



Skype Hardware Certification Specification

Video requirements for Computer Accessories and Computers

Version 6.3.2_ACC

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Revision History

Version	Date	Comments	Valid
6.3.2	2013-04-02	<p>Updated image of test target in chapter 3.13 to indicate the correct markers used.</p> <p>The table of lighting conditions in chapter 5.1.3 is amended with a new column to indicate which lamps are used.</p> <p>Tungsten light source is added to the list of inventory.</p> <p>'Total SNR' is renamed to 'Spatial SNR'. No changes in algorithm.</p> <p>The testing description in chapter 3.12 is amended with a note how to overcome of a possible problem with the Video Analyzer not being able to detect the ROI correctly in low resolutions.</p> <p>Updated the chapter 3.13 to cover the error condition of camera FOV being wider than the test chart.</p> <p>Broken links are replaced in chapters 5 and 6.</p>	2013-04-08
6.3.1	2013-03-08	<p>The video lab has been updated. The image of the setup is replaced. Added the description of tungsten light source.</p> <p>12"x12" TE-265 (Dead Leaves/Spilled Coins) is used for TV cameras that need to be tested at 1m.</p> <p>Video capture delay requirements are lowered.</p> <p>Video delay requirements over Skype call are lowered.</p> <p>Requirement added about receive path delays.</p> <p>The used ST-52 chart is supplied by Applied Image Inc.</p> <p>Specified that the testing will be done on Windows 8 platform.</p> <p>Respective GraphEdt screen captures are replaced.</p> <p>480x848 resolution can be provided in MJPEG by USB 2.0 webcams.</p> <p>The Large SFR is used in case the distance is exceeding 1.5m.</p> <p>The ST-52 images are updates under SNR tests to highlight the patch used for SNR measurements.</p> <p>The images of TE-265 (Dead Leaves/Spilled Coins) test charts are rotated and respective note added.</p> <p><i>Please note that this change is not compatible with Skype Certification Video Analyzer version 1.1 and will be addressed in version 1.2.</i></p>	
6.3	2012-12-21	<p>SNR measurement methodology is changed and the required values adjusted respectively.</p> <p>Relative illumination measurement methodology is revised and requirements added about low light condition.</p> <p>Oversharpening must not be higher than 20%.</p> <p>Veiling glare requirement reduced to 0.5%. Note added about alternative method to double check using alternative method in case of a failure.</p>	2013-01-15

Version	Date	Comments	Valid
		<p>Typo corrected in frame rate requirement.</p> <p>Section 3.15 is amended with requirements in LC1.</p> <p>The required resolutions are updated.</p> <p>1000lux tests on ST-52 chart are removed.</p> <p>Note added to the gamma requirement to indicate the plan to lower the maximum allowed gain in future test specifications.</p> <p>Formatting changes in sections 3.6, 3.7, 3.11, and 3.15.</p>	
6.2	2012-09-28	<p>CIF and QQVGA resolution is not required any more. Respective requirements removed from chapters 2.2 and 3.14.</p> <p>The framerate requirement in LC6 is lowered to 24fps (from 25fps).</p> <p>Spatial SNR test is replaced by Total SNR test.</p> <p>Temporal SNR requirements are reduced by 5dB.</p> <p>Edge roughness requirement is not applied to HD resolutions.</p> <p>Edge roughness requirement is relaxed.</p> <p>Fine texture acuity requirement is relaxed.</p> <p>CPU usage test description is changed.</p> <p>Hardware encoding related delay requirement is moved to chapter 4.</p> <p>The testing process descriptions changed to match the latest version of the Video Analyzer.</p> <p>Color accuracy tests are separated into 2 tests to avoid one requirement having 2 values.</p> <p>Geometric distortion is measured only in the maximum enabled HD resolution.</p>	N/A
6.1	2012-08-17	<p>Laptops / ultrabooks / tablets will be tested in 30lux (instead of 20 lux). 20lux test condition remains applicable to external webcams and All-in-One PCs.</p> <p>The exposure error is allowed to be up to -1.2 f-stops in low light.</p> <p>The exposure and gamma is also measured on ColorChecker.</p> <p>The measurements on ST-52 will be done using white shutters at left and right side of the target (adjusted manually to get the dynamic range correct).</p> <p>The test condition 6500K is replaced by 5500K.</p> <p>The SNR improvement requirement is removed.</p> <p>The algorithm of fine detail texture acuity test has changed.</p> <p>More saturation is allowed.</p> <p>Framerate requirement is lowered in 80lux. The test is kept to collect information.</p>	N/A
6.0	2012-07-22	<p>Draft released to partners to collect feedback.</p> <p>Major revision of tests – the testing methodology remained the same only for the tests in chapter 4.</p>	N/A

Version	Date	Comments	Valid
		Principal changes: <ul style="list-style-type: none"> • The majority of tests are NOT done over Skype call any more. • More resolutions are tested. • Test methods aligned more with Microsoft Lync test specification. 	

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1 Introduction

The technical requirements listed and respective testing methodologies in this document have been derived from earlier versions of Skype and Microsoft Lync video requirements.

This document applies only to solutions that are used with the public Skype for Windows application. Other video capable solutions will be tested against the CSpec_SDK_Video test specifications. Passing the requirements is required to enable video calls in 720p (*and higher*) resolutions with the camera and is a pre-condition to associate the camera with Skype branding.

Skype reserves the right to update the contents of this technical specification at any time without prior notice. Purposes of such updates include the capture of new capabilities in Skype platforms, new device categories, as well as performance improvements in the hardware used in peripheral devices.

1.1 Definitions

Algorithm	A process to be followed in calculations or other problem solving operations.
Autofocus convergence delay	The time it takes for the camera to automatically refocus.
Autofocus sensitivity to movement	The change in focusing distance in relation to change of target's location.
Block distortion (or tiling)	Distortion of the image characterized by the appearance of an underlying block encoding structure.
Capture gamma	A measure of camera contrast. It is the average power of the function that relates scene luminance to image pixel level. Approximately, $\log(\text{pixel level}) = (\text{capture gamma}) * \log(\text{luminance})$.
Color accuracy	Ability to reproduce colors with minimal chromatic distortion so that they are as close to real-life as possible, given the color-space limitations of the video standard being used.
Color uniformity	Alteration in image color at the edges of the image versus the center of the image.
Daylight light conditions	Light with color temperature of 5000 K.
Delay	A period of time by which something is late or postponed.
Distortion	An alteration of viewed images.
DUT (Device Under Test)	Solution being tested against the video test specification.

Dynamic range	The range of luminance levels (from lowest to highest) that the video acquisition system can capture with reasonable quality without clipping.
Encoding camera	A USB video input device that encodes video in hardware before transmitting it to the PC. In current specification, H.264 and MJPEG encodings are assumed.
Exposure accuracy	The ability of the video acquisition system to properly match the grayscale tonal levels of the scene being shot.
Field of view	The angular extent of the observable world that is perceived by the camera at any given moment.
Frame	One complete still image of video media.
Frame rate	The measurement of the frequency (rate) at which an imaging device produces unique consecutive images called frames.
Gradient	A graded change in the magnitude of some physical quantity or dimension.
Gray board	Background of the test charts, also used as a test target on certain tests.
Grayscale	An image representation in which each pixel is represented by a single sample value representing overall luminance (on a scale from black-0 to white-255).
High Definition video (HD)	720p video with 30fps or more.
High Quality Video (HQV) web camera	A camera that can produce 640x480 resolution with constant frame rate of 30 fps and passes the tests described in this specification.
Jerkiness (jerky motion)	Motion that was originally smooth and continuous perceived as a series of distinct 'snapshots'.
Lens distortion	The deformation of the image visible as straight lines in the subject being rendered as curved lines in the image from the camera. Also linear spatial deformation – horizontal or vertical stretch of the image.
Local preview	Video window of locally captured video during Skype video call where user can see possibly downscaled version of the video he/she is sending.
Motion blur	The apparent streaking of rapidly moving objects in a still image or a sequence of images such as a movie or animation.
MTF (Modulation Transfer Function)	The measurement of optical equipment's ability to represent signals with high spatial frequency (e.g. sharp edges) without blurring. Also known as Spatial Frequency Response (SFR).

MTF30	A spatial frequency at which the spatial frequency response has dropped to 30% of the zero frequency value.
MTF50	A spatial frequency at which the spatial frequency response has dropped to 50% of the zero frequency value.
Noise	Unwanted random spatial and temporal variations (e.g., snow) in the video picture.
Reduced light intensity	Light intensity of 30 lux.
ROI (Region Of Interest)	Selected subset of the test target used for conducting the measurements.
Sharpness	An image quality parameter that characterizes the richness of detail on the image. It is the opposite of blurriness.
Skype	A social networking software for making free calls over the internet to anyone else who has Skype (www.skype.com).
SMIA	Standard Mobile Imaging Architecture (www.smia-forum.org)
Snapshot	Still image capture on the PC. Also referring to snapshot function during Skype video call.
SNR (Signal to Noise Ratio)	Ratio of signal power to the noise power corrupting the signal.
Spatial edge noise	A form of edge busyness characterized by spatially varying distortion in close proximity to the edges of objects.
Spatial noise	Unwanted random spatial variations in one video frame.
Standard light intensity	Light intensity of 300 lux.
Stretch	Linear distortion in width or height of the image.
Still image	Non-moving visual information.
Temporal edge noise	A form of edge busyness characterized by time-varying sharpness (shimmering) to edges of objects.
Temporal noise	Unwanted random temporal variations in the video image.
Tungsten light condition	Light with color temperature of 3000 K.
Unique frame rate	Every frame in the video sequence must be unique. High frame rate achieved by frame rate multiplication (repeating same frame once or more) is not considered a video with unique frames.
UVC	USB Video Class ; a USB device class that describes devices capable of video streaming.

Video resolution QQVGA, QVGA, VGA	Video frame size in pixels. Usually first number indicates the horizontal pixel count and latter number the vertical pixel count.
White balance convergence delay	The time it takes for the camera to stabilize its white balance.
White balance sensitivity to movement	The change in white balance in relation to change in target's movement.

2 Entry criteria testing

A solution submitted to testing must meet some essential requirements to enable the testing.

If any of the tested items in this chapter fails then the tester has right to stop testing any further and the test will be considered completed (and the test fees will not be refunded).

Also note: **Microsoft Lync Devices Video Capture Specification requires that the webcam shipping protection must not be clear plastic** but a colored like blue or yellow. Also it should have a “Remove” label or icon.

2.1 Driver related requirements

Purpose: To ensure that the webcam is fully functional with default Windows drivers. If available then the OEM drivers must be signed by Microsoft to ensure meeting the basic level quality.
If the webcam has an integrated microphone then the same applies to the audio input soundcard too.
Note that the solution under testing must be capable to pass all the video tests with the Windows default and if available then also with OEM drivers. Only the built in webcams will NOT be tested with Windows default drivers unless used by default.

Required:

Requirement	Required value
2.1.1 Support USB Video Class (UVC) Driver	The webcam must support the UVC standard 1.0 or later versions and work with standard Windows XP SP2 or later versions, Windows Vista, Windows 7 and Windows 8 UVC drivers. Not applicable (N/A) to built-in webcams.
2.1.2 Support USB Audio Class (UAC) Driver	The webcam must support the UAC standard 1.0 and later and work with standard Windows XP SP2 or later versions, Windows Vista, Windows 7 and Windows 8 UAC drivers. Not applicable (N/A) to built-in cameras and webcams without the integrated microphone.
2.1.3 Product driver signed by Microsoft (HCK)	The drivers supplied with the webcam must be certified by Microsoft.
2.1.4 USB H.264 webcams must support the Version 1.5 of the USB Video Class (UVC) Definition for Video Devices standard	The webcam must pass the respective tests in Windows 8 HCK . Not applicable (N/A) to webcams that are not supporting H.264.

Testing: Run Device Manager and check if the webcam is using the Windows UVC driver usbvideo.sys and the provider is Microsoft. If the driver is not the Windows UVC driver, roll back the driver to the Windows UVC driver.
Run Device Manager and check if the webcam is using the Windows UAC driver usbaudio.sys and the provider is Microsoft. If the driver is not the Windows UAC driver, roll back the driver to the Windows UAC driver.
Validate that driver is signed by Microsoft. Open Device Manager / Properties / Driver / Driver Details, and then check whether Microsoft signed the driver.

2.2 Image resolution, frame rate and color space related requirements

Purpose: To ensure that the webcam is supporting the recommended image resolutions, native frame rates and color spaces.

Required: The requirements differ for USB 2.0, USB 3.0 and MIPI webcams. A dedicated table is provided for each one separately.

Requirements	Required value
2.2.1 Support required image resolutions in 15 and 30 fps.	USB2.0 webcam: in YUY2: 320x180, 320x240, 424x240, 640x360, 640x480 in MJPEG or YUY2: 848x480, 960x540, 1280x720 (<i>and 1920x1080 if revealed</i>) USB3.0 webcam: in YUY2: 320x180, 320x240, 424x240, 640x360, 640x480, 848x480, 960x540, 1280x720 (<i>and 1920x1080 if revealed</i>) MIPI camera: in NV12 or I420: 320x180, 320x240, 424x240, 640x360, 640x480, 848x480, 960x540, 1280x720 (<i>and 1920x1080 if revealed</i>) H.264 mode (if supported): 320x180, 424x240, 640x360, 848x480, 960x540, 1280x720 (<i>and 1920x1080 if revealed</i>)
2.2.2 Luminance and chrominance range for uncompressed frames (YUY2, I420 and M420)	Luminance: 16-235 Chrominance: 16-240
2.2.3 Luminance and chrominance range for compressed frames (MJPEG)	Luminance: 0-255 Chrominance: 0-255
2.2.4 Jitter	≤ 7 ms Measured in the maximum resolution supported by Skype at 30fps

* Skype will verify in End to End test that the actual achieved unique frame rate is respectively 30FPS in good light (200lux) and >15FPS in low light (20lux) for all the supported resolutions. The frame rate requirements must be met in 50Hz and 60Hz flicker reduction modes.

Test process: Run GraphEdt and preview the captured video.

Verify that the required resolutions are appearing in the “Pin Properties.”

Verify that the required resolutions are available and preview the 30 FPS video in 2 higher resolutions. The “Video Renderer Properties” must indicate the “Average frame rate achieved” figure being close to 30. Also verify that the “Jitter” is less or equal to 7ms.

2.3 Driver settings

Purpose: In order to enable the following testing it is necessary that the power line frequency flicker can be removed and that the webcam automatically adapts with the lighting conditions.

Required:

Requirement	Required value
2.3.1 Setting provided to remove power line flicker.	IF the flicker is not removed automatically then the setting must be provided for 50Hz and 60Hz power line frequencies.
2.3.2 Automatic exposure and gain controls are enabled automatically.	The webcam is automatically adapting to light conditions.

Testing: [Run GraphEdt - Mode 1](#) and preview the captured video.
Open “Filter Properties...” and verify that the requirements are fulfilled.

2.4 CPU usage

Purpose: Makes sure the webcam driver (not standard UVC/UAC drivers), which includes any video processing, doesn't have excessive CPU usage. Only the CPU usage of OEM drivers are measured, not the Windows in-box UVC/UAC drivers.

Required: Tested only if camera uses OEM driver and not the Microsoft UVC/UAC driver!

Requirement	Required value
2.4.1 CPU usage with VGA resolution at 30 FPS	<10% on 1.8 GHz dual core (In case of an integrated solution, check the usage on 2 cores)
2.4.2 CPU usage with 720p resolution at 30 FPS	<20% on 2 GHz quad core (In case of an integrated solution, check the usage on 4 cores)
2.4.3 CPU usage with 1080p resolution at 30 FPS	<20% on 2 GHz quad core (IF 1080p is supported) (In case of an integrated solution, check the usage on 4 cores)

Note: For computer embedded cameras that use OEM driver the computer's own CPU is used for test.

Testing: For each supported condition mentioned above:

- Run GraphEdt and preview the captured video.
- Use Task Manager to check the total CPU load.

2.5 Usage indicator

Purpose: To ensure that the user knows when the camera is on and imaging the user or off and not imaging the user.

Required:

Requirement		Required value
2.5.1	Usage indication during video capture	Light is ON
2.5.2	Usage indication if the camera is NOT capturing audio or video	Light is OFF

Testing: Monitor the webcam indicator light behavior in different usage scenarios. The activity can be ON or OFF if only audio is captured.

3 Video quality related tests

This section defines video metrics that help ensure good-quality Windows video capture for UC. All tests must be run using both the Windows UVC driver and any supplied video driver. The tests with Windows UVC driver can be skipped only in case of a built-in camera.

Please note that the light conditions in below test case descriptions are product category specific. Please refer to “Lighting Conditions” in paragraph 5.1.3

3.1 Image resolution quality

Purpose: To ensure that images provide a basic level of image acuity (for example, the lens is sharp enough for the sensor, and the sensor has enough pixels to capture the desired resolution after demosaicing and image processing). MTF30 is one good measure of acuity, but can be defeated by sharpening the image after capture via image processing. Oversharpening (and undersharpening) is a measure to ensure that cameras are not using extreme amounts of sharpening in the post-processing, which induces image artifacts like ringing or fuzzy images.

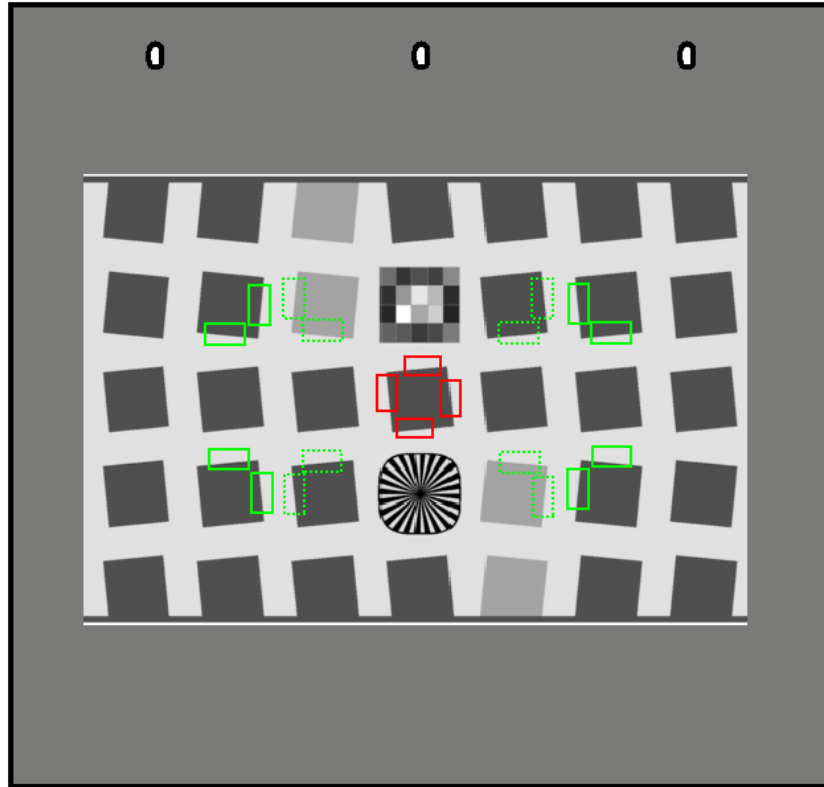
Edge roughness is a measure of image scaling quality (for example, bicubic scaling method is preferred over bilinear scaling that is greatly preferred over the nearest neighbor method).

