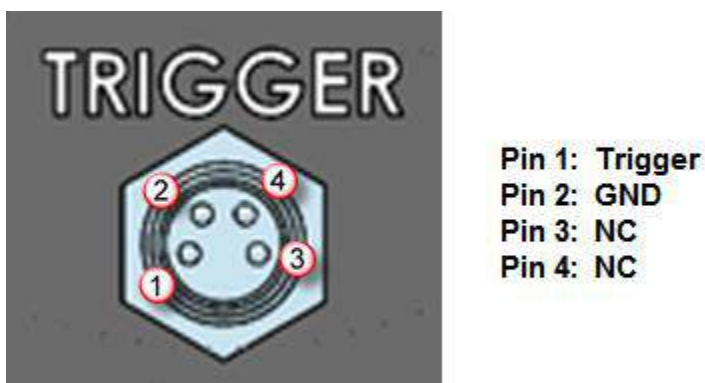
The trigger is opto-isolated, ESD protected, and reverse polarity protected

7 Specifications

7.1 Interfaces

7.1.1 A858x

AC Power	90-230V_{AC}, 50-60 Hz (using FLIR 4212680 power supply)
Control	GenICam over Gigabit Ethernet (10/100/1000)
Video Out	BNC
Frame Sync In	LVCMOS singled ended, BNC, selectable polarity, >160ns pulse width
Digital Video Out	14-bit Gigabit Ethernet (GigE Vision 2.0)
Optical Interface	FLIR FPO-M (4-tab bayonet, motorized)
Thermal Interface	Semi-sealed enclosure with integral forced air heat exchanger
Mechanical Interface	2 (two) ¼-20 tripod screws; 1 (one) $^3/_8$-16 professional tripod screw; 4 (four) 10-24 mount holes

7.1.2 A6000 Series

Specifications	A670x	A675x A675x SLS	A678x A678x SLS	A626x
AC Power	90-230V_{AC}, 50-60 Hz (using FLIR 4212680 power supply)			
Control	GenICam over Gigabit Ethernet (10/100/1000)			
Video Out	BNC			
Frame Sync In	TTL, BNC, selectable polarity, >160ns pulse width, 5.5V max			
Digital Video Out	14-bit Gigabit Ethernet (GigE Vision 2.0)			
Optical Interface	FLIR FPO 4-tab bayonet		FLIR FPO-M (4-tab bayonet, motorized)	C-Mount Lens interface
Thermal Interface	Semi-sealed enclosure with integral forced air heat exchanger			

Mechanical Interface	2 (two) ¼-20 tripod screws; 1 (one) $^3/_8$-16 professional tripod screw; 4 (four) 10-24 mount holes

7.2 Windowing Capacity

7.2.1 A858x

Window Sizes	Flexible, down to 32x4
Windowing Step Size	32 columns, 4 rows
Window Offset Step Size	No offset, FPA centered

7.2.2 A6000 Series

Specifications	A670x	A675x A675xSLS	A678x A678x SLS	A626x
Window Sizes	Full, ½, ¼	Flexible		
Windowing Step Size	N/A	Row: 16, Column: 4		Row: 32, Column: 4
Window Offset Step Size	No offset, FPA centered			

7.3 Acquisition Modes and Features

7.3.1 A858x

Frame Rate:	
Max at Full Window	45 Hz (GigE), (limited by GigE bandwidth), 60Hz (CXP)
Max w/ Windowing	192 Hz @ 640X512, 526 Hz @ 320X256
Max @ Min Window	3709 Hz @ 32x4
Minimum	1.45mHz
Resolution	480nS
Pixel Rate (burst)	100 MHz
Integration Width	
Maximum	~full frame period (1/frame rate)
Minimum	480nS
Resolution	160nS
Digital Video Output	Selectable: • Raw digital video (14-bits) • Gain and offset (NUC) corrected (14-bits) • NUC with bad pixel replaced (14-bits)

7.3.2 A6000 Series

Specifications	A670x	A675x A675xSLS	A678x A678x SLS	A626x
Frame Rate:				
Max at Full Window	60Hz	125Hz		180Hz (GigE Limited) 125 Hz (w/factory cal)
Max w/ Windowing	½: 250Hz ¼: 480Hz	½: 406Hz ¼: 1063Hz		½: 631Hz ¼: 1666Hz

