



## EAN-Infrared Temperature

2022-07-25

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Web: [sightlineapplications.com](http://sightlineapplications.com)


Sales: [sales@sightlineapplications.com](mailto:sales@sightlineapplications.com)


Support: [support@sightlineapplications.com](mailto:support@sightlineapplications.com)

Phone: +1 (541) 716-5137

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 **CAUTION:** Alerts to a potential hazard that may result in personal injury, or an unsafe practice that causes damage to the equipment if not avoided.

 **IMPORTANT:** Identifies crucial information that is important to setup and configuration procedures.

 *Used to emphasize points or reminds the user of something. Supplementary information that aids in the use or understanding of the equipment or subject that is not critical to system use.*



## 1 Overview

This document describes features surrounding infrared (IR) camera temperature measurements. SightLine hardware products can be used to acquire and process 14- or 16-bit data from IR cameras. This allows calculation of statistics on the raw pixel count data, which can be used to provide metrics such as the minimum, maximum, and average pixel value. The auto gain algorithm is configurable, allowing clipping of raw data to a specific digital range and the corresponding temperatures. Standard or custom false color lookup tables (LUT) can then be applied to highlight temperature regions. For more details on auto gain see the [Auto Gain Calculation Notes](#).

SightLine products allow snapshot exports of raw camera data. Raw can be saved in 16-bit PNG files. The process for saving these snapshots to the microSD card as well as extracting the data is detailed in [EAN-File Recording](#).

### 1.1 Camera Specific Features

The FLIR Tau 2 or DRS Tamarisk Superframe camera are both compatible with SightLine hardware. FLIR Tau 2 cameras can be purchased with a factory calibrated TLinear mode. This is not available on a non-calibrated Tau 2. The DRS Tamarisk Superframe camera also supports raw temperature calibrated data output. This data is full 16-bits.

These calibrated cameras allow the output data (pixel counts) to be converted to temperature using linear conversion provided by the manufacturer. Setup and configuration of these cameras will be detailed using the 1500-OEM.

Read the camera calibration overview in the FLIR *Advanced Radiometry App Note* document available at [FLIR](#) before attempting to use this feature.

### 1.2 Additional Support Documentation

Additional Engineering Application Notes (EANs) can be found on the [Documentation](#) page of the SightLine Applications website.

The [Panel Plus User Guide](#) provides a complete overview of settings and dialog windows located in the Help menu of the Panel Plus application.

The Interface Command and Control (IDD) describes the native communications protocol used by the SightLine Applications product line. The IDD is also available as a PDF download on the [Documentation](#) page under Software Support Documentation.

### 1.3 SightLine Software Requirements

**ⓘ IMPORTANT:** The Panel Plus software version should match the firmware version running on the board. Firmware and Panel Plus software versions are available on the [Software Download](#) page.

### 1.4 Application Bit Requirements

The functions described in this EAN require Application Bits (app bits) purchased from SightLine. App bits are enabled with a license file provided by SightLine at initial unit purchase or during a license upgrade process. License files use a hardware ID that is applicable to a specific hardware serial number. For questions and upgrade support contact [Sales](#).