Required:

Requirement	Required value
3.1.1 MTF30 (QVGA, chart center, 0.5m, LC2)	$0.3 \leq \text{MTF30} \leq 0.9$
3.1.2 Edge roughness (QVGA, chart center, 0.5m, LC2)	≤ 0.15 pixel
3.1.3 MTF30 (VGA, chart center, 0.5m, LC1)	$0.33 \leq \text{MTF30} \leq 0.8$
3.1.4 MTF30 (VGA, chart center, 0.5m, LC2)	$0.35 \leq \text{MTF30} \leq 0.8$
3.1.5 MTF30 (VGA, 6 of 8 chart corners, 0.5m, LC2)	$0.30 \leq \text{MTF30} \leq 0.8$
3.1.6 Oversharpening (VGA, chart center, 0.5m, LC2)	$\leq 20\%$
3.1.7 Edge roughness (VGA, chart center, 0.5m, LC2)	≤ 0.15 pixel
3.1.8 MTF30 (max supported 16:9 resolution, chart center, 0.5m, LC1)	$0.33 \leq \text{MTF30} \leq 0.8$
3.1.9 Oversharpening (max supported 16:9 resolution, chart center, 0.5m, LC1)	$\leq 20\%$
3.1.10 MTF30 (max supported 16:9 resolution, chart center, 0.5m, LC2)	$0.35 \leq \text{MTF30} \leq 0.7$
3.1.11 MTF30 (max supported 16:9 resolution, 6 of 8 chart corners, 0.5m, LC2)	$0.30 \leq \text{MTF30} \leq 0.8$
3.1.12 Oversharpening (max supported 16:9 resolution, chart center, 0.5m, LC2)	$\leq 20\%$

Note: In case of extraordinary products with a different main use case than PC webcam (a conferencing solution for example), then the distance to the test chart will be set according to the main use case.

Test target: SFRPlus chart ([Small SFR chart](#) for up to 1.5 m, [Large SFR chart](#) for > 1.5 m)



The red areas indicate the regions for “chart center” analysis and the green areas indicate the 8 regions for the “chart corners” analysis. If the squares for the green areas do not fit the camera field of view, then the alternative dotted green areas will be used for the “chart corner” analysis.

Algorithm: The analysis methods in related standard: ISO 12233-2000 are followed for Acuity and over sharpening.

The edge shape is approximated by a parabola fitted through the maxima of the image gradient, separately for each color channel. An edge profile is produced by averaging the linearized pixel values at the same distance from the parabola. The distance from edge is calculated in $\frac{1}{4}$ pixel width increments, so the edge profile is 4 times oversampled. The edge profiles for three color channels are combined as a single edge profile. The modulation transfer function (MTF) is found as the discrete Fourier transformation of the edge profile gradient. The spatial frequency where the MTF falls below 30% of its low-frequency value (MTF30) is used to describe the image acuity.

More information on Edge Roughness metric can be found at http://www.imatest.com/docs/sfrplus_instructions3/#edgerough

Testing: [Run GraphEdt - Mode 1](#)

For each combination of required conditions (distance, lighting, and video resolution):
Capture an image.

Open the captured image with Video Analyzer

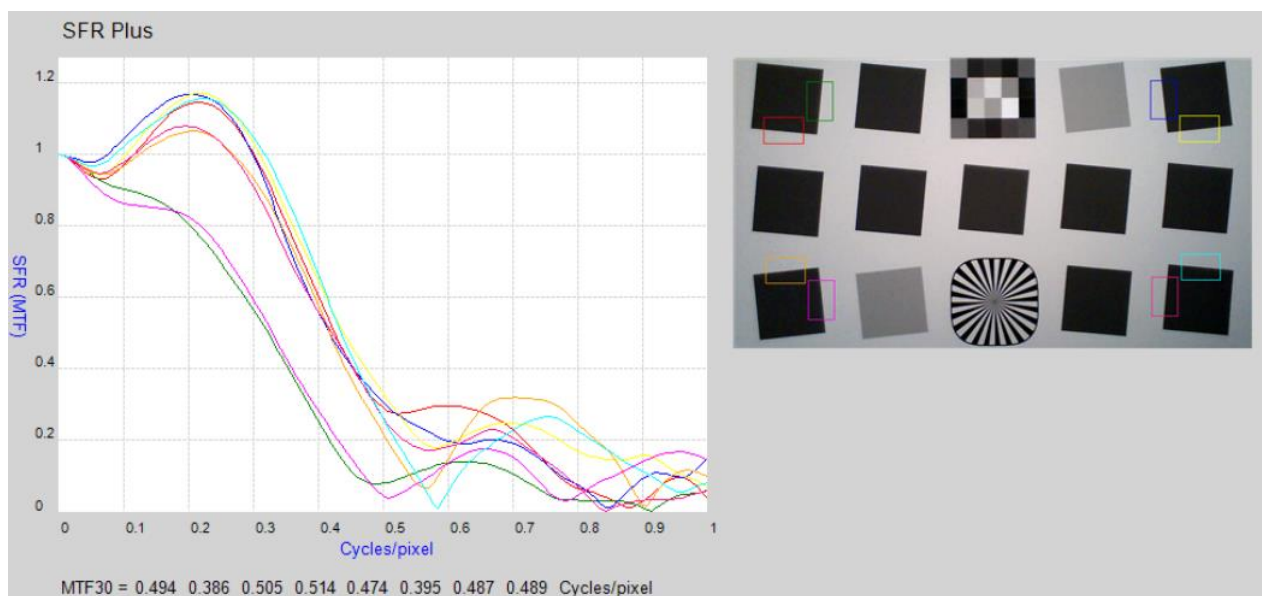
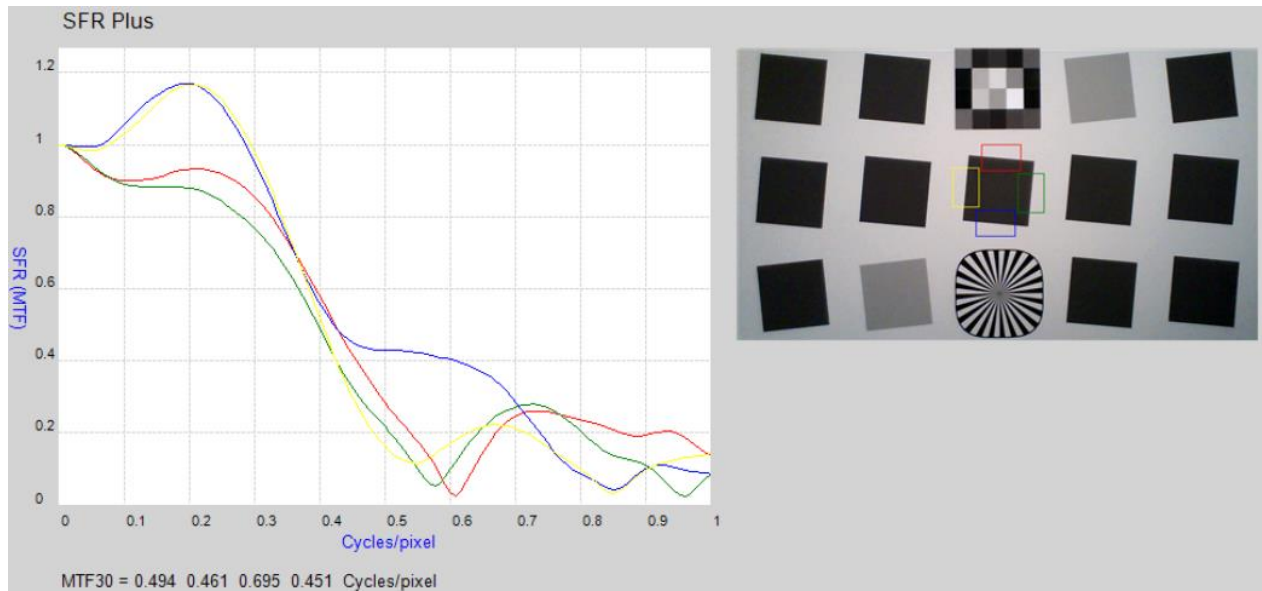
Select ‘Chart Type’ ‘SFR Plus’ and ‘Analysis Type’ as required.

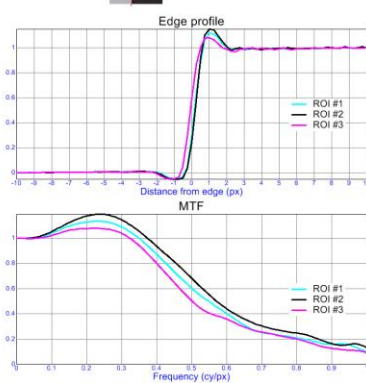
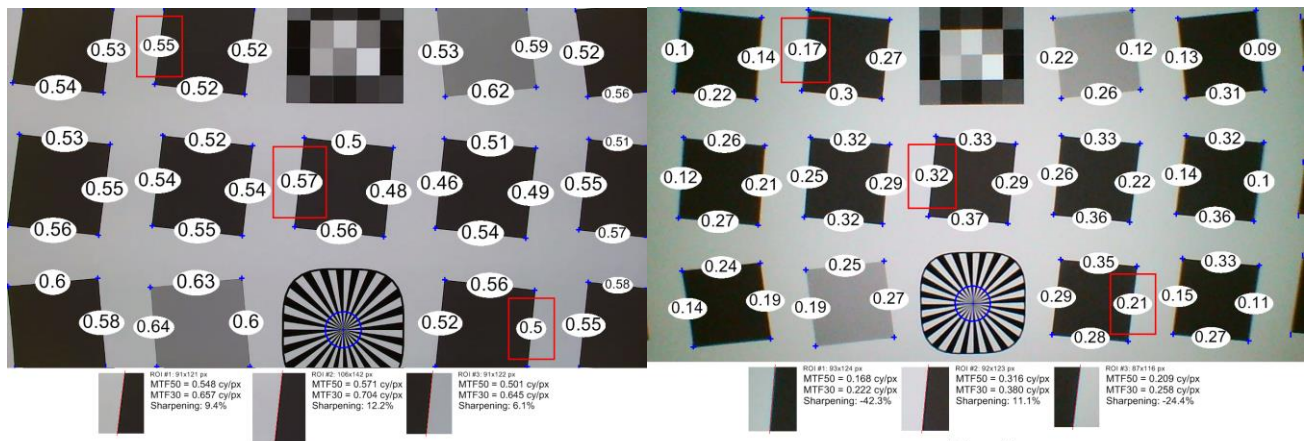
Click ‘Analyze’ and read the result. *It is suggested to save the result image – it is not done automatically.*

Note: For MTF30 in center 4 edges – each calculated MTF30 parameter must fall within the upper and lower limit. Same applies to the over sharpening parameter.

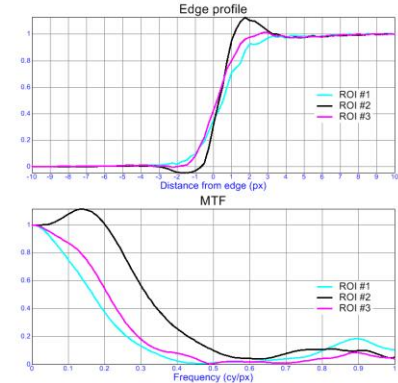
For corner MTF30, the parameter is calculated for each 8 regions. Two parameters that do not fit the required upper and lower limits are discarded. If the remaining 6 parameters fall within the limits then test result is “Pass”. If from the 6 parameters one or more still remain outside the upper and lower limits of MTF30, the test result is considered “Fail”

Samples:

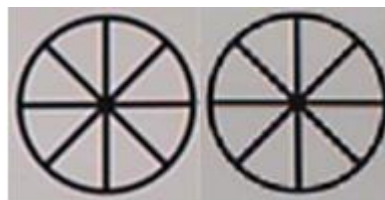




Sample of camera with passing performance
(note how a good acuity is kept over full image)



Sample of camera with failing performance (note
the loss of acuity of edges compared to the center)



Left: VGA image from the same 720p webcam scaled using bicubic with anti-aliasing¹, edge roughness=0.033(passing result).

Right: VGA image from a 720p webcam, edge roughness=0.151 (failing result)

3.2 Depth of field

Purpose: Defines the range the camera with fixed focus, manual focus, or automatic focus should be able to focus.

Required:

Requirement		Required value
3.2.1	MTF30(max supported resolution, center, 0.3m, LC2)	$0.3 \leq \text{MTF30} \leq 0.8$
3.2.2	MTF30(max supported resolution, center, 1.5m, LC2)	$0.3 \leq \text{MTF30} \leq 0.8$

Note: In case of Desktop PC-s (All In One PC) the closest distance can be 0.4m instead of the 0.3 to allow use of larger aperture lens for desktops.

In case of extraordinary products with a different main use case than PC webcam (a conferencing solution for example), the distances to the test chart will be set according to the recommended use cases in product manual / setup instructions.

Test target: SFRPlus chart ([Small SFR chart](#) for up to 1 m, [Large SFR chart](#) for > 1.5 m)

Testing: If the DUT has manual focus then use the focus set for the [image resolution quality](#) test. Measure the MTF30 at minimum and maximum distance as instructed for MTF30 test in chapter 3.1. *In case the DUT is covering lamps then try to compensate the light conditions so that the test target is still well illuminated.*

Note: For MTF30 for Depth of Field in center of target, all 4 edges are analyzed – each calculated MTF30 parameter must fall within the upper and lower limit. Same applies to the over sharpening parameter.

3.3 Fine detail texture acuity

Purpose: The pixel race and physical size reduction of camera modules has made noise reduction a significant part in the video image processing. Depending on the algorithms used and the underlying amount of noise that has to be removed, noise reduction leads to a loss of fine details with low contrast, also known as texture loss.

For more information please refer to:

[http://www.image-](http://www.image-engineering.de/index.php?option=com_content&view=article&id=570&Itemid=210)

[engineering.de/index.php?option=com_content&view=article&id=570&Itemid=210](http://www.image-engineering.de/index.php?option=com_content&view=article&id=570&Itemid=210)

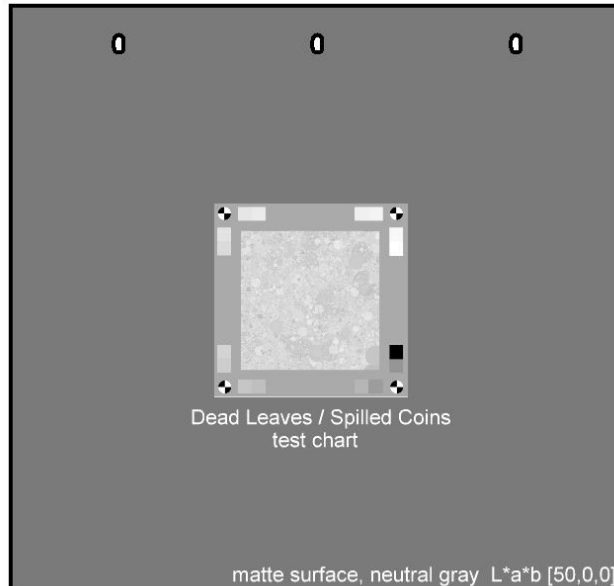
http://www.image-engineering.de/images/pdf/conference_papers/eic2010_7529_21.pdf

Required:

Requirement	Required value
3.3.1 Texture acuity (VGA, 0.5m, LC1)	≥ 0.65
3.3.2 Texture acuity (VGA, 0.5m, LC2)	≥ 0.65
3.3.3 Texture acuity (HD, max supported 16:9 resolution, 0.5m, LC1)	≥ 0.65
3.3.4 Texture acuity (HD, max supported 16:9 resolution, 0.5m, LC2)	≥ 0.65

* As this test case is based on a very new standard and uses a new method of testing Skype can make case by case exceptions during 2013 for the cameras not meeting the above criteria. Any design targets for cameras should still always aim to get a passing performance against the above requirements.

Test target: Dead Leaves / Spilled Coin test chart



Note !

The orientation of the chart has been changed, to be compatible with Imatest and Image Engineering orientation.

For Long Range cameras tested at 1m, the 12"x12" version of the chart will be used for test reliability.

This change is not compatible with Skype Certification Video Analyzer version 1.1 and will be addressed in version 1.2.

Algorithm: Linearize the image using the OECF calculated from the gray patches on the test chart.
Compute two dimensional MTF.
Average radially to get one dimensional MTF.
Compute acutance metric according to CPIQ phase 2 using the contrast sensitivity function.
Please refer to CPIQ 2.0 at <http://www.i3a.org/resources/#.UCjBP2y005I> for more details.

Testing: [Run GraphEdt - Mode 1](#)

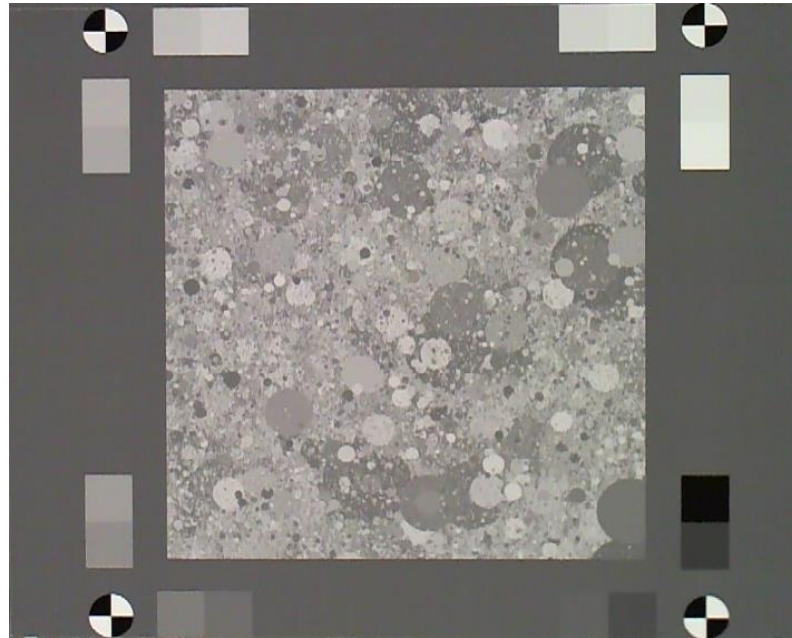
Capture an image.

