Microsoft Lync Devices Video Capture Specification

Document Number: H100693

(Rev. D Errata)

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1.0 Revision History

Revision	Date	Description
A	7/2/2009	First release
B	11/27/09	Added pixel aspect ratio, focus requirements. Made directivity a Premium requirement. Clarified oversharpening and geometric distortion is absolute. Clarified framerates. Added colorspace details. Updated dynamic range test. Added alternate to light sphere. Added requirement that MTF30<1. Renamed P420 to M420. Added check for color range. Added frame rate tests for 100 and 300 lux. Temporal SNR is measured in 300 lux.
C	4/15/10	Added M420, NOISE_REDUCTION, FACE_DETECTION GUIDs. Removed HFOV requirement and added relaxed VFOV standard requirement. Relaxed DOF max distance from 3m to 1.5m. Relaxed time to capture first image from 300ms to 500ms; changed measurement method. Audio specification refers to Microsoft Lync Devices Audio Specification. Dynamic range uses Rev A method (too many cameras don't have manual exposure; method is accurate enough). Added color ratios for relative illumination. Updated Auto exposure / gain test. Uses Day instead of U30 for most tests (more uniform in light box). Changed AEC/AGC test method. Changed doc title. Added A/V synchronization. Made spatial SNR lighting specific with two lighting conditions. Added overhead lighting test. Added test setup sections; added Imatest figures. Added max for relative illumination, color ratio. Updated usage light. Relaxed VGA latency to 70ms. Made manual focus default 0.5m. Made time to change resolution P2. Added formula for AEC/AGC to clarify. Clarified that all audio/video tests need to be run with both Windows and any provided drivers. Added room light measurement section with ANSI and OSHA based room light values. 50/60 Hz test uses temporal SNR for more robustness. Now uses total PC CPU time for CPU usage test.
D	10/21/10	Uses new lighting to achieve greater uniformity and better test accuracy. Uses 3500 K instead of U30 because 3500 K is much more common. Uses ΔC for color uniformity (based off CPIQ test) to improve test accuracy. Reduces number of light levels to improve testability. Uses ΔC00 for color accuracy to improve test accuracy. MTF uses large squares and lower contrast target to improve test accuracy. Temporal noise uses Imatest. New ColorRange filter supports MJPEG color range. Added Camera position API to enable improved eye gaze, support image orientation. Improved results workbook to improve testability. Added camera lens protection guidelines. Added lense cleaning guidelines. Updated AV sync spec to align with ITU-R BT.1359-1. Added related standards to relevant tests. Temporal and spatial SNR use the 0.7 density patch, which is closer to skin reflectance than SNR_BW patches; the criteria have been adjusted.

D Errata	11/12/10	Corrected light levels for 4.2.13P1: Automatic exposure and gain.

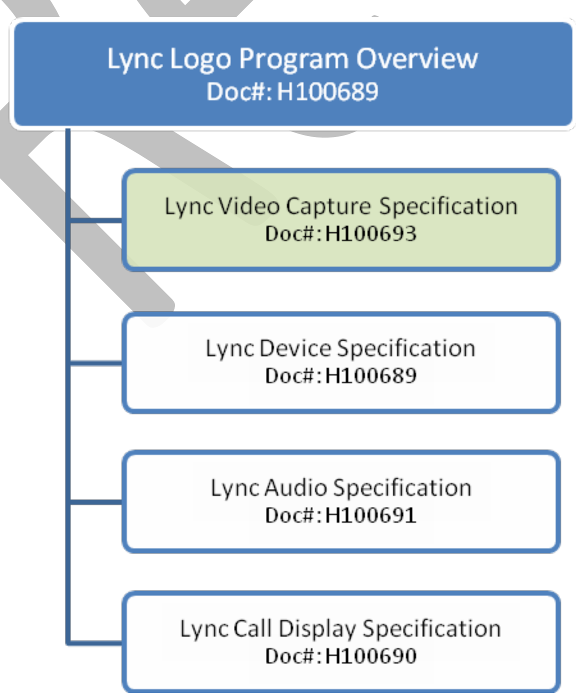
2.0 Overview

The technical requirements listed in this document, the *Microsoft Lync Devices Video Specification Version*, have been derived solely for the purpose of maximizing interoperability and optimizing the functional and quality experience of devices used with Microsoft Lync Server 2010 platform and certified under the *Optimized for Microsoft Lync Logo Program*. Any use of this technical specification for platforms other than the *Microsoft Lync Server 2010* platform is not authorized.

Partners, who license, develop market and/or sell Microsoft Lync devices that are qualified by Microsoft are required to adhere to the specifications outlined in this document. Partners seeking changes, modifications and/or additions to this specification will be required to receive written approval from Microsoft before certification of the device. Microsoft 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 Microsoft Lync platforms, new device categories, as well as performance improvements in the hardware used in peripheral devices.

3.0 Test Specifications

The family of Microsoft Lync documents supporting the Lync logo program is shown here and contains detailed requirements that candidate devices, being submitted to the Lync logo program, must meet. The technical requirements listed herein have been derived solely for the purpose of maximizing interoperability and optimizing the functional and quality experience of devices used with the Microsoft Lync platform. The test specifications are split into the four categories shown here:



This *LYNC Video Capture Specification* document details the image capture requirements for devices submitted for qualification to the Lync logo program. This document includes the following:

- A description of driver and CPU usage requirements for webcams and Lync PCs
- Required (P1) resolutions and color spaces for webcams and Lync PCs
- Image quality and functional requirements and test methods for webcams and Lync PCs

3.1 Additional References

This document references the following industry standards as well:

Document Name	Version	Hyperlink
Universal Serial Bus Specification	2.0	http://www.usb.org/developers/docs

Technical support and related information can be obtained from the following Microsoft websites:

Microsoft Developer Network (MSDN®), including newsgroups and library of technical information	http://msdn.microsoft.com/
Microsoft Lync / Office Communications Server Community	http://technet.microsoft.com/en-us/office/ocs/cc793962.aspx
Microsoft Knowledge Base	http://support.microsoft.com/

3.2 Contacting Microsoft

For any questions regarding the requirements detailed in the specification, please contact the Microsoft Lync Partner Team by sending an email message to lynclogo@microsoft.com.

3.3 Terms Used in This Document

This section describes standard terms and conventions used throughout the Microsoft Lync Device Specification.

Device Qualification	Refers to the process of formally submitting a device for qualification under the *Optimized for Microsoft Lync Logo Program*.
DUT	Device Under Test
Must	Refers to whether a device is required to implement the requirements outlined supporting a scenario for a particular device category.
ML	Microsoft Lync, an acronym for the implementation by Microsoft of unified communications.
Lync PC	Official category name for PC with integrated loudspeakers and microphone(s) which is optimized for Microsoft Lync. This includes laptops, netbooks, PCs integrated in monitors, desktop PCs bundled with audio devices, etc.
Optional	Refers to whether a device can optionally implement the requirements outlined that support a scenario for a particular device category.
ROI	Region of Interest
UC	Unified Communications, a set of products and services integrating non

	real-time and real-time communication services into a consistent user interface and experience.
UCW12	Abbreviation for “Wave 12”, Microsoft Office Communications Server 2007 platform launched in 2007.
W13	Abbreviation for “Wave 13”, Microsoft Office Communications Server 2007 R2 platform launched in 2009.
W14	Abbreviation for “Wave 14” or codename for Lync 2010, currently targeted for release in late 2010.

4.0 Microsoft Lync Device Video Requirements

This document provides performance requirements for Lync certified USB webcams, both external webcams and integrated webcams (notebooks and monitors). The requirements are intended to be put into an external document and communicated to camera manufacturer partners.

There are two levels of camera performance defined by this specification, which correspond to good and best quality webcams for UC. Within each level a webcam can be Standard Definition (SD) and High Definition (HD). A webcam must meet all Priority 1 (P1) requirements for Lync certification. Priority 2 (P2) requirements are recommended but not required.

4.1 Driver

4.1.1 P1: Support USB Video Class (UVC) Driver

4.1.1.1 Purpose

Lync webcams should be fully functional with default Windows drivers. Note all tests in this specification need to be run with the default Windows drivers as well as the OEM drivers.

4.1.1.2 Requirements

The webcam must support the UVC standard 1.0 or later versions and work with standard Windows XP SP2 or later versions, Windows Vista, and Windows 7 UVC drivers.

4.1.1.3 Test procedure

1. Verify DUT has WHQL certification for Windows XP SP2 or later versions, Windows Vista, and Windows 7.

4.1.2 P1: Support USB Audio Class (UAC) Driver

4.1.2.1 Purpose

Lync webcams should be fully functional with default Windows drivers.

4.1.2.2 Requirements

The webcam must support the UAC standard 1.0 and later and work with standard Windows XP SP2 or later versions, Windows Vista, and Windows 7 UAC drivers.

4.1.2.3 Test procedure

1. Verify DUT has WHQL certification for Windows XP SP2 or later versions, Windows Vista, and Windows 7.

4.1.3 P1: Product driver signed by Microsoft (WHQL)

4.1.3.1 Purpose

Ensures basic level of quality for OEM provided drivers.

4.1.3.2 Requirements

The drivers supplied with the webcam must be certified by Microsoft.

4.1.3.3 Test procedure

1. Validate that driver is signed by Microsoft. Open Device Manager / Properties / Driver / Driver Details, and then check whether Microsoft signed the driver.

4.1.4 P2: Method to control video processing in driver/camera

4.1.4.1 Purpose

While temporal and spatial noise reduction can improve image preview, it does not always improve end-to-end video performance since the video codec is a low-pass filter. Face detection may need to be disabled to save CPU usage, or if there are sufficient CPU cycles the face detection can be used to improve video codec performance.

4.1.4.2 Requirements

The requirements are given in Table 1:

Video enhancement	Requirement
Noise reduction	Supports API in Appendix 5.3
Face detection	Supports API in Appendix 5.2 Face detection accuracy MOS >=3

Table 1: Video processing control

The face detector MOS test is a scenario-based test that provides a Mean Opinion Score on the face detector's accuracy. The test is a check that the face detector works well enough to use for region of interest (ROI) encoding. The MOS score range is as follows: 1= unacceptable performance, 3=acceptable performance and 5=excellent performance.

4.1.4.3 Test procedure

1. Run TestFaceDetectionInterface.exe to test the face detecting interface.
2. Run TestNoiseReductionInterface.exe to test the noise reduction interface.

4.1.5 P1: CPU usage

4.1.5.1 Purpose

Makes sure the webcam driver (not standard UVC/UAC drivers), which includes any video processing, doesn't have excessive CPU usage.

4.1.5.2 Requirements

The CPU usage requirements are given in Table 2.

Resolution	CPU usage
CIF 15 FPS, VGA 30 FPS	<10% on 1.8 GHz dual core
720 p 30 FPS	<20% on 2 GHz quad core

Table 2: CPU usage

4.1.5.3 Test setup

Lighting	300 +/- 30 lux room (see Section 4.5.2)
Test charts	Not applicable
DUT position	Mounted normally, facing user
DUT settings	Default

Table 3: CPU usage test setup

4.1.5.4 Test procedure

1. For each resolution and max frame rate in Table 2:
    a. Run GraphEdit[1] and preview the captured video (see Figure 1).
    b. Use Task Manager to measure the CPU usage of GraphEdit.exe and total PC CPU usage (see Figure 2). Be aware that OEM camera drivers can make PC CPU usage significantly higher than GraphEdit.exe CPU usage.
    c. Compare total PC CPU usage with Table 2 requirements.

Notes:

- A quad core PC can be configured to use only two cores. For example, in Windows 7 use the “System Configuration” tool to set the “Number of processors” to 2 (found in the Boot tab and clicking “Advanced options…”).

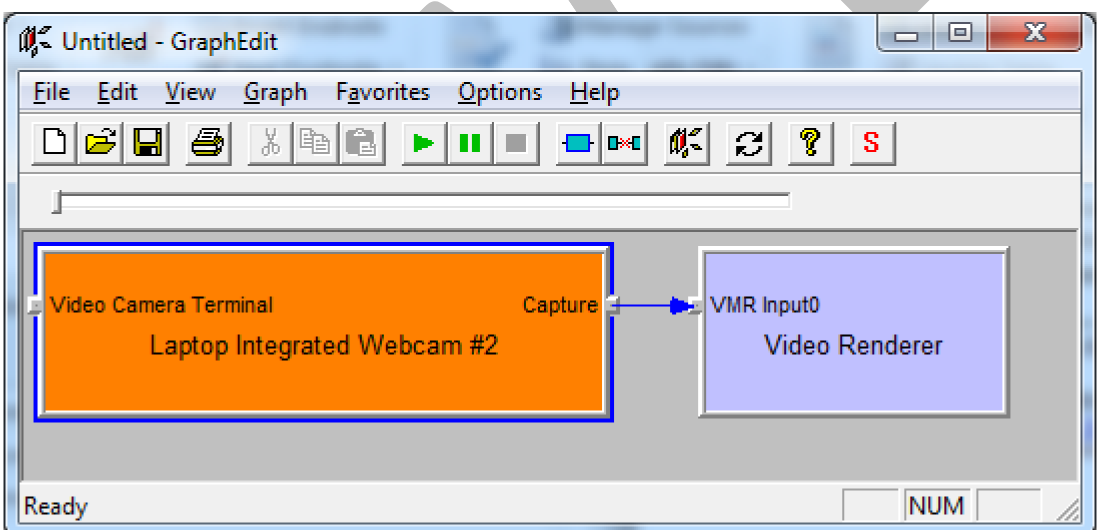


Figure 1: GraphEdit rendering webcam

[1] CIF requires a SmartTee filter before the VMR because of a bug, otherwise the image won’t be rendered correctly.

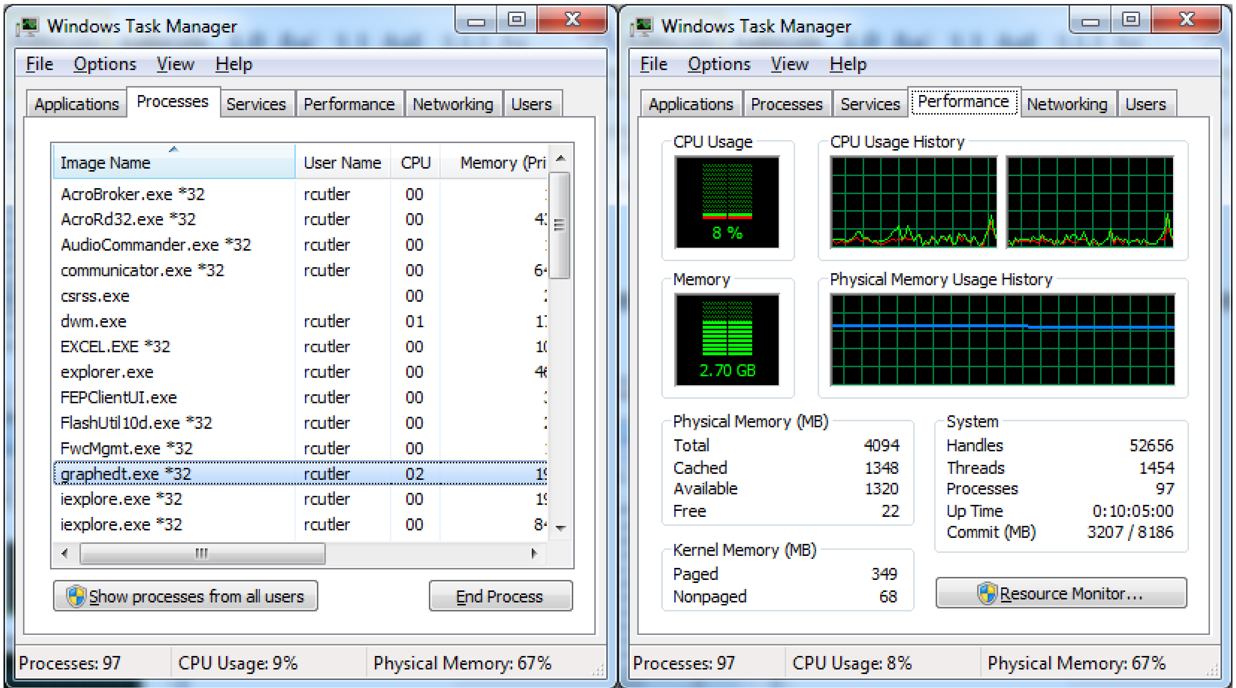


Figure 2: Windows Task Manager

4.1.6 P2: Method to determine camera position, orientation

4.1.6.1 Purpose

Eye gaze has been shown to be important for high task performance and conversational turn taking in video conferencing. However, the non-zero distance between the video capture devices (webcams) and video rendering devices (monitors) creates eye gaze error during video conferencing. The end result is that far-end users looking at remote participants on their monitor don't appear to be looking at the local participant. This artifact is called eye gaze error and can be measured in degrees using the locations of the participants, cameras and displays. Humans are particularly sensitive to eye gaze error and it becomes annoying when it is off by ~2^{o} in the horizontal direction and ~8^{o} in the vertical direction. By knowing the camera position with respect to the monitor Lync can position the far end rendered video to minimize eye gaze error.