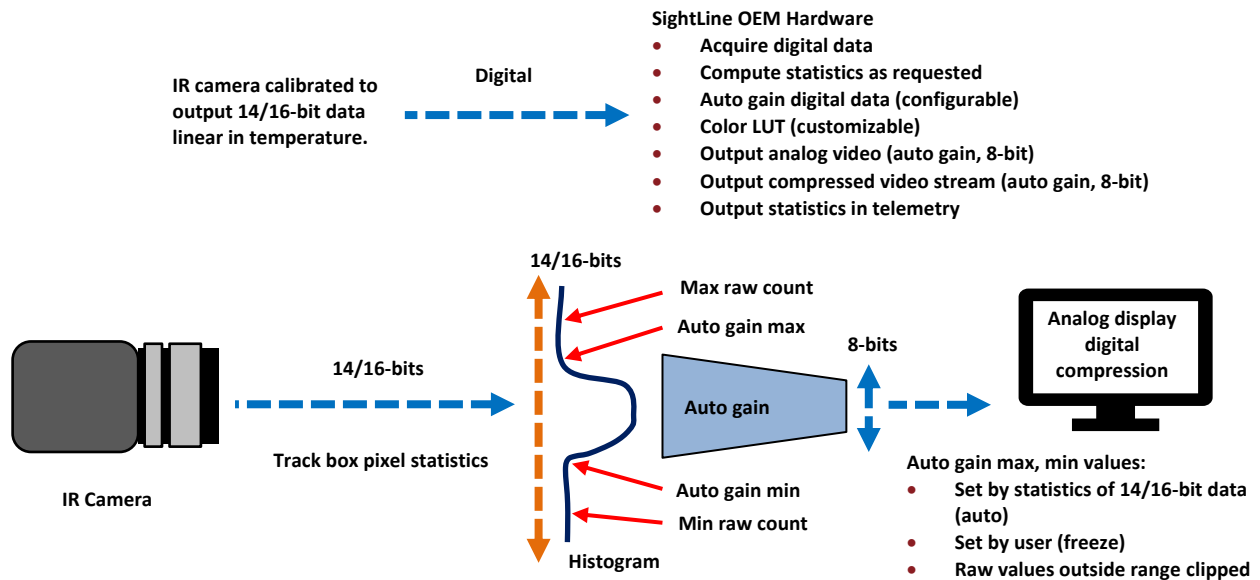
**Table 1: Application Bits Requirement Table**

Function	Initial Software Release	Required Application Bit(s) v7 License
Enhancement, High Depth and Radiometric temp <a href="#">Snapshot recording</a> requires Recording app bit	2.22.xx	Enhancement 0x0000 0080 Optional (recommended): Recording 0x0000 0400
High Bit Depth/Temp Telemetry <a href="#">Snapshot recording</a> requires Recording app bit	3.00.xx	High Bit Depth/Temp Telemetry 0x0002 0000 Optional (recommended): Enhancement 0x0000 0080 Recording 0x0000 0400

## 2 Requirements

The infrared camera should support the following:

- Output of digital pixel data with full resolution (14 or 16 bits).
- Operating mode where output digital counts are linear with temperature. Normal detector counts are linear with photons, i.e. flux, which not the same as temperature.



**Figure 1: IR Temperature Measurement System**

## 3 Automatic and Manual Gain

New in 3.2.x software.

Gain control, also known as auto gain, is used to convert a wide range of digital counts to an 8-bit range for display or compression. Gain control can be automatic (auto) or manual.

Auto gain maps the minimum and maximum digital counts in the incoming 16-bit image to 0 and 255, respectively in the resulting 8-bit image. The auto gain range can be locked to a specific region using the SVP command [SetDigitalCameraParameters \(0x70\)](#). Auto gain can also be set up in the Panel Plus *Capture* tab. *Brightness* and *Contrast* can be used to shift and stretch the mapping.



### 3.1 Auto Gain Region of Interest

Using the *Auto Gain Region of Interest* drop-down menu, the area over which the statistics are calculated can be set as either a percentage of the whole image or a preset quadrant within in the image.

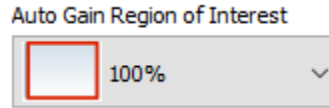


Figure 2: Auto Gain Region Configuration

### 3.2 Automatically Adjust Gain

To automatically adjust gain on a high-bit depth camera, set the *Auto Gain* mode to *High Bit Depth Auto Gain*. For each frame, the system will calculate statistics used to adjust the image to an 8-bit output.

*Request:* When this button is clicked, Panel Plus queries the OEM board for the current image control values (including exposure and gains values) and then fills them in. These values are then displayed on the *Manual Min* and *Manual Max* slider.

The input video is 16-bit images (grey values 0 to 65535). The internal (after auto gain calculation) and output video is 8-bit images (grey values 0 to 255). In this example, a value of 4019 in the input image will map to 0 in the internal/output and a value of 7419 will map to 255.

