FLIR Camera Adjustments Boson

Application Note

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1.0 Document

1.1 Revision History

Version	Date	Comments
100	10/06/2016	Initial Release
200	11/03/2016	-Added Detail Headroom description -Updated naming convention for AGC Parameters to match Boson GUI -SSO → Linear Percent -Entropy Based → Information-Based -Added table of default values and value ranges
210	6/8/2017	-Added API names to AGC Parameter chart
220	6/26/2018	-Removed <9Hz from title -General formatting -Updated description of ACE to describe potential issues
221	8/29/2018	-Updated footer to include export language

1.2 Scope

This note is intended to provide a better understanding of FLIR image processing algorithms in Boson. Once these are well understood by the user, the camera can be optimized to give the best possible image for a given scenario. This document applies to the FLIR Boson camera.

2.0 Automatic AGC Parameters

The digital image data collected by the sensor is 14.2 bits wide (hereon referred to as 16bits). However, almost all commercial displays are only capable of imaging 8bits of information. In other words, the video is displayed on a 0-255 scale rather than the full 0.00-16383.75 resolution of the sensor. Please note that the last two bits of the raw 16 bit data is used after the decimal point. In other words, the values will increment like [0.00 , 0.25 , 0.50 , … , 16383.50 , 16383.75]. Because we have to move from 16bit values to 8bit values, this means that there must be some compression to get the data into a format that can be displayed. The AGC algorithm, and the parameters that control it, is responsible for generating a "transfer function" that maps the data from 16bit to 8bit space. Throughout this note, there are illustrations and descriptions of histograms that are represented in Input Signal Value vs. Number of Pixels. A histogram is a sorting of pixel values into intensity "bins". What this means is the bit value (which increases as pixels get brighter) is on the x-axis and the number of pixels in the image that have that bit value is on the y-axis. This is a way of plotting image data in order to illustrate which are the most significant intensity values. (See Section 2.1 for a more thorough description of histograms.)

The Boson core uses one AGC algorithm that is divided into two modes. These modes include the following, with associated parameters shown below:

- **Plateau Equalization:** This AGC setting will redistribute output dynamic range proportional to the amount of pixels in every irradiance range. Similar to classical Histogram equalization (HEQ), Plateau Equalization computes a histogram of all pixel values in the scene, and the cumulative histogram (i.e., the integral of the histogram) is the mapping function that transforms data from 16-bit space to 8-bit space. Unlike classical HEQ, Plateau Equalization features some additional optimizations that can change how the histogram is calculated. These optimizations are described in more detail below.
- **Information-Based Equalization:** When enabled, this AGC setting will distribute output dynamic range proportional to the amount of scene information in every irradiance range. Many infrared scenes are comprised of a small number of objects superimposed against a fairly uniform background (or perhaps two backgrounds such as sky and ground). In such scenes, the background dominates the histogram and is therefore allocated a large percentage of the 8-bit gray shades, leaving few for the details in the foreground. In Information-Based Equalization, the scene data is segregated into details and background using a High-Pass (HP) and Low-Pass (LP) filter. Pixel values in the HP image are weighted more heavily during the histogram-generation process, which results in the details being allocated more 8-bit gray shades and thus benefiting from higher contrast in the resulting image.

Both Plateau Equalization and Information-Based Equalization use the same set of parameters, which are briefly described below. More detailed descriptions of each parameter are found throughout this document, and are distinguished by paragraphs written in blue:

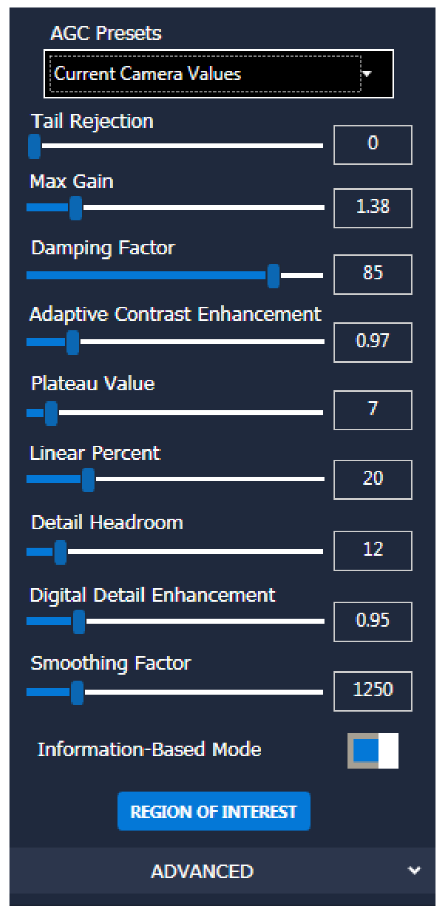
- **Linear Percent:** Most histogram-based AGC methods do not preserve the relative temperature of objects in the scene. Increasing values of Linear Percent more accurately preserves the visual representation of an object's temperature by mapping the data in a more linear fashion. For example, in a scene where the two hottest objects in the scene are a human and a heated stove-top, setting Linear Percent to zero will display the stove only slightly brighter than the human because no 8-bit grayshades are dedicated to the empty portion of the histogram between the two. With a high value of Linear Percent, the stove will appear much brighter than the human (as one would expect from a hot stove). However, this enhancement is at the cost of decreased contrast throughout the image because some of the available 8-bit grayshades are allocated to portions of the histogram which are not present in the scene.
- **Tail Rejection:** Determines the percentage of the histogram "tails" which are not ignored when generating the mapping function. The scene outliers which comprise the histogram tails are consequently mapped to either the minimum or maximum grayshade (0 or 255). A large value of Tail Rejection will dedicate more 8-bit grayshades to the central portion of the histogram, resulting in more contrast therein, but as a result, a small cold object or small hot object in the scene may appear completely washed out (no variation in grayshades).
- **Damping Factor:** As new objects enter the scene or the camera field of view changes, the AGC algorithm will be forced to update accordingly. Damping Factor increases or decreases the update rate of all AGC algorithms. A small value of Damping Factor allows a faster remapping in response to a change in the scene, but in some cases this can result in the background appearing to "flash" as it is quickly remapped to new 8-bit grayshades. A larger value of Damping Factor minimize flashing in response to a change in scene but at the expense of requiring more time to optimize the mapping function for the new scene content.
- **Adaptive Contrast Enhancement (ACE):** Used to adjust the perceived brightness of the image. An ACE value less than unity maps a larger percentage of the scene to the lower 8-bit grayshades while a value greater than unity maps a larger percentage of the scene to the higher 8-bit grayshades.
- **Max Gain:** Limits the maximum slope of the mapping function. In a relatively uniform image, a high Max Gain value increases the contrast of the image at the risk of over-exposure and more apparent noise in the image. Lower values of Max Gain result in a less grainy, lower contrast display.
- **Plateau Value:** Limits the population of any single histogram bin. Increasing values allow the mapping function to allocate more grayshades to dominant scene content, as seen in traditional HEQ. Smaller values of Plateau Value clip the heavily-populated bins, reserving more 8-bit grayshades for less heavily populated bins.