Camera orientation will be important for Tablet devices and Windows Phones that have cameras in portrait orientation (as well as landscape).

4.1.6.2 Requirements

The OEM driver should support the camera location interface defined in Section 5.4.

4.1.6.3 Test procedure

1. Run TestCameraLocationInterface.exe to test the camera location interface.

4.1.7 P2: Embedded camera shipping protection

4.1.7.1 Purpose

Most notebook and desktop embedded cameras ship with a protective plastic cover. Some of these covers are not noticeable by the user as they are clear and well aligned over the camera cover glass. In addition since the user only sees a preview image they won't see the full resolution lower quality transmitted image.

4.1.7.2 Requirements

The protective cover should be very obvious to remove. It must not be clear plastic but a colored plastic like blue or yellow. It should have a "Remove" label or icon.

4.1.7.3 Test procedure

1. Examine the DUT's protective plastic cover. It must not be clear and should include a "Remove" label or icon.

4.2 Video

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.

4.2.1 P1: Latency

4.2.1.1 Purpose

Makes sure the webcam doesn't induce excessive latency in the camera or driver, which would degrade the overall Lync video end-to-end experience.

4.2.1.2 Requirements

	Non-720p	**720p MJPEG**
Video latency	<= 70 ms	<= 120 ms

Table 4: Video latency

4.2.1.3 Test setup

Lighting	300 +/- 30 lux office lighting (see Section 4.5.2)
Test charts	NA
DUT position	Pointing at monitor (Figure 3) Embedded notebook cameras should use an external monitor (Figure 4)
DUT settings	Autofocus set to manual Exposure set to 1/250s (approximately)[2] Gain set to maximum value

Table 5: Video latency test setup

4.2.1.4 Test procedure

1. Run Virtual Stopwatch and start timer.

[2] The camera exposure setting should be an integer n, where the exposure is 2^n seconds. See ICameraControl::get_Exposure.

2. For each P1 resolution and max frame rate:
   a. Run GraphEdit to build a render graph and render (use VMR7 or VMR9 to render; see Figure 1) and point camera at screen centered at the Virtual Stopwatch window (see Figure 3). Or, point to an external monitor for notebook computers (see Figure 4). Be sure to clear “Use Clock” in GraphEdit.
   b. Press Print Screen to capture an image that contains the Virtual Stopwatch window and the GraphEdit render window. Capture 3 clean images.
   c. The video capture+render latency is the GraphEdit render window time minus the Virtual Stopwatch window time. Average the results from the 3 images.

Notes:

- A quad core PC should be used for 720p tests.
- A mirror can be used for notebook computers with integrated cameras so that the screen can be imaged.

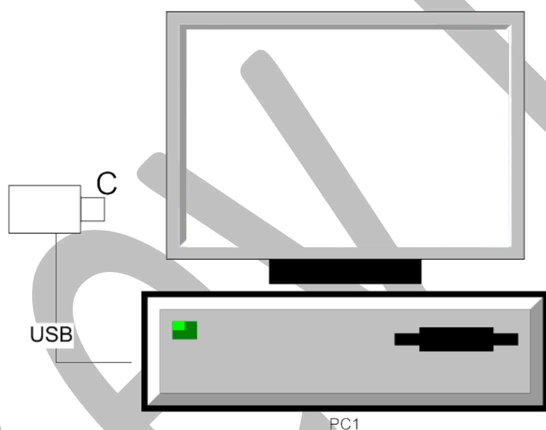


Figure 3: Video latency test setup with an external camera

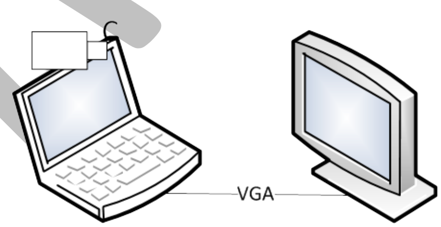


Figure 4: Video latency test setup with a notebook integrated camera

4.2.2 P1: Jitter

4.2.2.1 Purpose

Ensure the webcam and drivers don’t have excessive jitter.

4.2.2.2 Requirements

The jitter at all P1 resolutions and max frame rates must be <= 7 ms.

4.2.2.3 Test setup

Lighting	300 +/- 30 lux office lighting (see Section 4.5.2)
Test charts	Not applicable
DUT position	In typical usage position, pointing at user
DUT settings	Default

Table 6: Jitter test setup

4.2.2.4 Test procedure

1. For each P1 resolution and max frame rate, do the following:
    a. Run GraphEdit and render the captured video.
    b. Render the video for 30 seconds.
    c. Display the properties for the Video Renderer and read the jitter for the rendered video. Compare this value to the requirements.

Note: Jitter can be affected if the max frame rate is not achieved.

4.2.3 P1/P2: Time to capture first image, change resolutions

4.2.3.1 Purpose

The time to capture the first image is important to minimize delay seen by the user and to facilitate dynamic changing of resolutions in future versions of Microsoft Lync.

4.2.3.2 Requirements

The requirements for all P1 resolutions and max frame rates are given in Table 7.

	Standard	Premium	Priority
Time to capture first image	<= 1500 ms	<= 500 ms	1
Time to change resolutions	<=250 ms	<=250 ms	2

Table 7: Time to capture first image requirements

4.2.3.3 Test setup

Lighting	300 +/- 30 lux office lighting (see Section 4.5.2)
Test charts	NA
DUT position	In typical usage position, pointing at user
DUT settings	Default

Table 8: Time to capture first image test setup

4.2.3.4 Test procedure

1. For each P1 resolution and max frame rate:
    a. Run GraphEdit and build render graph.
    b. Using a camcorder or external webcam to record the following:
        i. Run GraphEdit graph, insert the DUT device, render the device, and press Run.

c. View the recorded view with a video editor (for example, VirtualDub) to determine the time difference between the Run event and when video appeared in the video renderer window and is stable (focused, exposure/gain converged).
d. Repeat 3 times and average the results. Store in the "Time to capture first image" in the Excel workbook.

2. For each P1 resolution and max frame rate:
   a. Using a camcorder or external webcam to record the following:
      i. Run GraphEdit graph, insert the DUT device, render the device, and press Run.
      ii. Stop the graph, delete the connections and filters between the capture device and renderer, change to another P1 resolution and max frame rate, and press Run.
   b. View the recorded view with a video editor (for example, VirtualDub) to determine the time difference between the second Run event and when video appeared in the video renderer window and is stable (focused, exposure/gain converged).
   c. Repeat 3 times and average the results. Store in the "Time to change resolutions" in the Excel workbook.

4.2.4 P1/P2: Image resolutions, frame rates, color spaces

4.2.4.1 Purpose

Ensures that required and recommended image resolutions, native frame rates, and color spaces are supported.

4.2.4.2 Requirements

Resolution	Frame rates	Color space	Priority
352x288	15 and 30	YUY2	1
		I420 or M420	2
640x480	15 and 30	YUY2	1
		I420 or M420	2

Table 9: 4:3 aspect ratio video

Resolution	Frame rates	Color space	Priority
1280x720	15 and 30	MJPEG or YUY2	1
	15	I420 or M420	2
960x544	15 and 30	MJPEG, I420 or M420	2
	15	YUY2	2
800x448	15 and 30	YUY2, I420 or M420	2
640x360	15 and 30	YUY2, I420 or M420	2
424x240	15 and 30	YUY2, I420 or M420	2

Table 10: 16:9 aspect ratio video for HD webcams

Note: Microsoft Lync will open a 1280x720 webcam in 720p mode if the PC has 4 cores or more and the webcam supports >= 15 FPS. It is critical that webcams do not expose 1280x720 modes if 15 FPS can't be met in the lighting conditions given in Table 12.

Webcams that are external devices will be tested under all available P1 resolutions and color spaces. Webcams that are embedded in a system (for example, Lync PCs) will be tested in the following resolutions if available:

- Both native resolutions for Lync conference video as dictated by the version of Lync Server:
  - CIF (used for W13 video conferences)
  - VGA (used for W14 video conferences) unless system is single core
- Native resolution for Lync peer-to-peer video as dictated by the CPU physical core count of the system
  - CIF if single core
  - VGA if dual core
  - 720p if quad or higher cores

For example, a system with dual core CPU will be tested under CIF and VGA resolutions but not MJPEG, while a quad core system will be tested under all three resolutions unless the camera does not announce all three.

The webcam must set the UVC Color Matching Descriptor the following values:

- Uncompressed frame type
  - bColorPrimaries=1 (BT.709, sRGB)
  - bTransferCharacteristics=1 (BT.709)
  - bMatrixCoefficients=4 (BT.601)
- MJPEG frame type
  - bColorPrimaries=1 (BT.709, sRGB)
  - bTransferCharacteristics=1 (BT.709)
  - bMatrixCoefficients=4 (BT.601)

The luminance and chrominance ranges for support color spaces are given in Table 11.

Color space	Luminance	Chrominance
YUY2	16-235	16-240
MJPEG	0-255	0-255
I420	16-235	16-240
M420	16-235	16-240

Table 11: Luminance and chrominance ranges

Table 12 gives the minimum frame rates required for various lighting levels.

Lighting (lux)	Frame rate (FPS)
50	>= 15 +- 1
200	30 +/- 1 (or max)

Table 12: Minimal frame rates

4.2.4.3 Test setup

Lighting	3500 K test lighting (Figure 32), 200 +/- 20 lux, 50 +/- 5 lux at target
Test charts	ST-52
DUT position	Pointed at ST-52, 0.5m from target
DUT settings	Default

Table 13: Image resolutions, frame rates, color spaces test setup

4.2.4.4 Test procedure

1. For each resolution, frame rate, and color space combinations:
    a. In 50 lux lighting:
        i. Run GraphEdit, select the resolution and frame rate, color space, and render the graph.
        ii. View the video for 30 seconds.
        iii. Read the actual frame rate from the video renderer's property page and compare to Table 12.
    b. In 200 lux lighting:
        i. Repeat steps a.i to a.iii.
2. Run [UVCView] and read bMatrixCoefficients for each resolution.
3. Build a graph using GraphEdit to render the ST-52 test chart in 3500 K lighting, including the ColorRange.dll filter. The luminance, chrominance and RGB values given in the properties dialog of the ColorRange filter should be in the range given in Table 11.

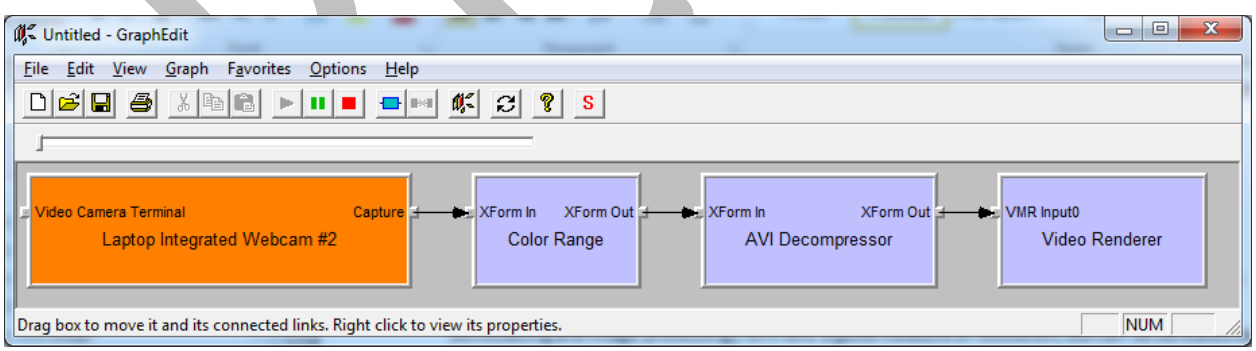


Figure 5: ColorRange filter example

4.2.5 P1: Image resolution quality (MTF, oversharpening, edge roughness)

4.2.5.1 Purpose

This test ensures 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 too much sharpening (or not enough), which induces image artifacts like ringing or fuzzy images. Edge roughness is a measure of image scaling quality (for example, bilinear is greatly preferred over nearest neighbor, and bicubic is preferred over bilinear).

Related standard: ISO 12233-2000.

4.2.5.2 Requirements

	Standard	**Premium**
MTF30 (horizontal and vertical)	0.3 <= MTF30 < 1	0.4 <= MTF30 < 1
Absolute_Value(Oversharpening)	<= 20%	<= 15%
RMS edge roughness	<= 0.1	<= 0.05

Table 14: MTF and edge oversharpening requirements

4.2.5.3 Test setup

Lighting	3500 K test lighting (Figure 32), 200 +/- 20 lux at target
Test charts	Slanted edge test chart (see Figure 33)
DUT position	Pointing at test chart at a distance of 0.5 m Ensure camera has <1% rotational error with respect to horizon Make target edge within +/- 20% of image center
DUT settings	Default

Table 15: Image resolutions, frame rates, color spaces test setup

4.2.5.4 Test procedure

1. For each P1 resolution and max frame rate, capture an image of the resolution chart:
    a. Run Imatest SFR on the captured image and select a horizontal edge in the center of the image (see Figure 6). Be sure to check the following:
        i. Align the red cross hair in the ROI to the edge. Not doing this results in inaccurate results.
        ii. The minimum region of interest size should be 60x40 or 40x60. Smaller sizes will result in reduced accuracy.
        iii. Image is not under or oversaturated (see Figure 8)
        iv. Edge angle is 5^{o} +/- 1^{o} (see Figure 8)
    b. Select cycles/pixel in the "SFR settings and options" dialog box (see Figure 7).
    c. Read off the MTF30 and edge roughness from the Cycles/Pixel window (see Figure 8) and oversharpening from the SFR_cypx.csv file.
    Note: watch for clipping in Figure 8. See Imatest documentation for further details.
    d. Repeat 3 and 4 for a vertical edge (see Figure 9).