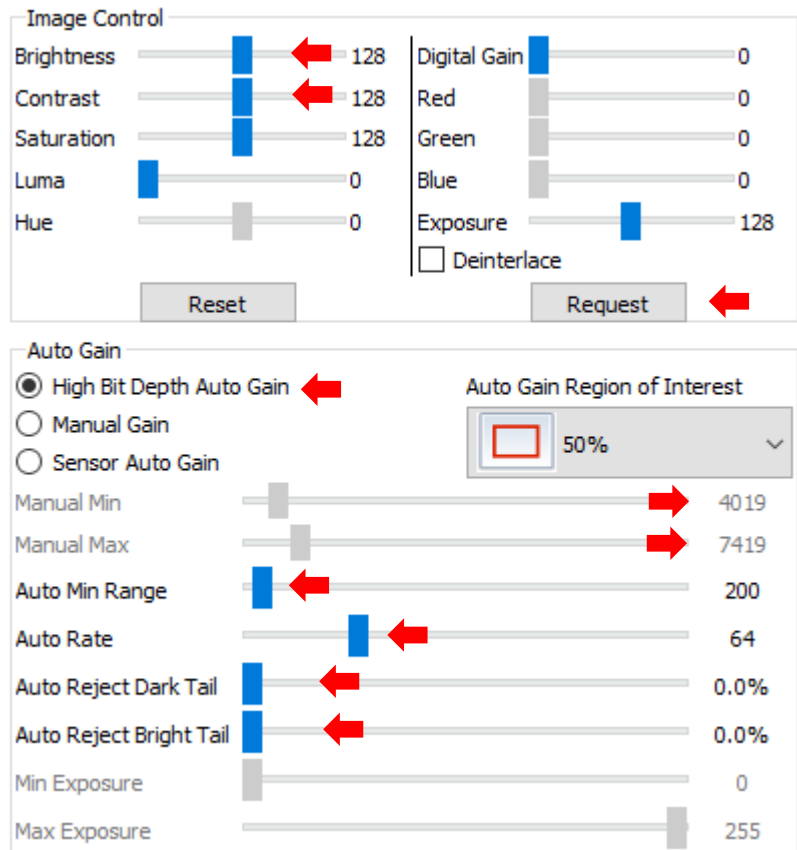


Figure 3: High Bit Depth Auto Gain

*Brightness:* Shifts the mapping to make the resulting image brighter or darker.

*Contrast:* Stretches the mapping to make the 8-bit image higher or lower contrast.

*Auto Min Range:* Sets the minimum spread (max pixel value - min pixel value) that the algorithm will produce data. This prevents over-scaling of flat scenes.

*Auto Rate:* Controls the rate (frames) that the auto gain algorithm adjusts: 1 = minimum rate, 255 = maximum rate, 32 = default.



New in 3.4.x software:

**Auto Reject Dark Tail:** Reject or ignore a percentage of the left/dark side of the histogram when calculating autogain. 0 = reject none, 10 = reject 1.0%, 255 = reject 25.5%. This is useful when there are a small number of very dark pixels in a scene.

**Auto Reject Bright Tail:** Reject or ignore a percentage of the right/bright side of the histogram when calculating autogain. 0 = reject none, 10 = reject 1.0%, 255 = reject 25.5%. This is useful when there are a small number of very bright pixels in a scene.

### 3.3 Manually Adjust Gain

To manually adjust gain on a high-bit depth camera and freeze the auto gain, set the *Auto Gain* mode to *Manual Gain*. Control the gain range with the *Min/Max* sliders. *Brightness* and *Contrast* are also applied in *Manual Gain* mode.

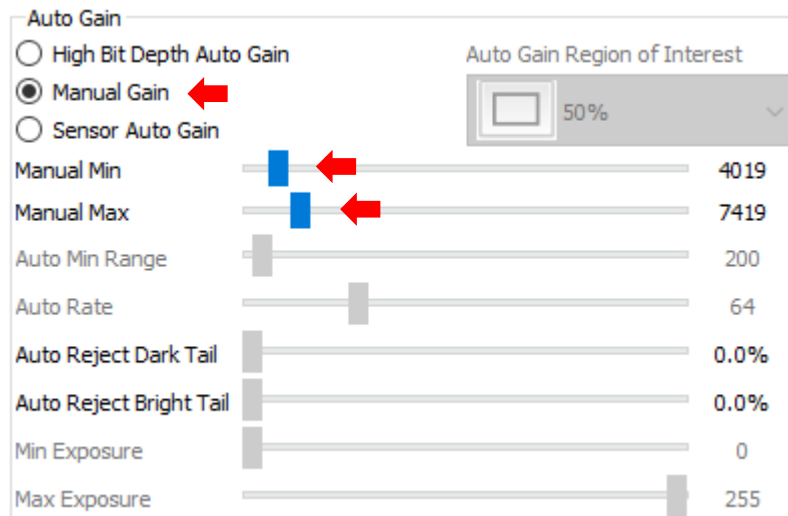


Figure 4: Manually Adjust Gain

### 3.4 Converting Raw Counts to Temperature

For both the FLIR Tau 2 and the DRS Superframe cameras, Panel Plus has built in functions to convert the raw pixel count to temperature. The temperature scale and the conversion factor can be selected in the *Thermal* section of the *Capture* tab.