- **Digital Detail Enhancement (DDE):** Attenuates or gains the HP content of the scene. Reduces the appearance of graininess but blurs the scene when set to values less than 1, and sharpens the details but increases the appearance of noise when set to values greater than 1.
- **Smoothing Factor:** Defines the cut off for the HP filter. Lower values of Smoothing Factor result in less data being included in the HP portion of the image. In other words, a low value of Smoothing Factor decreases the portion of the scene considered to be the more-heavily-weighted details. Smoothing Factor also affects which portion of the scene is attenuated or enhanced via DDE.
- **Detail Headroom**: Defines the amount of 8bit dynamic range is allowed for use by the LP filter data (the histogram equalized data). Increasing values will increase the number of 8bit shades—at the top and bottom of the dynamic range—to be reserved for the HP data.

The default values for all these parameters are shown on the right. The table below shows the range that each value can take.

Parameter	API Parameter Name	Range
Tail Rejection	OutlierCut	0 - 49
Max Gain	MaxGain	0.25 – 8.00
Damping Factor	df	0 - 100
ACE	Gamma	0.50 – 4.00
Plateau Value	PercentPerBin	1 - 100
Linear Percent	LinearPercent	1 - 100
Detail Headroom	DetailHeadroom	0 - 127
DDE	d2br	0.00 – 6.00
Smoothing Factor	SigmaR	1 - 8191

Note: FLIR highly recommends that each customer optimize AGC parameter settings for each particular application. "Preferred" AGC settings are highly subjective and vary considerably depending upon scene content and user preferences. Generally speaking, FLIR recommends the Information-Based Equalization mode over the Plateau-Equalization mode, but there are scenarios where Plateau-Equalization may be better suited. The one parameter which FLIR does not recommend changing from its default value is Smoothing Factor. The default Smoothing Factor value has been found to be ideal for almost all imaging scenarios.



2.1 Introduction to Histograms

The following histogram is the 16-bit data taken of a cold water bottle, a mid-temperature wall, and a hot coffee mug in the scene. These three objects can be seen in the data histogram as three separate peaks. The lowest bit values, which are farthest to the left in the histogram, are the coldest pixels in the scene. The values in 16-bit space range from 0.00 to 16383.75.

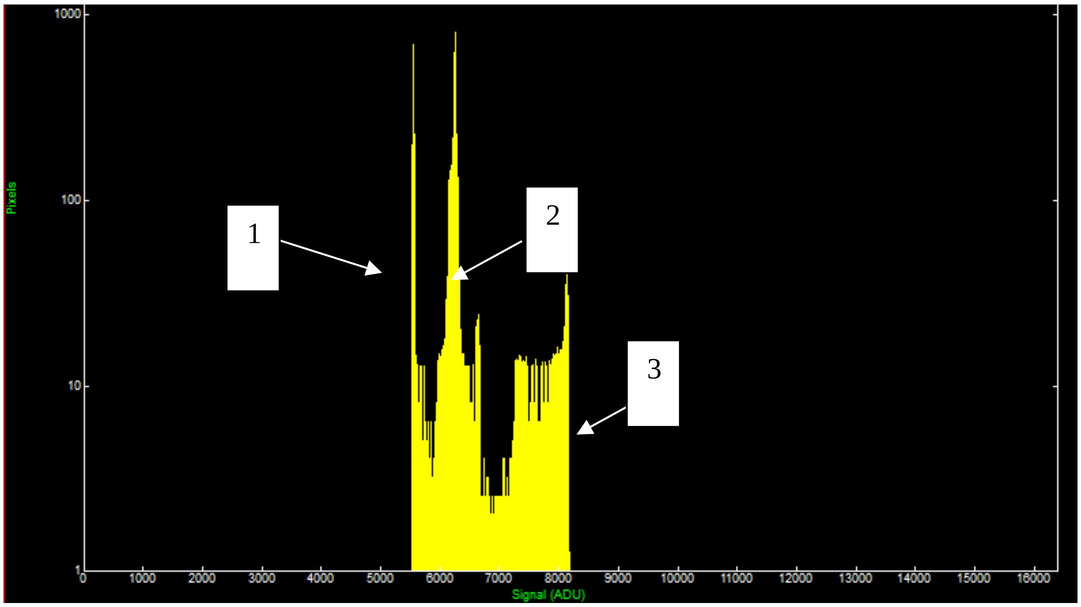


Figure 1: 16-bit Histogram

The following image is associated with this histogram. You can see the cold, black water bottle, the grey background, and the hot, white coffee mug. You can also see that the water bottle is fairly uniform and has a narrow spike whereas the mug has different temperatures in the handle and above the coffee line. For this reason, the data is more spread in the histogram at point 3.

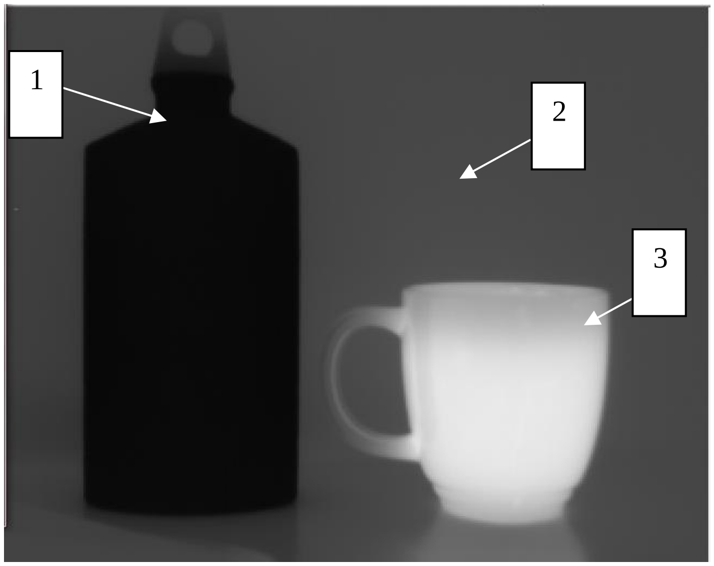


Figure 2: Image of scene

The simplest method to translate the data into 8-bit space is using a linear algorithm. Although this algorithm is not typically used, it will help illustrate the concept of using a transfer function to map from one space to another. The offset and gain—two parameters required to define a linear mapping—are set automatically so that the lowest value in the 16bit data is mapped to 0, and the highest value in the 16bit data is mapped to 255.

The following histogram is a representation of the same scene in shown in Figure 1 and 2, but mapped to 8-bit space using a linear mapping. Notice the three peaks from the 16-bit data represented in 8-bit space and that the values on the x-axis now range from 0-255 rather than 0-16383.

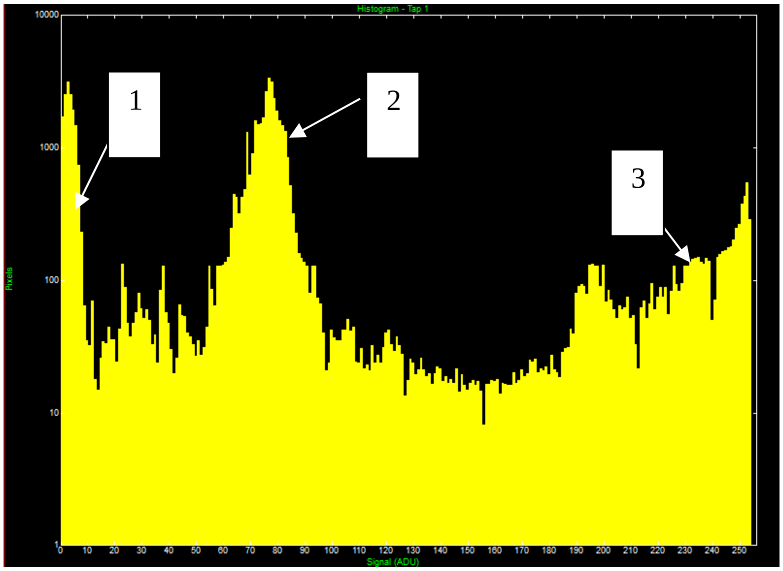


Figure 3: Linear AGC, ITT Mean: 127, Max Gain: 1

The linear histogram algorithm performs a linear transformation from 16-bit to 8-bit of the form:

$$S_{8bit} = (S_{16bit} - offset) \times gain$$

NOTE: Boson does not have an explicit AGC mode associated with a linear mapping style. However, Boson features a “Linear AGC” preset that populates the various parameters with FLIR’s recommendations for a linear-like transfer function.