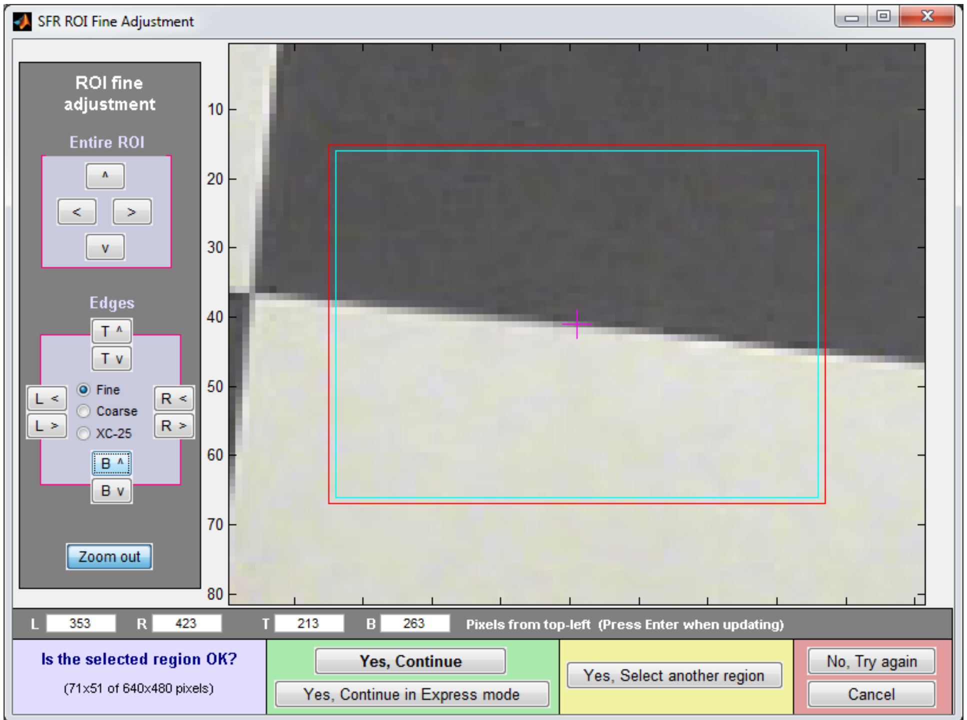


Figure 6: Vertical SFR ROI

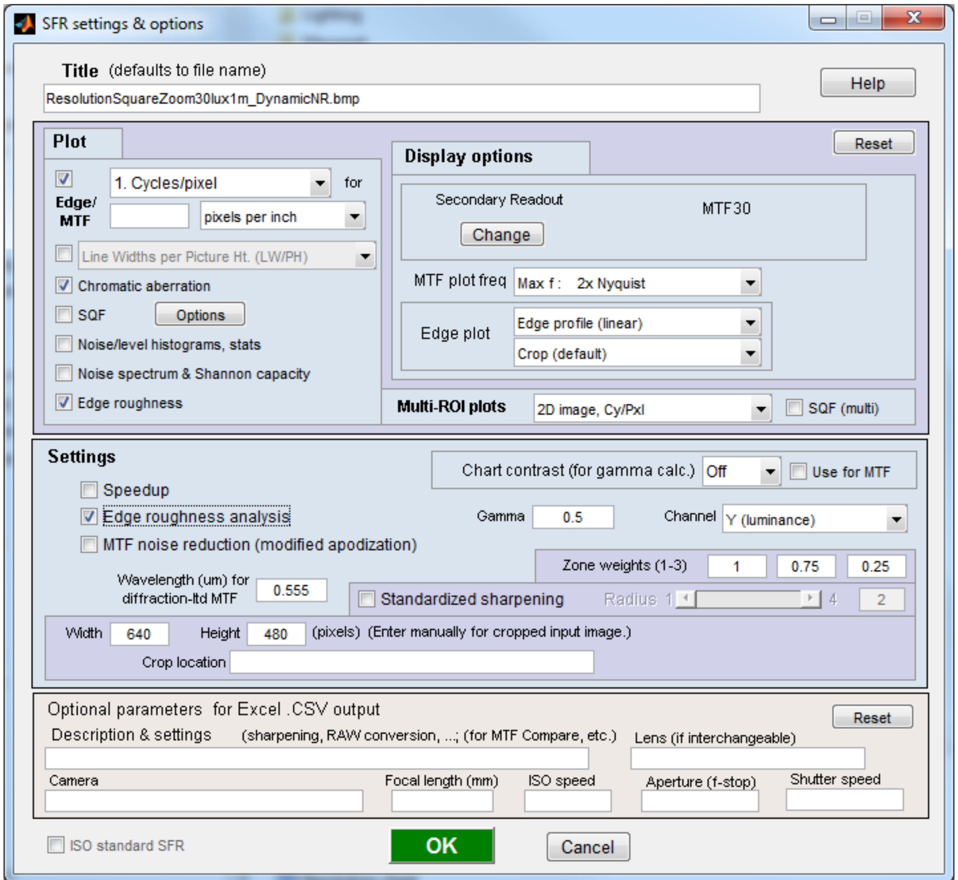


Figure 7: Imatest SFR setup

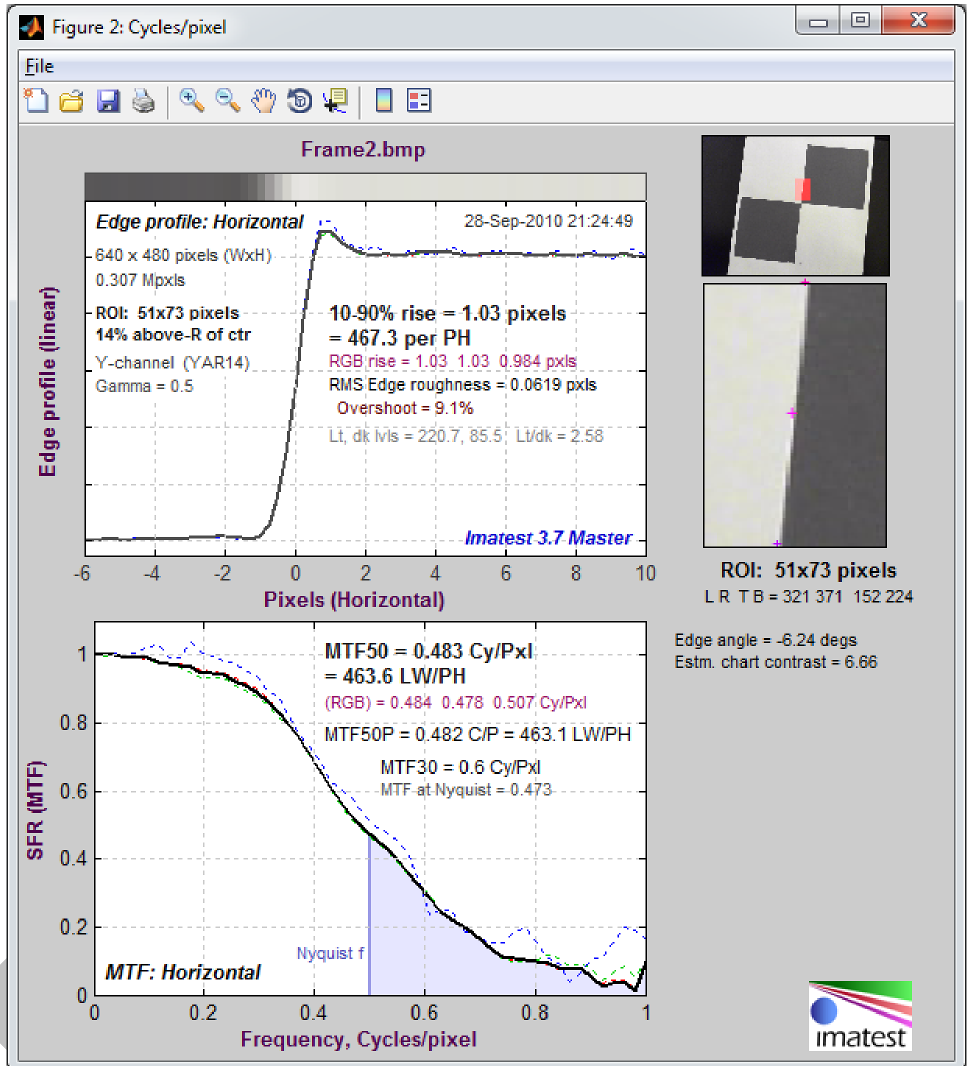


Figure 8: Imatest SFR results

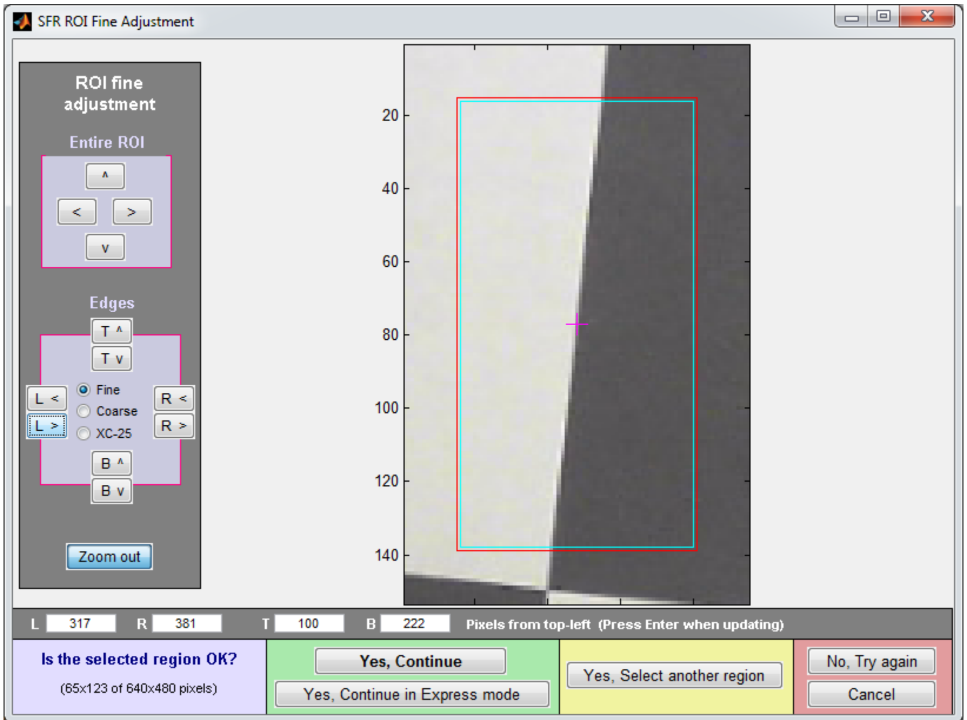


Figure 9: Horizontal SFR ROI

4.2.6 P1: Image dynamic range

4.2.6.1 Purpose

Sufficient dynamic range is required to capture the user and background without significant saturation. This test measures dynamic range in the test lighting setup (Figure 32), as well as a typical office environment to check the impact of overhead lighting. Cameras without lens hoods or sufficient anti-reflective coating will typically have a significantly lower dynamic range in the overhead lighting test. However, that is a typical user scenario, and therefore is the more important of the two tests.

Related standard: ISO 15739-2003.

4.2.6.2 Requirements

	Standard	Premium
Dynamic range	>= 36 dB	>= 42 dB

Table 16: Image DR

4.2.6.3 Test setup

The overhead lighting setup is shown in Figure 9. This configuration is a typical office environment with 300 lux lighting. The light is a 2 x 4-foot, fluorescent ceiling tile light.

Lighting	3500 K test lighting (Figure 32), 200 +/- 20 lux at target Overhead lighting, 300 +/- 30 lux (see Section 4.5.2)
Test charts	ST-52
DUT position	Pointing at test chart at a distance of 0.5 m
DUT settings	Default

Table 17: Image dynamic range test setup

Figure 10: Image dynamic range overhead lighting test setup

4.2.6.4 Test procedure

The test procedure for the test lighting (Figure 32) and overhead lighting is the same, and the criteria need to be met for both tests.

1. For each P1 resolution and max frame rate:
    a. Capture an image.
    b. Run Imatest and select the Stepchart analysis module.
    c. Adjust the ROI and select "Noise in pixels (max 255)" and "Pixel SNR (dB) (20*log10(S/N))" (see Figure 11).
    d. Do fine adjustments for the ST-52 ROI (see Figure 12).
    e. Read "Total dynamic range" in f-stops from "Stepchart noise detail" (see Figure 13); multiply this number by 6.02 to get dB and compare with criteria.

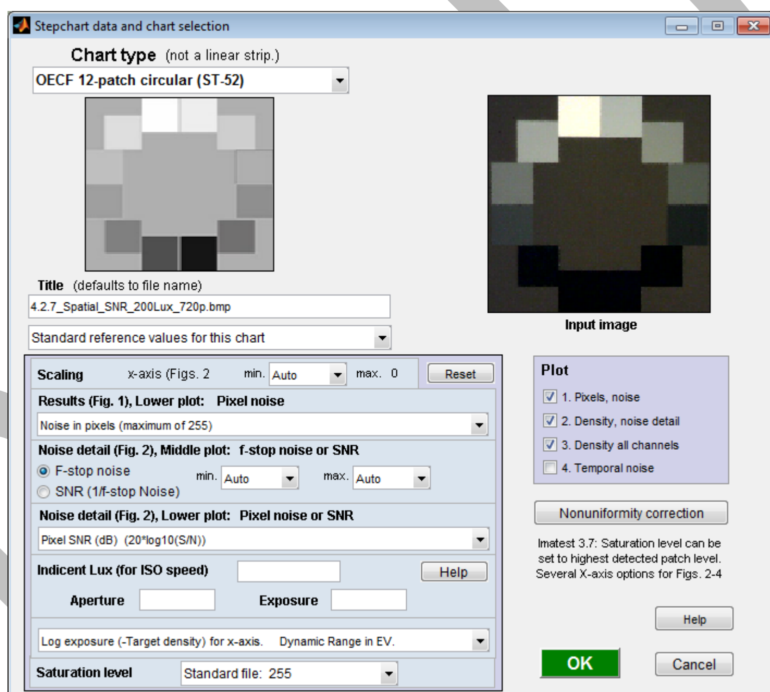


Figure 11: Imatest setup for dynamic range test

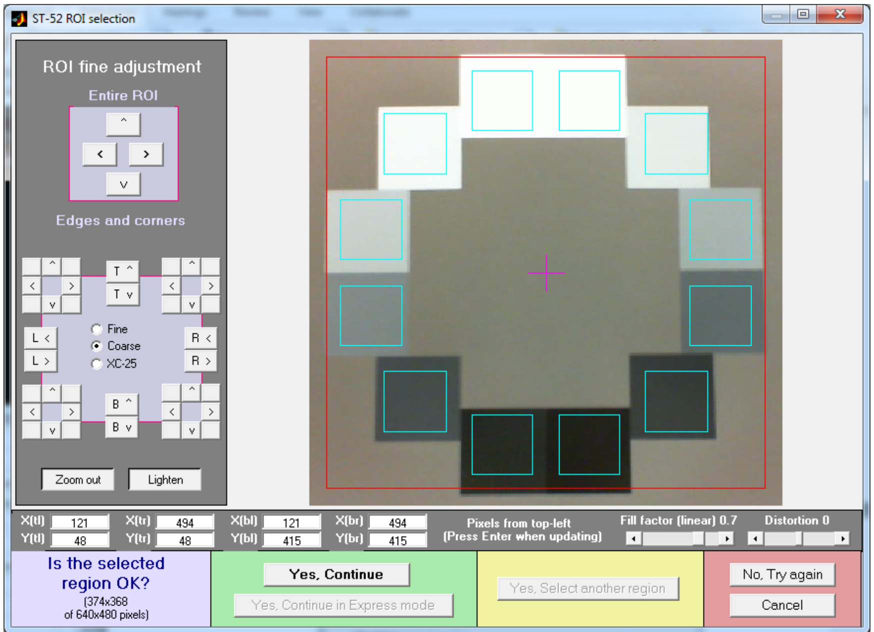


Figure 12: Imatest setup for dynamic range test

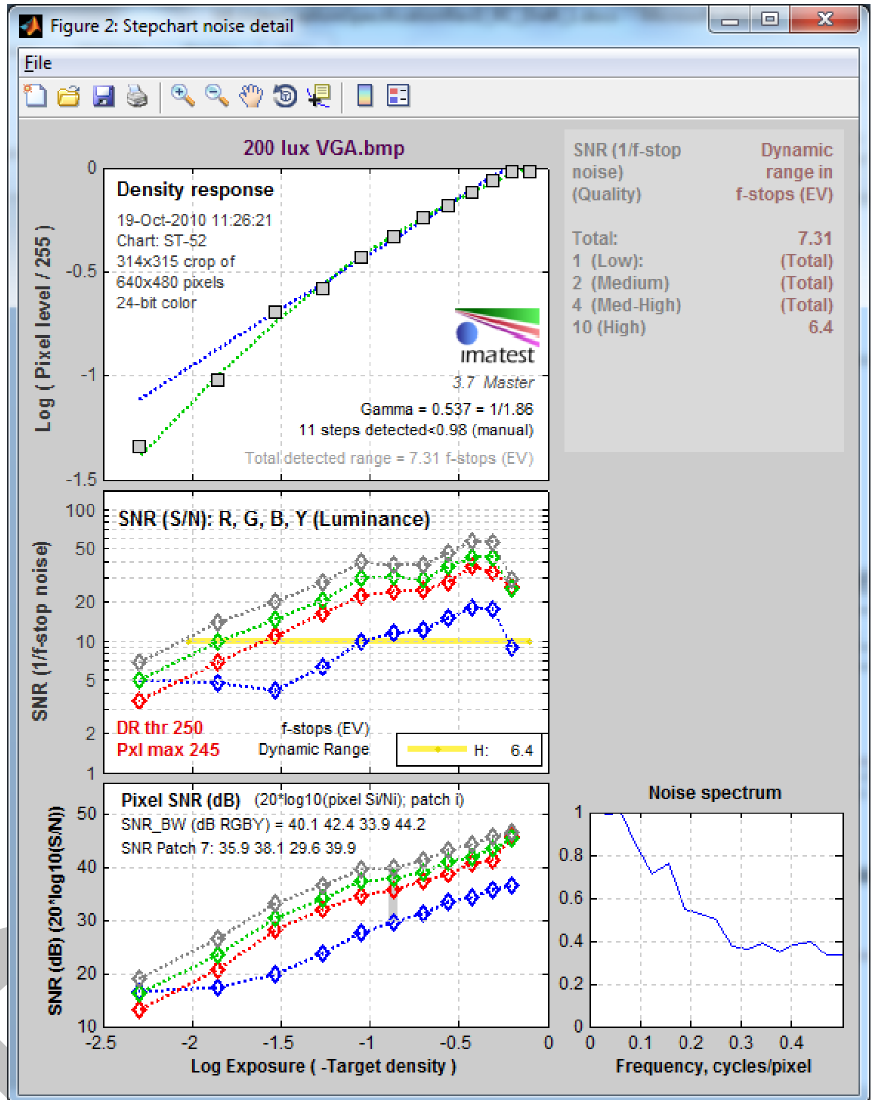


Figure 13: Imatest dynamic range results

4.2.7 P1: Image spatial SNR

4.2.7.1 Purpose

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

Related standard: ISO 15739-2003

4.2.7.2 Requirement

	Standard	Premium
SNR 50 lux	>= 30 dB	>= 33 dB
SNR 200 lux	>= 33 dB	>= 36 dB

Table 18: Image spatial SNR

4.2.7.3 Test setup

Lighting	3500 K test lighting (Figure 32), 200 +/- 20 lux, 50 +/- 5 lux at target
Test charts	ST-52
DUT position	Pointing at test chart at a distance of 0.5 m Ensure minimal keystoning (perspective distortion) with chart
DUT settings	Default

