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1.0 Document

1.1 Revision History

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<tr>
<td>110</td>
<td>6/20/2014</td>
<td>Updates for the Tau 2.7 and Quark 2 release</td>
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1.2 Scope

This note is intended to provide a better understanding of FLIR image processing algorithms. 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 Quark, Quark 2, Tau, Tau 2 and Neutrino cameras. These cores can be found in most FLIR Commercial Systems products.

The FLIR website will have the newest version of this document as well as offer access to many other supplemental resources: [http://www.flir.com/cvs/cores/resources/](http://www.flir.com/cvs/cores/resources/)

Here is a sample of some of the resources that can be found:

<table>
<thead>
<tr>
<th>Document Title</th>
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<tr>
<td>Tau Quick Start Guide</td>
<td>102-PS242-01</td>
<td>Quick Start Guide for first-time use</td>
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<td>102-PS242-43</td>
<td>Written for Software Engineers to have all necessary information for serial control of Tau 2 and Quark</td>
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<td>Assorted Mechanical Drawings and Models</td>
<td>Various</td>
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<td>Application Notes</td>
<td>Various</td>
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There is also a large amount of information in the Frequently Asked Questions (FAQ) section on the FLIR website: [http://www.flir.com/cvs/cores/knowledgebase/](http://www.flir.com/cvs/cores/knowledgebase/). Additionally, a FLIR Applications Engineer can be contacted at 888.747.FLIR (888.747.3547).
2.0 Automatic AGC Parameters

The first thing to understand is that the detector data is directly streamed from the sensor as 14-bit values for each pixel in the array. The analog image is displayed using 8-bit values and almost all commercial displays are 8-bit devices. In other words the video is displayed on a 0-255 scale rather than the full 0-16384 resolution of the sensor. This means that there must be some compression to get the data into a format that can be displayed. Throughout this note, there are histograms that are represented in Signal 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. The algorithms attempt to compress the data in a meaningful way that preserves as much of the image content as possible.

The Tau 2 core provides multiple AGC algorithms used to transform 14-bit data to 8-bit. These options include the following, with associated parameters shown below each algorithm:

- Plateau equalization
  - Plateau value
  - Maximum gain
  - ITT midpoint
  - ACE threshold
  - SSO value
  - Tail rejection
  - Region of Interest (ROI)
  - IIR filter

- Information-based and Information-based equalization
  - Information-based Threshold

- Linear histogram
  - ITT midpoint
  - ROI
  - IIR filter

- Manual
  - Brightness
  - Contrast
  - IIR filter
• Auto-bright
  o Brightness
  o Contrast
  o IIR filter
• Once-bright
  o Brightness bias
  o Contrast
  o IIR filter

Note: FLIR highly recommends that each customer optimize AGC 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 plateau equalization algorithm, but there are scenarios where each of the other algorithms may be better suited. The FLIR GUI provides auto presets that can be used to tune AGC to the specific scene.

2.1 Introduction to Histograms
The following histogram is the 14-bit data taken from a Tau 320 with 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 14-bit space range from 0 to 16384.

![Figure 1: 14-bit Histogram](image)

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

2.2 Linear Histogram
The first and 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. A typical linear intensity transfer table will map the middle 90% of the histogram to 8 bit space. The bottom and top 5% are discarded. This algorithm finds the interesting portion of the data and crops above and below it. The following histogram is a representation of the same scene in 8-bit space. Notice the three peaks from the 14-bit data represented in 8-bit space and that the values on the x-axis now range from 0-255 rather than 0-16384.

Figure 3: Linear AGC, ITT Mean: 127, Max Gain: 8
The linear histogram algorithm performs a linear transformation from 14-bit to 8-bit of the form:

\[ 8\text{bit}_i = m \times 14\text{bit}_i + b \]

The slope of the transformation is computed automatically based on the ROI histogram:

\[ m = \frac{255}{(14\text{bit}_\text{(100 - Tail Rejection)\%} - 14\text{bit}_\text{(Tail Rejection)\%})} \]

where \(14\text{bit}_\text{(Tail Rejection)\%}\) is the 14-bit value corresponding to the user selectable tail rejection percentage point on the cumulative ROI histogram and \(14\text{bit}_\text{(100 - Tail Rejection)\%}\) is the value corresponding to the difference between 100\% and the user selectable tail rejection percentage point in Tau 2.7 and Quark 2.0.