2.2 Plateau Equalization

The Plateau Equalization algorithm seeks to maximize the dynamic range available for the content of the scene. It does this using a transfer function that is based on the number of pixels that are in each bin and allocating more 8-bit range (in other words, contrast) to more heavily populated portions of the histogram. For example, an image with 60% sky will devote 60% of the available 8 bit shades to the sky and leave only 40% for the remaining image. This creates a non-linear mapping function that distorts the correlation between physical temperature of the scene and level of grey in the image, which is preserved in a linear histogram. However, this also results in the most efficient distribution of the available 8 bit shades among the scene content by. For example, Figure 4 below, we can see that there is a large gap in the histogram due to the bimodal scene content—the hot engine and cold car body. An entirely linear mapping of this data is shown, resulting in the red-zone where values of 8-bit data are being assigned to 16-bit values that are not present in the scene:

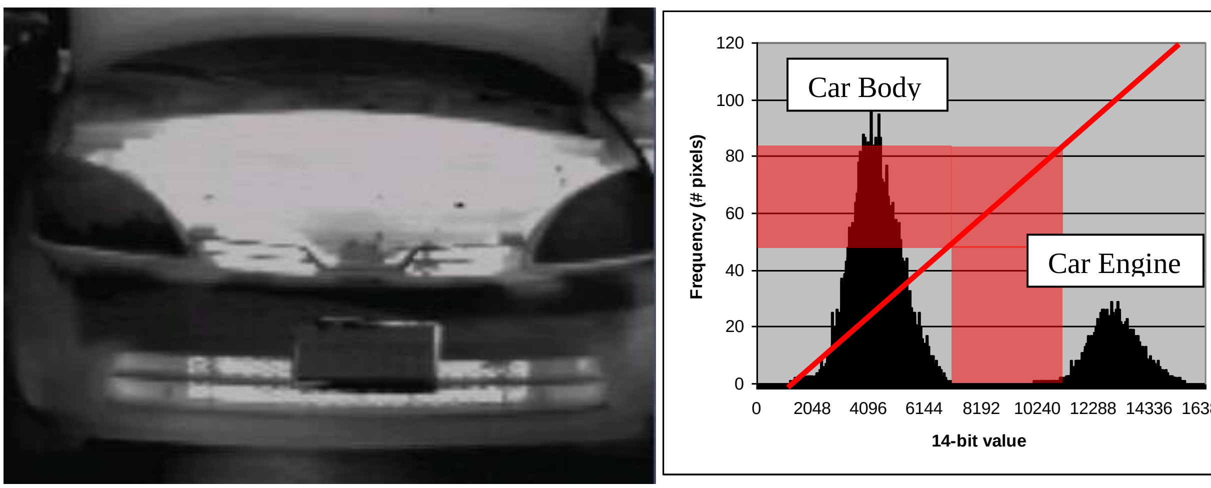


Figure 4: Bimodal scene with Linear AGC mapping

The result is that both the engine and car body are viewed as low-contrast objects.

The bottom right panel of Figure 5 shows the Image Transform Table for both Linear and Plateau Histogram Equalization. The 16-bit value on the x-axis will map to the 8-bit value on the y-axis where the conversion is plotted. In 16-bit regions with low contrast, the curve is much flatter and there are not as many 8-bit values consumed. In high detail regions, the curve is steep and more 8-bit values are used. For example, in Figure 5 below, the largest amount of scene data would be the field in the foreground. Most of the 8-bit shades have been mapped to the field, and therefore has the highest amount of contrast.

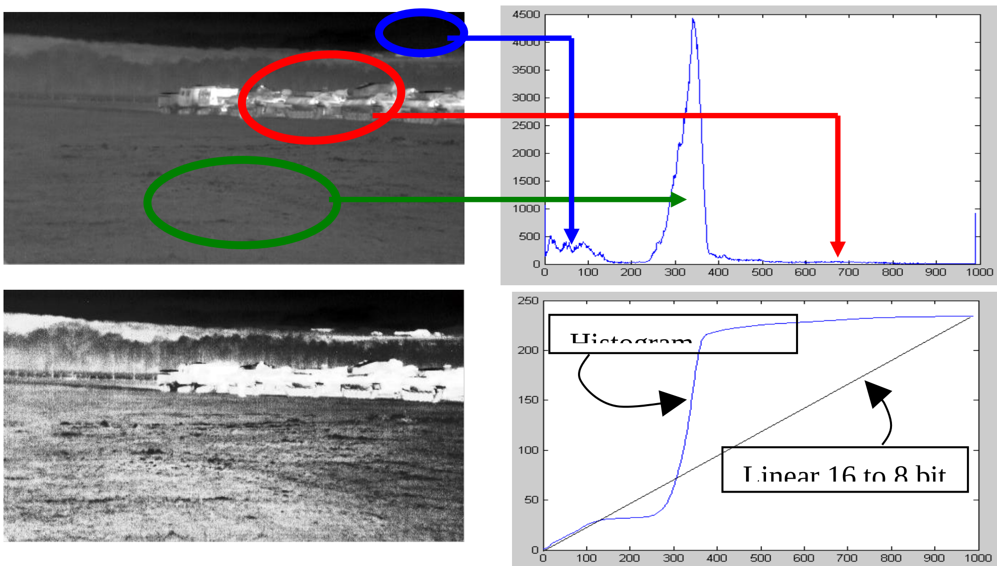


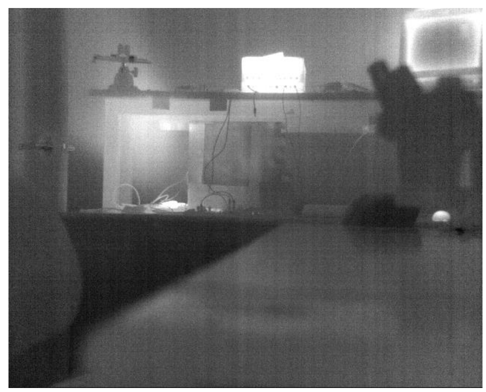
Figure 5: Image Transform Table for Linear and Plateau algorithms

The above examples have shown a basic variant of the Plateau Equalization algorithm. Boson additionally has the ability to optimize this algorithm. The various settings available are discussed below:

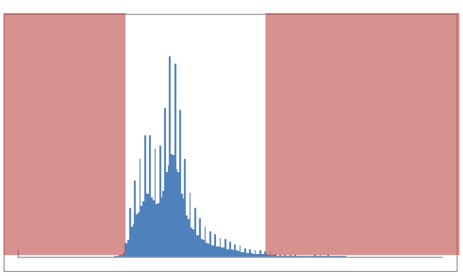
Linear Percent: Regardless of the signal processing algorithm used, two transfer functions are always produced. The first is a linear mapping of the signal data as described above. The second is a histogram produced using either the Plateau or Information-Based algorithm described below. The two histograms are weighted according to the Linear Percent parameter, and combined to create the final data map. The limit as Linear Percent approaches 100% results in an entirely linear mapping (none of the Plateau/Information-Based histogram is used). As Linear Percent approaches 0% the result is a mapping that is determined entirely by the histogram/Information-Based algorithm.