Table 19: Image spatial SNR test setup

4.2.7.4 Test procedure

1. For 50 lux setup: for each P1 resolution and max frame rate:
    a. Capture an image.
    b. Run Imatest and select the Stepchart analysis module.
    c. Adjust the ROI and select “Noise in pixels (max 255)” and “Pixel SNR (dB) (20*log10(S/N))” (see Figure 11).
    d. Do fine adjustments for the ST-52 ROI (see Figure 12).
    e. Read the “SNR Patch 7” (density 0.7) in Stepchart noise detail figure (see Figure 13); enter this value in the Excel workbook template and compare the results with the criterion.
2. Repeat for 200 lux.

4.2.8 P1: Image temporal SNR

4.2.8.1 Purpose

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

Related standard: ISO 15739-2003.

4.2.8.2 Requirement

	Standard	Premium
SNR 50 lux	>= 30 dB	>= 33 dB
SNR 200 lux	>= 33 dB	>= 36 dB

Table 20: Image temporal SNR

4.2.8.3 Test setup

Lighting	3500 K test lighting (Figure 32), 200 +/- 20 lux, 50 +/- 5 lux at target
Test charts	ST-52
DUT position	Pointing at test target
DUT settings	Exposure, gain, white balance set to manual

Table 21: Image temporal SNR test setup

4.2.8.4 Test procedure

1. For 50 lux setup: For each P1 resolution and max frame rate
    a. Capture two images of stepchart in rapid succession (ensure no lighting change occurs).

b. Run Stepchart analysis and select the two image files captured in the previous step.
c. Select "Read two files for measuring temporal noise" (see Figure 14).
d. Select "Noise in pixels (max 255)" and "Pixel SNR (dB) (20*log10(S/N))" as shown in Figure 15.
e. Adjust the region of interest as shown in Figure 12.
f. Read the "SNR Patch 7" (density 0.7) in Stepchart noise detail figure (see Figure 13); enter this value in the Excel workbook template and compare the results with the criterion.

2. Repeat for 200 lux.

Notes:

- If the camera doesn't support manual exposure/gain/white balance, then the temporal results might not be accurate (it will likely degrade the results).

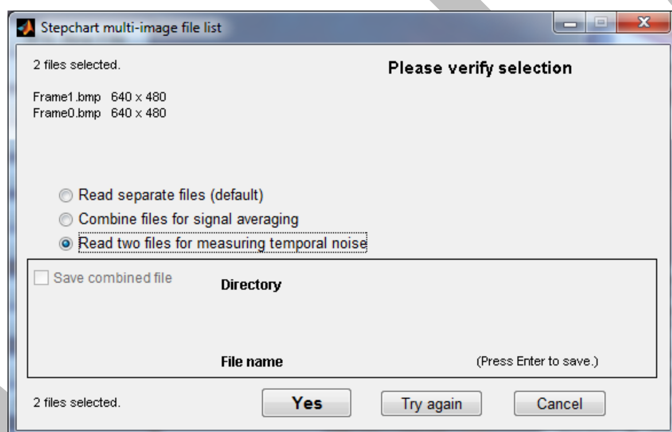


Figure 14: Imatest temporal SNR setup

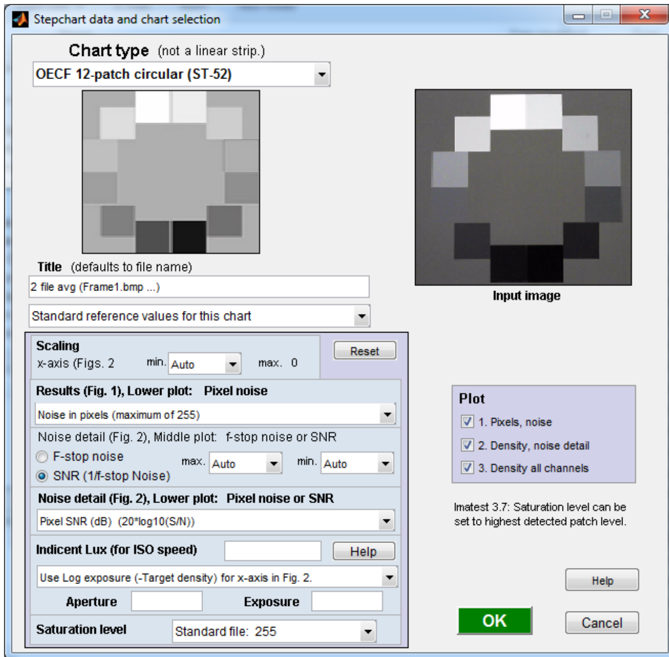


Figure 15: Imatest temporal SNR setup

4.2.9 P1: Gamma

4.2.9.1 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 color mapping.

Related standard: ISO 14524-1999.

4.2.9.2 Requirements

	Standard and Premium
Gamma	[0.4,0.65]

Table 22: Gamma

4.2.9.3 Test setup

See Section 4.2.6. Only the non-overhead lighting test needs to be used.

4.2.9.4 Test procedure

1. Do test procedure in Section 4.2.6.4.
2. Read off gamma from “Stepchart results” (see Figure 16).

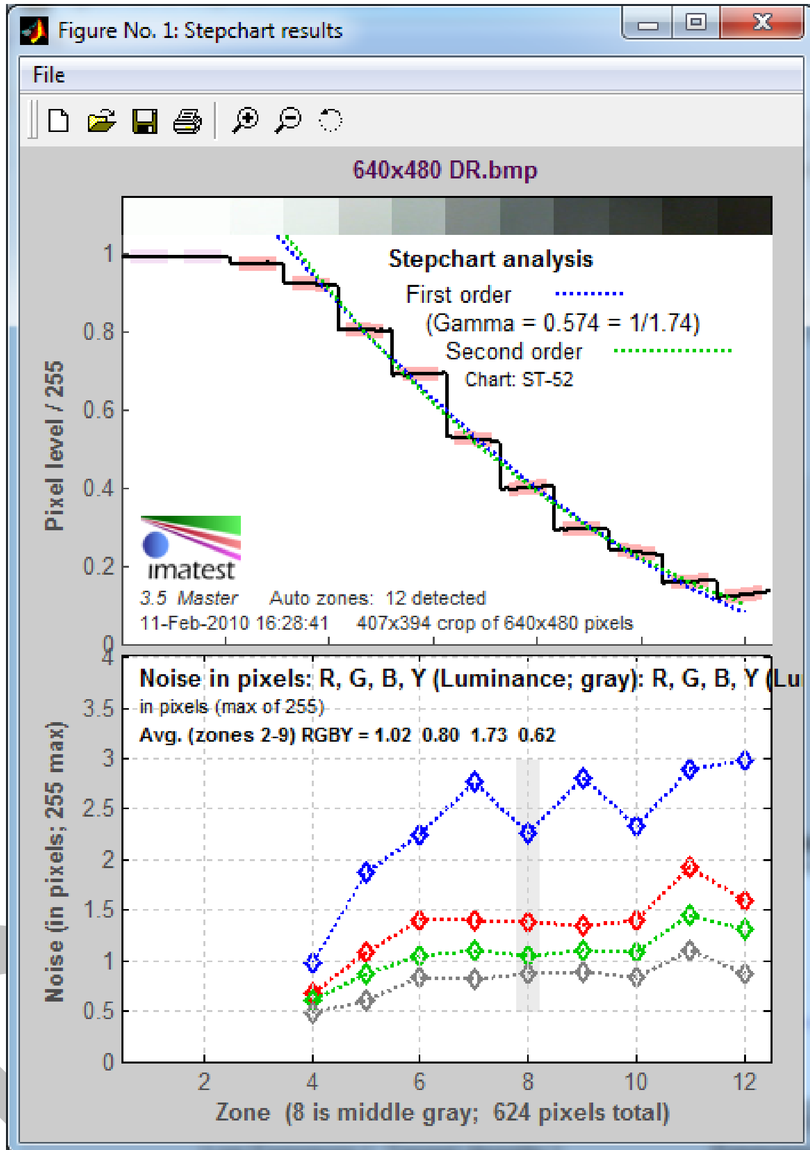


Figure 16: Imatest gamma results

4.2.10 P1: Relative illumination

4.2.10.1 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.

4.2.10.2 Requirements

	Standard	Premium
Relative illumination	70% <= RI <= 130%	80% <= RI <= 120%
Color uniformity	ΔC <= 10	ΔC <= 5

Table 23: Relative illumination and color ratios

4.2.10.3 Test setup

Lighting	Integrating sphere or 3500 K test lighting (Figure 32)
Test charts	NA
DUT position	In integrating sphere or uniform light source (see Section 4.5.1)
DUT settings	Default

Table 24: Relative illumination test setup

4.2.10.4 Test procedure

1. For each P1 resolution and max frame rate:
    a. Capture an image.
    b. Run Imatest, select the Light Falloff module, and read the captured image.
    c. Select the entire image as the ROI.
    d. Select “Display pixel contours only” and Channel: “Y” (see Figure 17).
    e. Select “20:15” for 4:3 images or “32:18” for 16:9 images.
    f. Using the “Luminance contours” result window (see Figure 18) use the minimum of corners or sides relative illumination (percentage). Compare these with the criteria.
    g. Using the “Grid Sector plot” result window (see Figure 19) read off the Mean and Max ΔC and enter them into the Excel workbook template. Compare the results to the criteria.

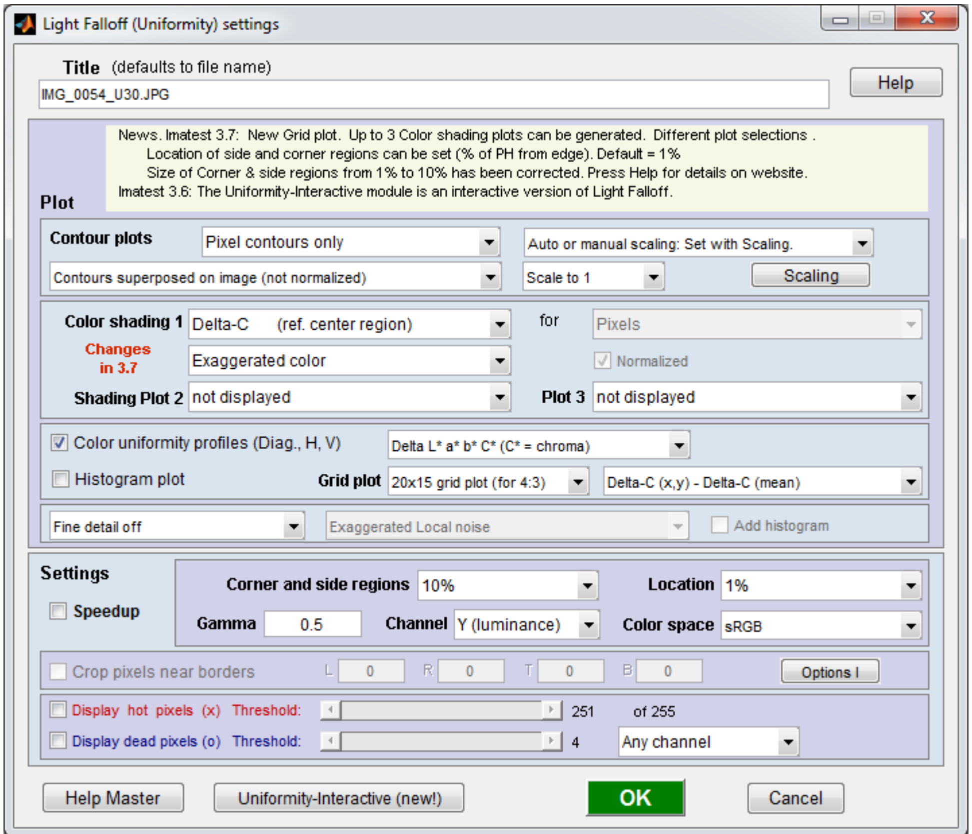


Figure 17: Imatest relative illumination setup

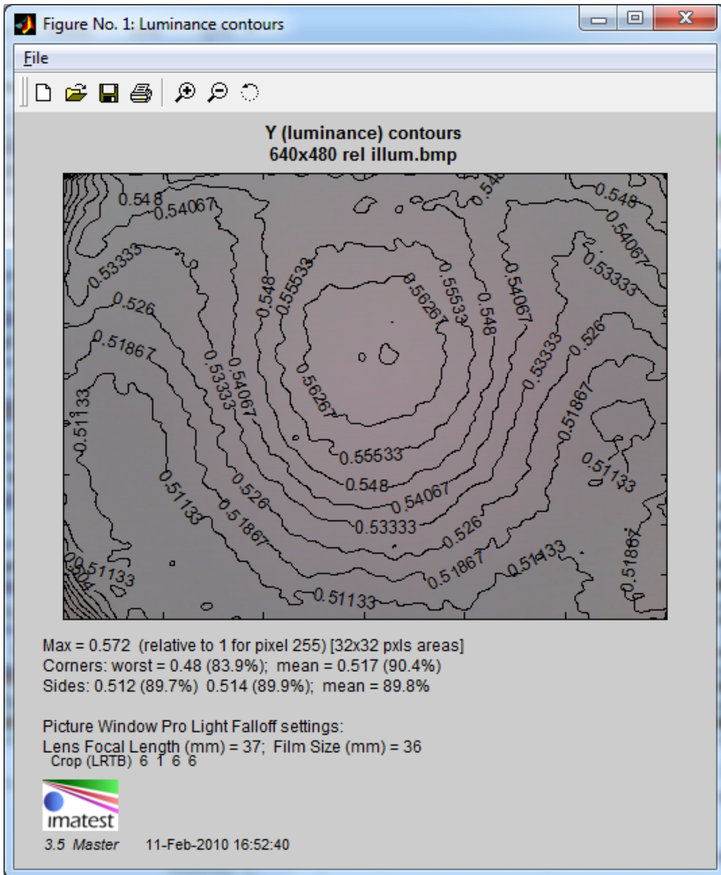


Figure 18: Imatest relative illumination test results

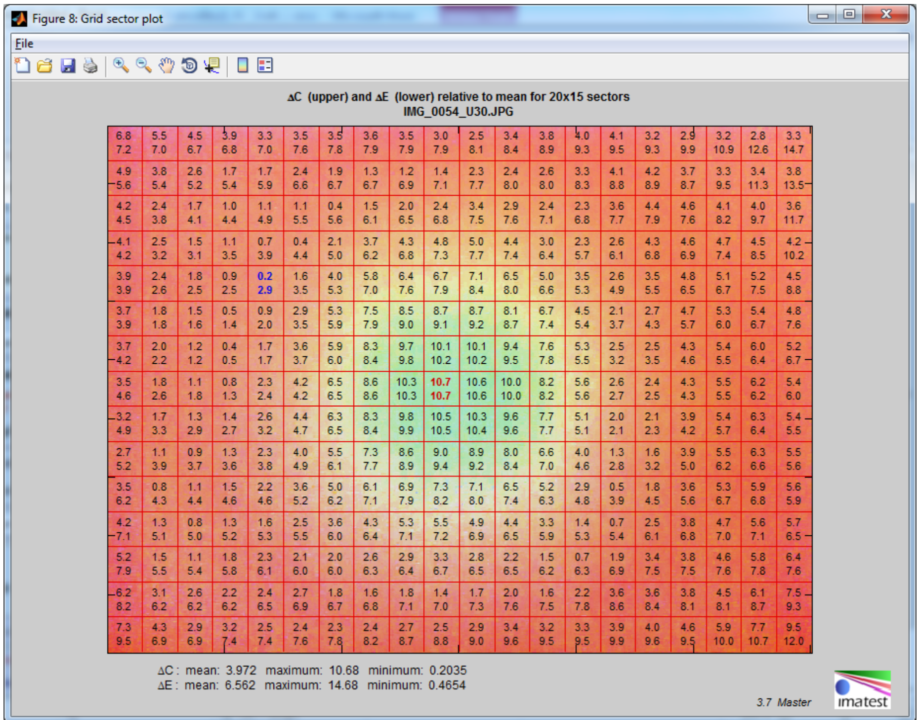


Figure 19: Imatest color uniformity test

4.2.11 P1: Field of view

4.2.11.1 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 20 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.