Open the captured image with Video Analyzer

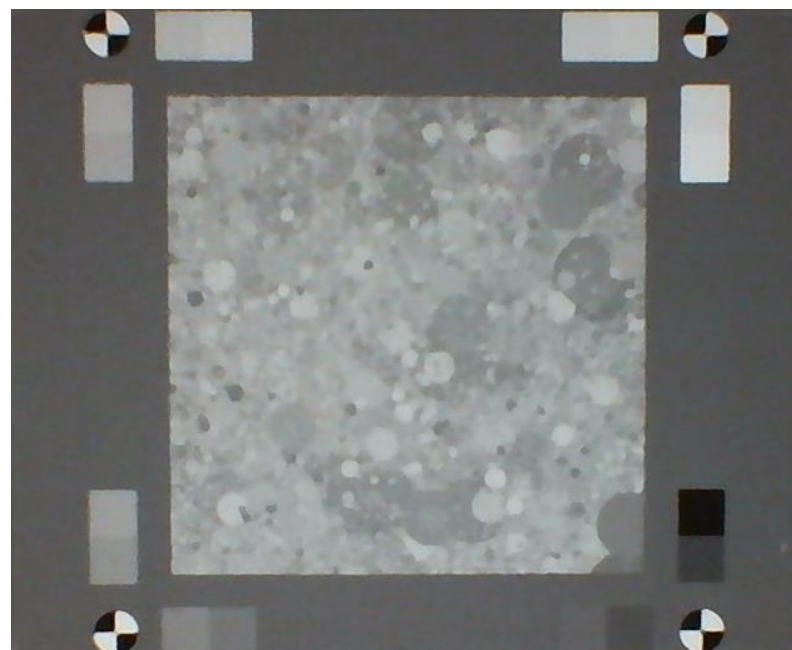
Select 'Chart Type' as 'Dead Leaves' and 'Analysis Type' as 'Acutance'.

Click 'Analyze' and read the result. *It is suggested to save the result image – it is not done automatically.*

Samples:



Sample of camera with passing performance



Sample of camera with failing performance (note the loss of fine detail and low contrast circles)

3.4 Automatic mode exposure and gain (ColorChecker target)

Purpose: Automatic exposure and gain control are needed to ensure the image has sufficient contrast and is not saturated or under exposed in typical light conditions.

Required:

Requirement	Required value
3.4.1 Exposure (ColorChecker, VGA, LC1)	$-1.2 \leq Err_{exp} \leq 0,5$
3.4.2 Exposure (ColorChecker, VGA, LC2)	$-0,5 \leq Err_{exp} \leq 0,5$
3.4.3 Exposure (ColorChecker, VGA, LC4)	$-0,5 \leq Err_{exp} \leq 1$
3.4.4 Exposure (ColorChecker, max 16:9 resolution, LC1)	$-1.2 \leq Err_{exp} \leq 0,5$
3.4.5 Exposure (ColorChecker, max 16:9 resolution, LC2)	$-0,5 \leq Err_{exp} \leq 0,5$
3.4.6 Exposure (ColorChecker, max 16:9 resolution, LC4)	$-0,5 \leq Err_{exp} \leq 1$

Algorithm: Test target is filmed and snapshots are taken. The exposure accuracy is obtained color errors in f-stops:

Frame is extracted. Average grayscale pixel values are found for all the grayscale patches on ST-52 chart (or alternatively ColorChecker chart is also supported for this analysis).

Measured grayscale pixel values are divided by reference values for each patch.

Average ratio is calculated and the result is converted to f-stops:

$$Err_{exp}[fstops] = 3,32 \frac{\overline{\log(P_i) - \log(P_{\gamma i})}}{\gamma}$$

, where $P_{\gamma i}$ is the reference pixel value of the specific patch. Exposure errors over the patches are averaged.

Test target: X-Rite ColorChecker Classic + Q14 gray steps



Testing: [Run GraphEdt - Mode 1](#)

For each combination of required conditions (video resolution, light conditions):
Capture an image.

Open the captured image with Video Analyzer

Select 'Chart Type' as 'Gretag-Macbeth' and 'Analysis Type' as 'Exposure Accuracy'. Click 'Analyze' and read the result. *It is suggested to save the result image – it is not done automatically.*

Samples:



Original picture

Black clipping sample
(details of dark objects lost)

White clipping sample (details
of bright objects lost)

3.5 Semi manual mode exposure and gain (ST-52 target)

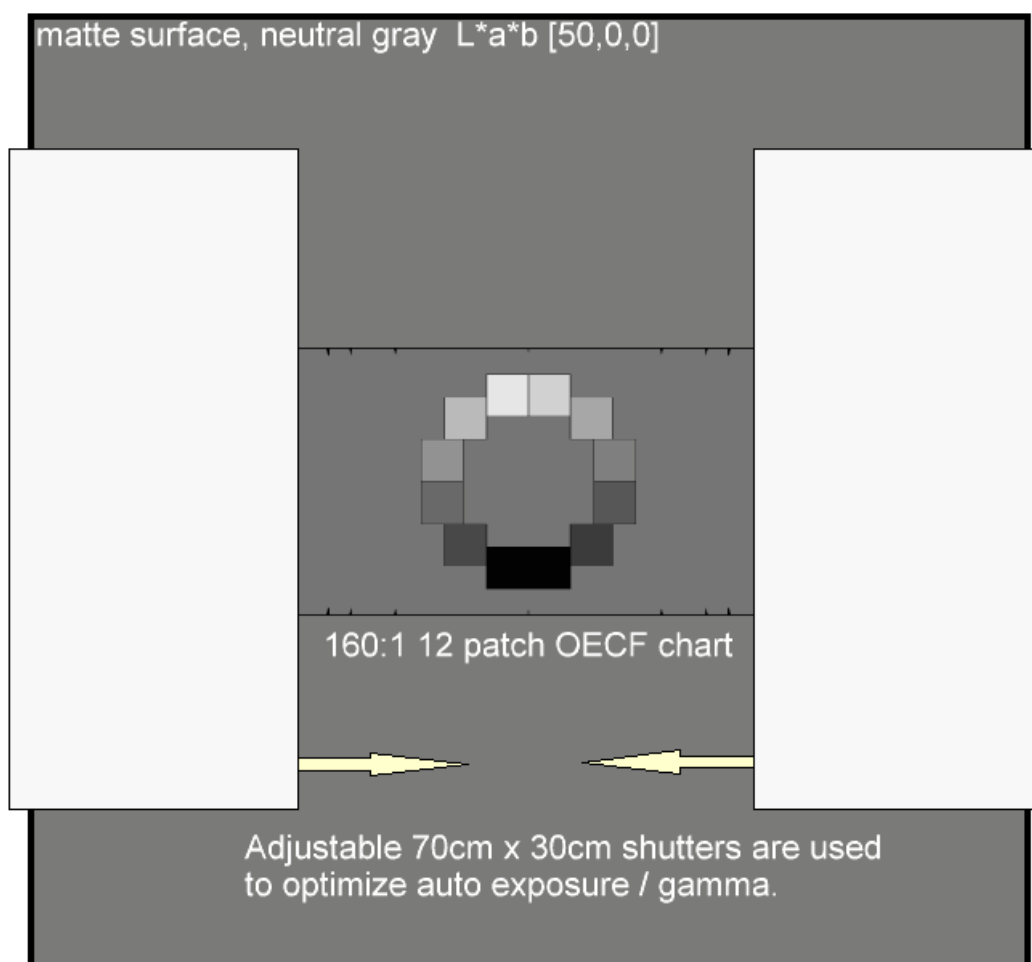
Purpose: Automatic exposure and gain control are needed to ensure the image has sufficient contrast and is not saturated or under exposed in typical light conditions.

Required:

Requirement	Required value
3.5.1 Exposure (ST-52, VGA, LC1)	$-1.2 \leq Err_{exp} \leq 0,5$
3.5.2 Exposure (ST-52, VGA, LC2)	$-0,5 \leq Err_{exp} \leq 0,5$
3.5.3 Exposure (ST-52, max 16:9 resolution, LC1)	$-1.2 \leq Err_{exp} \leq 0,5$
3.5.4 Exposure (ST-52, max 16:9 resolution, LC2)	$-0,5 \leq Err_{exp} \leq 0,5$

Note! The shutters are only adjusted according to light condition LC2 (200Lux 3500K), the other light conditions will use this same setting for the shutters.

Test target: ST-52 (ISO 14524 camera OECF test chart 1:160 contrast ratio / 12 patches)



Testing: [Run GraphEdt - Mode 1](#)

Follow the process given in appendix under “Semi manual test for exposure and gamma guidelines” 6.4

For each combination of required conditions (video resolution, light conditions):

Capture an image.

Open the captured image with Video Analyzer

Select ‘Chart Type’ as ‘ST-52’ and ‘Analysis Type’ as ‘Exposure Accuracy’. *In order to speed up the chart detection it is suggested to reduce the area of detection, but all the 12 patches must be intact on the selected subset of the captured image.*

Click ‘Analyze’ and read the result. *It is suggested to save the result image – it is not done automatically.*

3.6 Automatic mode gamma

Purpose: Windows monitors and projectors are standardized to have a gamma of 2.2 (via sRGB), so a camera gamma of 0.45 ensures a linear image capture to image render system.

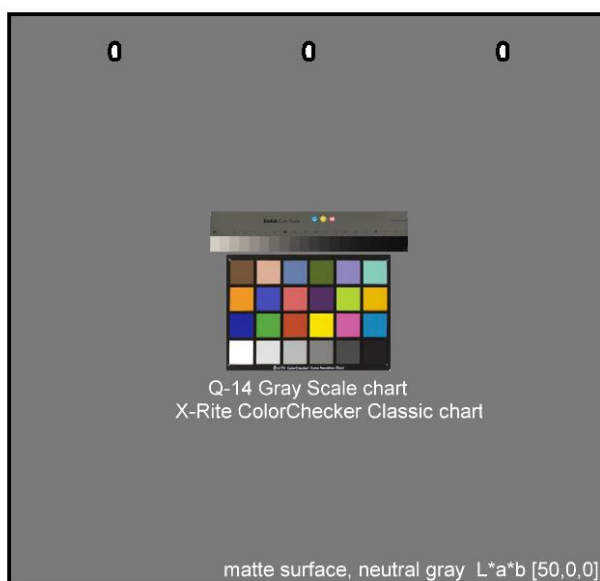
Gamma >> 0.45 can give images that have excessive contrast and look unnatural due to the non-linear luminance mapping.

Related standard: ISO 14524-1999. Scene based method B is used.

Required:

Requirement		Required value
3.6.1	Gamma(ColorChecker, VGA, LC1)	$0.4 < \gamma < 0.9$
3.6.2	Gamma(ColorChecker, VGA, LC2)	$0.4 < \gamma < 0.7$
3.6.3	Gamma(ColorChecker, VGA, LC4)	$0.4 < \gamma < 0.7$
3.6.4	Gamma(ColorChecker, max 16:9 resolution, LC1)	$0.4 < \gamma < 0.9$
3.6.5	Gamma(ColorChecker, max 16:9 resolution, LC2)	$0.4 < \gamma < 0.7$
3.6.6	Gamma(ColorChecker, max 16:9 resolution, LC4)	$0.4 < \gamma < 0.7$

Test target: X-Rite ColorChecker Classic + Q14 gray steps



Testing: [Run GraphEdt - Mode 1](#)

For each combination of required conditions (video resolution, light conditions):

Capture an image.

Open the captured image with Video Analyzer

Select 'Chart Type' as 'Gretag-Macbeth' and 'Analysis Type' as 'Gamma'. *In order to speed up the chart detection it is suggested to reduce the area of detection, but all the 12 patches must be intact on the selected subset of the captured image.*

Click 'Analyze' and read the result. *It is suggested to save the result image – it is not done automatically.*

3.7 Semi manual mode gamma

Purpose: Windows monitors and projectors are standardized to have a gamma of 2.2 (via sRGB), so a camera gamma of 0.45 ensures a linear image capture to image render system.

Gamma $\gg 0.45$ can give images that have excessive contrast and look unnatural due to the non-linear luminance mapping.

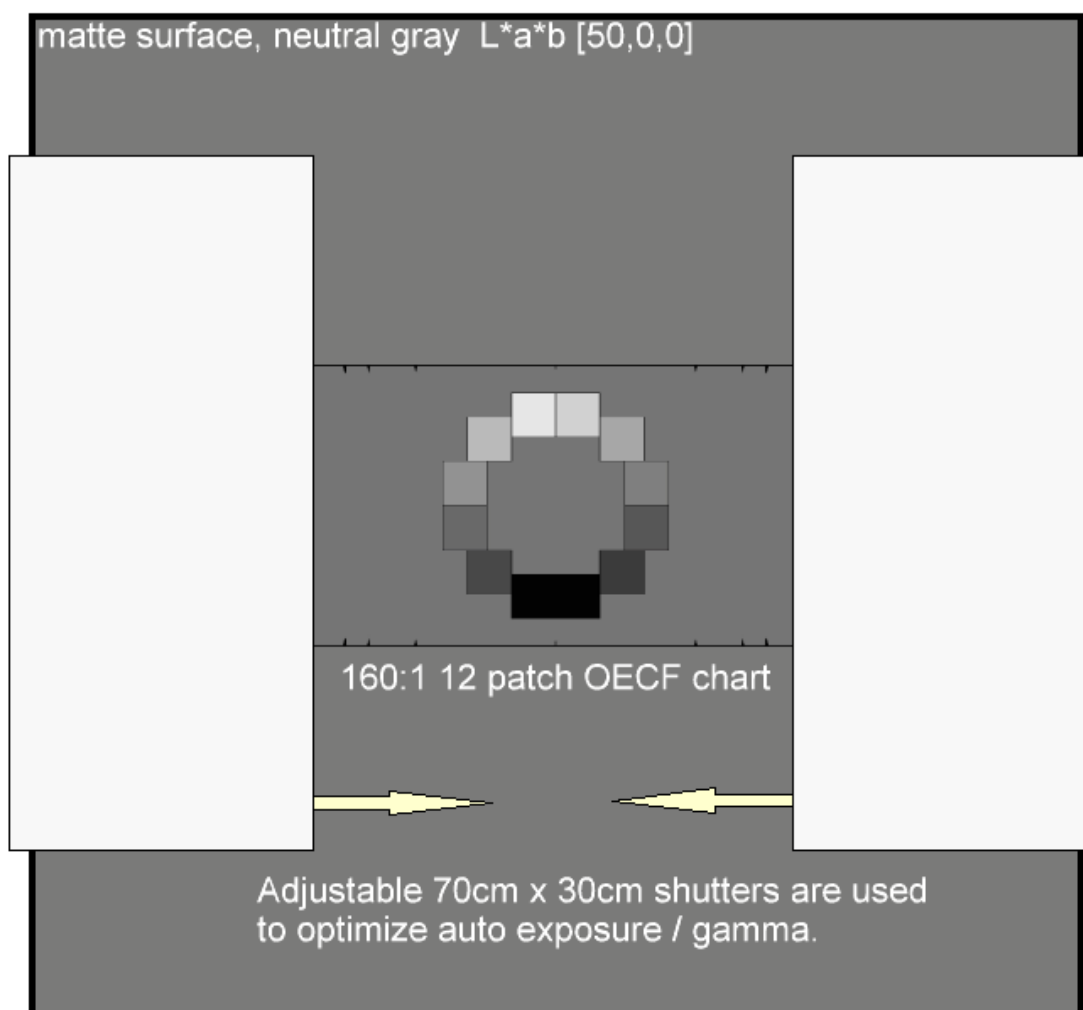
Related standard: ISO 14524-1999. Scene based method B is used.

Required:

Requirement	Required value
3.7.1 Gamma(ST-52, VGA, LC1)	$0.4 < \gamma < 0.9$
3.7.2 Gamma(ST-52, VGA, LC2)	$0.4 < \gamma < 0.7$
3.7.3 Gamma(ST-52, max 16:9 resolution, LC1)	$0.4 < \gamma < 0.9$
3.7.4 Gamma(ST-52, max 16:9 resolution, LC2)	$0.4 < \gamma < 0.7$

Note! The shutters are only adjusted according to light condition LC2 (200Lux 3500K), the other light conditions will use this same setting for the shutters.

Test target: ST-52 (ISO 14524 camera OECF test chart 1:160 contrast ratio / 12 patches)



Testing: [Run GraphEdt - Mode 1](#)

Follow the process given in appendix under “Semi manual test for exposure and gamma guidelines” 6.4

For each combination of required conditions (video resolution, light conditions):

Capture an image.

Open the captured image with Video Analyzer

Select ‘Chart Type’ as ‘ST-52’ and ‘Analysis Type’ as ‘Gamma’. *In order to speed up the chart detection it is suggested to reduce the area of detection, but all the 12 patches must be intact on the selected subset of the captured image.*

Click ‘Analyze’ and read the result. *It is suggested to save the result image – it is not done automatically.*

Note: The allowed tolerance is going to be reviewed in the next major release of the test specification (version 7).
It is likely to be [0.4, 0.65] in all light conditions.