Max @ Min Window	480Hz@¼	4,130Hz @ 16x4	26,150Hz @ 32x4
Minimum	<1Hz		
Resolution	480nS		
Pixel Rate (burst)	100 MHz		
Integration Width:			
Maximum	~full frame period (1/frame rate)		
Minimum	480nS		
Resolution	160nS		
Digital Video Output:	Selectable: • Raw digital video (14-bits) • Gain and offset (NUC) corrected (14-bits) • NUC with bad pixel replaced (14-bits)		

7.4 HD-SDI Video

7.4.1 A858x and all A6000 models

Video Output	SD-SDI 480i, 576i HD-SDI 720p @ 50/59.9Hz or 1080p @ 25/29.9
Data Output	Selectable • Raw, uncorrected • Corrected
AGC	Selectable • DDE • Plateau based equalization • Linear equalization
AGC Filter	User controlled damping factor User controlled update rate

Overlay	Available on HD-SDI output
Palettes	Selectable • Grayscale • Various color palettes
Zoom (HD-SDI video)	• Automatic, best fit

7.5 Performance Characteristics

7.5.1 A858x

Power Consumption **FLIR PWR Supply @ 120V$_{AC}$**	Continuous Cool Down:	50 VA
	Continuous Normal:	41 VA
Power Consumption **Camera DC Power @ 24V$_{DC}$**	Continuous Cool Down:	24 Watts
	Continuous Normal:	21.25 Watts
Cool-down Time	≈5-7 minutes to reach operating temperature	
Sensitivity (w/o optics) **NEΔT[1]**	1.5-5.0 µm: ≤ 30mK typical 3.0-5.0 µm: ≤ 25mk typical	

1) NEΔT is at 50% nominal bucket fill, 298K background, $\pm$ 5ºC signal

7.5.2 A6000 Series

Specifications	A670x	A675x A678x	A675x SLS A678x SLS	A626x
Power Consumption **FLIR PWR Supply @ 120V$_{AC}$**	Continuous Cool Down: 50VA			40VA
	Continuous Normal: 41VA			36VA
Power Consumption **Camera DC Power @ 24V$_{DC}$**	Continuous Cool Down: 24W			21W
	Continuous Normal: 22W			19W
Cool-down Time	≈5-7 minutes			≈2 minutes
Sensitivity (w/o optics)	3-5µm: ≤20mK		≤45 mK	N/A

NEΔT[1]		(≤40mK typical)	
	1-5μm: ≤25mK		

7.6 Non-Uniformity Correction

7.6.1 A858x and all A6000 models

NUC Types	Two Point (offset and gain values) non-volatile
	Two Point w/Bad Pixel Detection/Replacement
	Update Offset (recalculates offset using current gain)
NUC Source	Internal: Ambient flag (for 1-pt and offset update only)
	External: Any user supplied source which covers entire FOV
Bad Pixel Replacement	Two-Point Gradient and nearest neighbor (auto selected)
Number of NUC's	4 active NUC's in preset selectable form
	>100 NUCs in on-board flash
NUC Time	< 15 seconds
NUC Performance	0.1%

7.7 Detector/FPA

7.7.1 A858x

Spectral Response	A8580/82: 1.5-5um; A8581/83: 3-5um
	A8580 SLS: 7.5-12um
Detector Types	InSb or SLS
f/#	f/2.5 or f/4
Integration Mode	Snapshot
Format (HxV)	1280x1024
Operability	≥99.5%, 99.9% typical (InSb)
	≥98%, 99% typical (SLS)
Charge Handling Capacity[1]	A8580 (InSb) : 3.0×10^6 carriers (High Gain)
	A8580 (SLS) : 11.5×10^6 carrier (Low Gain)
Detector Pitch	12 microns
Detector Cooling	Linear Cryocooler