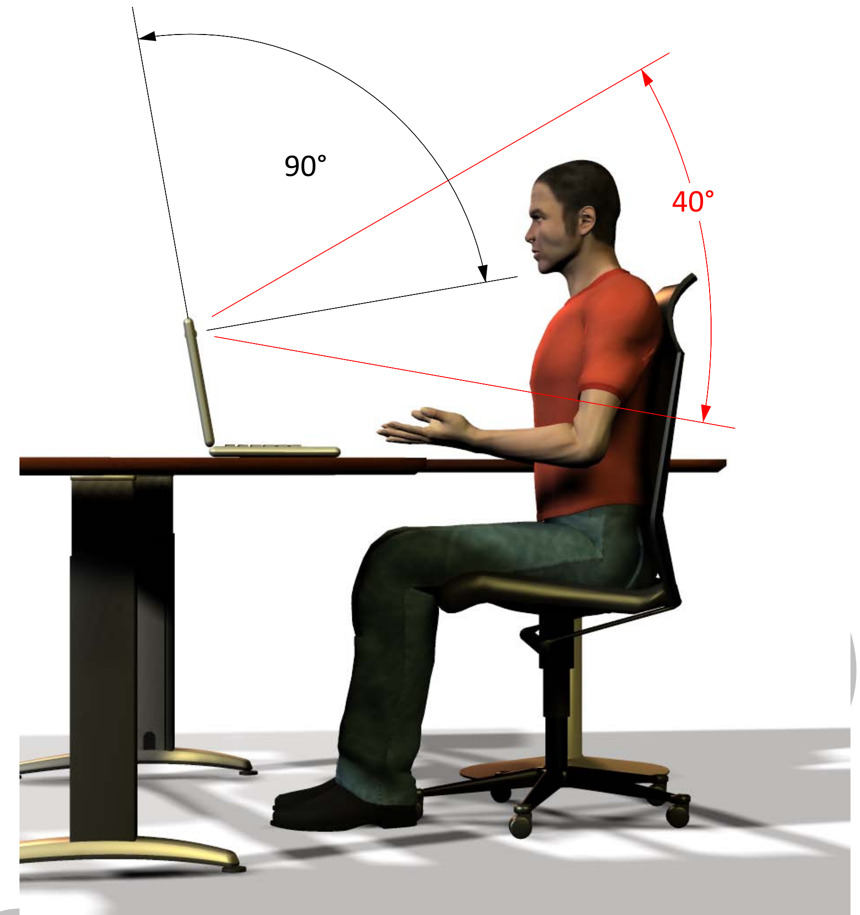


Figure 20: Vertical FOV

4.2.11.2 Requirements

	Standard	Premium
VFOV	>= 35 deg	>= 40 deg

Table 25: Field of view

4.2.11.3 Test setup

Lighting	Any
Test charts	NA
DUT position	Pointed at any test target at a distance D away
DUT settings	Default

Table 26: Field of view test setup

4.2.11.4 Test procedure

1. For each P1 resolution and max resolution:
   a. Measure the height of the target viewed (H) by the image (see Figure 21).
   b. Compute: $VFOV = 2\tan^{-1}\frac{H}{2D}$

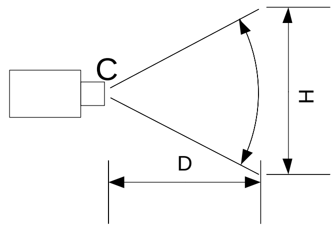


Figure 21: VFOV setup

4.2.12 P1: Depth of field

4.2.12.1 Purpose

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

Related standard: ISO 12233-2000.

4.2.12.2 Requirements

	Standard and Premium
Depth of field	0.3 m to 1.5 m

Table 27: Depth of field

4.2.12.3 Test setup

Lighting	3500 K test lighting (Figure 32), 200 +/- 20 lux at target
Test charts	Slanted edge resolution chart (Figure 33)
DUT position	Pointing at test chart at a distance of 0.3 m, 1.5 m
DUT settings	Default If the DUT is manual focus, focus it on test chart.

Table 28: Depth of field test setup

4.2.12.4 Test procedure

1. For each P1 resolution and max frame rate:
    a. If the DUT is manual focus, focus it on a target at 0.3 m away.
    b. Measure the MTF per Section 4.2.5.4 at a distance of 0.3 m.
    c. Measure the MTF per Section 4.2.5.4 at a distance of 1.5 m.
    d. Both 0.3 m and 1.5 m should pass the MTF criteria given in Table 14.

4.2.13 P1: Automatic exposure and gain

4.2.13.1 Purpose

Automatic exposure and gain control are needed to ensure the image has sufficient contrast and isn't saturated in typical light conditions.

4.2.13.2 Requirements

	Standard and Premium
Supports AEC and AGC	Default enabled

Table 29: Video AEC and AGC

4.2.13.3 Test setup

Lighting	3500 K test lighting (Figure 32), 50 +/-5 lux at target, 200 +/- 20 lux
Test charts	ST-52
DUT position	Pointing at test chart at a distance of 0.5 m
DUT settings	Default

Table 30: Automatic exposure and gain test setup

4.2.13.4 Test procedure

1. Run GraphEdit, insert the camera capture source, and render the graph.
2. In the 50 lux light level, take an image of the ST-52 chart.
3. In the 200 lux light level, take an image of the ST-52 chart.
4. Use Photoshop to check that the difference between the white square mean pixel level and the black square mean pixel level deviates less than 10% between images in step 2 and 3:

$$\frac{\max(|B_1 - B_2|, |W_1 - W_2|)}{255} < 0.1$$

4.2.14 P1: Geometric distortion

4.2.14.1 Purpose

Low geometric distortion makes images less distorted so that captured images more accurately represent the real scene.

4.2.14.2 Requirements

	Standard	Premium
Absolute_Value(Geometric distortion)	<= 6%	<= 3%

Table 31: Geometric distortion

4.2.14.3 Test setup

Lighting	3500 K test lighting (Figure 32), 200 +/- 20 lux
Test charts	Distortion grid (checkbox pattern)
DUT position	Pointing at test chart to fill the field of view.
DUT settings	Default

Table 32: Geometric distortion test setup

4.2.14.4 Test procedure

1. For each P1 resolution and max frame rate:
    a. Capture an image of the distortion grid.
    b. Run Imatest and select the Distortion module.
    c. Select the ROI (see Figure 22).

d. Select "Plot intersection points" and "Checkerboard" in the "Distortion settings and options" dialog (see Figure 23).

e. Compare absolute value of "SMIA TV Distortion" from the "Distortion Plot" (Figure 24) with above criteria.

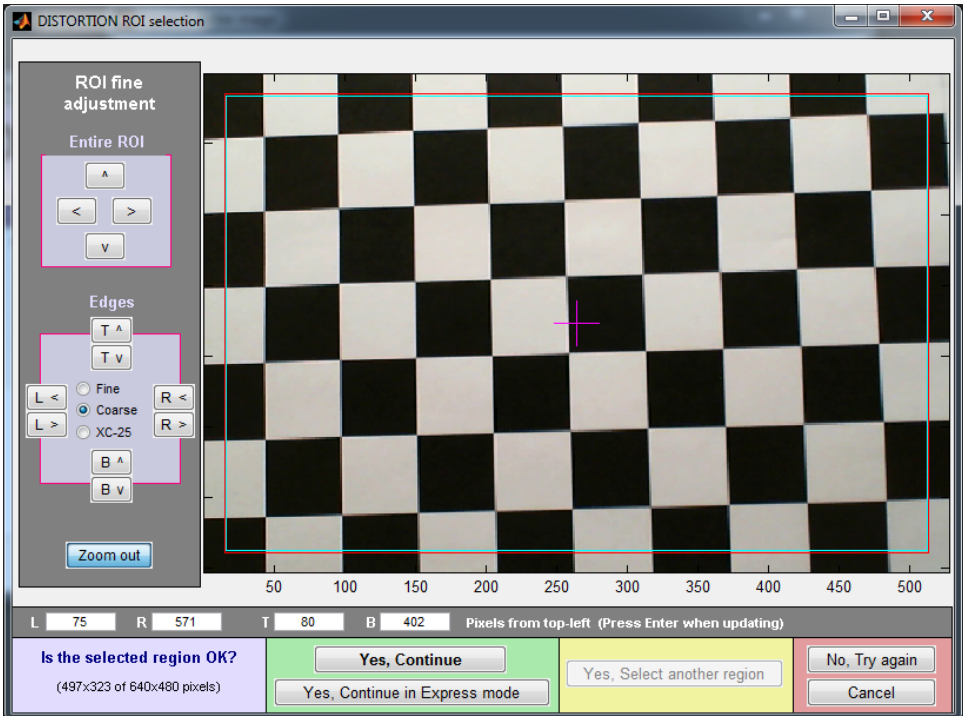


Figure 22: Imatest geometric distortion ROI

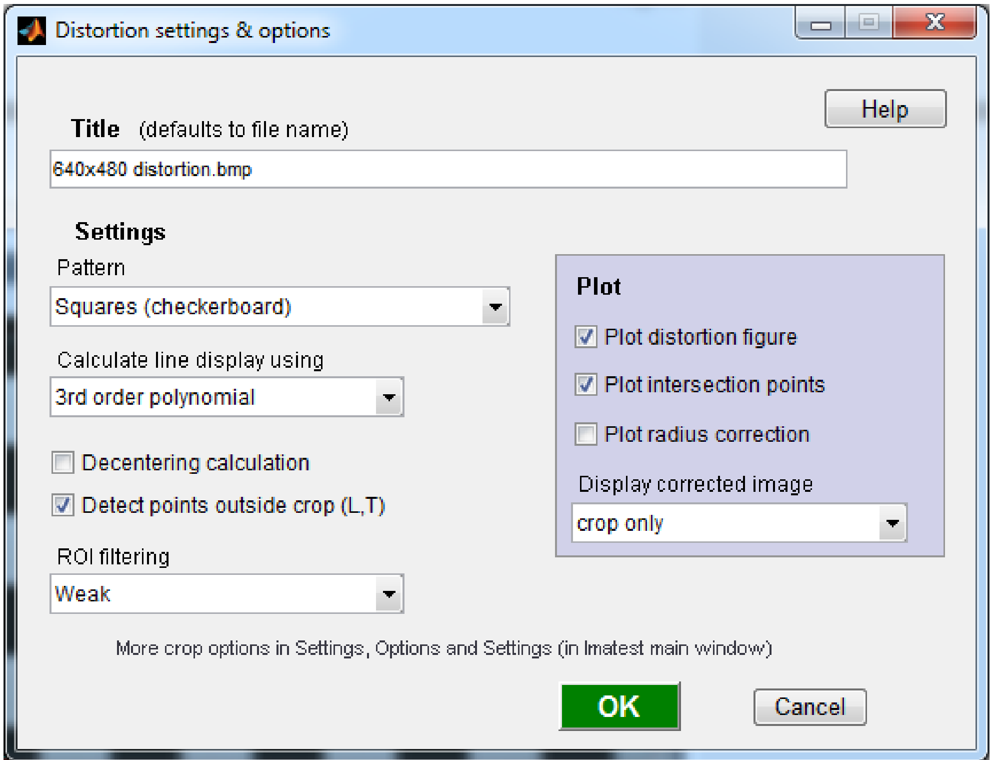


Figure 23: Imatest setup for geometric distortion

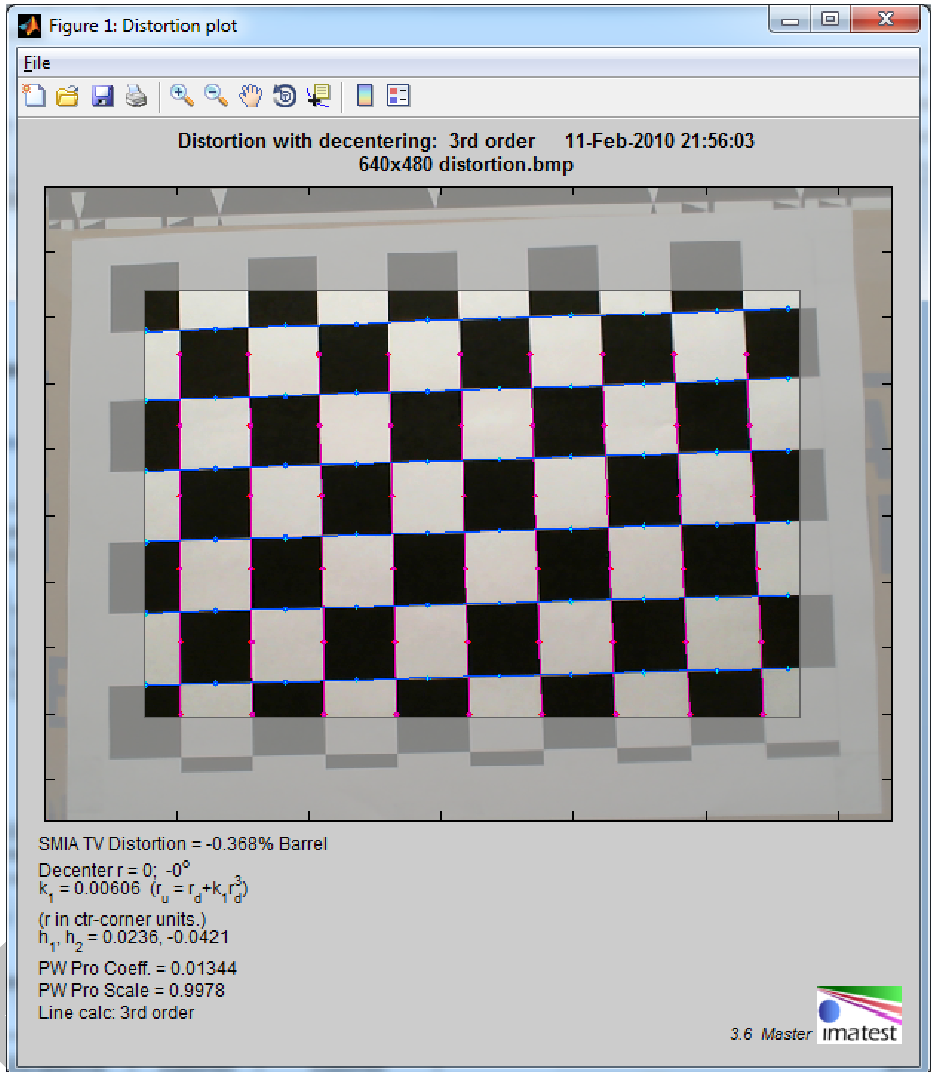


Figure 24: Geometric distortion results

4.2.15 P1: Pixel aspect ratio

4.2.15.1 Purpose

The correct pixel aspect ratio is important so that the captured images look normal and not stretched out horizontally or vertically. Note that this is particularly important for CIF which has a non-unity pixel aspect ratio. The nominal CIF aspect ratio is 0.92; the nominal non-CIF resolution aspect ratios are 1.0.