Maximum Gain. For scenes with high dynamic range (that is, wide 16-bit histogram), the maximum gain parameter has little effect. For a very bland scene, on the other hand, it can significantly affect the contrast of the resulting image. During the process of mapping values from 16-bit space to 8-bit space, we are often required to apply a universal gain to the data in order to properly fit the entire 8-bit spectrum. For example, if only we had 16bit scene data with a dynamic range of 200 counts, then we would need to increase the gain of our image to ~1.25 to fill the 255 count range of 8-bit space. In figure 5 below, we can see how the histogram can be 'stretched' to fill the 8-bit range by increasing the max gain value. Notice that the right-side histogram is stretched about 2x, despite having a max gain value of 3. This is because the image is only gained until the entire 8-bit space has been filled.

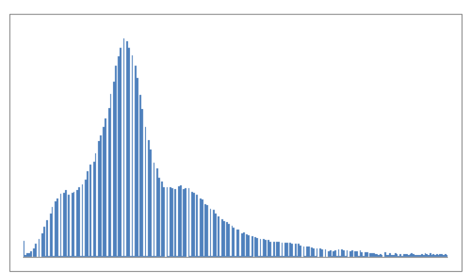
(a) Maximum Gain = **0.75**



(b) Maximum Gain = **3**



(c) 8bit Histogram for Max. Gain = **0.75**



(d) 8bit Histogram for Max. Gain = **3**

Figure 6: Illustration of Maximum Gain in a Bland Image

In the above case, the mapping with a max gain of 0.75 has resulted in a lower contrast image that does not utilize the entire range of 8-bit data (see the red-zone of figure 6c). By increasing the Max. Gain to 3 in Figure 6b, we can see that the 8-bit spectrum is being fully used. As a result, more detail and contrast can be distinguished in the image. However, by increasing the max gain, we have also increased the signal noise present in the scene.

Figure 7 shows an even more extreme example of a scene with a narrow, low-contrast 16-bit histogram. In the following examples, we will show how increasing values of Max Gain will change the histogram shape and image contrast.

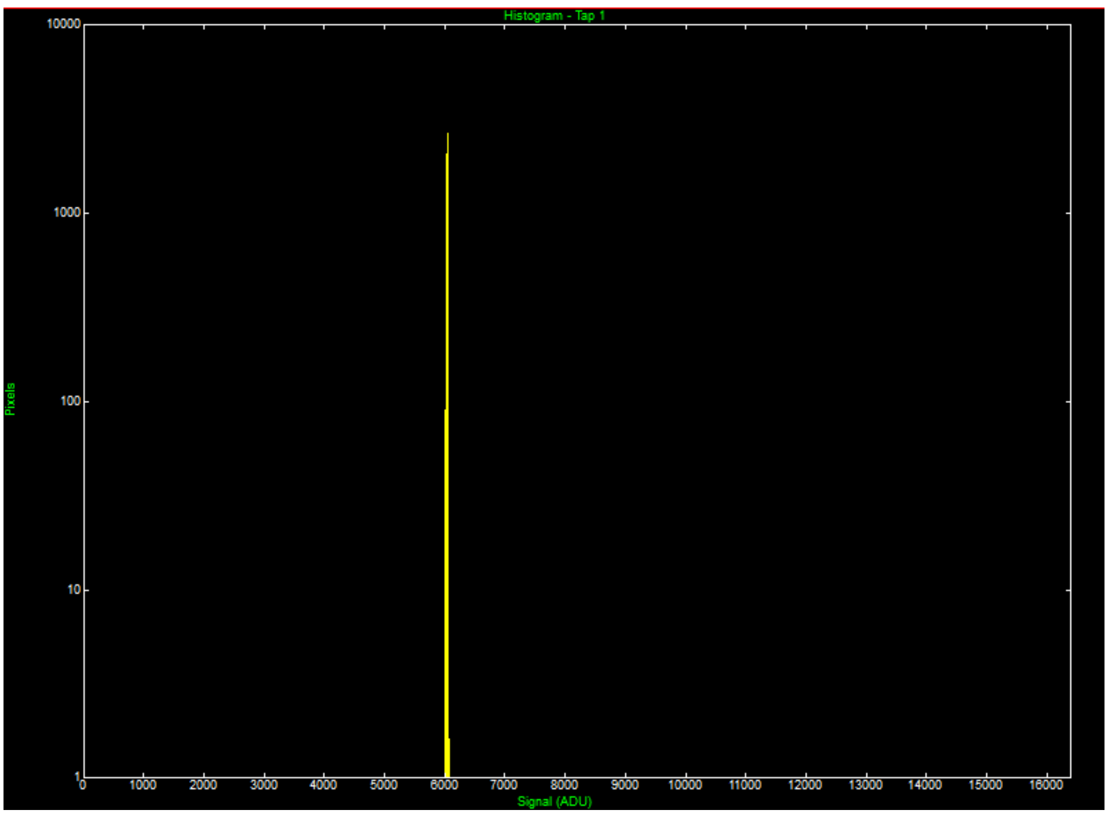


Figure 7: Low contrast scene in 16-bit space.

The large spike from the wall is the same value as in initial histogram.

The first image and histogram show the transformation of the above data 16-bit data with the default Max Gain setting of 1. Notice that there is a large amount of unused levels of grey on the left and right of the signal. The maximum gain setting sets the upper limit of gain that the algorithm can use as it attempts to stretch the data to fill the full 8-bit range. If the scene has a high level of contrast, it will use much less gain than the maximum gain setting. In typical applications, this value can be increased from the default of 1.38 to 1.5 or 1.75. Analytics that are not affected by spatial noise might tolerate higher values around 3 or 4. Values below are used for demonstration and do not represent typical settings.