7.7.2 A6000 Series

Specifications	A670x A675x A678x	A675x SLS A678x SLS	A626x
Spectral Response	A67x0/A67x2: 1-5μm A67x1/A67x3: 3-5μm	Lower: 7.5μm Upper: 10-11μm	A6261: 0.9-1.7μm A6262: 0.6-1.7μm
Detector Types	InSb	T2SLS	InGaAs
f/#	f/2.5 or f/4		w/ cal: lens locked at f/4 w/o cal: variable with lens
Integration Mode	Snapshot		
Format (HxV)	640x512		
Operability	≥99.5%, 99.9% typical	≥98%, 99% typical	≥ 99.5% (≥ 99.8% typical)
Charge Handling Capacity[1]	7.2M electrons		Low Gain: 1.44 Me-, Medium Gain: 95.7 ke-, High Gain: 19 ke-
Detector Pitch	15 microns		
Detector Cooling	Rotary Cryocooler (77K, nominal)		TEC (30C)

7.8 General Characteristics

7.8.1 A858x

Size	
Length	8.9 inches
Width	4.6 inches
Height	5.3 inches (not including lens or lens cover)
Weight	8.2 lbs. (not including lens or lens cover)

Operating Temperature Range	-20C to +50C (-4°F to 122°F)
Shock	40g, 11msec ½ sine pulse
Vibration	4.3 g RMS random vibration, all three axes
Humidity	<95% relative humidity, non-condensing
Operating Orientation	No restriction in orientation

7.8.2 A6000 Series

Specifications	A670x A675x and A675x SLS A678x and A678x SLS	A626x
Size		
	(not including lens)	(not including lens)
Length	8.9 in. (22.6cm)	8.5 in. (21.8cm)
Width	4.0 in. (10.2cm)	4.0 in. (10.2cm)
Height	4.3 in (10.9cm)	4.3 in (10.9cm)
Weight	5 lbs. (2.26kg)	
Operating Temperature Range	-20C to +50C (-4°F to 122°F)	0C to +45C (32°F to 113°F)
Shock	40g, 11msec ½ sine pulse	
Vibration	4.3 g RMS random vibration, all three axes	
Humidity	<95% relative humidity, non-condensing	
Operating Orientation	No restriction in orientation	

8 Maintenance

8.1 Camera and Lens Cleaning

8.1.1 Camera Body, Cables and Accessories

The camera body, cables and accessories may be cleaned by wiping with a soft cloth. To remove stains, wipe with a soft cloth moistened with a mild detergent solution and wrung dry, then wipe with a dry soft cloth.

Do not use benzene, thinner, or any other chemical product on the camera, the cables or the accessories, as this may cause deterioration.

8.2 Lenses

It is recommended that all optics be handled with care and the need for cleaning is eliminated or at least reduced. If, however, cleaning is deemed necessary, the methods herein are accepted industry standards and should yield good results.

Before you BEGIN,

Identify the type of optic to be cleaned.
- Is it hard or soft material?
- Is it coated & with what?

How is it contaminated?
- Particulate or film or both.

Set a standard of cleanliness.
- What is clean enough?
- Establish & document a standard.

Know your solvent.
- Read the MSDS
- See recommended solvents

Assemble your supplies:
- Latex gloves
- Clean, well-lit work area
- Inspection light
- Lens tissue or cloth
- Dust bulb or filtered air
- Proper solvent
- Solvent dispenser

The Drag Wipe Method:

Set-up a clean area to work from with an anti-roll barrier around the edge to prevent anything from leaving the table.

Use a clean, lint free cloth or lens tissue.

Wear latex gloves - clean them with alcohol or detergent before handling optic.

NEVER touch the face of the optic.

Cover the optic and store in a dry - dust free area immediately after cleaning.

1. Blow or brush loose particles from surface. Don't let them contaminate your work area. Use air from a can or a filtered source.
2. Apply solvent directly to your cloth. Use slow, even, light pressure working from edge to edge across the optic.

Recommended Solvents

Material	Solvent		
Fused Silica	1,2,3,4	Zinc Selenide	1,2,4
BK-7	1,2,3,4	Zinc Sulfide	1,2,4
Optical Crown Glass	1,2,3,4	Sapphire	1,2,3,4
Zerodur	1,2,3,4		
Calcium Fluoride	1,2,4	Coated Optics	
Magnesium Fluoride	1,2,4	Dielectric coating	1,2,3,4
Sodium Chloride	Nitrogen	Interference filters	3
Potassium Chloride	Nitrogen	Soft metallic coating	Air only
Potassium Bromide	Nitrogen	Hard/Protected metallic	1,2,3,4
Thallium Bromoiodide	Nitrogen		

1] Water free Acetone

2] Ethanol

3] Methanol

4] Isopropanol