4.2.15.2 Requirement

	Standard and Premium
CIF	0.90 <= R <= 0.94
All other resolutions	0.98 <= R <= 1.02

Table 33: Pixel aspect ratio

4.2.15.3 Test setup

See Section 4.2.14.

4.2.15.4 Test procedure

1. Run the test in Section 4.2.14.
    a. Select "Plot intersection points" in Imatest.
2. Read off pixel aspect ratio, $\Delta x / \Delta y$ in the Intersection Plot (see Figure 25).

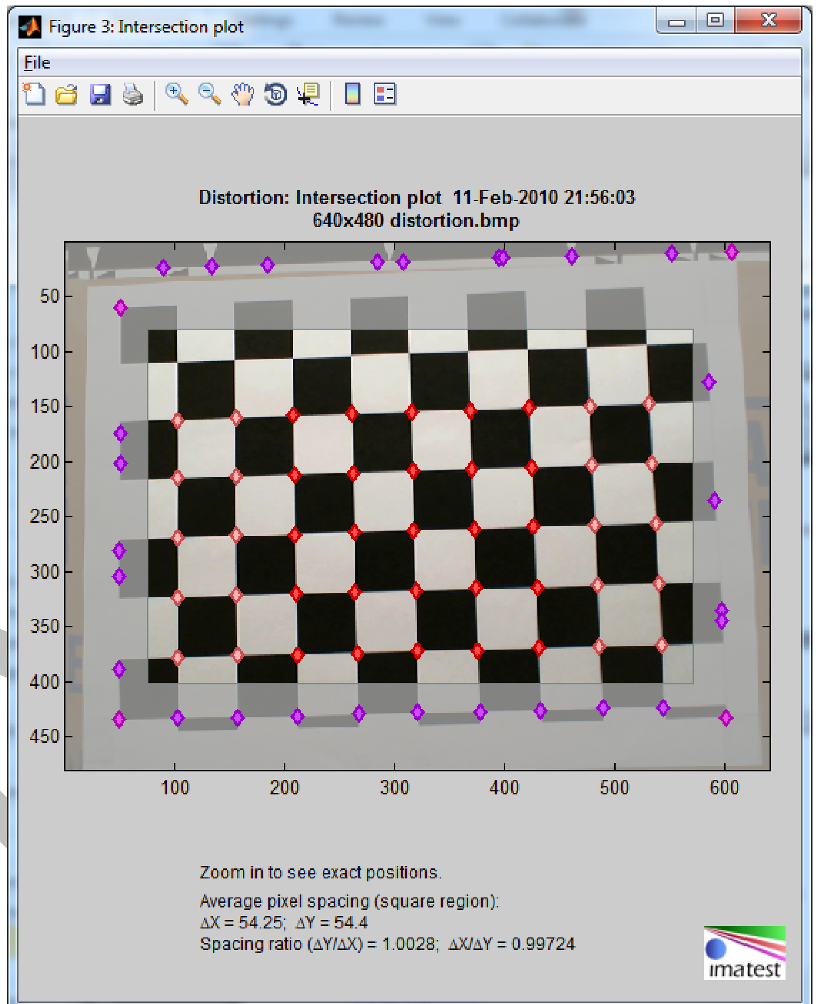


Figure 25: Pixel aspect ratio results

4.2.16 P1: Color accuracy

4.2.16.1 Purpose

Required to make images look natural under various lighting temperatures. Note the criteria for A (2856K) lighting is relaxed compared to 3500 K and Day to allow A lighting to still have a yellow tint.

4.2.16.2 Requirements

	Standard	Premium
Automatic white balancing	Supported	Supported
3500 K Day (6500 K)	Max $\Delta C_{00} \lesssim 15$ Mean $\Delta C_{00} \lesssim 10$	Max $\Delta C_{00} \lesssim 10$ Mean $\Delta C_{00} \lesssim 5$
A (2856 K)	Max $\Delta C_{00} \lesssim 20$ Mean $\Delta C_{00} \lesssim 15$	Max $\Delta C_{00} \lesssim 15$ Mean $\Delta C_{00} \lesssim 10$

Table 34: Color accuracy for different color temperatures

4.2.16.3 Test setup

Lighting	A, 3500 K, Day test lighting (Figure 32), 200 +/- 20 lux at target
Test charts	ColorChecker
DUT position	Pointing at test chart at a distance of 0.5 m
DUT settings	Default

Table 35: Color accuracy test setup

4.2.16.4 Test procedure

The first check is that the camera driver supports automatic white balance:

1. Run GraphEdit and insert the video capture source.
2. For each P1 resolution and max frame rate:
   a. Select the P1 resolution and frame rate.
   b. Right-click the capture filter and display the "Video Proc Amp" dialog. Examine the White Balance control. It should have "Auto" checkbox selected by default (selectable white balance isn't required).

The next test checks the color performance under different lighting temperatures.

1. For each P1 resolution and max frame rate:
   a. Capture an image of the ColorChecker chart with lights 3500 K, A (2856 K), and Day (6500 K).
   c. Run Imatest, select the Colorcheck module, and load a saved image.
   d. Select the ROI for the ColorChecker image (see Figure 26).
   e. Select the Delta C-00 option (see Figure 27).
   f. Read the mean and maximum correlated ΔC_{00} result from the "a*b* D65 Color error" figure (see Figure 28) and compare with the above criteria.
   g. Repeat for all temperatures.

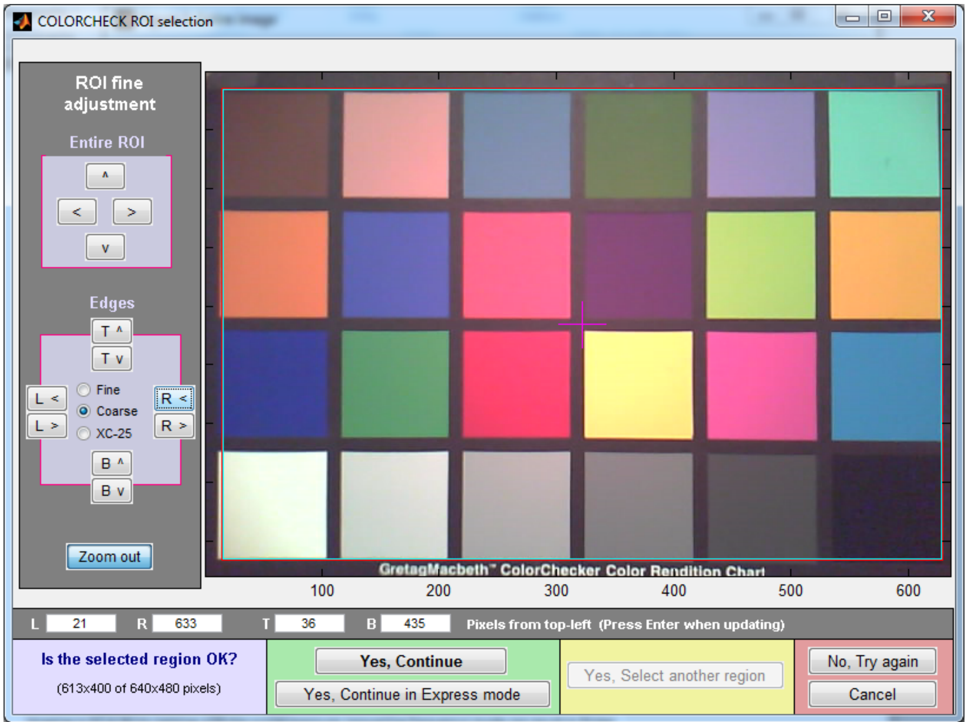


Figure 26: Color accuracy ROI setup

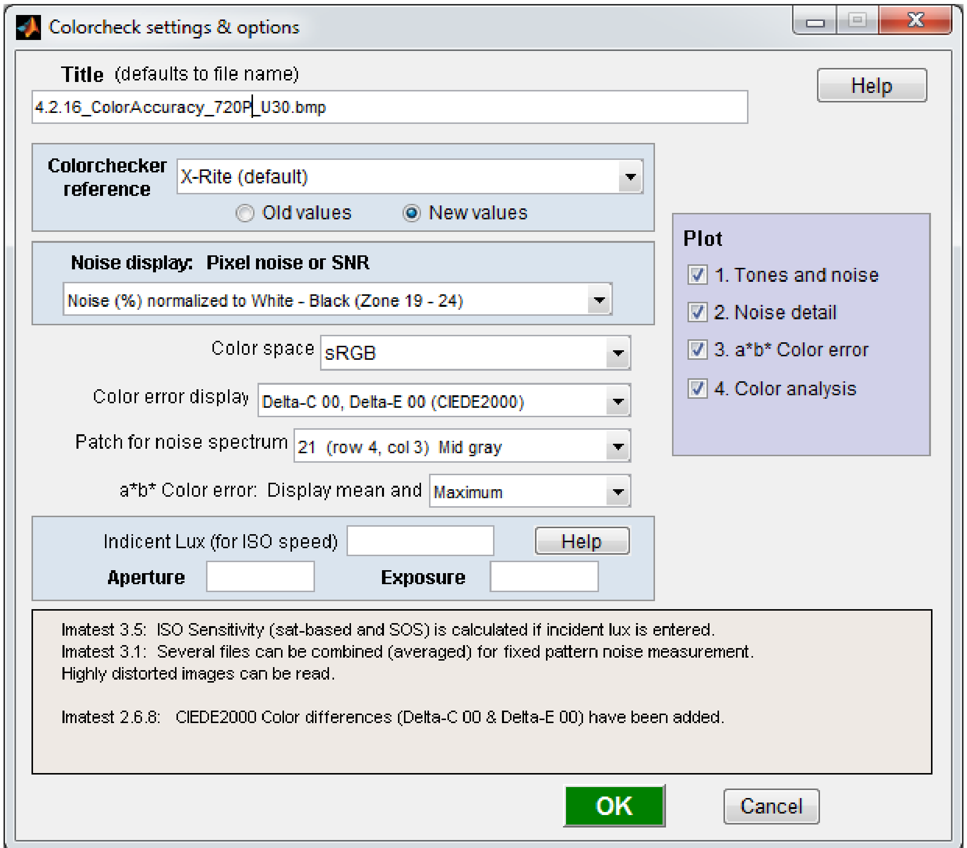


Figure 27: Color accuracy setup

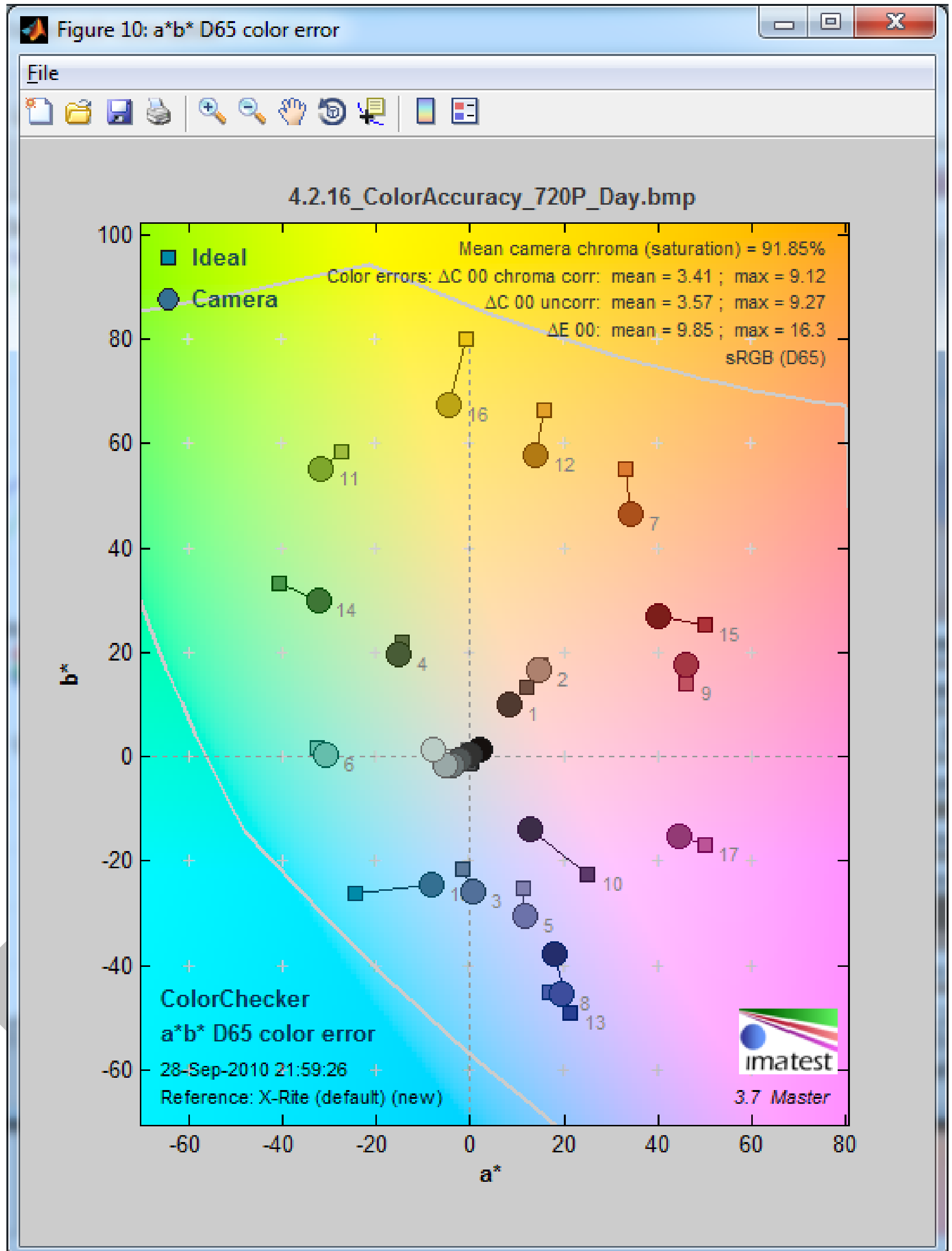


Figure 28: Color accuracy results

4.2.17 P1: Anti-flicker solution

4.2.17.1 Purpose

Imaging in 50 or 60 Hz lighting with the wrong exposure (powerline frequency) mode can result in flicker that significantly degrades SNR (> 8 dB in our tests).

4.2.17.2 Requirements

The camera must include one of the following solutions to remove flickers due to 50 and 60 Hz lighting.

	Standard	Premium
Anti-flicker	Support 50 Hz or 60 Hz AEC modes	Automatically selects 50 Hz or 60 Hz AEC mode

Table 36: Anti-flicker solution

4.2.17.3 Test setup

See Section 4.2.8. Incandescent (A) lighting should be used.

4.2.17.4 Test procedure

The first test is to verify that the camera and driver support the anti-flicker functionality:

1. Run GraphEdit and insert the video capture source.
2. Right-click the video capture source and select Filter properties. Examine powerline frequency control. If it supports a selectable 50 and 60 Hz frequency, then it passes the Standard criteria. If it has an “Auto” checkbox that is selectable (only OEM drivers can support a selectable checkbox) and default selected, or is hardcoded to automatic powerline frequency, then it passes the Premium criteria.

The next test compares SNR at different powerline frequencies. Tests need to be run for all P1 resolutions and for max frame rates. For Standard webcams:

1. Set the DUT powerline frequency to 50 Hz.
2. Use a 50 Hz light power source and measure the temporal SNR per Section 4.2.8.
3. Set the DUT powerline frequency to 60 Hz.
4. Use a 60 Hz light power source and measure the temporal SNR per Section 4.2.8.
5. Compare these 2 SNRs. They should be within 2 dB of each other to pass.
6. Inspect the video in step 2 and step 4 for powerline flicker. See Figure 29 for an example of the horizontal bands that move in the horizontal direction when the powerline frequency is not set correctly.