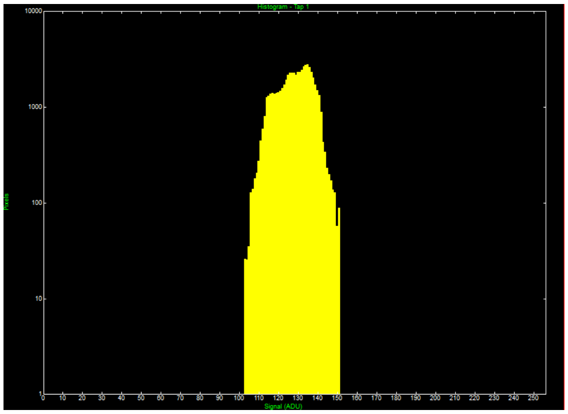


Figure 8: Max Gain: 1

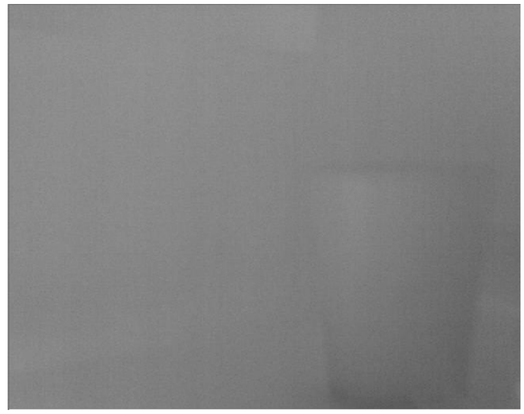


Figure 9: Low contrast Scene, default gain

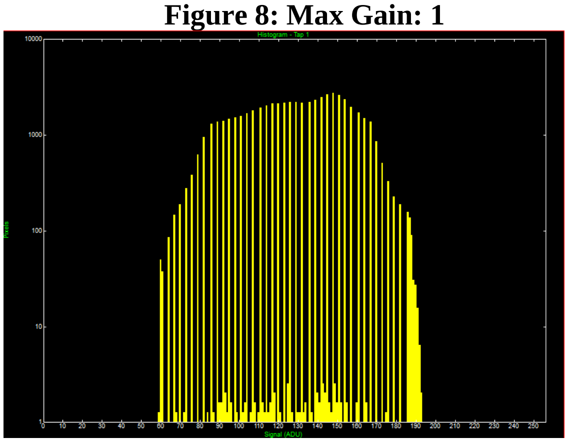


Figure 104: Max Gain: 3

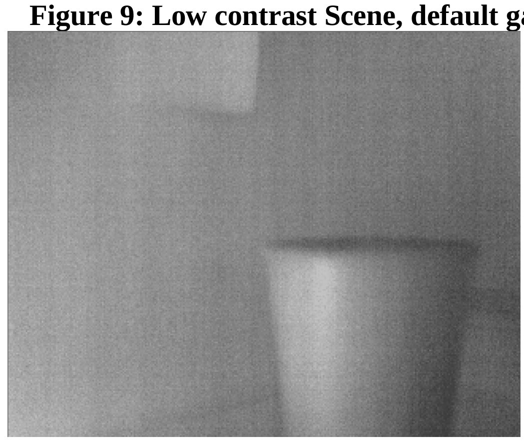
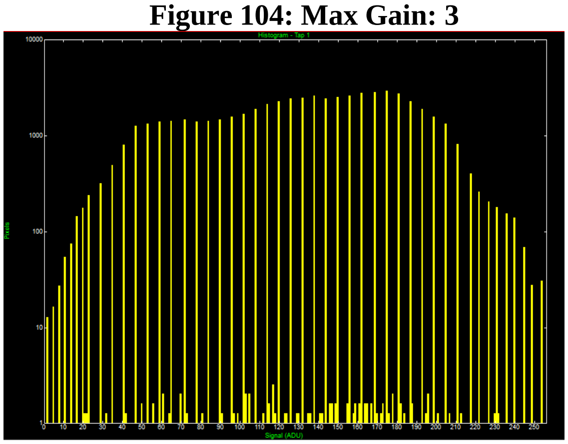


Figure 11: Low contrast scene, high max gain



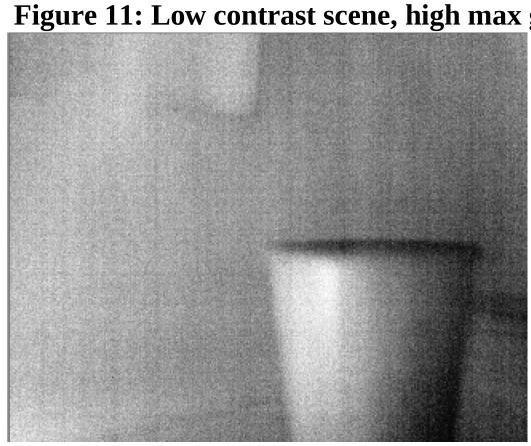
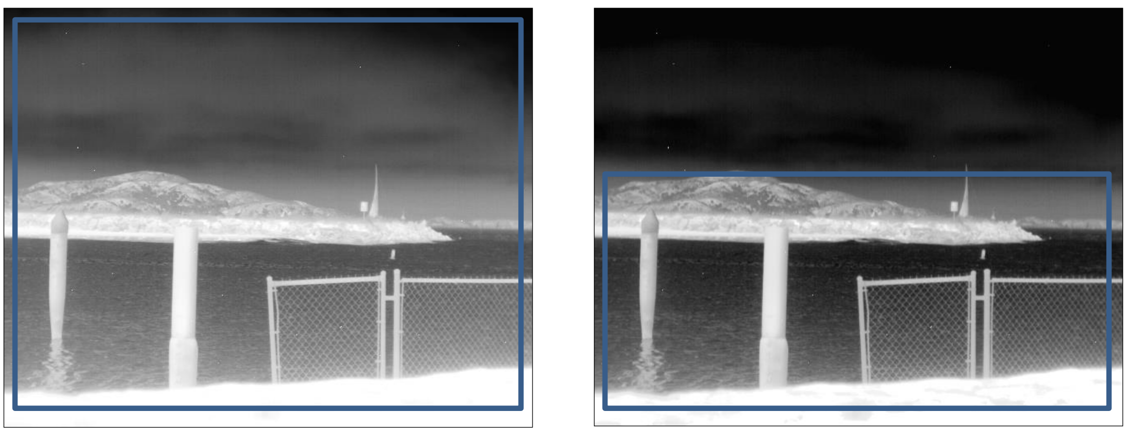


Figure 12: Max Gain: 5

Figure 13: Low Contrast Scene, very high max gain

Region of Interest (ROI): In some situations, it is desirable to have the AGC algorithm ignore a portion of the scene when collecting the histogram. For example, if the camera is rigidly mounted such that the sky will always appear in the upper portion of the image, it may be desirable to leave that portion of the scene out of the histogram so that the AGC can better optimize the display of the remainder of the image. This is illustrated in Figure 17. Similarly, for a hand-held application, it may be desirable to optimize the display of the central portion of the image. For those applications, it is possible to specify a region of interest (ROI) beyond which data is ignored when collecting the image histogram. Any scene content located outside of the ROI will therefore not affect the AGC algorithm. NOTE: this does not mean the portion outside of the ROI is not displayed, just that the portion outside does not factor into the optimization of the image.



(a) ROI = Full Image

(b) Sky excluded from ROI

Figure 17: Illustration of ROI in blue border

Plateau Value – This parameter sets a limit on how much the Plateau Equalization algorithm is allowed to favor dominant scene data. This parameter is most effective when a majority of the image is uniform, thereby taking up a large portion of the resulting 8bit shade of gray. This limits how much the uniform portions of an image would overwhelm the rest of the image, allowing more shades of gray back to the other parts of the image. One can calculate the maximum number of pixels assigned to any histogram bin by multiplying the Plateau Value by the total number of pixels within the specified Region of Interest (ROI). Lower values of Plateau Value will result in a more evenly distributed histogram among all the scene data, higher values will allow the Plateau Equalization algorithm to operate without any limitation, like traditional histogram-equalization. For most situations, FLIR recommends a default value of 7%.

Adaptive Contrast Enhancement (ACE)– Provides a contrast adjustment dependent on the relative scene temperature. The scale of values ranges from 0.5-4.0. A Gamma value less than 1 will darken the image, increase contrast in hotter scene content and decrease contrast in colder scene content. An ACE value greater than one will do the opposite, see Figure 14 below for a graphical representation. Notice in Figure 15, an ACE value greater than 1 will start to push the imagery content into the upper half of the histogram, whereas an ACE value less than 1 will push the imagery content towards the bottom half of the histogram. NOTE: When using the white-hot color palette, the ACE parameter will appear to brighten or darken the image. If the polarity of the image is switched to black-hot, then ACE parameter will appear to invert the effect. For example, in the white-hot polarity, increasing values of ACE will appear to brighten the image. However, in the black-hot polarity, increasing values of ACE will appear to darken the image.

