

Brighter images thanks to gain – How to work with gain

Your picture is too dark, but you cannot increase exposure time because your object is moving? Based on your lighting situation, flash lighting is no alternative? The adjustable gain feature may help.

Depending on the image sensor, three different gains are distinguished: master gain, analog gain boost, and color gain.

Background

In digital imaging, a voltage proportional to the amount of incident light is output by the sensor. To increase image brightness and contrast, this signal can be amplified by an analog gain and offset before the digitizing process. The results of analog signal processing are usually better than the results of digital post-processing.

Analog amplification of the read-out pixel values increases overall image brightness and contrast. Depending on the sensor type, a global gain value for all pixels (master gain) or a separate gain value for each color (RGB gain) can be set.

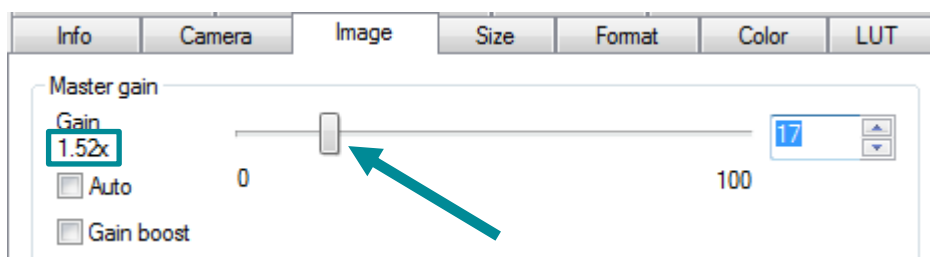
The gain can be specified as a factor or in decibels. A factor corresponds to decibels as shown in the table below:

Factor	Decibels	ISO
1x	0 dB	100
2x	6 dB	200
4x	12 dB	400
8x	18 dB	800

Setting the gain in uEye Cockpit

Open the camera properties in uEye Cockpit via “uEye > Properties”. In the “Image” tab, you can set the gain.

Master gain



Setting master gain

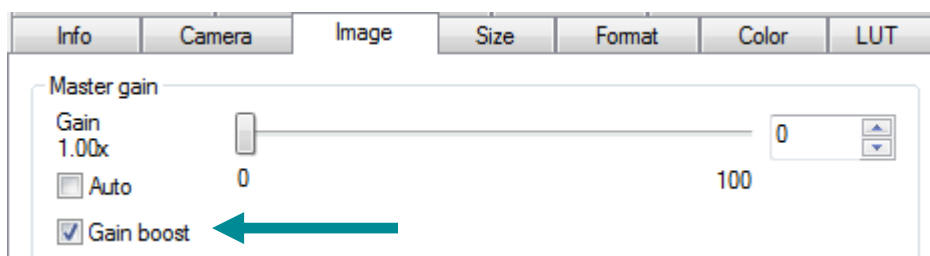
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The master gain can be set either manually or automatically. With the manual control, you set the master from 0 to 100 using the slider. The maximum value of 100 means the maximum possible gain which is different depending on the sensor. The actual gain factor is displayed on the left next to the slider. For the minimum value of 0, a gain factor of 1.0 is displayed; this means no gain.

Note that setting the slider to 50 is not necessarily half of the maximum factor. The gain increments are not graduated linearly throughout the range due to the sensor. The increments will typically be greater in the upper range than in the lower range. Depending on the sensor, the master is composed of analog and digital levels, e. g. large factors are set analog and finer intermediate levels are set digital.

If you check the “Auto” option, the automatic gain control is activated.

Analog gain boost



Activating gain boost

The “Gain boost” is analog in the hardware and therefore, it is preferable to the master gain. But not all sensor models support the analog gain boost. The gain factor ranges between 1.5x and 2x, depending on the camera model. Via the “Gain boost” option, you can enable or disable it.

Color gain

You can fix a setting (in kelvins) for the color temperature of an image when you are using a color camera. By default, the color gain is factory pre-calibrated to a daylight value (5500 Kelvin).

The function will use the sensor's hardware gain controls for the setting, as far as possible. In addition, you can choose between different color spaces. A specific color temperature will result in slightly differing RGB values, depending on the selected color space.