3.8 Image spatial SNR

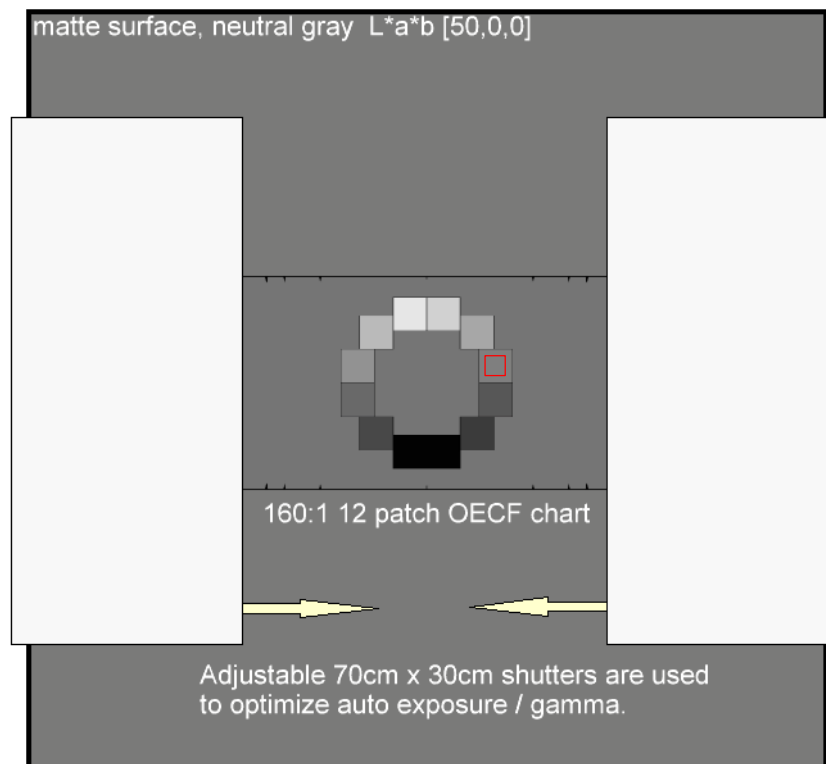
Purpose: Sufficient spatial signal-to-noise ratio is required for images to not look too noisy and for good video compression efficiency.

In lower light scenarios better image quality (higher SNR) can be obtained by reducing the frame rate from 30 FPS to 15 FPS. Further SNR improvements can be achieved by lowering the resolution, which effectively increases the pixel size. By reducing the resolution by 50% in each dimension the SNR theoretically can be increased by 6 dB if all of the pixels are used in the scaled image. The actual SNR improvement is less due to noise reduction (spatial filtering) in the ISP. Figure 48 shows a 720p image in 20 lux resized to 240p using nearest neighbor and antialiasing + bicubic interpolation. Nearest neighbor interpolation does not increase the image SNR and therefore gives no improved PSNR with the codec.

Required:

Requirement		Required value
3.8.1	SNR (total noise, QVGA, LC1)	≥ 30 dB
3.8.2	SNR (total noise, QVGA, LC2)	≥ 30 dB
3.8.3	SNR (total noise, VGA, LC1)	≥ 30 dB
3.8.4	SNR (total noise, VGA, LC2)	≥ 30 dB
3.8.5	SNR (total noise, 720p, LC1)	≥ 30 dB
3.8.6	SNR (total noise, 720p, LC2)	≥ 30 dB
3.8.7	SNR (total noise, 1080p, LC1)	≥ 30 dB (IF 1080p is supported)
3.8.8	SNR (total noise, 1080p, LC2)	≥ 30 dB (IF 1080p is supported)

Test target: ST-52 (ISO 14524 camera OECF test chart 1:160 contrast ratio / 12 patches)



Algorithm: Noise is expressed as the standard deviation of the signal coming from a uniform source, like a gray patch.

To calculate the total SNR:

- 1) Crop out the patch 7 (indicated with red rectangle on above image) of ST-52 (or Patch 22 of ColorChecker)
- 2) Convert each pixel RGB value to Luminance value:
 $(0.2125 * R + 0.7154 * G + 0.0721 * B)$
- 3) Calculate the average pixel luminance value (S)
- 4) Calculate the standard deviation (N) of the pixel luminance values
- 5) $SNR(dB) = 20 \log_{10} \left(\frac{S}{N} \right)$

Testing: [Run GraphEdt - Mode 1](#)

Follow the process given in appendix under “Semi manual test for exposure and gamma guidelines” 6.4

Open the captured image with Video Analyzer

Select ‘Chart Type’ as ‘ST-52’ and ‘Analysis Type’ as ‘Spatial SNR (Win HCK)’. *In order to speed up the chart detection it is suggested to reduce the area of detection, but all the 12 patches must be intact on the selected subset of the captured image.*

Click ‘Analyze’ and read the result. *It is suggested to save the result image – it is not done automatically.*

3.9 Image temporal SNR

Purpose: Sufficient temporal signal-to-noise ratio is required for images to not look too noisy and for good video compression efficiency.

Required:

Requirement	Required value
3.9.1 SNR (temporal, QVGA, LC1)	≥ 30 dB
3.9.2 SNR (temporal, QVGA, LC2)	≥ 30 dB
3.9.3 SNR (temporal, VGA, LC1)	≥ 30 dB
3.9.4 SNR (temporal, VGA, LC2)	≥ 30 dB
3.9.5 SNR (temporal, 720p, LC1)	≥ 30 dB
3.9.6 SNR (temporal, 720p, LC2)	≥ 30 dB
3.9.7 SNR (temporal, 1080p, LC1)	≥ 30 dB (IF 1080p is supported)
3.9.8 SNR (temporal, 1080p, LC2)	≥ 30 dB (IF 1080p is supported)

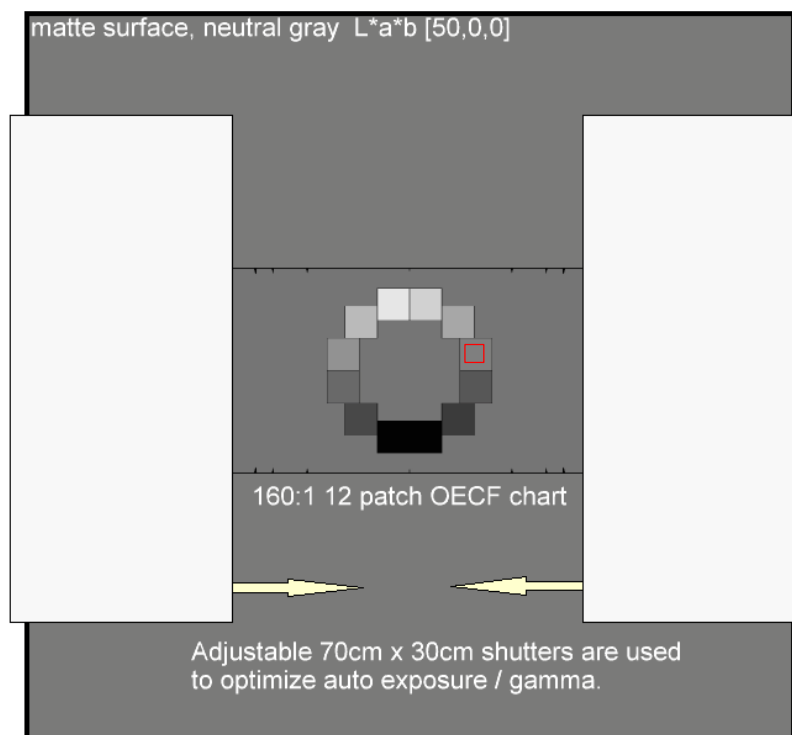
Algorithm: Temporal noise is expressed as the difference of noise (standard deviation of pixel luminance values) in two unique images captured in sequence in small time interval.

To calculate the temporal SNR:

- 1) Crop out the patch 7 (indicated with red rectangle on below image) of ST-52 (or Patch 22 of ColorChecker). Exactly the same region is used for both images.
- 2) Convert each pixel RGB value to Luminance value

$$(0.2125 * R + 0.7154 * G + 0.0721 * B)$$
- 3) Calculate the average pixel luminance value for the image 2 (S)
- 4) Calculate the differences of pixel luminance between image 1 and image 2
- 5) Calculate the standard deviation(N) of the difference values
- 6) $SNR(dB) = 20 \log_{10} \left(\frac{S}{N} \right)$

Test target: ST-52 (ISO 14524 camera OECF test chart 1:160 contrast ratio / 12 patches)



Testing: [Run GraphEdt - Mode 1](#)

Follow the process given in appendix under “Semi manual test for exposure and gamma guidelines” 6.4

For each combination of required conditions (video resolution, light conditions):

Capture an image.

Open the captured image with Video Analyzer

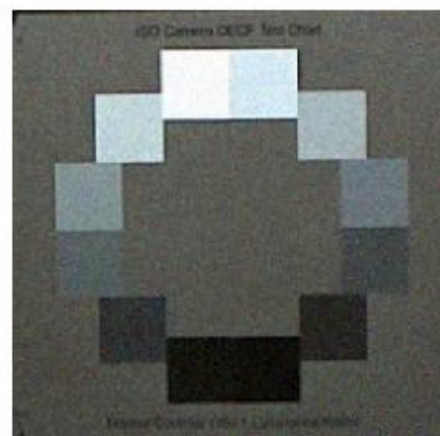
Select ‘Chart Type’ as ‘ST-52’ and ‘Analysis Type’ as ‘Temporal SNR (Win HCK)’. *In order to speed up the chart detection it is suggested to reduce the area of detection, but all the 12 patches must be intact on the selected subset of the captured image.*

Click ‘Analyze’ and read the result. *It is suggested to save the result image – it is not done automatically.*

Samples:



Measured SNR
before codec - 33dB



Measured SNR
before codec - 24dB



Measured SNR
after codec - ca 39dB



Measured SNR
after codec - ca 30dB
but subjective quality is
very poor with many artifacts

3.10 Image dynamic range

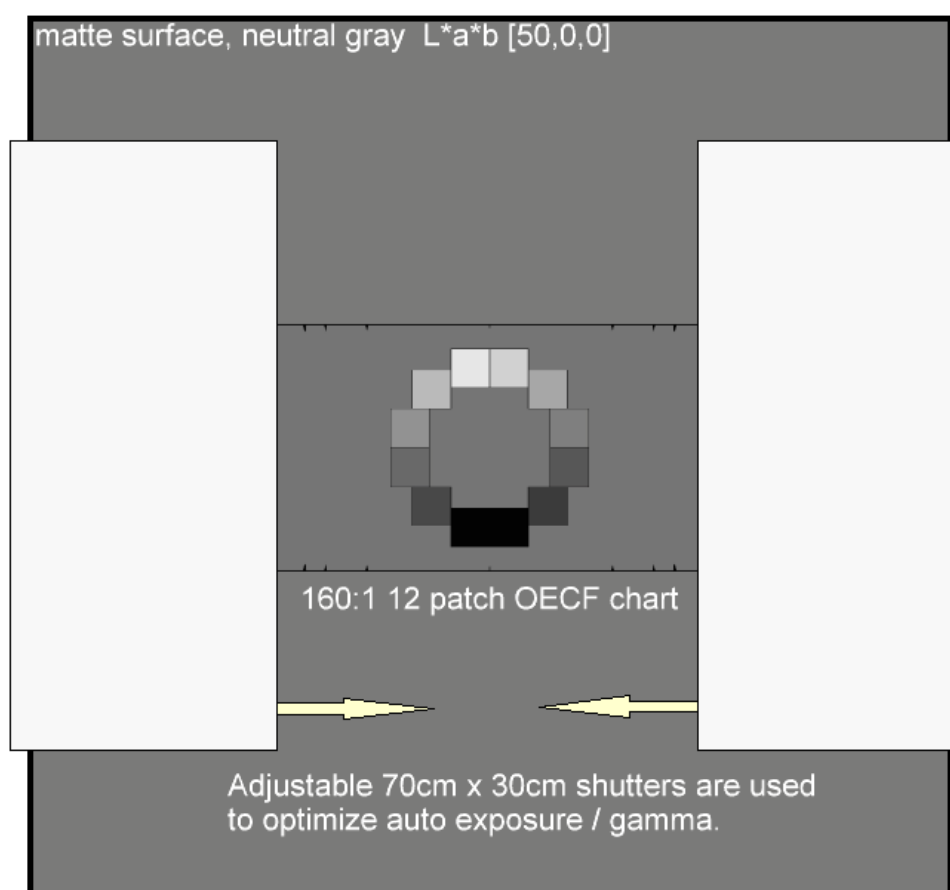
Purpose: Sufficient dynamic range is required to capture the user and background without significant saturation.

Dynamic range is a range of gray densities that camera can capture and represent unclipped.

Required:

Requirement	Required value
3.10.1 Dynamic range (VGA, LC1)	≥ 33 dB
3.10.2 Dynamic range (VGA, LC2)	
3.10.3 Dynamic range (max 16:9 resolution, LC1)	
3.10.4 Dynamic range (max 16:9 resolution, LC2)	

Test target: ST-52 (ISO 14524 camera OECF test chart 1:160 contrast ratio / 12 patches)



Algorithm: Measure the gray levels and standard deviations from the patches
Find clipping levels by analyzing the patches. Find patches that are not clipping.
Calculate preliminary dynamic range using the reference densities of the patches that were not clipping.
Using the linear regression (on the logarithmic scale) extend the preliminary dynamic range up to clipping levels.

Testing: [Run GraphEdt - Mode 1](#)

Follow the process given in appendix under “Semi manual test for exposure and gamma guidelines” 6.4

For each combination of required conditions (video resolution, light conditions):
Capture an image.

Open the captured image with Video Analyzer

Select ‘Chart Type’ as ‘ST-52’ and ‘Analysis Type’ as ‘Dynamic Range’. *In order to speed up the chart detection it is suggested to reduce the area of detection, but all the 12 patches must be intact on the selected subset of the captured image.*

Click ‘Analyze’ and read the result. *It is suggested to save the result image – it is not done automatically*

Samples:



Left: Original picture

Right: Camera with poor dynamic range

3.11 Relative illumination

Purpose: This test checks that a relatively uniform image of the user and the background is captured. Relative illumination ensures that the luminance is uniform across the image. Color uniformity ensures that the color is uniform across the image.

Related standards: CPIQ Phase 2 – Color Uniformity.

Required:

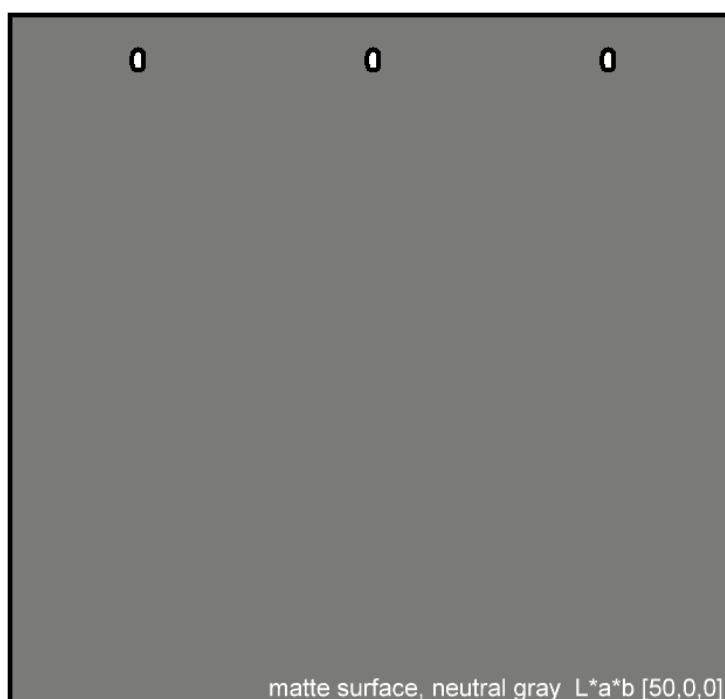
Requirement	Required value
3.11.1 Relative illumination (VGA, LC1)	$70\% \leq RI$
3.11.2 Relative illumination (VGA, LC2)	$70\% \leq RI$
3.11.3 Color difference (VGA, LC1)	$\text{Max } \Delta C \leq 10$
3.11.4 Color difference (VGA, LC2)	$\text{Max } \Delta C \leq 10$
3.11.5 Relative illumination (max 16:9 resolution, LC1)	$70\% \leq RI$
3.11.6 Relative illumination (max 16:9 resolution, LC2)	$70\% \leq RI$
3.11.7 Color difference (max 16:9 resolution, LC1)	$\text{Max } \Delta C \leq 10$
3.11.8 Color difference (max 16:9 resolution, LC2)	$\text{Max } \Delta C \leq 10$

Test target: Gray board.

A diffusing opal glass is used in front of the camera to guarantee a uniform light entering the lens/sensor. One possible source is

<http://www.edmundoptics.com/optics/windows-diffusers/optical-diffusers/opal-diffusing-glass/1671>

Light sources are adjusted in Lux level, so the light entering the lens/sensor would equal LC1 or LC2.



Algorithm: For analysis, the image is divided into 20×15 blocks for 4:3 aspect ratio, 24×16 blocks for 3:2 and 32×18 blocks for 16:9. Pixels within one block are averaged. The resulting image data (typically in RGB format) is converted to the CIELAB color space (see Annex A for a description of how to perform the conversion).

Analysis of the color shading is performed by first calculating the average a_i and b_i coordinates of the i -th region of interest (ROI), and then computing the overall average \bar{a} and \bar{b} for the entire image using the ROI averages. The deviation of the i -th ROI is defined by

$$\Delta C_i = \sqrt{(a_i - \bar{a})^2 + (b_i - \bar{b})^2}$$
$$\Delta C_{max} = \max(\Delta C_i)$$

Testing: [Run GraphEdt - Mode 1](#)

For each combination of required conditions (lighting, and video resolution):

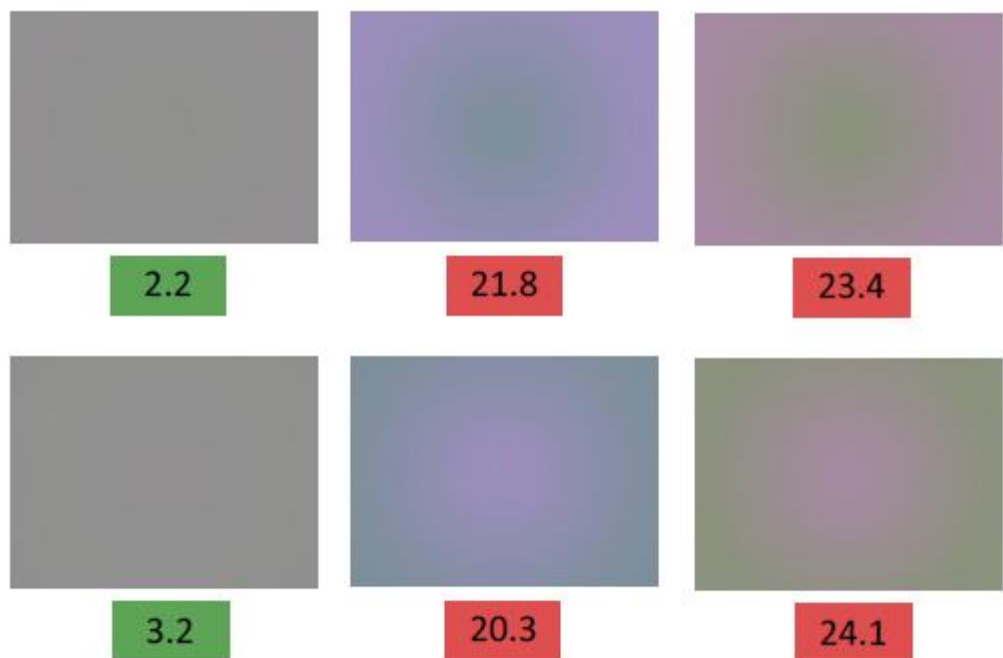
Capture an image.