Note: When viewing a scene with low thermal-contrast, ACE may tend to gain up parts of the scene that do not contain very much information. This may result in poor image contrast and an increase in temporal and fixed-pattern noise. Therefore, when using an ACE value other than the default, it is recommended to also increase tail rejection to approximately 1-2.

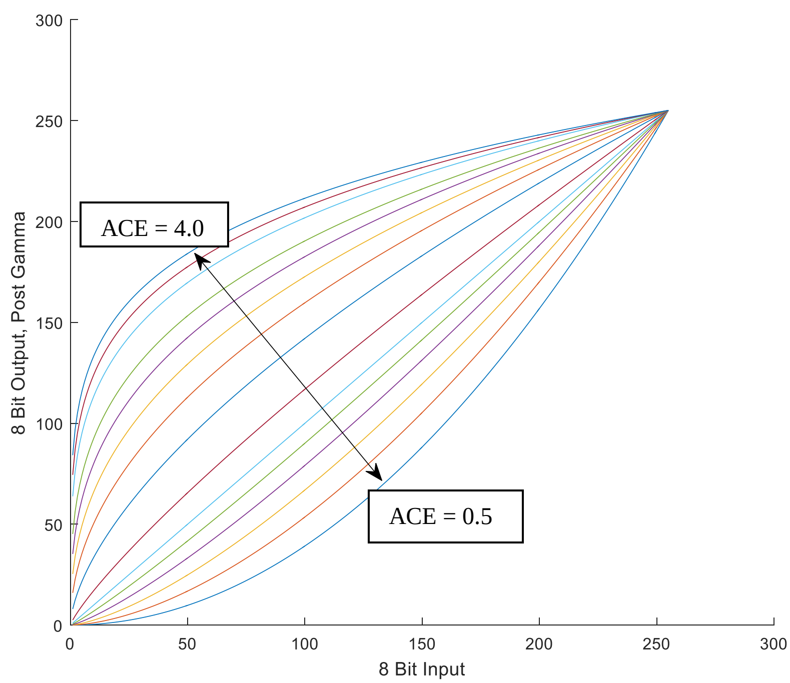


Figure 14: Graphical representation of the ACE mapping function

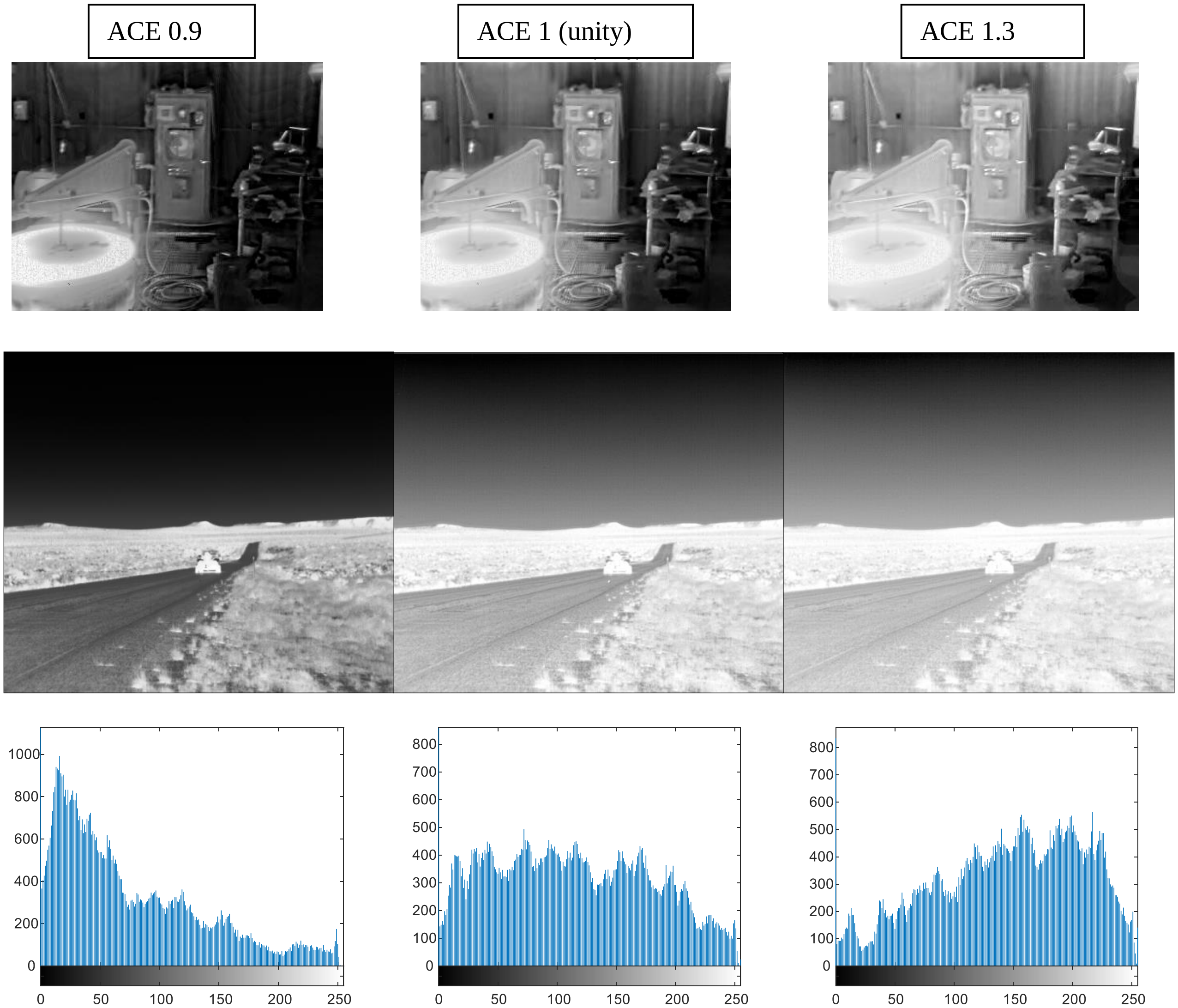
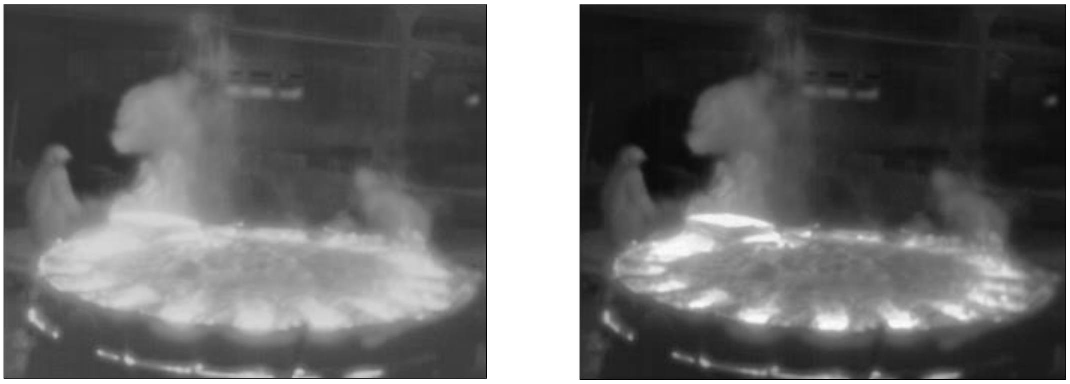