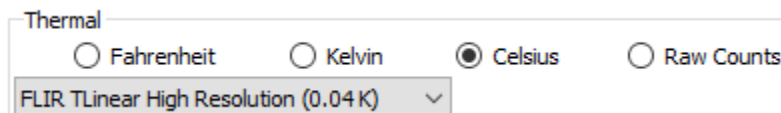


Figure 5: Temperature Scale and Conversion Factor

## 4 FLIR Tau 2 T Linear Camera Setup

### 4.1 Acquiring Tau 14-Bit Data

Open the Panel Plus application and connect to the 1500-OEM. See the [EAN-Digital-Video-Configuration](#) and the [camera configuration tables](#) for digital camera setup information.



*Digital camera setting: FLIR Tau 2 640 14-bit (or FLIR Tau 2 336 14-bit).*

## 4.2 FLIR T Linear Modes and Ranges

- FLIR TLinear supports low and high-resolution modes.
- 14-bit digital output maximum counts = 16383.
- Low resolution digital counts correspond to 0.4 Kelvin.
- High resolution digital counts correspond to 0.04 Kelvin.

*The Tau 2 camera has a gain mode setting of High, Low and Auto that can be set using the FLIR Camera Controller GUI.*

- High gain mode (default) limits maximum temp to about 350°F.
- Low gain mode allows for measuring higher temperature scenes.
- Auto mode switches between the two modes at a programmable scene temperature. This is the preferred selection.

**Table 2: FLIR TLinear High/Low Resolution Temperature Ranges**

	Min °K	Max °K	Min °C	Max °C	Min °F	Max °F
Low Res (0.4)	0	6553	-273	6280	-459	11336
High Res (0.04)	0	655	-273	382	-459	719

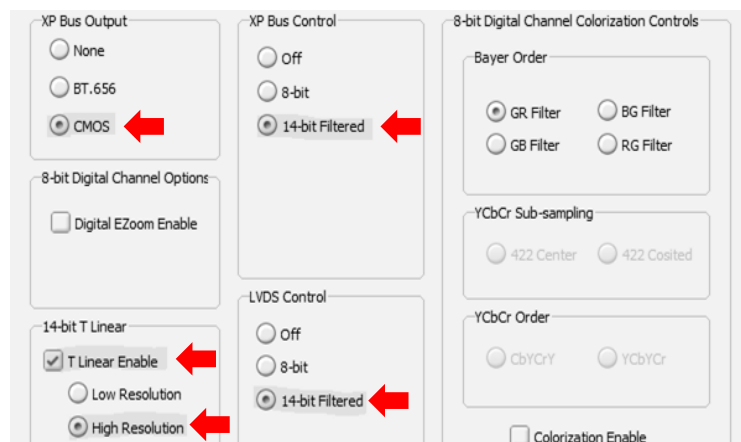
## 4.3 FLIR Tau 2 TLinear Configuration

The FLIR Tau 2 camera must be configured in 14-bit TLinear mode. This can be done using the USB dongle provided with the camera, or through the serial passthrough feature.

To use serial passthrough, setup serial port 2 using 57,600 baud. See the [EAN-Ethernet-and-Serial-Communication](#) document for details.

1. From the FLIR *Camera Controller* interface go to the *Digital Video* tab.
2. Select all the settings shown in [Figure 6](#).

*If the 14-bit TLinear options are not visible, the FLIR Tau 2 camera has not been factory calibrated.*



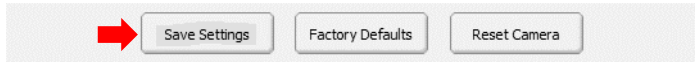
**Figure 6: FLIR Camera Controller Interface - Digital Video Tab**



- From the *Setup* tab, set *Gain Mode* to *Auto*.