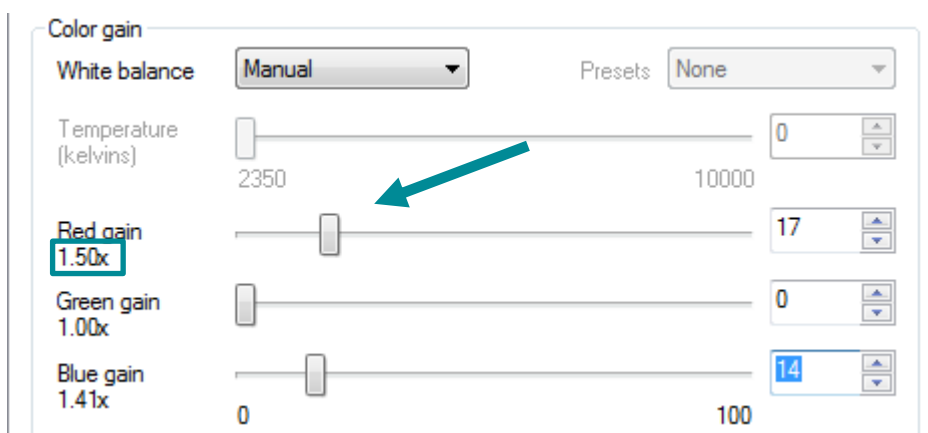
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Same color gain with different light sources



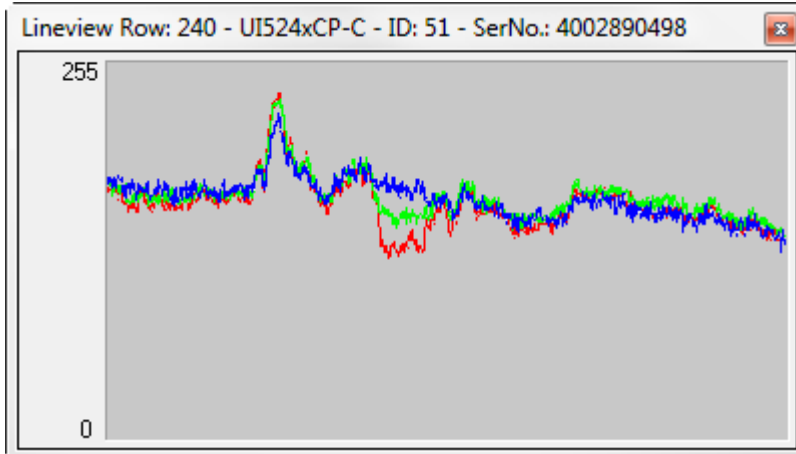
You can set each color value manually by using the three sliders for red, green, and blue gain. The analog control is performed in the sensor and achieves better results than software based image correction. As with the master gain, the sliders can be set from 0 to 100. The maximum value of 100 depends on the sensor. The actual gain factor is displayed on the left next to the slider.



Setting color gain

The two gain values are multiplied for cameras that have both a master gain and a color gain. This allows you to achieve very high gain values.

We recommend for color adjustment via the RGB sliders that you set the green slider to 0 and only use the red and blue gain. You can open the line view windows via "View > Line view (horizontal/vertical)" as additional help. These windows display the color values of a pixel row or pixel column.



Line view

The default values of the red, green, and blue gain depend on the set color space. If you change the color space, the returned default values may change. You change the color space via the “White balance” drop-down list.

Application areas

For moving objects in combination with high frame rates, you cannot increase the exposure time indefinitely. Because of the lighting conditions you also cannot brighten up by a flash. The use of the gain is especially suitable for mechanical engineering, quality assurance, or medical technology for example for light-sensitive samples.

Summary

If you don't have the conditions to use flash lighting, for example, you can use the software gain to improve the image contrast or brighten up dark images. However, you need to consider that by increasing the gain sensor artifacts become more visible such as noise or inhomogeneity.

We recommend that you first activate the analog gain boost (if supported by the sensor model) and then readjust – if necessary – with the master gain or RGB gain (color cameras only). If you use the gain, the following applies: set the gain value as high as necessary and as low as possible.

With the uEye API functions “is_SetHardwareGain”, “is_SetGainBoost” or the uEye .NET class “Gain” you can control the settings of the gain.

For further information on the gain settings and the gain factors which are supported by the different sensor models, refer to the uEye manual at <http://en.ids-imaging.com/manuals-ueye.html>.

Authors

Daniel Diezemann, Senior Vision Consultant
Marion Gentele, Technical Documentation

Contact

IDS Imaging Development Systems GmbH
Dimbacher Straße 6-8
74182 Obersulm
Germany

Phone: +49 7134 96196-0
Email: marketing@ids-imaging.com
Web: www.ids-imaging.com

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