The offset is then computed as

\[ b = \text{ITT midpoint} - \text{avg}(14\text{bit}_\text{(100 - Tail Rejection)\%}, 14\text{bit}_\text{(Tail Rejection)\%}), \times m \]

In other words, the algorithm attempts to map the midway point between the top and bottom tail rejection points on the cumulative histogram to the specified ITT midpoint, as shown in Figure 4 for the case in which the tail rejection parameter selected is 5\%. The 8-bit values resulting from the above equations are clipped to a minimum value of 0 and a maximum value of 255.

![Figure 4: Illustration of the Linear-Histogram Mapping Function](image)

(a) ITT Midpoint = 128  
(b) ITT Midpoint = 96

### 2.3 Plateau Histogram Equalization

The Plateau Histogram 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 for that bin. The Plateau value is the pixels/bin limit when the transfer function is maximized. When this number is small, the Automatic AGC will approach a linear algorithm that preserves a linear mapping between the 14-bit and 8-bit data. The goal of the Automatic algorithm is to try and make each of the 255 bins have the same number of pixels in it, which should give the best contrast for the given scene. When the plateau value is higher, the algorithm is more able to
redistribute the data to achieve this goal. This prevents wasted levels of grey on regions that have no scene content and can visually be seen in the histograms by noticing that peaks are much smoother and the data is spread much more evenly.

![Histogram Plot](image)

**Figure 5: Plateau: 150, ITT Mean: 127, Max Gain: 8**

*Compare to Linear Histogram in Figure 3*

The following plot shows the Image Transform Table for both Linear and Plateau Histogram Equalization. The 14-bit value on the x-axis will map to the 8-bit value on the y-axis where the conversion is plotted. In 14-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.
Figure 6: Image Transform Table for Linear and Plateau algorithms

In many applications, there are objects with different temperatures that all need to have contrast. In this case, the plateau value can be increased from the default setting of 150 to 250 or 300, depending on the content of the scene. This will provide the algorithm with more flexibility to generate an image with high contrast for both foreground and background targets. In applications where there is a large object of a small temperature range and the background is not important, lowering the plateau value to 100 or 50 will dedicate more contrast to the foreground object and the background will have less. This can also be done when an AGC ROI is used to discard scene content that is not important.

It is important to note that higher plateau value distorts the correlation between physical temperature of the scene and level of grey in the image, which is preserved in a linear histogram.

The ITT Mean sets the midpoint of the Image Transform Table and is applied after the histogram equalization on the 8-bit data. This can be thought of as an offset that shifts the entire distribution to the left or the right and directly affects the brightness of the image. It is important to notice that when the data is shifted, it is cropped and it is not stretched to fill the 8-bit range. This means that you are losing data by shifting, but the data on the top and bottom may not be the most important. Increasing the Plateau Value, as seen above, typically raises the perceived brightness of the scene. This could be counteracted by lowering the ITT Mean from the default of 127 to 120.
It is also important to note that changes in levels of grey are more perceptible to a human observer at lower levels of illumination. This is because a change from 5 to 10 counts is 100% and a change from 245 to 250 is about 2%. By lowering the ITT Mean, you can shift the luminance to a lower value so that a human observer will be more capable of seeing small changes in the scene. If you are using analytics, the performance will not likely be improved by this change and the default setting of 127 is recommended.

![Figure 7: Plateau: 250, ITT: 110, Max Gain: 8](image1)

![Figure 8: Plateau: 250, ITT: 150, Max Gain: 8](image2)

The final AGC parameter is the Max Gain. To demonstrate this, it will be better to look at a scene with very low contrast. The scene used was a uniform wall with an empty paper cup that was slightly warmer than the wall. Notice the very narrow spike in the 14-bit data and the very small bump just to the right of the spike.
Figure 9: Low contrast scene in 14-bit space.

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

The following histogram shows the 8-bit data with the default Max Gain setting of 8. 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 8 to 12 or 15. Analytics that are not affected by spatial noise might tolerate higher values around 25 or 30. Values below are used for demonstration and do not represent typical settings.