- Click *Save Settings* to save the settings for subsequent restarts.



## 5 DRS Tamarisk Precision Superframe Setup

The DRS Tamarisk Superframe is supported in firmware 2.22.15 and later. This has currently been tested on the 320 version of this camera (the 640 is not available).

See the [EAN-DRS-Tamarisk-Camera](#) for Panel Plus configuration settings.

### 5.1 DRS Superframe Modes and Ranges

Data output is 16-bits (there are no programmable ranges). Each 16-bit pixel value represents Kelvin temperature as 11.5 fixed point binary. For Celsius, use 16-bit pixel value as the integer, divide by 32.0, then subtract 273.15.

## 6 Measuring Temperature in Regions

Tracking provides mean, min, and max raw digital counts of up to five Region of Interests (ROI) within the image. Region of Interests can be specified through the Sightline Command and Control Protocol (SVP) **Modify Track command (0x05)** or by starting tracks with Panel Plus.

- From the Panel Plus main menu » *Track* » *Manual* tab, select a manual target designation mode from the drop-down menu.

Other controls can be used to adjust the region that the statistics will be calculated. Up to five (5) tracks can be selected.

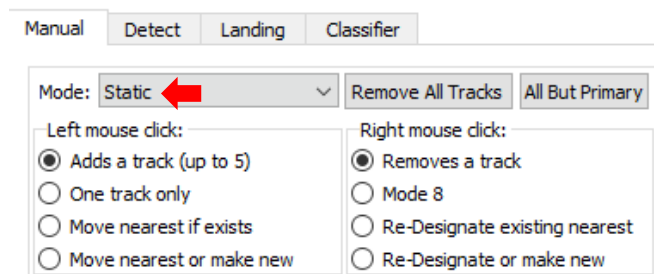
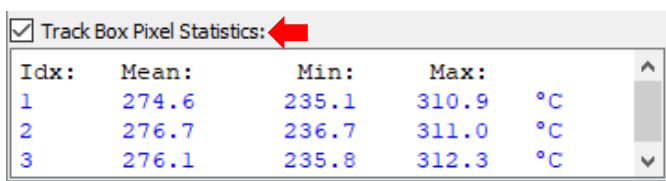


Figure 7: Manual Target Designation Modes

- Click *Show Telemetry* then enable *Track Box Pixel Statistics*. If a conversion factor has been selected (*Capture* tab), then the temperature values will be displayed instead of raw counts.



- Click the desired region on the image in Panel Plus to start a track.



Statistics values are read through the SVP **Tracking Box Pixel Stats command (0x78)**. Raw pixel count value is provided if the current camera is a high-bit depth digital imager, and the pixels stats output is enabled in the **Set Coordinate Reporting Mode command (0x0B)**.

Conversion from raw digital counts can be done based on the configuration of the IR imager.

## 7 Color LUT Display of User Defined Temperature Regions

The *Capture* tab also provides the ability to specify temperature ranges of interest. Freeze the auto gain algorithm to display the desired temperature range. Use the custom color LUT to highlight temperatures of interest. Additional information and options for setting the LUT can be found in [EAN-False Color](#).

### 7.1 Defined Temperature Range - Freeze Auto Gain

Example:

1. Set the range and freeze the auto gain:
  - a. Select *Manual Gain*.
  - b. The FLIR TLinear camera should be in high resolution mode (0.04 °K/count).
  - c. Set min temperature of interest to 80°F (300°K = 7500 digital counts).
  - d. Set max temperature of interest to 400°F (478°K = 11,950 digital counts).