Open the captured image with Video Analyzer

Select 'Chart Type' 'Uniform' and 'Analysis Type' as 'Light Falloff' (to measure the RI) or 'Color Uniformity' (to measure the ΔC).

Click 'Analyze' and read the result. *It is suggested to save the result image – it is not done automatically.*

Samples:



3.12 Field of view

Purpose: This test ensures that the camera has sufficient field of view (FOV) to capture the “talking head” scenario (a person in front of a PC). See Figure 32 for a typical notebook user scenarios and the Vertical FOV (VFOV). Note that notebook webcams typically point orthogonal to the screen and screen needs to be pointed down at a non-optimal viewing angle in order for the camera FOV to image the head and upper torso. An ideal integrated notebook webcam would have an adjustable tilt angle so that the display angle and camera angle can be simultaneously optimized. While a VFOV=40° captures the head and shoulders for this scenario, a VFOV=60° with a 10° down look angle is required to capture the body gestures, which are an important part of non-verbal communication.

Required:

Requirement	Required value
3.12.1 VFOV(VGA)	≥ 35 deg
3.12.2 VFOV(720p)	≥ 35 deg
3.12.3 FOV(consistency)	Image centers must match the 8% radius circle formed on highest resolution capture image.

Test target: X-Rite ColorChecker Classic + Q14 gray steps



Algorithm: For VFOV – vertical field of view is calculated from camera distance to chart and the known physical dimensions of the X-Rite color check chart.
 For FOV consistency
 The X-Rite color chart is found for all resolutions.
 Frame with highest resolution is taken as a base for coordinate system.
 X-Rite chart patches are found for every next resolution and mapped to same coordinate map.
 A circle with a radius equal to 8% of full image height is formed around the image center for the highest resolution capture.
 The center of image is found for all other resolutions.
 The found centers must fall in the circle formed on the highest resolution image.

Testing: [Run GraphEdt - Mode 1](#)

Capture an image with the following resolutions

- 1920x1080 (if supported)
- 1280x720
- 640x480
- 320x240
- 160x120

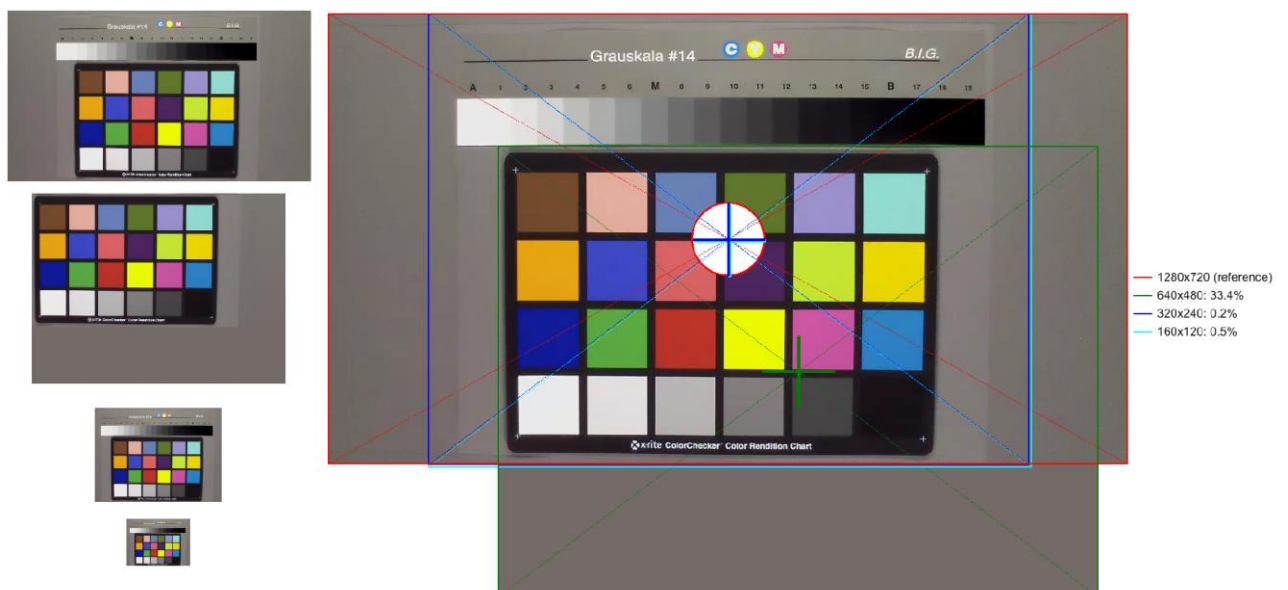
Open the captured images with Video Analyzer (select them all)

Select 'Chart Type' as 'Gretag-Macbeth' and 'Analysis Type' as 'FOV Consistency' (to measure the field of view consistency) or 'Field Of View (Vertical)' (to measure the vertical field of view).

Click 'Analyze' and read the result. *It is suggested to save the result image – it is not done automatically.*

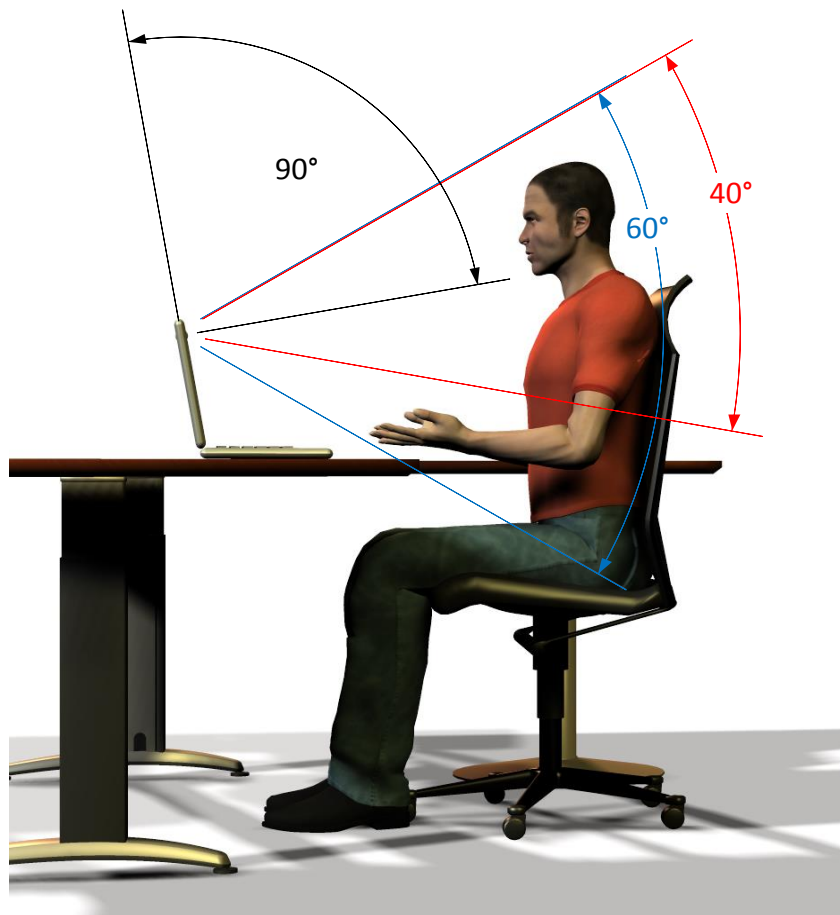
If there is a problem with detecting the chart in low resolutions then the solution is to put the camera closer to the target and restart the whole test.

Samples:



Sample of poor FOV consistency (the image center for VGA 640x480 resolution is different than QQVGA, QVGA and 720p resolutions)

Difference of Vertical Field of View



Vertical FOV for a notebook conferencing scenario



Left: 40° VFOV; Right: 60° VFOV

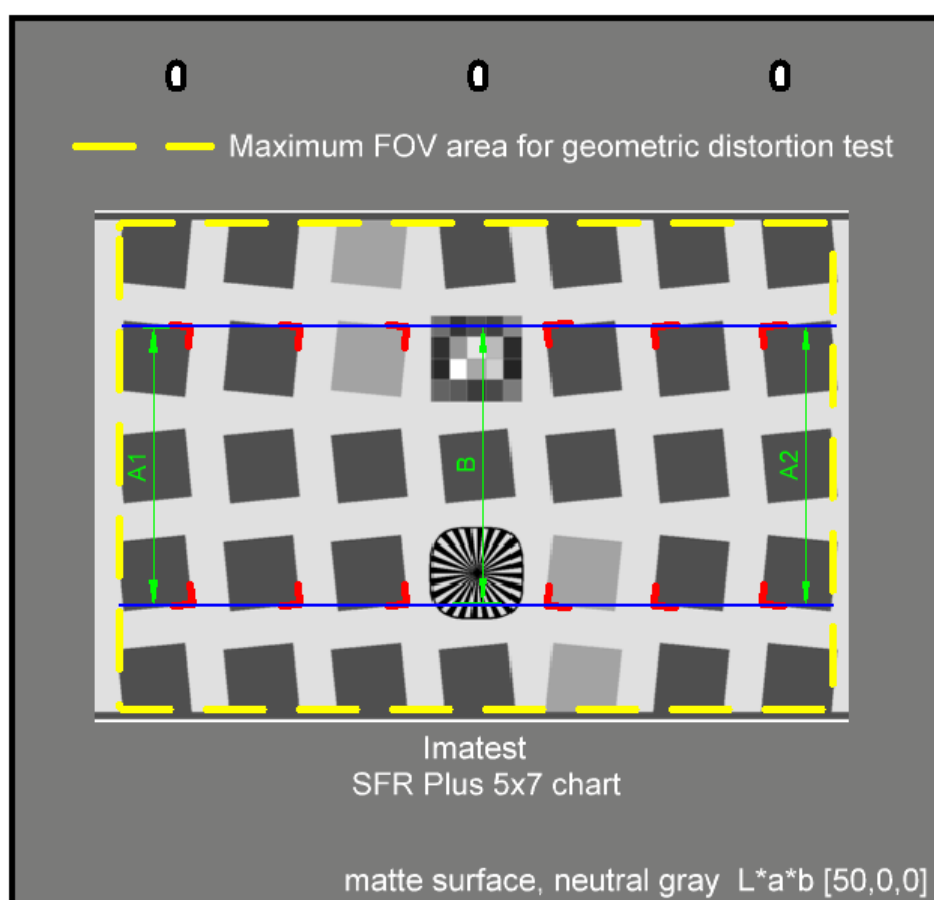
3.13 Geometric distortion

Purpose: Geometric distortions change the apparent shape and size of objects seen in images. Limiting these distortions allows captured images to more accurately represent the real scene.

Required:

Requirement	Required value
3.13.1 SMIA (max 16:9 resolution, LC2)	$ SMIA < 6\%$

Test target: Small SFRPlus chart



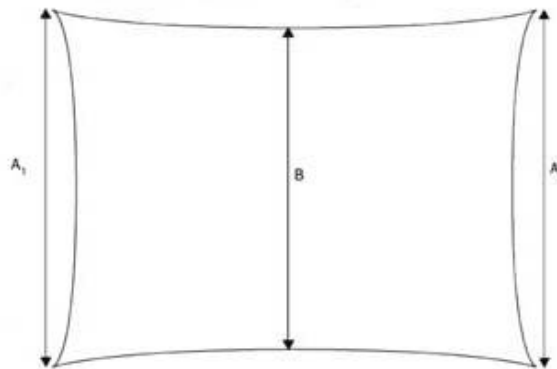
Red markers indicate the patch corners detected during the analysis. Blue lines indicate the straight lines formed.

Yellow lines indicate maximum visible area allowed for the camera – if camera can see more than the marked area then it must be moved closer to the test chart.

The SMIA is then calculated as specified under algorithm on the next page.

Algorithm: There are several standards for measuring the distortion in cameras. Skype has chosen the method described below for calculation.

$$\text{SMIA TV Distortion} = 100(A-B)/B \text{ where } A = (A_1 + A_2)/2$$



The SMIA TV distortion.

For more information refer to [here](#).

Testing: [Run GraphEdt - Mode 1](#)

Capture an image.

Open the captured image with Video Analyzer

Select 'Chart Type' 'SFR Plus' and 'Analysis Type' as 'Geometric Distortion (SMIA)'.

Click 'Analyze' and read the result. *It is suggested to save the result image – it is not done automatically.*

If the camera field of view exceeds the useful area of the test target then the solution is to put the camera closer to the target and restart the whole test.

Samples:



Original picture

Barrel distortion

Pincushion distortion

3.14 Pixel aspect ratio

Purpose: The correct pixel aspect ratio is important so that the captured images look normal and not stretched out horizontally or vertically.

Required:

Requirement	Required value
3.14.1 Aspect ratio (VGA)	0.98 ≤ R ≤ 1.02
3.14.2 Aspect ratio (720p)	

Test target: X-Rite ColorChecker Classic + Q14 gray steps

Algorithm: Calculate the height to width ratio of a color patch on X-Rite color chart.

Testing: Use the same captured images as in test “Field of view” test case 3.12

Capture an image.

Open the captured image with Video Analyzer

Select ‘Chart Type’ ‘Gretag-Macbeth’ and ‘Analysis Type’ as ‘Pixel Aspect Ratio’.

Click ‘Analyze’ and read the result. *It is suggested to save the result image – it is not done automatically.*

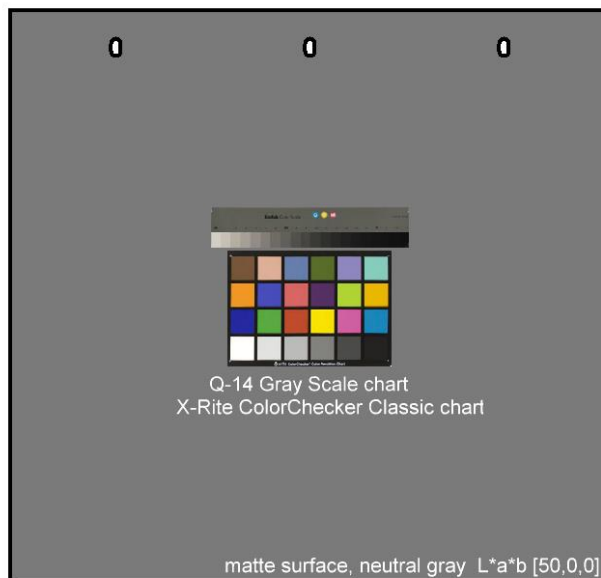
3.15 Color accuracy and saturation

Purpose: Accurate colors and saturation are required to make images look natural under various lighting temperatures. Note the criteria for A (2900K) lighting is relaxed compared to 3500 K and Day to allow A lighting to still have a yellow tint.

Required:

Requirement		Required value
3.15.1	Mean error (QVGA, LC2)	Mean $\Delta C_{00} \leq 15$
3.15.2	Max error (QVGA, LC2)	Max $\Delta C_{00} \leq 20$
3.15.3	Mean error (VGA, LC1)	Mean $\Delta C_{00} \leq 10$
3.15.4	Max error (VGA, LC1)	Max $\Delta C_{00} \leq 15$
3.15.5	Mean error (VGA, LC2)	Mean $\Delta C_{00} \leq 10$
3.15.6	Max error (VGA, LC2)	Max $\Delta C_{00} \leq 15$
3.15.7	Mean error (VGA, LC3)	Mean $\Delta C_{00} \leq 10$
3.15.8	Max error (VGA, LC3)	Max $\Delta C_{00} \leq 15$
3.15.9	Mean error (VGA, LC5)	Mean $\Delta C_{00} \leq 15$
3.15.10	Max error (VGA, LC5)	Max $\Delta C_{00} \leq 20$
3.15.11	Mean error (720p, LC1)	Mean $\Delta C_{00} \leq 10$
3.15.12	Max error (720p, LC1)	Max $\Delta C_{00} \leq 15$
3.15.13	Mean error (720p, LC2)	Mean $\Delta C_{00} \leq 10$
3.15.14	Max error (720p, LC2)	Max $\Delta C_{00} \leq 15$
3.15.15	Mean error (720p, LC3)	Mean $\Delta C_{00} \leq 10$
3.15.16	Max error (720p, LC3)	Max $\Delta C_{00} \leq 15$
3.15.17	Mean error (720p, LC5)	Mean $\Delta C_{00} \leq 15$
3.15.18	Max error (720p, LC5)	Max $\Delta C_{00} \leq 20$
3.15.19	Saturation (QVGA, LC2)	$90\% \leq \text{Sat} \leq 140\%$
3.15.20	Saturation (VGA, LC1)	$90\% \leq \text{Sat} \leq 140\%$
3.15.21	Saturation (VGA, LC2)	$90\% \leq \text{Sat} \leq 140\%$
3.15.22	Saturation (VGA, LC3)	$90\% \leq \text{Sat} \leq 140\%$
3.15.23	Saturation (VGA, LC5)	$75\% \leq \text{Sat} \leq 140\%$
3.15.24	Saturation (720p, LC1)	$90\% \leq \text{Sat} \leq 140\%$
3.15.25	Saturation (720p, LC2)	$90\% \leq \text{Sat} \leq 140\%$
3.15.26	Saturation (720p, LC3)	$90\% \leq \text{Sat} \leq 140\%$
3.15.27	Saturation (720p, LC5)	$75\% \leq \text{Sat} \leq 140\%$

Test target: X-Rite ColorChecker Classic + Q14 gray steps



Testing: [Run GraphEdt - Mode 1](#)

For each combination of required conditions (video resolution, light conditions):

Capture an image.