Figure 10: Plateau: 250, ITT: 127, Max Gain: 8

Figure 11: Low contrast Scene: default settings
The plateau equalization algorithm performs a non-linear transformation from 14-bit to 8-bit based on image histogram. It is a variant of classic histogram equalization, an algorithm that maps 14-bit to 8-bit using the cumulative histogram of the 14-bit image as the mapping function. In classic histogram equalization, an image comprised of 60% sky will devote 60% of the available 8-bit shades to the sky, leaving only 40% for the remainder of the image. Plateau equalization limits the maximum number of gray shades devoted to any particular portion of the scene by clipping the histogram (via the plateau value) and limiting the maximum slope of the mapping function (via the maximum gain value). It also provides an ITT midpoint value that allows mean brightness of the 8-bit image to be specified. The Tau 2.7 release includes the ability to allot a linear portion to the histogram (via Smart Scene Optimization), include an irradiance dependent contrast adjustment (via Active Contrast Enhancement), and specify outlier rejection (via Tail Rejection). The description below provides explanations of each of these parameters.
Plateau value. When plateau value is set high, the algorithm approaches the behavior of classic histogram equalization – gray shades are distributed proportionally to the cumulative histogram, and more gray shades will be devoted to large areas of similar temperature in a given scene. On the other hand, when plateau value is set low, the algorithm behaves more like a linear AGC algorithm – there is little “compression” in the resulting 8-bit histogram. The figures below illustrate both of the cases.

![Plateau Value Illustration](image)

(a) Plateau Value = **1000**  
(b) Plateau Value = **10**  
(c) 8bit Histogram for Plateau Value = **1000**  
(d) 8-bit Histogram for Plateau Value = **10**

**Figure 16:** Illustration of Plateau Value  
(Notice details in the sidewalk in the left image whereas more gray shades are available for the pedestrians in the right image.)
Maximum Gain. For scenes with high dynamic range (that is, wide 14-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. Figure 17 provides an example.

![Figure 17: Illustration of Maximum Gain in a Bland Image](image)

(Notice more details but also greater fixed-pattern noise in the right image.)
ITT Midpoint. The ITT Midpoint can be used to shift the 8-bit histogram darker or brighter. The nominal value is 128. A lower value causes a darker image, as shown in Figure 18. A darker image can help improve the perceived contrast, but it is important to note that more of the displayed image may be railed (8bit value = 0 or 255) by moving the midpoint away from 128. This can be seen in the histogram of Figure 18.

![Figure 18: Illustration of ITT Midpoint](image)

(a) ITT Midpoint = 127  
(b) ITT Midpoint = 96  
(c) 8bit Histogram for ITT Midpoint = 127  
(d) 8bit Histogram for ITT Midpoint = 96

(Notice image on the right is darker. Notice in the histogram on the right that far more pixels have a value of 0 and that no pixels have a value between 224 and 255.)
ACE Threshold. The Active Contrast Enhancement (ACE) feature provides a contrast adjustment dependent on the relative scene temperature. ACE thresholds greater than 0 impart more contrast to hotter scene content and decrease contrast for colder scene content (e.g. sky or ocean). ACE threshold less than 0 do the opposite by decreasing contrast for hotter scene content and leaving more of the gray-scale shades to represent the colder scene content. Figure 19 illustrates the effects of ACE. FLIR recommends a conservative setting of 3 for generic use-case scenarios.

![Figure 19: Illustration of Active Contrast Enhancement (ACE)](image)

(a) ACE threshold = -4  (b) ACE threshold = 0 (neutral)  (c) ACE threshold = 8

SSO Value. The Smart Scene Optimization (SSO) value defines the percentage of the histogram that will be allotted a linear mapping. Enabling this feature facilitates the avoidance of irradiance level compression, which is specifically important for bi-modal scenes. With SSO enabled, 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 20 illustrates the effects of SSO. In the left image, SSO is disabled and the hot object and person get mapped to two shades of gray next to one another causing a “washed out” effect and making it appear as though the person and fire are similar in temperature. In the right image, SSO is enabled, and the hot object and person are decompressed with gray shades separating them.
Tail Rejection. The tail rejection parameter defines the percentage of the total number of pixels in the array that will be excluded prior to histogram equalization. The user-selected percentage of pixels will be removed from both the bottom and top of the 14-bit histogram prior to AGC. 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.