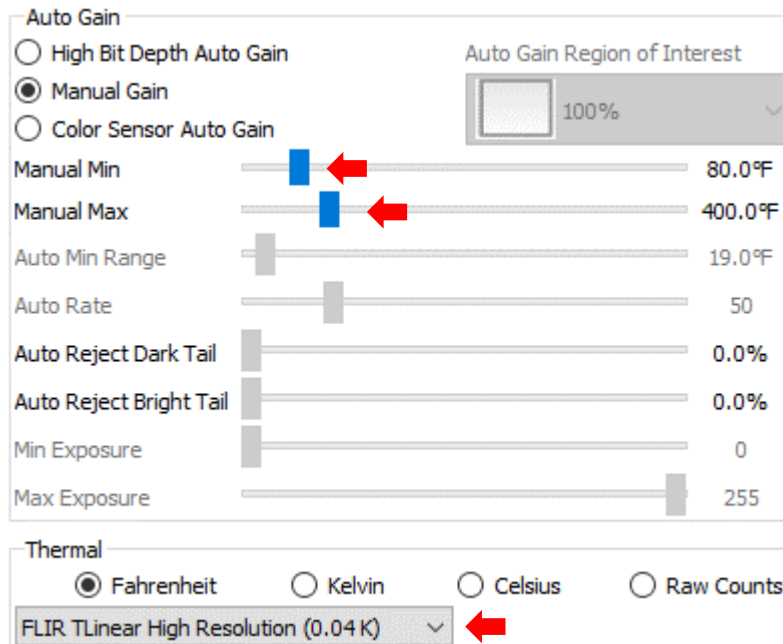


Figure 8: Defined Temperature Range

All temperatures below 80°F are now mapped to 0. All temperatures above 400°F are mapped to 255. Each output count in between now corresponds to a 0.8°F change in temperature. Temperature to count conversion is  $(temp-80) * (255) / (320)$ .

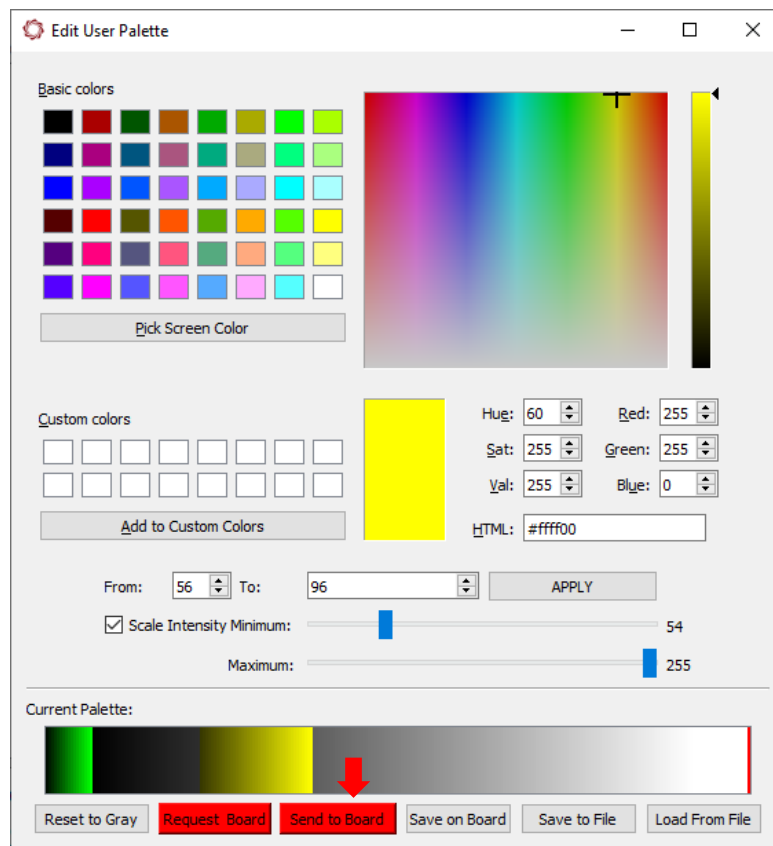




2. Set custom LUT setting 0 » 255 counts maps to RGB values (r,g,b):
  - a. From the Panel Plus *Enhance* tab, in the *False Color* drop-down menu select *User Palette*.

False Color: User Palette

- b. From the Panel Plus main menu » *Configure* » *User Palette*.
- c. Initialize the LUT to an incrementing grayscale LUT[x] = (x,x,x).
- d. Map the range of human body temperature (80°F - 100°F ) LUT[0 - 16] to a color range (e.g., green).
- e. Map the range of hot objects such as electrical wires (150°F - 200 °F) LUT[56 - 96] to a color range (e.g., yellow).
- f. Map all values above 400°F to pure red by setting LUT[255] to (255,0,0).
- g. Click *Send* to send the settings to the board.