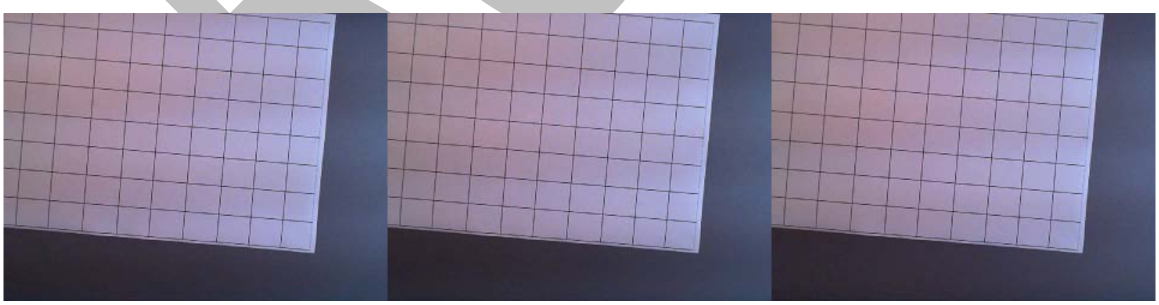


Figure 29: Video flicker example

For Premium webcams:

1. Use a 50 Hz light power source and measure the temporal SNR per Section 4.2.8.
2. Use a 60 Hz light power source and measure the temporal SNR per Section 4.2.8.
3. Compare these 2 SNRs. They should be within 2 dB of each other to pass.

4. Inspect the video in step 2 and step 4 for powerline flicker. See Figure 29 for an example of the horizontal bands that move in the horizontal direction when the powerline frequency is not set correctly.

4.2.18 P1: Focus

4.2.18.1 Purpose

This requirement specifies auto-focus performance and manual focus API support (also for cameras with auto-focus). Most webcams with autofocus experience “focus swimming” and sometimes get stuck in an unfocused state. The typical desktop scenario doesn’t need autofocus, as the camera’s depth of field at the nominal distance of 0.5 m from the camera to user is sufficient. To minimize focus swimming, the autofocus performance is specified in a real-world test. To allow Lync to programmatically specify manual focus, the manual focus performance is specified.

4.2.18.2 Requirements

1. Auto-focus performance: Images must be focused 99% of the time over 5 minutes in a typical use-case scenario (see test procedure).
2. Manual-focus performance: The default manual focus target must be 0.5 m. This allows manual focus to be used to eliminate focus swimming and ensures that users are in focus in most desktop and notebook scenarios. The default manual focus MTF30 must be with 10% relative error to the autofocus MTF30.

4.2.18.3 Test setup

Lighting	300 +/- 30 lux office lighting (see Section 4.5.2)
Test charts	NA
DUT position	In typical usage position, pointing at user
DUT settings	Default

Table 37: Focus test setup (auto-focus)

Lighting	3500 K test lighting (Figure 32), 200 +/- 20 lux at target
Test charts	Resolution chart
DUT position	Pointing at test chart at a distance of 0.5 m
DUT settings	Default

Table 38: Focus test setup (manual focus)

4.2.18.4 Test procedure

Auto-focus performance:

1. For each P1 resolution and max frame rate:
    a. Capture 5 minutes of video with AMCap of the user simulating a typical desktop video conference.
    b. Examine the captured video file and estimate the % of images that are not focused.
    c. Compare results with requirements.

Manual-focus performance

1. Set up the webcam 500 mm from the small ISO resolution chart.
2. For each P1 resolution and max frame rate:
    a. Run GraphEdit and render the capture source.
    b. Enable autofocus using the Camera Control dialog box (see Figure 30.)
    c. Capture an image.
    d. Disable autofocus.
    e. Select default focus.
    f. Capture an image.
    g. Run Imatest and compute the MTF30 for images (c) and (f). See Section 4.2.5.
    h. MTF30 must be within 10% relative error.

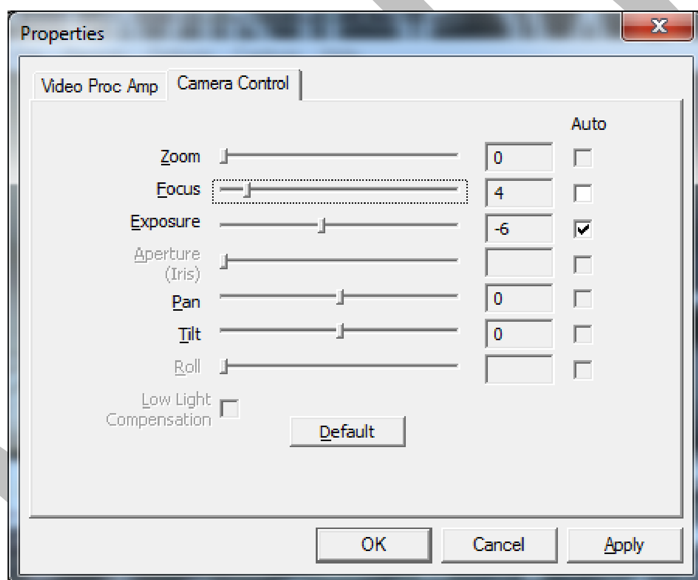


Figure 30: Camera Control dialog box for setting focus mode

4.2.19 P1: Audio/video synchronization

4.2.19.1 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.

4.2.19.2 Requirements

The requirements are given in Table 39. This is a capture+render specification and is adjusted to account for that. The actual A/V synchronization coming from the camera should be much tighter.

	Standard	Premium
A/V synchronization	Audio leads video <= 45 ms Audio lags video <= 90 ms	Audio leads video <= 35 ms Audio lags video <= 80 ms

Table 39: Audio / video synchronization

4.2.19.3 Test setup

Lighting	300 +/- 30 lux office lighting (see Section 4.5.2)
Test charts	NA
DUT position	In typical usage position, pointing at user holding clapper board
DUT settings	Default

Table 40: Focus test setup (auto-focus)

4.2.19.4 Test procedure

1. For each P1 resolution and max frame rate:
    a. Set AMCap to capture audio and video; set audio as the master.
    b. Capture a 30-second audio/video sequence with 3 uses of the "clapper board" (see Figure 31) or similar device. 16-kHz audio is preferred; otherwise test 48-kHz audio.
    c. Use audio/video editors like Adobe Premiere or VirtualDub to estimate the audio/video synchronization of each clapper board event (estimate the time difference between the time that the first frame is closed and the time of the audio spike).
    d. Average the estimates and compare to the criteria.

Figure 31: Clapper board

4.3 Audio

Webcams with built- in microphones must meet the requirements given in Table 41 specified in the *Microsoft Lync Devices Audio Specification*. Only send path handsfree audio is required from this specification. All tests must be run using both the Windows AVC driver and any supplied audio driver.

Priority	Requirement
P1	Sampling frequency
P1	Bit depth
P1	Latency
P1	Speakerphone Send Distortion and Noise Send
P1	Handsfree Device Send Frequency Response
P1	Send directivity

Table 41: Send audio requirements from Lync Devices Audio Specification

4.4 Other

4.4.1 P1: Usage indicator

4.4.1.1 Purpose

Lets the user know when the camera is on and imaging or off and not imaging.

4.4.1.2 Requirements

	Standard and Premium
Usage indicator	Light on when capturing video Light can be on when capturing audio (optional) Usage light off otherwise

Table 42: Usage indicator

4.4.1.3 Test setup

Lighting	300 +/- 30 lux office lighting (see Section 4.5.2)
Test charts	NA
DUT position	In normal usage position pointing at the user
DUT settings	Default

Table 43: Usage indicator test setup

4.4.1.4 Test procedure

1. The usage indicator light should be clearly visible (on/off) from a typical usage position.
2. With DUT plugged in but not in use, examine usage indicator; it should be off.
3. For each P1 resolution and max frame rate:
    a. Run GraphEdit and render the capture source. DUT usage indicator should be on.

4.5 Video test setup

4.5.1 Test components

The video test setup components include:

- The test room setup shown in Figure 32. Using two 45^0 lights help provide glare-free images and approximately uniform lighting. The lights need to support incandescent (A: 2856 K), florescent (3500 K[3]), and Day (6500 K[4]). Multiple lights or an aperture should be used to adjust the

[3] Sylvania Octron 3500 K FO17/735/ECO, 75 CRI

luminance on the target to 50 and 200 lux as measured with a calibrated light meter at the target. The uniformity across the target must be <10%. The test room color should be matte black using either paint or cloth to minimize reflections and improve test accuracy. The camera should only image an 18% neutral gray background (excluding the test charts).

- Imatest Master v 3.7 or newer
- Slanted edge resolution test chart created with Imatest (10:1 contrast ratio). See Figure 33. This chart should be A3 size, 720 DPI, and rotated 5^{o} with respect to the horizon.
- x-rite ColorChecker Classic color chart. See Figure 35.
- ISO-14524 contrast chart (ST-52 160:1 contrast ratio). See Figure 34.
- 50 and 60 Hz power source
  - For example, Xantrex Sine Wave Inverter 1000i
- GraphEdit, part of DirectX SDK.
- Virtual Stopwatch 3.X
- Integrating sphere, for example, SphereOptics; temperature 3000 K to 3500 K
  - Alternative uniform light source can be used; should be uniform with RI>=90%.
- Distortion chart printed with Test Charts module in Imatest
  - 720 dpi, A3 or US Tabloid size, checkerboard, divisions=10. See Figure 36.
- Light meter
  - For example, BK Precision 615
- Test PCs that are running Windows XP SP2, Vista SP1, Windows 7
  - 1.8 GHz dual core
  - 2 GHz quad core
  - Video display adapter that supports VMR7 or VMR9 and video acceleration (DirectDraw BitBlt) for YV12 and RGB24/RGB32. Most recent ATI and NVidia cards support this.

[4] GRETAGMACBETH F20T12/65 D65

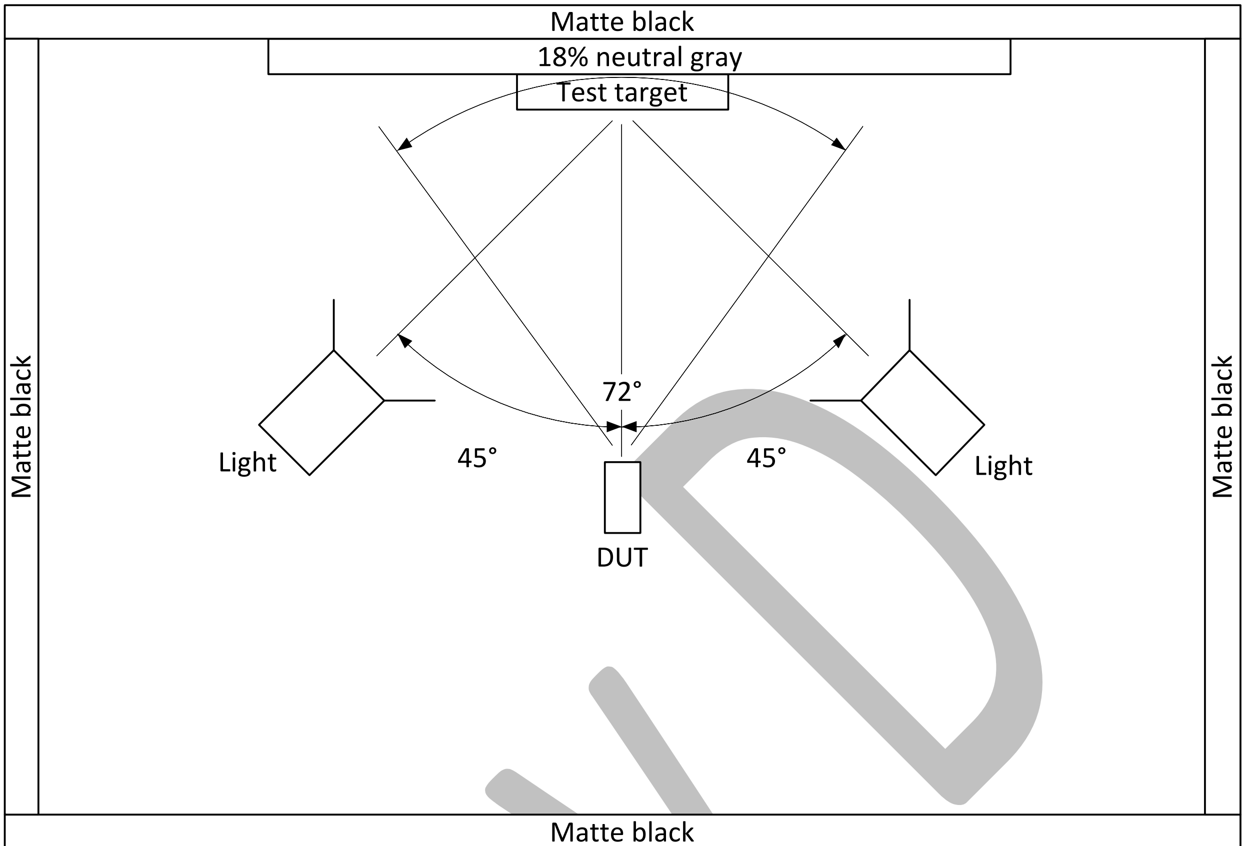


Figure 32: DUT test configuration

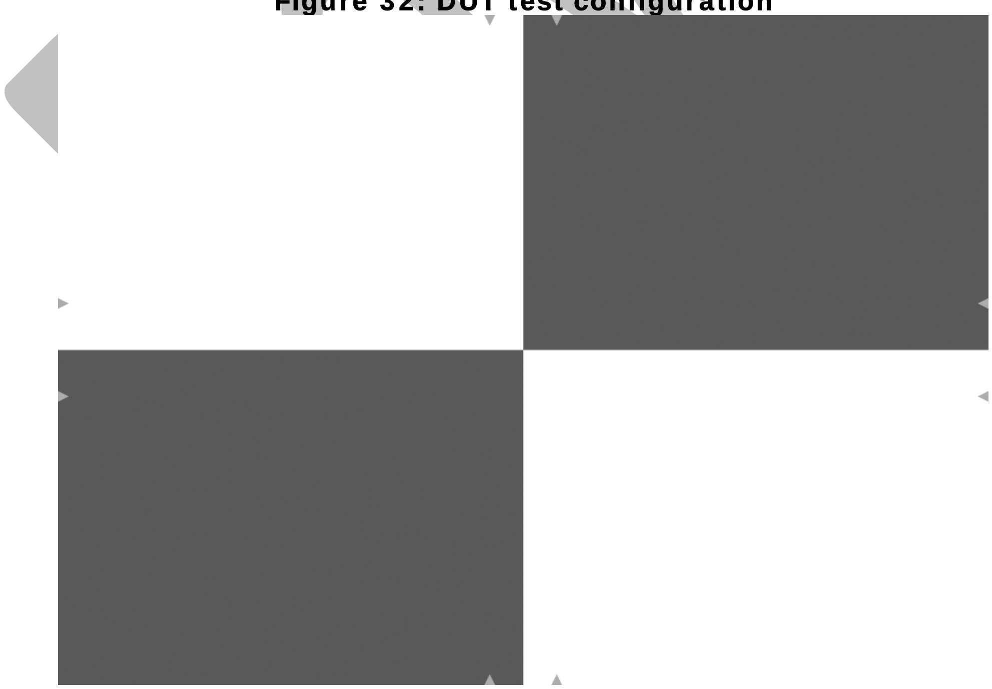


Figure 33: Slanted edge resolution chart (created with Imatest)