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 Tau 2 core 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 21. 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.)
For Tau 2.0, separate ROI are automatically applied for un-zoom, 2X, 4X, and 8X zoom. Coordinates for the ROI are as follows:

- **Top / Bottom:** 0 = center of the display, negative values are above center, positive values are below center, units are in pixels
- **Left / Right:** 0 = center of display, negative values are left of center, positive values are right of center, units are in pixels

For Tau 2.1 and later, a single ROI is specified regardless of zoom (see product specification). Coordinates for the ROI are as follows:

- **Top / Bottom:** 0 = center of the window, negative values are above center, positive values are below center, units are percentage of zoom window size (-512 = -50%, +512 = +50%).
- **Left / Right:** 0 = center of display, negative values are left of center, positive values are right of center, units are percentage of zoom window size (-512 = -50%, +512 = +50%).

![Figure 21: Illustration of ROI](image)

(Notice the image on the right has more contrast in the portion of the image below the sky.)
AGC Filter. The AGC filter is an IIR filter used to adjust how quickly the AGC algorithm reacts to a change in scene or parameter value. The filter is of the form

\[ n' = n \times \alpha/256 + n' - 1 \times (256 - \alpha)/256 \]

where:
- \( n' \) = actual filtered output value for the current frame
- \( n \) = unfiltered output value for the current frame
- \( n' - 1 \) = actual filtered output value for the previous frame
- \( \alpha \) = filter coefficient, user-selectable from 0 to 255

If the AGC filter value is set to a low 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 Tau 2.7 release, a filter coefficient of 255 is a special case for immediate updates, a value of 1 provides the most filtering or slowest refresh rate, and a value of 0 indicates no further updates to AGC. For previous releases of Tau 2, a filter coefficient of 0 was a special case for immediate updates, a value of 1 was the most filtering or slowest refresh rate, and the case for no AGC updates was unavailable.

2.4 Information-based and Information-based equalization

The Tau 2.7 release and subsequent releases include the Information-based algorithms which reserve more shades of gray for areas with more information or scene content by assigning areas with less information or scene content lesser gray shades. By assigning lesser gray shades to areas with less information (e.g. sky, sea, roads) the fixed pattern noise is reduced in these areas also allowing for more detail to be given to the more interesting portions of the image. Both Information-based algorithms undergo the plateau equalization process described in the previous section, and therefore all parameters described also apply.

The differences between the Information-based and Information-based Equalization algorithms are noteworthy as both have advantages. The Information-based algorithm completely excludes pixels from histogram equalization if they are below the information threshold (described later in this section). This is advantageous in that noise is completely removed from areas of the image determined by the algorithm to not contain information, but scenarios in which the user is attempting to detect small temperature or emissivity variations are not ideal for this mode because desired information may be lost depending on the threshold. The Information-based Equalization algorithm includes every pixel independent of scene information in the histogram equalization process, but simply weighs each pixel based on the information threshold. This mode shows more moderate improvements in scenes with large areas void of information, but the advantage over the Information-based mode is that scene content will never be removed. Figure 22 shows the Plateau Equalization algorithm on the left for reference and the Information-based and Information-based Equalization algorithms center and right respectively with information threshold set to 40.
Plateau Equalization

Information-based Equalization

Figure 22: Illustration of the difference between Plateau Equalization, Information-based, and Information-based Equalization algorithms

Information Threshold. The information threshold parameter defines the difference between neighboring pixels used to determine whether the local area contains “information” or not. Lower thresholds result in the algorithm determining that more of the scene contains information, resulting in more areas included in the Information-based algorithm and given a higher weighting in the Information-based Equalization algorithm. Decreasing the threshold will result in imagery approaching the appearance of the Plateau Equalization algorithm. Increasing the threshold will result in a more information-dependent image, that is the flat portions of the scene (e.g. sky or sea) are given less contrast and the pixels exceeding the information threshold will be given more contrast.

