

Measurement of signal-to-noise ratio (SNR)

The Axis method



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1. Introduction

The signal-to-noise ratio (SNR) is the ratio of the power of a desired signal to the power of background noise, and it is measured in decibels (dB). This white paper details the method by which Axis measures the SNR required by Axis network video products to produce images of a specified quality. The SNR measurement described herein is used for comparisons between different combinations of optics, that is, camera blocks in combination with sensors. SNR measurement is one step in Axis process to ensure state-of-the-art image quality.

The electric characteristics of the sensor determine which SNR that can be achieved. The more even the electric characteristics of a sensor are, the better SNR the sensor will have. Modern, light-sensitive sensors are shot-noise limited to a higher degree than older sensors, which means that photon shot-noise is the dominating noise factor.

2. An effective SNR

This section contains a brief description of how an abridged, best-case SNR can be estimated, based on measurements on a gray card. The images in this measurement all concern the processed image after the image processing pipeline (IPP), that is, the image presented to the end user. No human-reception weighting of the data is performed. Measurements are performed with sensor gain disabled, and the noise is assumed to be uncorrelated. Axis network cameras used for SNR measurements are always operating in day mode with their IR cut filters enabled.

See Section 4, Useful links, for more information on day and night functionality.

2.1 The Axis SNR method – A summary

1. Use a gray card with a reflectance value of approx. 30%, see Figure 1.

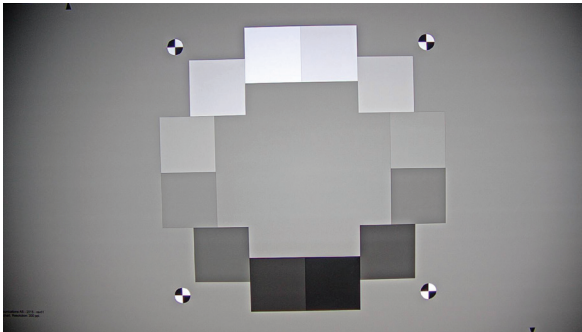


Figure 1: Axis gray card exposed at default settings.

2. Set up a minimum of two (2) broadcasting light boards to provide even illumination of the scene. The illumination level should be 2.0 klx at the scene and the color temperature should be 6500 K. Illumination level and color temperature have been chosen since this is a condition often found in broadcasting.

3. Disable the gain of the sensor.

4. Position the lens at wide.

5. Adjust the camera so that the gray card covers the entire image.

6. Tune the shutter time manually to achieve an image that is just below saturation, that is, the highest read ADC value should be ≤ 254 , see Figure 2.

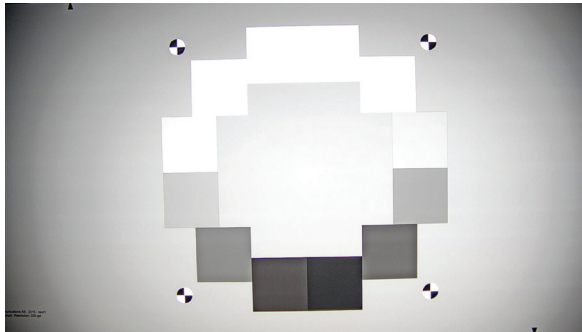


Figure 2: Exposure just below saturation.

7. Take five (5) snapshots of the scene. Exposure time should be less than one (1) frame.

8. Within each snapshot, plot the intensity profile and find the peak of the profile. In order to achieve a practical SNR, determine the size of a region around the peak that provides a relatively flat intensity profile (cropped region). For a 1080p sensor, a suitable region size is 100x100 pixels.

The reason for cropping the image to a region is to avoid the effects of vignetting from the optics and possible uneven illumination which would provide misleading values.

9. Within each cropped region, compute the SNR as:

$$\text{SNR} = 20 \log_{10} \left(\frac{\mu_R + \mu_G + \mu_B}{\sqrt{\sigma_R^2 + \sigma_G^2 + \sigma_B^2}} \right) \text{ dB}$$

where $\mu_{R;G;B}$ and $\sigma_{R;G;B}$ are the means and standard deviations of each color channel.

10. Approximate the final SNR as an average of the SNRs from the five snapshots.

3. Acronyms and abbreviations

ADC	Analog-to-digital conversion
dB	decibel
IPP	Image processing pipeline
IR	Infrared
SNR	Signal-to-noise ratio

4. Useful links

For more information, see the following link:

Axis Communications – 'Network cameras – Day and night functionality':
www.axis.com/learning/web-articles/technical-guide-to-network-video/day-&-night-functionality



About Axis Communications

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Axis has more than 2,500 dedicated employees in more than 50 countries around the world, supported by a global network of over 80,000 partners. Founded in 1984, Axis is a Sweden-based company listed on NASDAQ Stockholm under the ticker AXIS.

For more information about Axis, please visit our website www.axis.com.