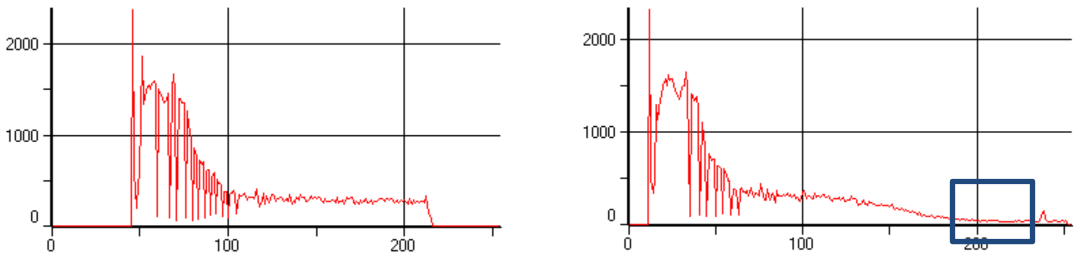
Figure 15: Illustrations of ACE

<u>Linear Percent:</u> This value defines the percentage of the histogram that will be allotted a linear mapping. Enabling this feature reduces the non-linear representation of temperature that can result from the Plateau algorithm causes. With Linear Percent set greater than 0%, the radiometric aspects of an image are better preserved (i.e. the difference in gray shades between two objects is more representative of the difference in temperature). While radiometry is better preserved with this feature, the compromise is the optimization in local contrast. Figure 16 illustrates the effects of Linear Percent. In the left image, the person and the hot object appear to be the same temperature. However, In the right image with Linear Percent set to 30%, the hot object and person are “decompressed” by mapping gray shades to the 16-bit

scene data that separates them. In Figure 16d, the blue area shows the extra 8-bit shades that have been mapped due to Linear Percent. Notice that the small spike at the end of the histogram—representing the hottest parts of the furnace in the image—have been mapped further away along the x axis from the rest of the scene.



(a) Linear Percent = **0 (disabled)** (b) Linear Percent = **30%**



(c) 8bit Histogram Linear Percent = 0 (d) 8bit Histogram of Linear Percent = **30**

Figure 16: Illustration of Linear Percent

Tail Rejection: Defines the percentage of the total number of pixels in the array that will be excluded prior to histogram equalization. Thus, for a Tail Rejection value of 13%, a total of 26% of the scene will be removed from the histogram equalization process—13% from the top and 13% from the bottom of the histogram. This feature is useful for excluding outliers and the most extreme portions of the scene that may be of less interest. FLIR recommends Tail Rejection settings less than 1% to avoid the exclusion of important scene content. In general, Tail Rejection only plays a large role when the Linear Percent parameter is set closer to 100%.

Damping Factor. The Damping Factor is an Infinite Impulse Response (IIR) filter used to adjust how quickly the AGC algorithm reacts to a change in scene or parameter value. If the Damping Factor value is set to a high value, then if a hot object enters the field of view, the AGC will adjust more slowly to the hot object, resulting in a more gradual transition. In some applications, this can be more pleasing than a sudden change to background brightness. For the Boson release, a factor coefficient of 0 results in immediate updates, a value of 99 provides the most filtering or slowest refresh rate, and a value of 100 indicates no further updates to AGC histogram and transfer function.

2.3 Information-Based Equalization

By default, Boson is set with Information-Based mode enabled. This algorithm will reserve more shades of gray for areas with more information or scene content. This results in fewer gray shades being mapped to areas with less information (e.g. sky, sea, roads), the effect of which reduces fixed pattern noise in low-contrast areas and also allowing for more detail to be given to the more interesting portions of the image. It achieves this by first using a High Pass filter to identify portion of the scene with more information. The High Pass filter data is subtracted from the original image to produce a Low-Pass image. Plateau Equalization is performed on the Low pass data to produce an initial histogram and then the HP data is used to further modify the histogram by favorably weighting the bins that have pixels present the HP image.

The Information-Based Equalization algorithm includes every pixel independent of scene information in the histogram equalization process, but simply weights each pixel based on the high-pass filter algorithm described above. Figure18 shows the Plateau Equalization algorithm on the left for reference and the Information-Based Equalization on the right respectively. Notice how the sky is being assigned more shades of grey in the left image when compared to the right image. When Information-Based Mode is enabled, the scene elements that have more 'information'—such as the people and ship—are given more shades of grey and more contrast. This is because, when the HP filter was applied, the algorithm identified that the ship and people have more high frequency data (or information) than the rest of the scene and should be assigned more 8-bit shades.

(a) Plateau Equalization

(b) Information-Based Equalization

Figure 18: Illustration of the difference between Plateau and Information-Based Equalization

Information-Based mode uses all of the parameters above because the LP data still undergoes the Plateau Equalization process. Furthermore, The HP data is used help sharpen or soften the image through the Digital Detail Enhancement (DDE) process described below. The cut off for the HP and LP filter is defined by the Smoothing Factor Parameter:

Smoothing Factor –*FLIR does not recommend moving this value from a default of 1250*. This is the roll off for the High Pass filter. A larger value will pull more scene content into the High Pass component, allowing it to be gained up to sharpen the imagery. The Low Pass data will be used to perform the Plateau

Equalization algorithm and the High Pass data will be used to calculate the weighting of pixels in the Information-Based Equalization Algorithm.

2.5 Digital Detail Enhancement (DDE)

The Boson will provide a "Digital Detail Enhancement" (DDE) algorithm which can be used to enhance details and/or suppress fixed pattern noise. It is important to note that the parameters used to control DDE are not an independent, and changes will result in modifications being made to the operation of the Information-Based or Plateau Equalization algorithms. The algorithm works by using the data that was separated into the high pass (HP) and low pass (LP) signal. The Smoothing Factor parameter used to control the Information-Based Equalization algorithm is what determines which parts of the image are split into the HP component and the LP component. DDE then applies a gain to the HP signal to enhance the details. The imagery below is an example of no DDE on the left, and DDE applied on the right.

Figure 19: On the left DDE = .8, on the right DDE = 1.3

DDE— This value is used to control how much sharpening or smoothing is applied to the signal. Fractional values will do a small amount of denoising and smoothing and values greater than 1 will sharpen the image.

Detail Headroom—Increasing this value will allow for more room at the top and bottom of the 8bit dynamic range to be reserved for the HP data. However, this is at the cost of reduced contrast for the LP data. Without any headroom given to DDE, it might be possible that the gained up high pass data will rail at the high end or low end of the 8bit dynamic range, resulting in less contrast for the HP data.

3.0 LUT Palettes and Polarity

Another topic related to the video-output signal is the image palette, also called the color LUT (Lookup Table). Palette files map a digital output value to a color value. Some palettes are monochrome, others create false color imagery, or pseudocolor. The color is not actually related to wavelengths of light, but rather the grayscale intensity. Two traditional options are White Hot and Black Hot, which are monochrome. The Black Hot palette is a pure inversion of the 8-bit data where zero becomes the hottest and 255 becomes the coldest. There are some applications where a Black Hot image allows for more perceived contrast in the image. This is primarily due to concept discussed earlier about low luminance changes.