Information Threshold = 20

Information Threshold = 80

Figure 23: Illustration of Information Threshold

2.5 Legacy AGC modes
Manual
The “manual” algorithm performs a linear transformation from 14-bit to 8-bit, with slope based solely on a specified contrast value and offset based solely on a specified brightness value as shown below:

\[ m = \text{specified contrast} / 64 \]

\[ b = 127 - (\text{brightness}) \times m. \]

Auto Bright
The auto-bright algorithm is identical to the “manual” algorithm except that brightness value is automatically and dynamically updated to equal array mean. In other words, the array mean is automatically mapped to an 8-bit value of 127.

Once Bright
The “once bright” algorithm is identical to the “auto-bright” algorithm except that the offset of the linear transformation, b, is computed only at the time the algorithm is selected and is not dynamically updated. It is computed as

\[ b = 127 - (\text{frame mean} - \text{brightness bias}) \times m, \]

where brightness bias is a user-specified parameter.

2.5 Digital Data Enhancement (DDE)
The Tau 2 core provides an optional “digital-data-enhancement” (DDE) algorithm which can be used to enhance image details and/or suppress fixed pattern noise. Two modes are available, “manual” and “dynamic”. The descriptions of each mode are as follows:

- **Dynamic mode**: DDE parameters are computed automatically based on scene contents. DDE index (which supplants the spatial-threshold parameter used in the manual algorithm) is the only controlling parameter and ranges from -20 to 100 for Tau 2.7 and later releases, with higher values representing higher degrees of detail enhancement. If no enhancement is desired, the value should be set to 0. Values less than 0 soften the image and filter fixed pattern noise, as exemplified in the figures below. Values greater than 0 sharpen the details in the image. For previous Tau 1 and Tau 2 releases, the DDE index ranged from 0 to 63, where 0 to 16 softened the image, 17 was neutral, and 18 to 63 sharpened detail.
Figure 24: Illustration of Noise Suppression with DDE

(Notice fixed pattern noise is reduced in the image on the right.)

Figure 25: Illustration of Detail Enhancement with DDE

Note: The recommended DDE mode is “dynamic”. “Manual” is provided for customers of previous FLIR cores that have familiarly with the manual DDE mode.
• **Manual mode**: The following three parameters are user-specified:
  
  o **DDE Gain**: ranges from 0 to 65535 for Tau 2.7 and later releases and represents the magnitude of high-frequency boost
    
    ▪ For gain = 0, DDE is disabled
    ▪ For gain > 0, details are enhanced by gain/2048. In other words, a value of 1 represents a 1/2048 attenuation of details whereas a value of 8192 represents a 4X enhancement of details. Note that gain is also applied globally and locally to the low frequency portion of the image, and therefore the DDE gain is relative (therefore users are strongly discouraged from using manual DDE mode).
  
  o **DDE threshold**: ranges from 0 to 255 and represents the maximum detail magnitude that is boosted. Details with variance exceeding the threshold are not enhanced. Details with variance less than the thresholds are enhanced. Values greater than 255 will place the camera in Dynamic DDE mode with a DDE index of x-255. In this case, DDE Gain and DDE spatial threshold are adjusted dynamically.
  
  o **DDE spatial threshold**: ranges from 0 to 15, and represents the threshold of the pre-filter (smoothing filter) applied to the signal prior to high-frequency boost. The pre-filter prevents low-magnitude fixed-pattern noise from being amplified. Note that the DDE spatial threshold also represents the DDE index when in automatic DDE mode.

### 3.0 LUT Palettes and Polarity

Another topic to discuss is the image LUT (Lookup Table). There are a number of lookup tables that make the image colored. This is called false color, or pseudocolor. The color is not actually related to wavelengths of light, but rather the grayscale intensity. The most useful might be the option for White Hot and Black Hot, which is also called the polarity of the image. 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 26: White Hot](image1)

![Figure 27: Black Hot](image2)
The Tau2 and Quark cameras contained the normal imaging LUTs which contain 256 colors or greyscale and map that to the 8-bit AGC data from the cameras. The imaging palettes are shown below. The palettes only affect the analog and BT.656 outputs of the Quark 1, Tau 2.3 and earlier releases. The Quark 2 and Tau 2.4 releases and later have an option for color in the CMOS and LVDS 8-bit data.