Open the captured image with Video Analyzer

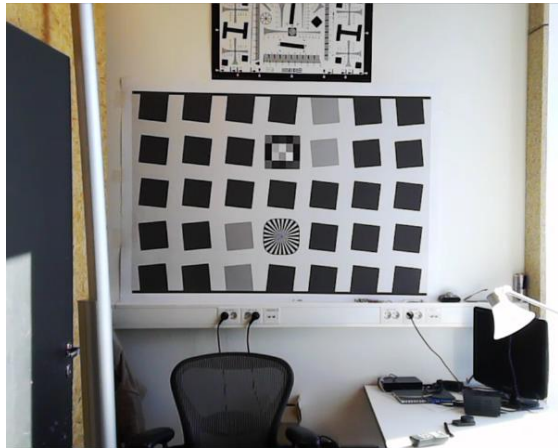
Select 'Chart Type' as 'Gretag-Macbeth' and 'Analysis Type' as 'Color Accuracy (CIEDE 2000) - Average'. 'Color Accuracy (CIEDE 2000) - Maximum' or 'Color Saturation'. *In order to speed up the chart detection it is suggested to reduce the area of detection, but all the 24 patches must be intact on the selected subset of the captured image.*

Click 'Analyze' and read the result. *It is suggested to save the result image – it is not done automatically.*

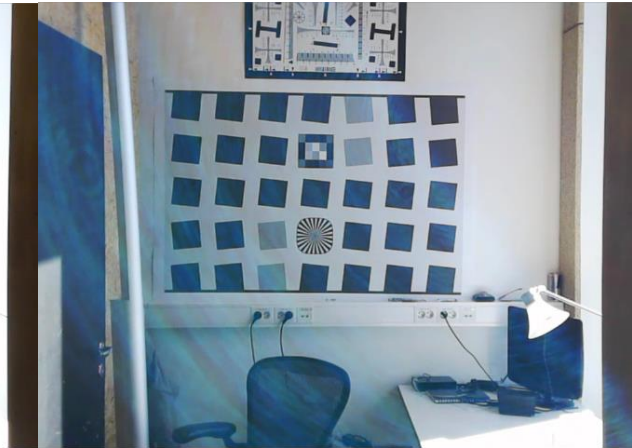
3.16 Veiling glare

Purpose: Cameras without lens hoods or with insufficient anti-reflective coating typically have significantly lower dynamic range in scenarios with overhead lighting or light sources on side, such as a window. Veiling glare is a standard measure of how stray light impacts image quality, especially dynamic range.

Related standards: ISO 9358



Window blinds on right of camera closed



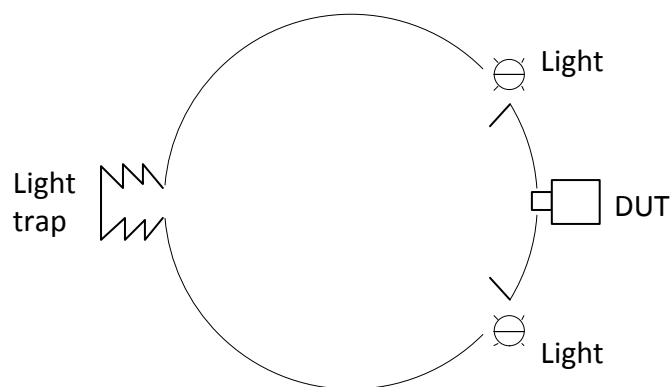
Window blinds on right of camera open

Required:

Requirement	Required value
3.16.1 Veiling glare	VGI \leq 0.5%

If a camera uses a pan/tilt function or a rotation of lens inside the camera enclosure the requirement may be relaxed to 1%.

Algorithm:



Integrating sphere and DUT setup (see ISO 9358)

To compute VGI:

1. Take an image with the device under test through the viewport
2. Determine the average RGB values of the black region using a 5x5 pixel region
3. Determine the average RGB values of the white region surrounding the light trap using a 5x5 pixel region
4. Convert the RGB values to linearized luminance Y

$$\text{Compute: } VGI = (Y_{black}/Y_{white})^{2.2}$$

Note: Note that the veiling glare test can be defeated by the ISP lowering the black level to zero which makes the veiling glare index arbitrarily small. Therefore the veiling glare test is necessary but not sufficient to test for stray light. Ideally veiling glare should be measured without such ISP methods. If the test with integrating sphere fails alternate methods will be used to confirm the fail.

Testing: Open the captured image with Video Analyzer, run the veiling glare analysis.

3.17 Autofocus performance

Purpose: This requirement specifies autofocus performance. Most webcams with autofocus experience “focus swimming” and sometimes get stuck in an unfocused state. The typical desktop scenario does not need autofocus, as at the nominal distance of 0.5 m from the camera to user the camera’s depth of field is sufficient. To minimize focus swimming, the autofocus performance is specified in a real-world test.

Required:

Requirement	Required value
3.17.1 Convergence time	The autofocus must adapt changed conditions within 1s
3.17.2 Convergence precision	$\leq 15\%$ relative error for MTF30, compared to manual focus
3.17.3 Autofocus accuracy	Image is focused 99% of the time during 5 minutes in a typical use-case scenario

Testing: [Run GraphEdt - Mode 1](#)

Convergence time and precision are analyzed the following way:

1. Enable autofocus using the Camera Control dialog box
2. Disable autofocus.
3. Adjust the focus so that the image is fuzzy.
4. Press the Default button in Camera control dialog box.
5. Capture an image 1s later.
6. Compute the MTF30 in the chart center.
7. MTF30 must be within 15% relative error compared to the image recorded during the Image resolution quality test.

3.18 Capture delays

Purpose: To ensure the webcam does not induce excessive latency in the camera or driver, which would degrade the overall video calling end-to-end experience.
The time to capture the first image is important to minimize delay seen by the user and to facilitate dynamic changing of resolutions to adapt to network conditions.

Required:

Requirement	Required value
3.18.1 Video stream delay in VGA resolution	≤ 130 ms
3.18.2 Video stream delay in 720p resolution (MJPEG mode)	≤ 150 ms
3.18.3 Video stream delay in 1080p resolution (MJPEG mode)	≤ 150 ms (IF 1080p is supported)
3.18.4 Time to capture the first image	≤ 1500 ms
3.18.5 Time to change resolutions	≤ 250 ms

Setup: Either Skype delay test setup or the LyncVidCap tool can be used for the delay measurements. The luminance of the scene during test must be >200lux to ensure the camera uses the highest frame rate during the test.

Testing: [GraphEdt – Mode 2](#)

Use Skype delay test setup in Appendix 6.5

3.19 Audio and video synchronization

Purpose: Audio video synchronization is required for lip synchronization. ITU-R BT.1359-1 gives recommended limits on audio video synchronization. Audio video synchronization can fail if the webcam uses excessive frame buffers for processing video with low latency audio, or has significant delay with audio processing with low latency video.

Related standard: ITUR BT.1359-1, ITU-T J.100.

Required:

Requirement	Required value
3.19.1 Audio leads video (max resolution, LC2)	≤ 45 ms
3.19.2 Audio lags video (max resolution, LC2)	≤ 125 ms
3.19.3 Audio leads video (VGA, LC2)	≤ 45 ms
3.19.4 Audio lags video (VGA, LC2)	≤ 125 ms

Testing: [GraphEdt – Mode 2](#)

Use Skype delay test setup in Appendix 6.5

4 Video tests over Skype

The tests are done over Skype to Skype call once the call has stabilized in highest resolution enabled with Skype unless specified otherwise.

4.1 Delays

Purpose: To ensure that the video would not have too high latency in lossless network condition and using a maximum frame rate.

Required:

Requirement		Required value
4.1.1	Send video delay (max resolution)	< 215ms
4.1.2	Preview video delay (max resolution)	< 150ms
4.1.3	H264 hardware encoded video stream delay in 480p resolution over Skype to Skype end to end test	≤ Skype software H264 encoder mode delay in VGA + 30ms (IF hardware encoding is supported.)
4.1.4	Receive video delay (applicable only for devices that have receive video capability as part of the solution)	< 215ms

Test target: Blinking LED. (Gray board is on the background).

Testing: Ensure the lights are set to >200lux to maximize the camera frame rate. Use Skype delay test setup in Appendix 6.5

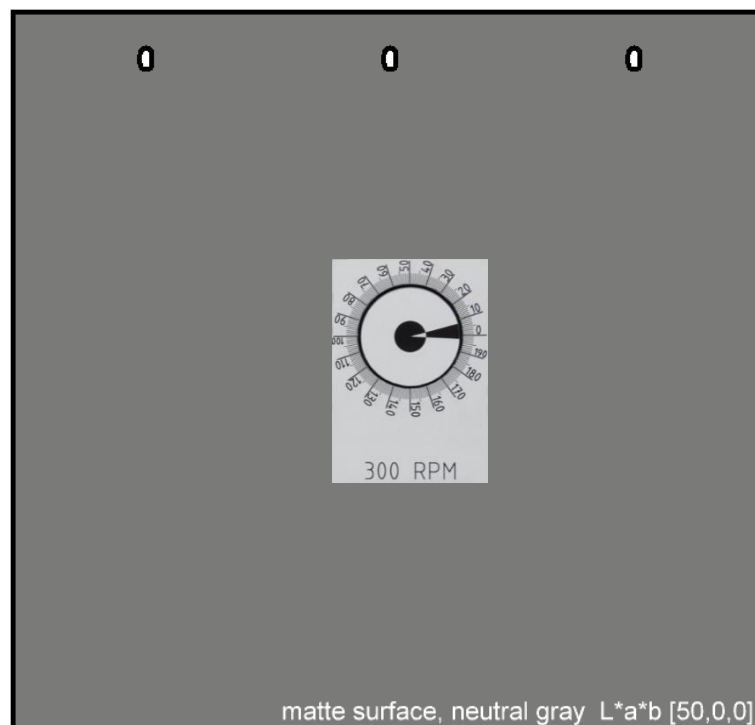
4.2 Actual framerate

Purpose: To ensure that frame rate – temporal resolution – would be high enough so that video runs smoothly without significant motion blur.

Required:

Requirement	Required value
4.2.1 Frame rate (send, LC1, perfect network)	≥15fps (New!)
4.2.2 Frame rate (send, LC7, perfect network)	≥15fps (New!)
4.2.3 Frame rate (send, LC6, perfect network)	≥24fps
4.2.4 Frame rate (send, LC2, perfect network)	≥30fps
4.2.5 Frame rate (preview, LC2)	≥30fps

Test target: Gray board with moving object.



Algorithm: Frames are counted in a 10 s interval. Frame rate is found by $f[fp] = \frac{N}{T[s]}$, where N is the number of unique frames and $T[s]$ is the time interval during which frames are counted.

A frame is considered unique if it is not identical with the previous frame. That enables to avoid artificially increased frame rate by frame repetition. If frames are repeated, counter N remains unchanged.

Also, if some frames are obtained by averaging following frames (resulting in motion blur), also if image is visibly more jerky than other cameras with the same frame rate or has some other motion artifacts, this test case fails automatically.

4.3 Encoding quality (only for cameras with hardware encoder)

Purpose: Tests are aimed to ensure the encoding quality of the encoder of device under test.

Required: The following items are compared with a reference camera in equal network bandwidth conditions on same DUT computer.

The reference camera used is **Logitech C920** run in H264 hardware encoding mode.

Requirement	Required value
4.3.1 Jerkiness	Jerkiness is the holding or skipping of video image frames or fields in a digital video. Jerkiness may occur when a significant number of burst errors occur during transmission, resulting in the inability of a receiver to display a new image frame.
4.3.2 Blockiness	A distortion that appears in compressed video material as abnormally large pixel blocks. Also called "macroblocking," it occurs when the encoder cannot keep up with the allocated bandwidth. It is especially visible with fast motion sequences or quick scene changes.
4.3.3 Other encoding artifacts	Potential video artifacts such as Blurring Color Bleeding Staircase Effect Ringing False Contouring Mosquito effect

Please refer to "Digital Video Image Quality and Perceptual Coding" ISBN-10: 0824727770 | ISBN-13: 978-0824727772 for more detailed explanations and samples for the above coding quality parameters.

Testing: Simulate typical user actions in typical conditions: moving slightly closer and further, talking, moving hands, placing an object near to the camera and taking it back, filming text/graphics and changing the viewing direction of the camera.

5 Test setup and test environment details

5.1.1 Main video test setup

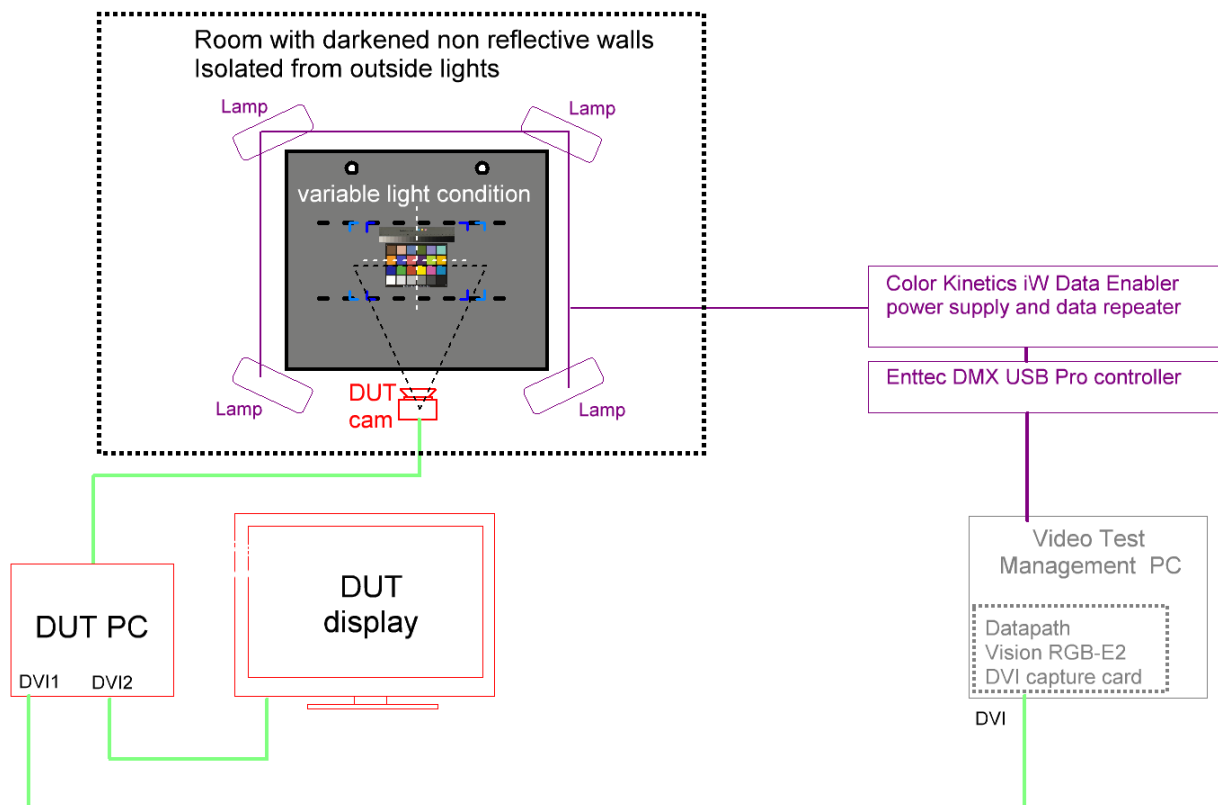
DUT camera is connected to a test PC unless it is an embedded camera in Laptop or All In One type of computer.

The video is opened with the help of the GraphEdt tool as described in section 6

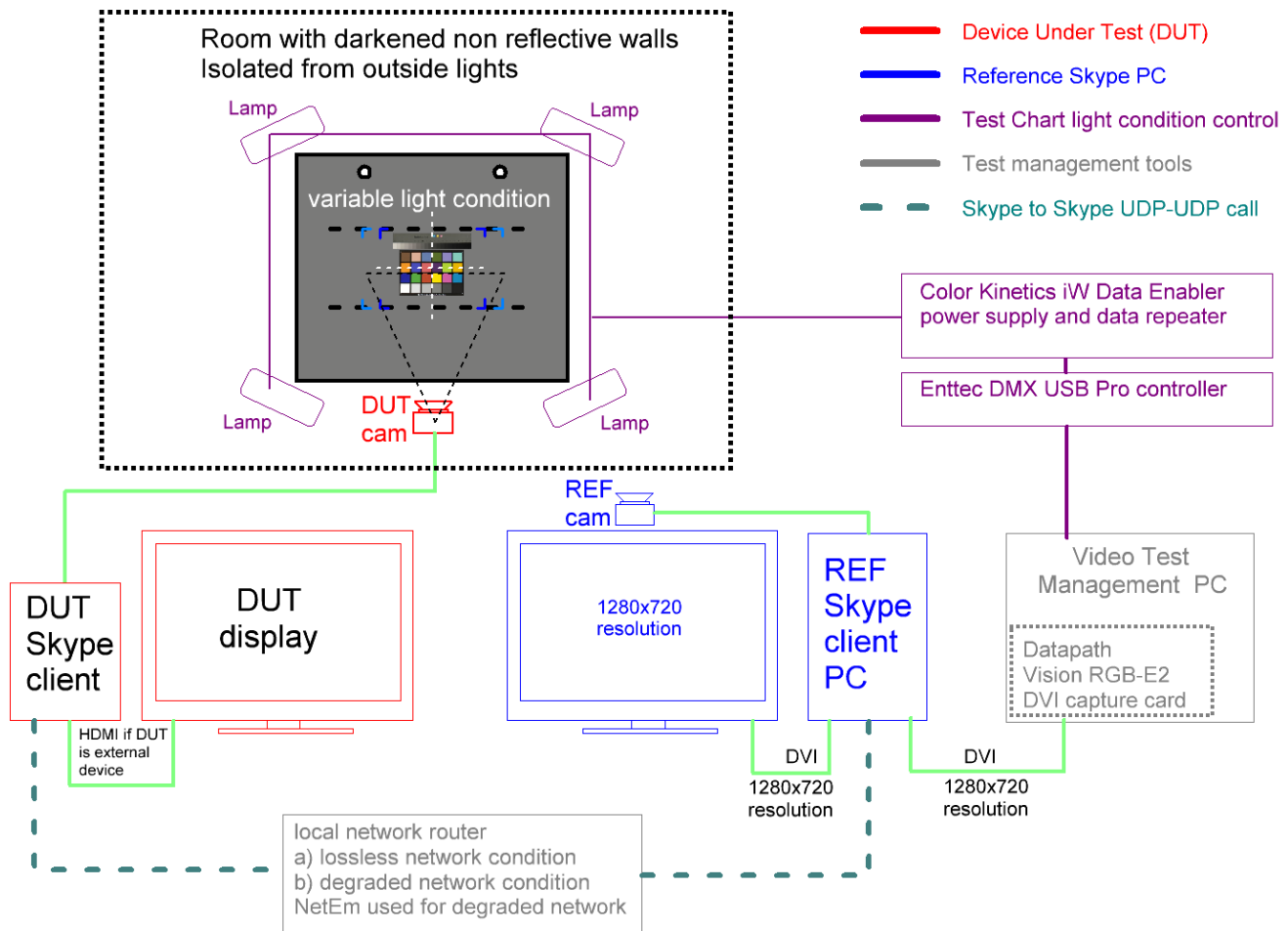
In Skype testing the images are captured with the DVI capture card from the Primary DVI output of the video card or from an external monitor output in case of Laptops and All In Ones.