**Figure 9: Setting Up a Defined Temperature Range**



### Auto Gain Calculations Notes:

- The auto gain algorithm is used to convert high-bit depth camera data into 8-bit data for display and compression. Grayscale data values range from 0 to 16383 (14-bits) or 0 to 65536 (16-bit).
- Define the information content of the scene and scale this range of data into 8-bits (255 counts).
- Standard deviation and mean are suitable measures of information content and are easy to calculate.
- The auto gain calculation currently uses a spread of four standard deviations and uses the mean as the center of the range, i.e.,  $\pm 2.0$  standard deviations about the mean.

## 7.2 Brightness and Contrast

Brightness and contrast can be adjusted in the *Capture* tab of Panel Plus. These settings are used to adjust the spread and center of the region used for auto gain. *Contrast* is used to scale the spread of the data. A higher contrast setting results in a smaller spread of data. *Brightness* is used to adjust the center of the region used for auto gain.

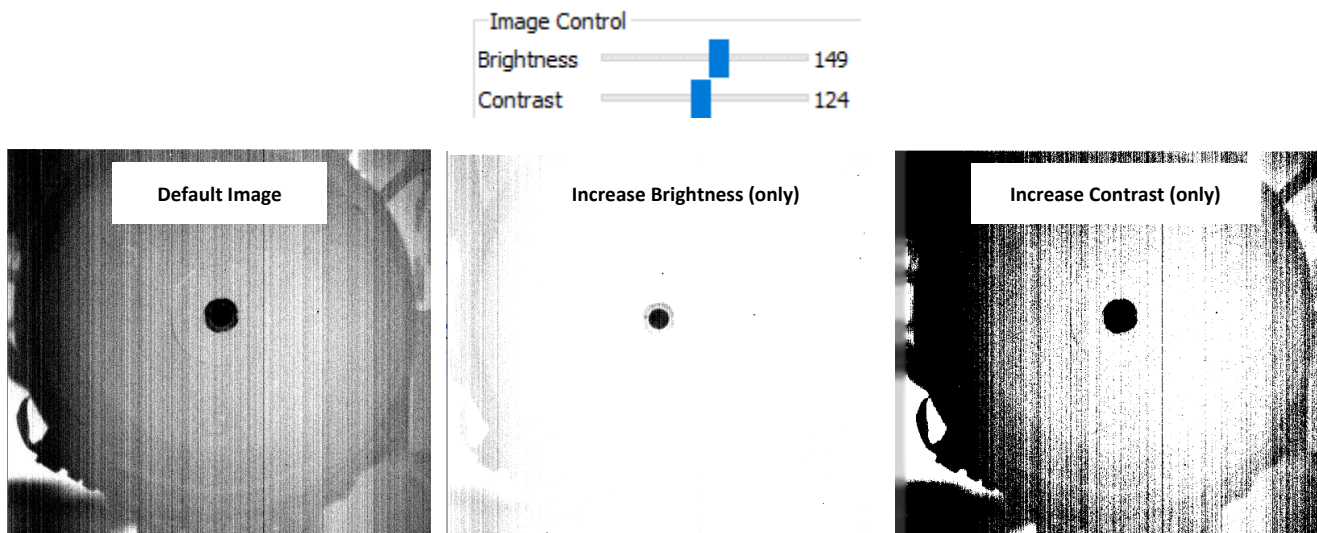



Figure 10: Brightness and Contrast

## 8 Smoothing Filter

If the spread and center were to be calculated and the new values applied to every frame, the image would change levels very quickly and the video quality would degrade. Instead, the min and max values of the data range to be displayed are calculated and then run through a smoothing filter with a time constant of  $\sim 1$  second. These smoothed values are then used to calculate the spread and center of the current auto gain calculation.

 To freeze the auto gain, or preset a specified max and min count, overwrite the filter output with a constant max and min value from the *Capture* tab in Panel Plus.



## 9 16-Bit Grayscale Snapshot

It is possible to capture snapshots of the raw 16-bit camera data to either the microSD card, FTP Server, or to the 4000-OEM USB device. This will enable conversion of each pixel element of the snapshot into full resolution temperature data offline. See the [EAN-File Recording](#) document for more information.

## 10 Questions and Additional Support

For questions and additional support, please contact [SightLine Support](#). Additional support documentation and Engineering Application Notes (EANs) can be found on the [Documentation](#) page of the SightLine Applications website.