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</table>

Figure 28: Look-Up Table Options (Without Isotherms)

The Tau 2.4 and Quark 2.0 releases and later added a second set of palettes associated with isotherms. The cameras detect and image the temperatures in a given scene. Within the camera, these temperatures are mapped (as determined by the AGC algorithm selected) to a range of 0 to 255 values. When Isotherms are enabled, the camera uses the first 128 values of the AGC data which is relative to the scene and the upper 128 palette values are linearly mapped to absolute temperatures.

The first Isotherm temperatures are mapped to 128 to 175, the second Isotherm temperatures are mapped to 176 to 223 and the third Isotherm temperatures are mapped to 224 to 255.

The two MidRangeIso LUTs scale 0 to 127 for the first half of the gray scale, then the first two Isotherm values use 128 to 175 to map yellow and then the scale continues on in gray scale until reaching the max value of 255.
Figure 29: Isotherm LUT Scale Example
### Figure 30: Look-Up Table Options (with Isotherms)

<table>
<thead>
<tr>
<th>Cold</th>
<th>WhiteHotIso</th>
<th>Cold</th>
<th>BlackHotIso</th>
<th>Cold</th>
<th>FusionIso</th>
<th>Cold</th>
<th>RainbowIso</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="image1" alt="WhiteHotIso" /></td>
<td></td>
<td><img src="image2" alt="BlackHotIso" /></td>
<td></td>
<td><img src="image3" alt="FusionIso" /></td>
<td></td>
<td><img src="image4" alt="RainbowIso" /></td>
</tr>
<tr>
<td>Hot</td>
<td></td>
<td>Hot</td>
<td></td>
<td>Hot</td>
<td></td>
<td>Hot</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cold</th>
<th>GlowboIso</th>
<th>Cold</th>
<th>IronbowWhiteHotIso</th>
<th>Cold</th>
<th>IronbowBlackHotIso</th>
<th>Cold</th>
<th>SepiaIso</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="image5" alt="GlowboIso" /></td>
<td></td>
<td><img src="image6" alt="IronbowWhiteHotIso" /></td>
<td></td>
<td><img src="image7" alt="IronbowBlackHotIso" /></td>
<td></td>
<td><img src="image8" alt="SepiaIso" /></td>
</tr>
<tr>
<td>Hot</td>
<td></td>
<td>Hot</td>
<td></td>
<td>Hot</td>
<td></td>
<td>Hot</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cold</th>
<th>MidRangeWHIso</th>
<th>Cold</th>
<th>MidRangeBHIso</th>
<th>Cold</th>
<th>IceFireIso</th>
<th>Cold</th>
<th>RainbowHCIso</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="image9" alt="MidRangeWHIso" /></td>
<td></td>
<td><img src="image10" alt="MidRangeBHIso" /></td>
<td></td>
<td><img src="image11" alt="IceFireIso" /></td>
<td></td>
<td><img src="image12" alt="RainbowHCIso" /></td>
</tr>
<tr>
<td>Hot</td>
<td></td>
<td>Hot</td>
<td></td>
<td>Hot</td>
<td></td>
<td>Hot</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cold</th>
<th>RedHotIso</th>
<th>Cold</th>
<th>GreenHotIso</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="image13" alt="RedHotIso" /></td>
<td></td>
<td><img src="image14" alt="GreenHotIso" /></td>
</tr>
<tr>
<td>Hot</td>
<td></td>
<td>Hot</td>
<td></td>
</tr>
</tbody>
</table>

**4.0 FFC Warning Indicator**

The camera displays an on-screen symbol called the Flat Field Imminent Symbol prior to performing an automatic FFC operation. It can be seen in the image below as the blue square in the upper right of the video output. This symbol is displayed in the analog video and the BT.656 digital output. By default, it is
displayed 2 seconds (60 frames) prior to the FFC operation. The duration of the FFC Imminent Symbol can be set in the FLIR Camera Controller GUI using the FFC Warn Time setting in the Analog Video Tab. Setting the Warn Time to less than 15 frames turns off the warning. When using analytics, this warning might induce false alarms and it is recommended to either disable this feature or create a region to ignore this area.

Figure 31: FFC Warning