Alternatively images can be captured from the DUT PC screen and saved to BMP or PNG format.

Automated script is used to set light conditions and capture the respective snapshots. Analysis is done later using a Skype proprietary Video Analysis tool..



5.1.2 End to End testing over Skype video call



End to End test is conducted over a Skype to Skype two way video call. Skype call is made in the ideal network conditions.

If the DUT is a laptop or All In One type of computer that allows both the LAN and Wi-Fi connection then LAN connection is used as a first preference and Wi-Fi verified as secondary. If only Wi-Fi is supported then Wi-Fi connection will be used.

Video resolutions (send and receive) and frame rates are the highest defaults which the device enables in ideal conditions, unless otherwise stated in the test case.

A call is made between the DUT and the Reference Skype PC. The Reference PC is configured for 1280x720 or 1920x1080 resolution and one of the two output DVI cables is connected to the DVI capture card in Test Management PC.

The tests are conducted by using the DVI capture card to capture the DUT camera send video and extracting the frames for image processing/analysis. The DVI video is captured at constant 50 or 60 frames per second.

On the reference Skype PC it is possible to open the call technical information window to verify the DUT send video parameters and network parameters. Go to Skype -> Call menu -> Technical Call Info (visible only if a call is ongoing).

Verify the following parameters from [Call Technical Info](#) prior to testing

- The call is UDP – UDP
- Relays = 0
- Video receive - resolution, frame rate, bit rate - make sure these parameters have reached the maximum supported before starting the testing (these are the DUT camera send video parameters!)

5.1.2.1 Call Technical Info during Skype calls

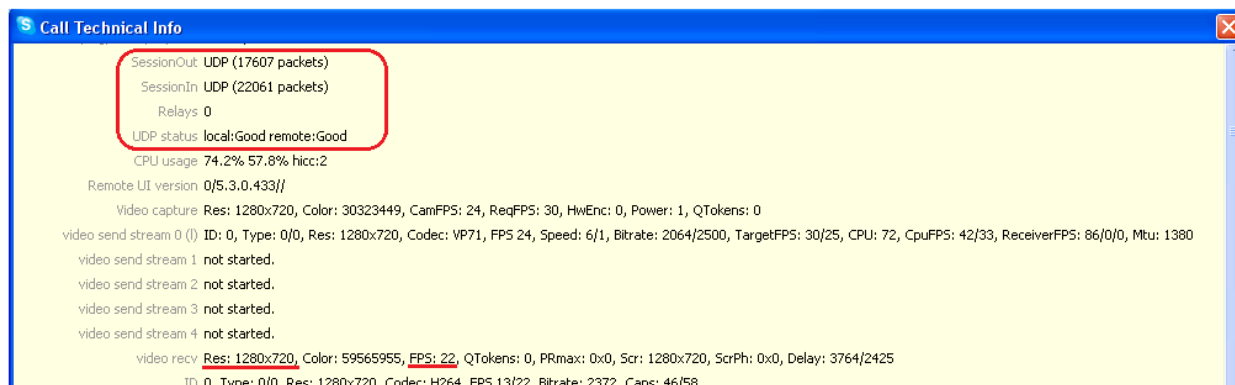


Figure 34. Snapshot of the call technical info displayed in Skype UI on reference PC.

Much more detailed description about the various info presented in the Call Technical Info window, please refer to <http://developer.skype.com/skypekit/development-guide/audio-video-integration/technical-call-info>

5.1.3 Lighting conditions

In order to control the lighting conditions a dedicated test room that is separated from the uncontrollable light sources should be used. The walls and objects in the room should be matt black or dark gray and not produce any disturbing reflections.

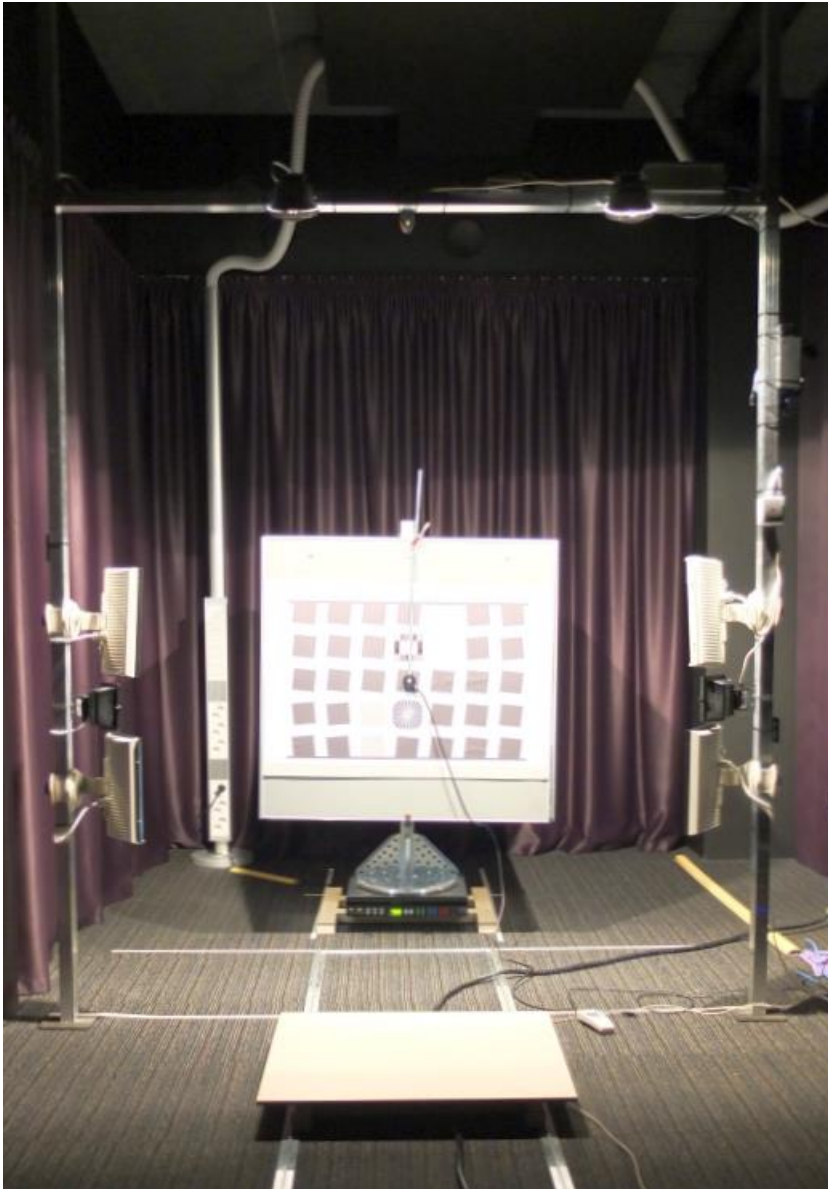
The lights for objective testing enable us to independently alter the color temperature and illuminance on the test target in given boundaries.

Color temperatures and illuminances used as testing conditions are defined as following:

Abbreviation used as parameters in requirements.	Condition applied to external webcams and 'All-in-One' solutions.	Condition applied to 'portable devices' as laptops, tablets, ultrabooks etc.	Light source
LC1	20lux, 3500K	30lux, 3500K	iWBlast 12, LED
LC2	200lux, 3500K		iWBlast 12, LED
LC3	200lux, 5500K		iWBlast 12, LED
LC4	1000lux, 5500K		iWBlast 12, LED
LC5	20lux, 2900K	30lux, 2900K	Incandescent – Osram Halogen Eco Superstar
LC6	160lux, 3500K		iWBlast 12, LED
LC7	80lux, 3500K		iWBlast 12, LED

On the flat test charts we provide as uniform illuminance as possible. Over the chart, illuminance can vary no more than 10%. The overall illuminance is within 10% of the specified value.

Lighting intensity and color temperature are calibrated at the test targets center position with three-channel photometer Gigahertz-Optik HCT-99D and verified with broadband spectroradiometer JETI Specbos 1211.



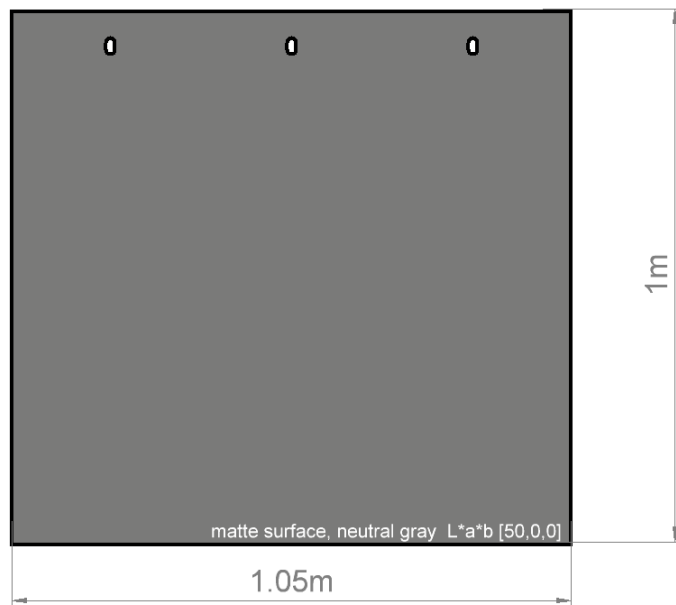
The picture shows

- Mechanical fixture for lights – mounting posts of lights positioned 0.74 meters from test board surface
- four of Color Kinetics [iW Blast 12 Powercore](#) lights
- Two tungsten lights with Orsram Halogen Eco Superstar 48W light bulbs.
- Gigahertz Optik HTC-99D sensor shown in center position of test targets. This is the position used for illuminance and color temperature calibrations of the lights for each light condition.

5.1.4 Test charts

List of all test charts used to measure objective image and video quality parameters:

5.1.4.1 Gray Board – for light falloff, color uniformity and framerate tests

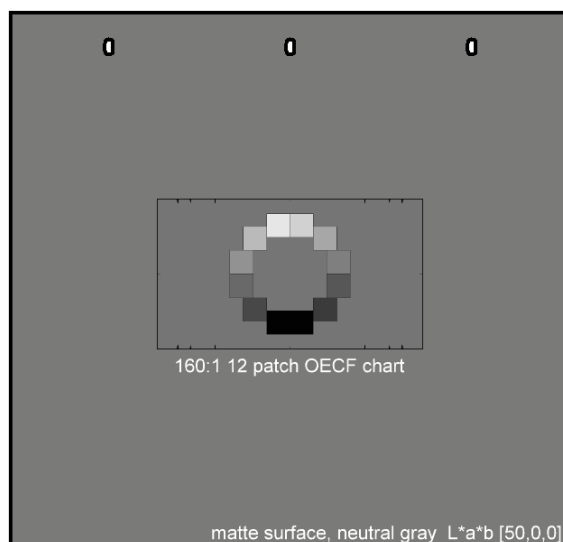


NB! The same dimensions apply also to the gray background test baffles of the other charts.

5.1.4.2 X-Rite ColorChecker Classic + Q14 gray steps together with Q-14 Gray Scale test charts



5.1.4.3 ST-52 / 12 patch 160:1 contrast ratio OECF chart

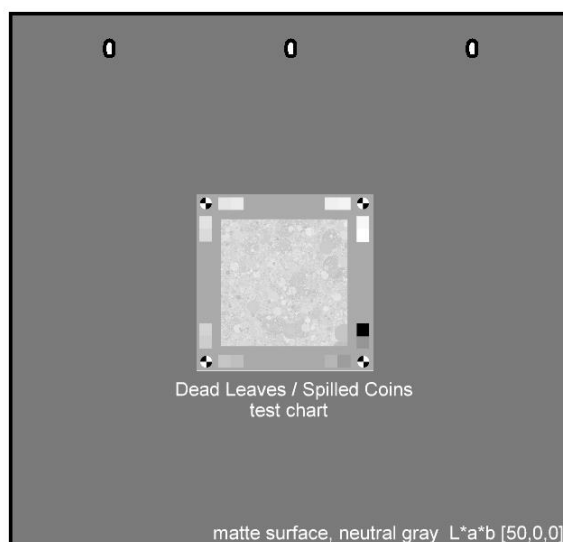


Note !

The chart used by Skype is from Applied Image Inc.

Chart model nr ST-52-RM

5.1.4.4 Dead Leaves / Spilled Coins - texture acuity test chart

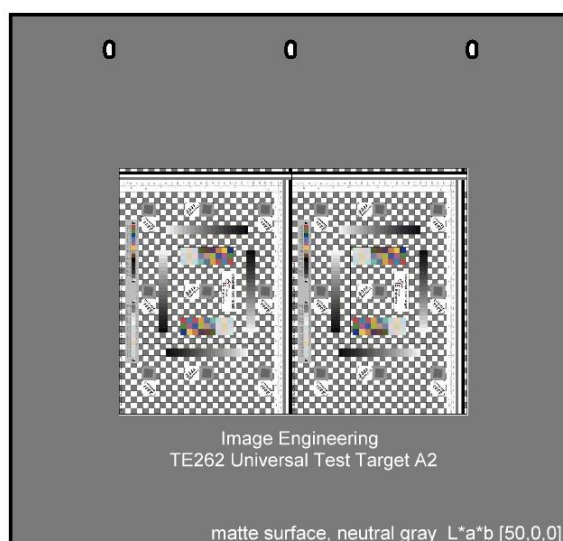


Note !

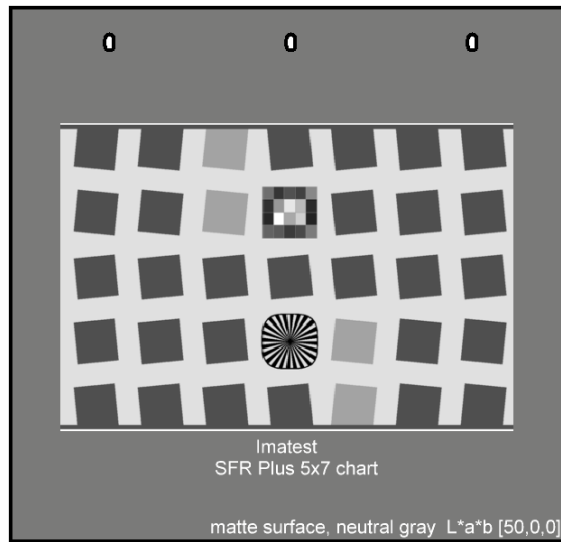
The orientation of the chart has been changed, to be compatible with Imatest and Image Engineering orientation.

For Long Range cameras tested at 1m, the 12"x12" version of the chart will be

5.1.4.5 Universal Test Target (TE262)

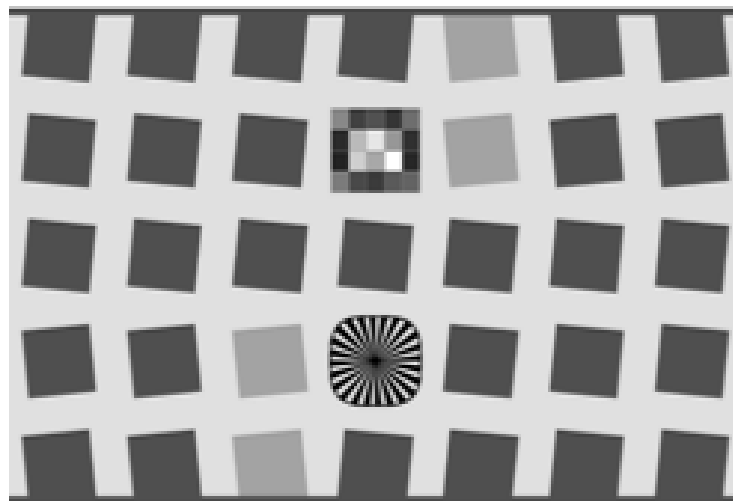


5.1.4.6 Small Imatest SFR Plus 5x7 chart for Acuity test



Imatest order information - SFRplus test chart, 24X40", 5X7, semi-gloss or matte , black&white, 2-tone

5.1.4.7 Large Imatest SFR Plus 5x7 chart – for >1.5m depth of field test



Imatest order information - SFRplus test chart, 40X60", 5X7, semi-gloss or matte, black&white, 2-tone

5.1.5 Other inventory

Besides the charts, Skype uses the following equipment when performing the certification tests:

- Lights with power supply and controller
 - four Color Kinetics [iW Blast 12 Powercore](#) lights
 - color temperature adjustable in the region of – 2900K – 6500K
 - luminous intensity controllable
 - average power consumption is 200W
 - AC/DC converter built into the lights
 - light controlling data path: PC → DMX USB Pro → Data Enabler → Lights
 - two tungsten lights with Osram Halogen Eco Superstar 48W light bulbs.
 - controlled by Enttec [DMX USB Pro](#) controller
 - Color Kinetics [iW Data Enabler](#)- power supply and data repeater (DMX version)
- Camera holder mechanism
- Laser distance meter
 - Bosch DLE 50 Professional
 - minimum measuring distance: 5 cm
- Reference PC
 - operating system: Microsoft Windows 7
 - CPU Type Core 2 Duo, 2,666 GHz
 - system memory: 2010 MB
 - video adapter : NVIDIA GeForce 8500 GT (512 MB)
- Color and lux-meter
 - Gigahertz Optik [HCT-99D](#) (measures both – color temperature and illuminance)
 - [JETI specbos 1211](#) broadband spectroradiometer (measures incident and reflected light spectra, color temperature, illuminance, and luminance)
- Datapath VisionRGB-E2 / [VisionRGB-E2s](#) Dual DVI capture card
- Video test management PC (hosts the above DVI capture card and runs the automated test scripts)