Figure 20: White Hot

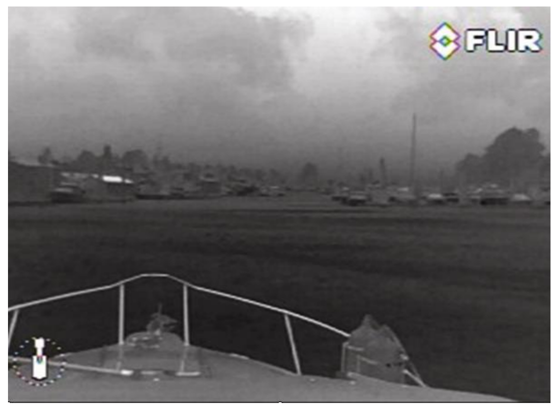


Figure 21: Black Hot

The Boson camera contains 10 factory-installed palettes, as shown in Figure 22 and 23.

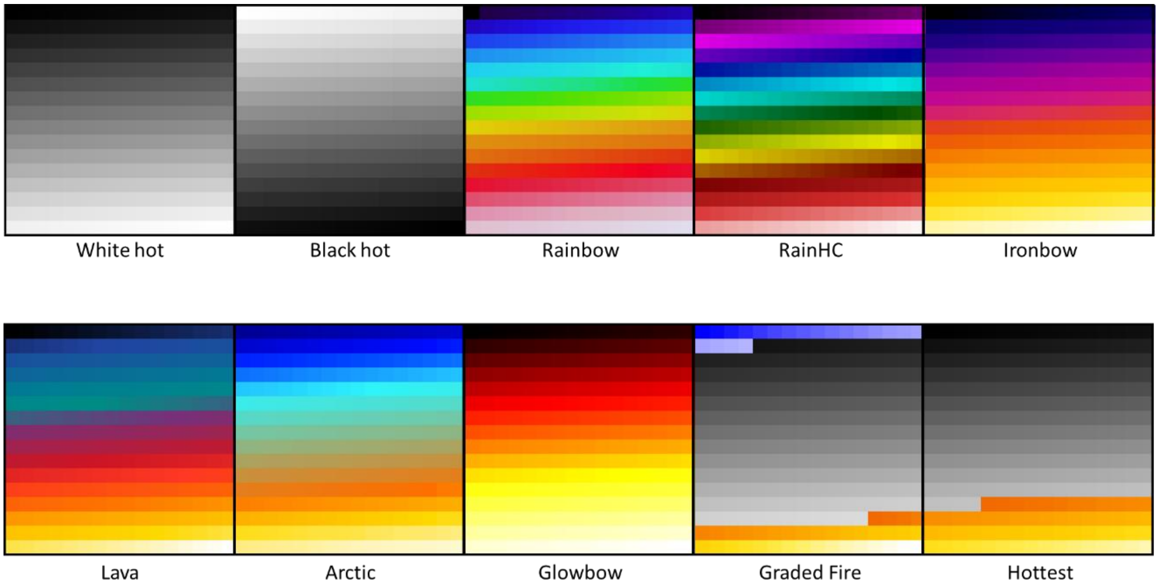


Figure 22: Boson's Factory-Loaded Color Palettes

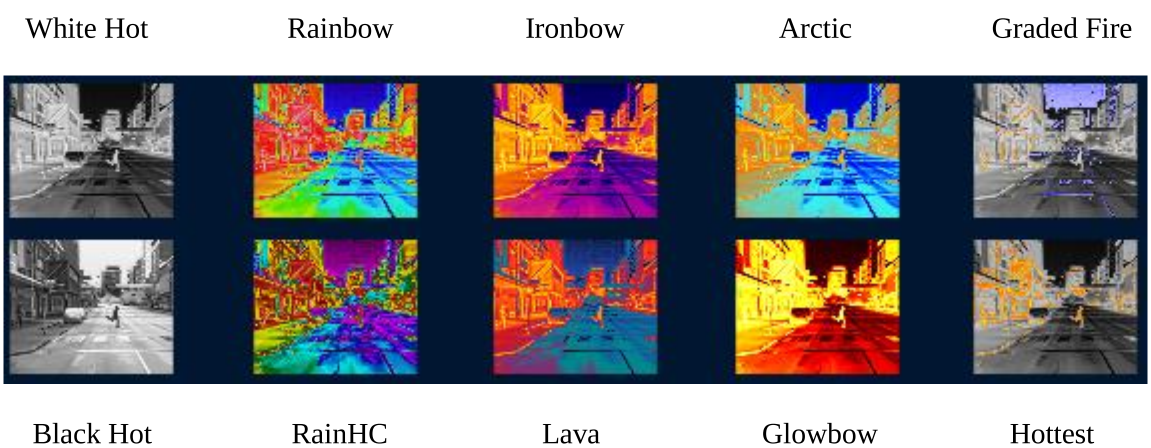


Figure 53: Boson's Color Palettes applied to images

4.0 Converting Tau 2.7 values to Boson

Many of the parameters featured in Boson are similar to the Tau2 LWIR sensor. The following section is a guide on how to convert Tau 2 values into appropriate Boson values. In some cases, values cannot be transformed exactly. In those cases, an approximate transfer method is described.

Plateau: The new plateau values can be exactly transformed using the following function:

$$\frac{(Plateau_{Tau}) \times 128}{(PixelTotal_{Tau})} = Plateau_{Boson}$$

Where

$Plateau_{Tau}$ is your old value of Plateau for Tau

$PixelTotal_{Tau}$ is the area of the Tau Pixel array (ex. 640 x 512 = 327680)

$Plateau_{Boson}$ is the new value of Plateau for Boson

Max Gain: The new max gain values can be exactly transformed using the following function:

$$\frac{MaxGain_{Tau}}{8} = MaxGain_{Boson}$$

ITT Midpoint: There is no longer a parameter that works similarly to ITT Midpoint in Boson. In order to adjust the brightness of the image, it is recommended to use the ACE parameter.

ACE: The ACE parameter can be transformed approximately using the following look up table. It should be noted that ACE is implemented differently in Boson, and therefore it may be difficult to emulate the same affect on Boson image quality.

Boson Values	Tau Values
0.4	-8
0.5	-7
0.6	-6
0.7	-5
0.75	-4
0.8	-3
0.85	-2
0.9	-1
1	0
1.1	1
1.2	2
1.25	3
1.3	4
1.4	5
1.7	6
2	7
2.5	8

AGC Filter: This parameter is now called Damping Factor in Boson. The new values can be transformed exactly using the following function:

$$\frac{255 - AGCFilter\_Tau}{255} \times 100 = DampingFactor_{Boson}$$

<u>SSO Value</u>: Is now called Liner Percent. These values are the same, and no transformation is required

<u>Tail Rejection</u>: These values are the same, and no transformation is required.

<u>DDE</u>: There is no longer a Manual Mode for DDE like what was featured in Tau. Furthermore, the DDE algorithm has been changed from the implementation in Tau. A qualitative assessment of the image will be required for accurate translation of Tau to Boson values. However, approximate values can be obtained by noting how DDE effects the image based on the range of input values:

DDE effect	Sharpening	No Effect	Softening
Tau 2 Value Range	1 to 100	0	-1 to -20
Approximate Boson Value Range	1.1 to 6	1	.9 to 0

By looking up your Tau 2 value in the above table, you can find the approximate range that will be appropriate in Boson.