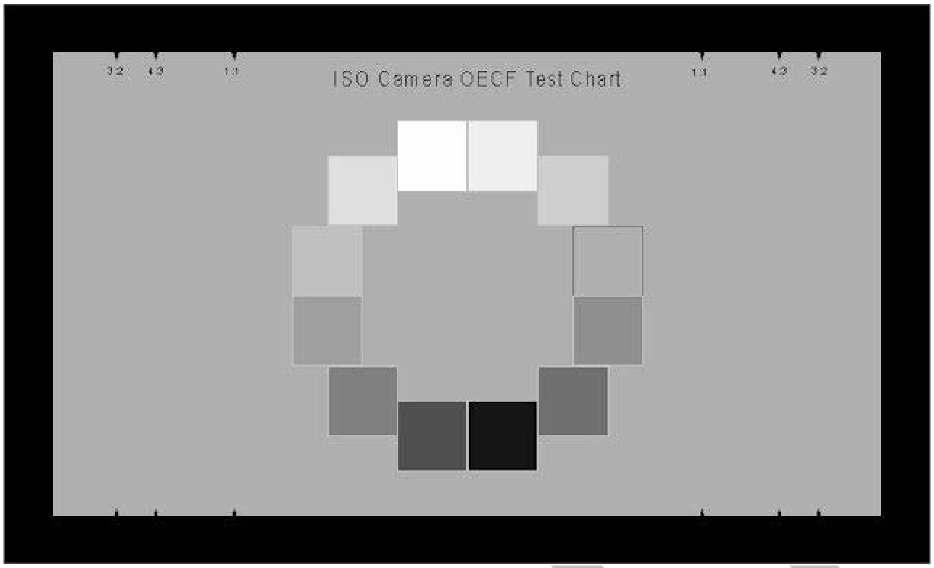


Figure 34: ISO-14524 contrast chart (ST-52)

Figure 35: ColorChecker chart

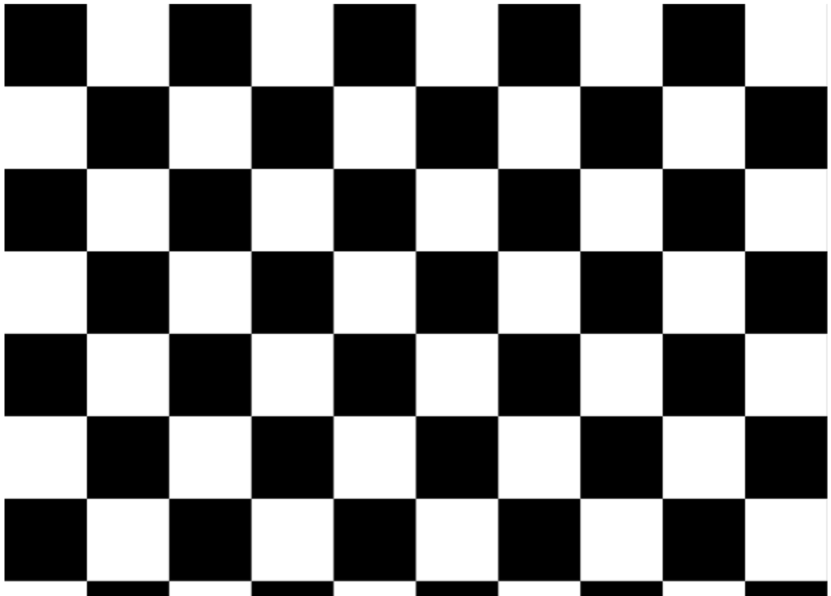


Figure 36: Distortion chart

4.5.2 Room light measurements

Several tests require ambient room lighting. The nominal office lighting used for these tests is 300 lux, which is derived from these standards:

1. ANSI RP-1-04 American National Standard Practice for Office Lighting: Office lighting for performing common visual tasks with high contrast objects is 300 lux, measured on the working horizontal surface (for example, desk) as shown in Figure 37.
2. OSHA 1926.56 Illumination: Offices are 30 foot-candles (330 lux).

For lower light office scenarios, 150 lux is used.

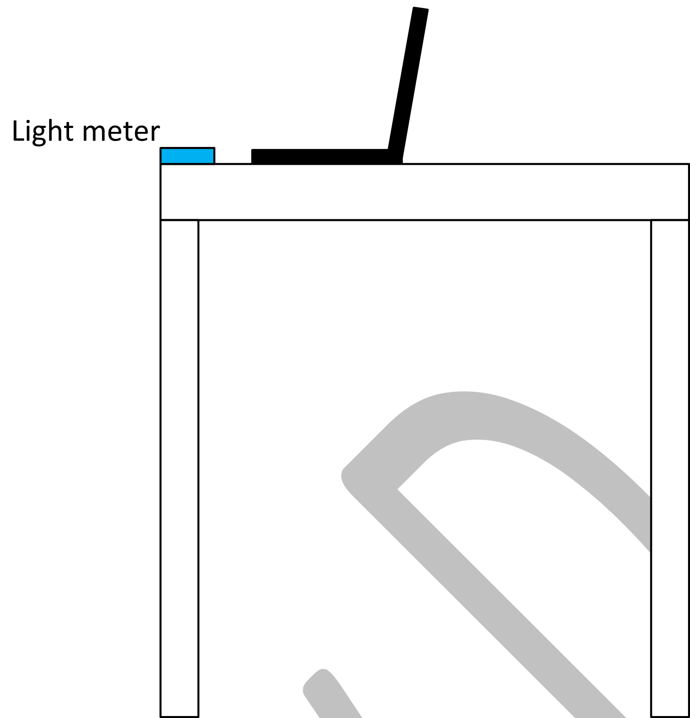


Figure 37: Light meter placement example for notebook computer ambient light

4.6 DUT preparation

The DUT lens or cover glass should be cleaned using a microfiber cloth before testing. Fingerprints or other smudges on the lens or cover glass will significantly degrade many of the test metrics.

5.0 Appendix

5.1 M420 FourCC format

Most webcams don't have a frame buffer to output the planar I420, so a new packed I420 format, M420, is proposed. The motivation for using this format is to reduce the USB bandwidth compared to YUY2 by using 12-bit instead of 16-bit pixels (on average), which increases the number of possible HD resolutions at 30 FPS on USB 2.0. There should be no loss in quality for applications that require I420 (for example, video conferencing using H.264 or RTVideo), and M420 is easier/faster to convert to I420 than YUY2. The byte order format is selected to make M420 to I420 a memory copy (no filtering is required).

The YUV sampling is shown in Table 44, a YUV pixel image of height H and width W is shown in Table 45, Table 46, and Table 47. Each 2x2 YUV pixel blocks are ordered in row major order. The byte order for an image is:

Y(1,1), Y(2,1), Y(3,1), Y(4,1), …, Y(W-1,1) , Y(W,1)
Y(1,2), Y(2,2), Y(3,2), Y(4,2), …, Y(W-1,2) , Y(W,1)
U(1,1), V(1,1), U(2,1), V(2,1), …, U(W/2,1), V(W/2,1)
…

Y(1,H-1), Y(2,H-1), Y(3,H-1), Y(4,H-1), …, Y(W-1,H-1) , Y(W,H-1)
Y(1,H), Y(2,H), Y(3,H), Y(4,H), …, Y(W-1,H) , Y(W,H)
U(1,H/2), V(1,H/2), U(2,H/2), V(2,H/2), …, U(W/2,H/2), V(W/2,H/2)

	Horizontal	Vertical
Y Sample Period	1	1
V Sample Period	2	2
U Sample Period	2	2

Table 44: M420 YUV sampling

Y(1,1)	Y(2,1)		Y(W-1,1)	Y(W,1)
Y(1,2)	Y(2,2)		Y(W-1,2)	Y(W,2)
Y(1,H-1)	Y(2,H-1)		Y(W-1,H-1)	Y(W,H-1)
Y(1,H)	Y(2,H)		Y(W-1,H)	Y(W,H)

Table 45: M420 YUV Y format

U(1,1)		U(W/2,1)
U(1,H/2)		U(W/2,H/2)

Table 46: M420 YUV U format

V(1,1)		V(W/2,1)
V(1,H/2)		V(W/2,H/2)

Table 47: M420 YUV V format

M420 uses the YUV 420 color alignment scheme used in MPEG-2. In this scheme the chrominance samples are vertically centered between the luminance samples but horizontally aligned with the luminance samples in the frame as shown in Figure 33.

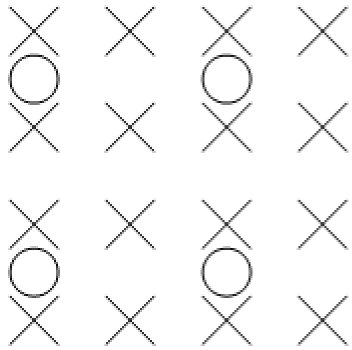


Figure 38: Luminance (X) and chrominance (O) alignment in M420

The M420 GUID is defined below:

```
// {3032344D-0000-0010-8000-00AA00389B71}
DEFINE_GUID(M420,
0x3032344D, 0x0000, 0x0010, 0x80, 0x00, 0x00, 0xAA, 0x00, 0x38, 0x9B, 0x71);
```

5.2 Face detector interface

The following interface allows Lync to interact with webcams that include face detector in their drivers. The IKsPropertySet::FACE_DETECTOR GUID is defined below:

```
// {B292AACE-1F6B-4DB7-931F-1D012FB8441B}
DEFINE_GUID(FACE_DETECTOR,
0xb292aace, 0x1f6b, 0x4db7, 0x93, 0x1f, 0x1d, 0x1, 0x2f, 0xb8, 0x44, 0x1b);
```

The IKsPropertySet::FACE_DETECTOR property returns a structure of the following format:

```
#define MAX_FACES 16

struct FaceDetectorResults {
        USHORT numFaces;
        Faces faces[MAX_FACES];
        REFERENCE_TIME detectionTime;
};

struct Faces {
        FLOAT likelihood;        // 0-1 likelihood that the RECT is a face
        RECT faceRect;
}
```

To query if the webcam driver supports face detection control:

```
#define FACE_DETECTOR_CONTROL 0
#define FACE_DETECTOR_RESULTS 1
```

```
#define FACE_DETECTOR_FREQUENCY 2
IKsPropertySet *propertySet = …
HRESULT hresult;
ULONG supported;
hresult = propertySet ->QuerySupported(FACE_DETECTOR,  FACE_DETECTOR_CONTROL,
&supported);
```

To enable the face detector:

```
#define FACE_DETECTOR_DISABLE 0
#define FACE_DETECTOR_ENABLE 1

IKsPropertySet *propertySet = …
FaceDetectorResults results;
HRESULT hresult;
ULONG setProp = FACE_DETECTOR_ENABLE;
hresult = propertySet->Set(FACE_DETECTOR, FACE_DETECTOR_CONTROL, 0, 0, &setProp,
sizeof(setProp));
```

To get the latest face detect results:

```
IKsPropertySet *propertySet = …
FaceDetectorResults results;
HRESULT hresult;
ULONG bytesReturned;
hresult = propertySet->Get(FACE_DETECTOR, FACE_DETECTOR_RESULTS, 0, 0, &results,
sizeof(results), &bytesReturned);
```

To set the requirement frequency of face detection:

```
IKsPropertySet *propertySet = …
FaceDetectorResults results;
HRESULT hresult;
FLOAT32 frequency = 1;   // Hz
hresult = propertySet->Set(FACE_DETECTOR, FACE_DETECTOR_FREQUENCY, 0, 0, & frequency,
sizeof(frequency));
```

5.3 Noise reduction interface

The following interface allows Lync to enable/disable noise reduction with for webcams that include noise reduction in their drivers. The IKsPropertySet:: NOISE_REDUCTION GUID is defined below:

```
// {E1599126-C0A9-4516-8D96-D109F1C23610}
DEFINE_GUID(NOISE_REDUCTION,
0xe1599126, 0xc0a9, 0x4516, 0x8d, 0x96, 0xd1, 0x9, 0xf1, 0xc2, 0x36, 0x10);
```

The IKsPropertySet::NOISE_REDUCTION property is used in the following ways.

```
#define NOISE_REDUCTION_ENABLE 0
#define NOISE_REDUCTION_DISABLE 1
```

To query if the webcam driver supports noise reduction:

```
    IKsPropertySet *propertySet = …
    HRESULT hresult;
    ULONG supported;
    hresult = propertySet ->QuerySupported(NOISE_REDUCTION,  0, &supported);
```

To enable the noise reduction of the webcam driver:

```
    IKsPropertySet *propertySet = …
    HRESULT hresult;
    ULONG enable= NOISE_REDUCTION_ENABLE;
    hresult = propertySet -> Set(NOISE_REDUCTION, 0, 0, 0, & enable, sizeof(enable));
```

To disable the noise reduction webcam driver:

```
    IKsPropertySet *propertySet = …
    HRESULT hresult;
    ULONG enable= NOISE_REDUCTION_DISABLE;
    hresult = propertySet -> Set(NOISE_REDUCTION, 0, 0, 0, & enable, sizeof(enable));
```

5.4 Camera location interface

The following interface allows Lync to query the webcam location and orientation with respect to the monitor. The IKsPropertySet::CAMERA_LOCATION GUID is defined below:

```
    // {E2F79997-A8AB-4A65-B824-C01CF3740A5F}
    DEFINE_GUID(CAMERA_LOCATION,
    0xe2f79997, 0xa8ab, 0x4a65, 0xb8, 0x24, 0xc0, 0x1c, 0xf3, 0x74, 0xa, 0x5f);
```

The IKsPropertySet::CAMERA_LOCATION property is used in the following ways. See Figure 39 for the coordinate system used in the camera locations.

```
#define MAX_CAMERAS 16
#define CAMERA_DIRECTION_FRONT_FACING 1
#define CAMERA_DIRECTION_REAR_FACING 2
#define CAMERA_ORIENTATION_PORTRAIT 1
#define CAMERA_ORIENTATION_LANDSCAPE 2
```

```
struct CAMERA_LOCATION_S {
    USHORT num_webcams;
    USHORT monitor_width;                    // in mm
```

```
        USHORT monitor_height;                          // in mm
        SHORT camera_x[MAX_CAMERAS];                    // in mm
        SHORT camera_y[MAX_CAMERAS];                    // in mm
        USHORT camera_direction[MAX_CAMERAS];           // front or rear facing
        USHORT camera_orientation[MAX_CAMERAS];         // portrait or landscape
};
```

To query if the display supports camera location:

```
IKsPropertySet *propertySet = …
HRESULT hresult;
ULONG supported;
hresult = propertySet ->QuerySupported(CAMERA_LOCATION,  0, &supported);
```

To query the camera locations:

```
IKsPropertySet *propertySet = …
HRESULT hresult;
CAMERA_LOCATION_S camera_location;
hresult = propertySet -> Get(CAMERA_LOCATION, 0, 0, 0, & camera_location,
sizeof(camera_location));
```

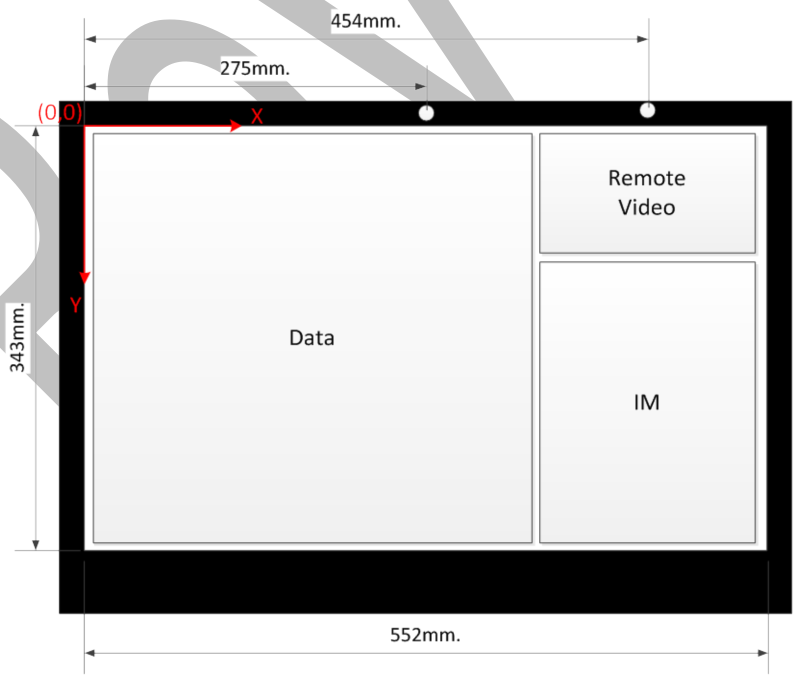


Figure 39: Coordinate system for defining camera locations and example for 2 camera desktop monitor

6.0 Test report template

The Excel Workbook file “MLVideoCaptureSpecificationTemplateRevD.xlsx” is a test report template that includes calculations and criteria for many of the tests. Self-tests must complete this form for review by Microsoft. If the webcam uses OEM drivers then two workbooks much be submitted, one for Windows in-box drivers and one for the OEM drivers.