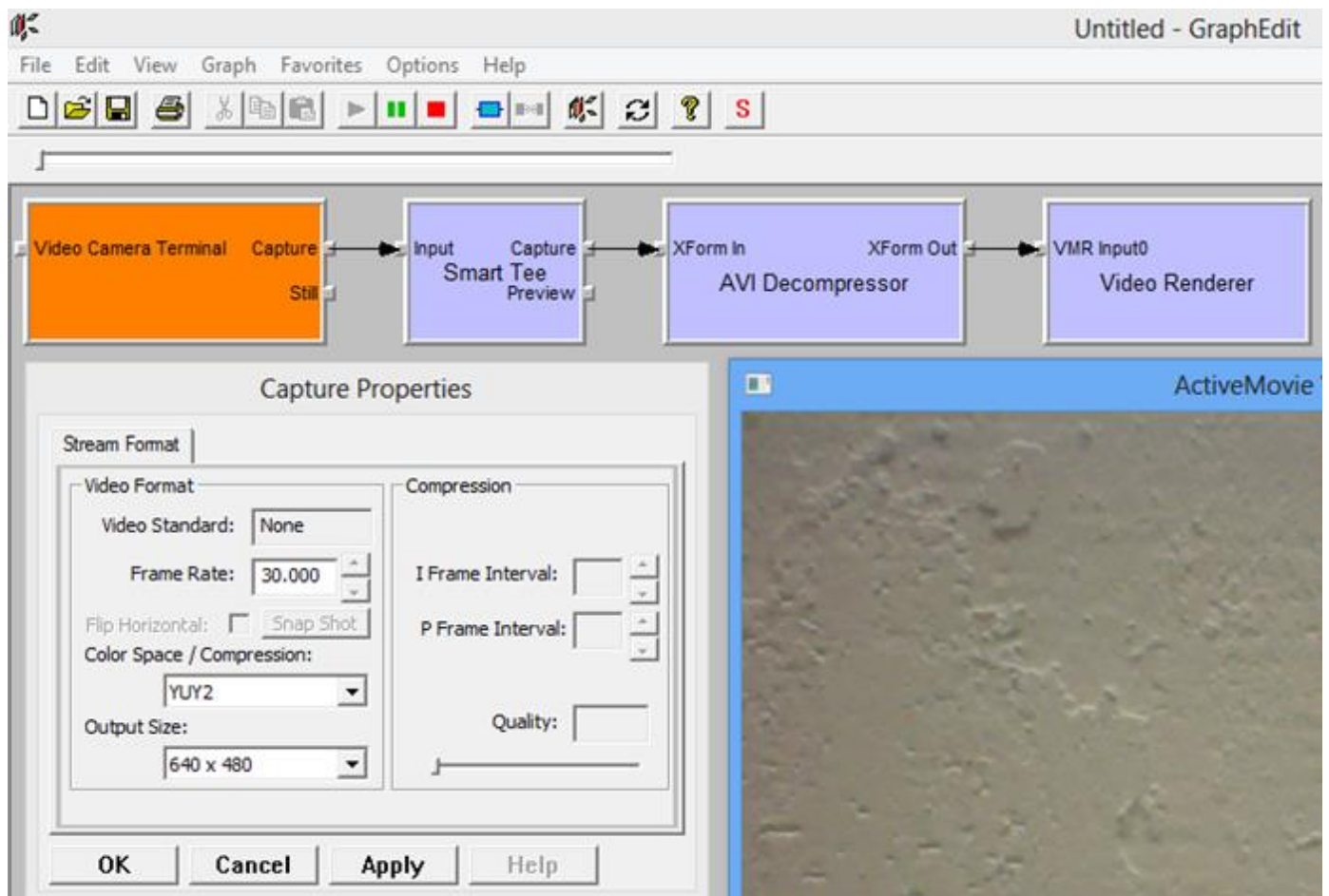
6 Appendix

6.1 Using GraphEdt – raw video modes

Testing is to be conducted on PC with Windows 8 operating system. For accessory cameras a PC with W8/64bit will be used.

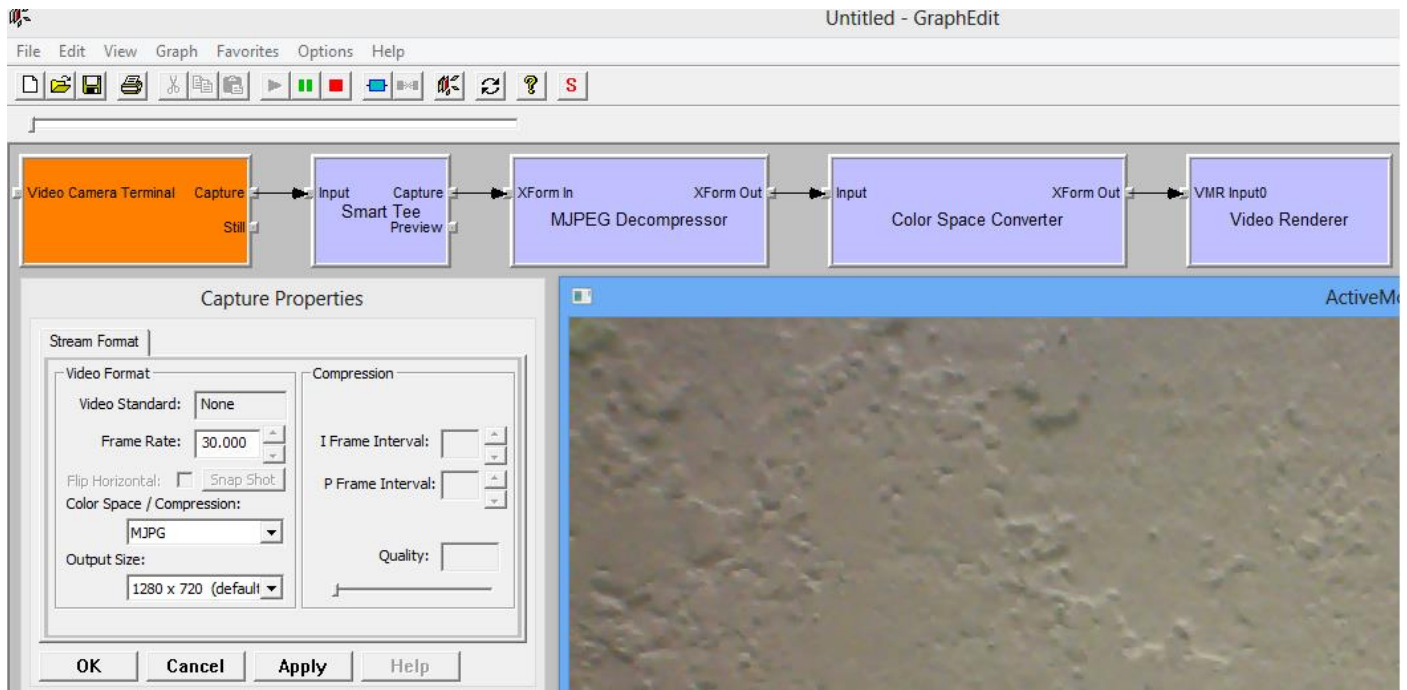
Graphedit is a tool included in the Windows Driver Development Toolkit. GraphEdt.exe is a development tool for visually building functional multimedia filter graphs using the DirectShow application programming interface.

[http://msdn.microsoft.com/en-us/library/windows/hardware/ff568651\(v=vs.85\).aspx](http://msdn.microsoft.com/en-us/library/windows/hardware/ff568651(v=vs.85).aspx)



6.2 Using GraphEdit – MJPEG modes

Testing is to be conducted on PC with Windows 8 operating system. For accessory cameras a PC with W8/64bit will be used.

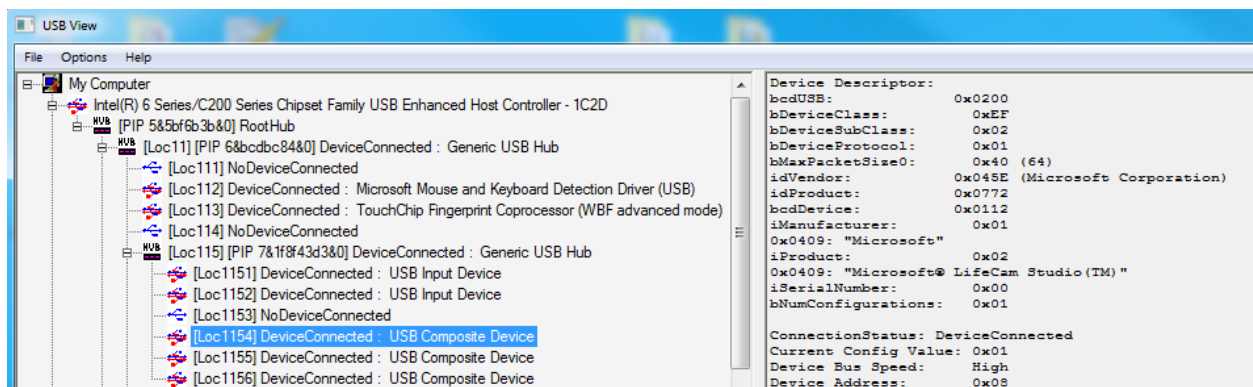


6.3 Using USBView

USBView.exe is a tool included in the Windows Driver Development Toolkit.

[http://msdn.microsoft.com/en-us/library/windows/hardware/ff554257\(v=vs.85\).aspx](http://msdn.microsoft.com/en-us/library/windows/hardware/ff554257(v=vs.85).aspx)

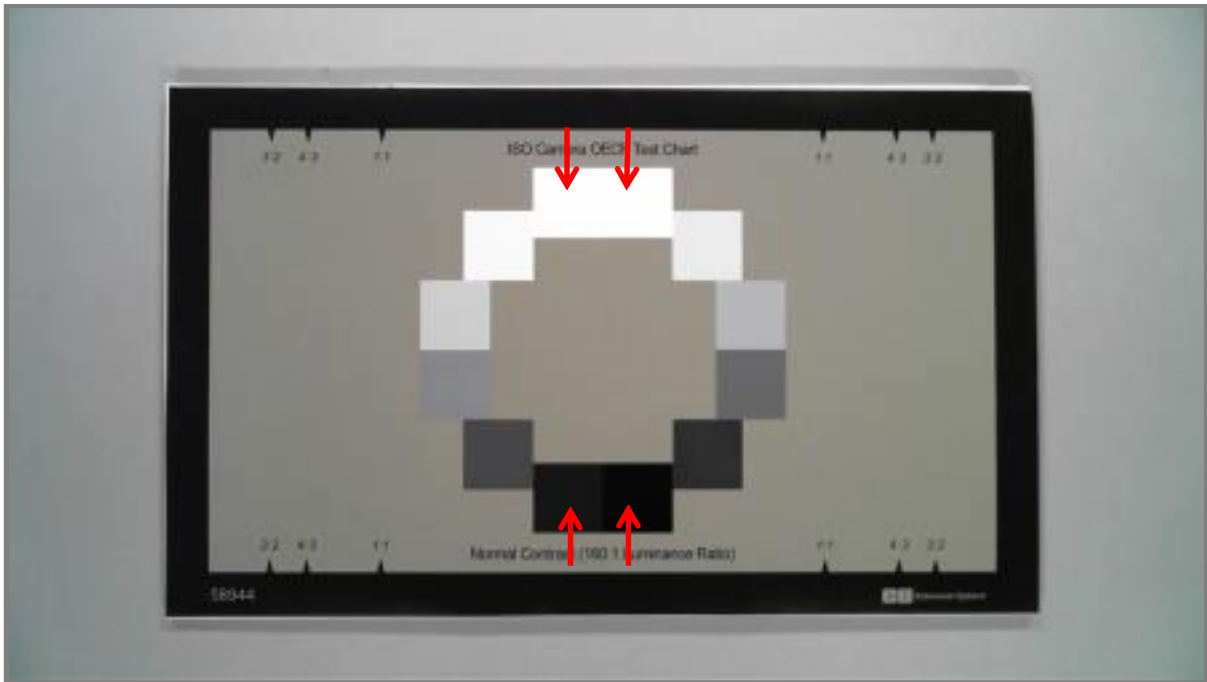
Locate the camera from USB device list and read out the needed parameters from right side of the window



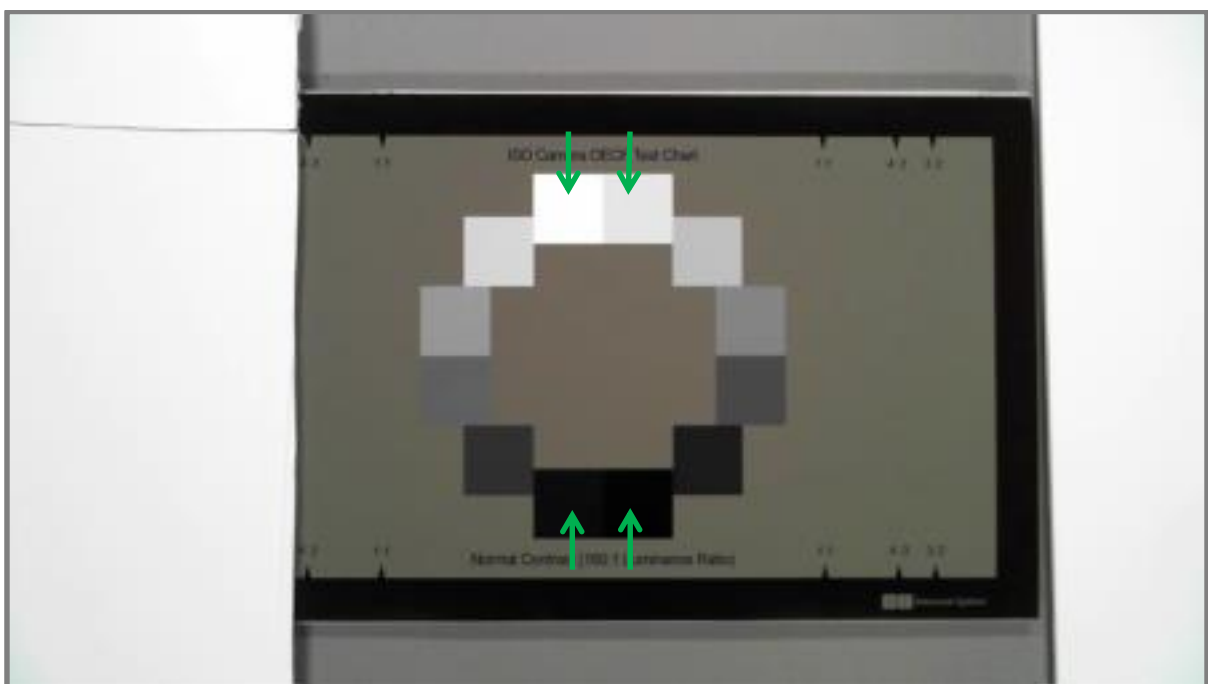
6.4 Semi manual test for exposure and gamma guidelines

As the ST-52 OECF chart has a middle gray background and so does the test board used as a background it is needed with some auto exposure cameras to modify the scene to get the scene brighter to avoid the camera from over exposing the image.

- 1) Put on the 200Lux 3500K light condition
- 2) Capture the ST-52 chart, if the two upmost white patches or the two lowest dark patches appear same light and are impossible to discern from each other, the camera needs the shutters to optimize the exposure and gamma for testing.



- 3) Both light patches appear solid white.
- 4) Start closing the shutters from both sides (3:2, 4:3 and 1:1 markers can be used as guidelines)
- 5) Continue capture -> check -> adjust, until both lightest and darkest patches are clearly discernible.



6.5 Skype Delay test setup

The delay test setup is illustrated above. Two LEDs are used that blink synchronously according to a MLS (pseudorandom) sequence. A signal with sharp auto correlation function is needed for later analysis and for this MLS sequence gives good results. LEDs are driven by the small Arduino based microcontroller.

LEDs serve as a temporal change generator. Since a LED is small and takes only a few pixels on the video image, blinking does not influence AWB/AE much. Also, it should have a minimal impact on video encoding/bitrate and similar parameters.

One LED is placed in front of the DUT and REF Skype cameras that are both filming the brightly illuminated Gray Board to ensure maximum framerate. The LED should be positioned near the center of the FOV for both cameras height wise.

As a result the blinking of this LED will be presented in DUT screen as Preview video, on DUT screen as Receive video and on PC screen as a Send video.

A fixed framerate camera (camcorder) with 30, 50 or 60 FPS is used for filming all of the following signals

- Reference LED (second LED pointed to capture camera)
- Send video
- Preview video

A video is captured with all of the above blinking signals in view. A 40second to 1 minute recording usually gives reliable results.

The resulting video is analyzed by cross correlating the REF LED blinking to all of the Send / Receive / Preview delays. Result is presented as a graph of the Send / Receive / Preview delays versus time.

Notes:

Correlation within 9 pixel brightness's within the selected regions is used for delay calculation.

Maximum delay length that can be measured is 1500ms

Correlation function window length is 2600ms

Extract from the Arduino LED blinker code:

```
int ledPin; // LED connected to digital pin 9

unsigned int a; //register

void setup() {

  // m-sequence registers

  // let's try to generate  $z^8 + z^6 + z^5 + z^4 + 1$ 

  a = 1;

  ledPin = 9;

  Serial.begin(9600);

}

void loop() {

  //unsigned int z_pow_0 = a & 1;

  //unsigned int z_pow_2 = (a & 4) >> 2;

  unsigned int z_sum = ( (a & 1) ^ ((a & 16) >> 4) ^

    ((a & 32) >> 5) ^ ((a & 64) >> 6) ^ ((a & 256) >> 8)) << 7;

  a >>= 1;

  //a &= 0xFF; // Just in case make most significant bit zero

  a |= z_sum;

  Serial.print(a);

  Serial.print("\n");

  // Now get a pseudo_random double

  double a_rel = a / 256.; // from 0 to 1

  if (z_sum)

    analogWrite(ledPin, 255);

  else analogWrite(ledPin, 0);

  delay(100);

}
```

6.6 References

- [1] Defining Video Quality Requirements: A Guide for Public Safety
<http://www.safecomprogram.gov/SiteCollectionDocuments/3aVideoUserRequirementGuidedoc.pdf>
- [2] ANSI T1.801.02 - <http://www.its.bldrdoc.gov/resources/video-quality-research/standards/analysis.aspx>
- [3] Video Quality Research Home Page
<http://www.its.bldrdoc.gov/resources/video-quality-research/video-home.aspx>
- [4] [Imatest](#): the world's leading software package for testing digital image quality, test charts and lots of useful information on video testing
- [5] [Wikipedia: CPU Time](#)
- [6] [Wikipedia: Depth of Field](#)
- [7] [Wikipedia: Frame Rate/Frame Frequency](#)
- [8] [Lync Logo requirements](#)
- [9] [Image Engineering](#) – image testing software, test charts and lots of useful information on video testing
- [10] IEEE CPIQ Standard for Camera Phone Image Quality
<http://grouper.ieee.org/groups/1858/>
<http://www.i3a.org/technologies/mobile-imaging/cpiq/#.UCjrbWy0O5I>
- [11] ISO standards: TC 42 - Photography section
http://www.iso.org/iso/home/store/catalogue_tc/catalogue_tc_browse.htm?commid=48420